

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Natural Systems, Biodiversity, and Wildlife Ecology

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
112	Watershed Protection and Management	10%	10%	10%	10%
123	Management and Sustainability of Forest Resources	10%	10%	10%	10%
135	Aquatic and Terrestrial Wildlife	20%	20%	20%	20%
136	Conservation of Biological Diversity	15%	15%	15%	15%
215	Biological Control of Pests Affecting Plants	15%	15%	15%	15%
216	Integrated Pest Management Systems	20%	20%	20%	20%
306	Environmental Stress in Animals	5%	5%	5%	5%
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: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	1.5	2.0	3.5	2.5
Actual Paid Professional	1.6	1.5	3.4	1.8
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
51700	116679	70078	286657
1862 Matching	1890 Matching	1862 Matching	1890 Matching
178983	116679	0	286657
1862 All Other	1890 All Other	1862 All Other	1890 All Other
200786	0	996286	759160

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research and extension programs will target: (1) 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; (2) 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; (3) 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; (4) 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; (5) 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; (6) Master Gardener Training - Extension programs will be developed and delivered on Wildlife Habitat Gardening, Waterwise Gardening, and use of native landscape plants in suburban gardens; (7) Human Activities and the Natural Environment - coupled environmental and socioeconomic modeling methodologies will highlight interactions between human activities (drivers), environmental impacts from those activities (stressors), potential changes to valued ecosystem components, and feedbacks experienced from the changes; (8) 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 felids, 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; (9) Fisheries - population status, spawning areas, and management of Atlantic sturgeon in the Delaware River.

2. Brief description of the target audience

Farm owners and operators, aquaculture producers, recreational fisheries, seafood consumers, water quality managers, agribusiness and private consultants, horticultural professionals, city land use planners and other policy-makers, home gardeners, childcare providers, environmental educators.

3. How was eXtension used?

In 2013 UD and DSU eXtension Institutional Team comprised of faculty and staff from across all planned program areas completed the following:

- Training on how to incorporate eXtension into grants
- Connected the Extension website with eXtension.org
- Implemented Ask an Expert throughout the state. Staff and faculty engaged in the eXtension Learn feature
- Faculty and staff increased participation in the Communities of Practice (COP)-DE is represented by 81 eXtension members in 43 of the 73 approved CoP
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We trained 40 "experts" to use the Ask an Expert system and have fielded over 295 questions in the past 9 months. (84% of those questions were answered by Delaware experts).

This planned program area receives the largest percent, 80% of the Ask an Expert questions. Questions ranged from horticulture, pests, lawn and turf, vegetables and weeds. UD and DSU staff answered 84% of all of the questions received. This program area also boasts of the highest number of views on our web presence and is linked to the eXtension resources in these areas.

Also, Delaware provides one Community of practice leader, Dr. Deb Delaney in Bee Health and has multiple members in the Climate, Forests and Woodlands, Invasive species, Freshwater Aquaculture, Forest Farming, Water Conservation for lawn and landscape, and Invasive Species. Deb has integrated web information through eXtension on line presence and provides an online course content for stakeholders.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	3967	25233	2018	500

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

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	3	33	36

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Competitive Grants Submitted

Year	Actual
2013	34

Output #2

Output Measure

- Number of Competitive Grants Awarded

Year	Actual
2013	24

Output #3

Output Measure

- Number of Research Projects Completed

Year	Actual
2013	19

Output #4

Output Measure

- Number of Undergraduate Researchers

Year	Actual
2013	45

Output #5

Output Measure

- Number of M.S. Graduate Students

Year	Actual
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2013 33

Output #6

Output Measure

- Number of Ph.D. Graduate Students

Year	Actual
2013	9

Output #7

Output Measure

- Number of Post-doctoral Research Associates

Year	Actual
2013	4

Output #8

Output Measure

- Number of Refereed Journal Articles

Year	Actual
2013	36

Output #9

Output Measure

- Number of Books and Book Chapters

Year	Actual
2013	3

Output #10

Output Measure

- Number of Technical Reports

Year	Actual
2013	24

Output #11

Output Measure

- Number of Extension Bulletins and Factsheets

Year	Actual
2013	19

Output #12

Output Measure

- Number of Invited Presentations

Year	Actual
2013	121

Output #13

Output Measure

- Number of Volunteered Presentations

Year	Actual
2013	72

Output #14

Output Measure

- Number of Websites Established

Year	Actual
2013	6

Output #15

Output Measure

- Number of Workshops Conducted

Year	Actual
2013	55

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased number of farmers and other producers aware of the principles of integrated pest management and familiar with the practices and technologies needed for a systems-based approach to prevent and control problems with insects, weeds, and plant pathogens.
2	Educational programs for K-12 youth and teachers on ecosystems and natural resources that emphasize the importance of sustaining biodiversity for natural and managed land uses.
3	Through the Center for Managed Ecosystems, conduct research and outreach programs on restoring and enhancing biodiversity and wildlife habitat in suburbanized landscapes.
4	Increased number of farmers and other land managers adopting integrated approaches to pest management for insects, weeds, alien invasive plants, and plant pathogens in agricultural and natural ecosystems.
5	Increased participation by all stakeholders in educational programs on responsible environmental management of natural resources, nutrients, and pesticides.
6	Increases in the amount of agricultural and suburban land where wildlife habitat has been restored or enhanced.
7	Integrated Pest Management: basic and applied research will increase the effectiveness of a systems-based approach to prevent or control pests (insects, weeds, plant pathogens) that threaten agricultural productivity and damage natural, urban, and suburban landscapes. Extension programs will promote adoption of IPM by farmers and other land managers.
8	Ecosystem restoration: fundamental research on ecosystem processes will provide evidence of the full range of ecological, water quality, and economic benefits associated with sustaining and enhancing natural ecosystems such as wetlands, forests, riparian corridors, and tidal marshes, and lead to greater restoration and expansion of areas important for wildlife habitat and biodiversity.
9	Wildlife habitat and management: research will assess the impacts of human activity on wildlife habitats and develop management practices that can protect threatened or endangered species and lead to policies that protect and enhance wildlife populations.
10	Protection of native species: research and extension programs will quantify the ecological and economic benefits of protecting indigenous plant species and restricting the spread of invasive plants and animals.

Outcome #1

1. Outcome Measures

Increased number of farmers and other producers aware of the principles of integrated pest management and familiar with the practices and technologies needed for a systems-based approach to prevent and control problems with insects, weeds, and plant pathogens.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Educational programs for K-12 youth and teachers on ecosystems and natural resources that emphasize the importance of sustaining biodiversity for natural and managed land uses.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Children in grades K thru 12 need to learn some basic information about fish and the role that aquaculture can play in supplementing natural fisheries.

What has been done

Aquaculture is particularly suited to teaching STEM (Science, Technology, Engineering and Math) to students, as many of the individual disciplines (chemistry, biology, geometry, etc.) can be applied directly and in a meaningful and practical way. In this programming effort, Delaware State University Cooperative Extension's Aquaculture specialist takes the research that DSU students have been working on and directly implement this in the local K-12 classrooms. In 2013, this program expanded to include a hands-on learning experience on the life cycle for Mrs. Susan Gilmore's fourth grade class at Clayton Elementary School in Clayton, DE. The subject species, *Fundulus heteroclitus*, lends itself particularly well to this program, as the eggs can be air-incubated and then hatched on demand. The students were able to see each life stage of the fish and then each received a small container with 3-4 fish eggs inside. Once the specialist added water to each dish, the students watched as their fish hatched before their eyes. Prior to hatching,

students viewed the embryos under the microscope throughout each stage of development.

Results

Collectively, students learned about a local estuarine species, the need to grow bait as a means of offsetting pressure on wild stocks, and about aquaculture and what role aquaculture can play in supplementing natural fisheries.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
136	Conservation of Biological Diversity
903	Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

Through the Center for Managed Ecosystems, conduct research and outreach programs on restoring and enhancing biodiversity and wildlife habitat in suburbanized landscapes.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many diverse natural resource groups gather throughout the state to discuss and act upon various environmental educational activities regarding our renewable resource usage and conservation efforts, but lack a connection to the research-based information offered through the University of Delaware.

What has been done

The University of Delaware Cooperative Extension is represented in the following groups: Delaware Forest Stewardship Council, Delaware Urban & Community Forestry Council, Delaware Tree Farm Program Committee (Chair), Delaware Association for Environmental Education (Board of Directors), Delaware Forestry Association (past-chair, current-Newsletter Editor), and

Delaware Clean State Program Stakeholder, along with professional organization involvement with the Society of American Foresters and the Association of Natural Resources Extension Professionals.

Results

Cooperative Extension engages in discussion targeting renewable natural resources and helps direct potential legislative issues and/or develop programs outreach efforts that provide scientific and research-based information. By participating in environmental education and helping to develop the Delaware Children in Nature Initiative, the effort is now connecting to the State Education standards (via. STEM) and expanding towards providing educational opportunities for all grades to participate in outdoor educational experiences as part of their school curriculum.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
903	Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

Increased number of farmers and other land managers adopting integrated approaches to pest management for insects, weeds, alien invasive plants, and plant pathogens in agricultural and natural ecosystems.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Increased participation by all stakeholders in educational programs on responsible environmental management of natural resources, nutrients, and pesticides.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

An increasing number of Delawareans are requesting assistance with home horticulture and environmental management needs. The limited number of agents representing Delaware Cooperative Extension require the help of a knowledgeable volunteer corps to meet the needs of agents available to answer these needs of Delaware residents. Volunteers participating in the Master Gardener program require access to current research-based education in order to best assist Delawareans who request their help.

What has been done

Delaware State University and University of Delaware partnered to deliver the intensive, biannual 16-week Master Gardener training course, which prepares Master Gardener candidates for volunteer service. Beyond the formal training course, each Master Gardener candidate agrees to volunteer 45 hours, 30 of which are spent answering the Garden Helpline. Each day, Helpline volunteers assist a growing number of Delawareans—including those who are either new to the state or new to gardening and landscaping—by answering their production, pest and invasive plant control, and conservation questions.

Results

In November 2013, 23 Master Gardener candidates (10 from Kent County; 13 from Sussex County) completed their formal training. Upon completing the requisite 45 volunteer hours, each candidate will obtain their Delaware Master Gardener title.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Increases in the amount of agricultural and suburban land where wildlife habitat has been restored or enhanced.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Natural resource managers, farmers, wildlife groups, state and federal agencies, and public citizens concerned about restoring wildlife habitat in urban areas.

What has been done

New approaches to landscape design have been implemented in an existing suburban community in Wilmington, Delaware to diversify vegetation, increase the percentage of native plants, and reduce inputs of chemicals used for lawn, the prior predominant land use.

Results

Researchers have installed a completely new landscape design, eliminating much of the lawn area, replacing it with mixtures of herbaceous and woody plants installed in a manner to reduce runoff (protect water quality) and provide habitat for wildlife, thus increasing biodiversity in an urban community. Educational programs demonstrating the ecosystem services provided by diverse vegetation are being conducted as well.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
903	Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

Integrated Pest Management: basic and applied research will increase the effectiveness of a systems-based approach to prevent or control pests (insects, weeds, plant pathogens) that threaten agricultural productivity and damage natural, urban, and suburban landscapes. Extension programs will promote adoption of IPM by farmers and other land managers.

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Ecosystem restoration: fundamental research on ecosystem processes will provide evidence of the full range of ecological, water quality, and economic benefits associated with sustaining and enhancing natural ecosystems such as wetlands, forests, riparian corridors, and tidal marshes, and lead to greater restoration and expansion of areas important for wildlife habitat and biodiversity.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Opportunities for economic enrichment in forested areas should not rely exclusively on harvest revenues from timber production ? other forest entities combine agriculture systems and food products in a sustainable method through various agroforestry practices (i.e., forest farming, windbreaks, riparian forest buffers, alley cropping, silvopasture, short-rotation woody crop plantations for bioenergy, animal waste and irrigation tailwater disposal, wildlife habitat enhancement, nut & fruit tree orchards and Christmas tree plantations).

What has been done

A regional SAF meeting on Agroforestry was coordinated for 35 local professional foresters, held in Middletown, DE. A tour to three operational New Castle County agroforestry sites was offered: a Black walnut/Christmas tree plantation, forest farming of Shiitake mushrooms enterprise combined with silvopasture for Emu farming and a large-scale family owned Christmas tree farm. A full-day event at the 2013 Delaware AG Week for forest landowners on Agroforestry issues was organized.

Results

As a result of the SAF meeting & tour to the Shiitake mushroom enterprise, marketing outreach for this business expanded from just the areas around Newark, Delaware to others placed in neighboring states ? providing economic gain for that business. Following the 2013 AG Week Agroforestry session, at least five participants noted their intention to begin Agroforestry practices

on their farms beginning the following year. One individual has implemented a Shiitake mushroom production operation on their farm in Greenwood, DE.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
136	Conservation of Biological Diversity
216	Integrated Pest Management Systems
903	Communication, Education, and Information Delivery

Outcome #9

1. Outcome Measures

Wildlife habitat and management: research will assess the impacts of human activity on wildlife habitats and develop management practices that can protect threatened or endangered species and lead to policies that protect and enhance wildlife populations.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Natural resource managers, wildlife conservation groups, agencies responsible for preserving and restoring wildlife habitats, public citizens.

What has been done

Research is underway to assess how powerful storms (e.g., Hurricane Sandy) degrade habitats for tidal marsh birds (saltmarsh sparrows, black ducks, American brants), to provide guidance for the habitat restoration strategies.

Results

A range of field research projects have been established in coastal regions impacted by Hurricane Sandy, where data from past studies on bird populations are available. Current research focuses on developing a platform for tidal marsh bird monitoring, as impacted by sea level rise, and is being used to identify regional population centers of saltmarsh sparrows, in hurricane-impacted areas where habitat restoration is underway. Other studies focus on mapping and predicting food supplies for the Atlantic brant, again in areas damaged by Sandy where restoration strategies are emerging and establishing food supplies for tidal marsh birds is critical

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
903	Communication, Education, and Information Delivery

Outcome #10

1. Outcome Measures

Protection of native species: research and extension programs will quantify the ecological and economic benefits of protecting indigenous plant species and restricting the spread of invasive plants and animals.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many individuals throughout Delaware lack basic knowledge and current research-based choices for renewable ?natural? resource (i.e., forestry, wildlife, soil & water) stewardship in our rural and urban communities.

What has been done

Critical issues of concern were identified with Delaware residents regarding forestry, wildlife management, water conservation, invasive species management, soil health and recycling of renewable resources. Educational experiences (i.e., workshops, field day events, tours, classrooms, interactive exhibits, trainings and conference sessions) were provided to help

individuals gain awareness and increase their capability to become better environmental stewards within their communities and extend this information to others through their personal interactions.

Results

Fourteen Delaware landowners went further to implement at least one management practice to prevent or control exotic invasive species on their individual property of that in a homeowner association. Twenty-two individuals participating in the New Castle County Master Gardener ?Advanced Training? received not only instruction on proper tree and shrub pruning techniques, but, as a result of this training, were then equipped to provide a similar workshop through the regular New Castle Master Gardener classes

4. Associated Knowledge Areas

KA Code	Knowledge Area
136	Conservation of Biological Diversity
903	Communication, Education, and Information Delivery

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

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation of the Natural Systems, Biodiversity, and Wildlife Ecology planned program for FY13 (5.2 Research FTEs, 3.1 Extension FTEs) shows ongoing high quality efforts by research and extension scientists and educators to address the ecological and natural resources problems facing Delaware and of relevance to many other states and countries. Significant advances have been made in our understanding of wildlife ecology and management, the role of migratory birds in the transmission of avian diseases, applications of radar technology to track migratory birds, and the use of biocontrol strategies to manage invasive plants and problem insects. Evaluations of research and extension productivity showed that 24 grants were awarded and that faculty in this program supported the efforts of 101 graduate students, post-docs, and undergraduate researchers, that they published 36 refereed journal articles and book chapters, made 193 invited and volunteered presentations at national and international meetings, and conducted 55 workshops. Our evaluations have included annual internal administrative reviews, periodic University level Academic Program Reviews, and - for extension - surveys

and other evaluations conducted with stakeholders participating in workshops and other extension programs. All evaluations and feedback from stakeholders have been positive in terms of the direction of research and extension programs, their relevance to Delaware, and their contributions to basic and applied science.

Key Items of Evaluation

There are no major items requiring NIFA attention at this time, other than the continued need for more federal funding for research and extension programs that seek to further expand our efforts to conduct research and outreach programs that meet the growing need to restore degraded ecosystems, protect biodiversity, and address the growing global problem of invasive species control.