

2012 University of New Hampshire Research Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

This report reviews the primary research activities from the New Hampshire Agricultural Experiment Station (NHAES). It covers federal Hatch and corresponding matching and non-matching funds. Our partner, the University of New Hampshire Cooperative Extension (UNHCE), is a separate administrative unit; each of us reports individually to USDA. Many of our activities are synergistic: NHAES covers the costs for the UNH farms, dairies, and greenhouses that are used in common with UNHCE. NHAES provides split salary funding for several UNHCE Faculty and direct research support for a number of UNHCE activities. Therefore, a portion of UNHCE FY2012 achievements are the result of NHAES support and, likewise, some of the achievements of NHAES are facilitated by UNHCE. However a large proportion of NHAES research is focused on discovery; the outcomes of these activities may require a few to several years before their findings lead to innovations in agriculture, nutrition, family, or supporting rural economies which are widely applied by producers and citizens. Disseminating best practice, without the discovery research component, is the primary responsibility of UNHCE.

In the report that follows, we have highlighted significant achievements. As recommended by previous reviews, we continue to work to distill technical descriptions of research outcomes to lay terms. We realize the importance of accessibility in our reports; these help USDA/NIFA make the case for the value of federal investment in the Agricultural Experiment Station system.

NHAES tests new ideas and technologies for regional agricultural operations and the nascent aquaculture industry, averting financial risk for regional producers while working towards improving their operations' bottom lines and sustainability. NHAES provides many opportunities for experiential learning for undergraduates, resulting in better educational outcomes and, ultimately, producing well-qualified employees. The ongoing activities of NHAES complement the renewed public interest in regional agriculture in New England and the growing local food movement. Between 2002 and 2007 there was a 24% increase in farm numbers in NH (Agricultural Census). There was a 37% increase in market value of agricultural products over this period. NH is first nationally in the percentage of farms with direct sales, with two counties, Hillsborough and Rockingham in the top 40 of U.S. counties in direct market sales. We expect these trends to continue when the 2012 Agricultural Census is completed.

NHAES supported research projects address issues central to regional agriculture and those within NIFA national priorities. The recent agroecology faculty cluster hire is already reaping benefits by initiating learning communities, reinvigorating graduate and undergraduate majors, and launching extensive interdisciplinary research activity. Their research activities have been providing practical information to stakeholders for changes in production.

Funds that support NHAES research activities come from a variety of sources. For Federal FY2012, 33% of funding was from federal capacity funds, 41% was from state appropriations and 26% was from other sources outside the University. With regard to the 26% of outside funds, this is a conservative estimate that includes only new grants initiated in FY2012 and not on-going projects; further these outside funds are clustered in high profile research areas (e.g. climate change). A major component of the outside funds came from a philanthropic gift, to build an aerobic composting renewable energy generation facility for the Organic Dairy Research Farm. By contrast NH State appropriations via the university were reduced

through the NH biennial budget beginning FY12, by 18% of total NHAES federal plus state dollars. Federal and state capacity funds are essential to NHAES's ability to contribute to advancing agriculture and related natural resources.

Collaboration with other New England land grants allows NHAES to effectively leverage its resources to address regional agricultural priorities. We have ongoing cooperation with the Maine Agricultural and Forest Experiment Station (MAFES), Vermont Agricultural Experiment Station (VTAES) and Cooperative Extension (VTCE), and the Massachusetts Agricultural Experiment Station (MAES) among others. In FY12, MAFES Cooperative Extension Specialists John Jemison and Ellen Mallory gave invited talks during the NHAES College of Life Sciences Sustainable Agriculture and Food Systems Seminar Series. Members of the Northern New England Agricultural Experiment Stations test different cultivars of fruits, vegetables, and grains as well as production practices suited to Northern New England. These crops must be adapted to our unique short growing season, cold winters, and increasingly greater fluctuations in temperature and rainfall. A portion of research on agricultural practices from other parts of the U.S. is not directly applicable to farming in Northern New England due to the specific soil types, climate, plant pathogens, and insect problems in the region. Therefore, a substantial amount of the agricultural research and integrated activities in Northern New England are targeted to regional concerns.

There is significant interest among producers in adopting sustainable agricultural practices, which have to be tailored to the climate, growing season, crops, soils, and pests of Northern New England. The NHAES Organic Dairy Research Farm is a living laboratory in which researchers work to understand nitrogen and carbon cycling under different land use regimens and investigate how to generate inputs for organic dairy production (bedding, energy) while maximizing energy and simultaneously minimizing release of manure nitrogen to the environment. Outcomes will improve the bottom line for dairy farmers and, potentially, other animal operations.

Other NHAES research focuses on the changing demographics of rural New Hampshire, better understanding of the obesity epidemic among college students, improved methods of monitoring bacterial pathogens in cultured shellfish, and factors that cause surface algal blooms in freshwater lakes.

The diversity of research activities supported by the NHAES do not lend themselves to summarization with the same logic models that our partner, UNHCE, uses in their annual report. Instead these are some of the highlights of NHAES research from the 2012AY report:

- The College Health and Nutrition Assessment Survey (CHANAS), including 5,874 UNH students, showed that the prevalence of overweight and obesity declined from 32.9% and 7.4% in 2005-2007 to 25.1% and 4.5% in 2010-2012.
- Preliminary measurements of tradeoffs among multiple land uses (organic and conventional farmland, forests, and residential) in their ability to either contribute to or mitigate climate change suggest that biophysical factors like albedo (reflection of light) and surface heat flux may be more important than biological processes, e.g., carbon storage, and greenhouse gas emission in driving climate change.
- A new method of tracking cyanobacteria microcystin toxins was developed by the UNH Lakes Lay Monitoring Program, which involves the toxicological analysis of subsamples "punched" from chlorophyll filters that are routinely collected by citizen lake monitors. This effort has grown into the first citizen-based microcystins monitoring program of lakes and drinking water supplies.
- When different soybean cultivars were tested for tolerance to ozone, resistance was correlated with the increase of polyamines, cations in ubiquitous in living organisms, but only when polyamines accumulated within a certain range.
- NHAES scientists have shown that buckwheat and tillage radish are particularly weed-suppressive cover crop species when sown in the spring and fall, respectively. These NHAES results have been disseminated via UNH Cooperative Extension to local farmers.
- Slick Pik YS26, a new variety of glabrous (spineless) summer squash, bred by a NHAES researcher,

was released through seed companies. The glabrous trait will reduce abrasions and brown discoloration to common spiny varieties of zucchini, improving marketability and reducing injury to harvesters.

- NHAES researchers assisted in the construction of the first genetic linkage map in diploid strawberry and a microarray to measure genetic polymorphism, both of which were used to identify two important agronomic traits in strawberry: flowering habit and fruit color intensity.
- New F1 hybrid varieties of winter squash have been developed and released through commercial seed producers. These new varieties have compact bush growth habits and resistance to powdery mildew, with flesh that have higher sugar and starch levels, and improved nutritional value (vitamin A, carotenoids).
- In recirculating aquaculture systems, supplementing juvenile summer flounder feed with a natural product from soybeans - the flavone genistein - caused 96% of summer flounder to develop as females. Reliably producing high proportions of female flounder should result in better economic returns for finfish production, as females grow much faster to market size than males.
- Kelp meal (*Ascophyllum nodosum* or rockweed) is a popular nutritional supplement for cows in organic dairies. NHAES research showed that incremental dietary levels of kelp meal did not improve animal performance, milk production and milk composition; however, the concentration of milk iodine increased linearly in response to incremental dietary levels of kelp meal. Notably, kelp supplementation caused milk iodine levels to approach toxic levels for children. This is a finding of high importance to organic dairy producers and organic milk consumers.
- New guidelines were developed for the use of controlled-release fertilizer for the greenhouse production of Gerbera and Begonia bedding plants. The switch from constant liquid fertilizers to controlled release fertilizers in greenhouse production systems has the potential to reduce fertilizer costs as well as environmental impacts of nitrogen and phosphorous leached into the environment.

Research conducted by NHAES scientists is of the highest quality. This year, results of NHAES-funded science were published in high-impact journals such as Nature as well as in other leading journals for individual disciplines. NHAES scientists were invited to speak at national and international conferences and at scientific society meetings. Research results and agricultural practice recommendations are regularly communicated to regional producers through field days, workshops, email, websites, and newsletters. Cumulative royalty income for the University of New Hampshire continues to be driven by licenses on plant varieties derived from NHAES plant breeding.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	11.2	0.0
Actual	0.0	0.0	29.6	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, manuscripts and products)

2. Brief Explanation

The New Hampshire Agricultural Experiment Station (NHAES) carries out a formal competitive peer review process for proposed research projects. The competition for NHAES support is announced to eligible faculty via email. Faculty are encouraged to submit a one page prospectus and discuss this with the 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, agricultural practices, approaches to improved transfer of immunity to newborn calves, and/or modifications to food rations for both organic and conventional dairies in ways that increase the producer's bottom line.

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 specifically with non-traditional groups
- Survey specifically with non-traditional 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 horticulture and agronomy farms, 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 various workshops sponsored by UNH Cooperative Extension. 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.

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 (interaction with 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 faculty participated in statewide initiatives and on state and regional committees (e.g., NH Sustaining Agriculture Coalition, NH Current Use Board, NH State Conservation Committee). UNH 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, 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. 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 with the general public (open meeting advertised to all)
- Meeting specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public

Brief explanation.

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

- growers;
- farmers;
- citizens;
- agricultural organizations and councils, including
 - members of various watershed alliances and lake associations
- fisherman and aquaculturists
 - natural resources professionals and managers;
 - representatives of state and federal agencies;
 - regional AES and Cooperative Extension administrators
 - project directors of ongoing research projects and their graduate and undergraduate students;
 - extension specialists;
 - others.

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

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 18,000 times during FY12. This is a fourfold increase over FY11. The Organic Dairy Research Farm section continues to attract the largest percentage of hits at 35%. The homepage of the NHAES site posts links to the USDA's Census of Agriculture and Ag is America.

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.

An unusual interaction with stakeholders occurred when a draft of the UNH Campus Master Plan was released in the spring of 2012. Notably the plan included moving the NHAES Greenhouses, Equine Facilities and Farm Services, and renting farm land on the west side of campus to big box retailers. Two scheduled public forums about the draft Master Plan were flooded with concerned students and citizens (estimated attendance of over 1000 people). Members of the agricultural community from across the state, rallied in support of the UNH's Land Grant Mission and against the proposed retail development of NHAES land. This robust response from agricultural stakeholders and students forced the University to make major changes to the proposed Campus Master Plan, preserving agricultural lands on the west side of campus. This public response reinforces results of a UNH survey data that 60% of residents believe that agriculture is important to the economy of NH. It also demonstrates the strong value our stakeholders place on the NHAES and its agricultural programs and facilities.

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
- 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. Several new faculty from the agroecology cluster hire took part in Cooperative Extension workshops and have initiated new research projects in direct response to issues raised by dairy farmers and horticulture growers. Some of these new research projects include evaluating production methods for day neutral varieties of strawberries, evaluating cultivars to use in season extending high tunnels, and testing strategies to improve pasture productivity over the growing season. 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. 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.

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	1829366	0

2. Totaled Actual dollars from Planned Programs Inputs				
Extension			Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	1953714	0
Actual Matching	0	0	2421560	0
Actual All Other	0	0	1554521	0
Total Actual Expended	0	0	5929795	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	150893	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Childhood Obesity
2	Climate Change
3	Food Safety
4	Global Food Security and Hunger
5	Sustainable Energy
6	Sustaining Natural Resources
7	Supporting Rural Economies
8	Agricultural Biotechnology and Genomics

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: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.4	0.0
Actual Paid Professional	0.0	0.0	2.1	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	100572	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	71252	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	19378	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

NHAES research covered a range of issues related to the US obesity epidemic, including discovery science, and developed interventions to improve weight and health.

2. Brief description of the target audience

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

3. How was eXtension used?

eXtension was not used.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1105	1360	15	0

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

Patent Applications Submitted

Year: 2012
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	10	10

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2012	16

Output #2

Output Measure

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

Year	Actual
2012	8

Output #3

Output Measure

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

Year	Actual
2012	14

Output #4

Output Measure

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

Year	Actual
2012	1

Output #5

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2012	5

Output #6

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2012	5

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of graduate students trained and ready to enter the workforce.
2	Number of undergraduate students involved and trained in engagement research.
3	Increased knowledge about the role of PBDE flame retardant in obesity related metabolism.
4	Availability of methods for participatory research related to obesity.
5	Evaluation of effectiveness of health screening combined with nutrition education for worksite wellness program in small organizations.

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
2012	1

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
2012	16

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Experiential learning opportunities reinforce classroom learning, and represent value-added education for which University of New Hampshire is known for.

What has been done

Sixteen students participated in research in four different labs. Many presented the results of their research at the annual college undergraduate research conference.

Results

These practical skills, and the work ethic that undergraduate research instills, enable these students to compete successfully for jobs and/or for entrance in top ranked graduate programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Flame retardants, including polybrominated biphenyl ethers (PDBEs), are now widespread in the environment. PDBEs have been proposed to function as obesogens, contributing to the obesity epidemic in the U.S. This project seeks to measure the impact of PDBEs on fat metabolism in a rat model, and to measure correlations between putative obesogens and fat accumulation in college students.

What has been done

- Rats were fed either corn oil (control) or with corn oil supplemented with PDBE at levels comparable to the level of environmental contaminants found in young adults. After 28 days, the amount of fat in the livers of both the treated and control rats was compared.
- The blood serum level of four classes of contaminants, dioxins, DDT, DDE, and PCBs was measured for 19 college students. For these same students, data were collected for a variety of health markers, including body mass index (BMI), serum triglycerides, and cholesterol.

Results

- In rats, exposure to PDBEs results in a 20% increase in liver fat, relative to control animals. This finding is consistent with the hypothesis that the flame retardant PDBE acts as an obesogen.
- College students were found to have significant levels of several environmental chemicals in their serum. However, contrary to our expectations, there was a statistically significant inverse relationship between serum PCB levels and triglycerides in these students. This finding needs to be investigated further.

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
2012	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Metabolic syndrome (MetS) is the name given to a cluster of associated health markers: elevated blood pressure, high fasting blood glucose, excess weight, low HDL cholesterol, and high triglycerides. MetS is correlated with increased risk for type II diabetes, stroke, and coronary artery disease. NHAES researchers are studying trends in young adult weight and biomarkers, and whether different interventions are successful in changing behavior or countering excess weight gain.

What has been done

- The College Health and Nutrition Assessment (CHANAS), which included 5,874 University of New Hampshire students, was analyzed. This assessment examines weight, blood pressure, abdominal obesity, and fasting blood glucose.
- NHAES researchers evaluated a ten-week, tailored, Internet-based intervention program, known as Young adult Eating and Active for Health (YEAH), developed to prevent excessive weight gain among 18 to 24-year-olds.
- A survey of college students was conducted to measure the impact of Guiding Stars (GS), a point of purchase consumer tool.
- Health assessment data was evaluated to determine whether body adiposity index (BAI) or body mass index (BMI) measurement methods more accurately reflect the total percentage of adiposity.

Results

- The College Health and Nutrition Assessment Survey (CHANAS) data suggest that rates of overweight and obesity have declined over the past eight years among young college age adults with a corresponding improvement in the proportion of students with MetS.
- The Young Adult Eating and Active for Health (YEAH) study findings suggest modest metabolic

improvements may be associated with web-based interventions that target healthy lifestyle behavior change among young adults.

-A survey of Guiding Stars (GS), a consumer tool for nutritional value at point of purchase, suggests that the presence of nutrition guidance positively influences students' perceptions that healthy foods are available.

-It was determined that the body adiposity index (BAI) more accurately reflects body fat percentage in college students than the commonly used body mass index (BMI) method.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior

Outcome #5

1. Outcome Measures

Evaluation of effectiveness of health screening combined with nutrition education for worksite wellness program in small organizations.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

-The U.S. obesity epidemic is associated with higher levels of inflammation, which may lead to heart attack and stroke.

-Experimental studies with laboratory animals suggest that increasing the ratio of omega 3 (anti-inflammatory) to omega six (inflammatory) fatty acids in diet decreases inflammation.

What has been done

A model of health screening and nutrition education for work-site wellness programs was tested with employees of NH Cooperative Extension over a two year period.

Results

Nutrition education intervention, related to the importance of benefits of omega-3/omega-6 fatty acids, was found to be significantly correlated to changes in both weight and risk of inflammation

that were measured periodically throughout the study.

The cost-effectiveness of the intervention was \$10.17 per percentage point reduction of low-density lipoprotein cholesterol and \$454.23 per point reduction coronary heart disease risk.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes

Brief Explanation

Reductions in state appropriations to the University system and the NH Agricultural Experiment Station resulted in less support dollars for research, and hence a slow down in research activities.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The principal means of evaluation of activities in this planned program continue to be peer evaluation of project proposals and the acceptance of manuscripts for publication in peer-reviewed journals. Ten peer-reviewed papers were published from research projects in this planned program in FY2012, and nine presentations were used in professional meetings. By these criteria, all research projects in this planned program continue to be effective.

Key Items of Evaluation

Continued evaluation of the obesity problem in college age students shows a significant improvement over the last seven years: the rates of overweight/obesity have decreased by 25% and 40% respectively. This positive development suggests that various nutritional, educational, and behavioral interventions are having a positive impact on young adults.

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
102	Soil, Plant, Water, Nutrient Relationships			42%	
112	Watershed Protection and Management			41%	
131	Alternative Uses of Land			17%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.8	0.0
Actual Paid Professional	0.0	0.0	2.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	382897	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	81953	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	242242	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- A comprehensive study is underway that examines how agriculture, forests, and residential land uses in a human-dominated landscape influence climate through a combination of carbon storage, greenhouse gas emissions (nitrous oxide and methane), alterations to shortwave albedo (reflected energy) and land surface heating. Measurements are being used to improve models for land management activities that mitigate drivers of climate change.
 - Predictions about climate change, which will influence natural resources and agricultural management strategies, are being brought to various NH state agencies.
 - NHAES researcher McDowell and his coworkers are bringing information about the regional atmospheric nitrogen deposition to the Environmental Protection Agency and to local municipalities as these groups work to reduce nitrogen pollution of the Great Bay Estuary and its watershed.

2. Brief description of the target audience

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

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	420	100	50	220

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

Patent Applications Submitted

Year: 2012
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	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
2012	7

Output #2

Output Measure

- Number of graduate students directly involved in the project

Year	Actual
2012	4

Output #3

Output Measure

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

Year	Actual
2012	4

Output #4

Output Measure

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

Year	Actual
2012	6

Output #5

Output Measure

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

Year	Actual
2012	3

Output #6

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2012	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of graduate students trained to become the future generation of scientists.
2	Information relayed to non-scientific stakeholders through integrated research and extension partnerships.
3	Unbiased knowledge about tradeoffs among multiple land management strategies in terms of their net climate effect.

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The precipitous increase in the planet's average temperature over the last century has resulted in the rapid melting of glaciers and polar ice caps. These changes are linked to varying weather patterns, severe storms, and the higher sea levels that have dramatic impacts on agriculture and coastal communities. Nitrogen and carbon cycling have impacts on climate change. NHAES research in climate change is training new generations of scientists (undergraduates, graduate students, and post docs) to monitor and integrate nitrogen and carbon fluxes.

What has been done

Students, graduate students, and research scientists took part in monitoring and comparing greenhouse gas emissions at UNH's organic and conventional dairies by monitoring fluxes in plant biomass and soils. In addition the carbon and nitrogen dynamics in feed, fresh manure, compost, and the cows themselves were measured. A second project quantifies the magnitude of atmospheric depositions of various pollutants in temperate and tropical watersheds.

Results

Four research scientists, four postdocs, two graduate students, and six undergraduates were trained to monitor greenhouse gas emissions and pollutant deposition in addition to estimating the fluxes in soils and plant biomasses. Of these, three research scientists, two postdocs, one graduate student and one undergraduate also developed methods to model carbon and nitrogen dynamics for the comparison of organic and conventional dairies.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

- New Hampshire's forested landscapes, 80%, are primary resources for industry, recreation and tourism. Landowners and land managers know little about how forests contribute to or help mitigate climate change.
- Atmospheric nitrogen deposition contributes to the overall problem of nitrogen pollution (eutrophication) in NH's Great Bay and the surrounding watershed.
- Regulatory agencies and water and sewage authorities need accurate information about all sources of nitrogen impacting NH Great Bay and its watershed.

What has been done

- Karen Bennett, UNHCE specialist and a coPI on this project, worked on three separate activities related to the NHAES multi-investigator climate change project.
Bennett:
 - worked with NH Fish and Game to revise climate adaptation strategies in the State Wildlife Action Plan;
 - held a roundtable discussion on winter climate change with the Hubbard Brook Research Foundation;
 - collaborated with the Northern Forest Center Staff for "carbon" programming, including the promotion of the workshop "Carbon: A Viable Forest Product?".
- NHAES researcher McDowell and his staff presented their findings to national and regional groups concerned with eutrophication of estuaries.

Results

- Broader impacts have resulted from extension activities, including revised climate adaptation strategies in the State Wildlife Action Plan (ongoing) and the education of fifty natural resource professionals and landowners learning about the viability of carbon as a forest product. Roundtable discussions (with 25 participants) on winter climate change were summarized by David Sleeper and Geoff Wilson of Hubbard Brook into a non-technical article that appeared in the October 14, 2012 issue of Boston Globe Magazine as A Climate Change Call to Arms.
- Information about atmospheric nitrogen deposition was disseminated to local communities through invited meetings with U.S. Senate staff members, representatives of the Environmental Protection Agency, NH Department of Environmental Services, local environmental consultants, and local town officials.

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 #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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What are tradeoffs among multiple land uses (organic and conventional farmland, forests or, residential land) in their ability to either contribute to or mitigate climate change?

What has been done

-NHAES researchers continued to measure carbon and nitrogen pools and greenhouse gas emissions in a mixed land use landscape. These data are being used to calibrate remote sensing imagery and conduct initial runs of the DeNitrification DeComposition (DNDC) model.

-Albedo (reflected energy) measurements were made for different landscapes; these allow

estimates of the net radiative forcing of the landscape, e.g. the difference between radiant energy received by the landscape and energy radiated back to space. The ratio of energy received to energy radiated determines whether warming or cooling occurs.

Results

-The refined DeNitrification DeComposition DNDC model runs indicate that forests are a net sink of greenhouse gases while grass and fodder production and livestock agriculture are net sources of greenhouse gases. The livestock system showed the highest global warming potential while the forest showed the lowest.

-Predictions are modified when greenhouse gas emissions are combined with albedo and heat fluxes to produce a net radiative forcing value for each land cover. Land conversion from forest to agricultural or residential land cover can either have a positive or negative impact on climate change depending on how albedo, surface heat fluxes, and human greenhouse gas emissions contribute to the radiative forcing budget.

-Findings to date suggest that biophysical factors, such as albedo and surface heat fluxes, may influence climate forcing more than biological processes, such as carbon storage and greenhouse gas emissions.

-As a result, the current policy focus on carbon sequestration in soils and plant biomass may be too narrow for developing a comprehensive approach for mitigating climate change across a mixed land use landscape.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes

Brief Explanation

Reductions in State funding of the University system and the NHAES resulted in reductions in work force at the farms and farm services, and a reduction in herd size in at the conventional dairy. This will result in differences in carbon and nitrogen pools measured at the conventional dairy.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

- A multi-investigator project covered in this planned program is still in the data generation phase; these data are needed to refine models and provide unbiased knowledge about tradeoffs among multiple land management strategies in terms of their net climate effects. Peer review publications will follow.

- Qualitative assessments, based on self-reporting, continue to show a high level of interaction between basic research and the extension component of this project.
- Requests for reports from the Multistate Atmospheric Deposition Program illustrate how this project is providing critical information to EPA and local municipalities as they work to reduce nitrogen pollution in NH Great Bay Watershed.

Key Items of Evaluation

NHAES researcher McDowell and colleagues spoke about their findings at six different regional and community meetings, and provided expert information to federal, state, and municipal lawmakers, and regulatory agencies.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Food Safety

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
133	Pollution Prevention and Mitigation			4%	
135	Aquatic and Terrestrial Wildlife			21%	
212	Pathogens and Nematodes Affecting Plants			8%	
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: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.8	0.0
Actual Paid Professional	0.0	0.0	1.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	107415	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	313982	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	61000	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities conducted under this planned program area ranged from discovery research (ecology of bacterial biofilms; genetic changes Vibrio bacteria in shellfish) to applied studies on monitoring microcystin toxins in lakes and using a relay method to decrease bacterial load prior to marketing shell fish. Results from both discovery and applied research were widely distributed to scientific audiences, and nonscientific stakeholders.

2. Brief description of the target audience

- There is a growing community of scientists interested in microbial biofilms; other stakeholders include farmers whose crops and farm animals are either beneficially or negatively impacted by different Pseudomonas species which grow as biofilms.
- The accumulation of microcystins in freshwater lakes is important to scientists, those that manage surface drinking water suppliers, as well public health and environmental agencies and the public who use these water systems.
- Vibrio contamination in shellfish is an emerging safety issue for the regional shellfish industry and governmental agencies.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	287	2650	70	150

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

Year: 2012
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	2	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2012	108

Output #2

Output Measure

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

Year	Actual
2012	4

Output #3

Output Measure

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

Year	Actual
2012	6

Output #4

Output Measure

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

Year	Actual
2012	4

Output #5

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2012	9

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 citizens engaged in educational presentations and workshops related to microcystins.
4	Number of agencies and stakeholder groups involved in research outreach related to vibrios in shellfish.
5	Increased knowledge about mechanisms of biofilm adaptation and diversification in pathogens and symbionts.

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The regional shellfish industry and NH Department of Environmental Safety have become aware of emerging problems with potential Vibrio pathogens in oysters. Virulent strains of Vibrios could become a public health issue among consumers who enjoy raw seafood.

What has been done

A new modified Vibrio culture medium (CHROMagar) was tested for identifying Vibrio parahaemolyticus in tissue from oysters. Vibrio colonies growing on the CHROMagar will have a color distinctive from that of other microbes. Oysters are relayed from harvest sites where Vibrios are present to areas where Vibrios are absent or only present in low concentrations. Vibrio levels were measured at different time periods after relay to evaluate the success of the treatment to decrease Vibrio load.

Results

The research to date has resulted in significant changes in our knowledge about the dynamics of Vibrios in oysters within Northeast US estuarine ecosystems. Our 2012 fieldwork showed how V. parahaemolyticus and V. vulnificus in oysters, sediments, and water are present in more areas and for longer periods of time compared to what was observed in the 1990s. These findings are consistent with the prediction that Vibrio infections are a potential emergent health problem for the shellfish industry in the NE.

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Changes in salinity and temperature are hypothesized to influence the success of "relaying", a process by which the load of Vibrios in oysters is reduced prior to sale.

What has been done

- The main experiments involved relaying oysters on a monthly basis to determine removal rates and efficiencies for reducing levels of *V. parahaemolyticus*. Relaying involves moving oysters from harvest sites where Vibrios are present to areas where Vibrios are absent or present only in low concentrations. The 2012 field season represented the 5th year during which Vibrio levels in oysters were monitored over the course of relaying.
- Vibrio levels were compared using the new CHROMagar culture method and quantitative Polymerase Chain Reaction (qPCR) to measure amounts of Vibrio-specific DNA.
- Gene sequences were compared for Vibrio populations over different time periods to determine whether the types of Vibrios present in the Estuary changed over the summer from year-to-year.

Results

- Across the 2012 field season (June through September), salinity and temperature (28 degrees Centigrade to 16 degrees Centigrade) varied. Even though water temperatures were conducive to Vibrio presence, levels declined to very low by October 2012, so that no relaying was conducted after September.
- Vibrio isolates from paired freshly harvested and temperature abused oysters were different, suggesting that temperature abuse changes the population structure and will not be a good strategy for studying relaying.
- Vibrio populations isolated during cold weather isolates were less diverse than those from warm weather.
- Six local and regional university and high school classes and meetings related to the project

focused on topics ranging from climate change to shellfish safety. The oyster relaying work has also shown unique dynamics and variability for *Vibrio* concentrations in oysters that have not been reported elsewhere, and suggests a biological factor is required for removal of *Vibrios*.

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 citizens engaged in educational presentations and workshops related to microcystins.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	250

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Cyanobacteria outbreaks in eutrophic lakes produce microcystin toxins that are linked to water quality issues and human health problems. With nearly 1000 lakes in NH, individuals residing near lakes and managers of local water supplies need information to make informed choices about how these bodies of water are used.

What has been done

Talks and workshops on cyanobacteria monitoring, and research on water quality and its health effects, were given to residents of Lake Winnepesaukee; citizens and professionals at the New England Chapter of the North American Lake Management Society; participants of the Canadian Water Conference; the Lake Attitash Association; citizens of Amesbury, MA; the general public and decision makers from the Town of Wolfeboro, NH; the Loon Preservation Society; and the Squam Lakes Association. Educational presentations were made to three UNH classes: Survey of Natural Resources and Introduction to Freshwater Resources, General Ecology, and Lake Ecology. Talks were also given to Project SMART (pre-college students) and the NSF supported "Connect Program" for minority students.

Results

A new method of monitoring cyanobacteria toxins was initiated in the UNH Lakes Lay Monitoring Program, which involves toxicological analysis of subsamples "punched" from chlorophyll filters that are routinely collected by citizen lake monitors. This effort has grown into the first citizen-based microcystin (MC) monitoring program for lakes and drinking water supplies.

The Interdisciplinary Lakes Management course addresses lakes with cyanobacteria bloom problems. Students interacted with local lake association members to increase their concern for water quality, further monitoring, and addressing the causes of the blooms. In Field Studies in Lake Ecology, students have learned the ecology of cyanobacteria blooms and how to sample for and quantify microcystins (MCs) in lake water components.

In extension outreach, research results have informed a wide range of stakeholders on how to best deal with cyanobacteria blooms. Research data from citizen and student monitoring have shown that MC levels rise with increasing total phosphorus concentrations in the lake. This information was instrumental in the decision of town planners, from three towns in the Lake Winnepesaukee watershed, to work to set appropriately low in-lake phosphorus criteria for their communities.

Education and outreach activities reached an estimated 90 adults directly, 650 adults indirectly, 30 youth directly, and 150 youth indirectly.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Vibrios are an emergent pathogen threatening consumers of oysters from revitalized oyster beds in NH's Great Bay and the nascent oyster harvesting industry in the Piscataqua watershed area.

What has been done

Results of the research were presented at six local and regional university and high school classes and meetings related to topics from climate change to shellfish safety. Dissemination involved frequent meetings with our shellfish industry partner, Spinney Creek Shellfish, to plan and carry out the oyster relaying experiments. We also engaged several researchers, outreach and education programs, cooperative extension departments, and other interested shellfish industry partners from Virginia to Maine in discussions about project findings and collaborations.

Results

Project findings and data were shared with the NH Shellfish Program manager and the Piscataqua Region Estuaries Partnership to help frame critical regional research needs. An ongoing collaboration with the non-profit organization Clean Air/Cool Planet included working with a research fellow during the summer to help develop outreach materials on climate change and pathogenic Vibrios for dissemination to the public, seafood industry, and public health/resource managers, especially in the Northeast US.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Biofilm, as growth on surfaces, represents the predominant microbial lifestyle on our planet. More than most environments, biofilms may harbor an immense diversity of species and genes. Biofilms pose many challenges that include antibiotic resistance or problems with decontamination. How this diversity assembles, evolves, and contributes to the overall function of the biofilm community is largely unknown. Biofilms may also be beneficial in the case of plant probiotic bacteria.

What has been done

To study biofilm ecology, NHAES researchers used an experimental evolution method that allowed diverse biofilm communities of *Pseudomonas* species to evolve under defined conditions. They developed a method to quantify fitness effects of altered clone physiology within the biofilm community as well as methods to identify rare variants.

Results

In experimental evolution, diversity observed in biofilms of the plant pathogen *Pseudomonas syringae* and the plant probiotic *P. fluorescens* biofilms were distinctly non-random. In both, diversity was essential for community function. Distinct bacterial types within a species utilized different ecological strategies (e.g., production of a metabolite governing the switch between free-swimming and biofilm lifestyles).

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

- Appropriations changes

Brief Explanation

Major reductions in state allocations through the University to the NH Agricultural Experiment Station have impacted project support.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

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

Yu, J.W. 2011. Incidence, abundance, postharvest processing and population diversity of pathogenic *Vibrios* in oysters from the Great Bay Estuary. M.S. Thesis. Dept. of Molecular, Cellular and Biomedical Sciences, University of New Hampshire, Durham.

Huey, K. 2011. Invasion of a littoral cladoceran, *Sida crystallina*, into the pelagic zone

of Christine Lake, NH, and its potential impact on the phytoplankton community. UNH Center Freshwat. Biol. Res. Vol 13 (2): 10-17.

Travers, B, A.L. MURBY and J.F. Haney. 2011. Bioaccumulation of microcystins by freshwater mussels in Mystic Lake and Middle Pond, MA. UNH Center Freshwat. Biol. Res. Vol 13 (1): 1-9. (not reported earlier).

Two of the four research projects in the program area are only a year old, and are expected to produce peer-reviewed publications in the next year.

Key Items of Evaluation

Two projects have led to extensive interactions with local, regional, or national stakeholders and resulted in increased awareness and/or new standards for monitoring.

- Project findings and data from one of the *Vibrio* projects were shared with the NH Shellfish Program manager and the Piscataqua Region Estuaries Partnership to help frame critical regional research needs.
- An ongoing collaboration with the non-profit organization Clean Air/Cool Planet enabled them to develop outreach materials on climate change and pathogenic *Vibrios* for dissemination to the public, seafood industry, and public health/resource managers, especially in the Northeast U.S.
- Increased knowledge of microcystins and cyanobacteria blooms has resulted in state and regional agencies working jointly with NHAES researchers to hold professional (water utilities, veterinarians, and agency staff) and public information sessions.
- Working with the NH DES Source Water Protection program and town water supply utilities, NHAES researchers initiated discussions to set state standards for microcystins (MC) in freshwater bodies and suggested sampling protocols they could employ. Specific assistance to the Town of Meredith resulted in their application for a source water protection grant to develop a MC monitoring program.

V(A). Planned Program (Summary)**Program # 4****1. Name of the Planned Program**

Global Food Security and Hunger

 Reporting on this Program**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			3%	
133	Pollution Prevention and Mitigation			4%	
135	Aquatic and Terrestrial Wildlife			4%	
201	Plant Genome, Genetics, and Genetic Mechanisms			4%	
202	Plant Genetic Resources			3%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			3%	
204	Plant Product Quality and Utility (Preharvest)			7%	
205	Plant Management Systems			4%	
206	Basic Plant Biology			4%	
211	Insects, Mites, and Other Arthropods Affecting Plants			3%	
212	Pathogens and Nematodes Affecting Plants			8%	
213	Weeds Affecting Plants			4%	
216	Integrated Pest Management Systems			1%	
301	Reproductive Performance of Animals			12%	
302	Nutrient Utilization in Animals			7%	
305	Animal Physiological Processes			5%	
307	Animal Management Systems			14%	
311	Animal Diseases			3%	
701	Nutrient Composition of Food			2%	
903	Communication, Education, and Information Delivery			5%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of FTE/SYs expended this Program**

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	7.0	0.0
Actual Paid Professional	0.0	0.0	20.5	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	1091178	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1426456	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	342079	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

NHAES scientists conducted applied and discovery research and undertook engagement with stakeholders in multiple aspects of plant and animal agriculture, related genetics and genomics, nutrition and health, and integrated aquaculture involving shellfish, finfish, invertebrates, and seaweed.

2. Brief description of the target audience

The target audience of this work includes consumers of animal and plant based foods and products, organic and conventional farmers, restaurants and other businesses reliant on local foods, master gardeners, home gardener associations, consumers and legislators, and those engaged in the extensive food systems network. It also includes scientists, veterinarians, agricultural researchers, Cooperative Extension specialists, agricultural teachers, graduate and undergraduate students, and the faculty and staff of the region's land grant universities.

3. How was eXtension used?

Farmers are referred to eXtension when the web site has information appropriate to their needs.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1994	1816	721	985

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

Year: 2012
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	1	35	35

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2012	83

Output #2

Output Measure

- Number of graduate students directly involved in the research

Year	Actual
2012	61

Output #3

Output Measure

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

Year	Actual
------	--------

2012 11

Output #4

Output Measure

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

Year	Actual
2012	0

Output #5

Output Measure

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

Year	Actual
2012	20

Output #6

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2012	6

Output #7

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2012	16

Output #8

Output Measure

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

Year	Actual
2012	3

Output #9

Output Measure

- Videos produced to highlight agricultural issues or methods.

Year	Actual
2012	2

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	Improved juvenile growth in cod aquaculture.
6	Knowledge about fatty acid composition in pasture fed and total mixed ration fed Jersey cows, and in their milk.
7	New genomic knowledge translated into tools and strategies to facilitate varietal selection through marker assisted breeding.
8	New commercialized varieties of cucurbit vegetables suited to state and region growing conditions.
9	Improved range of weed management options available for sustainable and organic growers.
10	New NH leafhopper data available through a web-accessible database
11	A working technology to produce triploid green sea urchins for use in natural harvest and land based aquaculture.
12	Improve understanding of the components and evolution of the reproductive neuroendocrine system in fish to provide tools for enhancing finfish aquaculture.
13	Evaluate new approaches to improving pasture and the production of baleage for organic and conventional farms in Northern New England.
14	Improve methods to study reproductive physiology in cows.
15	Identification soil borne pathogens of regional crops and devising production methods to control disease.
16	Increase knowledge about variation of ozone tolerance among soybean varieties.
17	Determine the extent to which cryptic hybridization between blue mussel (<i>Mytilus edulis</i>) and bay mussel (<i>M. trossulus</i>) occurs in commercial culture of mussels in New England, and assess the impact of sleeve culture on mussel heterozygosity and growth rate.

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

-High and low tunnels are being widely adopted across the region to extend the growing season for vegetables and enhance the region's local food capacity.

-As advanced production practices, the incorporation of cover crops may provide new ways to improve soil and reduce weeds.

-Across New England, there is great interest in local sources of wheat and other grains leads to the need for identifying modern varieties which are suited to the region. However, the reintroduction of grain production in New England comes with the heightened risk of infestations of wheat rust, as this fungal pathogen is harbored by widespread ornamental barberry.

-Economic evaluation of new day-neutral strawberry varieties and production methods must be carried out prior to grower adoption in the Northeast.

What has been done

-Variety trials were conducted for high tunnel cucumber, tomato, zucchini, and summer squash. Low tunnels are being used to overwinter moderate cold tolerant vegetables (onions).

-Specialty crop improvement included the sourcing and evaluating of 60 spring wheat varieties and advanced breeding lines, 40 winter wheat varieties and advanced breeding lines, and 20 winter triticale elite lines for performance as novel food grain and alternative forage crops at the NHAES Kingman Farm.

-Two videos were produced: a technical training video on isolating cereal rust pathogens from barberry (*Berberis* spp.) and an educational video (broad audience) on the life cycle of wheat stem rust.

-The first season of a two-year study evaluating the comparative performances of matted-row and raised-bed plasticulture strawberry production systems was completed.

Results

-Variety trials of each vegetable's performance indicated their growth in high tunnels in Northern New England and provided essential information to growers who want to add these crops to their own high tunnel production. Results of cultivars trials were disseminated to farms and master gardeners through three day-long grower conferences, two field days, farmer-to-farmer discussions, as well as ten one-on-one consultations. In addition, results were shared with professionals at three scientific conferences, through one peer-reviewed publication, and through emailed research reports that targeted growers.

-Variety trials for wheat and triticale will be completed in FY13.

-Information about videos, available at www.youtube.com/globalrust, will be disseminated through NHAES and UNHCE.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The research questions addressed by these projects emerged directly from organic and conventional dairy farmers in the region. If pasture-fed versus conventional dairies exhibited different nutrient composition in the milk each produces, this might demonstrate the added value of the pasture production and justify the higher cost of organic milk.

What has been done

NHAES scientists:

- evaluated milk production, milk composition, grazing behavior, markers of animal health (e.g., cortisol, antioxidant enzymes, etc.), nutrient digestibility, and nitrogen utilization in organic and conventional dairy cows fed kelp meal and flaxseed;
- evaluated and/or developed alternative feeding strategies to increase economic and environmental sustainability of organic and conventional dairy farms in the Northeast;
- determined whether pasture versus conventional, total mixed ration (TMR), influences the carotenoid content of bovine plasma or milk. (Carotenoids are essential nutrients for eye function.)

Results

- Incremental dietary levels of kelp meal did not improve animal performance, milk production or composition; however, the concentration of milk iodine increased linearly in response to incremental dietary levels of kelp meal. Notably, kelp supplements caused milk iodine levels to approach toxic levels for children.
- Incremental dietary levels of ground flaxseed linearly decreased dry matter intake, yields of milk and milk components, and methane emissions. Despite the positive response of ground flaxseed on mitigating methane emissions, decreases in milk yield may discourage farmers from feeding flaxseed, particularly in high levels (i.e., 15% of diet dry matter).
- Cutting red clover at sundown for baleage resulted in dry matter concentration of approximately 46% but did not preserve nonstructural carbohydrates; these were reduced by about half during fermentation. However, baleage quality appeared to be improved resulting in forage with enhanced nutrient digestibility as compared to red clover harvest at sunrise.
- Results showed that total carotenoids were significantly higher in milk from cows fed on pasture than conventional dairy total mixed ration (TMR); however, milk carotenoids levels varied over seasons in organic milk.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
305	Animal Physiological Processes
307	Animal Management Systems
311	Animal Diseases
701	Nutrient Composition of Food

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Acorn, buttercup/kabocha and butternut are the three most important classes of winter squash in North America. Good eating quality has been problematic in varieties of acorn, thus reducing consumer demand in retail markets. Most of the popular commercial varieties have nice appearance, but produce low starch and sugar content. Winter squash varieties vary in the composition and amount of carotenoid pigments, which are important nutrients for vision.

What has been done

NHAES researcher Loy has bred several F1 hybrid squash and evaluated the hybrids for eating quality, resistance to powdery mildew, and in collaboration with colleague Curran-Celentano, improved nutritional value (e.g. higher carotenoids).

Results

- Several F1 hybrids of winter squash show markedly enhanced eating quality, improved nutritional value and resistance to powdery mildew.
- One of these hybrids, Honey Bear, is now offered by several seed companies and another is scheduled for commercial production by a New England-based seed company.
- This past year, UNH hosted a field day at the Kingman experimental farms for growers to observe new experimental hybrids in pumpkins and squash. Cooperative Extension helped publicize the event which was successful; we plan to initiate more field days in the future to demonstrate new breeding results.
- Current efforts to promote new varieties of high quality acorn squash involve articles in trade magazines, newsletters disseminated by Cooperative Extension, and better variety description in seed catalogs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
701	Nutrient Composition of Food

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

While aquaculture is essential to ease the demand on wild fish stocks, it may have negative impacts on water quality and depends too heavily on fish-meal diets derived from wild harvested fish. The adoption of integrated multi-trophic aquaculture offers a sustainable alternative to intensive monoculture. Seaweeds and oysters could utilize waste products from finfish and sea urchins, increasing the economic potential of integrated multi-trophic aquaculture while minimizing the environmental impacts. The goal of this project is to develop integrated, multi-species aquaculture systems suited for New England which includes sea urchins, oysters, various indigenous seaweeds, seaworms, cod, northern NE species of marine baitfish (striped bass, bluefish, smelt).

What has been done

- The sea urchin hatchery produced one run of juveniles and tested a refinement of immediate introduction of fertilized eggs,
- The American oyster culture compared growth of seaweeds proximate to or distant from oyster culture cages.
- The finfish component of the project focused on determining ammonia production from fish, urchins, and sea worms.
- The seaweed project established cultures from wild-collected specimens of five native red seaweeds to remove nutrients from animal aquaculture effluent. Nutrient uptake has been examined in relation to nutrient concentration in the aquaculture system.

Results

- The major findings thus far for each portion of the project have led to refinements in experimental design and overall focus.
- Initial trials with warm water culture of European oysters and bait worms have been positive and will lead to their integration with black sea bass in the coming year.

- The information on ammonia production by sea bass, as well as sea urchins and bait worms, will be used to quantify the number (mass) of fish for recirculating integrated multi-trophic aquaculture systems.
- Intraspecific genetic variation was identified in the red alga *Porphyra umbilicalis*. This genetic variation will be exploited to improve the use of this red alga in multi-trophic aquaculture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
205	Plant Management Systems
302	Nutrient Utilization in Animals
307	Animal Management Systems
903	Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

Improved juvenile growth in cod aquaculture.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Aquaculture is becoming an increasingly important industry to supplant declining wild fisheries; however, desirable species such as summer flounder exhibit premature sexual maturation in aquaculture, which reduces their growth rate. Summer flounder females grow much faster than males, so methods to control differentiation in sexually dimorphic species would improve production rates in aquaculture.

Genistein and related flavones from soybean may influence sexual development in finfish.

What has been done

Immature summer flounder were fed increasing amounts of the flavone genistein from soybean. Histological studies were conducted to determine the impact of treatment on sexual differentiation.

Results

Moderate levels of genistein (100mg/kg) caused 96% of summer flounder to differentiate as females compared to 19% of control fish. This treatment should increase productivity of summer cod in recirculating aquaculture systems. Results were disseminated to local fish farmers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
903	Communication, Education, and Information Delivery

Outcome #6

1. Outcome Measures

Knowledge about fatty acid composition in pasture fed and total mixed ration fed Jersey cows, and in their milk.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There is increased concern in the US about the way food is produced and for the welfare of farm animals. The milk from pasture-fed dairy cows is known to have healthier ratios of omega 3 to omega 6 fatty acids and conjugated linoleic acids than that of conventional dairies where animals are confined to barns and fed total mixed rations (TMR). However very little is known about the relative health status of dairy cows in the two production systems.

What has been done

General and specific markers of health were measured for Jersey cows at the UNH Organic Dairy Research Farm (ORDF) and the UNH Fairchild Dairy, a conventional dairy. These markers included: body weights; body conformation scores; somatic cell counts; and levels of various biomarkers including cortisol (stress hormone), haptoglobin (anemia), fibrinogen (clotting), and white blood cell counts (infection). Comparisons were made within each group over time and between groups over time.

Results

-Cortisol levels, a stress hormone, at each of three time points during pasture season were significantly higher in the pastured cows as compared with those in the conventional system and varied significantly between time points within each farm. The temperature-humidity index was recorded and cortisol levels trended with the index in pastured cows but not those kept under more controlled conditions indoor at the conventional farm. The mild winter and other factors exacerbated an infestation of flies at the ORDF in 2012; these and the lack of shade were added environmental stressors compared to confinement barns in the conventional dairy which are equipped with cooling fans.

-Haptoglobin levels, which are correlated with hemolytic anemia, were not significantly different between groups but had a higher average and greater variability in the conventional group and showed significant differences within groups over time.

-Somatic cell counts, an indication of mastitis, were not significantly different between groups at either time point, but had a higher average and greater variability in the conventional dairy Jerseys.

4. Associated Knowledge Areas

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

Outcome #7

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Commercial strawberry varieties are octoploid; each plant has eight sets of chromosomes. Plants grown from seed segregate for many traits, hence, commercial strawberries are clonally propagated. However these clonal plants carry much higher viral disease loads. Alternative approaches for strawberry improvement include mapping important quantitative traits in diploid progenitors and using detailed molecular maps to facilitate marker-assisted breeding in

commercial strawberry.

What has been done

- A core breeding population of 1000 pedigreed strawberry plants and 200 hybrids was generated.
- An international consortium, including NHAES researchers, has mined the genome sequence of diploid strawberries to identify polymorphic markers for mapping and marker-assisted breeding.

Results

- NHAES researchers assisted in the construction of the first genetic linkage map in diploid strawberry.
- NHAES researchers assisted in the design of the first strawberry single nucleotide polymorphism (SNP) microarray, for use in marker-selected breeding.
- Using this microarray, and a second mapping population, NHAES researchers have identified new quantitative trait loci (QTLs) that influence two important agronomic traits: flowering habit and fruit color intensity.
- Genetic sources of resistance to Verticillium dahlia, a fungal pathogen of strawberry and mint, have been identified. Once mapped, these genes will be transferred to commercial strawberry with the use of marker-assisted breeding.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants

Outcome #8

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

-Agricultural regions growing squash and pumpkin for processing have considerably shrunken over the past three decades, mostly because of marginal profitability of the crop. In addition currently popular production varieties are susceptible to foliar and fruit rot diseases which have become problematic in production areas.

-NHAES researcher Loy, a premier breeder of cucurbits, has shown that interspecific hybrid varieties have higher yield, improved cooking qualities and potential resistance to soil borne pathogens.

-The appearance of abrasions and brown discoloration on the tender skin of yellow crookneck and straightneck squash in retail outlets severely reduces consumer demand for this vegetable. Glabrous spineless) varieties reduce injury to intact fruit from spiny stems and leaf petioles during windy weather, reduce fruit damage, and prevent skin irritation to workers during harvesting.

What has been done

-Interspecific hybrid varieties of winter squash from crosses of *Cucurbita maxima* (female parental lines) to *C. moschata* (male parental lines) were developed and compared to commercial varieties for growing characteristics and for processing.

- Seventy experimental hybrids and five commercial hybrid cultivars of ornamental pumpkin with intermediate powdery mildew resistance (PMR) were evaluated in single replicate, 10-plant plots. Most major size classes of pumpkin were represented, along with hybrids displaying new white and yellow rind colors.

-In melons, 37 experimental hybrids expressing a single gene trait, long shelf life (LSL), were compared to 7 commercial hybrids adapted to New England growing conditions and 23 short-season experimental hybrids not carrying the LSL trait.

-In breeding research on yellow summer squash conducted at the NHAES, a glabrous (trait has been incorporated into elite breeding lines and experimental hybrids.

-Three commercial hybrids and twelve experimental glabrous summer squash hybrids, some with PMR were evaluated for plant vigor, growth habit, fruit appearance and productivity.

Results

-F1 Hybrid *C. maxima* X *C. moshata* winter squash demonstrated hybrid vigor and increased yield. In part this is because their seeds are sterile, so photosynthetic energy is allocated primarily to the fleshy tissue of the squash rather than seed. Based on trials at UNH and with cooperating seed companies, six to ten of the hybrids included in the evaluation are being considered for commercial release.

-Based on evaluations at UNH experimental farms and elsewhere, one LSL melon hybrid is being slated for commercial production by a seed company in the Northeast.

-Yellow straightneck and crookneck summer squash varieties are less susceptible than the standard zucchini varieties to several diseases prevalent in New England; and so, the introduction of new yellow varieties which are easier to harvest and with better shelf appearance could dramatically expand acreage and demand for this important vegetable. One glabrous variety, Slick Pik YS26, of summer squash is currently being sold, and additional varieties are scheduled for release during the next two years.

4. Associated Knowledge Areas

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

Outcome #9

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Growers in New Hampshire are interested in using cover crops to suppress weeds and reduce the need for economically and environmentally costly herbicides.

What has been done

- Previous related work has captured the interest of farmers who wish to reduce their reliance on herbicides for weed control. Input on the current project has been solicited at regional growers meetings.
- The research included growing different cover crops in monoculture or mixtures to assess the impact on cover crop production, weed growth, the suppression of weed emergence, and growth from the seed bank.

Results

- The ultimate goal of this research is to develop crop and weed management practices that are economically sustainable and do not pollute the environment.
- NHAES scientists have shown that buckwheat and tillage radish are particularly weed suppressive cover crop species when sown in the spring and fall, respectively. These results have been disseminated via UNH Cooperative Extension to local farmers.
 - The results suggest that cover crops grown in mixture are no more weed suppressive than the most suppressive monoculture, but that biomass production of cover crop displays over-yielding tendencies when grown in mixture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
213	Weeds Affecting Plants

Outcome #10

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One hundred twenty eight leafhopper species are known to be vectors of different bacterial and viral disease. Except for in the Canadian Maritimes, no recent descriptions of the leafhopper species associated with agricultural crops are available for North America. The University of New Hampshire has a large and fairly comprehensive collection of New England leafhoppers, which is being leveraged against field collections to provide up-to-date information for extension agents and farmers.

What has been done

Leafhopper sampling, conducted in orchards and in vegetable and blueberry plots in south-central New Hampshire, involved organic, neglected, and managed farms. Comparison of leafhopper abundances and diversity were determined over two months, using different sampling techniques. These data were captured in a spreadsheet, and voucher specimens were placed into the insect collection.

Results

- Different collecting techniques were again shown to be differentially effective depending on the target leafhopper species.
- Potato leafhoppers are present whether farms are managed with chemicals or not, possibly due to immigration from peripheral areas, and can quickly become a major problem in organic farms. Potato leafhoppers are vectors of aster-yellows phytoplasma, those farms without cultivation or with a lack of herbicide strips, the insect vectors become extremely abundant and provide a serious threat to crops susceptible to these plant bacteria (phytoplasma).
- Recommendations were disseminated to growers with crops susceptible to aster-yellows phytoplasma, including carrots and certain nursery crops.
- In the last year of this project (FY13), an online database of leafhoppers is being developed for use by extension agents and growers.

4. Associated Knowledge Areas

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

Outcome #11

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	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 U.S. Processed sea urchin gonads (called uni) or whole urchins are sold in Japanese, American and other world markets. Alternatives to the direct harvest of wild sea urchins are vital to sustain this fishery that is the seventh largest in the Northeastern U.S. The aquaculture of sterile triploid sea urchins in near shore lease-sites will produce urchins with gonads that contain only nutrient storage cells called nutritive phagocytes (NPs), which are the preferred form of uni.

What has been done

Green urchins in the Gulf of Maine have three month reproductive period (December to late March) which constrains experimental work.

NHAES scientists expanded laboratory methodology to commercial levels in producing triploid sea urchins:

- transplanted juvenile triploid urchins in a Hatchery environment and
- identified and trained undergraduates for experiments scheduled during the next reproductive season.

Results

- Animals were collected at the aquaculture study site and provided for laboratory studies for triploid production.
- The hatchery produced one batch of juvenile urchins and these juvenile urchins were cultured under several feeding and density regimes in preparation for culturing of triploid embryos and

larvae in the coming year.

- Phytoplankton cultures are established and the hatchery is ready to begin culture of triploid larvae as soon as they are available.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #12

1. Outcome Measures

Improve understanding of the components and evolution of the reproductive neuroendocrine system in fish to provide tools for enhancing finfish aquaculture.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There is a need for a better understanding of the neuroendocrine system and how the hypothalamus of the brain regulates puberty. This information may be applied to improve finfish aquaculture by delaying puberty and increasing juvenile growth.

What has been done

- NHAES researchers participated in the genome sequencing and annotation of the sea lamprey, one of the two surviving lineages of ancestral fish.
- A variety of approaches were used to identify different components of the reproductive neuroendocrine system in the sea lamprey and black sea bass.

Results

- The major findings from the NHAES researchers' studies include the distribution of an estrogen receptor in the brain of lamprey, the identification and function of a novel gonadotropin-inhibiting hormone and a PQRamide hormone (RFamide peptides), the cloning and pharmacological characterization of two novel Gonadotropin-releasing hormone (GnRH) receptors in the lamprey, and the identification of two GnRHs in the black sea bass brain.
- Comparative genomics provide evidence to support the hypothesis that major brain circuits and

underlying molecular machinery regulating reproduction were established at the beginning of the vertebrate radiation, and are still present in lampreys. This area of study is significant because these more complex mechanisms in later-evolved vertebrates arose through elaborations of the basic architecture that is present in lampreys today.

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

Evaluate new approaches to improving pasture and the production of baleage for organic and conventional farms in Northern New England.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The cost of organic feed grains has steadily risen over the past several years, prompting organic dairy farmers in our region to look for alternatives to imported grain. The diversification of pasture resources may provide opportunities to extend the grazing season, buffer forage production against climate variability, and increase the production of on-farm feed grains.

What has been done

Researchers at the University of New Hampshire are investigating the effects of multi-cultivar forage mixtures and feed-grain intercropping systems on forage production and stability. Stakeholder input is sought through advisory board meetings associated with a related, externally-funded project that is focused on organic dairy and discussed at farmer field days and grower meetings.

Results

Preliminary NHAES research results suggest that forage grass production can be enhanced when

grown as multi-cultivar mixtures. The project interfaces with UNHCE, as it is associated with another externally-funded project that has a large extension/outreach component.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
213	Weeds Affecting Plants

Outcome #14

1. Outcome Measures

Improve methods to study reproductive physiology in cows.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Impaired reproduction is the major cause of reduced productivity and profitability for dairy and meat producers. NHAES scientists participated in a multistate research project to identify genetic, morphological, and physiological attributes of the ovaries of ruminants (cows, sheep) with the overall goal of improving fertility in these animals. One objective is to understand the physiology of subtypes of endothelial cells (EC) within the bovine corpus luteum (CL). EC cells contribute to the vasculature of the ovary and are important to the maturation and release of eggs, a critical process in fertility.

What has been done

-In collaboration with investigators from Penn State, NHAES scientists developed new methods of isolating high numbers of luteal-derived EC cells from whole tissue homogenates and of cryopreserving these EC cells.
-In addition, NHAES scientists refined methods to isolate and culture EC cells, which were used to advance investigations of their roles in ovulation.

Results

-The new methods of isolating and culturing EC led to greater knowledge about the complex mechanisms that drive the development and maintenance of EC. These involve known factors

that promote the development of vasculature (angiogenic factors), such as matrix metalloproteinases (MMPs) and the tissue inhibitors of metalloproteinases (TIMPs).
 -Notably, a possible new player, called CCN1, was identified in the development of blood vessels(angiogenesis) that not been previously described to be present in the bovine follicle and the CL. CCN1, an angiogenic inducer, was more highly expressed in the early stage of follicle growth, in developing CL rather than in the mid cycle and late stages of follicle development.
 -Further experiments are now possible to determine the interplay between CCN1 and known angiogenic factors during the transition of the ovarian follicle to the progesterone-producing CL.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals

Outcome #15

1. Outcome Measures

Identification soil borne pathogens of regional crops and devising production methods to control disease.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Soilborne pathogens are a diverse group of pathogens that reduce plant emergence and infect plant roots and crowns. The result is reduced plant productivity, increased costs to the grower and potential ecological damage to the adjacent natural environment.

What has been done

NHAES researchers characterized isolates of *Rhizoctonia solani* a fungus associated with 'damping off' of various crop seedlings.

Results

-NHAES researchers established that there are three distinct anastomosis groups of *Rhizoctonia solani* that are capable of infecting wheat; members of an anastomosis group are able to vegetatively fuse and potentially reproduce sexually. These anastomosis groups likely represent individual species. This knowledge will have an impact on growers and industry and academic

researchers as they move forward in developing chemical, biological, and cultural control strategies for all three distinct pathogens, which were previously believed to be a single species. -NHAES researchers determined anastomosis group AG2-1 of *R. solani* infects both canola and wheat; crop rotation with wheat and canola will likely lead to reduced yield due to infection by this fungus. This is an important finding as wheat is currently recommended for rotation with canola to reduce the incidence and severity of Sclerotinia stem rot and Blackleg of canola.

4. Associated Knowledge Areas

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

Outcome #16

1. Outcome Measures

Increase knowledge about variation of ozone tolerance among soybean varieties.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

-Ozone is a major environmental stressor of crop plants. In order to develop plants that are tolerant of ozone, we must understand the biochemical and physiological effects of ozone on plants and their interaction with the genetic background of plants.

- Polyamines (putrescine, spermine, spermidine) are thought to be biomarkers for abiotic stress.

What has been done

Activities were collaborative with Dr. Kent Burkey of North Carolina State University. He treated several soybean cultivars in open top chambers with varying levels of ozone (25- 120 parts per billion). Ozone treated plants were analyzed for polyamine content in Minocha's lab at the NHAES.

Results

-There are strong correlations between cellular polyamines and the tolerance of certain genotypes to ozone.

- Low levels of constitutive polyamines were correlated to low tolerance to ozone.
- Enhanced accumulation of polyamines (generally by 3 to 5-fold) was found to be a component of resistance to O₃.
- Interestingly, increases in polyamines less than 3-fold or more than 10-fold were not protective to ozone damage.

4. Associated Knowledge Areas

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

Outcome #17

1. Outcome Measures

Determine the extent to which cryptic hybridization between blue mussel (*Mytilus edulis*) and bay mussel (*M. trossulus*) occurs in commercial culture of mussels in New England, and assess the impact of sleeve culture on mussel heterozygosity and growth rate.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Blue mussel (*M. edulis*) is part of a species complex with bay mussel and Mediterranean mussel. Species identification is primarily based on morphometric features of the shell; however these features are highly plastic under different environmental conditions (wave exposure, salinity, position in the intertidal). Further the three species readily hybridize. The shell of bay mussel is more fragile than that of blue mussel, whereas hybrids have intermediate fragility. Mussels attach to rope culture through byssal threads. Managers of mussel aquaculture facilities are concerned about the extent of natural hybridization.

What has been done

-Wild mussels of various size classes were collected from the Coastal Marine Lab Pier (CML) and from the Wentworth by the Sea Marina (WSM). Rope-cultured mussels were obtained from Pemaquid Mussel Farm (PMF).

- DNA has been extracted from all samples and because PMF mussels exist in the region with another mussel, their species identity has been confirmed using a molecular marker.
- Mussels were characterized for growth rate, for cryptic hybridization and heterozygosity (genetic diversity) using various molecular markers.

Results

- Less than 0.01% of rope-cultured mussels were found to be *M. trossulus* (bay mussel), and no *M. edulis* x *trossulus* hybrids were found.
- Cultured mussel heterozygosity correlates negatively with mussel size, indicating a loss of heterozygous individuals over time.
- Preliminary data suggest that more byssal threads are produced during the winter by epibiont (barnacles)-covered mussels exposed to lower wave action. Similarly, effluents of crab predators and injured mussels elicit an increase in byssal thread production but effluents from sea stars, sea urchins, and lobsters had no influence.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Dramatic reductions in state appropriations to the University System and NHAES forced the station to decrease the size of the conventional dairy herd and number of the farm support staff; budget cuts also reduced the funds available to individual research projects. This slowed progress on many research projects. An unusually warm winter, with limited snow cover (2012), led to increased problems with ticks, flies, and other insects and resulted in mild drought conditions that impacted some field research.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The primary criteria for productivity for projects covered in this planned program are a robust record of peer-reviewed publication. Projects in this planned program produced 32 peer reviewed papers as well as five graduate theses, and five book chapters.

Multiple (14/29) NHAES projects have strong coalitions with UNHCE, assuring stakeholders are kept up to date with research outcomes.

Key Items of Evaluation

The NHAES director initiated an annual education session at the NH Farm and Forest Expo, the premier statewide conference for the state agricultural and forestry community. The event provides an opportunity for stakeholders to learn about ongoing research and provides NHAES with feedback from those stakeholders.

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: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.2	0.0
Actual Paid Professional	0.0	0.0	0.7	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	26143	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	550000	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

One research project is covered in this planned program area. The project reached the design phase for an aerobic composting facility, raised donor funding to build the composting facility, and

evaluated machines to produce animal bedding from cord wood.

2. Brief description of the target audience

In the Northeastern U.S., dairy farmers and equine operations require large amounts of animal bedding. These stakeholders are interested in the overall goals of this project, using woodlots to provide animal bedding and using aerobic composting to produce soil amendments, capture heat for various farm operations, while reducing off-farm inputs for animal bedding and reducing emissions of the greenhouse gas.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	6	4	0	0

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

Patent Applications Submitted

Year: 2012

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Output #2

Output Measure

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

Not reporting on this Output for this Annual Report

Output #3

Output Measure

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

Year	Actual
2012	2

Output #4

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2012	1

Output #5

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2012	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
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In the Northeastern U.S., the cost of off-farm inputs for animal bedding and energy are economic constraints for the viability of the farming operation as are the ecological impacts of managing animal manure. Aerobic composting presents an alternative method of extracting energy for farm operations, potentially reducing greenhouse gas emissions, and producing aged compost for pasture improvement.

What has been done

- researchers contributed to the design of the novel aerobic composting facility.
- Several types of industrial wood chippers, grinders, and shavers were evaluated for cost, ease of use, and time requirements.
- A one-acre test plot was logged to set aside wood for bedding preparation in the next year.

Results

- The design attracted the interest of Brian Jerosse of Waste Not Resources Solutions, Enosburg Falls, VT. Subsequently, Mr. Jerosse became an active partner in the facility design.
- A wood shaver was identified as the most appropriate means to produce animal bedding.

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Government Regulations
- Competing Programmatic Challenges
- Other (Competing time demands)

Brief Explanation

The PI for this project serves as the University Provost. This limits his availability on a day to day basis. The primary delays were to meet State and University regulations for building design and to raise \$550,000 in construction costs, from a single donor.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The goal is provide farmers with an easy to use model to evaluate whether it would be profitable to invest in a wood shaver or perhaps initiate a regional co-op to invest in the machinery. The economic model for "on-farm animal bedding" is still being developed. The model will be tested once wood shaving and large scale aerobic composting of manure and waste bedding have been initiated.

Key Items of Evaluation

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			10%	
112	Watershed Protection and Management			29%	
133	Pollution Prevention and Mitigation			2%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			25%	
403	Waste Disposal, Recycling, and Reuse			4%	
511	New and Improved Non-Food Products and Processes			3%	
608	Community Resource Planning and Development			10%	
901	Program and Project Design, and Statistics			7%	
903	Communication, Education, and Information Delivery			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.8	0.0
Actual Paid Professional	0.0	0.0	1.3	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	107415	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	313082	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	338091	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research conducted under this planned program ranged from discovery to applied science, including:

- studying nitrogen-fixing symbiosis of Frankia bacteria with actinorhizal plants that are important for land reclamation, fuel and fiber.
- evaluating baseline flow and seasonal storm fluxes of nitrate, phosphate and nitrogen in organic matter in the Lamprey River. This work is part of a larger effort to understand the source of nutrient inputs into eutrophic and endangered Great Bay of NH.
- identifying methods to enhance public participation in surveys of natural and agricultural resources. Refined survey methods have been introduced into upper division courses in resource economics.

2. Brief description of the target audience

The target audience include scientists working with actinorhizal plants, university students, NH Department of Environmental Services, NH Fish and Game, municipalities in the Great Bay Watershed, Piscataqua Regional Estuaries Partnership (PREP), and the Environmental Protection Agency.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2195	11037	40	0

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

Patent Applications Submitted

Year: 2012
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	6	6

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2012	12

Output #2

Output Measure

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

Year	Actual
2012	11

Output #3

Output Measure

- Number of stakeholder venues where results have been presented.

Year	Actual
2012	9

Output #4

Output Measure

- Web sites featuring results from NHAES research.

Year	Actual
------	--------

2012

2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	A spatially distributed river network model for the Great Bay watershed that relative land use sources and sinks for N, P and C.
2	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.
3	Number of stakeholders involved in presentations about magnitude and potential impacts of regional airborne nutrient deposition.
4	Increased understanding of the basis of interactions between Nitrogen fixing symbiotic Frankia bacteria and their actinorhizal plant hosts.
5	Evaluate web-based tools and mixed method approaches to engage stakeholders groups in survey research of Natural Resource and Agricultural Resource Management Policies

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Excess nitrogen and dissolved organic carbon in the watershed contribute to the eutrophication of the NH Great Bay Estuary. The Environmental Protection Agency and towns in the watershed need to know where nitrogen and dissolved carbon are coming from in order to make the best use of limited resources to restore the bay.

What has been done

- A suite of in situ water quality sensors was deployed in the Lamprey River to investigate seasonal storm flux and baseflow patterns and processes.
- Transplanted eelgrass beds were established downstream of two potential sources of pollution, a waste water treatment plant and a buffalo and dairy farm, and near a partially forested recreation area (control). Samples were collected for Nutrient Pollution Index studies to validate studies of the relative uptake of nitrogen in eelgrass from potential non-point sources of pollution.

Results

- During storm events, the nitrate concentration response exhibited a seasonal variability that may be attributed to seasonal land management practices and legacy pollutant impacts (the result of historical nutrient reserves).
- Nutrient concentrations vary during single storm events and among multiple storms occurring at different times throughout the year.
- Phosphate and dissolved organic carbon are limited by the amount of water flow.
- Dissolved organic carbon and phosphate concentrations typically peak as discharge declines during storms.
- Storms either increased or decreased nitrate concentrations; differences may indicate dissolved salt in groundwater.
- Nitrate concentrations are more variable throughout the year than dissolved organic nitrogen concentrations.

-Non-point nitrogen loading to the Great Bay includes both nitrate from anthropogenic (human activity) sources and dissolved organic nitrogen from wetlands.

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

Outcome #2

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The sources of excess nutrients in NH's Great Bay include both point sources (inadequate sewage treatment plants) and non-point sources (leaky septic systems, agricultural runoff, fertilizer from lawns, and runoff from a growing percentage of impervious surfaces like roadways and parking lots). Establishing the relative contributions of these inputs into the Great Bay is critical to guiding investments to remediate this pollution.

What has been done

Sensors were placed in different headwater streams draining three land use types to evaluate different stream responses to storm events. The three sites were Saddleback Brook in Deerfield, NH (forested reference); Wednesday Hill Brook in Lee, NH (suburban with septic waste); and Burley Demeritt Creek in Lee, NH (organic dairy).

Results

-Preliminary results on nutrient inputs from headwater streams of the Lamprey led to an improved understanding of the Lamprey watershed processes and data required to model nutrient fluxes.

- Non-point nitrogen loading to Great Bay includes both nitrate from anthropogenic sources and dissolved organic nitrogen from wetlands.
- Storm responses in both the suburban and agricultural sites resulted in a dilution of nitrate, except in late summer when flushes (increases) were observed.
- Baseflow nitrate is higher in the agricultural than suburban watershed.
- Diurnal variation in nitrate at baseflow in both suburban and agricultural catchments indicates uptake by algae or submerged plants.
- Nutrient loading is higher during storms than during baseflow, with the agricultural catchment, in general, having higher loads than the suburban catchment.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #3

1. Outcome Measures

Number of stakeholders involved in presentations about magnitude and potential impacts of regional airborne nutrient deposition.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	300

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The impact of airborne sources of nitrogen (nitrous oxide, nitrogen dioxide), mercury and other compounds on nutrient loads to watersheds is poorly understood. Excess nutrients may result in poor water quality.

What has been done

The levels of deposition of atmospheric pollutants are monitored regionally: in Durham NH, at the Hubbard Brook Long term ecological research site and in the tropics (Puerto Rico).

Results

Information about the magnitude of deposition of atmospheric nutrients was disseminated to nine stakeholder groups in the Great Bay watershed and seven presentations to scientists at national and international conferences

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #4

1. Outcome Measures

Increased understanding of the basis of interactions between Nitrogen fixing symbiotic Frankia bacteria and their actinorhizal plant hosts.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The bacteria Frankia form a symbiotic nitrogen-fixing association with over 200 species of plants in eight different families. Frankia establish nodules on filamentous roots referred to as actinorhizal plants. These actinorhizal plants are widely used in mine land reclamation and as a source of fuel and fodder for ruminant animals by subsistence farmers. Frankia have broad host ranges for symbiosis, however, little is known about how the bacterial strains recognize their hosts.

What has been done

- Next generation DNA sequencing has enabled researchers to generate the complete genome sequences for multiple strains of Frankia.
- A new semi-high throughput assay system has been developed to screen how plant root secretions (exudates) trigger changes in gene expression in the bacteria.
- Frankia strains were screened for heavy metal tolerance and their ability to break down environmental pollutants such as aromatic hydrocarbons.
- Changes in bacterial gene expression in the presence of various hydrocarbons were measured.

Results

- Comparing genome sequences of Frankia has led to the discovery of several gene clusters whose proteins produce novel compounds, which may be important in bacterial/plant symbiosis and nitrogen fixation.

- Genes for the synthesis of the plant hormone auxin were identified in Frankia; the bacterial production of auxin likely has a role in directing the plant to form nodules where the bacteria are able to fix nitrogen.
- Potential host recognition genes in Frankia were identified using bioinformatics analysis.
- The identification of key bacterial and plant genes involved in stress responses and survival in harsh environments will help efforts to extend the use of actinorhizal plants for bioremediation, soil stabilization, nurse cropping, biomass production, and land reclamation in the U.S. and across the developing world.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Evaluate web-based tools and mixed method approaches to engage stakeholders groups in survey research of Natural Resource and Agricultural Resource Management Policies

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

A common source of error in measuring public opinion to natural resource and agricultural management policies is that a high percentage of stakeholders fail to respond to surveys about policy or behavior.

What has been done

Seven different applied studies were conducted using innovative methods of data collection, and included:

- Evaluating the Efficacy of Wildlife Feeding Ordinances as a Management Tool for Reducing Human-Bear Conflicts in New Hampshire. This study sought to compare the level of nuisance bear activity within and between communities with and without wildlife ordinances. This study used both online surveys with and without reminder post cards.
- Evaluating the Attitudes and Preferences of Online Survey Participants Monitoring Eastern Wild Turkeys in New Hampshire. This NHAES research assisted NH Fish and Game with the

augmentation of their Wild Turkey monitoring program by enhancing the "online survey process" that a served to make the process more efficient in order to reach a broader constituent base.

Results

- Preliminary results from the bear study showed that wildlife ordinances can be an effective management tool to reduce human/bear conflict. In addition, the reminder post card increased participation in the survey by 12%, leading to an enhancement of the study sampling strategy of ordinance and non-ordinance communities and the development of a practical ground-validation strategy.
- A turkey brood survey attracted 960 participants in over 152 towns; 43% of these people chose to complete the online survey.
- Different enhancements to applied surveys will be used to develop a better understanding of the social science of non-response error rate in survey research across policy/programs and stakeholder groups.

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

In the last biennium the State of NH cut appropriations to the University System and NH Agricultural Experiment Station by 18%. This resulted in reduction of support dollars to individual research projects, and cuts of support personnel.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

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

Key Items of Evaluation

NHAES research is making significant contributions to the knowledge base needed to target efforts to reduce nutrient pollution of the Great Bay Estuary.

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			16%	
133	Pollution Prevention and Mitigation			5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			20%	
403	Waste Disposal, Recycling, and Reuse			10%	
405	Drainage and Irrigation Systems and Facilities			5%	
605	Natural Resource and Environmental Economics			2%	
608	Community Resource Planning and Development			2%	
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			15%	
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: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.1	0.0
Actual Paid Professional	0.0	0.0	2.3	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	95727	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	147719	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1731	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Discovery and applied research was conducted to improve ornamental horticultural crops and analyze demographic changes and special societal needs in rural populations.

2. Brief description of the target audience

Stakeholders of this research include the overall rural population; nursery and greenhouse producers; landscapers; and town, county, state and federal agencies charged with planning for and delivering services to changing rural populations.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	275	20400	0	0

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

Patent Applications Submitted

Year: 2012
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	3	3	6

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Output #2

Output Measure

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

Year	Actual
2012	7

Output #3

Output Measure

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

Year	Actual
2012	8

Output #4

Output Measure

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

Year	Actual
2012	6

Output #5

Output Measure

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

Year	Actual
2012	10

Output #6

Output Measure

- Number of graduate students directly involved in the research activities.

Year	Actual
2012	5

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

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

Outcome #1

1. Outcome Measures

Increased knowledge about economics and policy related to waste management.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Solid waste management continues to be a problem for local governments in rural communities. Concerns include rising costs, and facilities siting problems. Town governments are looking into privatization as a way to increase efficiency and reduce direct costs to their limited tax base.

What has been done

A town level survey of households in towns considering adopting single stream recycling was conducted. Three towns with different demographics were surveyed.

Results

Survey results and contingent choice analysis revealed most respondents do not favor single stream recycling adoption or curbside collection in their towns. Results also indicated that respondents were willing to pay a per bag fee to recycle, and that they were not willing to pay additional amounts for the "convenience" of single stream.

These results were disseminated to municipal and state waste management and planning agencies.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

Outcome #2

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Rural families face economic and life obstacles not experienced in urban areas: limited types of employment; lower wages; difficulties in arranging child care; and inadequate access to health care, especially mental health care. Statewide policies are often designed around urban communities without consideration of special obstacles to their implementation in rural areas. One of the greatest difficulties is finding out what family support services are available in rural areas.

What has been done

Semi-structured in depth interviews were conducted with eight rural, poor families to assess how they learn about health care and other support options.

Results

In 2008, the NH 2-1-1 service was initiated. It is supported by charitable, corporate, and state agencies to provide one-stop shopping for information about health care and other support opportunities. Interviews conducted in the NHAES project demonstrated that rural, low-income families benefit from access to community services through NH 2-1-1 as compared with prior periods.

4. Associated Knowledge Areas

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

Outcome #3

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
2012	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

- The research objective is to develop modified production systems for woody nursery crops in northern nurseries, which enhance the growth and quality that result in lower production costs and better availability of locally grown landscape plants.
- Controlled freezing tests will help develop a better understanding of root cold tolerance and confirm whether different container types can affect cold tolerance in woody plants.
- Current production systems (pot in pot) lead to malformations of growing roots, which may result in plant failure after landscaping.

What has been done

- Modified sampling procedures for root cold tolerance tests on excised roots were developed. Multiple freezing tests were conducted on five species acclimated under natural conditions.
- Eight presentations on tree and shrub container production were given at research field days, horticultural conferences, and landscape association meetings, etc.
- A video on tree nursery production methods was produced and is accessible, along with other updated information on the UNH Extension nursery crop production webpage, at <http://extension.unh.edu/Agric/AGNLT/NLTNC.htm>.

Results

- Over 80% of the 257 people who attended the related presentations increased their knowledge and are making more informed tree purchasing choices by opting for trees with improved root morphology, which will reduce landscape failures.
- Over 90% of the growers attending the nursery conferences indicated the intention to adopt new practices based on the presentations, impacting a total of \$1.28 million dollars in plant sales.
- A total of 321 people viewed the video on production methods for landscape trees.

4. Associated Knowledge Areas

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

Outcome #5

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
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

- Most greenhouse crops are fertilized with a water-soluble fertilizer on a constant or near-constant basis. Although constant liquid feed programs are relatively easy to manage, they can be very wasteful unless runoff is captured and reused.
- Controlled-release fertilizers (CRF) represent a potential economical alternative, with considerably less loss of excess fertilizer to the environment but have not yet been widely adopted in greenhouse production.
- Recent advancements in CRF production have decreased the size of fertilizer particles and provide more precision in nutrient delivery.

What has been done

- The growth of Gerbera and Begonia plants and seed geraniums and marigolds were compared with different treatments of controlled-release fertilizer or water-soluble fertilizer.
- Plant growth was measured as dry weight at termination and the cumulative leachate for nutrients were measured.
- These experiments were repeated for more than a year-long period, while monitoring air and substrate temperature and light levels, to develop guidelines for use of CRFs in greenhouse production systems.

Results

- The information from this study is providing guidelines in order for greenhouse growers to utilize controlled release fertilizers in fertilizer programs.
- The switch from constant liquid fertilizers to controlled-released fertilizers in greenhouse production systems has the potential to reduce fertilizer costs as well as environmental impacts.
- The guidelines for CRF application in Begonia, Gerbera, marigold, and geraniums in greenhouse production have been distributed through trade magazines and presentations at greenhouse

grower conferences, including Plant nutrient triangle, 2012; OFA Perennial Conference, Grand Rapids, MI; Using controlled released fertilizers in the greenhouse, 2012; and Ohio Florists' Short Course, Columbus, OH.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Determine demographic trends in rural areas of NH.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Rural populations continue to change. Knowledge about the demographics and needs of rural populations is critical to municipal, county, state and national policy makers and planners.

What has been done

Census data has been evaluated and compared to previous demographic information about the Northern Forest of NH and New England.

Results

- There is growing diversity and poverty of children in rural areas
- Although racial and ethnic diversity in NH remain modest, more than 50% of the state's population growth over the first decade of the century were among minority groups.
- There are changing patterns of natural population increase in rural areas of Northern New England
- Details of these findings have been widely report in media outlets; more than 1000 copies of the Carsey's Institute Policy Brief were distributed; the same brief was downloaded 1100 times so far
(<https://carseyinstitute.unh.edu/sites/carseyinstitute.unh.edu/files/Report-Carsey-Meta-web->

reduced.pdf)

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

- Significant reductions in state funding to the University System and the NH Agricultural Experiment Station has reduced support for staff and individual research projects.
- The Great Recession and its nascent recovery has impacted migration to and from rural parts of NH.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

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

Key Items of Evaluation

In this planned program area, demographic studies by Ken Johnson of the Carsey Institute are supported by a multi-state project. His work is widely followed by the press and by policy makers. For example, research findings about the growing diversity of the child population in rural areas have been widely reported and frequently quoted both in academia and the media. Overall, Johnson's work has been cited more than 3000 times in the media (newspapers, news magazines, TV, and radio outlets) over the last five years.

V(A). Planned Program (Summary)**Program # 8****1. Name of the Planned Program**

Agricultural Biotechnology and Genomics

 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
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			33%	
304	Animal Genome			33%	
306	Environmental Stress in Animals			34%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Actual Paid Professional	0.0	0.0	0.8	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	42367	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	67116	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

Discovery research was conducted under this planned program with regards to mechanisms of plant hormone (auxin) transport and signal transduction, how turnover of messenger RNAs is regulated in yeast, and which molecular mechanisms induce a fatal leukemia in soft shell clams. Clam leukemia contributed to the collapse of the soft shell clam fishery the northeastern U.S. and Canada in the 1990s, which resulted in major job losses and other economic hardships.

2. Brief description of the target audience

Molecular and marine biologists, university undergraduate and graduate students, clam fisherman and shellfish scientists in the U.S. and Canada. Outcomes of this research are also of interest to the broader public because of the long term productivity for agriculture, restoring the shellfish industry and for understanding cancer.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	158	20	13	28

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

Patent Applications Submitted

Year: 2012

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	4	4

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Undergraduate students trained in state of the art molecular biology.

Year	Actual
2012	16

Output #2

Output Measure

- Graduate students trained in the project

Year	Actual
2012	3

Output #3

Output Measure

- Book chapters published describing research results

Year	Actual
2012	2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Development of clam model system for leukemia
2	Implementation of new analytical approach to examine how organisms adapt to environmental changes by using altering gene expression via translational regulation

Outcome #1

1. Outcome Measures

Development of clam model system for leukemia

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The soft shell clam develops a fatal leukemia at high incidence (up to 20%) in natural populations along the northeastern coastal U.S. and Canada. This disease contributed to the collapse of the soft shell clam fishery in the 1990s. Over the course of this study, a culture system of cancerous hemocytes (clam blood cells) was developed to investigate leukemia in clams and provide comparisons and insights into the development of human leukemia.

What has been done

- The sequencing and annotation of the genome of soft shell clam, *Mya arenaria*;
- Monitored changes in the intracellular localization of a tumor suppressor protein p53 associated with the onset of cancer.
- Human cell lines for human neuroblastoma and acute myeloid leukemia (AML) and cancerous clam hemocytes were treated with small, interfering RNAs (Rnai) to decrease production of protein mortalin, which acts on p53.

Results

Walker's lab in the NHAES:

- led work to obtain the full genomic sequence for *Mya arenaria* and disseminated this data to interested individuals,
- determined that cytoplasmic sequestration of wild type p53 is responsible for immortalization of clam hemocytes; this transformation is a hallmark of cancers,
- confirmed that mortalin is over-expressed and responsible for inactivation of p53,
- demonstrated the high conservation of molluscan p53 upstream and downstream gene regulatory sequences with those of human p53 related genes,
- data from this study was used to initiate studies of human cancers with cytoplasmic sequestration of p53 in human neuroblastoma and Burkett's lymphoma.

4. Associated Knowledge Areas

KA Code	Knowledge Area
306	Environmental Stress in Animals

Outcome #2

1. Outcome Measures

Implementation of new analytical approach to examine how organisms adapt to environmental changes by using altering gene expression via translational regulation

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Central Dogma of Molecular Biology states that information stored in DNA is transcribed into messenger RNA (mRNA), which is translated into protein. The control of mRNA metabolism represents one of the major steps in the regulation of protein synthesis and is important to all organisms as an essential component of adaptation to rapid changes in the environment. New approaches are needed to understand the function of protein complexes that regulate translation. mRNAs have a long polyadenylated (polyA) tail. The protein CCR4 degrades the polyA tail, destabilizing the mRNA and thereby reducing protein production. The length of the polyA contributes to how long each mRNA exists, and hence the amount of protein that can be made from that mRNA.

What has been done

A very sensitive fluorescent detection system combined with analytical ultracentrifugation (AU-FDS) was developed by UNH researcher Prof. Tom Laue. AU-FDS was used to detect changes in mRNA bound to protein complexes associated with changes in protein translation, and specifically with those RNA-binding proteins associated with CCR4 during mRNA polyA breakdown.

Results

The AU-FDS system detected a new translational complex, not previously described by other experimental approaches. This complex, including CCR4 and other proteins is associated with deadenylation of mRNA. Since CCR4 is functionally conserved in plants and animals, the new

complex is expected to have a role in the regulation of agriculturally important organisms that regulate translation in response to rapid environment changes. These results were described in four peer-reviewed papers.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes

Brief Explanation

NH State Appropriations to the University System and the NHAES were dramatically reduced in the last bienium. As a result less support dollars were available to NHAES research projects

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The primary criteria for productivity for projects covered in this planned program are a robust record of publication. For the last fiscal year, three NHAES researchers in the area published four peer reviewed papers in prominent journals and two book chapters.

The work on the Clam Leukemia system has attracted the wide spread attention of environmental scientists and cancer researchers.

The three research projects covered in this planned program have been particularly successful in training undergraduates, with approximately 16 students participating in research over the last federal physical year.

Key Items of Evaluation

Understanding what triggers the high incidence of clam leukemia in the Northeast is of continued concern for the shellfish industry and is of interest to human cancer researchers. NHAES Walker researcher presents research progress updates annually at the Maine Fisherman's Forum.