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			5%	
112	Watershed Protection and Management			5%	
121	Management of Range Resources			5%	
125	Agroforestry			5%	
135	Aquatic and Terrestrial Wildlife			7%	
136	Conservation of Biological Diversity			10%	
201	Plant Genome, Genetics, and Genetic Mechanisms			5%	
212	Pathogens and Nematodes Affecting Plants			5%	
215	Biological Control of Pests Affecting Plants			8%	
302	Nutrient Utilization in Animals			5%	
303	Genetic Improvement of Animals			5%	
311	Animal Diseases			5%	
604	Marketing and Distribution Practices			5%	
605	Natural Resource and Environmental Economics			8%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			5%	
723	Hazards to Human Health and Safety			5%	
	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	15.0	0.0
Actual Paid Professional	0.0	0.0	105.5	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	795670	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	5781185	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	11431579	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The programs includes studies that focus on development of models of community-level responses to perturbations, population dynamics and habitat management for individual aquatic and terrestrial species, and development of methods for monitoring ecosystem changes.The experimental approaches that will be used to meet the specific objectives of these subprograms include field studies in the Oregon, the Pacific Northwest, the U.S., and abroad.In addition, the experimental approaches will also include controlled laboratory experiments and database/model development.

Theoretical and empirical models will be developed to examine land-use policies and impacts on water quality, wildlife habitat, watershed health, and other ecological indicators. Models will be used to examine how resource and agricultural policy affects major land use and cropping patterns, and how these may affect water quality.

In summary:

- conduct research experiments
- collect data
- conduct assessments
- develop monitoring protocols
- develop products, curriculum resources
- conduct workshops & meetings
- present seminars and professional talks
- provide training
- deliver services
- provide counseling
- partnering
- facilitating

2. Brief description of the target audience

- The general public and those in natural resource-based communities, including ranchers and fishermen
- The research community including scientists working in governmental, industrial, and academic sectors, including biomedical researchers, oceanographers, climatographers, virologists.

- Growers, crop consultants, extension faculty and researchers in the fruit and wheat industry; and ecologists, economists, and managers concerned with invasive species.Salmonid industry
-
- State and federal natural resources management and regulatory agencies, including land managers
- policy makers.

3. How was eXtension used?

eXtension was primarily used to disseminate small fruit (berries and wine grapes) information

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	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	4	68	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- 1. EFFECTS ON AND PROTECTION OF ENVIRONMENTAL HEALTH AND ECOLOGY 1a...natural history, e.g., fish life history variation, seasonal distributions of endangered great whales; 1b... insect biodiversity, conservation and dynamics; 1c...riparian systems and relationships; 1d ... soils factors, fluxes, respiration, landscape evolution, and microbial

Year	Actual
2012	0

Output #2

Output Measure

- 2. PROVIDE ADDITIONAL UNDERSTANDING FOR PLANT AND ANIMAL PROTECTION FROM DISEASES AND PESTS 1 - biology and control of diseases in plants, e.g., fire blight and blackberry rust, such as genetic mechanisms, disease spread, and effects of landscape variables; 2 - characterization and control of diseases in animals, including fish, mammals and invertebrates; control of invasive pests): 3 - determining appropriate variables and models

Year	Actual
2012	0

Output #3

Output Measure

- 3. STUDIES TO DECIPHER GENOMES, GENETICS AND MECHANISMS OF PLANTS AND ANIMALS 1 - determine life history strategies through emerging statistical and molecular genetic techniques, including those of marine and estuarine species, such as salmon, groundfish, and oysters; 2 - develop selective breeding programs, repositories, and resource center for various species; 3 - identify aspects of human biology and biotechnology of viruses and bacteria that affect human health

Year	Actual
2012	0

Output #4

Output Measure

- 4. PROVIDE TECHNICAL, ECONOMIC AND MARKETING MODELS AND ANALYSES THAT INFORM DECISION-MAKERS, INDUSTRY, AND PEERS 1 - develop models, market mechanisms, and policies for water resources, e.g., agricultural and non-agricultural uses, riparian zones; 2 - develop models to characterize and make predictions about habitat; 3 - develop models for stock assessment and management

Year	Actual
2012	0

Output #5

Output Measure

- 5. DEVELOP EDUCATIONAL STRATEGIES AND DISTANCE EDUCATION OUTLETS TO FURTHER REACH CLIENTELE. - adults and youth will have increased awareness and knowledge of ecosystem processes and functions and methods for restoring degraded habitats.

Year	Actual
2012	0

Output #6

Output Measure

- 6. OTHER SCHOLARLY EXCELLENCE: participation on professional society panels and boards, as well as science panels, and receipt of awards or recognition

Year	Actual
2012	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	1. New or better analytical tools, practices, and models for irrigation and water management, soil management, food production, natural resources management, and land-use decisions
2	2. Impacts of land use change on water quality, species and ecosystems
3	3. Best practices for climate change mitigation such as: a) chemical control, b) biological control, c) stock assessments, d) fishery management tools, e) nitrogen applications, f) water use efficiency, g) acres planted for carbon sequestration
4	4. Species, habitat and ecosystem responses to changes in environment as well as resource management strategies to mitigate
5	5. Genetic responses to climate and other environmental factors
6	6. Understand environmental and ecological factors affecting pathogenesis and spread of pathogens and pests
7	A2. Better decisions regarding water and use of production lands
8	A6. Improved technologies and practices used for control of pests and pathogens in crop and animal production
9	A3. New approaches for combating diseases provide improved health and safety
10	A4. Improved strategies are used to manage natural resources
11	Changes in environments for food systems, e.g., managing plant disease, stable marine food webs
12	Changes in societal views with regard to the value of habitats and conservation and how to manage them
13	Changes in ecosystems from carbon management strategies, soil microbial health, natural resource or ecosystem policies
14	A5. New genotypes developed and planted that show enhanced adaptive capacity to climate change
15	7. Researchers will show that international trade will be an important vehicle by which adaptations can be made to global climate change * key relationships that tie climate change to the distribution of crop yields, comparative advantage, geography, and international trade. * Numerical estimates regarding how climate change will affect crop prices, production costs, and the economic welfare of producers, consumers, and society at large
16	A1. - conservation strategies adopted, for example: o Conservation bio-control strategies are implemented differently and active restoration strategies occur. Land owners and managers assess ecosystem services provided by their riparian restorations via a user-friendly web tool. o Growers adopt improved, scale-dependent practices selected for various market

	niches with emphasis on reducing environmental degradation and impact. Commercial small farms will have more diverse and economically viable technologies and production techniques or systems available for their use o Growers implement drip irrigation and produce more marketable yields of onions, potatoes, and poplar trees than with furrow or sprinkler irrigation.and achieve efficient use of soil nitrate and the other available N sources under drip irrigation. o Generation of the viral vectors for grapevine disease control and functional genomics vectors have a potential for replacing current strategies of using chemical fungicides and bactericides with viral biocontrol strategies.
17	A7 - Climate change will be related to changes in comparative advantage in international crop production, and in turn the pattern and volume of trade.

Outcome #1

1. Outcome Measures

1. New or better analytical tools, practices, and models for irrigation and water management, soil management, food production, natural resources management, and land-use decisions

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Peat is used extensively nationwide and in the Oregon nursery industry as potting media to provide water holding. Peat mining, however, involves draining and destroying sensitive peat bog ecosystems, which store large volumes of carbon, in addition to requiring long shipping distances. The British government announced plans to gradually eliminate peat from all gardening products. Producing biochar, using waste biomass, can generate renewable bioenergy, sequester carbon, and produce value-added co-products with environmental benefits. This project works to produce high-value biochars from waste feedstocks for stormwater filtration and peat replacement in potting media, as well as help jump-start a biochar industry in the Pacific Northwest.

What has been done
Our robust, high-throughput biochar characterization protocol provides relevant char characteristics, including determination of ash, volatile matter, and fixed carbon by proximate analysis, surface area by BET-N2 analysis, pH and electrical conductivity, estimation of surface functional group composition by PAS-FTIR, water holding capacity by water uptake, and total pore volume by ethanol uptake and nitrogen pycnometry. This protocol has been used for six

chars produced from two feedstocks (Douglas-fir and hazelnut shell) made at three temperatures (370, 500, and 620 C) but is designed for use with any variety of char. We can rapidly compare different chars to allow an initial assessment of potential applications for different types of chars. We have also made significant progress towards developing a more comprehensive model of water uptake and retention in chars, with both total pore volume and surface hydrophobicity having been identified as important determinates.

Results
Due to the highly porous nature of wood and nutshell based biochars, we believe that we can produce peat-replacement biochars from locally-available waste biomass that meet or exceed the performance of peat to meet a growing market for peat-free potting media. Results from laboratory experiments indicate that high temperature Douglas-fir biochars hold nearly as much water as peat, and may be more complete potting media constituents due to their ability to hold air as well, which is also required in potting media. Further, storm water contamination is a serious problem facing water bodies across the country. There is increasing awareness of this challenge, especially in Oregon where efforts are underway to increase populations of iconic endangered and threatened species of wild salmon. Previous research has shown that biochars are effective at removing both heavy metals and volatile organic compounds (VOCs) from solution in laboratory batch experiments.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
125	Agroforestry
605	Natural Resource and Environmental Economics
723	Hazards to Human Health and Safety

Outcome #2

1. Outcome Measures

2. Impacts of land use change on water quality, species and ecosystems

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2012 2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Governments increasingly design programs to influence land and water use for social goals, e.g., reduce nonpoint solution, preserve open space, reduce sprawl, and provide compensation for loss of rights. Government becomes involved because open markets fail either partially or completely. The role of the economist is to understand the issue, identify reasons why normal market incentives do not achieve socially desirable outcomes, suggest ways in which policymakers can change these incentives to achieve more positive outcomes, and evaluate various policies to determine how individuals are likely to react. Economic issues underlie many of the political debates over land and water use in Oregon and the West.

What has been done
A project investigating the potential environmental impacts of increased reliance on corn-based bioenergy integrated economic and biophysical models to assess how increases in agricultural commodity prices, driven by ethanol production and other factors, affect land use and cropping systems in the U.S. Midwest. Researchers also studied how the changes in land use and cropping systems affect environmental quality in the region. An article summarizing the main results from this study has been published in Environmental and Resource Economics. Another aspect of this project evaluated the effects of the Conservation Reserve Program (CRP) on land prices. Researchers built a theoretical model to analyze the interaction between farmers CRP participation decisions and land prices.

Results
The results provide information for policy makers and land use planners to develop better regulations to address economic and environmental issues associated with agricultural production and land use. For example, results suggest that CRP had the most impact in the Mountain, Southern Plains, and Northern Plains regions, where it increased average farmland prices by 5%-14%, 4%-6%, and 2%-5%, respectively. CRP also had a statistically significant effect on developed land prices, but the percent increases were smaller.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics

Outcome #3

1. Outcome Measures

3. Best practices for climate change mitigation such as: a) chemical control, b) biological control, c) stock assessments, d) fishery management tools, e) nitrogen applications, f) water use efficiency, g) acres planted for carbon sequestration

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
We are addressing issues associated with the role of microbes in maintaining the health of the Earth and its inhabitants, and in sustaining agricultural productivity.

What has been done
The Giovannoni laboratory has established pure cultures and determined the genomic DNA sequence for several open ocean bacteria. These cultures and the information from the genome sequences are allowing widespread research on these bacteria to proceed in laboratories around the world, which are attempting to determine a more accurate understanding of the biological activities in the oceans.
The Kent laboratory, though collaboration with the Zebrafish International Resource Center, has contributed to knowledge and procedures that ensure researchers worldwide are able to conduct research with disease-free zebrafish.

Results
Our studies on the microbes in the oceans and freshwater systems and on the pathogens present and their effects on natural fish populations provide information valuable to predicting and documenting the effects of climate change. Understanding the contributions to carbon and other nutrient cycles of until recently uncultivatable bacteria in the oceans, is important in documenting and hopefully responding to climate change. These studies have, for instance, indicated that metabolism of low molecular weight volatile organic molecules that is not part of the usual carbon cycle considerations, can be considerable and should be considered in carbon cycle calculations for modeling climate change. In freshwater systems, our studies on genetic identification of potentially toxic cyanobacteria are allowing assessment of their occurrence and toxicity in the Pacific Northwest as blooms, potentially driven by climate change, are increasing. Our studies on parasite and other pathogens of wild salmonid fish in the Pacific Northwest are contributing to an

understanding of how climate change is likely to affect disease loads and mortality.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
311	Animal Diseases
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #4

1. Outcome Measures

4. Species, habitat and ecosystem responses to changes in environment as well as resource management strategies to mitigate

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Natural resource management is challenged by a changing climate and higher demand for extraction. Management understanding of what particular species require is limited in part to the extensive time and resources needed to gather sufficient information. Fish populations are managed at large spatial scales. Genetic tools provide valuable information about connectivity among discrete groups in large ecosystems over evolutionary time scales. However, society and natural changes can affect populations over much shorter time scales. Thus, different tools are needed to provide the information relevant to establishing management strategies and practices across much shorter time frames.

What has been done
Ocean conditions during early marine residence influence the survival of Pacific salmon, but the mechanisms regulating survival remain poorly understood, as is the relative and potentially interactive effects of freshwater and marine residence on overall survival. Field studies, genetic stock identification, and analytical chemistry generated novel information on important stocks of Chinook salmon in Central Valley, California and in the Columbia River. We quantified the relative contribution to the adult population of juveniles with distinct migratory behaviors. We found that size at and timing of marine entry were not important although very early marine growth was critical to overall survival; growth during initial marine residence is critical for spring Chinook salmon survival. Ocean conditions may mediate the negative effects of poor freshwater rearing in some years, and should not be ignored.

Results
The Central Valley research led to an improved understanding of how juveniles interact with the freshwater and delta systems and demonstrated the small, yet consistent, contribution of naturally-produced individuals in this species of concern under the Endangered Species Act (ESA). We demonstrated that management actions, which are focused on survival of the hatchery-produced populations, may be inadequate for the maintenance of the diversity of naturally-occurring migratory behaviors. The Columbia River research also focused on populations that are listed under the ESA; a synthesis document on the Columbia River salmon research was prepared in 2012 and is currently being used to evaluate the future intersection between ocean science and salmon management on the Columbia River. Ocean conditions may mediate the negative effects of poor freshwater rearing in some years, and should not be ignored. Overall, this type of research allows decisions to be based on empirical evidence that will contribute to the management of salmon populations and hydropower systems as well as habitat restoration efforts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
302	Nutrient Utilization in Animals
311	Animal Diseases

Outcome #5

1. Outcome Measures

5. Genetic responses to climate and other environmental factors

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The goal of the research was to develop biological and other novel control approaches for fire blight disease of pear and apple, thereby enhancing the sustainability of pear and apple fruit production in the Pacific Northwest. Fire blight is caused by a bacterial pathogen, and is responsible for millions of dollars of lost fruit production each year. Severe fire blight epidemics can destroy entire orchards; restoration of tree health after even a modest infection event is expensive and time-consuming. Moreover, because this disease is exacerbated by high temperatures, there is potential that outbreaks become more frequent and/or severe in the future as the climate warms.

What has been done
Early detection of the fire blight pathogen in flowers by loop-mediated isothermal DNA amplification (LAMP) was used in commercial orchards to evaluate the effects of orchard sanitation on the increase of pathogen populations over time. This technology is now being adapted to a point-of-care diagnosis protocol with the goal of providing a tool for individual producers to assess their risk of disease development. Studies concerned with systemic acquired resistance in pear and apples trees were conducted to determine if induction of host defense genes can contribute significantly to protection from and clean-up of fire blight infections.

Results
The molecular detection technology, LAMP, has continued to show value in fire blight management, and has motivated new research to streamline this assay for use as a risk assessment tool by advisors and growers. Detection of the fire blight pathogen by LAMP demonstrated that orchard sanitation practices for fire blight delays the increase of the pathogen population in flowers, and also demonstrated that a greater emphasis needs to be placed on host protection from fire blight during the later stages of the bloom period.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms

212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #6

1. Outcome Measures

6. Understand environmental and ecological factors affecting pathogenesis and spread of pathogens and pests

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Appropriate host variables (abundance, heterogeneity, or spatial structure) need to be included in models to make good predictions about disease risks, and to determine the relative importance of each to disease spread. Determining whether focus size influences spatiotemporal spread of disease has important implications for modeling epidemics over large areas and may indicate that some existing models need to be reevaluated. This will be important to developing general theories for large-scale epidemics. If disease spread and effects of landscape variables are similar at different spatial scales, then epidemic modeling at large scales can be developed largely based on smaller-scale experiments with occasional validation experiments at larger scales to confirm hypothesis consistently holds true.

What has been done
Field experiments with wheat strip rust were conducted to test variables and models. In these experiments, epidemic spread was strongly suppressed by host heterogeneity, increased by increasing 'grain' of host spatial structure, and unaffected by host abundance. For all degrees of host heterogeneity, wheat stripe rust spread farther as initial focus size increased. Wheat stripe rust epidemics can very consistently be scaled by the size of the initial disease focus. Lack of an effect of host abundance was a highly unexpected result and is most likely because rates of local deposition of inoculums are substantially higher than had been expected in the past. High local infection rates also explain why certain very simple models of disease spread can describe field data fairly accurately.

Results

The host spatial pattern model (relationship between host patch size and initial disease focus) so far suggests that the ratio of patch size to focus size is the important variable to study. The accelerating epidemic velocity model predicts that location of the epidemic front will approximately double per unit time used to measure initial velocity. This model provided a good fit to experimental data. We were able to scale-up by six orders of magnitude to describe the continental-scale spread of epidemics of a diversity of diseases: potato late blight, wheat stem rust, southern corn leaf blight, West Nile virus, and avian bird flu strain H5N1. Our model provided a good fit to all of these data sets. Our model seems to work well whenever the pathogen's dispersal kernel is dominated by simple dilution and there is potential for significant long-distance dispersal. The model predicts very different outcomes than the classic traveling wave model, which has been the primary model for describing epidemic spread in the past. Our results all point strongly to pathogen reproduction in the initial outbreak focus as the major determinant of subsequent epidemic spread.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #7

1. Outcome Measures

A2. Better decisions regarding water and use of production lands

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Government is increasingly involved in designing programs to influence land and water use as a means of achieving some desired social and environmental goals, including reducing nonpoint solution, increasing instream flows, preserving open space, reducing sprawl and accompanying traffic problems, and providing compensation for loss of rights to land and water use. Such involvement is required when open markets fail either partially or completely. Economic issues underlie many of the political debates over land and water use in Oregon and the West; the role of the economist is to understand the issue, identify reasons why normal market incentives do not achieve socially desirable outcomes, suggest ways in which policymakers can change these incentives to achieve more positive outcomes, and evaluate various policies to determine how individuals are likely to react.

What has been done
Research addressed methods to assess economic and environmental impacts of agricultural technologies, and application of those methods to technology adoption, greenhouse gas mitigation, ecosystem services supply, and climate impact assessment. Outputs included software and related training materials made available on a project web site (Antle and Valdivia 2011), with more than 300 researchers globally downloading the software (see the map at tradeoffs.oregonstate.edu); publications, conference presentations, and web-based documents and publications. Research received two national awards for quality.

Results
The impact assessment methods and software developed in this research are being used by hundreds of researchers and research institutions internationally, thus facilitating improved capability to assess impacts of technology adoption, greenhouse gas mitigation, climate impacts, and ecosystem services supply by agriculture. More than 50 researchers from the U.S. and international institutions were trained in the use of the methods and software through in-person workshops; more than 200 others used self-guided training materials provided online. Research publications have contributed to the growing literature showing the economic feasibility of greenhouse gas mitigation in agriculture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
125	Agroforestry
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics

Outcome #8

1. Outcome Measures

A6. Improved technologies and practices used for control of pests and pathogens in crop and animal production

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Invasive species imperil the production of food and fiber, and they undermine biodiversity and ecosystem services. Our research provides a scientific foundation for biological control, the use of natural enemies (herbivores, predators, parasites, pathogens) for the control of pest insects and weeds.

What has been done
A moth that scientists released into the wild in Oregon to control a poisonous invasive weed has unexpectedly evolved to survive the cooler climate. The cinnabar moth was introduced into Oregon in 1960 for biological control of tansy of ragwort. The insect was originally used only at lower elevations to control the weed, which is toxic to horses and cattle. The moths quickly evolved to thrive in the cooler, higher elevations and shortened growing season. Its life cycle altered so that now the insect develops from egg to the overwintering pupa more quickly than its cousins in the warmer Willamette Valley.

Results
Collectively these results show that there is a role for evolutionary biology in biological control procedures including climate matching and host specificity testing. Our results show that biological control organisms are capable of rapid evolution following colonization of new environments, making the evaluation of evolutionary potential a necessary component of risk-benefit-cost analysis of candidate biological control organisms prior to release. It would be desirable and feasible to screen for genetic variation among families and populations when evaluating traits prior to releasing new organisms into the environment. More generally our research shows how an ongoing ecological process like invasions is shaped by evolution. The effect of ecological change on evolution has long been a focus of scientific research. This area of research has spawned the new field of eco-evolutionary dynamics, which investigates the reciprocal feedback between evolution and ecology.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants

Outcome #9

1. Outcome Measures

A3. New approaches for combating diseases provide improved health and safety

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is increasing concern over the environmental impact of agricultural chemical use, and nationwide there are many vineyard businesses managing their vineyards through sustainable practices and joining certification programs.

What has been done
Research conducted from 2008-2011 in commercial Oregon vineyards evaluated the timing and intensity of cluster-zone leaf removal to reduce 2 main diseases in grapevines: powdery mildew and Botrytis bunch rot. Leaves were removed in the cluster zone, much more than is typically done by growers. Leaf removal early in the season, before bloom or at bloom, resulted in less disease at harvest. In addition to having less incidence and severity of diseased fruit, the berries had higher color and quality compounds that are important to wine quality. The treatments were innovative as growers had previously only removed half as many leaves in the cluster zone during later stages of berry development.

Results

Disease reduction in commercial vineyards, where they apply well-designed fungicide spray programs, suggest that leaf removal is an important method to be used in combination of a typical spray program. Vineyard managers and winemakers report significant savings due to reduced disease found in fruit and reduced fungicide applications, providing an estimated savings of $92-$184 per acre annually; leaf removal earlier in the season was less time consuming, providing a 15-20% savings in labor. More savings can be realized if crop is not lost due to powdery mildew or Botrytis infections. One organic production vineyard and winery indicated that wines had less microbial problems, increased stability and greater color than those wines produced from fruit with later leaf removal. New leaf removal practices were implemented widely across the Willamette Valley of Oregon during 2010 and 2011, resulting in an estimated $1015 per acre net profit for the growers. Since approximately 50% of the state industry conducts this practice, industry gained an estimated $10.2 million in annual profits.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #10

1. Outcome Measures

A4. Improved strategies are used to manage natural resources

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Greater than 50% of wetlands in the coterminous United States have been lost to human related activities. While Oregon losses are below the national average (ca. 35%), specific wetland

ecosystems have been lost at a far greater rate, including 99% of the wet prairie habitat in the Willamette Valley. Wetlands persist on once prairie habitat that has been converted to agricultural lands, but their biological value is largely unknown. One effort to restore native wetland habitats is the federally funded Wetland Reserve Program (WRP), which works by providing funding to private landowners for preservation restoration activities, but few studies have assessed the biological structure and function of wetlands created via the WRP.

What has been done
A diverse collaboration of researchers assessed the impacts of farming conversion practices on intermittent streams and isolated wetlands located in the Calapooia Watershed in the southern Willamette Valley. Other efforts looked at the biological value of wetlands created by the WRP to migratory waterfowl and how migratory waterfowl contribute to wetland plant community structure, restoration, and management by serving as dispersal mechanisms for the seeds of wetlands plants.

Results
Remnant wetlands on agricultural lands do provide habitat for many aquatic invertebrates, contributing to regional biodiversity and providing food resources. The agricultural operations can influence invertebrate diversity, but not abundance; while agricultural wetlands may not contribute to regional invertebrate biodiversity they are important as producers of food. Plant community structure and food production in WRP lands were similar to reference wetlands and therefore have comparable value to wintering waterfowl. Wetland quality is strongly influenced by management. Thus, if food production for migratory waterbirds is an important objective, active management should be a goal. The plant community in unmanaged wetlands was dominated by perennial invasives, most notably Reed Canary Grass, and active management is required if minimizing invasive species is an objective for wetlands created using the WRP. Our findings were used by Pacific Coast Habitat Joint Venture to revise their bioenergetic models to estimate habitat carrying capacity for migratory waterfowl. We also have communicated the results of our project to the National Resource Conservation Service so they may consider our results when designing future WRP projects. Our work also show that migratory waterfowl are very capable of dispersing wetland plant seeds, but variation in survivorship among plant species indicates that not all plants are equally adapted to using waterfowl as dispersal vectors. This has important implications for understanding plant species colonization associated with wetland restoration and understanding how wetland plants may respond to large scale disturbances like climate change.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #11

1. Outcome Measures

Changes in environments for food systems, e.g., managing plant disease, stable marine food webs

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many efforts to conserve and restore populations of vertebrates are motivated by responses of animals to habitat alteration. Fire, for example, has a strong effect on succession in sagebrush communities, where factors such as fire size, severity, and time since the fire influence how bird and mammal populations fare in burned landscapes. Globally, habitat loss and fragmentation drive strong reductions of biodiversity. Responses of vertebrates vary depending on how well they move between forest fragments and how well they cope with altered dynamics within fragments. The goal of our work is to understand how agricultural practices and climate change influence animal populations and communities through their effect on habitat.

What has been done
Birds respond quickly to vegetation changes associated with fires; grassland-preferring species appear soon but disappear within 10 years as shrubs return to the landscape. Reproductive success is not consistently associated with successional changes but correlates with abundance of nest predators. Small mammals were most numerous in the first few years after a fire. Livestock grazing research improved our knowledge of how to manage Northwest Bunchgrass rangelands for multiple ecosystem services. Our research on the effects of climate change and agricultural intensification on ecosystem services associated with streams and riparian areas is on-going, but preliminary results suggest that stream drying and buffer reduction may have large effects on some ecosystem services.

Results
Management plans use our work as a reference for expected responses of small vertebrates to wildfires. Our grazing study is useful to livestock producers and resource managers in developing sustainable grazing practices that minimize negative ecological effects and maximize economic return to the grower; low to moderate stocking rates do not appear to have large negative impacts on birds or the invertebrate prey they depend on, while high stocking rates do. Our fragmentation

studies in Panama have set the stage for parallel collaborative projects across tropical forests of the world to evaluate fragmentation effects in all types of tropical forests. A Tropical Forests in a Changing World NSF Research Coordination Network brought ornithologists together to evaluate ways forward using parallel efforts in Latin America, Africa, Southeast Asia, and tropical Australia.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
125	Agroforestry
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
302	Nutrient Utilization in Animals

Outcome #12

1. Outcome Measures

Changes in societal views with regard to the value of habitats and conservation and how to manage them

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Previously, there was little historical information on aquatic ecosystems of the mainstem Willamette River, nor was the information framework for fish community information integrated in a readily accessible database with a spatial explicit information system. Information on aquatic communities provides essential metrics of ecosystem services and ecosystem health.

What has been done
We built on past efforts to restore the ecological health of the Willamette River, its floodplain, and its native fish communities by developing the SLICES framework, an approach for field sampling and measurements of fish communities and habitat quality and an information system for tracking

and integrating monitoring data within a publicly available website. We have also collaborated with colleagues in Japan, France, Italy, Germany, and England to develop better approaches for managing large rivers throughout the world.

Results
Our program has contributed to the ecological priorities guiding river management, which have been derived from a set of science-based plans designed to recover endangered salmon, mitigate the impacts of flood management structures, restore natural function to the Willamette and its tributaries, and meet state and federal water quality standards. Our aquatic research extended the technical basis for conservation and restoration opportunities in the Willamette River and enhanced the information framework for the Willamette Basin. The Oregon Habitat Technical Team and Special Investment Partnership use our information to conduct proposal reviews. NGOs, land owners, and agencies along the Willamette River use our information on aquatic communities and habitats to develop new practices and conservation projects. We participate in the collective efforts of the state of Oregon, Meyer Memorial Trust, other land trusts, and the public to make the Willamette Valley more livable and ecologically healthy. In 2012, this collective effort received the Thiess International Riverprize, a prestigious recognition of river conservation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
302	Nutrient Utilization in Animals
311	Animal Diseases
605	Natural Resource and Environmental Economics

Outcome #13

1. Outcome Measures

Changes in ecosystems from carbon management strategies, soil microbial health, natural resource or ecosystem policies

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Since 2006, some Pacific salmon stocks have decreased to only a fraction of their normal population, resulting in large area closures, significant harvest reductions, and declarations of ?Salmon Disasters? by the West Coast Governors and NOAA. Economic impacts have totaled more than $300 million to businesses and communities that depend on healthy salmon runs.

What has been done
CROOS (Collaborative Research on Oregon Ocean Salmon) was formed to find solutions to the West Coast salmon disaster. It improves management of weak stocks by using real time genetic information to identify stock structure and migration patterns. Combined with oceanographic data, the information directed fishermen to areas of healthier stocks, and reduced costly coast wide fishery closures. CROOS has worked with more than 150 salmon fishermen and piloted new concepts in science, technology, and data sharing, enabling salmon harvest and data collection. Information support systems include electronic data loggers, data storage and distribution systems, bar coded tags, kiosks, and interactive websites to improve marketing and management (www.PacificFishTrax.com) (www.FishTrax.com)

Results
This project has helped in supporting global food security by improving utilization of salmon stocks as well as conservation. The project has helped to retain more than 300 fishing and fishing related jobs and more than a $2 million in exvessel revenue. Workshops have helped train over two hundred fishermen in research protocols and project findings. Almost 10,000 fish have been marketed using project bar codes that assist the marketplace in tracking product and the location and timing of the harvest. More than $15,000 of product has been sold through test pilot electronic kiosks in Portland area retail stores that link consumers directly with product information. Project CROOS and PacificFishTrax and FishTrax have become brand names to support science and seafood marketing consistent with creating a broader community interested in local sustainable fisheries. A real time fishery information system has been completed that will fundamentally change management approaches for developing, transmitting, storing, and sharing fishery information.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
311	Animal Diseases
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

Outcome #14

1. Outcome Measures

A5. New genotypes developed and planted that show enhanced adaptive capacity to climate change

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over the past 5 years, Oregon produced an estimated 10 million tons of wheat and barley with an estimated farm gate value of 2 billion dollars. The total economic impact on Oregon and the region is orders of magnitude greater. Continued progress in variety development and fundamental science is essential. New varieties must be efficient in input use (e.g. nitrogen and water) and resistant to a range of biotic stresses (e.g. diseases) and abiotic stresses (e.g. moisture and low temperature). Progress in variety development requires progress in fundamental research on the genetic basis of target traits. Grain quantity alone is not sufficient, continued progress is essential in terms of grain quality.

What has been done
The project team reached thousands of stakeholders and results are distributed via web, email, newsletters, print media, and various extension outlets as well as delivered to clientele through field days, grower meetings, crop tours and hands-on events. Stakeholders have heightened awareness of the nutritional importance of whole grain diets, and of the importance of barley, achieved by hands-on exercises with practitioners in venues ranging from the Kneading Conference West to the Wheat Marketing Center. In the past five years, the PIs have released 12 varieties and germplasms, and over 4 million dollars in external funding were secured by the investigators.

Results
Notable advances in our understanding are of the genetics of low temperature tolerance, durable resistance to a range of diseases, and cereal quality. The impact of Oregon wheat and barley varieties has led to significant changes in varieties planted, marketed, and used. Oregon wheat varieties were planted on 80% of the winter wheat acres in Oregon in the past five years with varieties such as ORCF 101 and ORCF 102 becoming the top varieties grown in 2011 in Oregon and Washington, respectively. Tthe overall quality of Oregon soft white wheat has been improved

through the release of superior quality varieties (e.g. Skiles, Ladd, and Kaseberg). The barley varieties Full Pint (2010), Verdant (2011), Alba (2012), and Streaker (2013) represent, respectively, new opportunities for growers to produce malt free of epiheterodendrin, high quality forage with less water input, higher yields of feed without fungicide, barley without hulls suitable for direct human consumption.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
723	Hazards to Human Health and Safety

Outcome #15

1. Outcome Measures

7. Researchers will show that international trade will be an important vehicle by which adaptations can be made to global climate change * key relationships that tie climate change to the distribution of crop yields, comparative advantage, geography, and international trade. * Numerical estimates regarding how climate change will affect crop prices, production costs, and the economic welfare of producers, consumers, and society at large

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Extreme weather results in high year-to-year variability in yields, which may become more pronounced under future climate change. International trade may be a vehicle by which to alleviate this problem, for while one region has a crop failure, it is likely that another place or region is having a bumper crop. However, genuine trade liberalization has not occurred for agriculture; market-insulating tariff and non-tariff barriers remain high. For many countries the agricultural sector remains the most protected sector of the economy. We need an economic simulation model that accounts for the trade barriers that separate nations, and which can be

used to predict what happens to trade between pairs of specific countries in agricultural products when there are shocks to yield.

What has been done
The relationship between international trade and natural resources was formalized mathematically in an economic model that ties together resource endowments (land), agricultural productivity, geography, and other key determinants of trade. Once the model parameters were calibrated, one or more exgenous parameters (concerning climate, yield, technology, or trade barriers) can be shocked, such that prices, quantities, and trade flows could be compared to the baseline. A number of different such simulations were run for different assumptions about changes in yield variability, trade liberalization.

Results
The strength of the model is its ability to predict, when there is a shock to the system, how trade between pairs of specific countries changes for products that use land intensively. Commodities are characterized as homogenous, such that patterns of trade are driven largely by which country can be the low-cost supplier to a given destination. The cheapest supplier for a given country is influenced by the border policies of the importer on products from a source country, transport costs from that country, and by the supplier?s cost of production. This work has been extended to agricultural trade in terms of how it relates to water, with new data compiled on water availability and use by different drops in different countries. The focus is on understanding how future changes in climate, as well as natural existing variability, influence how crop decisions are made, how patterns of commodity trade will adjust in response, and how producers and consumers will be affected. We contribute to improved knowledge of the mechanisms at the international level by which crop agriculture must adapt to new climate possibilities. Openness to international trade offers possible adjustment to climate change variability.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

<u>Outcome #16</u>

1. Outcome Measures

A1. - conservation strategies adopted, for example: o Conservation bio-control strategies are implemented differently and active restoration strategies occur. Land owners and managers assess ecosystem services provided by their riparian restorations via a user-friendly web tool. o Growers adopt improved, scale-dependent practices selected for various market niches with emphasis on reducing environmental degradation and impact. Commercial small farms will have more diverse and economically viable technologies and production techniques or systems available for their use o Growers implement drip irrigation and produce more marketable yields of onions, potatoes, and poplar trees than with furrow or sprinkler irrigation.and achieve efficient use of soil nitrate and the other available N sources under drip irrigation. o Generation of the viral vectors for grapevine disease control and functional genomics vectors have a potential for replacing current strategies of using chemical fungicides and bactericides with viral biocontrol strategies.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	40

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In agricultural lands, activities such as channeling, ditch digging, and diking, aim to eliminate or reduce natural stream flow variation and channel activity (i.e., channel migration, seasonal floods, etc.). These types of projects disconnect fluvial systems from their floodplains. Consequently, seasonally wet habitats, secondary channels, beaver ponds, sloughs, small tributaries and riverine ponds are eliminated with ensuing reduction in ecosystem productivity, filtering capacity, biodiversity, and critical habitat for fish and wildlife. These ecosystem alterations reduce the watershed capacity to buffer some of the effects of land uses on water quality and aquatic habitats.

What has been done
We conducted field based studies in eastern Oregon streams to understand how temperature and food availability affected growth rate and energy stores in fish and to examine intermittent and perennial streams and their associated riparian areas. We sampled aquatic species richness and abundance under different agricultural practices and estimated several ecological functions associated with each stream/riparian type, including aquatic macroinvertebrate production, stream quality, and invertebrate-mediated pest control and pollination. We are also modeling threatened Umatilla River steelhead responses to climate change and agricultural intensification, and working on valuation of these ecosystem services.

Results
We showed that some different farm conservation practices (originally for water quality protection) benefit fish and other aquatic organisms and no-till after harvest practice adopted by many farmers in our study area increased both the abundance of aquatic invertebrates and the numbers and diversity of fish. Over 40 Willamette Valley grass seed farmers now use these conservation practices. Those farms represent some 120,000 acres (the average grass seed producing farm in the valley is 3,000 acres). Approximately 300 grass seed producers in the Valley are aware of the fish and amphibian fauna that occupies agricultural drainage ditches and seasonal streams during the late-fall to spring period. USDA and NRCS staff confirmed that a high percentage of the growers are now willing to leave grass and other vegetation growing on waterway substrates to increase fish habitat complexity. Preliminary results from our ongoing research on climate change and agricultural intensification suggest that stream drying and buffer reduction may have large effects on some ecosystem services (e.g., stream quality, salmonid habitat quality, pollination services), but not on others (e.g., macroinvertebrate production).

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
302	Nutrient Utilization in Animals

Outcome #17

1. Outcome Measures

A7 - Climate change will be related to changes in comparative advantage in international crop production, and in turn the pattern and volume of trade.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
We sought to analyze factors contributing to changing global trade patterns in agriculture and processed food industries, with emphasis on technological change and trade costs. Our current research is focused on measuring the impact of changes in trade costs, which refer to all factors limiting the movement of goods and services across countries (e.g. transportation costs, tariffs) on domestic production and exports, and employment in food industries.

What has been done
Having completed the measurement of trade costs by U.S. regions in agricultural and processed food industries, we proceeded to examine their impacts on business dynamics, i.e., has the falling trade cost created more opportunities for U.S. businesses? Also, how did continuing businesses alter production and employment when faced with declining trade costs? Empirical analysis showed that falling trade costs increases exit of domestic firms, presumably the low-productivity ones. However, net job creation of continuing firms in these industries remains unaffected by declining trade costs. Moreover, substantial regional variation is observed in the impact of falling trade costs on business dynamics.

Results

This research has contributed to improved understanding of factors limiting U.S. trade in agriculture and food at a regional level. For instance, bilateral trade costs between U.S. - China has significantly declined during the past decade especially for the west coast states relative to those on the east coast of the United States. Similarly, the Great Lakes region faces relatively lower bilateral trade costs with Canada, while Texas or Arizona have lower trade costs with Mexico. Such variations in trade costs among regions bring about interesting patterns of business dynamics: firm entry, exit and net job creation. Thus, regional economic development depends on alleviating high trade costs faced by several U.S. regions in accessing global markets.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)
- Other (climatic or environmental condit)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Formative evaluations are still underway but we expect to see greater adoption of practices related to agricultural lands as important habitats for management

Key Items of Evaluation