2013 University of New Hampshire Research Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

{NO DATA ENTERED}

Total Actual Amount of professional FTEs/SYs for this State

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	23.8	0.0
Actual	0.0	0.0	31.6	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 and manuscripts)

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. 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:

- relationship to Hatch or Hatch-Multistate programs and to the NHAES mission and priorities;
- scientific and technical merit;
- soundness of approach, procedures, and methodology;
- likelihood of significant outcomes and/or innovation;
- demonstrated previous accomplishments or potential productivity;
- probability to leverage NHAES resources;
- likelihood of significantly enhancing NHAES research capability and competitiveness

Evaluations are discussed by the review panel, the members of which rank each proposal's funding priority. The Director and Faculty Fellow use the panel evaluation, along with their own evaluations with

respect to NHAES priorities and resources, to make recommendations on which projects to fund. These proposals are submitted to NIFA for final approval before funding.

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 in planning to address excess Nitrogen in the NH's Great Bay estuary.

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 reviewers)

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 non-traditional stakeholders both as individuals and groups. These included: research field days at the MacFarlane Greenhouses, and the Woodman horticulture and agronomy farm; an education session at NH Farm and Forest Expo (the largest gathering of agricultural and forestry industry in NH); and the participation of NHAES researchers at workshops sponsored by UNH Cooperative Extension.

Other less formal events draw members of the general public. During FY13 these included: Granite State Dairies Open Barn Day (Fairchild Dairy); Durham Farm Days (Fairchild Dairy, Woodman Farm) ; Poinsetta trials and Spring Greenhouse Open House (MacFarlane Greenhouses);, NH Environthon Training Days, and a farmer tour organized by Organic Valley Cooperative (Organic Dairy Research Farm). Over the year more than 3,100 members of the public visited the Fairchild Dairy, (NH Ag in the Classroom tour groups, summer camp and various undergraduate groups); there were 2800 visitors at MacFarlane Greenhouses, 483 visitors the Organic Dairy Research Farm and 900 visitors between the Woodman and Kingman Horticulture and Agronomy Farms. The farms, dairies and greenhouses provide important venues for experiential learning for the University of New Hampshire.

We continue to expand our interactions with less traditional, but enthusiastic stakeholders via local farmers markets where we engaged Community Supported Agriculture (CSA) and Community Supported Fisheries (CSF) operations. Through these activities, we are working to better target outreach to identify and engage non-traditional stakeholders, especially those who may be unaware of the research outcomes from the NHAES. 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);
- meetings for multi-state 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.

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.

The NHAES website was overhauled in 2010 and continues to be updated. Our goal is to make the experiment station and agriculture more prominent and accessible via the web. We are tracking "hits" to the website and found the NHAES website was accessed more than 22,700 times during FY13. This is a 25% over FY12. The Organic Dairy Research Farm section continues to attract the largest percentage of hits.

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
- Open Listening Sessions
- Use Surveys
- Other (UNH Cooperative Extension)

Brief explanation.

We partner with UNH Cooperative Extension; the NH Department of Agriculture, Markets and Food; the College of Life Science and Agriculture; and the NHAES external (producer) advisory Committee, faculty, and staff to identify both individual stakeholders and groups. 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 include the 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

Brief explanation.

The types of input vary between stakeholder groups. These include:

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.

- farmers
- growers
- fishermen and aquaculturalists
- agribusiness
- forestry
- greenhouse and plant nurseries

The Advisory board meets annually for discussion but both the NHAES faculty fellow and director speak with members of the Adivsory committee at various events across the state over the year.

The NHAES also has regular interactions with state and federal agencies about common concerns. The NHAES has strong connections with:

- National Resources Conservation Services
- NH Deparment of Agriculture, Marketing and Food
- NH Fisheries and Wildlife, Department of Environmental Services
- Department of Resources and Economic Development

In addtion the NHAES maintains communication with of NH's congressional delegation, and members of the State Legislature Committee on the Environment and Agriculture.

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. 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.

Brief Explanation of what you learned from your Stakeholders

NHAES has received ongoing input and interest in deepening the focus on sustainable agricultural and food systems as well as increasing local food and opportunities to improve the nutrition profile and healthfulness of regionally produced food. There is considerable interest in the ornamental horiticulture industry in new methods for overwinter shrubs and trees. Local food production is gaining momentum in the state, with increases in the number of farmers' markets and the growing popularity of restaurants that feature locally sourced foods. A UNHCE research field day on production of winter greens drew 100 visitors; indicative of the high interest in season extension for NH farmers and greenhouse operators. The number of undergraduates in the new Sustainable Agriculture and Food Systems major continues to grow, consistent with the net increase in the number of small, diversified farms in NH in the last decade.

NHAES researchers working with local and regional dairy farmers have identified new research imperatives: during the seven months each year when cows are off pasture, farmers must supplement locally produced hay and silage with expensive soybean meal to provide protein which supports milk production (Perralta et al. in press). Research will be carried out to develop feeding guidelines for alternative protein supplement crops: locally produced field peas, flax seed, and canola meal. To developing mechanisms to reduce feed costs, the following critical needs must be addressed: 1) design efficient protein supplementation strategies for producing milk with low carbon and N footprints; 2) enhance feed conversion efficiency to minimize grain purchase.

Members of the State Legislature Committee of on the Environment and Agriculture sought NHAES technical expertise to discuss a legislative bill to reguire labeling of food products made from genetically modified crops. While University policy prohibits the NHAES from taking a formal stance on what is considered political issue, the NHAES Dean and Director asked several faculty to participate in the Committee's fact finding sessions, to discuss the technology of genetic modified crops.

Town and University planners from Durham took particular interest in ongoing NHAES research monitoring of nitrogen fluxes in the Lamprey River. This lead to the addition of new sensor

arrays along the Durham's Oyster River, as a part of a long term effort to decrease nitrogen levels in the Great Bay estuary.

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	1682384	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	1682384	0
Actual Matching	0	0	1904445	0
Actual All Other	0	0	3570316	0
Total Actual Expended	0	0	7157145	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			16%	
701	Nutrient Composition of Food			4%	
702	Requirements and Function of Nutrients and Other Food Components			42%	
703	Nutrition Education and Behavior			20%	
704	Nutrition and Hunger in the Population			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: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.1	0.0
Actual Paid Professional	0.0	0.0	2.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	113240	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	83564	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	452701	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Project activities included

- Characterized biochemical impacts in tissues of animals exposed to environmental chemicals which appear to act as obesogens.
- Determined the oxidative stress impact of environmental obesogens on key glucose-metabolizing tissues of animals.
- Examined effects of inflammatory omega six fatty acids and non-inflammatory omega three fatty acids from dairy fats on the development of respiratory allergy in a rat model.
- Enhanced student researchers' skills in participatory research techniques and built and partnerships among researchers, extension and outreach educators, and populations of young adults through the development of cooperative intervention programs to limit weight gain in young adults. This project developed community-based applications that will be refined and evaluated in future projects.
- Developed cutting edge analytical methods to evaluate the hypothesis that metabolic syndrome, a precursor to type II diabetes and heart disease, is associated with specific epigenetic changes in chromatin of differentiating adpiocyte (fat cells). This process was studied in a mouse model.

2. Brief description of the target audience

These research projects are 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. Several research projects looked at genetic, epigenetic, and/or biochemical mechanisms associated with obesity and how different types of unsaturated fatty acids influence one's susceptibility to allergic responses. Initial outcomes inform scientific communities and human health regulatory agencies.

3. How was eXtension used?

eXtension was not used directly by these projects. However, some of the online activity and diet tools developed and evaluated as a part of this planned program could be integrated into eXtension in the future.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1666	2270	500	0

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

Patent Applications Submitted

Year:	2013
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	7	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2013	15

Output #2

Output Measure

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

Year	Actual
2013	9

Output #3

Output Measure

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

Year	Actual
2013	11

Output #4

Output Measure

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

Year	Actual
2013	3

Output #5

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2013	7

Output #6

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2013	4

Output #7

Output Measure

- Research outcomes disseminated by websites

Year	Actual
2013	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

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
2013	2

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
701	Nutrient Composition of Food
703	Nutrition Education and Behavior

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
2013	15

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
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
723	Hazards to Human Health and Safety

Outcome #3

1. Outcome Measures

Increased knowledge about the role of PBDE flame retardant in obesity related metabolism.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2013 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Being obese or overweight increases one's risk of many diseases, including type 2 diabetes, coronary heart disease, stroke, and certain cancers. There is increasing of experimental evidence suggesting certain environmental chemicals?or obesogens?could disrupt the body's metabolism and contribute to the obesity epidemic. This project has examined whether environmental chemicals found in fire retardants may impair glucose metabolism.

What has been done
1. The first project tested the hypothesis that one class of brominated flame retardants, polybrominated diphenyl ethers (PBDEs), suppress the activity of phosphoenopyruvate carboxykinase (PEPCK) in adipose tissue. This metabolic response could lead to insulin resistance.
2. The second project validated that liver cytochrome YP3A (CYP3A), a cytochrome P450 drug-metabolizing enzyme responsible for detoxifying PBDEs, is induced by in vivo PBDE treatment.

Results
polybrominated diphenyl ethers (PBDEs), suppress the activity of phosphoenopyruvate carboxykinase (PEPCK) in adipose tissue. This metabolic response could lead to insulin resistance.
2. The second project validated that liver cytochrome YP3A (CYP3A), a cytochrome P450 drug-metabolizing enzyme responsible for detoxifying PBDEs, is induced by in vivo PBDE treatment.
Results: (10-12 lines)
1. NHAES researchers findings from research using a rat model suggest that PBDEs suppress a key enzyme, PEPCK, during glucose and lipid metabolism in adipose tissue as well as in the liver.
2. Twenty-eight days of PBDE treatment caused a 30-fold induction of liver CYP3A activity compared to corn oil treatment. This response may suppress vitamin D3 synthesis.
3. Rats exposed to synthetic flame retardants have perturbations of glucose and lipid metabolism in their fat tissue,which could promote diabetes, and enzyme changes in their liver, which could promote an additional health problem of Vitamin D deficiency.These findings establish the possible health consequences of environmental chemical exposure.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Availability of methods for participatory research related to obesity.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Excessive weight gain is associated with an increased risk of developing cardiovascular disease, hypertension, and type 2 diabetes. Young adults are at a unique risk for weight gain because of rapidly changing social situations that influence exercise and eating behaviors. Research is needed to elucidate the combination of individual and environmental factors associated with unhealthy weight gain among college students. This project will refine and validate instruments to assess the environmental and individual factors associated with health outcomes and define the relationship between environmental and behavioral factors to create a College Health Campus Index.

What has been done
1.The Young adult Eating and Active for Health (YEAH) project has been established to investigate the effectiveness of a 10-week tailored, Internet-based intervention to prevent excessive weight gain among 18-24 year olds (n=360).
2. Guiding stars (GS), a point of purchase consumer tool, was evaluated to determine whether GS would influence consumers' perceptions and choice of food at two campus eateries. A survey was conduct pre-GS and post-GS at both venues.

Results
1. The Young adult Eating and Active for Health (YEAH) Internet-based intervention program was found to support metabolic improvement among subjects assigned to the intervention--as compared with control condition--and included lower rates of elevated glucose (4 vs. 13%, $p<0.01$), lower rates of elevated blood pressure (3 vs. 8%, $p=0.06$), and lower numbers of metabolic syndrome criteria (0.6 vs. 0.9, $p<0.05$).
2. Survey results revealed that Guiding Stars significantly increased consumers' perceptions that healthy foods are available.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #5

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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over the last forty years, there has been an upward trend in the incidence of respiratory allergy and asthma in children. One dietary factor that has been suspected to be a causal factor is the imbalance in dietary levels of omega-6 versus omega-3 polyunsaturated fatty acids. The imbalance is believed to be, in part, the result of eating meat products and milk fat from farm animals that have been fed cereal grains?which are in higher omega-6 (inflammatory) fatty acids?rather than pasture-fed animals products, which are higher in omega-3 n (non-inflammatory) fatty acids.

What has been done
Experiments were designed to test the hypothesis that consumption of milk fat that is high in omega 6 relative to omega 3 fatty acids induces a shift in the chemical function of lung (alveolar) macrophages which stimulate the allergic mediators prostaglandinE2 (PGE2) and interleuken12. Male C57BL/J6 mice were fed the same milk fat-based diet, which was varied in the ratio of omega6/omega3 fatty acids as follows: 1:1, 6:1, 15:1. Half of the animals on each diet were vaccinated (sensitized) with the egg protein, ovalbumin. On week 16, macrophages were collected surgically from the lungs for biochemical testing.

Results
Prostaglandin E2 is a hormone associated with the regulation of immune responses. Alveolar (lung) macrophages of mice that consumed diets imbalanced in omega 6 and omega 3 fatty acids (6:1; 15:1), produced significantly more prostaglandin E2 (PGE2) than cells of the animals that

consumed the diet balanced (1:1) in fatty acids. These preliminary findings suggest that diets imbalanced in fatty acids can affect the biochemical function of lung macrophage cells, which could promote respiratory allergy in humans.

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 #6

1. Outcome Measures

The impact of a whole foods curriculum for older adults will be evaluated.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Older adults are at risk for obesity-related disabilities. There is a need for research on interventions to improve diet and exercise in older adults, which may improve their health trajectories.

What has been done
A whole grains food education program has been developed and is being tested across multiple states.

Results
Research is providing evidence for recommendations as well as identifying barriers to the consumption of whole grain foods. The consumption of whole grain foods has been shown to reduce the risk factors of age related diseases

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Programmatic Challenges
- Other (Two project directors were on medical leave over part of FY13 slowing experimental work)

Brief Explanation

The NHAES suffered a ~23.9% cut in state funds in the budget that ran through FY13. This has necessitated cuts in investigator support budgets and funding for students/postdocs, which has slowed overall progress.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The success of research projects in this planned program is measured in several ways:

· For new projects, are preliminary results statistically significant and do the results test underlying hypotheses?
o Preliminary results support the hypothesis that fat from conventionally raised dairy cows, compared to pasture fed dairy cows, stimulated the production of immune system molecules in a way consistent with enhanced allergic reactions.
o UNH researchers have demonstrated that rats exposed to synthetic flame retardants have perturbations of glucose and lipid metabolism in their fat tissue, which could promote diabetes and enzyme changes in their livers that could promote additional health problems with Vitamin D deficiency.

· For mature projects, have results been published in peer reviewed journals? Do project directors participate in national and international conferences?
o There were nine peer-reviewed papers over five projects.
o There were eight published abstracts from national and international conferences over five projects.
o Where appropriate outcomes/protocols, etc. were disseminated to stakeholders and adopted by the broader public.
o Results have been broadly disseminated on a local, regional, and international level.

· NHAES believes research conducted under the auspices of this program has been very effective by the measures listed above.

Key Items of Evaluation

- Of particular significance are the results of the College Health and Nutrition Assessment Survey, which shows that rates of obesity are on the decline.
- The Young adult Eating and Active for Health (YEAH) study findings suggest modest metabolic improvements may be associated with web-based interventions targeting healthy lifestyle behavior change among young adults.
- The Guiding Stars (GS) survey suggests that the presence of nutrition guidance positively influences consumers' perceptions that healthy foods are available.

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			6%	
102	Soil, Plant, Water, Nutrient Relationships			36%	
112	Watershed Protection and Management			17%	
131	Alternative Uses of Land			41%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.9	0.0
Actual Paid Professional	0.0	0.0	7.6	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	411129	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	376251	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	664356	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

NHAES scientists have:

- Measured soil carbon (C) pools and greenhouse gas emissions (CO_2, CH_4, N_2O) in agricultural and suburban landscapes and compared these data with data previously collected from forest plots in the same area;
- Used the combined data set to calibrate aircraft remote sensing data, which provided resolution to a five meter square spatial scale;
- Used field and remote sensing data to parameterize the denitrification decomposition (DNDC) computer simulation model, validate and upscale model predictions;
- Generated 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);
- Made 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;
- Integrated climate change issues in conference planning for the 2014 New England Society for American Foresters;
- Analyzed the effects of different cropping systems, soil insects, and microbial community composition on Soil Organic Matter (SOM) turnover and soil nitrogen cycling;
- Disseminated findings that quantify the impacts of forest loss on water quality.

2. Brief description of the target audience

Target audiences include university students interested in global nitrogen and carbon cycles, and sustainable agroecosystem management, agricultural and natural resource producers and consumers, those involved in the related food products and marketing webs, land managers, scientists, public policy makers, and those who currently rely on agricultural and forest products and will in the future. Ultimately, all citizens in NH, New England, and the US have a strong stake in this topic and, therefore, the research outcomes.

3. How was eXtension used?

eXtension was not specifically used in the project. However results and outcomes of several research projects have been made available via websites appropriate to specific target audience. e.g. http://www.wildlife.state.nh.us/Wildlife/Wildlife_Plan/climate.html

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2330	1050	365	70

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

Patent Applications Submitted

Year:	2013
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	5	5

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2013	9

Output #2

Output Measure

- Number of graduate students directly involved in the project

Year	Actual
2013	8

Output #3

Output Measure

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

Year	Actual
2013	3

Output #4

Output Measure

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

Year	Actual
2013	16

Output #5

Output Measure

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

Year	Actual
2013	11

Output #6

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2013	2

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.

   Not Reporting on this Outcome Measure

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
2013	2

3c. **Qualitative Outcome or Impact Statement**

Issue (Who cares and Why)
Climate change is impacting wildlife and forests in Northern England. It is important to convey climate change research results and predictions to stakeholder audiences in a way that empowers these groups to protect the regional resources.

What has been done
One of the major climate change research projects in the climate change program planned program includes an UNHCE extension specialist; this individual is on the conference planning committee for 2014 meeting New England Society of American Foresters (NESAF) and served as a reviewer for the draft State of New Hampshire's Ecosystems and Wildlife Climate Change Adaptation Plan.

Results
?In part, as a result of the efforts of the UNHCE Extension Specialist the theme of the 2014 NESAF conference is "Resource -Resilience-Renewal-Restoration." The conference features multiple breakout sessions on climate change impact on New England forests.
?The Extension Specialist was influential in the completion of the climate change addendum to the New Hampshire Wildlife Action Plan. http://www.wildlife.state.nh.

us/Wildlife/Wildlife_Plan/climate.html

4. Associated Knowledge Areas

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

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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change is already impacting agriculture and forestry in New England in both positive (i.e., longer growing seasons) and negative (i.e., spreading insect pests) ways. The role of ecosystems in climate regulation is that of regulators of carbon dioxide and other greenhouse gases as well as effecting surface albedo(radiation of heat) and other biophysical properties. Comprehensive studies are needed, on regulators of greenhouse gases and on the effects of land management, which balance climate mitigation with agriculture, forest resources, and the ecosystem services these land uses provide.

What has been done
Surface heat flux is being monitored using an eddy flux system to improve estimates of net radiative flux in mixed forested, agricultural, and residential landscapes. Field sampling of carbon and nitrogen fluxes have been completed, and farm management information has been collected. These data will be used in calibrating modeling with remote sensing imagery, obtained by a synergistic project funded by the National Science Foundation, to improve an ecosystem biogeochemistry model of Denitrification and Decomposition (DNDC). This model predicts fluxes in greenhouse gases.

Results

Analysis of soil samples collected across the landscape indicates that residential and agricultural soils can be a significant carbon sink. Although forests contain the highest concentration of carbon in the soil profile, carbon stocks are similar among land cover types. Higher bulk densities and finer soil textures may be partially responsible for this surprisingly high carbon storage capacity in agricultural and residential soils. More importantly, patterns in soil physical properties among our research sites are consistent with those that occur through the study area: forests tend to have coarser soils while farms and residential developments are typically located where soil has a finer texture. These patterns are likely the result of previous land use change and will likely influence soil carbon stocks as the landscape continues to develop in the future.

This project includes the first winter measurements of soil CO2 fluxes through the snowpack in the Northeastern US, and is important for improving climate change models.

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
2013	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. A nationwide network of sites (NADP) measures this deposition around the country. New Hampshire scientists will help provide information, useful to environmental management in New England, and describe the effects of atmospheric deposition on terrestrial and aquatic ecosystems, biogeochemical cycling, climate

change, and human health.

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. 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 the management of the Great Bay Estuary, NH.

Results
The primary output of the project is the dissemination of findings that quantify the impact of dirty rain in temperate and tropical watersheds. Understanding the relative impact of atmospheric deposition compared with various point- and non-point sources of pollution is being incorporated into local planning of pollution mitigation for NH's Great Bay Estuary and in Puerto Rico. Dissemination activities included presentations for high school students, local and regional planning groups, a US House of Representatives committee, US Senate Staff members, US Environmental Protection agencies, the NH Department of Environmental Safety, as well as press releases for UNH Today, the UNH Campus Journal, NH Public Radio, and via the web. http://ecosystemsandsociety.blogspot.com

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
2013	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. The loss of SOM enhances soil compaction and emissions of trace gases, increasing dependence upon external fertilizer inputs, and exacerbates environmental nitrogen losses. Conventional theories argue that SOM formation is a function of the quality and chemistry of soil carbon(C) inputs; in contrast, new models downplay the importance of substrates and emphasize the role of microbial transformations of substrate inputs. Resolving the pathways of SOM formation is critical to sequestering soil C, to limit the release of greenhouse gas emissions and understanding N cycling in SOM, which is critical both to crop fertility and minimizing the nutrient run off that pollutes water systems.

What has been done
?A multi-tiered approach, which includes meta-analysis, observations, and field manipulations, addressed questions related to the role of soil biological communities in SOM formation.
?Field studies included looking at the impacts of different crop rotations, with and without cover crops, on soil structure and SOM composition.

Results
?Preliminary experiments indicated that N fertilization influences the breakdown of corn stover to SOM, influencing different chemical constituents in different ways. These changes may stem from the impact of fertilization on N cycling in soil microbes.
?Rotational and cover crop impacts were determined on a soil physical structure, associated microbial communities and activity, and soil C storage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
131	Alternative Uses of Land

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Appropriations changes

Brief Explanation

The NHAES continues to suffer from a ~25% decrease in state funding beginning in 2011, which has reduced farm support staff.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

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

- Publication of peer reviewed papers in high impact journals. One of the three projects has been highly productive over the last year with five publications.
- 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 the NH Great Bay Estuary.

Key Items of Evaluation

- 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. This information has been critically important in local discussions and decision-making related to management of the Great Bay Estuary, NH.
- NHAES research includes the first winter measurements of soil CO_2 fluxes through the snowpack in the Northeastern US, and is important for improving climate change models.

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			22%	
212	Pathogens and Nematodes Affecting Plants			7%	
215	Biological Control of Pests Affecting Plants			8%	
311	Animal Diseases			10%	
501	New and Improved Food Processing Technologies			12%	
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			12%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.9	0.0
Actual Paid Professional	0.0	0.0	1.7	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	103848	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	116704	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	477487	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

NHAES researchers have investigated the several priority issues surrounding human, plant and animal health.

Vibrio bacteria occurs in coastal waters and may grow in oysters; some but not all strains of Vibrio species cause disease in humans. Methods were developed and refined for the detection and enumeration of Vibrio parahaemolyticus and Vibrio vulnificus and their virulence genes in the Great Bay Estuary.

1. "Relay" methods were evaluated by moving newly harvested oysters to locations with low bacterial levels to reduce Vibrio parahaemolyticus from locally grown oysters.
2. Environmental and biological factors associated with reduced concentrations of pathogenic Vibrios were examined in freshly harvested and post-harvest, processed oysters.
3. The multiple genetic changes, which occur in Pseudomonas sp. communities as they adapt as biofilms, were documented.
4. The presence, impacts, and pathways of microcystin toxins exposure in animals and humans were evaluated through a variety of means.
5. The results of various activities were disseminated via scientific, extension, formal, and informal teaching venues .

2. Brief description of the target audience

The target audiences for this work include:

- Vibrio studies: the shellfish industry, public health and shellfish regulatory agencies in New England,
- Microcystins: graduate and undergraduate students, high school students, faculty collaborators, those interested in ALS (Lou Gehrig's Disease), veterinarians, state and regional conservation groups; town planners, decision-makers and conservation commissions, lakes planning commissions, state and federal agencies, lake association members, lake shore residents, public water suppliers, scientists working in related areas, and cooperative extension educators.
- Other research scientists and college students interested in processes related toenvironmental microbiology in relationship to agriculture and water systems.
- Pseudomonas sp. Researchers studying how bacteria evolve diversity and how this contributes to the

functioning of surface-associated communities--pathogenic or mutualistic--with the long-range goal of managing biofilms in illness or in health.

3. How was eXtension used?

While eXtension was not used directly for this planned program, two of the research projects in this planned project have an active online presence with resources for the public.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	890	1350	50	100

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

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	4	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2013	23

Output #2

Output Measure

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

Year	Actual
2013	3

Output #3

Output Measure

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

Year	Actual
2013	10

Output #4

Output Measure

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

Year	Actual
2013	10

Output #5

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2013	11

Output #6

Output Measure

- Weekly online hits at Feedthedatamonster: a blog including biofilm community evolution research.

Year	Actual
2013	300

Output #7

Output Measure

- Visits to: An-image based key to the Zooplanton of the Northeast, USA Version 5.0.

Year	Actual

2013	57353

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	Number of citizens engaged in educational presentations and workshops related to toxic algal blooms and the potential health impact of microcystins
6	Development of a laboratory infection model to identify virulence factors of the harmful bacteria Vibrio parahamolyticus.

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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Gastroenteritis infections caused by V. parahaemolyticus (Vp), and death in certain health-compromised individuals caused by V. vulnificus (Vv), are typically associated with shellfish from warmer areas like the Gulf of Mexico. Recent Vp outbreaks in more-northern Pacific and Atlantic waters are evidence of widening infections and have heightened nationwide public health concerns.

What has been done
Not all strains of these bacteria can cause disease. Researchers therefore tested water, shellfish, and sediments for the presence of genes associated with clinical (disease-causing) strains to determine their incidence and where/when/why they are present. This knowledge will help manage shellfish harvesting and processing to reduce public health infection and disease threats.

Results
Recent fieldwork has demonstrated that Vp and Vv in oysters, sediments, and water are present in more areas and for longer periods of time compared with those observed in the 1990's. Elevated temperatures in the Gulf of Maine Region are a likely cause. Those considered to be pathogenic strains were not detected from Great Bay estuary oysters, water or sediments until this year. Pathogenic strains were detected in oysters from MA and CT, collected from areas closed to harvesting, in 2013 because of Vp infections. Detection of these putatively pathogenic strains is significant because they are rarely detected in environmental samples from New England waters.

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

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Little is known about where and when it is safe to harvest shellfish in New England coastal waters during warmer months when pathogenic Vibrio species may be present. To reduce economic hardships associated with limiting shellfish harvesting during warm summer months, there is a need for the development of post-harvest treatments of shellfish that reduce bacteria to safe levels and maintain high quality shellfish that can be eaten raw.

What has been done
Long-term (2007-13) surveillance of the occurrence and levels of Vibrio parahaemolyticus, V. vulnificus, and V. cholerae in oysters, sediment, and overlying waters in the Great Bay estuary of New Hampshire and in Maine show they are present longer, in more areas, and at higher levels compared to the 1990?s. Oyster relaying?moving newly harvested oysters to locations with low bacterial levels for several weeks?has been introduced to reduce pathogenic loads of Vibrio in locally harvested oysters.

Results
State shellfish industries in New England can use the results of this work to design Vibrio surveillance programs to track conditions where shellfish can be safely harvested without undue risk of disease from pathogenic Vibrio species. Postharvest relaying provides shellfish harvesters with a strategy for continuing the harvesting of shellfish even during those times during the year when pathogenic Vibrio species may otherwise limit harvesting.

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

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
2013	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
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Biofilms are likely the predominant mode of life for bacteria, yet the ecology, diversity, and physiology of these structured communities remains mostly unknown. Understanding how diversity contributes to the functioning of surface-associated communities?pathogenic or mutualistic?is an essential next step toward the long-range goal of managing biofilms in illness or in health.

What has been done
An experimental evolution method was used that allowed diverse biofilm communities of Pseudomonas species to evolve under defined conditions. New mutations that arose in this system were characterized by next generation DNA sequencing and bioinformatic analysis.

Results
1. Adapting Pseudomonas populations are dynamic, genetically and phenotypically, due to strong biotic interactions between members.

2. Experimentally evolved populations converge on several traits commonly observed during chronic lung infections, including modification to Type IV pili and RNA polymerase.

3. Adapting Pseudomonas biofilms repeatedly evolve an elevated mutation rate, or hypermutation, more than expected by chance alone.

4. A molecular mechanism of adaptation, which enabled the fixation of hypermutation in one replicate population, also evolved a mutation in the ppk gene that alters phosphate storage.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Number of citizens engaged in educational presentations and workshops related to toxic algal blooms and the potential health impact of microcystins

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	246

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Development of a laboratory infection model to identify virulence factors of the harmful bacteria Vibrio parahamolyticus.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Currently researchers are unable to definitively determine whether shellfish harbor harmful Vibrio parahaemolyticus because of a lack of understanding of the characteristics of virulent strains. Identification of virulence characteristics that define infectivity or transmissibility could inform specific diagnostic detection protocols, which?when implemented as part of a management plan--could aid in ensuring shellfish is safe for consumption. Virulence assessment requires laboratory infection models, which are currently lacking.

What has been done
Alternative laboratory models (fruit flies, mice, nematodes, Arabidopsis) were evaluated for laboratory infection systems to quantify virulence of different Vibrio isolates. Two promising model systems?nematodes and the plant Arabidopsis thaliana?were further optimized for the assay system.

Results
Nematodes proved to be a highly reproducible laboratory model for virulence in Vibrio parahaemolyticus. This model was used for the evaluation of natural isolates from both clinical and environmental sources, and for screening mutant bacteria for reduced or attenuated virulence.
Mutations that reduce virulence are potential diagnostics for virulence factors. The laboratory model was used to confirm a prior hypothesis that normal human body temperature is an important cue in triggering virulence by infective strains?but not in harmless environmental strains?, further indicating that virulence traits may be identified by comparison of gene expression at normal human body temperature.
UNH investigators are collaborating with a researcher at the FDA lab in Dauphine Island to transfer the nematode protocols, so that the laboratory model will be more widely used and potentially applied in assaying oyster samples for pathogens as a biological surveillance mechanism.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes

Brief Explanation

The NHAES suffered a ~23.9% cut in state funds in the budget that ran through FY13. This has necessitated cuts in investigator support budgets and funding for students/postdocs.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The success of research projects in this planned program is measured in several ways:

- For new projects, is there evidence of progress toward objectives?
- Research projects in this planned program all demonstrated significant progress toward their objectives.
- For more mature projects, have results been published in peer reviewed journals? Do project directors participate in national and international conferences?
- Researchers for all projects have actively participated in regional, national, and international conferences.
- Where appropriate are outcomes/protocols, etc. disseminated to stakeholders or adopted by the public safety agencies.
- The new laboratory model, developed by NHAES researchers, for evaluating the virulence of natural Vibrio isolates has been transferred to Food and Drug Administration labs in order to improve monitoring for the presence of pathogenic Vibrio in oysters.
- Results have been broadly disseminated on a local, regional, and international level.
- The testing protocols of the microcystin toxin study are being widely disseminated to regulatory agencies throughout New England.
- Collaborations with NHAES researchers have been initiated with public safety agencies across New England, related to monitoring for and reducing potential infections loads of Vibrios in oysters.

The NHAES believes research conducted under the auspices of this program have been very effective by the measures listed above.

Key Items of Evaluation

- New methods have been developed for the detection of virulent strains of pathogenic Vibrios that may be associated with oysters and other mollusks, and cause serious human disease.
- A new laboratory model system has been developed for the analysis of virulence

factors in Vibrios, naturally occurring bacteria in marine environments that are associated with shellfish-borne diseases.

- The NHAES is working with the NH Department of Environmental Services' Source Water Protection program and town water supply utilities to discuss whether to set state standards for microcystins in fresh water lakes. Sampling protocols developed by NHAES researchers will be used in monitoring.

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
133	Pollution Prevention and Mitigation			3%	
135	Aquatic and Terrestrial Wildlife			4%	
201	Plant Genome, Genetics, and Genetic Mechanisms			6%	
202	Plant Genetic Resources			4%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			4%	
204	Plant Product Quality and Utility (Preharvest)			6%	
205	Plant Management Systems			2%	
206	Basic Plant Biology			2%	
211	Insects, Mites, and Other Arthropods Affecting Plants			4%	
212	Pathogens and Nematodes Affecting Plants			13%	
216	Integrated Pest Management Systems			1%	
301	Reproductive Performance of Animals			11%	
302	Nutrient Utilization in Animals			8%	
303	Genetic Improvement of Animals			2%	
305	Animal Physiological Processes			5%	
307	Animal Management Systems			12%	
311	Animal Diseases			4%	
601	Economics of Agricultural Production and Farm Management			1%	
701	Nutrient Composition of Food			2%	
903	Communication, Education, and Information Delivery			6%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	12.8	0.0
Actual Paid Professional	0.0	0.0	18.4	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	920021	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1221301	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1441077	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

There are more than thirty individual NHAES projects covered in this planned program. Applied and discovery research was conducted in multiple aspects of plant and animal agriculture; related genetics and genomics; nutrition and health; and aquaculture involving shellfish, finfish, invertebrates, and seaweed. Research discoveries and agriculture/aquaculture recommendations were conveyed to stakeholders through engagement events (e.g., twilight meetings, research field days, growers' workshops), education sessions, newsletters, and web sites. Research discoveries were disseminated at regional, national, and international conferences and through refereed papers

2. Brief description of the target audience

There is a diverse target audience of the various research projects in this planned program. The audience includes consumers of animal- and plant-based foods and products, organic and conventional farmers, dairy farmers, orchardists, aquaculture ventures, and those engaged in the extensive food systems network. Other stakeholders include restaurants and other businesses reliant on local foods, food companies who process squash and pumpkins, master gardeners, home gardener associations, and legislators. Target audiences also include scientists, veterinarians, agricultural researchers, fisheries managers, Cooperative

3. How was eXtension used?

Several research projects in this planned program disseminated results either thru UNH Cooperative Extension websites (http://extension.unh.edu/resources/), and associated newsletters (http://extension.

unh.edu/Fruit-Vegetable-Production/Newsletters-Email-Alerts), or through another website for the identification of insects (http://pick18.pick.uga.edu/mp/20q?guide=Hemiptera_New_Hampshire). Two eOrganic webinars related to this research were delivered, addressing the impact of flies on organic dairy farmers and the use of annual forage crops for extension of the grazing season http://www.extension.org/pages/68106/organic-dairy-forages:-focus-on-summer-annuals#.UzDVQ_ldXzh.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2898	17617	306	450

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

Patent Applications Submitted

Year: 2013
Actual: 1

Patents listed
Patent number 611793374 Methods of identification and use of nematicide compounds.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	1	29	30

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2013	65

Output #2

Output Measure

- Number of graduate students directly involved in the research

Year	Actual
2013	50

Output #3

Output Measure

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

Year	Actual
2013	1

Output #4

Output Measure

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

Year	Actual
2013	38

Output #5

Output Measure

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

Year	Actual
2013	14

Output #6

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2013	6

Output #7

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2013	17

Output #8

Output Measure

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

Year	Actual
2013	3

Output #9

Output Measure

- Number of leafhopper insect species documented for New Hampshire and surrounding areas

Year	Actual
2013	591

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about plant 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 nutritional benefits including carotenoid concentrations.
4	Increased knowledge about integrated multispecies 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	New NH leafhopper data available through a web-accessible database
9	A working technology to produce triploid green sea urchins for use in natural harvest and land based aquaculture.
10	Improvement in finfish aquaculture in recirculating production systems
11	Develop regionally appropriate management systems to suppress soil borne pathogens for both organic and conventional farms.
12	Knowledge related to how the neuroendocrine system influences reproduction in fin fish aquaculture and other vertebrate animals and in the control of pest species such as lamprey eels.
13	Identify biological targets specific to parasitic nematodes, as potential molecular targets for development of enzyme inhibitors that will serve as a nematicidal agent.

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Most vegetable and fruit breeding occurs in climates that are very different from New England?s. Crop varieties that are developed elsewhere may or may not be adapted to the short growing season, cold winter temperatures, specific soil types, or prevalent pests of NH. As a result, varieties must be carefully evaluated for performance in this region. The overall goals of the project are to 1) evaluate the horticultural characteristics and adaptation of vegetable and fruit varieties using various production systems in NH, and 2) evaluate and/or develop new management techniques to extend the growing season, increase profitability, reduce environmental impact, or improve efficiency of vegetable and fruit cropping systems in NH.

What has been done
?The third year of a high tunnel tomato variety trial was carried out at the NHAES Woodman Farm, and a variety trial was initiated for field grown tomatoes. The traits evaluated included quality; yields; resistance to late blight, early blight, and septoria leaf spot. A subset of varieties was tested at two other field sites in the region.
?A study of low tunnels? temperatures and yields throughout fall, winter, and spring was continued with a second round, investigating the potential overwintering of onions for an early spring harvest.
?The growth of mesclun and other greens in winter green houses with supplemental heating was evaluated.
?The effects of intercropping and planting date on yields of organically-managed sweet corn were evaluated.

Results
?Preliminary results revealed significant differences between tomato varieties grown in high tunnels in terms of yield, quality, and disease resistance.

?Some onion varieties appeared to be well-adapted to overwintering, and produced high yields of marketable onions by late May/early June.
?While heating to a higher temperature (50°F vs. 40°F) increases the rate of growth of mesclun greens, the quality of greens grown at warmer temperatures is not as high. Preliminary results suggest that heating mats may be the most reliable, easy to implement, and cost-effective strategy to improve germination for benchtop greens production.
?NHAES research trials of sweet corn intercropping revealed that intercropping in sweet corn did not adequately suppress annual weeds in a field with high weed pressure, and that early seeding of intercrops between sweet corn plants resulted in more competition and reduced sweet corn performance than later seeding of intercrops.
?Results of each of these studies are being shared with grower fact sheets available through UNH Cooperative Extension and at meetings with growers.

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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
?Purchased feeds accounts for an average of 36% of the total cash expenses of New England Organic dairy farms. High costs are one of the most challenging aspects of sustaining organic dairying in the region. Strategies to reduce feed costs through sourcing lower-cost yet high nutritional value feed ingredients may optimize milk production, which enhances the economic and social sustainability of NE organic dairy farming.
?Forty percent of the nation?s dairy herds does not receive enough IgG antibodies through

colostrum at birth. As a consequence heifers are more prone to disease, impacting their adult milk production.

What has been done

1.Two feeding trials were conducted to assess the effects of liquid molasses on milk production and nitrogen utilization in organic dairy cows.
2.Kelp meal (ascophyllum) is widely used in the organic dairy farm industry in the Northeast. Feeding studies were conducted to produce specific guidelines for how to use kelp as a mineral supplement.
3.Two feeding studies were carried out with flaxseed as a feeding supplement. Flaxseed is an oilseed rich in energy and omega-3 fatty acids, and it has the potential to not only increase energy intake in dairy cows but also change milk fatty acid profile toward a more human- healthy product.
4.Research was conducted on the effects of supplementing colostrum replacer with sodium bicarbonate to increase IgG uptake.

Results

1.Feeding liquid molasses along with corn meal?a source of sucrose?resulted in better nitrogen utilization compared with feeding corn meal alone.
2.In general, results from both kelp meal studies showed no statistical effect of kelp meal on milk production, milk quality, nutrient intake, and most blood parameters. However, milk iodine content increased substantially as a result of kelp meal supplementation, thus indicating a high transfer of iodine from kelp to milk. Iodine concentrations found in milk from this research may be in excess of federally recommended requirements for young children.
3.Results from both flaxseed studies showed that flaxseed enriches milk with heart-healthy omega-3 fatty acids. However, milk production as well as yields and concentrations of milk components were reduced.
4.Results from studies 1-3 were disseminated to farmers throughout the Northeast in eOrganic Webinars. Results were also disseminated through scientific venues.
5.Raising the pH of colostrum replacer from 6.25 to 7 enhanced IgG uptake under some conditions but the results were not uniform

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
307	Animal Management Systems
311	Animal Diseases
903	Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over recent decades, a large portion of squash/pumpkin acreage and production for processing has shifted from the Northeast to the Midwest. This has resulted in a shift from the use of a Golden Delicious-type of Cucurbita maxima to the Dickinson Field strains in C. moschata. The concentration of production acreage in a single region exposes the latter crop to a greater propensity for disease and insect problems as disease pressures on processing pumpkins are indeed increasing, compromising the health of the industry.

What has been done
New processing varieties were developed with the favorable processing attributes of Golden Delicious strains, the high yield capacity of Dickinson Field strains, greater regional adaptability and improved disease and insect resistance would help insure future viability and, perhaps, expansion of the pumpkin processing industry. Bush strains of C. maxima processing squash were developed, which are being used as the female parent in crosses to selected strains of C. moschata. Several of the hybrids derived from this parentage display rapid leaf canopy development, high productivity, resistance to squash vine borer, tolerance for predation by squash bugs and foliar diseases, and relative freedom from fruit rots.

Results
In breeding for the pumpkin and squash processing market, one hybrid in particular?a cross of NH65, a bush Golden Delicious strain, to SC936, a Dickinson Field strain of C. moschata provided by Rupp Seeds?has performed exceptionally well. This hybrid produced 61,225 pounds of fruit fresh weight (FW) and 5725 lbs of fruit DW per acre in field trials conducted during 2013, compared to 44,535 lbs fruit FW and 2,583 lbs fruit DW biomass for the SC936 variety in field trials conducted during 2012. There was no plant loss to insects and disease and the % DW of fruit averaged 9.3, a level which provides much better consistency of cooked pie puree than the value of 6% for SC936.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Increased knowledge about integrated multispecies aquaculture systems.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Globally, the demand for seafood continues to rise while many wild fish stocks are at or beyond sustainable harvest levels. The growth of aquaculture is, however, meeting resistance in many areas due to water quality problems and reliance on fish meal-based diets derived from wild harvested fish. The adoption of integrated multi-trophic aquaculture (IMTA) offers positive benefits over intensive monocultures. For instance, by integrating the production of commercially important seaweed species, which can utilize the waste products of cultured animal species (e.g. fish, sea urchins), the total economic potential of an aquaculture site increases while environmental impacts are minimized.

What has been done
1.Field caging growth experiments were carried out at two sites with sea urchins and European oysters.
2.Physiological studies were conducted to determine the best culture conditions for the red alga Porphyra (Nori) in closed systems. Additional studies were conducted to determine whether nori could withstand freezing for long periods and subsequently be used to reestablish cultures.
3.Steelhead trout were grown in association with blue mussel and kelp in near-shore cage systems. The kelp were evaluated for environmental services (waste removal) and as a value-added crop.

Results
1.Sea urchins were very effective at keeping the oyster shells and the interior of cages free of fouling, but did not show any effect on the settlement of new oysters within the cages at either site.
2.Nori survived long term freezing to re-establish cultures.
3.Studies of blue mussel and kelp growth, in association with near shore cage systems for Steelhead trout, were monitored for growth. The best growth period for kelp was in the spring before fouling by bryozoans and summer water temperatures degraded the health and acceptability of the product. Mussel growth was also good. Based on the initial trial, additional trials of this integrated multi-trophic aquaculture system are underway.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
204	Plant Product Quality and Utility (Preharvest)
302	Nutrient Utilization in Animals
307	Animal Management Systems

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The rapid development of locally adapted crop varieties will serve consumer demand for high quality, locally grown produce, and value-added horticultural products. Strawberry, one of the most valuable fruit crops, is particularly difficult to breed because it is octaploid; that is, strawberry has eight sets of chromosomes. Currently strawberry is propagated by vegetative plugs. The downside of vegetative propagation is that it is associated with the transmission of viral and other

diseases. Advances in genomics have enabled marker assisted breeding that will accelerate the pace of varietal breeding.

What has been done
NHAES researchers collaborated in an international effort to design the first strawberry microarray chip, which can identify single nucleotide polymorphisms (SNP) genetic variation at 90,000 genes simultaneously. Genetic mapping was carried out for a trait, for the presence or absence of flower color, which was introgressed into cultivated strawberry from wild strawberry germplasm.

Results
NHAES researchers had access to the strawberry SNP microarray before its commercial release in October 2013. Using a multi-generation mapping population, NHAES scientists have identified a suite of closely linked SNP markers that define the chromosomal location of the genetic locus, determining the presence/absence of flower color in strawberry. These will be used to accelerate the breeding of new strawberry varieties intended for home garden production of high quality strawberry fruit on ornamentally attractive plants. At the same time NHAES researchers will test the hypothesis that flower color (hue) is a useful, early predictor of fruit color, which is an important component of fruit quality and contributor to consumer appeal.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New curcubit (winter squash) varieties with better disease resistance, improved nutrition, greater adaptability, and which provide a greater diversity of food and ornamental products, will help to sustain local agricultural production and will enhance the ability of regional seed companies to

remain competitive and profitable.

What has been done
The cucurbit breeding program at the University of New Hampshire, largely funded by the NHAES, represents the longest continuous squash and pumpkin breeding program in North America. New varieties of acorn, kabocha/buttercup, and butternut squash?based on UNH germplasm?were released via seed companies. In 2013, 41 hybrids with Powdery Mildew Resistance (PMR) were evaluated for size, shape, eating quality, resistance to squash vine borer, tolerance to squash bug predation, and longer storage life

Results
The fifty-four varieties of melons, squash, gourds, and ornamental pumpkin released by UNH during the past 15 years have had a major impact on agriculture in the Northeast. Most recently, a new variety of acorn squash is in commercial production for release in 2014. In the kabocha/buttercup class, new varieties with a semi-bush, more upright growth habit have been introduced. Powdery mildew resistance (PMR) has been introduced to a high quality butternut squash variety. This past year, the wholesale value of cucurbit seed, marketed from varieties with UNH parentage, was over two million dollars. The value of farm produce derived from those varieties would be several-fold that of seed sales.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
2013	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. The availability of effective biologically-based weed management strategies would reduce the need for mechanical and physical weed control and improve agricultural sustainability.

What has been done
Research was conducted and data was collected on the productivity and weed suppression abilities of five different spring-sown cover crops grown in monoculture and polyculture. A two-year evaluation of cover crops and their effects on weed suppression and weed growth was concluded.

Results
These data were also used to calculate the land equivalent ratio (LER) for the cover crop mixture. The LER is a useful metric for evaluating the performance of crop polycultures; however, its use in the evaluation of cover crops is quite novel.
An additional product of this work is the use of "test crops," coupled with aerial imagery, as a strategy for visually communicating the results of this work. An example of this type of imagery from our studies is available at: http://agroecologyunh.blogspot.com/2013/08/student-research-using-phytometer-to.html
This study identified the cover crops that are highly effective at weed suppression. In particular, tillage radish?a relatively new cover crop in the Northeast?was most effective at suppressing weed growth. This information has been disseminated to farmers at field day demonstrations, and has been used to prepare manuscripts for scientific journals which are under review.

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

New NH leafhopper data available through a web-accessible database

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual

2013 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Leafhoppers are obligate plant feeders that have been well-known for the problems that their feeding creates for many crops, ornamental shrubs and trees, and flowers. New Hampshire's agricultural basis is rapidly changing in the direction of high value/acreage crops, such as organically-grown crops, stone fruits, grapes, woody ornamentals, and flowers grown outdoors for the retail market. Many of these crops are known to be attractive to certain leafhoppers, and most are susceptible to leafhopper-borne diseases, such as Aster yellows or X-disease, or feeding damage via phytotoxic saliva. Particularly exposed are the many organically-grown crops, which comprise the most significant recent growth in agricultural acreage in the state.

What has been done
Leafhopper species and their relative abundances found in or near selected treated, untreated/wild, or organically-grown crops in New Hampshire were documented.

Biological data on habitat or host associations of species known from or expected to occur in New Hampshire was compiled.

Results
Based on material taken during the study and in the UNH Insect Collection, 570 species are documented for NH, with an additional 20 species taken in nearby areas of Maine and Massachusetts, for a total of 590 species. These data, including abundances, have been placed in a database and are georeferenced. Currently, the study?s results can be found on a webpage, hosted through DiscoverLife.
Host records, diseases for which the species are known vectors, and seasonalities given for adjacent states and Quebec have been captured from the literature and placed in a separate database linked by current species name. Known pests species that occur in NH are identified, and their distribution in the state and abundances documented. Differences in leafhopper communities between organic/neglected crops and chemically managed crops were documented, and the most effective sampling techniques based on color (yellow, red, blue) and type (pan trap, sticky trap, and sweeping) were documented for the leafhopper species involved in transmission of diseases, or for those producing economic damage through their feeding activities. There are an estimated 300 new state records for leafhopper species.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #9

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	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. Whole urchins or their processed gonads (called uni) are sold in Japanese, American, and other world markets (e.g., Italy and Belgium). The wild urchin fisheries collapsed in many parts of the US in the 1990?s. Alternatives to the direct harvest of wild sea urchins are vital in sustaining this valuable fishery. NHAES researchers have developed methods to generate sterile triploid sea urchin embryos, which is the starting point for developing a profitable sea urchin aquaculture system.

What has been done
One graduate student was employed to collect urchins during the last reproductive season. Four UNH undergraduate students have been trained and have successfully carried out the production of triploid sea urchin embryos in the lab.

Results
In the short winter reproductive season, triploid sea urchin embryos were produced in the lab. These larval sea urchins were maintained to the late echinopluteus larval stage, but did not develop further in the lab. In FY 14, late stage echinoplutei larvae will be grown out in the hatchery under conditions more favorable for metamorphosis to juvenile urchins.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #10

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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The United States is a major consumer of marine aquaculture products, yet we grow only a small fraction of what we consume. The growth of aquaculture is meeting resistance in many areas, however, because of multiple user conflicts, concerns over environmental degradation, and reports of the spread of diseases to wild fish populations. 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 building and operating these systems, high value fish, such as summer flounder and black sea bass must be produced. NHAES researchers are developing methodologies to produce these fish species more efficiently in recirculating systems.

What has been done
During the last federal fiscal year, methods for raising valuable finfish in recirculating systems were tested. The soybean phytoestrogen genistein was used to feminize summer flounder populations as the female flounder has a higher value for aquaculture. The effects of population density on sex differentiation in black sea bass were tested in aquaculture recirculating systems.

Results
Genistein was successfully used to feminize southern and summer flounder while population densities influenced the endocrine status of juvenile black sea bass. In addition, regulation of the black sea bass gonadotropin releasing hormones was characterized in conjunction with a second NHAES research project. This information will be used for future studies on gonadotropin-releasing hormone and its role in sex determination and sex reversal.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

305 Animal Physiological Processes
307 Animal Management Systems

Outcome #11

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil borne diseases continue to be one of the most persistent yield limiting factors in agriculture. In the past, management of many soil borne plant pathogens relied heavily on fungicide seed treatments or soil fumigation with methyl bromide (MeBr). Methyl bromide phase-out has encouraged the development of alternative chemical and non-chemical management strategies, strongly grounded on a better understanding of plant pathogen diversity and the complex interactions among soil microbial communities. Alternative control strategies, such as cultivar mixtures, cover crops, and organic amendments alter the microbial community in the soil and may provide new ways to control soil borne diseases.

What has been done
1.NHAES researchers completed a survey of the genetic diversity of Rhizoctonia solani, which causes the damping off disease associated with wheat, canola, soybean, and dry bean.
2. Cover crop species were to studied to determine whether they harbor asymptomatic infections by the soilborne pathogen Verticillium dahliae. Some strains of this pathogen cause verticillium wilt.
3.Fungal and bacterial pathogens associated with the forage crop perennial ryegrass were evaluated

Results
1.The results of the genetic survey of Rhizoctonia solanai strains, associated with four crops (wheat, canola, soybean and drybean) in the Northeast, have been completed. This will inform farmers about best practices for crop rotations to minimize damping off diseases.
2.Many cover crop species, including buckwheat, crimson clover, and winter rye, appear to be

harboring the Verticillium dahliae, but display no visual symptoms of infection. Using a genetically engineered strain of Verticulum dahliae that expresses the green fluorescent protein (GFP), researchers were able to follow asymptomatic colonization of these cover crops. This new approach will be used to study the GFP strain of Verticillium dahliae to measure the colonization of susceptible, tolerant (visually healthy but ingress of fungal hyphae present), and resistant (visually healthy with no ingress of fungal hyphae).
3.An evaluation of the fungal and bacteria associated with cultivar mixtures of perennial ryegrass is being used to identify cultivar mixtures to that are able to recruit fungal symbionts while excluding pathogens.

4. Associated Knowledge Areas

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

Outcome #12

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The production of sterile fish in aquaculture conditions would eliminate early sexual maturation, resulting in an increase in the size of the fish and its flesh quality. To control reproduction, it is critical to understand the underlying mechanisms of neuroendocrine manipulation. A key neuroendocrine function of the hypothalamus in the control of reproduction is the release of the decapeptide, gonadotropin-releasing hormone (GnRH) that?in turn?acts on the pituitary by regulating the pituitary-gonadal axis. This pathway impacts pre-harvest sexual maturation or early puberty.

What has been done
Over the last two years, researchers in the NHAES were part of an international collaborative to describe the genes of the lamprey eel, an ancestral vertebrate fish. This produced new information, which was key in understanding the neuroendocrine system that controls reproduction in vertebrates and has impacts on cultivating valuable species for aquaculture.

Results
NHAES researchers were coauthors in the first description of the genes in the lamprey eel, announced in a paper published in the prestigious scientific journal Nature Genetics during FY2013. New information from the lamprey genome project has allowed NHAES researchers to propose a modified paradigm in which the neuroendocrine control of reproduction and thyroid functions in the sea lamprey exhibits an overlapping, simplified organization represented by one glycoprotein hormone putatively interacting with two receptors.

4. Associated Knowledge Areas

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

Outcome #13

1. Outcome Measures

Identify biological targets specific to parasitic nematodes, as potential molecular targets for development of enzyme inhibitors that will serve as a nematicidal agent.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural damage caused by nematodes primarily occurs through the crop?s root system; nematode damage to crops costs hundreds of millions of dollars worldwide each year. Traditional nematicides are typically neurotoxins that are environmentally dangerous, of limited efficacy, and toxic to humans, birds, fish, and other non-target organisms. There exists a need to develop next-

generation nematicides with greater target discrimination, efficacy, and environmental safety profiles. The phosphodiesterase enzyme (PDE) family controls cyclic nucleotide metabolism; targeted PDE inhibitors may disrupt the life-cycle of nematodes without adversely effecting the host plant or animals. The pharmaceutical industry has produced large numbers of chemical inhibitors of PDEs.

What has been done
An evolutionarily diverse set of ~100 vertebrate PDE sequences were collected to identify orthologs of Class I PDEs present in plant parasitic nematodes. Using a draft version of the Meloidogyne hapla genome (northern rootknot), NHAES researchers assembled the complete coding sequence for six PDEs that correspond to specific vertebrate PDE family orthologs.

Results
Comparison of the protein sequences was used to identify amino acids in the catalytic domain of the amino acid and amino acids that distinguish PDE families. Six class-specific differences in drug interaction sites between nematode and vertebrate PDE3, PDE4, and PDE10 support the idea that nematode-specific inhibitor compounds, targeting specific PDEs, may be feasible. Proof of concept for this method of developing targeted nematicide compounds has led to the filling of patent application 611793,374.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Government Regulations
- Competing Programmatic Challenges

Brief Explanation

The dramatic cut in state appropriations to the NHAES two years ago continues to impact the staff and resources available for research projects.

Barberry is an alternate host to wheat rusts; genetic tools for barberry are needed to monitor changes in these fungal pathogens of wheat, the most important grain crop in the world. Government regulations have slowed the development of a barberry research facility at UNH.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The success of research projects in this planned program is measured in several

ways:

- For new projects, is there evidence of progress toward objectives?

o Research projects in this planned program all demonstrated progress toward their objectives.

- For more mature projects, have results been published in peer reviewed journals?Do project directors participate in national and international conferences?
  - Researchers have published multiple papers including several in prestigious journals.
  - Researchers participate in national and international conferences
- Are practical outcomes disseminated to stakeholders?

o Outcomes are being disseminated to stakeholders through research field days, various growers' meetings, newsletters, and online resources.

Key Items of Evaluation

- Variety trials have been conducted and new methods of extending the growing season in Northern New England have been developed to improve the production and value of vegetable crops. Use of a better adapted tomato cultivar may improve a farmer's profit by as much as $10,000 for a single high tunnel.
- Over the last fifteen years, 54 new varieties of melon, squash, and pumpkin have been produced by the curcubit breeding program at the NHAES. The seed value of these varieties sold last year was over 2 Million dollars, and the resulting value of the crops to farmers is many fold higher.
- NHAES researchers contributed to the analysis of diverse genomes from microbes to strawberry to lamprey. Genomic information is being mined to develop marker-assisted-breeding for strawberry, and to control reproduction in fish aquaculture.
- Comparative genomics and protein structure predictions have been used to develop a new method for the identification of nematicide compounds (patent 611793,374)

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Sustainable Energy

☑ 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			30%	
403	Waste Disposal, Recycling, and Reuse			70%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.5	0.0
Actual Paid Professional	0.0	0.0	0.0	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	17213	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	8688	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

With funding from a private donor, a state-of-the-art static pile aerobic composting system with heat

capture capabilities was built at the NHAES Organic Dairy Research Farm. The composting heat, captured from composting, is used to pre-heat water for the dairy's milking parlor. Testing is underway to optimize composting mixtures, airflow, etc. to maximize heat extraction.

2. Brief description of the target audience

There are two major audiences for this work. The first is small-to-moderate scale dairy farmers in the northeastern U.S., and others who may use bedded pack systems for housing animals and managing manure. The second is the growing number of off-farm composting operations in the region who want to optimize the static-pile aerobic composting system for thermal energy gain.

3. How was eXtension used?

A static-pile aerobic composting manual is being prepared for dissemination through UNH Cooperative Extension. Eventually this information will be disseminated through eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	210	8	0	0

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

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	1	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2013	3

Output #2

Output Measure

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

Output #3

Output Measure

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

Year	Actual
2013	6

Output #4

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2013	2

Output #5

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2013	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	New and improved knowledge about compost-based renewable energy systems for small animal operations available to peers and stakeholders.

Outcome #1

1. Outcome Measures

New and improved knowledge about compost-based renewable energy systems for small animal operations available to peers and stakeholders.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Among the biggest challenges facing organic dairy farmers in the Northeast are the cost of imports, which include feed, bedding, and energy. However, many of these dairy farms have underutilized resources, which could help alleviate import costs: wood from on-farm woodlands, and manure. This project is exploring technologies to produce animal bedding sustainably from softwoods in the farm's woodlands and examining the use static-pile aerobic composting to extract heat for on-farm energy needs.

What has been done
The economics of the sustainable production of animal bedding from local woodlots are being investigated in a companion McIntire-Stennis research project.
An anonymous donor contributed funds and, with additional support from a USDA-SARE award, a state-of-the art aerobic composting facility was built at the NHAES Organic Dairy Research Farm (ODRF) in Lee NH. Pilot studies with the composting facilities began in June, to optimize physical operations (manure + bedding loading) and provide the most favorable conditions for microbial growth (temperature, C:N ratio, density).

Results
Continuous measurements of the pile and air-stream temperatures started in June. Optimization of compost management to boost energy recovery is ongoing. The composting system has attracted attention at farm days and through other group visits to its location on the NHAES Organic Dairy Research Farm. Researchers have begun partnering with several local commercial composters, and continue a partnership with AgriLab Technologies, LLC who produces the heat exchange system that is part of the composting facility. This is only the 4th static aerobic composting system of its kind; a similar model has produced energy savings of approximately $10,000 per year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
403	Waste Disposal, Recycling, and Reuse

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Government Regulations
- Competing Programmatic Challenges
- Other (Competing time demands)

Brief Explanation

The Project Director (PD) also served as the University of New Hampshire Provost through June 2013. Provost duties competed with his time for this research project.

It has taken several years for the design phase of the compositing facility and to raise money to build it. The experimental static pile aerobic compositing facility went online in the fourth quarter of FY13. Work continues to optimize temperature profiles (to kill pathogens), without killing beneficial microbes, in order to maximize energy capture.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The success of the research project in this planned program is measured primarily in terms of progress towards the overall goals (1) of using on-farm resources to reduce input costs for animal bedding and (2) to compost bedding and manure for energy production with the goal of reducing energy costs associated with organic dairy farms in the NE.

Key Items of Evaluation

The static-pile aerobic composting system was completed in the spring of 2013; pilot studies were initiated in June. This is only the 2nd or 3rd system of this type in the Northeast, and it is specifically designed for research. The composting system has attracted quite a bit of attention at farm days and through other group visits to the Organic Dairy Research Farm in Lee NH. In addition to the farming community, the project has attracted the attention of several local commercial composters, a potential new market/application for this technology.

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			13%	
112	Watershed Protection and Management			39%	
133	Pollution Prevention and Mitigation			3%	
403	Waste Disposal, Recycling, and Reuse			5%	
511	New and Improved Non-Food Products and Processes			3%	
608	Community Resource Planning and Development			13%	
901	Program and Project Design, and Statistics			10%	
903	Communication, Education, and Information Delivery			14%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.7	0.0
Actual Paid Professional	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	35908	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	493879	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Diverse activities in the planned program included the following activities.

- A sensor network was installed in the headwaters and mainstem of the Lamprey River, and on the Oyster River, to monitor nitrate, phosphorous, and organic nutrients levels. Sensor data will be used to develop a model for nonpoint sources of nutrient flux into NH's Great Bay.
- The river network model will be used to evaluate potential land use priorities or modifications, which could affect the water quality of rivers that are tributaries to the Great Bay Estuary and coastal margins.
- In a pilot study to decrease nutrients in the Great Bay estuary, eelgrass rack was harvested and repurposed as horse bedding.
- Methods to enhance two-way communication among stakeholders, who are interested in potential agricultural and natural resources decisions, were developed and tested.

2. Brief description of the target audience

Residents of New Hampshire and New England; private, public and municipal users of water; agricultural and suburban land use planners and managers, individuals and organizations interested in conservation of water and estuarine resources, town managers and relevant committee members, other scientists, undergraduate and graduate students, state and federal agencies, and natural resources professionals.

3. How was eXtension used?

eXtension was not used directly in this program. Instead several web based resources were developed that are project specific. Web surveys have been used to collect data for several social science projects and to evaluate the quality of data collected by these survey to improve agricultural and natural resource management policies and programs.

A Facebook site was developed for NH Route1A/1B Corridor Study Adivosry Committee to communicate activities to residents of the NH Seacoast.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1372	2100	47	0

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

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	3	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of graduate students trained and directly involved in the research.

Year	Actual
2013	7

Output #2

Output Measure

- Number of undergraduate students trained and directly involved in the research.

Year	Actual
2013	11

Output #3

Output Measure

- Number of stakeholder venues where results have been presented.

Year	Actual

2013	8

Output #4

Output Measure

- Publications in peer reviewed journals and in meetings proceedings.

Year	Actual
2013	4

Output #5

Output Measure

- Development of databases including social science data for collaborative projects with citizens, advisory groups and state agencies.

Year	Actual
2013	24

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Knowledge of the relative contributions of different agricultural land management practices and suburban land uses toward N, P and C exports from the watersheds to the coastal estuary.
2	Improved collection of social science data from end users for public policy makers and regional planners with respect to natural resource management.
3	A spatially distributed river network model for the Great Bay watershed that includes relative land use sources and sinks for N, P and C.

Outcome #1

1. Outcome Measures

Knowledge of the relative contributions of different agricultural land management practices and suburban land uses toward N, P and C exports from the watersheds to the coastal estuary.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Among the public, there is poor understanding of how non-point sources of nitrogen and phosphorous contribute to the nutrient levels in the NH Great Bay estuary. These non-point sources include agricultural, forested, and suburban landscapes. Climate extremes that generate storm events have become more common in the last decade, leading to episodic increased fluxes from these various landscapes. The NH Great Bay estuary is highly eutrophied and local municipalities are planning expensive upgrades to sewage treatment plants. Understanding the relative contributions of point and nonpoint sources to eutrophication of the Great Bay is a regional imperative.

What has been done
Sensors for nitrate, dissolved organics, oxygen, pH and conductivity have been deployed in the Lamprey River headwaters and mainstem and are being continuously monitor. The Lamprey is one of the seven major rivers feeding into the Great Bay estuary. Leveraging other grant sources have expanded monitoring to the Oyster River. The data collected will be used to measure the relative contributions of agricultural, forested suburban landscapes to nutrient run off into the Great Bay. The sensor information allows researchers to detect storm water responses in a variety of land uses and watershed sizes during different seasons.

Results
Although nitrate concentrations were highest at the agricultural site during summer baseflow, area-weighted nitrate fluxes in the headwaters were similar to those of the suburban site. During storms, dilution of nitrate concentrations occurred at both the suburban and agricultural sites. However, nitrate flux always increased during high flow in both catchments. Nitrate concentration response during storm events exhibited seasonal variability, which may be attributed to seasonal land management practices and legacy pollutant impacts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #2

1. Outcome Measures

Improved collection of social science data from end users for public policy makers and regional planners with respect to natural resource management.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Systematic research is needed for evaluating the effectiveness of various survey tools used with natural and agricultural resources. Documenting the value of engaging and communicating with the public and stakeholders will inform managers and policy makers.

What has been done
Qualitative and quantitative methods have been used to evaluate the effectiveness of web- based tools intended to enhance the two way communication with the public and stakeholders in the decision-making processes associated with the management of natural and agricultural resources. These web-based tools have been applied to diverse policy and resources studies: monitoring wild turkeys in NH, conducting a survey of members of the Atlantic States Marine Fisheries Commission (ASMFC) to document social science needs of the commission, and initiating the engagement of stakeholders in the Corridor Management Plan for Route 1A/B in Rockingham County.

Results
?A survey has been completed to assess public attitudes and interest in monitoring wild turkeys in New Hampshire, which will ultimately enhance the ability of the New Hampshire Fish and Game Department (NHFG) to recruit and retain public participation in wild turkey monitoring programs. These surveys have led to a dramatic increase in documented observations and have successfully engaged a large portion of the public with a strong and growing interest in wild turkeys.

?A survey of ASMFC commissioners (50% response) showed no consensus was apparent on the most effective use of either economic or social information in making management and policy decisions. The results from the web survey serve to stress the importance of making a distinction between qualitative and quantitative data since these data are collected for achieving different goals. The commission's level of understanding of these approaches is critical since stakeholders may try to influence their decisions through the misuse of data.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
901	Program and Project Design, and Statistics
903	Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

A spatially distributed river network model for the Great Bay watershed that includes 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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Since 1980, there has been a 65% increase in population and associated development in NH?s Strafford and Rockingham Counties that surround the Great Bay Estuary. Over this period, the Great Bay has become hyper-eutrophied with respect to nitrogen and phosphorous, with corresponding declines in eelgrass and habitats for juvenile marine organisms. Ameliorating the degraded state of the Great Bay requires a better understanding how the rivers in the watershed are sources and sinks, leading nitrogen, phosphorous, and carbon to the Great Bay.

What has been done
A distributed sensor network in the Lamprey and Oyster Rivers has provided baseline data for the development of a river model of the Great Bay Watershed.

Results
The river model has been developed, and scenarios have been run to understand the factors controlling N fluxes to the coastal zone. Modeling results have revealed that the Lamprey River network has a moderate capacity to remove elevated inorganic nitrogen inputs. The moderate capacity occurs in part because much of the developed area of the watershed is skewed to the watershed mouth, or to the larger river mainstem, providing less residence time and contact with benthic sediments where permanent N removal (denitrification) occurs.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Appropriations changes
- Competing Programmatic Challenges

Brief Explanation

A decrease of 23.9% in state matching funds in the previous biennium continues to limit research support dollars.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The success of research projects in this planned program is measured in several ways:

- For new projects, is there evidence of progress toward objectives?

o Research projects in this planned program all demonstrated progress towards objectives.

- For more mature projects, have results been published in peer reviewed journals?Do project directors participate in national and international conferences?

o Researchers in one project have published several papers, including one in the prestigious journal Nature.
o Researchers in two projects have actively participated in regional, national and international conferences.

- Where appropriate, are outcomes disseminated to stakeholders, policy groups and state and regional agencies?

o Results and outcomes of one project to monitor nitrogen run off from agricultural, forested, and suburban landscapes have been incorporated into the planning activities of communities in the Great Bay estuary and state and federal agencies, all of whom are developing interventions to ameliorate eutrophication of the Great Bay.
o Improvement of web-based methods and tools for engaging stakeholders has led to better data for local, regional, and national policy makers.

Key Items of Evaluation

Nitrate levels have been monitored in the headwaters of the Lamprey River, one of the major rivers feeding the Great Bay estuary. Although nitrate concentrations were highest at the agricultural site during summer baseflow, area-weighted nitrate fluxes were similar to those of the suburban sites.

This project's monitoring activities have been expanded to several locations in the Oyster River watershed to improve understanding of non-point sources for the town of Durham and University of New Hampshire's effort in creating a single integrated waste water permit.

V(A). Planned Program (Summary)

Program # 7

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%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			25%	
801	Individual and Family Resource Management			10%	
802	Human Development and Family Well-Being			10%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities			25%	
805	Community Institutions, Health, and Social Services			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.9	0.0
Actual Paid Professional	0.0	0.0	1.1	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	81025	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	97937	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	40816	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• A better understanding was achieved through an evaluation of the role of amenities in rural development and the impact of economic and social changes on the quality of life in rural communities.
• Individual and family level characteristics and policies, which impact physical and mental health in diverse rural low-income families, were investigated.
• The aging of the rural population was examined within the context of overall U.S. population aging, and the impacts of in-migration, aging-in-place, and other demographic forces that shape the spatial distribution and composition of rural populations were investigated.
• Various over-wintering techniques for large container grown trees and shrubs were investigated to save labor and enhance profitability for northeastern producers.
• Greenhouse trials were conducted to determine effective and resource-efficient management techniques for the use of controlled-release fertilizers in producing potted bedding plants of importance to the state and region.

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.
• Rural, low-income families, and private and governmental social services personnel and entities, especially in terms of employment and health care.
• Federal, state policy makers, planners and concerned citizens who will facilitate actions to enhance the social and economic development of rural communities in the state.
• Owners and operators of greenhouses that produce floriculture crops.
• Nursery producers and landscape contractors in NH and throughout the northeast.
• Cooperative Extension educators who work in horticulture.

3. How was eXtension used?

Two of the project directors in this planned program have split appointments with UNHCE, so outcomes of their research are disseminated in part via UNHCE websites.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	193	6000	0	0

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

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	30	7	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2013	6

Output #2

Output Measure

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

Year	Actual
2013	3

Output #3

Output Measure

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

Year	Actual
2013	3

Output #4

Output Measure

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

Year	Actual
2013	1

Output #5

Output Measure

- Number of graduate students directly involved in research project.

Year	Actual
2013	1

Output #6

Output Measure

- Number of undergraduates involved in research projects

Year	Actual
2013	1

Output #7

Output Measure

- Citation of NHAES supported demographic studies by the major national, regional, and local media.

Year	Actual
2013	1000

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge among rural individuals and families related to employment and health care.
2	Number of presentations to civic and government entities to increase knowledge of demographics and migration in the region and nation.
3	Availability of modified production systems for woody nursery crops in northern nurseries.
4	Availability of new management guidelines for use of controlled-release fertilizers in greenhouse floriculture.

Outcome #1

1. Outcome Measures

Increased knowledge among rural individuals and families related to employment and health care.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Rural Coos county has the highest unemployment rate in the state of NH. Rural residents are more likely to be the working poor, to experience bouts of unemployment, and are less likely to have health insurance and good access to health care. Policy makers and cooperative extension agents need to better understand the connection between the health issues of the rural poor in the context of the interactions between individuals, families, communities, and policies.

What has been done
A second wave of in-depth interviews was conducted with eight participants who had been a part of the first wave of interviewees. Participants were selected based on demographic variables to ensure a variety of family constellations.

Results
Rural residents, including New Hampshire rural residents, have difficulty in accessing health care and experience more health issues than their urban counterparts, which can negatively influence their ability to engage in labor force activities.

4. Associated Knowledge Areas

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

Outcome #2

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
2013	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #3

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nursery crop production in containers continues to increase nationwide. Since the root environment is quite different in containers than in soils, an understanding of how roots respond to growing in containers is important to producers, landscapers, and consumers. Better landscape plants save money (in removal and replacement costs) and enhance the environment. One foremost economist estimates the value of each tree (in oxygen provided, water recycling, soil protection, and air pollution control) to be $162,000 over a 50-year lifetime.

What has been done
Root zone temperatures in containers were investigated in over-wintering nurseries. Protocols were established for determining at what temperatures severe root damage occurs, which varies with species and environmental conditions. The impact of the root pruning of plants grown in containers was also evaluated.

Results
The results of root damage studies of different species in different container systems are being used to generate plant groupings, which growers and retailers can use to determine what type of winter protection is needed. By not treating everything the same, producers can cut the costs and cut the losses associated with winter protection of container crops and purchasers can have better quality plants with a higher rate of survival and long-term success in the landscape.

4. Associated Knowledge Areas

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

Outcome #4

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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A common practice with most greenhouse crops is to fertilize with a water-soluble fertilizer on a constant or near constant basis. Although constant liquid feed programs are relatively easy to manage, their use can be very wasteful unless runoff is captured and reused. With ever increasing fertilizer costs, growers will need to reduce the amount of unused fertilizer lost due to leaching. Controlled-release fertilizers (CRF) are commonly used in the nursery trade and have been shown to reduce the amount of nutrients lost to leaching, which, subsequently, reduces fertilizer cost. To date, CRFs have not been wildly adopted for greenhouse crops even though CRFs have the potential to reduce costs and increase profitability for greenhouse growers.

What has been done
Using conventional liquid fertilizer treatments as a comparison, a 52-week experiment was conducted with Poinsettias, Gerber Daises, Cyclamen, and Geranium plants to track the substrate pH and electrical conductivity of soil, at various temperatures and light levels, which had been fertilized by CRF.

Results
Container plants grown under several different CRF treatments performed as well or better than plants grown with liquid fertilizer. Nitrogen leachate from pots was dramatically lower for CRF treatments. The costs of growing potted plants with CRFs were less than 1/4 of the costs of liquid fertilizer.
Recommendations for these four popular greenhouse flower crops will be released to the public in FY14.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

Cuts in state appropriations to the NHAES in 2011, 23.9%, reduced farm staffing and project support budgets. These appropriations changes continue to impact research productivity. The Great Recession had strong impacts in rural parts of NH, changes in both in-migration and aging in place.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The success of research projects in this planned program is measured in several ways:

- For new projects, is there evidence of progress toward objectives?

o Research projects in this planned program all demonstrated progress toward their objectives.

- For more mature projects, have results been published in peer reviewed journals? Do project directors participate in national and international conferences?

o Researchers have published several papers and participate in national and international conferences.
o Outcomes of demographic studies associated with this planned project are heavily cited by national, regional, and local media sources.

- Are practical outcomes disseminated to stakeholders?

o New methods for the propagation of woody bedding plants have sparked widespread interest in the regional nursery and landscaping industries.

Key Items of Evaluation

Recently completed trials of four popular greenhouse crops (Poinsettias, Gerber daises, Cyclamen and Geranium) compared controlled release fertilizers (CRFs) to convention liquid fertilizers. Plants grown with CRFs performed as well or better than those grown with liquid fertilizers. CRFs cost a fraction (less than 25%) of liquid fertilizers; with CRFs producing far less N leachate into wastewater compared to conventional liquid fertilizer treatments.