2009 University of New Hampshire Research Annual Report of Accomplishments and Results

Status: Accepted

Date Accepted: 06/16/2010

I. Report Overview

1. Executive Summary

The New Hampshire Agricultural Experiment Station (NHAES) resides within the University of New Hampshire College of Life Sciences and Agriculture (COLSA). It has responsibility for Hatch, McIntire-Stennis, Animal Health, and Multistate Research Programs. The NHAES and COLSA gained new leadership over the last 2-3 years. Combined with a new college strategic plan which fed into reorganization of the eight former departments into three more comprehensive units, the Dean and Director's Office along with faculty and staff are committed to reinvigorate agricultural research and teaching programs at UNH. The combined federal and state formula (capacity) funds remain fundamental to our abilities to continue to have positive impact on agriculture and related natural resources in New Hampshire and the region. We function as an incubator and test bed of new ideas and technologies, diverting economic risk from our stakeholder operations. We attract and engage students in the research enterprise, creating better learners and well qualified employees, and in many cases new converts to agriculture. Much of our science addresses specific local concerns and examples within national priority areas, bringing strong relevance to leading research conducted in New England. We develop new varieties and cultural practices specifically adapted to New England's unique climatic, soil and pest/pathogen conditions. Our faculty contribute to advancing state-of-art molecular technologies in service to agriculture, and to integrated aquaculture systems that recycle and reduce waste while providing healthy sources of protein. We continue to work with colleagues in the other New England land grants to find ways to pool expertise and resources for benefit of the region.

The goal of our planned programs is to provide fundamental and applied research in support of critical regional agricultural issues,many within recognized national priority areas, and which will lead to enhanced knowledge and technologies in support of sustainable agriculture and the environment. A secondary and synergistic goal is to help train the next generation of agricultural scientists. Our research efforts provide excellent return on the investment of taxpayer funds through federal and state contributions. New Hampshire currently matches federal capacity funds at a rate of 2.7:1, demonstrating strong commitment to our shared goals. Our research findings, developments and technologies are transferred through diverse mechanisms including classroom, laboratory and field instruction, stakeholder workshops, a variety of publication formats, presentations at local, regional, national and international scientific and stakeholder meetings, websites, web portals and genomic data banks, technology transfer, policy recommendations, and other venues. To maximize our future impacts we increasingly reach beyond the college to engage the strongest possible expertise. Examples include gathering an outstanding interdisciplinary team to help understand and ameliorate potential climate change impacts on agriculture, and engaging faculty from the UNH social science and health units to work on rural demographics and community issues. We have initiated dialogues with UNH Cooperative Extension about exploring a more targeted approach to integrated research-extension programs. We are exploring novel ways to leverage our excellent field and laboratory research facilities to integrate and invigorate our undergraduate and graduate teaching programs.

One of the critical benefits of the capacity (formula) funding we receive is our resulting ability to undertake continuing long-term research concerning topics of state and regional importance, to strategically provide seed money to build strong research programs in targeted areas, and to provide both the human and capital infrastructure (farms, dairies, greenhouses) needed to support research, extension and teaching programs in agriculturally related areas. Within NHAES we have implemented over the past two years a strong focus on ensuring relevance and productivity of funded projects, through review and screening criteria that emphasize accountability of outputs, outcomes, and impacts for New Hampshire, New England and the nation. Commensurate with this we are investing substantial energy and resources toward incentives which will make our supported scientists more committed and successful in leveraging their federal-state capacity funding with extramural resources. Examples of the effectiveness of this strategy during 2009 include two of our junior faculty members who received NHAES seed dollars and were able to parlay their Hatch project results into large competitive grant awards: a $773,000 NSF ARRA and $1,000,000 NSF CAREER award, respectively. A senior faculty member directly leveraged his Hatch research to secure $500,000 in competitive awards during 2009 from NIFA and other sources; this work is in collaboration with international colleagues. Our supported research is of excellent quality, and was presented at many invited venues including Gordon Conferences, and published in highly prestigious scientific journals as well as in multiple outlets more accessible to our many local stakeholders. These examples selected from many illustrate the critical impact of formula funds in building the required capacity to become viable for competitive research awards while directly helping to solve regional problems. Importantly, we are in the process of adding up to 7 new faculty members as part of research cluster hires in Sustainable Agriculture and Sustainable Ecosystem Science and Management. This is in sharp contrast to the lack of new associated faculty hires during the past decade (with exception of the two junior faculty mentioned above), and will be

critical to our renewed emphasis on well-integrated research. Our ability and willingness to initially support these new hires using NHAES capacity funds was a critical factor in our having received university permission to initiate a search for new agricultural faculty members.

Our national research priorities are informed by the USDA-NIFA strategic areas, and local emphases are informed by knowledge of agricultural production in New Hampshire and the region. Based on the most recently available data from the USDA-National Agricultural Statistics Service (NASS) the number of New England farms increased significantly from 2002 to 2007, but have decreased somewhat during the past year, presumably as a result of the economic downturn. The number of NH farms and land in farms was reported as having held steady during the past year, having increased 24% since the 2002 census. The most growth since 2002 has come in farms with less than $100,000 in annual sales. Land in farms had also increased by six percent, meaning that more land has been returned to production. However, the trend continues to be more farms of smaller size; average farm size went from 132 to 113 acres. Farm numbers grew nationally, too, but at only one-sixth of New Hampshire's rate of growth. Market value of agricultural production in NH grew 37% to over $199 million, and was nearly balanced between crop and livestock sector sales. NH ranked very high nationally in several key NASS agricultural metrics. With 173 organic farms in 2007, we were first in the nation for value of organic as percent of total sales. We were number two nationally in percent of farms with female principle operators, and number three in the nation for percent of agricultural sales from direct marketing. Finally, NH was number three nationally in percent of total value of agricultural sales from direct sales. These statistics provide incentive to, and are consistent with, our strategies to emphasize these and related aspects of integrated small-scale agriculture, natural resources, and food health and safety that are important to NH and New England, in how we prioritize our research projects and expenditures. Our research and teaching programs increasingly emphasize sustainable agriculture and food systems, and will contribute to the development of a highly competitive and sustainable agricultural system for local, regional and global markets.

A crucial role for NHAES is to undertake research that addresses priority local, state and regional needs. As an example, regionally applicable agricultural research is needed to identify crops, crop varieties, and production practices that are best suited to the unique climatic conditions of NH and Northern New England. Although vegetable and fruit production is economically significant for NH, NH production constitutes a very small percentage of U.S. production for almost all horticultural crops. As a result, most research on production methods is applicable to terrain and climates that are very different from those faced by NH and New England growers. Crop varieties that are developed elsewhere may or may not be adapted to the short growing season, cold winter temperatures, specific soil types or prevalent pests of our area. As a result, varieties must be carefully evaluated for performance in this region. It is expected that results of these investigations will directly impact the practices and varieties that farmers try on their farms. Results might directly favor adoption of specific practices, but they are equally useful if they prevent farmers from trying practices that are shown to be unsuccessful or not profitable. A similar line of reasoning is equally appropriate for any of the diverse range of topics in agriculture, natural resources, and rural life that we cover within the Hatch program.

During FY2009, 64 faculty members along with multiple UNH and outside collaborators and technical support persons, and 221 students (80 graduate, 121 undergraduate, and 20 high school) directly participated in 55 research projects supported by the NHAES. This represents similar number of faculty and projects, and greater number of graduate and undergraduate engagement than for FY2008. The projects undertook basic and applied research in 10 Planned Program Areas that included Agricultural Systems (2 projects); Animals and Animal Products (5 projects); Biotechnology & Genomics (3 projects); Economics & Commerce (7 projects); Food, Nutrition & Health (9 projects); Natural Resources & Environment (11 Projects); Pest Management (1 project); Plant & Plant Products (5 projects), Sustainable Horticulture (6 projects); and Sustainable Marine Aquaculture & Fisheries (7 projects). Overall, the research projects advanced knowledge in a wide variety of fields. New information discovered was disseminated through 41 peer-reviewed publications in scientific journals, 6 book chapters, 13 graduate student theses and dissertations, 9 reviewed publications, 38 abstracts, 8 symposia proceedings, and numerous extension and popular press articles and publications. Research results and their implications were presented at scores of regional, national and international scientific meetings and workshops, websites, producer workshops and meetings across New Hampshire and New England, legislative hearings, and other public venues.
This Annual Report represents the primary research component from UNH, and does not include New Hampshire Cooperative Extension which is a separate administrative unit. As a result of different local and national criteria, both entities pursue different methods that fit their respective needs to obtain, collate and disseminate information from supported faculty and staff, making joint reporting of outcomes and impacts problematic. Consequently some portion of the reported FY2009 UNH Extension achievements may credibly be associated with the NHAES, and conversely for aspects of this report.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	23.1	0.0
Actual	0.0	0.0	9.0	0.0

II. Merit Review Process

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

- Internal University Panel
- Expert Peer Review

2. Brief Explanation

The New Hampshire Agricultural Experiment Station conducts a formal peer review process for proposed research projects. An announcement is sent to eligible faculty announcing the availability of support. Faculty are encouraged to submit a one page description of their proposed project and meet with the NHAES Associate Director to discuss the work. If the proposed project is considered to fit within the guidelines for support, the faculty member is encouraged to develop a full proposal. Submitted proposals are sent for external review, and the faculty member is provided an opportunity to review the anonymous comments, and to revise the proposal and/or prepare rebuttal. Proposals are then critically and independently reviewed by an internal panel of six representative faculty members plus the Associate Director. The committee develops a categorized list of projects recommended for potential approval or denial of funding. The NHAES Director and Associate Director use this recommendation along with their own evaluations related to Station priorities and available resources to make the final decision as to which projects to fund. Approved proposals are forwarded to NIFA for ultimate approval of funding. We recently modified this procedure in response to stakeholder input, with the criteria used for proposal evaluation as: 1) relationship to the Hatch, McIntire-Stennis, and/or Hatch-Multistate programs, and to the NHAES mission and research priorities; 2) scientific and technical merit; 3) soundness of approach, procedures and methodology; 4) likelihood of significant contributions and/or innovative advances; 5) demonstrated previous and current research productivity and accomplishments and likelihood to leverage NHAES resources with others [or potential, for new investigators]; and 6) likelihood of significant enhancement in research capability and competitiveness.

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 selected individuals from the general public
- Other (Request critical comments from proposal reveiwers)

Brief explanation.

NHAES highly values the input we receive from our stakeholders. We are supportive and respectful of diverse viewpoints, and we interpret our mandate very inclusively. Input to inform NHAES activities and priorities is encouraged by multiple means, including presentations and meetings with traditional and non-traditional stakeholder individuals and groups.

Traditional stakeholders are generally very interested in the work done by the NHAES and are most willing to offer

input and suggestions on what the NHAES can do that would help them. In most cases, the only action required is to meet with them or contact them in some other way. We also interact with less traditional but highly engaged stakeholders via local farmers markets where we engage CSA and CFA operations (including meat, produce, seafood, and agricultural products), and other venues. We are increasing efforts to identify and engage non-traditional stakeholders, many of whom are marginally or unfamiliar with the services available through NHAES. Input by stakeholders within individual NHAES projects is encouraged in a wide variety of ways including surveys (telephone, in person, and web-based), through presentations at scientific and non-scientific conferences, through educational workshops, through multistate project meetings, via mass media, through publications, through the university classroom and via educational programs aimed at K-12 students and teachers. We are genuinely interested in stakeholder participation in our activities, and strive to relay this attitude, as well as how their input is incorporated, to encourage their continued involvement.

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
- Open Listening Sessions
- Other (UNH Cooperative Extension)

Brief explanation.

Stakeholder input is sought to help shape and strengthen the future of our agricultural programs. Our partners at UNH Cooperative Extension, the NH Department of Agriculture, Markets and Food, the college and NHAES advisory committees, and individual faculty and staff have been extremely helpful in identifying stakeholder individuals and groups. Administrative presence on multiple initiatives (state and regional committees, boards, etc.), and consistent participation in appropriate gatherings such as the annual NH Farm & Forest Exposition, facilitate direct identification and communications with a very diverse group of stakeholders. Listening to and speaking with participants during field days, open houses, and Extension sponsored conferences and workshops provides insights from grower groups, professionals, government agencies, home gardeners and many others. The UNH Diversity and Affirmative Action & Equity Offices aid in identifying potentially underrepresented and under served 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
- Meeting with 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
- Survey of selected individuals from the general public
- Other (Encouraged ad hoc input from various stakeholders)

Brief explanation.

For strategic planning and development of NHAES programs and priorities, input is collected primarily through meetings with stakeholder groups and individuals including growers, farmers, citizens, agricultural organizations and councils, natural resources professionals and managers, state and federal agency representatives, neighboring state AES and Extension administrators, research project directors, graduate and undergraduate students, extension specialists, and so forth. While most meetings are open discussions, some are presentations followed by questions and answer sessions. The NHAES directors and scientists also attend many Cooperative Extension workshops and meetings and takes advantage of these opportunities to participate in discussion with groups and individuals.

The College of Life Science and Agriculture and NHAES are completely overhauling the Agriculture and Research sections of our website to make the Experiment Station and agriculture much more prominent, visible and

accessible to those who explore or interact through that venue. The updated NHAES website welcomes stakeholder input, and clearly states our commitment to equal opportunity access.

NHAES research project participants obtain direct and indirect stakeholder input through varied avenues. Projects with social science components frequently use questionnaires and surveys. Stakeholder input to many basic science and some applied projects occurs in the form of reviewer inputs to proposals and manuscripts, and from questions, comments and discussions following presentations at regional, national and international conferences. Stakeholder input for other projects is collected through comments and questions at workshops and training sessions for end users.

3. A statement of how the input will be considered

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

Brief explanation.

Stakeholder input is used in reviewing our existing and proposed strategic and operational activities, including expenditures. All input will continue to be objectively considered for prioritization within our finite budget, personnel, faculty expertise and other resources. Among activities suggested by stakeholders, we are investigating the feasibility of teaching and outreach programs related to cheese making and dairy beef production at our organic dairy research farm, of similar efforts related to meat processing, and will initiate targeted field days at our research facilities (farms and greenhouses) to more directly engage and communicate our activities.

Brief Explanation of what you learned from your Stakeholders

We continue to receive broad and strongly supportive input concerning our current move towards a focus on sustainable agriculture, agro-ecosystems, local food opportunities, and nutrition and health aspects of agricultural products. This includes our having created a new research facility that operates as a diversified organic farm, and having certified organic fields to grow most of the forage for our dairy and equine facilities. Some long term stakeholders initially expressed concern about whether we were moving away from supporting traditional activities, and we continue to assure them that within our abilities we fully intend to provide broad support for all manner of relevant agricultural enterprises that can help our region to thrive. Increasing interactions with community supported agriculture groups brings interest in potential interactions. We maintain communication with the director of the NH Division of Agriculture, Markets and Food, who is an excellent source of feedback on our efforts to revitalize agricultural research and teaching, and how they are received around the state.

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	1596383	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	1599483	0
Actual Matching	0	0	3047030	0
Actual All Other	0	0	0	0
Total Actual Expended	0	0	4646513	0

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

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Agricultural Systems

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
131	Alternative Uses of Land			5%	
302	Nutrient Utilization in Animals			30%	
305	Animal Physiological Processes			10%	
307	Animal Management Systems			20%	
315	Animal Welfare/Well-Being and Protection			5%	
601	Economics of Agricultural Production and Farm Management			5%	
608	Community Resource Planning and Development			15%	
903	Communication, Education, and Information Delivery			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.4	0.0
Actual	0.0	0.0	0.7	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	119976	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	253992	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

Project 1 identified future opportunities for New England land grant university farms and town agricultural commissions to serve the food security needs of the people in New England. Though visits, interviews, studying master plans and documents, the university farms of the six New England land grant universities were inventoried, assessed and described, with particular emphasis on New Hampshire and the surrounding states of Maine, Vermont and Massachusetts. The project studied and assessed the work and accomplishments, thus far, of existing town agricultural commission in New Hampshire and Massachusetts. Through assessment of the minutes of town meeting their activities were compared with the intent of their enabling statutes and the principles and practices of sustainable agriculture. This project has one year remaining.

Project 2 was part of a multistate effort to develop management systems to improve the economic and environmental sustainability of dairy enterprises. There were two components of the project at the NHAES. The first part of the project used the research dairy herd and laboratory analyses to study the effects of colostrum replacers, essential oils and pasturing on heifer and calf growth. The second used the UNH research dairy and laboratory analyses to conduct in vitro and in situ assays to quantify amino acid availability in distiller's grains, and in vivo assays to evaluate lysine and methionine as modifiers of rumen fermentation, in lactating dairy cows. Data was disseminated to researchers in ruminant nutrition, developers of ruminant nutrition software programs, and dairy nutritionists and farmers, via published manuscripts, conference presentations and publications, and workshops and seminars. Dr. Schwab was lead investigator in this aspect of project 2, and retired during mid-2009. His coinvestigator in Project 2 completed the studies in collaboration with the NHAES dairy research technician and finishing graduate students. This project was part of a continuing multistate research committee.

2. Brief description of the target audience

The target audience for the first project included land grant universities and their agricultural experiment Stations, researchers, farm managers, students, town governments, town, state and national agricultural commissions and agencies, farmers, food producers and processors, citizens and consumers. The target audience for the dairy management projects included dairy nutritionists, dairy farmers, dairy industry workers and companies, and scientists in dairy nutrition.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	1000	2000	50	100
Actual	850	2200	100	150

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

Year: 2009
Plan: 0
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	2	
Actual	0	4	4

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in the project (not including audience counts)

Year	Target	Actual
2009	8	6

Output #2

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	3	5

Output #3

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	2	0

Output #4

Output Measure

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

Year	Target	Actual
2009	3	5

Output #5

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	1	3

Output #6

Output Measure

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

Year	Target	Actual
2009	4	9

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	0	0

Output #8

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	3	2

Output #9

Output Measure

- Number of websites in which project results have been incorporated

Year	Target	Actual
2009	2	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge of the land grant farm infrastructure in New England (qualitative outcome statement)
2	Increased knowledge of the number and activities of town agriculture commissions in New Hampshire and Massachusetts (qualitative outcome statement)
3	Increase knowledge of the protein composition of distiller's grain and it nutritional value for lactating dairy cows (qualitative outcome statement)
4	Increased utilization of distiller's grain by New England dairy farmers (qualitative outcome statement)
5	Increased knowledge of optimal practices for promoting growth and health of calves and heifers (qualitative outcome statement)
6	Overall enhancement of knowledge and methods of the support of sustainable agricultural systems in New Hampshire and the region (qualitative outcome statement)
7	Increased understanding of the digestibility of amino acids in the rumen undegraded protein fraction of feeds.

Outcome #1

1. Outcome Measures

Increased knowledge of the land grant farm infrastructure in New England (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Knowledge of the land grant infrastructural basis for agricultural sustainability in New England is critical to development of effective strategies for aggregated local agriculture and food systems, as these resources are of fundamental importance to regional research, teaching and outreach.

What has been done
Research was completed during the year at Orono, Maine, Burlington, Vermont, Amherst, Massachusetts, Kingston, Rhode Island, Durham, New Hampshire, and Storrs, Connecticut, as well at each of the six New England Agricultural Experiment Stations and at each one of the university farms of these Agricultural Experiment Stations. Research was also conducted in numerous Massachusetts towns which have Town Agricultural Commissions and at some of the Agricultural Commissions now established in New Hampshire.

Results
As a result of meetings and dissemination of project results, the level of education and understanding of the value of local food and local farms, regional food sufficiency and security, etc. is high and growing.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
307	Animal Management Systems
601	Economics of Agricultural Production and Farm Management
608	Community Resource Planning and Development

Outcome #2

1. **Outcome Measures**

Increased knowledge of the number and activities of town agriculture commissions in New Hampshire and Massachusetts (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Increase knowledge of the protein composition of distiller's grain and it nutritional value for lactating dairy cows (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

Increased utilization of distiller's grain by New England dairy farmers (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

Increased knowledge of optimal practices for promoting growth and health of calves and heifers (qualitative outcome statement)

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Early growth and ultimate performance of dairy calves is dependent on their staying healthy.

What has been done
Calves are born without immunity to disease. They must receive critical immunoglobulins from their dam's colostrum. Utilizing colostrum replacer (dried colostrum) has become important because some debilitating

diseases, such as Johne's, can be spread from the cow to the calf. Research compared colostrum replacer formulations and found that adding sodium bicarbonate within the first 24 h of life increased indication of improved immunity by 25 percent over that of calves receiving colostrum replacer alone.

Results
Farmers can be confident that a colostrum based dehydrated replacer can provide adequate immunity to the newborn calf. Results were disseminated in a journal publication, through a handout at the NH dairy breed show, and will be provided to dairy and related stakeholders in a NHAES dairy report.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
305	Animal Physiological Processes
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection
601	Economics of Agricultural Production and Farm Management

Outcome #6

1. Outcome Measures

Overall enhancement of knowledge and methods of the support of sustainable agricultural systems in New Hampshire and the region (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Increased understanding of the digestibility of amino acids in the rumen undegraded protein fraction of feeds.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The intestinal digestibility of feeds is critical to animal performance and economic success of animal operations. An important aspect is to identify in vitro methods that could be used by commercial feed testing laboratories to estimate the intestinal availability of amino acids (AA) in the rumen undegraded protein (RUP) fraction of feeds.

What has been done

One study was conducted to measure intestinal and total tract digestibility of crude protein (CP) and amino acids (AA) in rumen undegradable protein (RUP) in five different corn silage hybrids. A second study was initiated to measure intestinal and total tract digestibility of CP and AA in RUP of a variety of feedstuffs with the goal of comparing the results obtained with a new and modified procedure with the results obtained with more standard techniques (MBT, modified TSP and the precision-fed rooster assay).

Results

Three outcomes were realized. First, digestibility of protein and total AA in RUP from corn silage is variable and in all cases, was lower than the value of 70% used in the NRC (2001) model. Second, intestinal digestibility of the individual AA in RUP are also variable within a corn silage sample, indicating the intestinal digestibility of total protein or total AA may not always be the same as for an individual AA. And finally, attempts to feed the rumen-undegraded residues to cecectomized roosters were not successful because of the high content of fiber in the residues. These data contribute to a database of digestibility of AA in the RUP fraction of feeds commonly fed to lactating dairy cows. The anticipated impact of these efforts are commercial acceptance of the most effective described in vitro methods, and development of improved ration formulation models that include estimates of AA digestibility and allow for more efficient use of dietary protein for milk production.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- After Only (post program)
- Before-After (before and after program)
- During (during program)
- Comparisons between program participants (individuals, group, organizations) and non-participants

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Animals & Animal Products

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
301	Reproductive Performance of Animals			20%	
302	Nutrient Utilization in Animals			20%	
303	Genetic Improvement of Animals			10%	
308	Improved Animal Products (Before Harvest)			5%	
311	Animal Diseases			10%	
315	Animal Welfare/Well-Being and Protection			20%	
723	Hazards to Human Health and Safety			15%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.4	0.0
Actual	0.0	0.0	0.9	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	137307	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	319610	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

Project 1: Through collaborative work with other institutions as part of a multistate research project, conducted animal experiments and laboratory studies to examine the genetics of antibody response and disease resistance in poultry. Results were presented at multi-state and national meetings and published in peer-reviewed journals.

Project 2: Standard laboratory assays were performed to follow responses following reintroduction of pathogens in animal subjects to evaluate evolution of bacterial strains and initiate strain characterization. A goal was to evaluate bacterial convergence with known symbiont traits critical to pathenogenesis. Results were presented at scientific meetings and published in peer-reviewed journals.

Project 3: In vitro, in situ and in vivo assays were conducted to quantify amino acid availability from distiller's grain in lactating dairy cow diets. Results were disseminated to researchers in ruminant nutrition, developers of nutrition software programs, and dairy nutritionists and farmers via published manuscripts, conference presentations and publications, and workshops and seminars. PI Chuck Schwab retired during mid-2009, but the project was finished up by a faculty colleague, the NHAES dairy technician, and the PI's finishing graduate students.

Project 4: It is important to evaluate sperm production when assessing the potential reproductive toxicity of environmental agents and/or proposed new human or animal drugs. Laboratory and animal experiments were performed to test the effects of drugs on male rat fertility, as analogues for domesticated animals. After mating trials occurred, male rats were sacrificed and their tissues processed to enable determination of the numbers of sperm received per mated female. Mated females were sacrificed to permit determination of pregnancy rates, litter size and numbers of fetal resorptions. Results were submitted to peer-reviewed journals.

Project 5: This project investigated aspects of improved fertility in ruminants. Laboratory experiments were conducted with the corpus luteal endothelial cells, which line the microvasculature of the cow ovary. Tissue was collected from cows over an extended time period. Magnetic beads were used to isolate endothelial cells and flow cytometry to distinguish them through expression of cytoskeletal proteins and adhesion molecules. Then, microarray analysis was performed to profile genetic attributes of these endothelial cell subtypes. Results were presented at scientific meetings, national conferences, and in peer-reviewed journals.

2. Brief description of the target audience

Project 1: Poultry scientists from production, breeding, health and other companies. Allied, basic scientists with animal or human health expertise.

Project 2: Scientists and practitioners working in fields related to mutagenesis, symbiosis and emergent diseases.

Project 3: Feed companies and suppliers of protein supplements for the commercial dairy industry, dairy farmers, professional dairy nutritionists, individuals and companies that produced ration formulation and diet evaluation software for ruminant animals, and commercial feed testing laboratories.

Project 4: This work was primarily of interest to reproductive biologists and toxicologists with an interest in assessing the reproductive capacity of normal males and those exposed to potential reproductive toxins or proposed new human or animal drugs.

Project 5: Scientists in the discipline of reproductive physiology, UNH animal science undergraduate and graduate students, livestock producers in the state and region, dairy and meat animal producers, and members of the scientific community whose collective goal was to improve reproductive performance in domestic ruminants.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	350	1150	50	25
Actual	225	800	25	50

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

Year: 2009

Plan: 0
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	8	
Actual	0	6	6

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in the project (not including audience counts)

Year	Target	Actual
2009	15	12

Output #2

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	5	12

Output #3

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	3	6

Output #4

Output Measure

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

Year	Target	Actual
2009	5	4

Output #5

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	3	6

Output #6

Output Measure

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

Year	Target	Actual
2009	10	8

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	0	0

Output #8

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	10	15

Output #9

Output Measure

- Number of websites in which project results have been incorporated

Year	Target	Actual
2009	2	2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge of the genetic basis for resistance and immunity to avian diseases (qualitative outcome statement)
2	Increased knowledge of the mechanism of bacterial-induced tissue responses in animals that provide protection from further super-infection (qualitative outcome statement)
3	Increased knowledge of the metabolic relationships in the supply of nutrients for lactating dairy cows (qualitative outcome statement)
4	Improved methods for assessing the effect of agents on the testis (qualitative outcome statement)
5	Increased knowledge of ovarian influences on embryonic survival in ruminants (qualitative outcome statement)

Outcome #1

1. Outcome Measures

Increased knowledge of the genetic basis for resistance and immunity to avian diseases (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Avian diseases are critically important to agricultural production and because of the risk of disease transfer to humans. Understanding the genetic bases for resistance and immunity is therefore of national and global interest.

What has been done
Replicated experiments were completed using cell cultures and with tenth generation male avian progeny within environmental chambers. RNA based molecular techniques were used to evaluate differentially expressed genes involved in cell signaling, reception and transcription.

Results
Many of the differentially expressed genes are involved in cell signals, receptors and transcription factors. The specific genes, regulators and direct and indirect impacts on organismal function are described in peer-reviewed papers and in presentations to target audiences. These contributions augment our abilities to understand, anticipate and potentially manipulate existing and future disease in avian species.

4. Associated Knowledge Areas

KA Code	Knowledge Area
303	Genetic Improvement of Animals
311	Animal Diseases

Outcome #2

1. Outcome Measures

Increased knowledge of the mechanism of bacterial-induced tissue responses in animals that provide protection from further super-infection (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Identification of the mechanisms of interaction between bacterial-induced tissue responses in animals that provide protection from further super-infection could allow us to manipulate host-microbe interactions to promote animal health. For example, our initial observations indicate that bacterial colonization of squid light organs restricts super-infection by other bacteria. Ability to generate clean mutants in target genes must be developed to advance this goal.

What has been done
Ability to generate clean mutants in target genes must be developed to advance this goal. As necessitated by the project, we created a new method for the isolation of difficult bacterial mutants using Penicillin (streptozotocin) enrichment.

Results
This new method will greatly enhance the ability of microbiologists working with any bacterial species with limited mutagenesis tools to more rapidly generate mutants for direct hypothesis testing. Expected applications will accrue over multiple years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
303	Genetic Improvement of Animals
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection

Outcome #3

1. Outcome Measures

Increased knowledge of the metabolic relationships in the supply of nutrients for lactating dairy cows (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Improved methods for assessing the effect of agents on the testis (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
It is important to evaluate sperm production when assessing the potential reproductive toxicity of environmental agents and/or proposed new human or animal drugs.

What has been done
An experiment was conducted to assess the rate of replenishment of the EGR in male rats after depletion of the extragonadal sperm reserves EGR)by mating.

Results
The observation that only a portion of the EGR was removed by mating in the present study was expected. However, it was determined that approximately 46, 60 or 74 rats would be required per treatment group to provide experiments of 80, 90 or 95% power for detecting a statistically significant (P<0.05) 20% difference in the total number of sperm in the EGR. This information should be useful during the design of future mating trials with the rat.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
723	Hazards to Human Health and Safety

Outcome #5

1. Outcome Measures

Increased knowledge of ovarian influences on embryonic survival in ruminants (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
One goal of this multistate project was to conduct experiments to identify physiological attributes of the corpus luteum considered to improve fertility in ruminants. The primary function of the corpus luteum is to produce progesterone, the hormone that regulates reproductive cycles and pregnancy.

What has been done
In collaboration with our colleagues at Penn State University, we started to develop protocols to obtain pure mixed populations of endothelial cells from the bovine corpus luteum. Preliminary analysis of these endothelial cells for their ability to produce MMPs was also performed.

Results
We found that commercially-purified mixed endothelial cells, as well as those obtained from our own protocol, produced the gelatinases, MMP-2 and MMP-9. This finding is exciting because it enables us to use our own protocol (in collaboration with Penn State University) to not only continue studying other physiological attributes of endothelial cells from the mid-cycle corpus luteum, but from the early and late stages as well. These results were shared at our annual project meeting, which included members from University of Connecticut, Cornell University, Penn State University, University of Massachusetts (Amherst), University of Wisconsin (Madison), University of Nebraska, and West Virginia University.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
303	Genetic Improvement of Animals
308	Improved Animal Products (Before Harvest)
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)
- Time series (multiple points before and after program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Biotechnology & Genomics

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
212	Pathogens and Nematodes Affecting Plants			30%	
301	Reproductive Performance of Animals			30%	
304	Animal Genome			30%	
305	Animal Physiological Processes			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.0	0.0
Actual	0.0	0.0	0.6	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	200927	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	236448	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

Project 1. Performed laboratory molecular, biochemical, and physiological research to analyze data and screen lamprey genome. Prepared and submited manuscript for to peer-reviewed journals for consideration. Trained undergraduate and graduate students.

Project 2. Used laboratory molecular biological techniques to study mRNA degradation in yeast, including complexes in which PAB1 is involved.

Project 3. Used laboratory analyses to study interactions between three different bacterial taxa and Caenorhabditis

nematodes. Findings were presented to scientific peer groups, graduate and undergraduate students. Local extension researchers were engaged to incorporate findings into management strategies.

2. Brief description of the target audience

Project 1: Other scientists and students in related disciplines and fisheries/aquaculture managers.

Project 2: The target audience for this research was the international community of biological researchers who were interested in understanding regulatory processes in controlling gene expression. This specifically included those scientists interested in mRNA degradation and protein synthesis.

Project 3: The target audience for this research included scientists using bacterial and nematode systems, those interested in entomopathogenesis and mutualism, and those scientists and stakeholders interested in the use of safe and environmentally friendly biological control agents to control insect pests.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	500	600	25	50
Actual	200	350	20	50

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

Year: 2009
Plan: 1
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	9	
Actual	0	4	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Submission of cDNA, ESTs, proteins, genes, RNA to GenBank

Year	Target	Actual
2009	0	0

Output #2

Output Measure

- Number of participants in the project (not including audience counts)
  Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	3	16

Output #4

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	4	11

Output #5

Output Measure

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

Year	Target	Actual
2009	4	3

Output #6

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	0	0

Output #7

Output Measure

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

Year	Target	Actual
2009	10	13

Output #8

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	1	1

Output #9

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	9	2

Output #10

Output Measure

- Number of websites in which project results have been incorporated

Year	Target	Actual
2009	3	2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increase knowledge of endocrine control of reproduction (qualitative outcome statement)
2	Increase knowledge of the character and control of yeast regulatory genes (qualitative outcome statement)
3	Increase knowledge of the mechanisms predisposing mutualism or pathogenesis in bacterial-nematode interactions (qualitative outcome statement)
4	Overall increase in knowledge and methodology in genomics and biotechnology with application for agriculture (qualitative outcome statement)

Outcome #1

1. Outcome Measures

Increase knowledge of endocrine control of reproduction (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Evolution of genes and related systems is integral to understanding animal evolution and practical applications that will arise from this fundamental knowledge. As an agnathan, the oldest extant lineage of vertebrates, the sea lamprey has become a model system for analysis of the evolution of many genes and systems including the evolution of the neuroendocrine regulation of reproduction and the evolution of development.

What has been done
We are proposing a modified paradigm in that the neuroendocrine control of reproduction and thyroid functions in the Agnathan sea lamprey exhibits an overlapping, simplified organization represented by one glycoprotein hormone putatively interacting with two receptors.

Results
This transforming paradigm serves as a model for analysis of the evolutionary mechanisms leading to emergence of the highly specialized Gnathostome endocrine axes.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Increase knowledge of the character and control of yeast regulatory genes (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Regulatory genes are fundamental to growth and behavior of organisms, with relevance to multiple agricultural, food, disease, and natural resources problems.

What has been done
This year we analyzed complexes in which PAB1 is involved. Our mass spectroscopic analysis identified some 25 proteins which are specifically associated with PAB1. Twelve of these proteins were found to bind to one or another of PAB1 domains. To identify the complexes these proteins form with PAB1, analytical ultracentrifugation with fluorescent detection system (AU-FDS) was conducted on PAB1 purified material. Two majors complexes were identified. Additional experiments confirmed that one of the complexes was translationally relevant, as environmental effects that stopped translation caused rapid disappearance of the complex.

Results
Our results establish the first methodology for rapidly identifying the components of the 48S pre-initiation complex. Several novel components of this complex were identified. Moreover, we were able to identify the migration of individual mRNA into the 48S complex. These results indicate that the temporal pattern of mRNA movement through the translational process can now be studied.

4. Associated Knowledge Areas

KA Code	Knowledge Area
304	Animal Genome

Outcome #3

1. Outcome Measures

Increase knowledge of the mechanisms predisposing mutualism or pathogenesis in bacterial-nematode interactions (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Overall increase in knowledge and methodology in genomics and biotechnology with application for agriculture (qualitative outcome statement)

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Government Regulations

Brief Explanation

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- After Only (post program)
- Before-After (before and after program)
- During (during program)
- Time series (multiple points before and after program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Economics & Commerce

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
403	Waste Disposal, Recycling, and Reuse			8%	
605	Natural Resource and Environmental Economics			15%	
608	Community Resource Planning and Development			22%	
610	Domestic Policy Analysis			5%	
703	Nutrition Education and Behavior			15%	
724	Healthy Lifestyle			2%	
801	Individual and Family Resource Management			4%	
802	Human Development and Family Well-Being			2%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities			15%	
805	Community Institutions, Health, and Social Services			5%	
901	Program and Project Design, and Statistics			2%	
903	Communication, Education, and Information Delivery			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.3	0.0
Actual	0.0	0.0	1.3	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	175758	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	466219	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

Project 1. The project was a collaboration with local food system stakeholders to identify high priority information needs and the forms in which information should be shared. Working together, we identified and analyzed ongoing and potential forces that were maintaining or transforming the relationships between localities and their food systems and examined the diverse strategies local food system stakeholders were using or might use to create and manage ongoing or potential change in the food system. University programs were also developed in response to project findings. We will continue one-on-one and workshop extension support linking growers and producers with school food service programs; coordinate regional networking of farm-to-school programs; the second technician coordinated activities of the New Hampshire Center for a Food Secure Future supporting a web-based clearinghouse and network communications linking agriculture, food enterprises and nutrition.

Project 2. (1) Facilitated two-way communication between the public, stakeholders, managers and policy makers; (2) provided the opportunity to increase knowledge and improved understanding about natural resource management and agriculture; (3) documented the role a web-based tool plays in this process; (4) ascertained the various value differences between the public, dominant stakeholder groups, and managers/decision makers that lead to conflicts over program or policy decisions; and (5) factors that facilitated the beliefs or perceptions that the decisions were adequately arrived at because the public and/or individual stakeholders directly participated in, or were adequately represented in, the systematic research used as input into the program/policy development /decision making process.

Project 3. This program assessed the current use and potential demand for energy efficient technology in the home. Since residential real estate development was projected to have a profound impact on our land and resources, it was important to assess the needs and demands of future energy use. We were asking residents about their understanding and willingness to adopt energy efficient and low impact technology, such as geothermal heat, solar energy, sustainable building materials, and general energy efficiency in the home.

Project 4. This project adapted over the years to address changing issues related to waste management. Previous research efforts examined siting problems, economics of recycling, and waste generation. Current efforts focus on waste produced through construction and demolition activities. Results were presented at professional conferences, published and distributed via experiment station publications, popular press and other trade publications for information dissemination, and peer reviewed journal articles were used to inform peers and those who study the topic in depth.

Project 5. Analyzed the interactions among public assistance and informal social supports, community context, and individual and family characteristics and their relation to the functioning and well-being of rural low income families with children over three years time. Assessed across time the relative effects of economic opportunity, and personal attributes and actions, on employment and self-sufficiency among the rural low income families participating in the study. Assessed over time how families have adapted to policy and economic changes to achieve self-sufficiency (household adaptive strategies and well being that are associated with economic, food security, family functioning and policy). Collected additional data to track the functioning of the participating families related to changing policies and economic conditions.

Project 6. Identified and analyzed ongoing and potential changes in rural labor markets and the impacts of migration, commuting, and workforce development policies on rural labor markets. Investigated the potential for rural development policies based on entrepreneurship, industrial clustering, value-added and nontraditional agricultural businesses and analyze the spatial implications of industrial restructuring on employment and earnings. Investigated the changing organizational structure, tax policy

and fiscal standing of local governments and the impact of tax and/or expenditure limitations on local government fiscal stress and economic growth in rural areas. Developed a better understanding of the role of amenities in rural development and the impact of economic and social changes on the quality of life in rural communities.

Project 7. Examined the aging of the rural population within the context of overall U.S. population aging, described how in-migration, aging-in-place, and other demographic forces shape the spatial distribution and composition of rural older populations, and analyzed the impacts of retirement migration and aging-in-place on individual and community well-being. Examined the interplay between retirement migration and increases in ethnic diversity in retirement destination communities. Described the changing racial and ethnic composition of rural areas and its impact on economic vulnerability and inequality, and analyzed conditions affecting social and economic integration of diverse populations, including the unique challenges facing immigrant families to rural destinations. Investigated how changes in the size and composition of the rural population affect changes in land use and analyzed the linkages between demographic change and emerging land use conflicts in different regional and local contexts.

2. Brief description of the target audience

The target audience for all projects in the program included other scientists in related disciplines, graduate and undergraduate students.

Project 1. Food growers and producers, distributors, marketing/retail and direct marketing enterprises; school food service directors, nutritionists, land conservation groups and planners.

Project 2. Customers of public drinking water and waste water management utilities, users of water supply reservoirs, members of innovative organizations responding to management and regulatory change in rural and urban/interface communities in New England, forest land owners, recreation users, forest land managers in the Northeast's Northern Forest, a variety of stakeholder groups actively engaged in cooperative research, fishery management and the establishment of marine protected areas, small business owners, teachers and environmental educators.

Project 3. Target audiences included land use policy makers, non-profit sustainable energy associations, developers, legislators, property owners and alternative energy contractors.

Project 4. Municipalities, especially in rural areas; researchers in related fields such as political science, business, economics, and public administrators, graduate students, New Hampshire Municipal Associations.

Project 5. Policy and decision makers, low income tax payers, and researchers who have interest in low-income and or rural populations.

Project 6. New England retirees, corporations interested in hiring retirees on a part-time basis, the academic community interested in providing input to models designed to bridge the "job-information-gap" between the corporate community and retirees.

Project 7: Target audiences included rural citizens and rural communities, migrating ethnic and minority populations, policy-makers and the media.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	10000	2000000	2000	10000
Actual	21000	380000	600	3000

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

Year: 2009

Plan: 1
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	8	
Actual	0	8	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in the project (not including audience counts, survey respondents, etc.)

Year	Target	Actual
2009	25	27

Output #2

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	6	4

Output #3

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	5	6

Output #4

Output Measure

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

Year	Target	Actual
2009	5	5

Output #5

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	6	4

Output #6

Output Measure

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

Year	Target	Actual
2009	6	9

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	2	0

Output #8

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	15	6

Output #9

Output Measure

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

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Changes in policy, programs, and stakeholder awareness related to the sustaining local food systems in a globalizing environment (qualitative output statement)
2	Increased public and stakeholder engagement in natural and agricultural resource management policies and programs (qualitative output statement)
3	Increased knowledge of the benefits and costs of natural resource policies affecting public and private lands (qualitative output statement)
4	Increased knowledge and/or changes in practices related to municipal solid waste disposal (qualitative output statement)
5	Increased knowledge of rural low-income family well-being and function in an era of welfare reform (qualitative output statement)
6	Increased knowledge of changes in rural markets, governance and quality of life (qualitative output statement)
7	Develop tools to facilitate stakeholder participation in natural resources planning, policy and management initiatives through distributed input.
8	Increase public awareness of population dynamics and change related to aging, ethnicity and land use in rural communities.

Outcome #1

1. Outcome Measures

Changes in policy, programs, and stakeholder awareness related to the sustaining local food systems in a globalizing environment (qualitative output statement)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Increased public and stakeholder engagement in natural and agricultural resource management policies and programs (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Effective management of resources within the fragmented rural and urban landscape of New England requires effectively identifying and engaging stakeholders in natural resource management and development programs and related policy initiatives.

What has been done
A stakeholder assessment mail questionnaire to a random sample of residents of the Lamprey River Watershed (n=768) gave residents an opportunity to think about the resources in their region and to begin to make connections between biophysical and socio-cultural variables including the health of their environment, their own personal behaviors and health, and the health of the social networks in their neighborhoods and communities.

Results
The outcomes of this research include the development of a comprehensive management plan for the Lamprey River Watershed. The results and key findings were distributed through numerous public meetings and direct communication planning boards and conservation commission members from numerous communities within the Lamprey River Watershed.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Increased knowledge of the benefits and costs of natural resource policies affecting public and private lands (qualitative output statement)

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Increased knowledge and/or changes in practices related to municipal solid waste disposal (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Given the fiscal stresses being experienced by local governments and the difficulty in finding the funds to provide essential services, research on municipal solid waste disposal is important to help provide direction for local and state government entities struggling with these issues.

What has been done
Economic research was conducted on the effects of unit based pricing (pay as you throw, or payt) on waste production and recycling, and initiatives toward privatization of solid waste disposal and other services by local governments. Collaboration was initiated to conduct multi-state analyses using New Hampshire, Wisconsin, and Illinois.

Results

The econometric analysis we have been using on payt data has called into question some commonly held beliefs both about the statistical accuracy of prior research efforts, and their conclusions regarding the own price elasiticy of demand for solid waste management. Two major findings have been: first, that lack of consideration of the endogeneity inherent in selection of payt by towns can lead to biased estimators; and second, that previous studies which have found own price elasticity of demand for solid waste disposal to be highly inelastic are in stark contrast to the findings of elastic demand, possibly owing to mis-specification of data sets and failure to account for the large number of non adopting towns.

4. Associated Knowledge Areas

KA Code	Knowledge Area

403	Waste Disposal, Recycling, and Reuse
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

Outcome #5

1. Outcome Measures

Increased knowledge of rural low-income family well-being and function in an era of welfare reform (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Low income dual earner couples struggle to maintain financial security. Low income rural mothers, including those in New Hampshire, have few avenues for improving their financial security. Their own health and that of their children and spouses/partners often complicate their lives and make maintaining full-time employment challenging. Assistance through earned income tax credit can be important to their success.

What has been done
A presentation was made to the statewide community partners meeting of the New Hampshire Individual Community Loan Fund in January 2009 about Earned Income Tax Credit and Child Tax Credit. The New Hampshire Statewide EITC Alliance website (http://www.nheitc.org) was updated for Tax Year 2008. Input was provided to the Family Assistance Advisory Committee on the benefit of the Earned Income Tax Credit to raise families above the poverty line. With the New Hampshire Statewide EITC Alliance organized a statewide kick-off January 2009 to educate agencies, organizations, congressional delegations, mayors and key personnel about the free tax preparation sites in NH and the importance to EITC to their constituents.

Results
The New Hampshire Statewide EITC Alliance coordinated by Cooperative Extension reached more than 13,000 residents. There was an increase in tax returns filed at free tax preparation sites for Tax Year 2008. There over 13,000 returns filed for Tax Year 2008. The VITA sites prepared returns that generated $2,968,715 in refunds, $829,874 in Earned Income Tax Credit and $456,827 in Child Tax Credit.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services

Outcome #6

1. Outcome Measures

Increased knowledge of changes in rural markets, governance and quality of life (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Maintaining or expanding the rural labor force is an integral component for the viability of rural economies. Rural communities throughout the United States continue to suffer maladies associated with dwindling employment opportunities. Exacerbating the problem, an out-migration of younger community members has left behind many older citizens who were displaced by a rapidly changing economy. Unemployment in rural areas is often due to a weak demand for labor, coupled with low wages.

What has been done
This study focuses on quarrying the skills sets in the New England retiree labor force and the enthusiasm of (including potential hours preferred by) retirees wishing to return to work under certain conditions. Concurrently, the enthusiasm of employers that retirees can adequately meet their business needs is measured.

Results
The statistics obtained to date clearly indicate a general compatibility of employer/employee interests. One-half of the businesses surveyed indicated a moderate to strong interest in offering positions to qualified retirees. Nearly one-half of the retirees surveyed in New England (48 percent) were enthusiastic about the possibility of gaining meaningful part time employment. Of the retirees wishing to return to the workforce, over one-third (34 percent) stated that a need for intellectual stimulation was the most important reason for doing so. When asked if individuals would like to work from home, several (58 percent) were moderately to very interested in doing so. Nearly three-fourths of employers surveyed (74 percent) indicated that the work-at-home option was available if desired.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
610	Domestic Policy Analysis

Outcome #7

1. Outcome Measures

Develop tools to facilitate stakeholder participation in natural resources planning, policy and management initiatives through distributed input.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Advancing knowledge in support of successful management of natural resources through the collection and application of credible and relevant social science data from the public, stakeholders and communities of interest is critical to land grant engagement.

What has been done
A web-forum provided the opportunity for stakeholders to participate in various stages of the research design, implementation, analysis and evaluation of a variety of issues associate with public access to private lands for recreation and tourism in the Northern Forest. Findings were disseminated through round table discussion held throughout the region and the project web site.

Results
The findings collected though the project served as a starting point for landowners, planners, natural resource agencies and recreation interests to better understand landowner behaviors and perception and improved communication between diverse stakeholders. The information collected via the web based engagement tool included an interactive communication component that allowed stakeholders to examine and share their interpretation of the information collected via a research forum.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

Increase public awareness of population dynamics and change related to aging, ethnicity and land use in rural communities.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Knowledge of population dynamics in rural communities is critical to economic and policy undertakings. Given the changing demographic trends fostered by the economic recession, timely demographic information is needed to develop appropriate economic and social responses.

What has been done
Research examined recent demographic trends in New Hampshire and in the U.S. Demographic reports were published in multiple peer reviewed and reviewed formats, and delivered to public, professional, and management audiences.

Results
Resulting demographic knowledge was effectively disseminated to the public and to policy makers. More than 100 media interactions were conducted and articles about this research appeared in nearly 450 papers including USA Today, The Wall Street Journal, New York Times (3 separate stories), Chicago Tribune and several New Hampshire papers. The numerous national and local radio venues have spanned from NPR to Radio Free Mississippi. Results were provided by request to the Chief of the Forest Service, Leadership New Hampshire, and the New Hampshire Charitable Foundation.

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

- Economy
- Public Policy changes
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)
- Time series (multiple points before and after program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Food, Nutrition & Health

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
304	Animal Genome			3%	
305	Animal Physiological Processes			25%	
702	Requirements and Function of Nutrients and Other Food Components			20%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			12%	
723	Hazards to Human Health and Safety			25%	
724	Healthy Lifestyle			15%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.4	0.0
Actual	0.0	0.0	1.2	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	232871	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	415935	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

Project 1. In laboratory studies that used integrated cell culture and real time PCR, detection of Reovirus were compared in 1) alkaline stabilized and 2) anaerobically digested, Class A biosolids. Results were discussed with FDA and related agency representatives, presented at scientific meetings and published in peer reviewed journals.

Project 2. Used laboratory research to develop mechanisms to prevent Escherichia coli O157:H7 infections leading to hemolytic uremic syndrome (HUS) especially in children. Strategies were to interrupt this cycle and help lead to improved human health and better acceptance of food products. Findings were published in peer reviewed journals as well as at national, international and regional meetings and workshops.

Project 3. Completed laboratory studies to examine the molecular basis of visual signaling and determined how the biochemical pathways that regulated rod photoreceptor vision (night vision) differed from those that control the light response in cone photoreceptors (daytime and color vision). This research emphasized analysis of the structural and functional differences in key enzymes in the signaling pathway. Ultimately, understanding the molecular details of rod and cone visual signaling permitted new treatments to preserve vision and prevent retinal degeneration and blindness in humans and animals. Results were presented at scientific meetings and published in peer reviewed journals, along with creation of web-based information.

Project 4. Exposed a laboratory model of the blood-brain barrier to conditions that are deficient or excessive in zinc while monitoring the transport of zinc across this barrier. Measured the relative abundance and location of specific zinc transport proteins and related this to changes in transport kinetics to describe its regulation. Results were presented at scientific meetings and published in peer reviewed journals.

Project 5. Improved methods of measuring intake of fruit, vegetables and whole grains to include biomarkers, dietary assessment and associations with obesity, other biomarkers and functional endpoints in older adults. Developed effective assessment techniques and intervention strategies to improve intake of fruit, vegetables and whole grains by older adults.

Project 6. The research focus was to investigate the possible disparate effects between polyunsaturated n-6 and n-3 fatty acids on activation and release of alveolar macrophages and chemical mediators PGE2, TNF&alpha, IL-6 and LTB4, using a clonal cell model of immune alveolar macrophage (3D4/31). The project used laboratory analyses and animal studies to examine the effect of insulin resistance on Th1/Th2 cytokines, TNF-alpha and pulmonary function in miniature swine. Findings were reported in research publications, professional meetings and meetings with general public.

Project 7. The primary focus of this project was to increase our knowledge about the potential health impacts of flame retardants - specifically polybrominated diphenyl ethers, or PBDEs - and their possible contribution to the obesity epidemic in humans. Using Wistar rats as our animal model, we will investigated the effect of PBDEs on growing and developing rats.

Project 8. Carried out laboratory experiments to determine the sensitivity of Jagged1 transcription under conditions that promote adipogenic cell differentiation. Jagged1 mRNA levels and transcription rates were measured in cells exposed to adipogenic hormones using quantitative real time PCR and nuclear run-on assays. Once the expression pattern was known, we identified the transcriptional regulators that govern its expression using luciferase reporter assays and chromosomal immunoprecipitation. Functional significance of factor binding was assessed through mutational analysis of the Jagged1 promoter

2. Brief description of the target audience

The target audience for all projects in the program included other scientists in the discipline, graduate and undergraduate students.

Project 1. There were three primary targets that this work will impact. First was the regulatory bodies governing the land application of biosolids, such as the EPA, both at the national and regional levels, as well as local regulators such as the New Hampshire Department of Environmental Services. The second target was the agricultural industry. Biosolids are a major source of inexpensive, easily obtained fertilizer for crops and fields. Regulations governing the safe practice of land application of biosolids had an impact on the agricultural sector that utilizes biosolids as a form of fertilizer. The last audience to be affected would be the general public, especially home owners who abut rural areas were large scale practices of land application occurs. Their main concern is the health and wellbeing of those who might be exposed to biosolids contaminated with viral pathogens.

Project 2. Because of the nature of the pathogen investigated, this works targets health care personnel, food industry specialists, veterinarians, molecular biologists, infectious disease professionals and those interested in developing appropriate and safe measures for the production and distribution of food stuffs from "farm gate to dinner plate". This project also serves to increase the knowledge and awareness of the general public about Escherichia coli O157:H7 and the diseases it causes.

Project 3. Researchers studying the molecular basis of vision. Scientists and educators interested in the flow of information

in sensory signaling pathways Educated laypeople interested in vision, visual disorders, and blindness Pharmaceutical companies seeking therapeutic treatments using drugs that target enzymes in the retina or the vascular system. Breeders seeking to avoid inherited visual disorders and blindness that are common in certain breeds of dogs and other animals.

Project 4. Scientists, nutritionists, teachers and clinicians working in related areas.

Project 5. Adults 65 years of age or older who shop for and prepare at least one meal a day, social and nutritional workers, state and local legislators.

Project 6. The outcome of the research from this project will have relevance to nutrient composition of feed products used in the beef, poultry and swine industries, and will be translatable to nutrition educators for teaching the possible health complications of obesity and dietary imbalances in omega 6 and omega 3 fatty acids on airway health.

Project 7. All citizens, public health and environmental safety workers and policy makers.

Project 8. Target audiences include scientists and clinicians studying the Notch signaling pathway, adipogenesis, hematopiesis, diabetes/insulin signaling and genomics. Information generated by the studies are expected to be disseminated to these audiences through presentations at regional and national meetings (oral and/or poster), publications and lectures to both undergraduate, graduate and medical students at the University of New Hampshire, the University of New England and Maine Medical Center Research Institute.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	1700	7900	70	0
Actual	1500	6500	80	25

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

Year: 2009
Plan: 2
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	9	
Actual	0	5	5

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in the project (not including audience counts, subjects or survey respondents)

Year	Target	Actual
2009	18	12

Output #2

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	6	9

Output #3

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	6	13

Output #4

Output Measure

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

Year	Target	Actual
2009	8	5

Output #5

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	4	0

Output #6

Output Measure

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

Year	Target	Actual
2009	9	12

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	0	1

Output #8

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	15	4

Output #9

Output Measure

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

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about methods for detecting reovirus in Class A biosolids (qualitative output statement)
2	Increased knowledge about regulation of Escherichia coli Shiga-like toxins and their impact on host cell apoptosis (qualitative output statement)
3	Increased knowledge about effects of hyperglycemia and dyslipidemia on the expression of adhesion molecules by arterial endothelial cells (qualitative output statement)
4	Increased knowledge about nucleotide metabolism during signal transduction in retinal photoreceptor cells (qualitative output statement)
5	Increased knowledge about regulation of zinc transport by endothelial cells (qualitative output statement)
6	Increased knowledge about fruit, vegetable and whole grain) availability and intake in older adults (qualitative output statement)
7	Increased knowledge about metabolic links that would explain the relationship of obesity and development of allergic disease (qualitative output statement)
8	Increased knowledge about links between environmental pollutants and obesity (qualitative output statement)
9	Increased knowledge about regulation of gene expression in adipogenic cells by insulin, glucocorticoids and phosphodiesterase inhibitors (qualitative output statement)

Outcome #1

1. Outcome Measures

Increased knowledge about methods for detecting reovirus in Class A biosolids (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Reovirus pathogens in biosolids used for land spreading or other applications must be accurately quantified. The PFU method is used for the analysis of biosolids for all viral pathogens by the EPA, but may not be the most appropriate.

What has been done
The three sets of primers and probes used in this study allowed for differentiation between the types of reovirus detected. Out of the 24 samples evaluated, 54% of them were positive for Reovirus using the ICC-PCR method while none were positive by the plaque assay. 12 out of 15 untreated samples were positive and 1 out of 9 treated samples were positive by the ICC-PCR method and negative by the PFU method. Of those that were positive, type 1 was most prevalent in NH and PA while type 3 was found in TX.

Results
This study demonstrates that the ICC-real-time RT-PCR method can be used to determine reovirus presence. Integrated cell culture with real-time RT-PCR detects more mammalian orthoreovirus than the plaque assay method current used. Evaluation of these results demonstrates the limitations of using the plaque assay as the method of choice when evaluating biosolids for infectious virus. Work done on this study was shared with the EPA and the Committee on Pathogen Reduction.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Increased knowledge about regulation of Escherichia coli Shiga-like toxins and their impact on host cell apoptosis (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Enterohemorrhagic E. coli O157:H7 (EHEC) may cause hemolytic uremic syndrome (HUS), a severe complication of hemorrhagic colitis (HC). Approximately 5 percent of cases with HC progress to HUS, especially in the young and those with impaired immune function. The condition is characterized by renal failure, blood cell damage and system-wide organ shutdown. In children under five years old this condition often proves fatal. The CDC reports approximately 73,000 cases of food borne illness and over 60 deaths attributed to this pathogen annually in the US. Several spectacular outbreaks of EHEC have occurred in recent years from contaminated foods including unpasteurized apple juice, spinach, and most commonly ground beef. The pathogen produces Shiga-toxins (Stx) that are major virulence factors responsible for disease.

What has been done
The pathogen produces Shiga-toxins (Stx) that are major virulence factors responsible for disease. Data on toxin production generated by cytotoxicity and ELISA assays indicated that DNA-damaging antibiotics increased Stx-2 production by triggering the DNA SOS response while other antibiotics did not. Likewise, co-cultivation with lactobacilli significantly decreased toxin production. It was also determined that Stx-2 output rose in the presence of increased glucose while varying concentrations of glycerol had no effect on Stx-2 production. Increasing concentrations of cAMP decreased the amount of Stx-2 produced.

Results
These studies suggest that glucose but not glycerol stimulated Stx-2 expression in E. coli O157:H7 strains that carried the lambda-like phage 933-W. Also, that Stx-2 could delay neutrophil apoptosis by binding to pro-apoptotic Bcl-2 group proteins within the cell. To evaluate whether the delay in apoptosis is due to the interaction of Stx-2 with Bax within neutrophils the generation of a mutated Stx-2 toxin was initiated and this work is ongoing.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Increased knowledge about effects of hyperglycemia and dyslipidemia on the expression of adhesion molecules by arterial endothelial cells (qualitative output statement)

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Increased knowledge about nucleotide metabolism during signal transduction in retinal photoreceptor cells (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many diseases of the eye affect both humans and many inbred strains of animals, including domestic animals (e.g., dogs, cats) farm animals (e.g., pigs, chickens) and laboratory animals (e.g., mice, rats). For most retinal diseases, there is neither means for a cure nor prevention. In economic terms, eye diseases and blindness cost the United States billions of dollars each year. Progress against these conditions depends on gaining new knowledge of the fundamental molecular and cellular processes underlying normal retinal function.

What has been done
Work was undertaken to understand how rod and cone photoreceptors in cow retinas function differently by acquiring new knowledge in the molecular characteristics of the key enzyme in the cone visual signaling pathway, cone phosphodiesterase-6 (PDE6).

Results
We have learned that the gene for cone PDE6 cannot be successfully introduced into a heterologous expression system consisting of viral infection of this gene into insect cells grown in culture. This experimental failure to produce active PDE6 enzyme in a recombinant expression system is unique to PDE6, since we have successfully expressed the closely related PDE5 enzyme under identical conditions. Current experiments seek to optimize the bacterial expression of truncated PDE5 so that we can introduce site-directed mutants to generate chimeras of PDE5 and cone PDE6 to identify critical structural elements needed for expression of active enzyme and to elucidate the structural features that distinguish the cone PDE6 from PDE5. The eventual outcome of this work is two-fold: understanding how differences in cone and rod PDE6 impart physiological differences in rod and cone photoreceptor function, and defining biochemical and pharmacological differences between PDE5 and PDE6 that will improve design of better PDE5 drugs for vascular diseases of animals and humans.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes

Outcome #5

1. Outcome Measures

Increased knowledge about regulation of zinc transport by endothelial cells (qualitative output statement)

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Increased knowledge about fruit, vegetable and whole grain) availability and intake in older adults (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Increasing dietary intake of lutein rich vegetable or other food source of lutein by one serving per day may increase the retinal carotenoids and alter physiological markers in such a way as to reduce risk of Age-related Macular Degeneration (AMD).

What has been done
Fifty healthy non-smoking adults ages 25-65 were recruited for the first study where they consumed one additional serving of a lutein rich vegetable entree daily for 4 months. Spinach was grown and processed and provided to the subjects in frozen (equivalent) half-cup servings. Blood samples were collected at baseline and monthly for 6 months. Macular pigment was measure by heterochromatic flicker photometry, background diet was assessed using food frequency questionnaires. The same protocol was followed to assess the bioavailability of lutein from egg yolk and lutein supplements (10 and 30 mg).

Results
Increasing one serving of a lutein-rich food increased macular pigment density in most but not all subjects. The results of the study showed that carotenoid-rich food is an effective vehicle for delivering lutein to tissue, similar to that of dietary supplements.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Increased knowledge about metabolic links that would explain the relationship of obesity and development of allergic disease (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Respiratory allergic disease including asthma has more than doubled in the last thirty years. An imbalance in consumption of foods high in the ratio of n-6:n-3 fatty acids related to the wide scale use of vegetable oils and feeding cereal grain for livestock products are suspected factors.

What has been done
Alveolar macrophage cells, will, when exposed to chronic high levels of n-6 relative to n-3 fatty acids, alter their biochemical phenotype activated toward allergy development. We investigated the possible disparate effects between polyunsaturated n-6 and n-3 fatty acids on activation and release of alveolar macrophages and chemical mediators PGE2, TNFα, IL-6 and LTB4, using a clonal cell model of immune alveolar macrophage (3D4/31). The application of 3D4/31 cells to study allergic disease is new.

Results
Our experimental findings suggest that 3D4/31 cells show many of the key phenotypic characteristics of a classically activated alveolar macrophage. Further that 3D4/31 cell is a useful model of alveolar macrophage to test our hypothesis, in vitro. We expect the outcome of our line of research will have important health and agricultural implications.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety

Outcome #8

1. Outcome Measures

Increased knowledge about links between environmental pollutants and obesity (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Obesity is recognized as a serious health problem in adults and children, and may be affected by exposure to environmental chemicals. Knowledge about the health impact of flame retardants - specifically polybrominated diphenyl ethers, or PBDEs - and their possible contribution to the obesity epidemic in humans, is critical.

What has been done
Using Wistar rats as our animal model, we investigated the effect of PBDEs on growing rats and developing rats.

Results
In developing rats, PBDE exposure during pregnancy and lactation affected body weight of dams, and developmental exposure of rats to flame retardants can interact with the diet of the offspring to influence weight gain. The study found that PBDE treatment affected final body weight in dams. Food intake was significantly increased in pups consuming a HFHS diet compared to control diet. Glucose transported into fat cells decreased in pups fed a HFHS diet compared to a control diet. Metabolic efficiency of pups decreases with a HFHS diet compared to a control diet. Weight gain in pups tended to be affected by both PBDE treatment and diet. Epididymal fat pad weights were greater in the HFHS fed pups. We continue to assess the obesity-promoting effects of PBDEs in the rat model.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety

Outcome #9

1. Outcome Measures

Increased knowledge about regulation of gene expression in adipogenic cells by insulin, glucocorticoids and phosphodiesterase inhibitors (qualitative output statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Understanding the regulation of gene expression related to Jagged1/Notch signaling in adipogenic development is important to reducing and treating obesity.

What has been done
We continued to explore the mechanism by which insulin downregulates Jagged1 mRNA expression levels using transcriptional inhibitors. In addition to the molecular/biochemical data, we have also continued to develop computer-based tools (software) to analyze our novel data in which we utilized a bioinformatics approache to identify the conserved 1500 bp region within the jagged1 promoter. Unique scripts (small computer programs) were generated to increase the probability of locating "true" transcriptional elements within this region.

Results
We found that insulin treatment is likely to affect Jagged1 transcription, not degradation. This will be of interest to not only the adipogenic/obesity community but has import in regards to studies centered on insulin-regulated metabolic responses since Jagged1 is expressed in many cell types. We found 7 putative elements that were found to be conserved among mammals within this region; unfortunately, most are associated directly with hematopoiesis, not adipogenesis or insulin signaling.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Government Regulations
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

- Time series (multiple points before and after program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Natural Resources & Environment

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
112	Watershed Protection and Management			9%	
123	Management and Sustainability of Forest Resources			10%	
124	Urban Forestry			5%	
133	Pollution Prevention and Mitigation			6%	
135	Aquatic and Terrestrial Wildlife			30%	
136	Conservation of Biological Diversity			15%	
201	Plant Genome, Genetics, and Genetic Mechanisms			6%	
213	Weeds Affecting Plants			9%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	5.8	0.0
Actual	0.0	0.0	1.0	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	137252	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	354101	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

Note that six of the ten projects included under this Planned Program in the 2009 Plan of Work are funded by McIntire-Stennis funds, so are not covered by this report. Therefore several of the state defined outcome measuress will not be reported on.

Project 1. Used field and laboratory methods to research spatial distribution of both blue green bacteria and resulting microcystin toxin and to examine water, wildlife and sediment components for toxins. Results were disseminated through publications and presentations at scientific meetings. A statewide biotoxin monitoring program and workshops on monitoring procedures were developed.

Project 2. Undertook field collection of marine invertebrates in the Gulf of Maine and use molecular laboratory methods to sequence "barcode" genes. The project developed an open access web page with information on marine invertebrates of the Gulf of Maine, including genetic, habitat and species data.

Project 3. Made field collections of native and introduced seaweeds in diverse Gulf of Maine habitats in order to assess historical and recent patterns of diversity and introduced taxa. Specimens were deposited in the UNH Herbarium.

Project 4. Collected field population samples of invasive seaweeds in the Gulf of Maine and will use laboratory analyses to document genetic structure. Specimen were preserved in the UNH Herbarium. Findings were reported in the scientific literature. Information will be conveyed to the public through pamphlets, and an informational website.

2. Brief description of the target audience

Project 1. Primary audiences include the State Watershed and Drinking Water Divisions of the NH Department of Environmental Services, towns, and lake associations. Results from the study may be used by towns, lake associations and citizens to assist in the planning for the development and remediation of their lakes. Other audiences include the US Environmental Protection Agency, with whom we are currently developing a web-based open-source data base for data on lake cyanotoxins and water quality. Through this project we also train students in our classes on the subject of cyanotoxins and lake management as well as in the techniques for measuring water quality and analyzing data.

Project 2. Ecologists, marine invertebrate biologists, conservation biologists, invasion biologists, fisheries and aquaculture managers, resource managers, and personnel responsible for biosecurity.

Project 3. Target audiences include taxonomists, invasive biologists, and citizens, workers and agencies concerned about impacts of invasive seaweeds, coastal managers, diverse governmental agencies, and private conservation groups maintain and preserve productive coastal ecosystem.

Project 4. Ecologists, conservation biologists, resource managers, aquaculture farmers, fisheries biologists, and biosecurity officers (customs officials, specialists for invasive species control, etc.).

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	900	1500	50	80
Actual	1050	2500	80	30

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

Year: 2009
Plan: 0
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	12	
Actual	0	5	5

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants directly involved in the project (not including audience counts, workshop participants, survey respondents, etc)

Year	Target	Actual
2009	45	18

Output #2

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	15	6

Output #3

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	15	10

Output #4

Output Measure

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

Year	Target	Actual
2009	15	5

Output #5

Output Measure

- Number of workshops and training sessions

Year	Target	Actual

2009	3	10

Output #6

Output Measure

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

Year	Target	Actual
2009	15	8

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	1	1

Output #8

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	18	5

Output #9

Output Measure

- Number of websites in which project results have been incorporated

Year	Target	Actual
2009	12	4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about ecosystem services in a fragmenting forested landscape (quantitative outcome statement)
2	Increased knowledge about the effects of historic and contemporary land uses to exotic shrub invasions (quantitative outcome statement)
3	Increased knowledge about human community adaptation to forested ecosystem migration as a result of climate change (quantitative outcome statement)
4	Increased knowledge about guide integrated upland and wetland habitat management for vernal pool-dependent amphibians (quantitative outcome statement)
5	Increased knowledge about effects of forest management on stream insect biodiversity (quantitative outcome statement)
6	Increased knowledge about microcystins in New Hampshire lakes, the localized impacts of blooms and implications for human health (quantitative outcome statement)
7	Increased knowledge about the biodiversity of invertebrates in the Gulf of Maine (quantitative outcome statement)
8	Increased knowledge about seaweed biodiversity and introduced seaweeds within the Gulf of Maine (quantitative outcome statement)
9	Increased knowledge about the population genetics and dispersal of invasive seaweeds in the Gulf of Maine (quantitative outcome statement)
10	Progress in scanning, databasing, and curating the UNH Herbarium (quantitative and/or outcome statement)

Outcome #1

1. **Outcome Measures**

   Increased knowledge about ecosystem services in a fragmenting forested landscape (quantitative outcome statement)

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   Increased knowledge about the effects of historic and contemporary land uses to exotic shrub invasions (quantitative outcome statement)

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Increased knowledge about human community adaptation to forested ecosystem migration as a result of climate change (quantitative outcome statement)

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Increased knowledge about guide integrated upland and wetland habitat management for vernal pool-dependent amphibians (quantitative outcome statement)

   Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

   Increased knowledge about effects of forest management on stream insect biodiversity (quantitative outcome statement)

   Not Reporting on this Outcome Measure

Outcome #6

1. **Outcome Measures**

   Increased knowledge about microcystins in New Hampshire lakes, the localized impacts of blooms and implications for human health (quantitative outcome statement)

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cyanobacteria blooms that may be stimulated by agricultural runoff can produce toxic microcystins, affecting residents and visitors to regional water bodies.

What has been done
Supported scientists provided eight workshops and training sessions targeted at the public, citizen lake monitors, federal, state and local government agency personnel, and persons working in veterinary medicine and areas related to drinking water. One of these workshops brought neuroscientists, toxicologists and other human health professionals together with federal, state, academic, and Tribal environmental scientists to discuss regional strategies aimed at understanding possible links between environmental exposure to cyanobacterial neurotoxins and human neurodegenerative disorders such as Amyotrophic Lateral Sclerosis (ALS, Lou Gerhig's Disease), Parkinson's and Alzheimer's diseases.

Results
Knowledge obtained and transferred to the public and diverse stakeholders increased the awareness and understanding of this important situation. The group worked with the USEPA to develop a web-based portal for presentation and analysis of cyanobacteria toxin data, and is assisting in the development of a USEPA-sponsored workshop.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals

Outcome #7

1. Outcome Measures

Increased knowledge about the biodiversity of invertebrates in the Gulf of Maine (quantitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Early detection of invasive marine species is important to protect the viability of aquaculture operations and marine ecosystems upon which they depend. Development of molecular 'barcodes' to help identify certain marine invertrebrates can contribute to this goal.

What has been done
Field collection of marine invertebrates was undertaken in the Gulf of Maine and molecular laboratory methods were used to sequence 'barcode' genes. The total number of collected and sequenced specimens for the time period covered was 131, representing 13 species of Annelida, one species of Nemertea, 13 species of Crustacea, two species of Cnidaria, and two species of Echinodermata. Congeneric species were found for crustaceans, cnidarians and echinoderms, allowing for the calculation of interspecific genetic variation, in addition to intraspecific distances

Results
Comparisons of intra- and interspecific genetic distances for multiple species showed that levels of genetic variation in the CO-I gene are appropriate for use as a molecular barcode for congeneric species of crustaceans and hydrozoan cnidarians. However, the approach is not suitable for asteroid echinoderms because intraspecific distances overlap with interspecific distances. Hence, no barcode gap exists.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #8

1. Outcome Measures

Increased knowledge about seaweed biodiversity and introduced seaweeds within the Gulf of Maine (quantitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual

2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Invasive and introduced seaweeds can foul apparati of aquaculture operations, and interfere with the native ecosystem on which these operations depend. Assessment of such seaweeds within the Gulf of Main is needed to inform stakeholders about their potential spread.

What has been done
Studies of distributional and abundance patterns of seaweeds within the Gulf of Maine were conducted based upon rapid assessment evaluations, plus extensive seasonal and spatial evaluations. Enumerations of introduced and invasive seaweeds from Asia and Europe are being documented based upon field and molecular investigations. Rapid assessment surveys (RAS) of fouling seaweed populations were conducted at 67 sites between Downeast Maine and Staten Island, New York in order to document floristic changes and impacts of anthropogenic impacts. Molecular ecological studies of several "cryptic" introduced seaweeds were conducted in order to document introduction patterns of non-native species within the Gulf of Maine, particularly within embayments, harbors, and marinas.

Results
Dissemination of results has occurred via scientific publications, presentations of significant findings to coastal resource managers (e.g. Fish and Game Units, Environmental Protection Units), and interactions with several conservation units such as the Nature Conservancy, Friends of Casco Bay, the Great Bay Stewards, etc. This knowledge has increased their abilities to take appropriate action to mitigate or adapt to the presence or potential of these seaweed species.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
136	Conservation of Biological Diversity

Outcome #9

1. Outcome Measures

Increased knowledge about the population genetics and dispersal of invasive seaweeds in the Gulf of Maine (quantitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The invasive seaweed Codium can interfere with aquaculture activities by attaching to shellfish then pulling large sections loose in response to storms. The seaweed has rapidly replaced native species or disrupted natural ecosystems when introduced into new locations. Ability to effectively discriminate between subspecies is important for management and predictive purposes.

What has been done
With combined funding from the NHAES and the National Sea Grant College Program, range-wide collections of Codium fragile from Long Island Sound to the Canadian Maritimes were evaluated for morphological variation and for chloroplast haplotype. Neither overall utricle size nor mucron length was adequate to distinguish between Codium fragile subspecies. New molecular markers are being developed for Codium nuclear loci, and it is hoped that these markers will be more variable and therefore useful to examine population structure of the introduced species.

Results
We continue to advance knowledge about the species to determine its origins and economic and ecological impacts on the region's fish and shellfish populations. Stories carried by both Maine and New Hampshire Public Radio, the UNH website, and picked up by multiple other visible locations disseminated information to large numbers within the public and management sectors.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms

Outcome #10

1. Outcome Measures

Progress in scanning, databasing, and curating the UNH Herbarium (quantitative and/or outcome statement)

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Natural Disasters (drought, weather extremes, etc.)
- Government Regulations

Brief Explanation

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- After Only (post program)
- Retrospective (post program)
- Before-After (before and after program)

- During (during program)
- Time series (multiple points before and after program)
- Case Study

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Pest Management

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
211	Insects, Mites, and Other Arthropods Affecting Plants			100%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.5	0.0
Actual	0.0	0.0	0.3	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	26445	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	74994	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

This program area contains a single project. The PI had to deal with significant health issues during 2009, which reduced the ability to advance the work at the level intended, leading to limited output.

Beetles of several species were trapped locally to investigate hormonal control of parental care in burying beetles. Hemolymph was taken at designated times and during a reproductive bout and was analyzed using radioimmunoassay for juvenile hormone titers. Manuscripts were submitted to peer reviewed journals. Presentations were given at regional, national and/or international meetings. Grant proposals were submitted. There was training of undergraduate students, graduate students and/or postdoctoral fellows.

2. Brief description of the target audience

The target audience included students in university classrooms, and the scientific community, particularly those in the fields of animal behavior, behavioral ecology and evolution, and agricultural pest research.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	50	50	0	0
Actual	25	150	0	0

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

Year: 2009
Plan: 0
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	1	
Actual	0	1	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in the project (not including audience counts)

Year	Target	Actual
2009	3	2

Output #2

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	1	2

Output #3

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	1	1

Output #4

Output Measure

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

Year	Target	Actual
2009	1	1

Output #5

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	1	0

Output #6

Output Measure

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

Year	Target	Actual
2009	1	0

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	0	1

Output #8

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	1	0

Output #9

Output Measure

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

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increase in knowledge about hormonal control of reproduction and parental care in beetles (qualitative outcome statement)

Outcome #1

1. Outcome Measures

Increase in knowledge about hormonal control of reproduction and parental care in beetles (qualitative outcome statement)

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (Health status of supported scientist.)

Brief Explanation

The supported scientist underwent treatment for serious health issue during 2009.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- After Only (post program)
- During (during program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Plants & Plant Products

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			10%	
202	Plant Genetic Resources			10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			40%	
206	Basic Plant Biology			40%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.3	0.0
Actual	0.0	0.0	0.7	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	90611	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	156294	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

One of the five projects included in the 2009 Plan of Work is funded by McIntire-Stennis and therefore not included in this report.

Project 1. Conducted laboratory studies to investigate the role of iron deficiency in altering and reducing the efficiency of anti-oxidant systems in limiting damage and stress to photosynthesis. It tested a variety of photosynthetic marine micro-organisms at a range of iron levels, determine photosynthetic sensitivities, antioxidant levels and responses.

Project 2. Conducted greenhouse, field and laboratory experiments to determine whether plants have a generalized response to abiotic stress at the cellular and tissue level. Papers were published in peer reviewed journals describing results of these studies as well as presentations at scientific meetings. A web site specific to this project was developed.

Project 3. Carried out laboratory molecular studies to identify genetic mechanisms involved in plant responses to DNA damage (an abiotic stress) in the model plant Arabidopsis thaliana. Included undergraduate training and teaching, through understanding of the genetic mechanisms in response to DNA damage. Research was presented at local and national meetings, published in peer and non-peer reviewed journals. Graduate students were trained.

Project 4. Conducted growth chamber and molecular biological studies to assess the effects of stress and the role of protein phosphatases on the response of roots to gravity. Undergraduate and graduate student participants were trained in the techniques of biotechnology and genetic analyses.

2. Brief description of the target audience

Project 1. Biological oceanographers, chemical oceanographers, and plant physiologists and biochemists specializing in oxidative stress in photosynthetic systems.

Project 2. Scientists in plant stress biology, plant breeders, and those interested in abiotic stresses in plants.
Project 3. Graduate, undergraduate and high school students, agricultural and biomedical researchers.

Project 4. The target audiences for this research are undergraduate and graduate students, faculty and other researchers in the area of plant sciences. Ultimately agricultural plant breeders and seed producers will be target audiences.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	400	1500	10	0
Actual	300	1200	15	30

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

Year: 2009
Plan: 0
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	5	
Actual	0	2	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants directly involved in the project (not including audience counts, workshop participants, survey respondents, etc)

Year	Target	Actual
2009	15	30

Output #2

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	5	15

Output #3

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	5	4

Output #4

Output Measure

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

Year	Target	Actual
2009	5	5

Output #5

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	0	0

Output #6

Output Measure

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

Year	Target	Actual
2009	5	3

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	1	1

Output #8

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	8	0

Output #9

Output Measure

- Number of websites in which project results have been incorporated

Year	Target	Actual
2009	3	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about the relationship between iron deficiency, oxidative stress and the inhibition of photosynthesis (quantitative outcome statement)
2	Increased knowledge about generalized stress response at the cellular and tissue level for leaves exposed to osmotic stress and mechanical injury (quantitative outcome statement)
3	Increased knowledge about DNA damage from UV radiation in Arabidopsis thaliana (quantitative outcome statement)
4	Increased knowledge about the regulation of polyamine metabolism and stress response in poplar (quantitative outcome statement)
5	Increased knowledge about the role of protein phosphatase in auxin signaling and root response to gravity (quantitative outcome statement)

Outcome #1

1. Outcome Measures

Increased knowledge about the relationship between iron deficiency, oxidative stress and the inhibition of photosynthesis (quantitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Photosynthesis is the driver of primary productivity in plants. Low iron produces photosynthetic stress resulting in severe reductions in net cellular growth rates, photosynthetic rates, and increases membrane damage in photosystem 2 as reduction in fluorescence parameters.

What has been done
The oceanic species Dunallella was used as representative organism. Multiple culturing and cell molecular investigations under varied iron levels were conducted to evaluate impacts on photosynthesis mechanisms. Overall, iron deficiencies produced large decreases in the cellular defenses that normally protect against oxidative stresses in photosynthesis.

Results
These results imply that severe iron deficiencies in marine photosynthetic organisms likely reduce primary production not only by limiting the electron transport chain which directly requires a large amount of iron, but also indirectly by severely limiting the defensive antioxidant enzymes that scavenge excess reactive oxygen species, and thereby allow increases in active oxygen concentrations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology

Outcome #2

1. Outcome Measures

Increased knowledge about generalized stress response at the cellular and tissue level for leaves exposed to osmotic stress and mechanical injury (quantitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many abiotic stresses are routinely or periodically encountered by agricultural plants. Because of limited mobility plant survival depends on rapid acclimation to environmental stressors. It is possible that plants may elicit a relatively few pre-programmed generalized stress responses. If true, knowledge of these will advance our abilities to effectively and efficiently produce food products under variable climate scenarious.

What has been done
The impacts of mechanical damage on the chloroplast, mitochondria, vacuole volume percent of the cell, starch volume percent of the chloroplast were measured. Thylakoid (appressed, non appressed and margin) surface to volume ratio in the chloroplasts was also measured withing 7 mm of a hole punched into the leaf and compared against controls from the same leaf 25 mm from damaged area.

Results
No significant changes were observed within 0-7mm of the site of mechanical damage over the 13 hr test period for any of the parameters measured. Mechanical stress (hole punch) did not appear to evoke a type 1 stress response. The results from part one of this study indicate that plant cells (Sunflower) have effective mechanisms for isolating the effect of mechanically damaged cells to an extremely limited area (less than 1mm) of the damaged site. The effects of post traumatic drying were not evaluated in this study and may be a factor in actual field conditions. However, the effect of mechanical damage is very limited based on changes in cell structure. Although neither changes in biochemistry nor physiology were measured, mechanical damage from insect bites, harvesting or sampling equipment appear to cause minimal or no alteration in cell structure.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Increased knowledge about DNA damage from UV radiation in Arabidopsis thaliana (quantitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
DNA damage to crop plants reduces their productivity, and potentially the viable growth range (regions) under climate change. The plant model Arabidopsis thaliana is commonly used to evaluate molecular mechanisms of plant response.

What has been done
Experiments were completed to to understand the principles of how plants combat the effects of abiotic stress, particularly DNA damage such as UV light. Damage response proteins and programmed responses to replication inhibitors were evaluated using controlled growth chamber environments.

Results
We discovered new genes involved in the DNA damage responses to UV light, and have studied how these genes protect plants from DNA damage and the resulting mutation and stress. The impact from these studies includes the potential to discover novel ways to improve crop productivity, thereby increasing crop production output in New Hampshire and elsewhere.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Increased knowledge about the regulation of polyamine metabolism and stress response in poplar (quantitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Increased knowledge about the role of protein phosphatase in auxin signaling and root response to gravity (quantitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A fundamental understanding of plant responses to stresses is critical for US agriculture. One stress factor that is often regional but is increasing with reduction of available fresh water resources is salinity. The overall objective of this research project is to understand the role of protein phosphatase 2A (PP2A) in plant responses to salt stress.

What has been done
In the first year of this project experiments investigated salinity impacts on amyloplast sedimentation in plant cells which is important for root responses to gravity. Both normal and mutant plants were grown on increasing concentrations of salt and amyloplasts were detected with iodine staining.

Results
No differences in the rate of disappearance of amyloplasts were observed when wildtype and mutant roots were compared, indicating that amyloplast disappearance is not correlated with the mutant phenotype. Interestingly, mutant roots did show a reduced ability to change root growth direction following gravistimulation (reorientation of the seedlings) and this was correlated with a slower redistribution of the plant hormone auxin in gravistimulated mutant seedlings. The impact of the research has been to generate fundamental new knowledge about the genes involved in plant responses to salt stress.

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
- Other (Equipment malfunction or breakdown.)

Brief Explanation

Equipment breakdown including growth chambers and electron microscope delayed aspects of some research.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- After Only (post program)
- Retrospective (post program)
- During (during program)

- Time series (multiple points before and after program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 9

1. Name of the Planned Program

Sustainable Horticulture

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			4%	
201	Plant Genome, Genetics, and Genetic Mechanisms			16%	
202	Plant Genetic Resources			4%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			10%	
204	Plant Product Quality and Utility (Preharvest)			35%	
205	Plant Management Systems			23%	
216	Integrated Pest Management Systems			4%	
503	Quality Maintenance in Storing and Marketing Food Products			4%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.4	0.0
Actual	0.0	0.0	0.9	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	236304	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	247642	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

Project 1. This project used genomic tools to guide a breeding program for strawberries and mint. The project used a combination of laboratory molecular analyses, bioinformatics, greenhouse experiments and breeding, and field trials to develop and test new varieties.

Project 2.Continued a long-term breeding initiative that led to the development of many new varieties of melons and squash, many of which were in commercial production. The project was part of a multistate effort to conserve and utilize plant genetic resources. Activities included field breeding and field trials to select for commercially important characteristic in melons, squash, pumpkins and gourds.

Project 3. Used the same breeding methodology as in Project 2 to specifically improve nutritional quality of squash, including the content of antioxidants carotenoids which have long been known to be important for eye function. In addition, carotenoids have antioxidant properties and have been implicated in reducing risk of cardiovascular disease, certain cancers, cataracts and age-related macular degeneration. The study used laboratory nutritional analyses to guide the breeding work and assess the results.

Project 4. The fourth project used a series of field trials to assess the effectiveness of row covers, high tunnels and mulch for season extension and insect and diseases prevention in blackberries, sweet peppers, and sweet potatoes. Field variety trials were conducted for cantaloupes and sweet potatoes to determine varieties optimum for northern climates. Quality assessments were done via laboratory analyses and blind taste tests. The study also evaluated Winter Sprouting Broccoli as a new crop for New England. A goal of the project was to increase grower awareness of new crops and varieties that increase diversity and profitability. Multiple workshops were held for growers.

Project 5. The fifth project continued to assess cultural factors that influenced production and landscape establishment of trees and shrubs. One component of the project was to develop and compare methods of over-wintering container-grow shrubs and trees. Available and experimental products were tested in the field. Root zone temperature was continually recorded with data loggers. Root damage was assessed in the spring and general health and growth monitored after planting in the landscape. Results were presented to nurserymen and landscapers via workshops and publications

Project 6. This project was added during 2008, following hire of a new faculty member. It conducted extensive greenhouse trials to develop production guidelines for Osteospermum, including nutrient sufficiencies, optimal lighting protocol, and other factors.

2. Brief description of the target audience

Project 1. The primary target audiences for this project were plant breeders and crop producers (growers). The efforts directed at developing germplasm and genomic resources and identifying genes involved in agriculturally important traits were intended to encourage and facilitate the use by breeders of molecular markers as an aid to plant breeding (marker assisted selection), to efficiently exploit wild related species as gene sources for improvement of cultivated strawberries and mints, and to aid in the ultimate production of superior varieties that will benefit growers and consumers.

Project 2. The major target audiences were vegetable growers who grow and market improved varieties of vegetables. However, the end users are the consumers of produce. In addition, information were disseminated on squash quality in popular publications with the intent on increasing awareness of squash quality among those individuals involved in marketing at the wholesale level to large supermarket chains and to produce managers that handle produce at large retail outlets.

Project 3. Target audiences were consumers of vegetables, produce managers at retail produce outlets, wholesale brokers and distributors of vegetables, vegetable growers, Cooperative Extension Specialists, food scientists, and horticulturists.

Project 4. Targets included regional vegetable and fruit growers, home gardeners, extension specialists, and consumes of local farm products.

Project 5. Nursery owners, managers and growers in the state and region, and those seeking effective options for sustainable landscapes.
Project 6. Commercial nursery and greenhouse operations, consumers of young and matured ornamental plants, and those interested in sustainable greenhouse production methods.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	300	500	0	200
Actual	800	4500	25	40

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

Year: 2009
Plan: 0
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	5	
Actual	0	3	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	4	12

Output #2

Output Measure

- Number of participants in the project (not including audience counts)

Year	Target	Actual
2009	10	12

Output #3

Output Measure

- Number of undergraduate students involved in the research projects

Year	Target	Actual

2009	5	10

Output #4

Output Measure

- Number of graduate students involved in the research project

Year	Target	Actual
2009	2	8

Output #5

Output Measure

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

Year	Target	Actual
2009	3	5

Output #6

Output Measure

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

Year	Target	Actual
2009	4	7

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	0	0

Output #8

Output Measure

- Number of non-peer reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	2	4

Output #9

Output Measure

- Number of websites in which the project results are incorporated.

Year	Target	Actual
2009	2	4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Improvement in nutritional and cultural quality of fruit and vegetable varieties produced by breeding programs. (qualitative outcome statement)
2	Suitability of varieties tested in field trials (qualitative outcome statement)
3	Effectiveness of season extension and pest/disease control methods for which field trials were completed (qualitative outcome statement)
4	Effectiveness of genomic tools used to guide breeding program (qualitative outcome statement)
5	Effectiveness of workshops and other presentation in informing growers and consumers about new varieties (qualitative outcome statement)
6	Effectiveness of undergraduate and graduate student training through project participation and classroom presentation. (qualitative outcome statement)
7	Overall effectiveness of the Planned Program in addressing issues and needs of the state and region (qualitative outcome statement)
8	Release superior new varieties of vegetable crops suited to state and regional conditions and markets.
9	Ability to breed for nutritional quality in squash.
10	Disseminate vegetable and small fruit production research results to growers and consumers.

Outcome #1

1. Outcome Measures

Improvement in nutritional and cultural quality of fruit and vegetable varieties produced by breeding programs. (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Increasing public awareness of the dietary importance of healthful fruits, vegetables, and herbs creates both demand and opportunity for the development of new horticultural crop varieties. Wild relatives of these specialty crop species are valuable resources from which genes and traits can be transferred via sexual hybridization. The project aim was to develop new germplasm resources and genomic knowledge needed by specialty crop breeders who seek to shorten varietal development cycles by implementing marker-assisted breeding (MAB) techniques, and to exploit wild germplasm as sources of useful genes.

What has been done
We have discovered and/or developed new germplasm resources, and have isolated, sequenced and mapped over 25 genes of potential economic important in relation to traits such as fruit quality, flowering habit, sex determination, and disease resistance. This research has addressed such issues as the adverse environmental and health related impacts of pesticide and soil fumigant application by seeking genetic solutions to the widespread problem of verticillium wilt disease, due to the fungal pathogen Verticillium dahliae. We screened over 60 germplasm accessions of wild and cultivated strawberries, discovered useful sources of resistance, and performed resistant x susceptible crosses as a step towards developing resistant varieties. In the mint model species Mentha longifolia, we isolated and sequenced thirteen alleles of the mVe2 gene, a homolog of the tomato Verticillium wilt resistance gene Ve, and studied the relationships of these alleles to plant resistance.

Results
These and other results provide a foundation for the envisioned initiation of a program of marker-assisted strawberry breeding at the New Hampshire AES. The research was intended to provide tangible intermediate term benefit (within five to-ten years) to the citizens of New Hampshire, New England, and beyond by encouraging the development of locally adapted specialty crop varieties that will enhance opportunities for profitable, local crop production and marketing. By generating and disseminating knowledge via publically available venues and databases, this project has national and international synergies: reciprocal benefits have resulted from collaborations with researchers in eight states and nine countries.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Suitability of varieties tested in field trials (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Field testing of vegetable varieties is critical to developing improved products that are more suitable to growers, marketers and consumers.

What has been done
Breeding lines of melon, summer squash, gourds, winter squash and tomato are being developed with improvements in disease resistance, eating and shipping quality, nutrition and earlier maturity. These breeding lines, together with proprietary lines from cooperating seed companies, are being used to produce experimental hybrids for testing at the NHAES, in other university trials, and with several seed companies. During the summer of 2009, we evaluated the following experimental hybrids: cantaloupe, honeydew and Galia melon (41), Cucurbita pepo summer squash (36), C. pepo pumpkin (62), C. pepo seed pumpkins (6), C. pepo acorn (6), C. maxima kabocha (8), C. moschata butternut and round-fruited hybrids (10), and tomato (12).

Results
In Cucurbita pepo gourd we have successfully transferred a dominant gene for reverse strip into bush strains of egg and spoon gourd, resulting in a much greater array of attractive gourd phenotypes for future variety release. In melon, we have incorporated a dominant, long shelf-life gene into some of our germplasm to investigate the feasibility of using this trait in different types of melon (cantaloupe, honeydew, Galia and casaba), and to see if quality traits other than high sugar can be combined with the long shelf-life gene. In Cucurbita maxima we have developed several processing squash lines with large fruit and a bush phenotype over the past 30 years. The bush lines alone lack acceptable adaptability to release as cultivars, but in combination with vine lines, produce vigorous F1 hybrids with good fruit type. An additional potential use of these lines is for producing F1 interspecies hybrid crosses with C. moschata. Several successful cross combinations with different cultigens of C. moschata were made during the summer of 2009, suggesting a wide compatibility of the bush processing lines with C. moschata for producing productive, seedless F1 hybrids.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Effectiveness of season extension and pest/disease control methods for which field trials were completed (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Effectiveness of genomic tools used to guide breeding program (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Effectiveness of workshops and other presentation in informing growers and consumers about new varieties (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Evaluating effectiveness of workshops and other presentation to growers and consumers helps us to determine the value of our activities.

What has been done
Conducting variety trials and cultural experiments over a three-year period with several different vegetable crops has enabled scientists and extension educators to present commercial farmers and gardeners accurate and region-specific information about how to succeed with these crops in the Northeast.

Results
A UNH Cooperative Extension fact sheet, "Growing Sweetpotatoes in New Hampshire" was developed and published, and is accessed frequently (23 times during the 30 days preceding the writing of this report). As a direct result of our experiments and outreach, we estimate that ten commercial vegetable growers started growing or increased area of sweetpotato production, and five other growers who had grown sweet potatoes previously reported that they changed their production and marketing practices based on results of this research.

We have identified the top red and yellow colored bell pepper varieties for the Northeast, as well as common production constraints. The unavailability of a very high-yielding orange variety in our climate, while disappointing, is good information. We estimate that at least ten growers have experimented with new high-yielding and high-quality pepper varieties as a result of this work.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

Effectiveness of undergraduate and graduate student training through project participation and classroom presentation. (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Overall effectiveness of the Planned Program in addressing issues and needs of the state and region (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Release superior new varieties of vegetable crops suited to state and regional conditions and markets.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Locally-grown vegetables are being highly touted in the Northeast. Production costs are high throughout much of the Northeast, and so growers must receive premium prices for locally grown produce to be profitable and sustainable. Part of the justification for paying higher prices for produce is the consumer expectation that locally

grown vegetables will have better eating quality and/or nutritional value than vegetables purchased in large supermarkets. The focus in cucurbit breeding at the University of New Hampshire on eating quality and nutrition dovetails nicely with increased emphasis on small-farm production for local markets.

What has been done
We have introduced a white pumpkin, Moonshine, an early hybrid which has been well received by customers in retail outlets. Our newest development is a small bright yellow pumpkin that looks especially attractive in displays with Moonshine. Fitting into the concept of improved quality are two recent UNH squash introductions, Honey Bear, a high quality, mini-acorn with good powdery mildew resistance (PMR), designed to be served in the half-shell, and Sugar Dumpling, a smaller, more uniform type of Sweet Dumpling squash with good eating quality and PMR. Honey Bear has a compact (bush) habit of growth, so is adapted for home gardeners as well as commercial growers. Sugar Dumpling also has a fairly compact growth habit. Another promising new NH variety introduced this past year is Slick Pik (trademark) YS26, a unique yellow straightneck summer squash with glossy fruit and stems that are largely devoid of the prickly spines which irritate pickers.

Results
The multiple new releases of cucurbits and other vegetable crop varieties provides our growers with superior products for local and regional markets, and our consumers with better tasting, more nutritious, and better looking foods.

4. Associated Knowledge Areas

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

Outcome #9

1. Outcome Measures

Ability to breed for nutritional quality in squash.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The key nutritional benefit of winter squash, other than being an excellent carbohydrate source, is its high content of carotenoids. Beta-carotene and alpha-carotene as precursors to vitamin A have long been known to be important for eye function. In addition, however, carotenoids have antioxidant properties, and have been implicated in reducing risk of cardiovascular disease, certain cancers, cataracts and age-related macular degeneration.

What has been done
During the past three years we conducted studies of carotenoid content and profiles in cultigens of Cucurbita maxima and moschata with three major objectives: (1) determine the degree of variability in carotenoid content

among different cultivars and breeding lines, (2) determine the effect of premature harvest and storage on carotenoid content, and (3) examine variability in carotenoid profiles among cultigens, with a focus on the most nutritionally important carotenoids - beta-carotene, lutein and zeaxanthin.

Results
Our spectrophotometric analysis of total carotenoid contents in mesocarp tissue of 17 varieties confirmed visual observations that most modern cultigens of these two species contain relatively high amounts of carotenoids and that selection can be effective in developing breeding lines with exceptionally high levels. We found that carotenoid levels in most cultigens are 30 to 85% higher in squash harvested at maturity (60 days after pollination) than those harvested prematurely at 40 DAP, and in most cultigens, carotenoid levels increase between 20 to 65% with 30 days of storage at 14 C. Our results from examining a limited number of cultigens indicate extensive variability in types of carotenoids in flesh of squash fruit, and a high likelihood that the content of the most important carotenoids implicated in human health - beta-carotene, lutein and zeaxanthin - can be substantially increased through selection in a conventional breeding program. Our research on eating quality and total carotenoid levels in squash in relation to harvest period and storage time provide base-line information on proper harvest period and storage time for optimizing eating quality and nutrition in squash.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
503	Quality Maintenance in Storing and Marketing Food Products

Outcome #10

1. Outcome Measures

Disseminate vegetable and small fruit production research results to growers and consumers.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Effective dissemination of research results to stakeholders is important to maximize the impacts of funded research. Integration of AES and Extension resources is an effective means to achieve this.

What has been done
Results were disseminated to local, state, regional and national audiences through a variety of approaches. Local citizens have been reached primarily through efforts with the NH Master Gardener program, but also through presentations to garden clubs and through Cooperative Extension publications such as Fact Sheets on vegetable varieties and cultural practices for new crops. The primary target audience for our work is commercial vegetable

and fruit producers in NH and neighboring states. This group has been reached through many presentations at meetings including those of the New England and NH Vegetable and Berry Growers Associations, the Northeast Organic Farming Association (NOFA) chapters in MA, NH and VT, and the Maine Organic Farming and Gardening Association (MOFGA). We also reach this audience through publication of research results in the New Hampshire Vegetable and Fruit Newsletter, which reaches approximately 250 growers and educators. National impact has come through publication of research results as abstracts of presentations and peer-reviewed publications in the journals and conferences of the American Society of Horticultural Science.

Results

As a result of integrated NHAES and Cooperative Extension funding, state and regional producers and consumers are more informed about appropriate cultural methods, varieties and handling of small fruits and vegetables.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
216	Integrated Pest Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Weather conditions affected outcomes of some field experiments, as was not unexpected. The unique and variable land and environmental conditions in New Hampshire and New England are a fundamental impetus to undertake horticultural research targeted at state and regional producers and consumers.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- After Only (post program)
- During (during program)
- Other (see below)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 10

1. Name of the Planned Program

Sustainable Marine Aquaculture & Fisheries

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			2%	
135	Aquatic and Terrestrial Wildlife			5%	
204	Plant Product Quality and Utility (Preharvest)			7%	
302	Nutrient Utilization in Animals			7%	
303	Genetic Improvement of Animals			7%	
305	Animal Physiological Processes			5%	
306	Environmental Stress in Animals			20%	
307	Animal Management Systems			10%	
308	Improved Animal Products (Before Harvest)			9%	
311	Animal Diseases			16%	
501	New and Improved Food Processing Technologies			2%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.6	0.0
Actual	0.0	0.0	1.3	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	242032	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	521795	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

Project 1. Looked at stock-specific growth characteristics of Atlantic cod from the Gulf of Maine in order to optimize genotype selections and genetic diversity for aquaculture. Spawning cod from distinct spring and winter populations were captured from the wild and genotyped using molecular analyses. Juvenile cod (15g) were produced from each population and grown in recirculating aquaculture tanks at three different temperatures. Feed intake, growth rates and feed conversion rates were determined and compared. The experiment was repeated with larger fish (100g).

Project 2. In an integrated aquaculture system, sea urchins were used to remove nutrients that were produced by the fed components. Seaweeds and microalgae took up nutrient excreted by fish and used them for protein production and growth, sea urchins eat algae and used nutrients growth. When the urchins were harvested, the nutrients were removed from the system. The sea urchin project used laboratory and field studies to refine methods of promoting juvenile growth rates and increasing out-planting success.

Project 3. Developed seaweed culture methods to mass produce sporeling (small plant) for grow-out in intergrated aquaculture systems. The project isolated two commercially important native seaweed species from the field and carry out laboratory culture experiments to determine the optimum conditions to promote reproduction. Culture methods were developed that can be adapted to a commercial scale.

Project 4. This project focused on diseases that affected commercial bivalves. It developed and refined methods for detecting Vibrio in oysters and conducted field tests under different environmental and water quality conditions to determine situations where infections are most likely.

Project 5. Related to Project 4, this study also examined Vibrio bacterial infections that affected oysters and ultimately presented a health hazard to consumers. It undertook laboratory studies of the mechanism by which host adaptive evolution and host-range expansion occurs in Vibrio.

Project 6. This was a study of leukemia in soft-shell clams and its implications for the New England shellfish industry. The project used laboratory studies to study the disease at the molecular level. New knowledge was disseminated to the shellfish industry through presentations at the Maine Fishermen's Forum and interactions with Spinny Creek Shellfish.

Project 7. An ongoing study of movement of lobsters in response to thermal gradients. It lead to a better understanding of migration patterns and ultimately to better management of lobster fisheries. The project used a combination of laboratory studies and field monitoring using electronic tracking, underwater observation via SCUBA and remote video.

2. Brief description of the target audience

Project 1. This project targeted active and potential cod culturists and fisheries scientists in northern New England. They will be reached through scientific publications, presentations and extension activities.

Project 2. The primary audience for this project was the fishing industry in New England and particularly in Maine. The sea urchin fishery has played a significant role in the economy of the Maine coastal zone and there is interest in sea urchin aquaculture as a complement to the wild fishery. Sea urchin aquaculture has a potential role in the academic and scientific

communities as a source of animals for developmental studies and class demonstrations of early development.

Project 3. The scientific community, especially phycologists interested in systematics, ecology and biogeography of seaweeds in the North Atlantic. The findings, especially the discovery of non-indigenous species is also of interest to mangers of the Great Bay Estuarine Research Reserve.

Project 4. Shellfish program managers are targeted to inform them about the environmental conditions that affect pathogenic vibrio incidence and abundance as they adapt to emerging requirements to better monitor for these bacteria in shellfish. Work with extension agents will help to inform the public about the potential risks for vibrio diseases associated with eating shellfish from New England. Ongoing communication with an array of researchers helps them to better understand the ecology of these pathogenic bacteria in shellfish harvesting areas and the potential for post harvest processing for reducing the risks from vibrios.

Project 5. The audience is quite broad and encompasses scientists in theoretical and applied evolution, symbiosis, and emergent disease, as well as those interested in shellfish diseases in coastal wild and aquaculture systems.

Project 6. Aquaculturists, shellfish biologists and fishermen, invertebrate pathologists, human cancer biologists and specifically those working with Gulf of Maine shellfish, scientists and environmental consultants.

Project 7. Those working with lobster management and production, coastal managers and environmental groups, marine biologists, shellfish consumers and the local seafood industries.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	200	1000	20	100
Actual	500	2500	30	80

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

Year: 2009
Plan: 0
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	7	
Actual	0	4	4

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants in the project (not including audience counts)

Year	Target	Actual
2009	16	24

Output #2

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Target	Actual
2009	5	19

Output #3

Output Measure

- Number of graduate student directly involved in the projects

Year	Target	Actual
2009	4	13

Output #4

Output Measure

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

Year	Target	Actual
2009	5	6

Output #5

Output Measure

- Number of workshops and training sessions

Year	Target	Actual
2009	2	5

Output #6

Output Measure

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

Year	Target	Actual
2009	7	8

Output #7

Output Measure

- Number of book chapters written

Year	Target	Actual
2009	1	0

Output #8

Output Measure

- Number of non-peer-reviewed publications (abstracts, newsletters, fact sheets, articles, etc)

Year	Target	Actual
2009	8	6

Output #9

Output Measure

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

Year	Target	Actual
2009	4	4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge of stock-specific growth characteristics in Atlantic cod (qualitative outcome statement)
2	Incorporation of stock-specific growth characteristics knowledge into commercial aquaculture (qualitative outcome statement)
3	Increased knowledge of juvenile sea urchin growth rates and out-planting success (qualitative outcome statement)
4	Increased knowledge of seaweed culture conditions required to promote reproduction (qualitative outcome statement)
5	Advances in scalable technology for production of seaweed sporelings (qualitative outcome statement) Enhanced knowledge about lobster behavior, ecology and population dynamics (qualitative outcome statement)
6	Improvements in detections methods for Vibrio infections in oysters (qualitative outcome statement)
7	Increased understanding of the relationship between environmental conditions and Vibrio infections in oysters (qualitative outcome statement)
8	Increased understanding of the mechanism of host adaptive evolution and host-range expansion in Vibrio (qualitative outcome statement)
9	Increased understanding of the molecular basis for leukemia in soft-shelled clams (qualitative outcome statement)
10	Increased knowledge of clam leukemia within the shellfish industry (qualitative outcome statement)
11	Overall enhancement of technology and knowledge in support of sustainable marine aquaculture and fisheries management (qualitative outcome statement)
12	Enhanced knowledge about lobster behavior, ecology and population dynamics.

Outcome #1

1. Outcome Measures

Increased knowledge of stock-specific growth characteristics in Atlantic cod (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Incorporation of stock-specific growth characteristics knowledge into commercial aquaculture (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Increased knowledge of juvenile sea urchin growth rates and out-planting success (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Sea urchins represent a potential market for aquaculture in the Gulf of Maine. In order to be successful, knowledge of appropriate juvenile sea urchin outplanting techniques and their growth rates are needed.

What has been done
Laboratory growth studies in collaboration with scientists from other states were performed comparing formulated diets and also the impact of density on growth rates for a single diet. Juvenile urchins were produced and utilized in grow out experiments. A grow out experiment at the Isles of Shoals represents the first significant recruitment event seen there in a decade, and is consistent with the highest numbers from recruitment monitoring seen in more than five years as well as reports from urchin harvesters on large numbers of small urchins seen on bottom at several sites around the Gulf of Maine.

Results
The results were utilized in courses in Invertebrate Zoology and Bioinvasions and in the mentoring of undergraduate students involved in independent research projects focusing on sea urchin growth. Information gathered from field studies at the lease sites and in monitoring sea urchin recruitment at sites in the Gulf of Maine

were utilized to contribute to the Maine Committee on Invasive Species, New England Aquatic Nuisance Species panel, and the Maine Sea Urchin Zone Council. The project leader is a member of the State of Maine Sea Urchin Zone Council and chair of their research subcommittee, which allows direct involvement in managing the urchin fishery and input on the future role of aquaculture in this industry.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Increased knowledge of seaweed culture conditions required to promote reproduction (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Better understanding of seaweed culture methods and of target species present is required to develop effective approaches to function of multi-trophic aquaculture operations.

What has been done
Field collection of "seed" stock of Ulva and Gracilaria species was completed, and cultures of both genera were initiated. Species identities of collected and cultured specimens were confirmed by DNA sequencing of the rbcL gene and ITS-1 spacer region. Nutrient uptake kinetics by the Ulva species were examined and its impact on protein, chlorophyll and carotenoid content was assessed.

Results
A significant change in knowledge resulted from the discovery that there were more species of Ulva and Gracilaria in the Great Bay Estuarine System than had previously been known. Two of the Ulva species and one of the Gracilaria species were determined via DNA sequencing to be introduced species of Asian origin. One of the Ulva species is a new record for the northwestern Atlantic. Also based on DNA evidence, it was determined that some Ulva species exhibit more morphological variability than previously was realized. The discovery of the Asian Gracilaria and Ulva species may explain the recent increase in biomass of both genera throughout the estuary.

4. Associated Knowledge Areas

KA Code	Knowledge Area

133	Pollution Prevention and Mitigation
204	Plant Product Quality and Utility (Preharvest)
302	Nutrient Utilization in Animals
308	Improved Animal Products (Before Harvest)

Outcome #5

1. Outcome Measures

Advances in scalable technology for production of seaweed sporelings (qualitative outcome statement) Enhanced knowledge about lobster behavior, ecology and population dynamics (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Improvements in detections methods for Vibrio infections in oysters (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Development of useful tools is needed for assessing shellfish safety relative to the risk of vibrio disease incidence for managing the risks associated with human consumption of oysters and other bivalves.

What has been done
A qPCR detection method for Vibrio parahaemolyticus using a BioRad system with SYBR Green detection was standardized then tested on oyster, sediment and water samples from different areas and at different times.

Results
The pathogenic vibrio detection method is being considered for wider application across the New England states, where monitoring for vibrios has not been routine in the past but may soon be required by the US FDA. The application of the refined detection method in NH and southern ME areas over the past year has helped to define the environmental and meteorological conditions that affect the presence and abundance of pathogenic vibrios in oysters, blue mussels and softshell clams. This work is helping to refine and inform monitoring strategies for these pathogens in colder north temperate coastal waters in relation to emerging US FDA guidelines. The research on post harvest process strategies to reduce vibrios from shellfish has shown promising results. The successful reduction of V. parahaemolyticus levels in oysters under relaying conditions is a significant finding that will inform PHP strategies and harvest area management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #7

1. Outcome Measures

Increased understanding of the relationship between environmental conditions and Vibrio infections in oysters (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Increased understanding of the mechanism of host adaptive evolution and host-range expansion in Vibrio (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Fundamental knowledge is needed to help understand mechanisms of host adaptive evolution and symbiosis in bacteria.

What has been done
We completed the evolution of several bacterial strains through 15 squid passages and initiated strain characterization.

Results
As a result of adaptation to a novel animal host, some of our bacterial strains did converge with the known symbiont for traits that we predict or know are involved in symbiosis. This provides important validation of the evolution model, and the data was met with great enthusiasm by researchers in symbiosis. Two other traits implied in but not proven to be involved in symbiosis, siderophore and biofilm capacity, were also altered in several strains. Because these traits are critical in pathogenic associations, our model may also provide insight into the role of these in symbiosis, and also as a target of adaptation. Finally, diet breadth of evolved strains also converged with the symbiont, indicating adaptation to the nutrient environment. Thus, adaptive evolution was dependent upon several disparate traits for improved symbiosis.

4. Associated Knowledge Areas

KA Code	Knowledge Area
311	Animal Diseases

Outcome #9

1. Outcome Measures

Increased understanding of the molecular basis for leukemia in soft-shelled clams (qualitative outcome statement)

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Increased knowledge of clam leukemia within the shellfish industry (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Incidence of cancers in the soft shell clam presents threat to consumers and associated challenge to shellfish producers. Research and dissemination is needed to help understand the mechanisms and associated environmental conditions, and to predict and potentially reduce its occurrence.

What has been done
We generated 5 years of continuous data on clam hemocyte cancer in the soft shell clam, Mya arenaria, from three sites in New England where commercial clam harvesting has been negatively impacted by this disease.

Results
The highest annual frequency of clams with 100 percent cancerous hemocytes from New Bedford Harbor in December (9.49 percent), when seawater temperature is low and the lowest annual frequency in July (1.082 + 0.4) when seawater temperature is maximal. These results may indicate vulnerability of clams with hemocyte cancer to seasonal increases in environmental temperature and resulting oxidative or other stressor. Based on shell measurements and a theoretical mathematical age model which correlates susceptibility to cancer with sexual maturity, we suggest that the soft shell clam is only susceptible to this disease between one and two years of age. Results have been shared with shellfish biologists, marine resource agencies, and stakeholders in the aquaculture industry. GenBank deposit made for EF576660.1: Mya arenaria mitochondrial mortalin splice variant mRNA, complete cds, alternatively spliced; nuclear gene for mitochondrial product.

4. Associated Knowledge Areas

KA Code	Knowledge Area
306	Environmental Stress in Animals
311	Animal Diseases

Outcome #11

1. Outcome Measures

Overall enhancement of technology and knowledge in support of sustainable marine aquaculture and fisheries management (qualitative outcome statement)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Lobster are a primary economic driver in New England coastal communities. Knowledge of lobster movements is critical to appropriate management of the biological and marine resources.

What has been done
About 48 lobsters were equipped with ultrasonic tags to track their movements, and this was combined with a number of dives to observe them in their habitat.

Results
The intersection of lobsters on the ocean bottom with "bait plumes" that emanate from traps has yielded two new concepts in lobster research -- "trappable area" and "neighboring traps" -- that might help researchers and fishermen determine an optimum trap density. The Maine Department of Marine Resources is using our results along with their synergistic work, to evaluate whether high catch rates might be maintained while using fewer traps than now populate the Maine Coast. As example of stakeholder engagement, about 60 commercial fishermen recently heard a report during the Maine Fishermen's Forum.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife
305	Animal Physiological Processes
307	Animal Management Systems

Outcome #12

1. Outcome Measures

Enhanced knowledge about lobster behavior, ecology and population dynamics.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Effective research methods and technologies are required in order to understand the behavior of key marine and estuarine species that cannot easily be directly observed for sufficient periods.

What has been done
Forty eight lobsters were equipped with ultrasonic tags and their movements tracked. A number of dives were also conducted to directly observe the lobsters and their habitat. We also developed a novel method for measuring the activity of lobsters, using small accelerometers. One of the most significant findings was that lobsters tended to remain resident in areas of the estuary where the bottom had vegetation and complex habitat that closely resembled the NH coast. This is likely the reason they moved little during the time they were being tracked.

Results
The new techniques developed for measuring the activity of freely moving lobsters is very exciting and it will aid our research as well as the research of others. It will also help shed light on the factors that influence seasonal movements of lobsters. This will impact how the species is managed and how it might recover from natural and manmade environmental stressors, such as hurricanes and oil spills.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife
305	Animal Physiological Processes
306	Environmental Stress in Animals

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

Efforts to produce batches of new juvenile urchins in the hatchery were unsuccessful, presumably due to spring runoff in the tidal channel that is the source of hatchery seawater. Salinities remained low through

most of the spring and summer in the Great Bay Estuarine System due to continued rain for the first half of the summer.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- After Only (post program)
- Retrospective (post program)
- Before-After (before and after program)
- During (during program)
- Other (see below)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}