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			7%	
102	Soil, Plant, Water, Nutrient Relationships			41%	
112	Watershed Protection and Management			12%	
131	Alternative Uses of Land			33%	
401	Structures, Facilities, and General Purpose Farm Supplies			2%	
403	Waste Disposal, Recycling, and Reuse			3%	
605	Natural Resource and Environmental Economics			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	2.9	0.0
Actual Paid	0.0	0.0	3.8	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	165030	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	132117	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

Activity for the program includes:

- Measuring C pools and greenhouse gas emissions (CO_2, CH_4, N_2O) in agricultural and suburban landscapes and comparing these data with data previously collected from forest plots in the same area
- Using the combined data set to calibrate a high spectral resolution remote sensing image from NASA's AVIRIS instrument in the Durham, NH area
- Using the field and remote sensing data to parameterize the denitrification decomposition (DNDC) computer simulation model, validate and upscale model predictions
- Generating spatially continuous predictions of C pools, greenhouse gas emissions, and reflection of solar radiation (shortwave albedo) to determine the net radiative forcing values (in W m^{-2}) for the major components of the landscape (mowed versus grazed pasture, corn fields, forest, and suburban lawns)
- Making future projections of C, N and water balances for both agricultural and forested landscape units, using newly available CO_2 and climate change projections through 2100.
- Investigating the effects of different cropping systems, soil insects, and microbial community composition on Soil Organic Matter (SOM) turnover and soil nitrogen cycling.

2. Brief description of the target audience

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

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	821	2230	441	299

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	18

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2014	16

Output #2

Output Measure

- Number of graduate students directly involved in the project

Year	Actual
2014	5

Output #3

Output Measure

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

Year	Actual
2014	3

Output #4

Output Measure

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

Year	Actual
2014	16

Output #5

Output Measure

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

Year	Actual
2014	16

Output #6

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2014	4

Output #7

Output Measure

- Postdocs and other scientists taking who learn climate change research methods.

Year	Actual
2014	5

Output #8

Output Measure

- Produce a detailed database of carbon pools in soils and plant biomass and soil greenhouse gas emissions as well as information about farm management practices was amassed for use in calibrating and validating process-based models of drivers of climate change (Community Land Model).

Year	Actual
2014	1

Output #9

Output Measure

- Documented concentration of total dissolved nitrogen in wet deposition (rain, snow) in the Great Bay watershed over three years.

Year	Actual
2014	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of graduate students trained to become the future generation of scientists.
2	Information relayed to non-scientific stakeholders through integrated research and extension partnerships.
3	Unbiased knowledge about tradeoffs among multiple land management strategies in terms of their net climate effect.
4	Understanding the impact of atmospheric deposition on water quality in order to develop management strategies that stakeholders can used to improve water quality.
5	Address microbial contributions to soil organic matter accumulation, and also to the timing and extent of soil organic matter (SOM) loss and N mineralization in various cropping systems

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results
This quantitative measure only counts students who have completed a MS or Ph.D. degree

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Information relayed to non-scientific stakeholders through integrated research and extension partnerships.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
It is well accepted that ecosystems respond to climate variability, atmospheric deposition, and changing landscapes. Detailed measurements and modeling of the responses provide critical information of local communities to develop more sustainable practices and protect sensitive ecosystems such as New Hampshire's Great Bay Estuary.

What has been done
The amount of nutrients and acids in precipitation has been assessed through continued long-term sampling of rain chemistry in New Hampshire. Baseline quantification of the magnitude of and timing of nitrogen fluxes were determined for the Lamprey River and Oyster River. A budget was determined to net radiative forcing of mixed forested, agricultural and residential landscape while carbon pools and greenhouse emissions were measured over these landscapes.

Results
Wet deposition is the largest source of imported of nitrogen (29 percent) in both the Great Bay watershed and the Lamprey River watershed. These results were communicated to multiple stakeholder and policy groups in public presentations throughout the year and through reports to the Lamprey River Hydrologic Observatory and the Durham/UNH Integrated Permit Project Team/Agency. Results of landscape modeling were presented to the New England Society of American Foresters, the Society for the Protection of New Hampshire Forests and via a report for the National Center for Climate Education.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
131	Alternative Uses of Land
401	Structures, Facilities, and General Purpose Farm Supplies
403	Waste Disposal, Recycling, and Reuse

Outcome #3

1. Outcome Measures

Unbiased knowledge about tradeoffs among multiple land management strategies in terms of their net climate effect.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change and ecosystems processes are influenced by mixed land including agriculture, forest and residential homes. Carbon storage, non-carbon greenhouse gas emissions and surface energy exchange mediated by shortwave albedo, are altered by land management; each can have climate consequences that either offset or exacerbate one another. Thus far, there are few tools available to help scientists or policy makers weigh the relative tradeoffs of various land cover types and land management activities for climate mitigation strategies.

What has been done
Over the course of this project, a database was amassed of carbon pools and greenhouse emissions. Remote sensing images were calibrated for foliar N and albedo. Model simulations with the DeNitrification-DeComposition (DNDC) model were used for estimating carbon storage and greenhouse gas losses in agricultural landscapes. Synergistic efforts with NH EPSCoR have allowed estimates carbon pools and greenhouse gas emissions in the forested portion of the study area using the Photosynthesis (Pn) and EvapoTranspiration (PnET) model.

Results
Findings to date suggest that at both short and long-term time horizons, biophysical factors such as albedo and surface heat fluxes may influence climate forcing more than biological processes such as carbon storage and greenhouse gas emissions. As a result, the current policy focus on carbon sequestration in soils and plant biomass may be too narrow for developing a comprehensive approach for mitigating climate change across a mixed land use landscape.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
131	Alternative Uses of Land

Outcome #4

1. Outcome Measures

Understanding the impact of atmospheric deposition on water quality in order to develop management strategies that stakeholders can used to improve 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)
Atmospheric deposition,the transfer of nutrients, metals, and microbes from the atmosphere to the earth's surface, is a fundamental part of environmental health. This information is useful for assessing the impacts of dirty rain on ecosystem health, relative to other human impacts such as forestry and agriculture. This information has been critically important in local discussions and decision-making related to management of New Hampshire's Great Bay Estuary. The primary output of the project is the dissemination of findings that quantify the magnitude of atmospheric deposition of various pollutants in temperate and tropical watersheds.

What has been done
Quantifying the amount of nutrients and acids in precipitation has been assessed through continued long-term sampling of rain chemistry in New Hampshire and Puerto Rico.

Results
One NHAES project documented that the concentration of total dissolved nitrogen in wet deposition (precipitation and snowfall) in southeastern New Hampshire ranged from 0.56-0.66 mg N/L on an average annual basis from 2011 to 2013. Total annual precipitation amounts from 2011-2013 have ranged from 1028 to 1303 mm/yr. Wet deposition is the largest source of imported of nitrogen in both the Great Bay watershed and the Lamprey River watershed. Based on the Great Bay Nitrogen Non-Point Source Study conducted by the NH Department of

Environmental Services (2014), it is estimated that approximately 29 percent of the total nitrogen (both point and non-point sources) delivered to Great Bay is from atmospheric deposition. Isotopic signature of nitrate found in several streams throughout the Great Bay watershed does not reflect the isotopic signature of wet deposition and suggests that the nitrogen originating from atmospheric deposition is highly processed prior to reaching Great Bay.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #5

1. Outcome Measures

Address microbial contributions to soil organic matter accumulation, and also to the timing and extent of soil organic matter (SOM) loss and N mineralization in various cropping systems

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 loss of soil organic matter (SOM) is one of the greatest challenges to agricultural sustainability. It has enhanced soil compaction and trace gas emissions,increased dependence upon external fertilizer inputs, and exacerbated environmental nitrogen losses.

What has been done
If soil organic matter is predominantly microbial biomass, plant inputs that build biomass should also increase Soil Organic Matter (SOM). The MIcrobial-MIneral Carbon Stabilization (MIMICS) model, newly built upon the Community Land Model (CLM) platform, was used with meta-analyzes of with a new microbial-explicit soil biogeochemistry model to explore the relationships between plant litter chemistry, microbial communities, and SOM stabilization in different soil types and with different management practices.

Results

Globally that the highest SOM concentrations are associated with plant inputs containing low C/N ratios. These results are confirmed by individual tracer studies pointing to greater stabilization of low C/N ratio inputs, particularly in clay soils. Reconsideration of the mechanisms stabilizing SOM also will challenge long-held views about how to optimize plant community management to increase SOM.

New carbon inputs are more rapidly incorporated into biomass in organic systems, which is related to 20 percent higher microbial growth rate, 15 percent higher biomass, and 20 per cent higher growth efficiency. These differences in microbial physiology appear related to greater stabilization of new carbon inputs. Thus,microbial communities in diverse organic cropping systems have microbial physiological characteristics that enhance the efficiency of new carbon input conversion to soil organic matter.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (none)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

While research projects in this planned program are at different states of maturity, all are considered successful and productive.

- Publication of peer-reviewed papers in high impact journals. There were 18 publications from resulting from several of the research projects. Many were in high impact journals.
- Presentations in major national and international conferences: all three projects in the planned program have featured presentations at national and international meetings.
- Results of the atmospheric deposition program are being incorporated in local and regional planning efforts to ameliorate eutrophication of New Hampshire's Great Bay Estuary.

Key Items of Evaluation

- Discovery of more efficient C cycling in organic cropping systems. New carbon inputs are more rapidly incorporated into biomass in organic systems, which is related to 20

percent higher microbial growth rate, 15 percent higher biomass, and 20 percent higher growth efficiency. These differences in microbial physiology appear related to greater stabilization of new carbon inputs. Microbial communities in diverse organic cropping systems have microbial physiological characteristics that enhance the efficiency of new carbon input conversion to soil organic matter. (Ninh, H.T., A.S. Grandy, K. Wickings, S.S. Snapp, W. Kirk, and J. Hao. Organic amendment effects on potato productivity and quality are related to soil microbial activity. Plant & Soil, 386:223-236, 2015)

- Findings to date suggest that at both short and long-term time horizons, biophysical factors such as albedo and surface heat fluxes may influence climate forcing more than biological processes such as carbon storage and greenhouse gas emissions. As a result, the current policy focus on carbon sequestration in soils and plant biomass may be too narrow for developing a comprehensive approach for mitigating climate change across a mixed land use landscape. (Burakowski et al. Spatial scaling of reflectance and surface albedo over a mixed-use, temperate forest landscape during snow-covered periods. Remote Sensing of Environment. 158, 465-477. 2015).
- The concentration of total dissolved nitrogen in wet deposition (precipitation and snowfall) in southeastern NH ranged from 0.56-0.66 mg N/L on an average annual basis from 2011-2013. These data were integrated into Non-Point Source Study conducted by the NH Department of Environmental Services (2014); it is estimated that approximately 29 percent of the total nitrogen (both point and non-point sources) delivered to Great Bay is from atmospheric deposition.