

V(A). Planned Program (Summary)

Program # 12

1. Name of the Planned Program

Environmental Stewardship In A Changing Climate

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
111	Conservation and Efficient Use of Water	10%	10%	10%	10%
112	Watershed Protection and Management	10%	10%	10%	10%
124	Urban Forestry	5%	5%	5%	5%
132	Weather and Climate	10%	10%	10%	10%
135	Aquatic and Terrestrial Wildlife	15%	15%	15%	15%
136	Conservation of Biological Diversity	10%	10%	10%	10%
216	Integrated Pest Management Systems	20%	20%	20%	20%
302	Nutrient Utilization in Animals	5%	5%	5%	5%
806	Youth Development	10%	10%	10%	10%
903	Communication, Education, and Information Delivery	5%	5%	5%	5%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual Paid	6.9	1.9	12.2	4.8
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
468092	258963	439893	869295
1862 Matching	1890 Matching	1862 Matching	1890 Matching
371651	258963	794889	869295
1862 All Other	1890 All Other	1862 All Other	1890 All Other
472458	11198	4031153	1428228

V(D). Planned Program (Activity)

1. Brief description of the Activity

I. Increased knowledge of and best management practices to mitigate the effects of climate change

a. Animal agriculture: understanding impacts of climate change on animal physiological processes, health, and disease, particularly for poultry and dairy; developing management practices to rapidly diagnose, prevent, and mitigate (e.g., new vaccines) effects of avian diseases on poultry health and productivity, including current disease problems and new ones that may appear and proliferate under new climatic conditions; developing new systems and technologies to reduce effects of environmental stress on animal health and productivity. The latest research projects are focusing on animal care, management and environmental design to ensure animal well-being and raise awareness of environmental protection, law and legislation. These studies are on four fronts, including monitoring technologies for animal physiological and behavioral response, assessment of animal-environment interactions, quantitation of air quality and emissions from animal feeding operations, and assessment and development of best management practices aiming at mitigating air emissions based on their character, amount, and dispersion.

b. Agronomic crops: basic research on how environmental stresses associated with climate change (e.g., heat, moisture stress) affect crop physiology and productivity; plant genetics and breeding studies to develop cultivars of major crops better adapted to a changing climate, in terms of water use efficiency and resistance to insects and disease; applied research and extension programs on irrigation management and water use efficiency for periods of prolonged drought and restricted water use and for groundwater that may become more saline from salt water intrusion; integrated pest management to diagnose and control insects, weeds, and diseases (current and newly emerging) during longer growing seasons and under warmer and wetter growing conditions; nutrient cycling and management, particularly for manures and other byproducts where decomposition and nutrient release rates and timings are affected by warmer, wetter climates; basic and applied research on factors controlling C sequestration and new agronomic management practices that help mitigate greenhouse gas emissions by sequestering C in soils; and new studies now underway on how changing temperature and rainfall patterns will affect phosphorous management and water quality impacts, using isotope geochemistry to identify how and why the phosphorous has been released from cropland to surface and ground waters. Integrated Pest Management - developing and delivering integrated pest management (IPM) programs, a "systems" approach using chemical, cultural, mechanical, and biological control to increase profits to producers and protect the environment;

c. Natural Ecosystems: characterizing effects of climate change on biodiversity of plants and wildlife exposed to greater pressure from droughts, insects, disease, and invasive species; studying how climate change affects natural ecosystems and insects critical to crop production (e.g., pollination, honeybees);

investigate value of marshes, wetlands, and forests to sequester C; increase C storage by encouraging tree planting and sustainable forestry management; and new studies using weather radar to quantify bird distributions and to track migratory birds. Understanding stopover ecology of migratory birds, including how they select the habitats where they stop and how that impacts their behavior and the success of their migrations is an important area of ecological research today. Sustainable Agriculture/Forestry - developing and promoting efficient and sustainable agricultural, forestry, and other resource conservation practices and policies that ensure sustained ecosystem function and provide food and habitat for biodiversity, including crop diversification, agroforestry, native windbreaks, cover crops, living mulches, field border systems, and conservation buffers; Wildlife, Woodlands, and Aquatic Resources - understanding and mitigating the impact of agricultural practices and urbanization on biodiversity, woodlands, and aquatic resources. Focus will be on human impacts on the fundamental processes that create and maintain biodiversity, such as atmospheric nitrification of ecosystems, minimal habitat requirements, speciation, predator-prey interactions, community and ecosystem structure, and extinction processes. Approaches to develop and sustain biodiversity in agriculture, suburban landscapes, and natural habitats, will be studied. Nonpoint source nutrient pollution models will assess impacts of land use/cover change from agriculture to urban on water quality and quantity on local ponds and creeks; Wetlands Ecosystems - improve understanding of wetlands restoration, protection, and preservation. Emphasis will be on seasonally saturated and non-seasonally saturated wetlands, the wildlife species that inhabit them, and the importance of sedges in wetland habitats; Protection of Delaware's Native Species - research on non-indigenous invasive species, a leading cause of plant and animal extinction in Delaware, will focus on impacts of invasive species on ecosystem function and on methods of restoration after their removal. Wildlife Management - effects of human activity on migratory shore birds, box turtles in suburban habitat fragments, neotropical bird migrants in Delaware, Bobwhite quail in warm season grasslands, horseshoe crab ecology in the Delaware Bay, insect biomass production in suburban habitats, habitat restoration for bats and White-tailed deer populations and lead to recommendations for improved habitat management; new research focuses on the ecology and conservation of wild fields, the evaluation of wildlife behavioral response to human recreation, the development of new technologies in wildlife research, the application of hierarchical models, and monitoring bird and bat flight activity near wind turbines; Fisheries - population status, spawning areas, and management of Atlantic sturgeon in the Delaware River.

d. Resource economics: develop creative new economic policies to profitably link agriculture and forestry with those sectors generating significant quantities of greenhouse gases (e.g., energy, transportation) in cooperative efforts to mitigate greenhouse gas emissions; improve understanding of the relationship of climate change to agricultural and environmental policy development, including farmland preservation, conservation reserve programs; study impacts of climate change on groundwater aquifers, integrate climate change into the Chesapeake Bay water quality model; contribute to policies and educational programs on recycling, develop environmentally-friendly bio-based fuels from local feed stocks, and assist in analysis of Delaware's greenhouse gas inventories from energy use (mobile sources, utilities, residential, industrial, transportation, commercial, natural gas distribution, waste management, agriculture, land use, etc.).

2. Brief description of the target audience

For animal agriculture, target audiences are primarily poultry integrators, growers, breeders, trade groups and allied industries; dairy and beef producers; livestock commodity groups; forage producers, equine owners, producers and interest groups. For crop and soils related research and extension programs, the audience includes existing and prospective grain crop producers, mixed (animal and crop production, e.g., dairy, horse) farms, crop commodity groups and trade associations, the "green industry" (e.g., horticulture, field border systems, and conservation buffers; Wildlife, Woodlands, and Aquatic Resources - understanding and mitigating the impact of agricultural practices and urbanization on biodiversity,

woodlands, and aquatic resources. Focus will be on human impacts on the fundamental processes that create and maintain biodiversity, such as atmospheric nitrification of ecosystems, minimal habitat requirements, speciation, predator-prey interactions, community and ecosystem structure, and extinction processes. Approaches to develop and sustain biodiversity in agriculture, suburban landscapes, and natural habitats, will be studied. Nonpoint source nutrient pollution models will assess impacts of land use/cover change from agriculture to urban on water quality and quantity on local ponds and creeks; Wetlands Ecosystems - improve understanding of wetlands restoration, protection, and preservation. Emphasis will be on seasonally saturated and non-seasonally saturated wetlands, the wildlife species that inhabit them, and the importance of sedges in wetland habitats; Protection of Delaware's Native Species - research on non-indigenous invasive species, a leading cause of plant and animal extinction in Delaware, will focus on impacts of invasive species on ecosystem function and on methods of restoration after their removal. Wildlife Management - effects of human activity on migratory shore birds, box turtles in suburban habitat fragments, neotropical bird migrants in Delaware, Bobwhite quail in warm season grasslands, horseshoe crab ecology in the Delaware Bay, insect biomass production in suburban habitats, habitat restoration for bats and White-tailed deer populations and lead to recommendations for improved habitat management; new research focuses on the ecology and conservation of wild fields, the evaluation of wildlife behavioral response to human recreation, the development of new technologies in wildlife research, the application of hierarchical models, and monitoring bird and bat flight activity near wind turbines; Fisheries - population status, spawning areas, and management of Atlantic sturgeon in the Delaware River.

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3. How was eXtension used?

In 2014 the eXtension Institutional Team comprised of faculty and staff from across all planned program areas continue to provide the leadership for this work. This past year the team has focused on the following:

- Developing a strategic plan for use of social media (created by eXtension Fellow)
- Implementing social media strategic plan- including two social media campaigns
- Additional training and implementation on Ask an Expert
- On-line course development
- Became a premier member of new eXtension structure

This year the groundwork has been established for the development of online course development around nutrient management and new and beginning farmers. Both of these programs are a part of this goal and anticipated outcomes of this effort will be realized in 2016.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	11755	37332	449	295

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	4	30	34

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Competitive Grants Awarded

Year	Actual
2014	14

Output #2

Output Measure

- Undergraduate Researchers

Year	Actual
2014	68

Output #3

Output Measure

- M.S. and Ph.D. Students

Year	Actual
2014	40

Output #4

Output Measure

- Post-doctoral Researchers

Year	Actual
2014	12

Output #5

Output Measure

- Refereed Journal Articles

Year	Actual
2014	34

Output #6

Output Measure

- Books and Book Chapters

Year	Actual
2014	7

Output #7

Output Measure

- Extension Bulletins and Fact Sheets

Year	Actual
2014	19

Output #8

Output Measure

- Webpage views/downloads

Year	Actual
2014	57555

Output #9

Output Measure

- Workshops at regional, national, and international levels

Year	Actual
2014	317

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	We anticipate an increase in knowledge of, an acquisition of skills, and/or an adoption of practices that: 1) mitigate the effects of climate change; 2) reduce greenhouse gas emissions and increase carbon sinks; 3) use energy efficiently; 4) protect and improve soil, air, and water quality; 5) promote biodiversity and sustainable landscapes; 6) reduce risks through Integrated Pest Management tactics.

Outcome #1

1. Outcome Measures

We anticipate an increase in knowledge of, an acquisition of skills, and/or an adoption of practices that: 1) mitigate the effects of climate change; 2) reduce greenhouse gas emissions and increase carbon sinks; 3) use energy efficiently; 4) protect and improve soil, air, and water quality; 5) promote biodiversity and sustainable landscapes; 6) reduce risks through Integrated Pest Management tactics.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 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 2004 Chesapeake Bay Watershed Blue Ribbon Finance Panel estimated that it will cost approximately six billion dollars per year to clean up the Chesapeake Bay to fishable and swimmable standards. As a result of these costs, EPA contracted with the University of Maryland's Environmental Finance Center (EFC) to conduct education and outreach events across the 64,000 square mile Chesapeake Bay Watershed on funding options available to help implement the best management practices (BMPs) necessary to achieve the needed pollutant reductions in each state.

What has been done

A meeting with the funders was organized to provide better understanding of key issues and potential barriers to promote ag BMPs to help implement Delaware's WIP and craft a more productive meeting for farmers later in the year.

The "Delaware Agricultural Financing Forum: Show Me the Money" event was held on August 20th and was sponsored by UD Extension, PNC Bank, MidAtlantic Farm Credit, Chesapeake Bay Foundation, and hosted by the EFC.

Results

The financing forum was well attended with 44 attendees, approximately half of whom were farmers or representatives from ag industry. An evaluation was distributed at the close of the forum and 11 attendees submitted a completed form (25% response rate). Of those surveyed, 100% of respondents indicated that, as a result of the program, they gained a better understanding about the resources available to help finance effective BMPs. Six of the 11 respondents (55%) indicated that they increased their knowledge about the environmental and operational benefits of precision agriculture tools, conservation tillage practices, and irrigation systems, a direct indicator of the participants increasing their knowledge of BMPs to protect and improve soil, air, and water quality. Four of the 11 respondents (36%) indicated that they now intend to adopt one of the featured BMPs to protect and improve soil, air, and water quality. As a result of the program's success and feedback, a new session for Delaware's Ag Week has been developed that will feature an interactive financing game, and provide an overview of local financial resources.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
903	Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Public Policy changes
- Government Regulations

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Research:

- Biological control, which involves importing host-specific insects that feed on and suppress non-native weeds, provides an environmentally sound method of control that can improve and help restore native ecosystems. In FY 2014, our laboratory determined the developmental threshold and number of degree days required for development of the mile-a-minute weevil, a biological control insect for mile-a-minute weed (*Persicaria perfoliata*).

This information will help us to predict under what environmental conditions the weevil will successfully control the weed. In addition, a new project was initiated to look for biocontrol agents aimed at Japanese stiltgrass, one of the most damaging and difficult to control invasive weeds in our native forest understory.

- The relative effectiveness of a novel bioretention basin design for removal of nitrogen and phosphorous from stormwater runoff is being investigated. Nitrogen and phosphorous are two macronutrients that play important roles in the degradation of surface waters. Water quality samples for paired bioretention systems show the advanced media that incorporates water treatment residuals is more effective than a conventional media for removal of phosphorous. We need to collect additional warm-weather data to determine the effectiveness of the design for removal of nitrogen through denitrification.

- It is increasingly realized that the concentration based research as well as assumption based model simulations are not sufficient to understand the intricacies of nutrient cycling. Concept of recycling and recalcitrancy in the environmental context been barely considered seriously. Our approach of source tracking using stable isotopes from molecular scale to ecosystem scale processes, for example, identifying sources and processes of phosphorus in the Chesapeake Bay and understanding nutrient cycling in soils has generated several new findings. The major being the predominance of organic matter remineralization as a dominant pathway of phosphorus cycling. This finding has the potential for paradigm shift on current understanding on how coastal dead-zone are formed and sustained.

- A recognized concern of on-farm manure storage and usage is the exposure to human pathogens that may occur in the manure. Manure handling and field application procedures have been implicated in the pollution of surface waters by pathogens, especially bacteria. Chirnside's research examined a novel, engineered treatment method that can reduce bacteria numbers within dairy cattle wastewater before it is applied on agricultural fields. We demonstrated that a particular white rot fungus could reduce the numbers of bacteria in the liquid dairy manure. The fungus was grown in bioreactors designed to treat the liquid wastewater before it is handled by agricultural workers.

- Spark's research on the impact of sea level rise on contaminant cycling is being shared with a low socio-economic community in Wilmington. This community is located in old industrial areas that have large concentrations of contaminants, such as arsenic and chromium, and is in an area that is adjacent to the Christina River. Flooding is increasingly a problem, exacerbated by climate change, and the community is concerned about the cycling of the contaminants. Our data will provide important information to them about the impacts of sea level rise and flooding on the cycling of As and Cr.

- Dr Vargas has established the first outdoor laboratory in Delaware to study greenhouse gases from a coastal ecosystem. This outdoor laboratory has state-of-the art instrumentation that will provide invaluable information to managers, policy makers, researchers and student regarding the health and value of coastal ecosystems. Dr. Vargas is working towards quantifying a greenhouse balance inventory of this coastal ecosystem to improve the understanding of ecosystem resiliency to climate variability and global environmental change.

- Dr. Ozbay's research at DSU examines the impact of *Phragmites australis* on native invertebrates using blue crab as an indicator species at the Delaware Blackbird Creek. This research showed that total phosphorous, nitrate, total nitrogen are high in areas dominated by *Spartina* and mixed marsh grass species. This effort has provided enhanced insight into the importance of marsh surface vegetation in relation to the way blue crabs and resident fish utilize such habitats. This information will contribute to improved management and restoration efforts currently in place that address the common reed.

Extension:

Issue: Poultry Production and Nutrient Management Program

Commercial poultry growers in Delaware are required to be certified by the Delaware Nutrient Management Program and must maintain certification by attending programs that offer continuing education credits.

Response:

The Nutrient Management Program at the University of Delaware strives to provide growers with educational opportunities to maintain their certifications and provide information on the latest technologies that enable them to be competitive, as well as aware of conservation practices that benefit the state's water quality. A recent program showcased talks on mortality freezers, cost share opportunities, animal welfare and LED lighting.

Results:

The Poultry Production and Nutrient Management Program was attended by 66 individuals. The total poultry capacity of the farms present during the meeting was 3,056,900. Based on the evaluations of the program, 11 of the participants plan to adopt the poultry freezers, 20 plan to participate in the cost share programs, 14 plan to adopt new animal welfare practices, and 30 plan to use LED lighting on their operations after hearing about these new practices/ technologies.

Issue: Evaluating and Revision the Delaware Phosphorus Site Index Update

Historical use of manure at rates exceeding the phosphorus (P) requirements of field crops has resulted in elevated soil test P levels in Delaware that increase the risk for P loss from agricultural soils. Phosphorus loss from agricultural fields in Delaware (and the Mid-Atlantic) is a major concern, because of water quality degradation in the Chesapeake Bay, Delaware Inland Bays, and other regionally sensitive water bodies.

Response:

Delaware received \$130K from an NRCS Conservation Innovation grant as part of a regional Chesapeake Bay group (PSU, UD, UM, V&A Tech, Cornell, WVU, USDA-ARS, and UMES). As part of this multi-state team, Delaware will evaluate and update the Delaware P Site Index over the next few years. As part of the regional Conservation Innovation Grant, a survey was distributed to certified nutrient consultants to get input from practitioners of the Delaware P Site Index to identify strengths and weaknesses of the tool and professional opinions on if and how the tool should be modified. A regional panel of experts was also convened to represent the Coastal Plain region of the Chesapeake Bay watershed. In conjunction with researchers at USDA-ARS, UMES, and Rutgers, UD researchers and graduate students were awarded a \$25K seed grant from the Delmarva Land Grant Universities to begin investigating subsurface transport of P in artificially (ditch) drained agricultural fields on Delmarva.

Results:

A total of 18 people responded to the consultant survey. In general, survey respondents indicated that any revised P Site Index should be based on physiographic region rather than state boundaries and that a screening tool should be used to determine when risk assessment was needed. Only eight of 18 respondents felt that revisions to the Delaware P Site Index were necessary; two respondents thought that a revised index should be more restrictive and future limit manure applications. The regional expert panel, which included representatives from DE and MD Departments of Agriculture, VA Department of Conservation, USEPA, environmental organizations, farmers, and consultants, concurred with many findings of the survey. Most participants wanted a P Site Index based on physiographic boundaries with interpretation (i.e., value for low, medium, high) at the state scale. The panel overwhelming agreed that subsurface transport of P needed to be better

understood and considered in risk assessment tools on the Coastal Plain. More results are expected as research activities continue over the next two years.

Key Items of Evaluation