V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Food Safety

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
133	Pollution Prevention and Mitigation			4%	
135	Aquatic and Terrestrial Wildlife			21%	
212	Pathogens and Nematodes Affecting Plants			8%	
215	Biological Control of Pests Affecting Plants			8%	
311	Animal Diseases			10%	
501	New and Improved Food Processing Technologies			12%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			25%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			12%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.8	0.0
Actual Paid Professional	0.0	0.0	1.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

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

V(D). Planned Program (Activity)

1. Brief description of the Activity

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

2. Brief description of the target audience

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

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

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

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

Patent Applications Submitted

Year:	2012
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	2	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2012	108

Output #2

Output Measure

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

Year	Actual
2012	4

Output #3

Output Measure

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

Year	Actual
2012	6

Output #4

Output Measure

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

Year	Actual
2012	4

Output #5

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2012	9

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about the incidence and detection of vibrio in oysters.
2	Knowledge of environmental and biological factors associated with reduced concentrations of vibrios in harvested and processed oysters.
3	Number of citizens engaged in educational presentations and workshops related to mycrocystins.
4	Number of agencies and stakeholder groups involved in research outreach related to vibrios in shellfish.
5	Increased knowledge about mechanisms of biofilm adaptation and diversification in pathogens and symbionts.

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

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

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

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

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

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

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

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

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

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Number of citizens engaged in educational presentations and workshops related to mycrocystins.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	250

3c. Qualitative Outcome or Impact Statement

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

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

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

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

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

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

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

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

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

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

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

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

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

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

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Appropriations changes

Brief Explanation

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

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

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

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

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

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

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

Key Items of Evaluation

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

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