

**V(A). Planned Program (Summary)**

**Program # 6**

**1. Name of the Planned Program**

Sustaining Natural Resources

Reporting on this Program

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			10%	
112	Watershed Protection and Management			29%	
133	Pollution Prevention and Mitigation			2%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			25%	
403	Waste Disposal, Recycling, and Reuse			4%	
511	New and Improved Non-Food Products and Processes			3%	
608	Community Resource Planning and Development			10%	
901	Program and Project Design, and Statistics			7%	
903	Communication, Education, and Information Delivery			10%	
	<b>Total</b>			100%	

**V(C). Planned Program (Inputs)**

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

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.8	0.0
Actual Paid Professional	0.0	0.0	1.3	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	107415	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	313082	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	338091	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

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

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

**2. Brief description of the target audience**

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

**3. How was eXtension used?**

eXtension was not used in this program

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	2195	11037	40	0

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

**Patent Applications Submitted**

Year: 2012  
 Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2012	Extension	Research	Total
Actual	0	6	6

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

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

Year	Actual
2012	12

**Output #2**

**Output Measure**

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

Year	Actual
2012	11

**Output #3**

**Output Measure**

- Number of stakeholder venues where results have been presented.

Year	Actual
2012	9

**Output #4**

**Output Measure**

- Web sites featuring results from NHAES research.

Year	Actual
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2012

2

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

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

## **Outcome #1**

### **1. Outcome Measures**

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

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Condition Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	0

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

#### **Issue (Who cares and Why)**

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

#### **What has been done**

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

#### **Results**

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

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

#### 4. Associated Knowledge Areas

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

#### Outcome #2

##### 1. Outcome Measures

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

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

###### **Issue (Who cares and Why)**

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

###### **What has been done**

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

###### **Results**

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

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

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

#### Outcome #3

##### 1. Outcome Measures

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

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Condition Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	300

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

###### **Issue (Who cares and Why)**

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

###### **What has been done**

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

###### **Results**

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

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

#### Outcome #4

##### 1. Outcome Measures

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

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

###### **Issue (Who cares and Why)**

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

###### **What has been done**

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

###### **Results**

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

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

#### 4. Associated Knowledge Areas

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

#### Outcome #5

##### 1. Outcome Measures

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

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

###### **Issue (Who cares and Why)**

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

###### **What has been done**

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

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

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

#### **Results**

- Preliminary results from the bear study showed that wildlife ordinances can be an effective management tool to reduce human/bear conflict. In addition, the reminder post card increased participation in the survey by 12%, leading to an enhancement of the study sampling strategy of ordinance and non-ordinance communities and the development of a practical ground-validation strategy.

-A turkey brood survey attracted 960 participants in over 152 towns; 43% of these people chose to complete the online survey.

-Different enhancements to applied surveys will be used to develop a better understanding of the social science of non-response error rate in survey research across policy/programs and stakeholder groups.

#### **4. Associated Knowledge Areas**

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

#### **V(H). Planned Program (External Factors)**

##### **External factors which affected outcomes**

- Economy
- Appropriations changes

##### **Brief Explanation**

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

#### **V(I). Planned Program (Evaluation Studies)**

##### **Evaluation Results**

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

##### **Key Items of Evaluation**

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