2014 University of Maine Research Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

Merit Review Process
The external scientific peer review process fully described in our 2016-2020 Plan of Work continues to be used to evaluate all MAFES projects, regardless of funding source. A total of 23 Hatch, Animal Health, and McIntire-Stennis projects went through the process in FY2014.
Stakeholder Input
MAFES took several actions to seek stakeholder input including formal meetings with advisory groups, attending monthly meetings of the Agricultural Council of Maine, using the Maine Agricultural Center to facilitate communication between MAFES and University of Maine Cooperative Extension, faculty interaction with stakeholder groups and individuals in both formal and informal settings, and field days at our research facilities.
Stakeholder groups were identified through coordinating and advisory committees. Input was collected through formal organization processes, feedback on research programs of faculty via stakeholder grant review programs, and through informal conversations with groups and individuals by MAFES leaders. Input was used internally to evaluate research, outreach, and hiring priorities for MAFES and the Maine Agricultural Center (MAC).
Station administrators have learned that stakeholders would like more research on food safety, climate change, agricultural economics, and agricultural engineering. Stakeholders emphasized that research on climate change, food safety, food agricultural economics, and agricultural engineering was important to Maine.
Expenditure Summary
In our 2014 Plan of Work, the Maine Agricultural & Forest Experiment Station (MAFES) estimated 37.1 SYs for 2014; the actual number of SYs was 36.1 for FY2014. For FY2014, MAFES expended $2,446,879 (Actual Formula Funds), $3,906,385 (Actual Matching Funds), $906,116 (Actual All Other Funds), for a total of $7,259,380. We are continuing to report on McIntire-Stennis and Animal Health projects in the appropriate program area. The All Other Funds column for our program areas includes totals spent on these funds (MS and A) and their associated match. Extramural grants awarded are entered as an output for each program area. MAFES researchers in these program areas received a total of $7,600,851 in grants and contracts in university fiscal year 2014 (July 1, 2013, through June 30, 2014).
Planned Programs
Global Food Security and Hunger
In our 2014 plan of work, we estimated that there would be 15.0 SYs in this program area; the actual amount of SYs allocated for 2014 was 17.0. During FY2014, MAFES expended $1,289,209 (Hatch), and $1,916,486 (1862 Matching), and $0 (1862 All Other), for a total of $3,205,695 in this program area; there were 48 research projects in this program area.
MAFES research in this program area has resulted in a number of outputs for FY2014, including completed projects, peer-reviewed and other publications, presentations at professional meetings, workshops, and other venues. One patent was submitted. Faculty working in this area brought in $2,838,605 in extramural funding during university fiscal year 2014.
There were several outcomes in this program area during FY2014. To highlight a few: MAFES and UMaine Extension scientists have helped developed local, organic food grain economies in our region;

MAFES food science research showed that green crabs could be trapped and processed effectively, with a 50% yield of minced crab meat. The meat mince has excellent nutritional and microbiological quality and can be used in the development of consumer-acceptable food products..

Climate Change

In our 2014 plan of work, we estimated that there would be 3.9 SYs in this program area; the actual amount of SYs allocated for 2014 was 2.8. During FY2014, MAFES expended $143,384 (Hatch), $237,656 (1862 Matching), $288,422 (1862 All Other, includes M-S funds and their state match) for a total of $669,461 in this program area; there were six research projects in this program area.

MAFES research in this program area has resulted in a number of outputs for FY2014, including completed projects, publications, and presentations at professional meetings, workshops, and other venues. Faculty working in this area brought in $433,597 in extramural funding during university fiscal year 2014.

There were several outcomes in this program area during FY2014. To highlight one: In Maine, as a result of multistate, integrated research, tree fruit growers are planting trees that are more productive and have greater adaptation to the local climate.

Food Safety

In our 2014 plan of work, we estimated that there would be 2.6 SYs in this program area; the actual amount of SYs expended for 2014 was 2.3. During FY2014, MAFES expended $192,816 (Hatch), and $281,284 (1862 Matching), $0 (1862 All Other) for a total of $474,101 in this program area; there were seven research projects in this program area.

MAFES research in this program area has resulted in a number of outputs for FY2014, including publications, presentations at professional meetings, workshops, and other venues, and systems for detecting particular food pathogens.

There were several outcomes in this program area during FY2014. To highlight one: MAFES food scientists have developed chitosan films containing cranberry concentrate and tested them for antibacterial activity on poultry drumsticks over a period of 5 days. Due to their antibacterial nature, these films present themselves as an effective means of naturally treating poultry with cranberry that does not decrease the aesthetic appeal of the product.

Sustaining Maine's Natural Resources

In our 2014 plan of work, we estimated that there would be 7.0 SYs in this program area; the actual SYs allocated for 2014 were 8.4. During FY2014, MAFES expended $508,897 (Hatch), $949,440 (1862 Matching), and $414,232 (1862 All Other, includes M-S funds and their state match) for a total of $1,872,568 in this program area. There were 18 research projects in this program area.

MAFES research in this program area has resulted in a number of outputs for FY2014, including completed projects, peer-reviewed and other publications, and presentations at professional meetings, workshops, and other venues. Faculty working in this area brought in $2,123,202 in extramural funding during university fiscal year 2014.

There were several outcomes in this program area during FY2014. To highlight a couple: MAFES scientists created a technical report, which has been made available to transit managers, natural resource managers, and policymakers. The report examines transit indicators used by different natural resources agencies such as the National Park service, Forest Service, and US Fish and Wildlife Service and suggests a means to improve the development of monitoring key indicators. MAFES researchers created maps that document forest stand vulnerability to spruce budworm. The maps were made available to the Maine Forest Service and major forest landowners in northern Maine and are being used to determine locations of high vulnerability stands where pheromone traps will be positioned.

Supporting Maine's Rural Communities

In our 2014 plan of work, we estimated that there would be 6.0 SYs in this program area; the actual amount of SYs expended for 2014 was 5.6. During FY2014, MAFES expended $312,573 (Hatch), $521,519 (1862 Matching) and $203,464 (1862 All Other, includes M-S and AH funds and their state match) for a total of $1,037,555 in this program area. There were 14 research projects in this program area.

MAFES research in this program area has resulted in a number of outputs for FY2014, including

completed projects, peer-reviewed and other publications, and presentations at professional meetings, workshops, and other venues. MAFES scientists also provided assistance to Biotechnology Services and Maine Diagnostic Innovations in development of a rapid point-of-care test for Streptococcus equi. Faculty working in this area brought in $2,205,447 in extramural funding during university fiscal year 2014.
There were several outcomes in this program area during FY2014. To highlight a couple: MAFES researchers provided recommendations to fishery managers, fishing communities, and other stakeholders for improving resilience in Maine's fishing communities. A team of MAFES and UMaine Extension researchers has developed protocols for sampling and assessing streptococci in water as a way to conduct surveillance for strangles.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	37.1	0.0
Actual	0.0	0.0	36.1	0.0

II. Merit Review Process

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

- Internal University Panel
- External Non-University Panel
- Expert Peer Review

2. Brief Explanation

The station uses its standard external scientific review process for continuing faculty proposing new projects and a fast-track project approval process for new faculty. The standard external scientific peer review process fully described in our Plan of Work 2016 update is used to evaluate the scientific and societal significance of proposed MAFES projects, regardless of funding source. The fast-track process is intended for new faculty, where an accelerated approval process and a shorter two-year project period better meets the needs of the faculty member and station. Subsequent development of a five-year project begins during the initial two-year project. A total of 23 Hatch, Animal Health, and McIntire-Stennis projects went through the process in FY2014; of this total, seven were fast-track projects.
For the standard process, MAFES-funded projects go through the following review process. First, all pre-proposals are reviewed by the MAFES Research Council, which is comprised of senior faculty who have an established record of high productivity and high-quality research. The Research Council reviews the pre-proposals to ensure that the proposed work falls within the purview of MAFES, addresses an important need identified by stakeholders, and that the faculty member submitting the pre-proposal possesses the expertise to conduct the research.
Upon receiving the input of the Research Council, faculty members develop full research proposals for the work they wish to perform. Completed full proposals are sent out for external, expert peer review by scientists who are qualified to review the proposals. All reviewers are external to the University of Maine. Potential reviewers are identified through the CRIS system, faculty, and department chairs who work in related areas, and through other experiment station directors. Each proposal is sent to three to five reviewers. Upon completion of the external expert peer reviews, proposals are returned to the researchers, who then make changes based on the comments of the reviewers. Finally, the proposals are reviewed and

approved by the Research Council before being submitted to USDA for final approval.
The fast-track process for MAFES-funded projects is initiated by the station director after consultation with the unit director/chair. The fast-track process can begin prior to a faculty member arriving on campus. The goal is to complete project development and obtain USDA approval in four months, which is substantially shorter than the time line for standard projects. Fast-track projects also are two years in duration compared to standard five-year projects. Subsequent development of a five-year project will occur during the initial two-year project.

The shorter time line for fast-track projects is achieved by using an abbreviated and internal proposal review, reducing proposal requirements, and expediting processing. Proposals are reviewed by a member of the research council and a faculty member designated by the unit director/chair to ensure that the proposed work falls within the purview of MAFES, addresses an important need identified by stakeholders, and that the faculty member submitting the proposal possesses the expertise to conduct the research.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- 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
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public

Brief explanation.

The Maine Agricultural & Forest Experiment Station encouraged stakeholder input by hosting (along with the college leadership) formal meetings with advisory groups including the Board of Agriculture (thrice annually), the Forest Resources Advisory Committee (twice annually), the Potato Licensing Advisory Committee (twice annually), and the Coordinating Committee of the Maine Cooperative Fish and Wildlife Research Unit (annually). This year again, as a way to encourage more participation by state legislators, one Board of Agriculture meeting was held in the state capitol building.
The associate director attended a legislator's tour of Maine's wild blueberry industry, which included participation by local growers and presentations on the station's research programs. Associated discussions help inform the station on current research needs. The director and associate director also take part on on-campus legislative tours.
Other key stakeholders groups also provided input in direct or indirect ways. Three boards or committees (Wild Blueberry Commission of Maine Advisory Committee, Maine Potato Board, Cooperative Forestry Research Unit) held funding competitions where MAFES scientists submitted all or the majority of project proposals. The director and associate director met with the executive committee of the Maine Pomological Society for input on research needs of the apple industry and upgrading our research farm, Highmoor Farm, to ensure that we have appropriate orchard resources to meet these needs in the future. A committee of horticultural professionals along with the associate director approves research proposals supported by a horticulture fund. Feedback from these committees provides information on research priorities and needs for these commodity groups. The station also met with several private businesses and foundations to explore potential partnerships for future research in bioenergy, forest ecology, and sustainability.
The director and associate director discussed current research programs with legislators at two college exhibitions at the State House, one in association with the agricultural industry. Station

administrators worked with the Board of Agriculture to create a report to the University of Maine president and University of Maine System chancellor on capacity needs for food and agricultural research and extension programs.
The associate director of MAFES attended monthly meetings of the Agricultural Council of Maine (AGCOM) as a way to maintain effective communication with the wide array of agricultural organizations in the state. These meetings provide MAFES administration with good information on issues important to Maine's agricultural community.
The Maine Agricultural Center continued to facilitate improved communication between MAFES and University of Maine Cooperative Extension and therefore between researchers and extension faculty. Extension educators are both stakeholders in research and good sources of information about the research needs of the groups they serve.
MAFES faculty, through their interaction with stakeholder groups and individuals in both formal and informal settings, also continued to encourage stakeholder participation. Our research facilities hosted field days for apples, small fruits, and vegetables, potatoes, grains, and wild blueberries and other interests of growers, which allow researchers and administrators to learn more about the needs of the stakeholders in attendance.
Overall, the station makes every effort to allow all groups and individuals to express their suggestions and concerns about station-sponsored research through the mechanisms discussed above.

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions

Brief explanation.

In the agricultural and forestry sectors, the major stakeholder groups are identified through coordinating and advisory committees such as the Board of Agriculture, the Forestry Research Advisory Committee, and the Coordinating Committee of the Maine Cooperative Fish and Wildlife Research Unit. MAFES provides input on potential committee members as do the current member stakeholder groups. For agriculture and forestry, MAFES maintains a list of all known stakeholder groups, and these groups are contacted on a regular basis. Individual stakeholders are identified in a variety of ad hoc ways including through faculty and department/school contacts as well as UMaine Cooperative Extension.

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Survey of the general public
- Meeting specifically with non-traditional groups

- Meeting specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public

Brief explanation.

Input is collected through formal organization processes (Board of Agriculture, Forest Resources Advisory Committee, and Maine Cooperative Fish and Wildlife Research Unit Coordinating Committee) and feedback on research programs of faculty via stakeholder grant review programs (Wild Blueberry Commission of Maine Advisory Committee, Maine Potato Board, Cooperative Forestry Research Unit). Faculty researchers meet with and collect input from both traditional and nontraditional stakeholders at the group and individual level.

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

Brief explanation.

Input was used internally to evaluate research, outreach and hiring priorities for MAFES and the Maine Agricultural Center (MAC). Based on the input received and the priorities set by the Board of Agriculture and Forest Research Advisory Committee, critical areas were identified for emphasis and support. Since agriculture is a dynamic industry, MAC/MAFES needs to update long-range plans, and will rely on the recently completed strategic plan of the Agricultural Council of Maine. Faculty, where appropriate, develop their research proposals to address the stated concerns of stakeholders.
The Highmoor Farm advisory committee, made up of the associate director, farm superintendent, and faculty users of the farm, is using the Pomological Society's input in developing a concept plan for facility modernization. After discussions with leaders from the Maine Dairy Industry Association, a taskforce of animal and veterinary sciences faculty, the farm superintendent, and station/college administrators is conducting a review of the Witter Center (animal science research facility) programs and will be making recommendations to the dean/director.

Brief Explanation of what you learned from your Stakeholders

Based on the needs assessment of agricultural research and extension priority areas, station administrators have learned that stakeholders would like more research on food safety, climate change, agricultural economics, and agricultural engineering. As part of the newly created Northern New England Collaborative Research Funding Program, Maine has joined with the New Hampshire and Vermont experiment stations to encourage regional collaborative research projects. To address the need for research on climate change, the focus of the first two rounds of funding will be on adaptation to or mitigation of climate variability and change by agriculture in northern New England. Stakeholders provided information on trends in their industries, which the station is using to modernize facilities and programs at two research farms.

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	2417465	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	2446879	0
Actual Matching	0	0	3906385	0
Actual All Other	0	0	906116	0
Total Actual Expended	0	0	7259380	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	29417	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Global Food Security and Hunger
2	Climate Change
3	Food Safety
4	Sustaining Natural Resources
5	Supporting Rural Economies

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Global Food Security and Hunger

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			10%	
201	Plant Genome, Genetics, and Genetic Mechanisms			5%	
202	Plant Genetic Resources			7%	
205	Plant Management Systems			9%	
211	Insects, Mites, and Other Arthropods Affecting Plants			4%	
212	Diseases and Nematodes Affecting Plants			5%	
213	Weeds Affecting Plants			7%	
215	Biological Control of Pests Affecting Plants			7%	
216	Integrated Pest Management Systems			2%	
301	Reproductive Performance of Animals			3%	
302	Nutrient Utilization in Animals			2%	
303	Genetic Improvement of Animals			2%	
305	Animal Physiological Processes			2%	
311	Animal Diseases			9%	
403	Waste Disposal, Recycling, and Reuse			2%	
501	New and Improved Food Processing Technologies			4%	
601	Economics of Agricultural Production and Farm Management			5%	
605	Natural Resource and Environmental Economics			6%	
702	Requirements and Function of Nutrients and Other Food Components			4%	
703	Nutrition Education and Behavior			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	15.0	0.0
Actual Paid	0.0	0.0	17.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	1289209	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1916486	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

Conduct scientific research. Publish peer-reviewed journal articles and other publications. Present findings at professional meetings, at field days for growers, and at other venues. Educate undergraduate and graduate students.

2. Brief description of the target audience

Maine crop and livestock farmers, aquaculture industry, food processors and marketers, Cooperative Extension staff, other scientists, state policymakers, regulators, and legislators, classroom teachers

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

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

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

Patent Applications Submitted

Year:	2014
Actual:	2

Patents listed
Plant Variety Protection Application, Easton potato variety
Plant Variety Protection Application, Sebec potato variety

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	49	49

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- # of other publications

Year	Actual
2014	61

Output #2

Output Measure

- Amount of extramural funds awarded to researchers in this program area

Year	Actual
2014	2838605

Output #3

Output Measure

- # of sheep producers trained to interpret parasite egg count and speciation data reports

Year	Actual
2014	67

Output #4

Output Measure

- # of sheep producers trained to perform their own diagnostics for fecal parasite egg identification using simple microscopic procedures

Year	Actual
2014	23

Output #5

Output Measure

- # of high school students involved in a project on oyster culture and parasite transmission. These students were taught microscopy, animal husbandry and visited oyster farms to learn about oyster farming and aquaculture in coastal waters.

Year	Actual
2014	9

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies, and management systems
2	More sustainable, diverse, and resilient food systems in Maine
3	Improved tools for fighting plant diseases
4	Increase productivity through proper management of weeds, diseases, insect pests, and nutrition
5	Number of new or improved innovations developed for food enterprises
6	Adoption of strategies/tools for increasing productivity of Maine's fruit growers
7	Number of producers (and other members of the food supply chain) that have increased revenue
8	Improved tools for fighting plant and animal diseases
9	Test/develop new, high-yielding, high-quality, and/or pest resistant crops, livestock, and brood stock for Maine farmers and aquaculturists
10	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources

Outcome #1

1. Outcome Measures

Enhanced capacity of a sustainable global food system including new/improved plants, animals, technologies, and management systems

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Potatoes are the most valuable cash crop in Maine and potato ranks among the top three vegetable crops produced in FL, ME, NC, NY, OH, PA and VA. Cash farm receipts for eastern potatoes during 2011 were approximately $493 million and multiplier effects in the state and regional economies are many times this amount. Most potato production systems used in the U.S. require high rates of chemical fertilization to maintain yields and frequent chemical sprays for disease control. Improving nutrient-use and chemical-use efficiency in potato production systems will help the Maine potato industry to increase productivity, quality, and efficiency to be successful into the future.

What has been done
MAFES agronomists tested whether a "sufficiency level" approach for K2O fertilizer recommendations could provide comparable yield and quality to the "build and maintain" approach recommended by the University of Maine for many years. They also evaluated a new program that included low rates of at-planting K2O followed by soil- and foliar-applied potassium thiosulfate (KTS). Nine experiments comparing these programs were conducted from 2011 to 2013 using representative fry processing (Russet Burbank) and chipping (Atlantic) potato varieties.

Results
The results demonstrate that the sufficiency-level approach can be used to provide modest potash savings relative to the build and maintain approach (~60 to 100 lbs of K2O per acre) on soils that have moderately high to high potassium fertility. The data do not support decreasing at-planting potash rates to the lowest levels used in these experiments (15 to 60 lbs/A during 2011; 125 to 184 lbs/A during 2012; 55 to 135 lbs/A during 2013). The relatively poor yield and quality results obtained at the sites and using the systems with the lowest rate of at-planting K2O suggest that the at-planting K2O rate can be reduced too far for optimum yield and quality in our

production system. The higher K2O rate build & maintain program would be best used when growing a variety that is particularly blackspot bruise susceptible or has very high specific gravity. The research provided no evidence that the "spoon-feeding" KTS treatments were advantageous relative to at-planting KCl.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
212	Diseases and Nematodes Affecting Plants

Outcome #2

1. Outcome Measures

More sustainable, diverse, and resilient food systems in Maine

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Pollinated food crops are the major source of vegetables, fruits, and nuts worldwide. The current estimate is that pollination services are worth $18 billion in the U.S. alone. Honey bees have been used in much of this production in the past, but with Colony Collapse Disorder and consistently high levels of colony losses since 2006, alternatives to the honey bee are required. Native wild bees are an ecosystem service that has been largely ignored in crop production, perhaps because there is much annual uncertainty in terms of wild pollinator numbers. Commercial bumble bees, however, are a fairly new pollination resource that has been slowly adopted by farmers. Maine blueberry growers require high levels of pollination and bumble bees are ecologically and behaviorally adapted to this North American native crop.

What has been done
A MAFES entomologist, with a joint appointment with UMaine Extension, assessed the potential of commercial bumble bees for wild blueberry pollination as well as their environmental impact.

Results
The scientist has developed new guidelines for managing commercial bumble bees in wild blueberry in Maine, with a new factsheet to be published by UMaine Extension in the spring of 2015. This research has also resulted in an increase in the use of bumble bees as an alternative pollinator (substitution for honeybees) in Maine's wild blueberry fields. As of spring 2014, 3,100 quads were brought into Maine for pollination. At the recommended rate of 1 quad/acre this suggests that about 3,100 acres of wild blueberry or about 1% of the crop is being pollinated by commercial bumble bees. That blueberry growers are diversifying their pollination tactics, away from a sole reliance on honey bees, will help make Maine's blueberry industry more sustainable and resilient.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #3

1. Outcome Measures

Improved tools for fighting plant diseases

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Potatoes are the most valuable cash crop in Maine and potato ranks among the top three vegetable crops produced in FL, ME, NC, NY, OH, PA and VA. Cash farm receipts for eastern potatoes during 2011 were approximately $493 million and multiplier effects in the state and regional economies are many times this amount. Most potato production systems used in the U.S. require high rates of chemical fertilization to maintain yields and frequent chemical sprays for disease control. To increase productivity, quality, and efficiency for Maine potato farmers, it is important to develop new, disease-resistant potato varieties.

What has been done

Late blight resistant varieties (LBRV) have the potential to reduce the reliance on foliar fungicides. To test the concept, field studies were conducted from 2010 to 2014 to compare the performance of susceptible varieties to moderately resistant varieties. Two fungicide schedules were used: (1) a standard program based on UMaine IPM scheduling; and (2) a reduced schedule, ~50% reduction in fungicide applications.

Results
Foliar late blight was not observed during 2010 or 2012. In 2011, 2013, and 2014, when late blight was observed, there was significantly less foliar late blight incidence in the LBRV compared to susceptible checks, especially in the reduced fungicide program. Fungicide program had no effect on total yield or marketable yield in 2010, 2011, and 2012. Yields were higher in the standard program and rot incidence was reduced in one of two experiments during 2013 and in the 2014 experiment. The reduced fungicide programs, however, provide substantial savings in the amount of fungicide used and also reduce fuel, maintenance, and labor costs. Per acre savings were calculated as part of this project. Profits could likely be increased with the implementation of LBRV potatoes and reduced fungicide spray programs, but uncertainty remains due to effects of disease infection dates, weather patterns, and reliability of the storage rot data.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Increase productivity through proper management of weeds, diseases, insect pests, and nutrition

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
More than 60% of Maine vegetable growers use hoop houses. Primarily the structures are used for the production of summer season tomatoes and/or fall through spring greens with little crop rotation or cover cropping. Little attention is given to maintaining soil health other than application

of typically large volumes of compost or manures. Overtime there is a build-up of disease organisms, accumulation of salts, and imbalances in plant nutrients resulting in reductions in yield and quality.

What has been done
Scientists in this integrated MAFES/Extension project used two 26x96-feet hoop houses to investigate possible interactions between irrigation frequency and compost application rates and to develop baseline data for recommendations regarding compost application within high tunnels. The study employed two irrigation treatments: one designed to mimic typical grower practices (2-3 irrigation events per week lasting between 1 and 2 hours), and a second treatment to provide the equivalent of 1-acre inch of water to the crop split into 2 irrigation events per day. They also randomly assigned five compost application rates within each irrigation main plot. ?Big Beef? tomato seedlings were transplanted at 18-inch spacing. The plants were trellised and pruned to a single stem. Yield (number and weight of fruit graded as first, second and cull) was measured from the center three plants of each plot. At the end of the growing season, stem fresh and dry weights were recorded for each plant.

Results
The scientists found no differences in fruit yield between irrigation treatments, possibly due to the frequent high rainfall events which occurred through the summer. Fruit number and total marketable weight was significantly lower in the 10 yd3/acre compost treatment compared to the 20, 50, and control treatments. No significant differences were seen between the 20, 50, 90 yd3 or control treatments. However, fruit number and weight were lower in the 90 yd3 treatment compared to the 20 or 50 yd3 treatments, suggesting an over-application of compost. These data indicate that compost application rates greater than 20 yd3/acre have no additional beneficial effect on yield.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Number of new or improved innovations developed for food enterprises

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The shellfish industry generates thousands of tons of processing by-products and undersized animals each year that could be used in the production of food ingredients. Additionally, invasive green crabs are very abundant in Maine; however, due to their small size, hand-picking of crab meat is not feasible and there is no commercial fishery for them.

What has been done
MAFES food scientists, working with Maine Wild Caught, evaluated the mechanical processing of green crab, assessing effects of processing on yield and mince quality, and then created a novel food product, an empanada, containing the green crab mince as a primary and tested its consumer acceptability.

Results
This research showed that green crabs could be trapped and processed effectively, with a 50% yield of minced crab meat. The meat mince has excellent nutritional and microbiological quality and can be used in the development of consumer-acceptable food products. In the short term, this project resulted in harvest income for a Maine lobsterman, and the removal of several thousand of these invasive animals from in-shore areas. At least 100 seafood researchers, local fishermen, and economic development specialists became more knowledgeable about this potential method of mitigating the green crab invasion. The data indicate long-term potential for the harvest, mechanical processing, and use of green crab that will add value to the efforts of fisherman and provide a use for a nuisance species.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies

Outcome #6

1. Outcome Measures

Adoption of strategies/tools for increasing productivity of Maine's fruit growers

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One of the principal desires of producers of specialty horticultural crops is to increase local consumption of locally grown agricultural products. Small-scale producers are often in a comparatively advantageous location that allows access to the most populated regions of the U.S. Yet, small-scale producers must maintain the quality of their perishable commodities and increase storage life in order to recover costs and make a profit. Pricing of perishables is difficult during a short season, being largely determined by supply and demand in the marketplace. Thus, these producers are at a disadvantage when negotiating prices during the peak, high supply harvest period. With the means to extend the storage duration of their produce, growers would have the option to sell when and where the prices are higher and still have the ability to supply top-quality products to the market.

What has been done

A MAFES researcher with a joint appointment with UMaine Extension is part of a multistate integrated project to develop and adapt postharvest strategies to improve quality and market competitiveness of local and small-scale fruit producers with a focus on apple and plum. The research has focused on testing methods that prevent losses in storage while maintaining optimum quality with an emphasis on handing procedures that can be adapted for small-scale producers.

Results

Apple growers in Maine used harvest and storage recommendations developed from this project to store and market Honeycrisp apples throught fall and winter with minimal losses to chilling injury. The Honeycrisp variety is more profitable than traditional varieties. The researchers also compared seven plum varieties at two stages of maturity to represent plums suitable for shipping and tree-ripened. Fruit quality and health-beneifical compounds were measured to determine if tree-ripened fruit differs from fruit harvested for shipping.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies

Outcome #7

1. Outcome Measures

Number of producers (and other members of the food supply chain) that have increased revenue

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Demand for local organic food has inspired new interest in growing bread-quality wheat in New England. The region's farmers have long produced small grains for animal feed on dairy and crop farms, but lack local knowledge and research information regarding production for the organic bread market.

What has been done
In this integrated project, MAFES researchers worked with organic farmers, millers, and bakers to develop strategies for organic bread wheat production that satisfy multiple criteria: productivity, profitability, milling and baking quality, and flavor.

Results
A 2013 survey of 30 New England commercial grain farmers revealed that 83% had adopted at least one and, on average, three new management practices based on the project's research results. As a result, farmers reported increases in grain yields (47%), grain quality and crop value (75%), buyers (40%), employment (33%), and wheat acreage (80%). The economic value these farmers placed on the benefits they gained from the project was an average of $7,000 each. Bakers and distributors reported they increased their knowledge and skills related to local grain sourcing and use (93%), and, as a result, used more locally grown grains (71%), developed new products (36%), and contacted someone new (86%). They estimated an average of $5,000 and up to $20,000 in economic gain to their businesses from the project. Maine Grains at the Somerset Grist Mill provides a specific example of this project?s broad impacts. The owner says the tours of local wheat systems in Quebec and Denmark gave her confidence that her business model was appropriate, examples of successful locally scaled mills to share with potential investors, and specific ideas that she implemented for handling and packaging flour. She relies on the project?s personnel and resources to provide farmers with technical assistance, and noted a marked increase in farmers? knowledge and skills regarding bread wheat production as a result

of the project. Her business now serves markets throughout New England, employs two full- and two part-time workers, and is the anchor for the Skowhegan food hub. Stakeholders credit this project with serving as the cornerstone for a new organic grain sector in New England by inspiring and enabling new markets for other food grains, other end uses (e.g., malt and spirits), and organic or non-GMO feed. Our region now has at least 7 flour mills, 3 malt houses, 5 distilleries, and dozens of bakeries for whom using locally grown organic grains is central to their business model.

4. Associated Knowledge Areas

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

Outcome #8

1. Outcome Measures

Improved tools for fighting plant and animal diseases

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A major obstacle in the development of truly sustainable aquaculture is the health and welfare of culture fish and shellfish and the interactions between wild and farmed populations. This has become increasingly pertinent with the development of integrated polyculture aquaculture systems (IPTA) where a more terrestrial model has been adopted for aquaculture systems with the waste nutrients from the main crop being recycled to produce fodder or other cash crops for the farm.

What has been done
To improve the health and welfare of farmed fish, MAFES researchers have worked on the development of several new vaccines formulations. This work was developed using in vitro models before carrying out larger-scale animal based trial.

Results

This research has led to the submission of one new patent, and the scientists are working with two local biotech companies (Kennebec River Biosciences & Fish Vet Group USA) on developing several new vaccines for use in the U.S. aquaculture industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
311	Animal Diseases

Outcome #9

1. Outcome Measures

Test/develop new, high-yielding, high-quality, and/or pest resistant crops, livestock, and brood stock for Maine farmers and aquaculturists

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Diversification of the shellfish culture industry will provide opportunities to exploit new markets as well as to expand to new culture sites that are better suited to alternative species.

What has been done
MAFES researchers began developing culture techniques for the Atlantic jackknife clam (Ensis directus), a species that can provide for industry diversification in the Northeast. The scientists conducted multiple spawnings of razor clams in the summer of 2012 using both field-collected, ripe broods and broods conditioned in the lab. They used larvae from these spawns to compare the efficacy of using downwellers versus trays filled with sandy and mud substrates for nursery-phase culture of razor clam offspring, currently a bottleneck in the production of razor clam seed.

Results
Although downwellers are the typical method for early nursery-phase culture of oysters, the scientists observed complete mortality of clams in downwellers, indicating they are unsuitable for razor clams. Sediment-filled trays represent a potential solution to problems often encountered with nursery phase culture of razor clams. The scientists found that the use of sediment-filled trays provided a substantial increase in the growth and survival of immediate post-set razor clams in the hatchery. They also conducted experiments investigating sediment preference for razor

clams at 6 months post-settlement. Juvenile razor clams took over five times as long to explore the sediments surface and initiate burrowing when presented with mud sediments when compared to clams presented with sand or mixed sediments. Juvenile razor clams expressed a clear preference for sand or sandy-mud substrates, and clams exposed to mud remain exposed on the surface where they are prone to predation, disturbance, and are unlikely to feed which will affect their growth and survival.

4. Associated Knowledge Areas

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

Outcome #10

1. Outcome Measures

Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	300

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Increasing energy costs have driven up the price of chemical fertilizers in recent years. At the same time, conventional and organic growers alike are looking for sources of N that may fortify their soil's shrinking organic matter base, making applied nutrients more efficient to use. Growers throughout New England are increasingly turning to locally available byproducts of the livestock, marine, and plant-based industries to provide nutrient sources that can bolster declining soil organic matter levels, while supplying readily-available nutrients at reasonable costs. Such sources include composted poultry manures, marine waste composts, bloodmeal, fish meals, and various seed meals left after extraction of cooking oils from crops like canola. The N release patterns of of these materials have not been well studied and their ecological and economic efficiencies are largely unknown.

What has been done
MAFES scientists conducted field trials to assess the effects of timing of application of an array of "bagged" biologically based fertilizers approved for organic farms. Six different organic fertilizers

were evaluated in experiment station fields over five years in triticale, sweet corn, and broccoli. Distinct patterns of N availability emerged from the research indicating the effectiveness of each N source under cold (triticale), cool (broccoli) and warm (sweet corn) soil temperatures and varying rates of plant growth. Soil nitrate and ammonium was monitored on a bi-weekly basis throughout the growth period of each crop.

Results

Over 300 growers (primarily organically certified) gained an improved knowledge of the relative benefits of 8 to 10 biologically based soil amendments, including their relative economic and ecological efficiency in providing nitrogen and other essential nutrients to a range of crops grown in cold, cool, and warm soils in Maine. The findings showed that blood meal provided N most readily at cold and cool temperatures, whereas fertilizers that contained a carbon component, such as soymeal, were slow to mineralize N in cool temperatures, but effective at providing timely N and other nutrients during the warmer summer months. Additionally, while each of the fertilizers was applied to supply the same rate of N, they varied significantly in the proportions of other nutrients, including both macro- and micronutrients. Fish meal, which had a broader array of nutrients than the other sources, consistently led to higher crop yields in each trial than the other applied nutrient sources over all five years and three crops.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluations are currently conducted at the project and program levels. At the project level, all projects are reviewed by an internal research council and external peer reviewers when initiated and again at completion by the research council. During the research council final evaluation, the focus is on determining if terminating projects met their stated objectives, secured extramural funding, and produced peer-reviewed publications. For FY14, 10 projects went through the review process in this program area. As for other measures of

successful research programs, faculty in this program area published 49 peer-reviewed articles and secured more than $2,838,605 in extramural funding.
Researchers use a variety of methods to evaluate their own research projects including evaluations retrospectively, before-after, and during the life of the project; case studies; and comparisons between treatment/intervention and nontreatment/nonintervention.
At the program level, external NIFA review teams are asked to review the research programs of schools/departments. These teams provide input on the impact and productivity of research programs supported through the station. The station is working to develop a standard program-level evaluation process, which will be used to evaluate each station program area. Our current plans include an approach based on use of expert panels as recommended by the federal Government Accounting Office with individual program evaluations occurring every four to five years on a staggered time table.

Key Items of Evaluation

For FY14, 10 projects went through the review process in this program area. As for other measures of successful research programs, faculty in this program area published 49 peer-reviewed articles and secured more than $2,838,605 in extramural funding.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Climate Change

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources			5%	
102	Soil, Plant, Water, Nutrient Relationships			20%	
112	Watershed Protection and Management			16%	
123	Management and Sustainability of Forest Resources			16%	
133	Pollution Prevention and Mitigation			6%	
135	Aquatic and Terrestrial Wildlife			13%	
136	Conservation of Biological Diversity			3%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			21%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.9	0.0
Actual Paid	0.0	0.0	2.8	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	143384	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	237656	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	288421	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Conduct scientific research. Publish peer-reviewed journal articles and other publications. Present findings at professional and public meetings and at other venues. Educate undergraduate and graduate students.

2. Brief description of the target audience

Maine natural-resource-based industries, Cooperative Extension staff, other scientists, state and federal policymakers, regulators, and legislators, classroom teachers

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

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

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	18	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of other publications

Year	Actual
2014	5

Output #2

Output Measure

- website: www.mainelandusefutures.org

Year	Actual
2014	1

Output #3

Output Measure

- Extramural funds awarded to researchers in this program area

Year	Actual
2014	433597

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Development of new knowledge and technologies and the transfer of these to clientele to address the effects of climate variability and change
2	Enhance adaptive capacity of production and natural systems to reduce exposure and vulnerability to climate change
3	Improve mitigation strategies for the reduction of greenhouse gas emissions and increase carbon sequestration in production and natural systems and communities
4	Improve knowledge on the effects of climate change on Maine's lake water quality

Outcome #1

1. Outcome Measures

Development of new knowledge and technologies and the transfer of these to clientele to address the effects of climate variability and change

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Freshwater ecosystems are heavily affected by a combination of ongoing and accelerating global climate changes and a suite of localized environmental stressors linked to increasing human resource use. These impacts have the potential to strongly degrade freshwater ecosystems and the cultural, economic, and social services (e.g., fisheries) they provide the people of Maine. Although water managers can do little about changes in temperature and hydrological cycles expected with the regional effects of climate change, they can mitigate impacts by prioritizing the maintenance of resilient freshwater ecosystems when making decisions on the sustainability of localized environmental stressors. However the ability to make these decisions is limited by a lack of understanding of how local stressors influence the vulnerability of freshwaters to climate change.

What has been done
MAFES researchers are analyzing the current biological monitoring database to investigate the impact of natural and anthropogenic environmental gradients on freshwater food webs, using the database in a novel way by partitioning the abundance of commonly assayed organisms into three trophic levels (predators, herbivores and algae) to quantify how the trophic structure of food webs (e.g., relative abundance of predators and prey) change with local environmental stress.

Results
To date, the scientists have, made a series of recommendations on how to improve the use of biological information in wetland assessment. Their recommendations include (i) developing closer links between structural and functional measures of ecosystems and (ii) incorporating the confounding effects of spatial and temporal drivers of ecological processes. Results from a field survey of the impact of urbanization on the structure and function of vernal pool food webs revealed that the more open canopies of urban vernal pools produced communities more dependent on algal resources, whereas the heavily shaded vernal pools in unmodified forest were

dominated by detritivores consuming terrestrial leaf litter. The researchers has shared his findings with a broad audience of freshwater and fisheries scientists and resource managers from Maine Department of Environmental Protection, Maine Department of Inland Fisheries & Wildlife, NOAA, USFWS, Penobscot Nation and the Atlantic Salmon Federation during participation in working groups and focus groups.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #2

1. Outcome Measures

Enhance adaptive capacity of production and natural systems to reduce exposure and vulnerability to climate change

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Facing a variety of pressures, from a highly competitive international market to the uncertainty of potential climate changes, tree-fruit growers must look to economically and environmentally sustainable management schemes of production. Growers who want to stay profitable must establish high-density plantings with smaller trees using new cultivars. These high-density plantings cost 10 to 20 times more per land area to establish than lower-density plantings, thus greatly enhancing economic risk. Additionally, high-density systems were originally developed in Europe with rootstocks adapted to a European climate. Finding new high-performing rootstocks less susceptible to the rigors of the North American production areas is important. Furthermore, some scientists predict that rootstocks will have to be more competitive for nutrients and water as inputs decline due to environmental stressors.

What has been done
In this integrated project, MAFES scientists, as part of multistate project NC140, established a trial was established with 10 different rootstock genotypes to measure suitability to high-density orchards in Maine. Another trial was established with four genotypes as a grower-collaboration in far northern Maine. They measured cold-temperature tolerance fall, winter, and spring in 16

genotypes, and under deacclimating conditions in four genotypes. Early onset of cold hardiness, an economically important trait, occurred in several varieties of apple. The ability to maintain hardiness during warm weather in winter is critical to tree survival and occurred in one of the four varieties measured.

Results
Results from NC-140 research continue to accelerate the process of identifying superior performing tree rootstocks and of their propagation and commercialization. Growers in various regions of the North America have benefited by having these rootstocks made available earlier by nursery companies. The NC-140 cooperative plantings have identified the benefits of the disease resistant CG rootstocks for North American sites. In Maine, as a result of this research, growers are planting trees that are more productive and have greater adaptation to the local climate.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Improve mitigation strategies for the reduction of greenhouse gas emissions and increase carbon sequestration in production and natural systems and communities

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Improve knowledge on the effects of climate change on Maine's lake water quality

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Although recent research has documented earlier ice-off dates and increased concentrations of dissolved organic carbon (DOC) in many lakes of the northeastern U.S., the extent to which associated changes in the physical and biological structure of these systems are occurring remains unclear. These changes, however, have the potential to substantially alter lake productivity and community structure thereby affecting drinking water quality, trophic transfer of toxic substances, and fisheries resources. Understanding the links between DOC, algal communities, and climate-relevant lake thermal structure will aid drinking water utilities in assessing the degree of risk and required treatment strength with DOC fluctuations in their water source.

What has been done
MAFES scientists conducted a detailed survey of Jordan Pond in Acadia National Park, a lake that has been exhibiting declining water clarity and increasing DOC over the past two decades. The researchers collected detailed baseline data for the lake, by conducting vertical profiles of the lake every 2 weeks over a 7-month period. Samples were collected for physical, chemical, and biological features.

Results
This research provided a more comprehensive perspective on the dynamics of physical, chemical, and biological succession from the time the ice went off this Maine lake to the time it went back on in the fall.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluations are currently conducted at the project and program levels. At the project level, all projects are reviewed by an internal research council and external peer reviewers when initiated and again at completion by the research council. During the research council final evaluation, the focus is on determining if terminating projects met their stated objectives,

secured extramural funding, and produced peer-reviewed publications. For FY14, 2 projects went through the review process in this program area. As for other measures of successful research programs, faculty in this program area published 18 peer-reviewed articles and secured more than $433,597 in extramural funding.
Researchers use a variety of methods to evaluate their own research projects including evaluations retrospectively, before-after, and during the life of the project; case studies; and comparisons between treatment/intervention and nontreatment/nonintervention.
At the program level, external NIFA review teams are asked to review the research programs of schools/departments. These teams provide input on the impact and productivity of research programs supported through the station. The station is working to develop a standard program-level evaluation process, which will be used to evaluate each station program area. Our current plans include an approach based on use of expert panels as recommended by the federal Government Accounting Office with individual program evaluations occurring every four to five years on a staggered time table.

Key Items of Evaluation

For FY14, 2 projects went through the review process in this program area. As for other measures of successful research programs, faculty in this program area published 18 peer-reviewed articles and secured more than $433,597 in extramural funding.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Food Safety

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			1%	
311	Animal Diseases			14%	
501	New and Improved Food Processing Technologies			20%	
502	New and Improved Food Products			16%	
503	Quality Maintenance in Storing and Marketing Food Products			1%	
605	Natural Resource and Environmental Economics			3%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			3%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			42%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.6	0.0
Actual Paid	0.0	0.0	2.3	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	192816	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	281284	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

Conduct scientific research. Publish peer-reviewed journal articles and other publications. Present findings at professional and public meetings and at other venues, and provide training sessions for food producers and processors. Educate undergraduate and graduate students.

2. Brief description of the target audience

Maine food producers and processors, Cooperative Extension staff, other scientists, state policymakers, regulators, and legislators, classroom teachers

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

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

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	15	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- # of other publications

Year	Actual
2014	3

Output #2

Output Measure

- Released new Capsicum germplasm containing high levels of capsinoids (bioactive compounds)

Year	Actual
2014	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increase number of viable technologies to improve food safety
2	Reduce incidence of foodborne illness
3	Increase adoption of recommended safe food-handling practices at the individual, family, community, production and supply system levels.
4	Using cranberries to improve food safety
5	New ways to control Toxoplasma gondii contamination

Outcome #1

1. Outcome Measures

Increase number of viable technologies to improve food safety

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many potato farmers lose potatoes during storage due to the length of storage and microbial contamination. During harvesting, potatoes may become injured and susceptible to microorganisms such as yeast and molds and bacteria. When in storage, bacteria and fungi that were potentially introduced during harvesting may contaminate some potatoes.

What has been done
MAFES food scientists developed a novel, simple gaseous chlorine dioxide (ClO2) method that could effectively control microorganisms on potatoes during storage.

Results
Results were effective for yeasts and molds, natural microbiota, and P. aeruginosa. Gaseous ClO2 did not affect the overall visual quality of the potato. The residue of ClO2 decreased to < 1mg/l after 14 days consistently for each treatment. Gaseous ClO2 may be scaled up to increase profitability of Maine?s potato farms as it reduces crop loss in storage due to microbial contamination.

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

Reduce incidence of foodborne illness

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Increase adoption of recommended safe food-handling practices at the individual, family, community, production and supply system levels.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Using cranberries to improve food safety

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Control of foodborne pathogens and the reduction in the potential health risks to consumers from pathogens is one of the most urgent problems confronting the food industry. Chemical agents with antimicrobial activity have been used as one of the most traditional techniques. However, consumers today are increasingly concerned about the safety of these chemical additives in foods and prefer natural, healthy, and unadulterated foods. Consequently, many researchers are searching for naturally occurring antimicrobial compounds from sources such as fruit, plants and herbs.

What has been done

MAFES researchers studied the antimicrobial mechanisms of action of bioactive compounds in cranberries on cellular and molecular levels against human pathogens.

Results
The researchers? results indicated that each fraction of bioactive compounds showed significant antimicrobial effects ($P < 0.05$) compared to the control (0%) at 24h. They also developed chitosan films containing cranberry concentrate and tested for antibacterial activity on poultry drumsticks over a period of 5 days. Due to the antibacterial nature of these films, they present themselves as an effective means of naturally treating poultry with cranberry that does not decrease the aesthetic appeal of the product.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

New ways to control Toxoplasma gondii contamination

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Protozoan parasite Toxoplasma gondii is one of three pathogens (together with Salmonella and Listeria) that account for >75% of all deaths due to foodborne disease in the USA. One-third of the human world population is infected with T. gondii. The high disease burden in combination with disappointing results of the currently available treatments has led to a plea for more effective prevention.

What has been done
Working with wild blueberries because of their economic importance to the state of Maine, the researchers have examined the effectiveness of using peroxyacetic acid, lactic acid, chlorine dioxide, and chlorine washes to remove T. gondii oocysts inoculated on the surface of

blueberries.

Results
The peroxyacetic acid and lactic acid washes removed significantly ($p<0.05$) more oocysts, 4.9 and 4.8 log, respectively, than the water wash, whereas the ClO2 and NaClO washes removed similar levels of oocysts as the water wash. The chemical wash treatments did not alter the appearance of blueberries. This study suggests that peroxyacetic and lactic acid washes are more effective in removing T. gondii oocysts from blueberry surface than ClO2, NaClO and water washes. Interventions targeting the oocyst stage are imperative for controlling T. gondii contamination of fruits and other produce. The use of peroxyacetic acid and lactic acid washing could be a viable method of controlling T. gondii oocysts contamination on blueberries. Additionally, this project has expanded the number of scientists conducting research on T. gondii through training by collaborators in the USDA. It has lead to the creation of facilities and protocols to handle working with a protozoan. New standard operating procedures have been developed both at the University of Maine and the Eastern Regional Research Center at Wyndmoor, PA.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluations are currently conducted at the project and program levels. At the project level, all projects are reviewed by an internal research council and external peer reviewers when initiated and again at completion by the research council. During the research council final evaluation, the focus is on determining if terminating projects met their stated objectives, secured extramural funding, and produced peer-reviewed publications. This program area ended in FY2014, and projects have been moved to the Maine Food Systems program area starting with the FY2015 Plan of Work.

Key Items of Evaluation

This program area ended in FY2014, and projects have been moved to the Maine Food Systems program area starting with the FY2015 Plan of Work.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Sustaining Natural Resources

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			3%	
111	Conservation and Efficient Use of Water			6%	
123	Management and Sustainability of Forest Resources			12%	
131	Alternative Uses of Land			2%	
132	Weather and Climate			2%	
134	Outdoor Recreation			6%	
135	Aquatic and Terrestrial Wildlife			21%	
136	Conservation of Biological Diversity			14%	
202	Plant Genetic Resources			6%	
204	Plant Product Quality and Utility (Preharvest)			1%	
206	Basic Plant Biology			6%	
215	Biological Control of Pests Affecting Plants			6%	
301	Reproductive Performance of Animals			2%	
306	Environmental Stress in Animals			5%	
605	Natural Resource and Environmental Economics			6%	
723	Hazards to Human Health and Safety			2%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	7.0	0.0
Actual Paid	0.0	0.0	8.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	508897	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	949440	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	414231	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Conduct scientific research. Publish peer-reviewed journal articles and other publications. Present findings at professional and public meetings and at other venues. Educate undergraduate and graduate students.

2. Brief description of the target audience

Other scientists; teachers at all levels; directors of aquariums and museums, exhibit halls, etc.; endangered species biologists/managers; state and local policymakers; state regulatory agencies; environmental consultants; landowners

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

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

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

Patent Applications Submitted

Year:	2014
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	41	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- # of other publications

Year	Actual
2014	10

Output #2

Output Measure

- # of websites http://www.tidalmarshbirds.org; www.vernalpools@me; http://ofpoolsandpeople.weebly.com

Year	Actual
2014	2

Output #3

Output Measure

- Gulf of Maine Bird Watch page on Facebook, which now has an international following

Year	Actual
2014	0

Output #4

Output Measure

- Extramural funds awarded to researchers in this program area:

Year	Actual
2014	2123202

Output #5

Output Measure

- Led educational field experiences on bird migration for six rural K-12 classrooms in Acadia National Park and presentation on the effects of climate change on birds to a further ten rural K-12 classrooms on the UMaine campus in Orono

Year	Actual
2014	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Improve knowledge of, or strategies and tools for, protecting fish and wildlife habitat
2	Adoption of strategies for protecting fish and wildlife habitat
3	New strategies for improving and/or preserving surface and ground water quality
4	Adoption of strategies for improving/preserving surface and ground water quality
5	Enhance sustainability, diversity, and resiliency of Maine's natural resource-based industries
6	Improve health, distribution, and/or abundance of crucial plant and animal species
7	Improve knowledge of ways to protect wildlife habitat

Outcome #1

1. Outcome Measures

Improve knowledge of, or strategies and tools for, protecting fish and wildlife habitat

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As Maine forest landscape continues to change in response to economic and societal expectations, it has become critical for researchers and natural resource managers to have access to the most advanced information and technologies to plan for the future. Adding further uncertainty to the future outlook for Maine?s forests is the eastern spruce budworm (SBW), a pest native to the Northeast and eastern Canada, which has historically infested these regions every 30 to 50 years, causing widespread defoliation and mortality of balsam fir and spruce trees. The last major SBW outbreak in Maine was in the 1970s.

What has been done
MAFES researchers are using time-series medium-spatial-resolution satellite imagery in combination with FIA data and spatial landscape disturbance models to predict and map the vulnerability of northern forest stands to spruce budworm defoliation.

Results
A SBW stand vulnerability map was developed under two U.S. Forest Service, Northern State Research Cooperative-funded research projects. The maps were made available to the Maine Forest Service and major forest landowners in northern Maine. The maps are being used to determine locations of high vulnerability stands where pheromone traps will be positioned all over northern and eastern Maine unorganized townships.

4. Associated Knowledge Areas

KA Code	Knowledge Area
136	Conservation of Biological Diversity
301	Reproductive Performance of Animals

Outcome #2

1. Outcome Measures

Adoption of strategies for protecting fish and wildlife habitat

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

New strategies for improving and/or preserving surface and ground water quality

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
River and stream ecosystems play a critical role in the Maine landscape as valuable habitats and fluvial connectors, linking upland watersheds with downstream aquatic and estuarine ecosystems through fluxes of water, matter, and energy. Increasingly, rivers and other aquatic ecosystems are facing pressures and threats associated with human population growth, climate changes, land development, invasive exotic species, and non-point pollution.

What has been done
In collaboration with the NSF-EPSCoR SSI program at the University of Maine, this project has examined the effects of urbanization on stream ecosystems and the potential impacts of future land use changes on small watersheds and streams in Maine.

Results
MAFES scientists developed biogeochemical indicators based on dissolved organic matter characteristics and fluorescence analysis that help to identify thresholds of impairment in streams affected by urbanization. These indicators were compared with existing biometrics used by Maine DEP, and were found to provide a strong biogeochemical complement to those approaches. Their complementary work on modeling land use suitability sets the stage for ongoing research aimed at predicting streams and watersheds at risk of impairment from future land use changes. Our

interactive land use modeling results have been made available to all interested professionals and citizens through our online website at www.mainelandusefutures,org.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Adoption of strategies for improving/preserving surface and ground water quality

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Enhance sustainability, diversity, and resiliency of Maine's natural resource-based industries

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In response to the increased traffic congestion, wildlife habitat degradation and air and noise pollution plaguing federal recreation areas due to exponential growth in visitation, many recreation areas have begun implementing alternative transportation systems, primarily in the form of transit buses. The federal government allocated 1.2 billion dollars for transit planning and implementation over the last five years alone, however, the majority of this funding was swallowed up in capital costs, leaving a small portion for research. As a result, transit systems are rapidly popping up across recreation lands, yet no formal performance-measurement system currently exists for evaluating the effectiveness of transit. Without a standardized system for quantifying system performance, transit systems may fail to fulfill their destiny as transportation solutions for

recreation managers, but rather lead to more inefficient and unsustainable transportation.

What has been done
Building on transit performance-measuring in traditional urban settings, MAFES researchers are investigating transit performance-measures, given the inherent differences in federal land management agency missions, visitor motivation and expectation associated with transportation for leisure purposes.

Results
Based on their findings, MAFES researchers created a technical report, which has been made available to transit managers, natural resource managers, and policymakers. The report examines transit indicators used by different natural resources agencies such as the National Park service, Forest Service, and US Fish and Wildlife Service and suggests a means to improve the development of monitoring key indicators.

4. Associated Knowledge Areas

KA Code	Knowledge Area
134	Outdoor Recreation
136	Conservation of Biological Diversity
206	Basic Plant Biology

Outcome #6

1. Outcome Measures

Improve health, distribution, and/or abundance of crucial plant and animal species

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Improve knowledge of ways to protect wildlife habitat

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2014 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The single defining challenge to our modern biological resources is one of rapid landscape evolution. To manage these impacts and make informed choices concerning the tradeoffs between biological conservation, economic prosperity, and the Maine way(s) of life, we need to understand what species and communities are most at risk to different disturbances.

What has been done
MAFES scientists censused the tidal marsh bird and plant communities from Maine to Virginia for the second bird breeding season following the passage of Hurricane Sandy.

Results
The scientists have proofed these data and begun analysis to describe the sensitivity of the community to large storm events. The data showed that marsh specialists are more sensitive than generalists. The researchers presented this information at three professional meeting (one scientific, one applied, and one with stakeholders at the Region 5 office of USFWS).

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
132	Weather and Climate
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)
- Other (new invasive species)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluations are currently conducted at the project and program levels. At the project level, all projects are reviewed by an internal research council and external peer reviewers when initiated and again at completion by the research council. During the research council final evaluation, the focus is on determining if terminating projects met their stated objectives, secured extramural funding, and produced peer-reviewed publications. For FY14, 3 projects went through the review process in this program area. As for other measures of successful research programs, faculty in this program area published 41 peer-reviewed articles and secured more than $2,123,202 in extramural funding. Researchers use a variety of methods to evaluate their own research projects including evaluations retrospectively, before-after, and during the life of the project; case studies; and comparisons between treatment/intervention and nontreatment/nonintervention.
At the program level, external NIFA review teams are asked to review the research programs of schools/departments. These teams provide input on the impact and productivity of research programs supported through the station. The station is working to develop a standard program-level evaluation process, which will be used to evaluate each station program area. Our current plans include an approach based on use of expert panels as recommended by the federal Government Accounting Office with individual program evaluations occurring every four to five years on a staggered time table.

Key Items of Evaluation

For FY14, 3 projects went through the review process in this program area. As for other measures of successful research programs, faculty in this program area published 41 peer-reviewed articles and secured more than $2,123,202 in extramural funding.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Supporting Rural Economies

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			9%	
112	Watershed Protection and Management			2%	
123	Management and Sustainability of Forest Resources			2%	
131	Alternative Uses of Land			1%	
134	Outdoor Recreation			18%	
136	Conservation of Biological Diversity			3%	
311	Animal Diseases			9%	
315	Animal Welfare/Well-Being and Protection			9%	
605	Natural Resource and Environmental Economics			19%	
607	Consumer Economics			3%	
608	Community Resource Planning and Development			13%	
609	Economic Theory and Methods			4%	
610	Domestic Policy Analysis			4%	
723	Hazards to Human Health and Safety			4%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	6.0	0.0
Actual Paid	0.0	0.0	5.6	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	312573	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	521519	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	203464	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Conduct scientific research. Publish peer-reviewed journal articles and other publications. Present findings at professional and public meetings and at other venues. Educate undergraduate and graduate students.

2. Brief description of the target audience

Scientists, economists, state and local policymakers, extension specialists, green/horticulture industry, tourism planners, land use commissions, and commercial fishermen

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

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

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	21	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of other publications

Year	Actual
2014	31

Output #2

Output Measure

- Assistance to Biotechnology Services and Maine Diagnostic Innovations in development of a rapid point-of-care test for Streptococcus equi.

Year	Actual
2014	1

Output #3

Output Measure

- Generalized code for implementing hierarchical learning classifier systems. The code is derived from the code used to model the lobster fishery; however, it has been made generic so that it can be easily used by other modelers. The code is publicly available on the OpenABM website: https://www.openabm.org.

Year	Actual
2014	1

Output #4

Output Measure

- TV show: Preserving Paradise Mapping Maine?s Future. 30-minute MPBN television special on the SSI Alternative Futures Project. http://www.mpbn.net/Television/LocalTelevisionPrograms/SustainableMaine/Preserv

Year	Actual
2014	1

Output #5

Output Measure

- Extramural funds awarded to researchers in this program area: $2,205,447.

Year	Actual
2014	2205447

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Improve knowledge of, or strategies and tools for, sustaining Maine's rural economies and comunities
2	Adoption of strategies/tools for sustaining Maine's rural economies and communities
3	Enhance sustainability, diversity, and resiliency of Maine's rural economies and communities

Outcome #1

1. Outcome Measures

Improve knowledge of, or strategies and tools for, sustaining Maine's rural economies and comunities

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the Maine Farm Bureau, Maine is home to 35,000 horses, with an economic impact of approximately $364 million. Although isolated, Maine is nevertheless on the front lines of national biosecurity due to its extensive sea and land borders and at risk for new outbreaks of diseases in animal populations. The economic impact of such disease outbreaks can be devastating to individual farms, the state, and the nation. Maine is also home to a strong biotechnology sector with a successful track record in development of animal-disease diagnostics. To benefit both the agriculture and biotechnology sectors of Maine's economy, we wish to foster innovation and commercialization of new technologies of animal-disease surveillance.

What has been done
Using Maine as a testing ground, this team of MAFES and UMaine Extension researchers is developing a model of strangles surveillance that could be applicable nationally and internationally towards eventual eradication of the disease worldwide.

Results
The scientists have assessed the technique of guttural pouch endoscopy and catheterization. They have established, and confirmed with local veterinarians, that endoscopic catheterization of the guttural pouch is relatively simple, while introducing the endoscope itself into the guttural pouch is more challenging and requires practice and training. They have also developed protocols for sampling and assessing streptococci in water as a way to conduct surveillance for strangles. Their proposed method for surveillance combines testing of water with follow-up endoscopy. The protocol involves determining sensitivity of water testing by examining water from acutely infected, positive cases and by performing follow-up culture, and if necessary, guttural pouch endoscopy, on clinically normal animals whose water tests positive for strangles. Additionally working with Maine Biotechnology Services and Diagnostic Innovations, the scientists have optimized the point-of-care prototype to a sensitivity of approximately 50-500 cfu of S equi,

which is within the clinically useful range.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Adoption of strategies/tools for sustaining Maine's rural economies and communities

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The quality of rural life both affects and is affected by the movement of people into and out of rural communities, the evolution of agriculture and industry, local social organization, and public policy. As part of multistate project NE1049, MAFES economists are understand the emerging opportunities and threats to the economic structure of rural communities arising from the potential shifts in local and regional food systems. To identify and analyze policies and strategies contributing to the viability and resiliency of communities in responding to economic and policy changes and to natural and human-made shocks. Maine has the third-largest maple industry in the United States. According to the USDA, maple syrup is produced in 10 states ? Connecticut, Maine, Massachusetts, Michigan, New Hampshire, New York, Ohio, Pennsylvania, Vermont, and Wisconsin.

What has been done
As part of multistate project NE1049, MAFES and UM Extension economists are investigating the emerging opportunities and threats to the economic structure of rural communities arising from the potential shifts in local and regional food systems. They are also attempting to identify and analyze policies and strategies contributing to the viability and resiliency of communities in responding to economic and policy changes and to natural and human-made shocks.

Results
The results of their analysis of the incidence and importance of microenterprises to Maine?s employment base was published in the Maine Development Foundation?s 2014 ?Measures of Growth? report, which is distributed to economic development officials, Extension educators, policy officials, and legislators in Maine. Their research on the number of businesses reached annually by UMaine Cooperative Extension and the number of workers employed in those businesses annually helped document the economic importance of Cooperative Extension and their business clientele to the Maine economy. These findings were shared with the chancellor of the University of Maine System, University of Maine senior administrators, legislators, Extension County Executive Committees, and other Maine policy officials.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
609	Economic Theory and Methods

Outcome #3

1. Outcome Measures

Enhance sustainability, diversity, and resilency of Maine's rural economies and communities

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Northeast fisheries crisis and regulatory responses aimed to rebuild depleted stocks have resulted in severe social, economic, and cultural impacts on Maine's fishing communities. Understanding the vulnerability and resilience of these communities is critical for predicting and mitigating the likely impacts of future policies.

What has been done
This project assessed vulnerability and resilience in Maine fishing communities through interviews, a rapid assessment, site visits, and focus groups, producing 18 fishing community profiles that provide social and economic ?baseline? information necessary for understanding

future impacts of social-environmental change on fishing communities. The researchers also conducted mixed methods social science research to examine several efforts aimed at broadening participation in science and management, including extended peer communities, collaborative fisheries research, sustainability science, and fisheries co-management.

Results

The project produced oral history interviews that document, and protect for future generations through their archival, the lived experience and knowledge of Maine fishermen. This project provided recommendations to fishery managers, fishing communities, and other stakeholders for improving resilience in Maine?s fishing communities. The researchers also published their findings on co-management and collective action in the groundfish, lobster, and sea urchin fisheries. They have documented several case studies of cooperative fisheries research in the Northeast U.S., including strategies helpful for collaboration such as boundary spanners, boundary management, and transparency. They also implemented a trans-disciplinary, sustainability science research approach to understand tidal power development in eastern Maine, in collaboration with fishing community members, regulatory agencies, and tidal energy industry representatives. These studies have provided recommendations for enabling and improving broader participation in science and management that will help enhance the sustainability of coastal Maine communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluations are currently conducted at the project and program levels. At the project level, all projects are reviewed by an internal research council and external peer reviewers when initiated and again at completion by the research council. During the research council final evaluation, the focus is on determining if terminating projects met their stated objectives, secured extramural funding, and produced peer-reviewed publications. For FY14, 3 projects went through the review process in this program area. As for other measures of

successful research programs, faculty in this program area published 21 peer-reviewed articles and secured more than $2,200,000 in extramural funding.
Researchers use a variety of methods to evaluate their own research projects including evaluations retrospectively, before-after, and during the life of the project; case studies; and comparisons between treatment/intervention and nontreatment/nonintervention.
At the program level, external NIFA review teams are asked to review the research programs of schools/departments. These teams provide input on the impact and productivity of research programs supported through the station. The station is working to develop a standard program-level evaluation process, which will be used to evaluate each station program area. Our current plans include an approach based on use of expert panels as recommended by the federal Government Accounting Office with individual program evaluations occurring every four to five years on a staggered time table.

Key Items of Evaluation

For FY14, 3 projects went through the review process in this program area. As for other measures of successful research programs, faculty in this program area published 21 peer-reviewed articles and secured more than $2,200,000 in extramural funding.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
0	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
1	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.