

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Climate Change, Environmental Quality and Stewardship

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			15%	
102	Soil, Plant, Water, Nutrient Relationships			10%	
112	Watershed Protection and Management			15%	
132	Weather and Climate			10%	
133	Pollution Prevention and Mitigation			15%	
135	Aquatic and Terrestrial Wildlife			25%	
605	Natural Resource and Environmental Economics			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	8.0	0.0
Actual Paid	0.0	0.0	8.2	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	423845	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1116157	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	969429	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research to assist in the preservation of West Virginia's soil, water, forest and wildlife resources is a high priority in the West Virginia Experiment Station particularly given the extra stresses and uncertainty imposed by a changing climate. The focus of Station research is on studying, protecting and restoring environmental quality while developing economically effective and environmentally sustainable management practices for agriculture, forestry, mining and rural communities and anticipating and adapting to climate change. Our primary environmental research areas involve mine land restoration, soil science, ecosystem resiliency to climate change and other environmental stressors, water quality, wetlands, and aquatic and terrestrial wildlife ecology.

Contamination of soil and water with acid mine drainage from abandoned surface and underground coal mines and natural gas fields and restoration of the landscape from surface mining are important issues in West Virginia. Disturbed soils, such as those resulting from agriculture, erosion, deforestation, road building, urbanization, and surface mining require specialized treatments to make them suitable for subsequent use and management. Research is being conducted to characterize the nature and scope of these problems and to develop cost effective remediation programs. Work is being conducted to evaluate properties of soil materials placed on the surface and determine their suitability for a variety of land uses such as agriculture, forestry, building site potential, recreation, and energy production. Relevant research projects include restoring surface mines to productive forestland or grassland (including switchgrass as a possible feedstock for biofuels), use of different types of soil amendments such as biochar and poultry litter on damaged soils to restore productivity, and restoring lost aquatic ecosystem functions on reclaimed mine sites and watersheds. Progress continues in assessing the ecological functions of restored and created wetlands.

Once introduced into soils and waters, metals and metalloids are difficult to remove. Lead and zinc are common soil contaminants. They are often found together in soils, but have very different biogeochemical properties. Zinc is a plant and animal essential element that can be toxic at elevated concentrations; lead has no known function in plants or animals, and causes adverse effects in animals, even at very low concentrations. Selenium is an essential element for animals but tends to bio-accumulate in aquatic organisms. The ecosystem services provided by reclaimed mine soils, including surface water quality is directly related to the quantity and stability of the soil organic matter. One project examined the impacts of augmenting damaged soils with different forms of biochar. In particular, the researchers compared the impacts of poultry litter biochar with poultry litter as a soil amendment. Poultry litter biochar was more effective at removing potential metals of concern from a contaminated soil than was poultry litter applied at the same rate.

Quantifying the effects of natural resource management on hydrology and water quality has remained a

central research interest during the past several decades. Land-change science has received scientific attention due to the potential consequences of land-use/land-cover changes on hydrological, ecological, and socioeconomic systems worldwide. Specifically, changes in land-use and land-cover from natural resources management can lead to major changes in hydrology, water quality, and biogeochemical cycling. In the Central Appalachian Mountains region of the United States, forest harvesting, surface mining, and reclamation were dominant drivers of land-use/land-cover change in the latter quarter of the twentieth century. The relationship between forest harvesting and peak flow, storm flow, and water yield is well documented throughout the Appalachian region and elsewhere. Less understood are the effects of wide-scale disturbances on landscapes and ecosystem processes such as nutrient, sediment, and biogeochemical cycling, stream flow generation, catchment mean residence time (MRT), and the relationship between catchment attributes and hydrologic responses. As the demand for natural resources is expected to increase, there remains a critical need to quantify process-level hydrologic changes following disturbances. Process-level understanding across scales is required to more appropriately manage West Virginia's natural resources in order to meet growing energy and materials needs and maintain healthy aquatic and terrestrial ecosystems.

One study is seeking to develop statistical and modeling methods capable of detecting and discerning changes in hydrologic and water quality records following historical, present-day, and future disturbances. It will be able to evaluate changes and response thresholds in runoff generation mechanisms and biogeochemical cycling that potentially have deleterious consequences to downstream communities. So far this project has established the first multi-scale hydrology study on the impacts of mountaintop removal mining on water quantity; developed change detection models to assess the impacts of contemporary forest harvesting practices on water quantity and quality; and initiated the first longitudinal study to assess the impacts of unconventional gas development on shallow groundwater used by the US Forest Service in the Monongahela National Forest, WV. The results of this study, which are currently being disseminated, will lead to more informed policymaking regarding the rapidly expanding non-conventional petroleum and gas industries.

Identification of critical fish habitat is paramount in the protection and restoration of stream habitat and stream fish populations. Brook trout (*Salvelinus fontinalis*) are the only native salmonid to the Appalachian Mountains and their populations and distributions have declined through habitat degradation and in some areas such as the Smoky Mountains, through possible competition with exotic salmonids. For 15 years WVU researchers have been working with the WV Department of Natural Resources to restore a wild brook trout fishery to the upper Shavers Fork on Cheat Mountain in Randolph and Pocahontas Counties. At one time, this section of Shavers Fork was considered to be one of the best native trout fisheries in the Eastern U.S. In the early 20th century, logging and railroad construction degraded the fish habitat by warming the water due to the loss of the forest canopy and because of culverts that limited access of the fish to cooler water for spawning. Beginning in 2000, Davis College researchers began studying the problems with this fishery. The results of this research led to the Shavers Fork Stream Restoration Program that has included habitat enhancement along 4 miles of main stem channel and removal or replacement of railroad culverts. The ultimate goal of this WVDNR - WVU collaboration is to turn a marginal trout stream back into a high value wild recreational fishery promoting economic development for the region. The research will also inform future stream restoration decisions in the State. Fishery restoration on Shavers Fork has been a major factor in expanding an existing private tourist railroad based in Elkins. This 90-mile loop, which includes Cass Scenic Railroad, is expected to generate approximately \$500 million in recreation and tourism related economic development to the region over the next 30 years.

2. Brief description of the target audience

The activities in this area are used to contribute to the body of knowledge in the environmental and natural sciences, and to inform policy makers, planners, regulatory agencies and public interest and citizens groups.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	34	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Presentations on research at professional meetings

Year	Actual
2014	16

Output #2

Output Measure

- Popular press articles on research

Year	Actual
2014	6

Output #3

Output Measure

- Completed graduate degree programs

Year	Actual
2014	23

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Reduce the number of state streams classified as impaired by agricultural and forestry activities.
2	Number of State landowners adopting reclamation and watershed protection practices in consultation with Experiment Station Faculty.
3	Increase our understanding of the environmental impacts of mountaintop-removal coal mining and unconventional natural gas production

Outcome #1

1. Outcome Measures

Reduce the number of state streams classified as impaired by agricultural and forestry activities.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Identification of critical fish habitat is paramount in the protection and restoration of stream habitat and stream fish populations. Brook trout (*Salvelinus fontinalis*) are the only native salmonid to the Appalachian Mountains and their populations and distributions have declined through habitat degradation and in some areas such as the Smoky Mountains, through possible competition with exotic salmonids.

What has been done

For 15 years WVU researchers have been working with the WV Department of Natural Resources to restore a wild brook trout fishery to the upper Shavers Fork on Cheat Mountain in Randolph and Pocahontas Counties. At one time, this section of Shavers Fork was considered to be one of the best native trout fisheries in the Eastern U.S. In the early 20th century, logging and railroad construction degraded the fish habitat by warming the water due to the loss of the forest canopy and because of culverts that limited access of the fish to cooler water for spawning. Beginning in 2000, Davis College researchers began studying the problems with this fishery.

Results

The results of this research led to the Shavers Fork Stream Restoration Program that has included habitat enhancement along 4 miles of main stem channel and removal or replacement of railroad culverts. The ultimate goal of this WVDNR/WVU collaboration is to turn a marginal trout stream back into a high value wild recreational fishery promoting economic development for the region. The research will also inform future stream restoration decisions in the State. Fishery restoration on Shavers Fork has been a major factor in expanding an existing private tourist railroad based in Elkins. This 90-mile loop, which includes Cass Scenic Railroad, is expected to generate approximately \$500 million in recreation and tourism related economic development to the region over the next 30 years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
605	Natural Resource and Environmental Economics

Outcome #2

1. Outcome Measures

Number of State landowners adopting reclamation and watershed protection practices in consultation with Experiment Station Faculty.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Increase our understanding of the environmental impacts of mountaintop-removal coal mining and unconventional natural gas production

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Mountaintop mining is a widely used but controversial method of extracting coal in the Appalachian Region. The method is controversial because there is much disagreement as to the long-term environmental impacts of the practice.

What has been done

One study is seeking to develop statistical and modeling methods capable of detecting and discerning changes in hydrologic and water quality records following historical, present-day, and

future disturbances. It will be able to evaluate changes and response thresholds in runoff generation mechanisms and bio-geochemical cycling that potentially have deleterious consequences to downstream communities.

Results

So far this project has established the first multi-scale hydrology study on the impacts of mountaintop removal mining on water quantity; developed change detection models to assess the impacts of contemporary forest harvesting practices on water quantity and quality; and initiated the first longitudinal study to assess the impacts of unconventional gas development on shallow groundwater used by the US Forest Service in the Monongahela National Forest, WV. The results of this study, which are currently being disseminated, will lead to more informed policymaking regarding the rapidly expanding non-conventional petroleum and gas industries.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Experiment Station research program evaluation will take place at two levels and on two different time cycles. All programs will use these general criteria plus additional criteria tailored to each program as detailed in the Plan of Work under Outputs and State Defined Outputs and Outcomes.

Annual evaluation will continue as before, looking at productivity in terms of immediate impact:

- Referee journal articles and books
- Professional presentations
- General audience papers and news reports
- M.S. and PhD graduates
- Trends in terms of competitive funding

And in terms of longer-term impact:

- Citations in scientific journals
- Patents
- Successful technology transfer or start-ups based on research programs
- Awards based on continuing impact and research excellence

In addition, every five years we will have a full portfolio review of our research programs in terms of:

- Long term productivity
- Relevance to our constituent groups and the State and Region
- The allocation of research inputs among the programs
- Consideration of eliminating some research programs that are not productive or have diminished relevance given NIFA and State priorities
- Consideration of adding additional program areas given NIFA and State priorities

Our standard annual evaluation results are detailed in the state defined outputs and state defined outcomes sections of this report. This program area has received very positive support from our constituents. Our legislators, federal and state, are impressed by how closely we cooperate with state and federal agencies. At the state level we have strong applied research agreements with the Division of Natural Resources, the Department of Forestry, the State Agricultural Commissioner and the Department of Agriculture and the Department of Environmental Protection. At the federal level we cooperate with the Department of Energy, the Environmental Protection Agency, the Department of the Interior, the US Department of Agriculture and the Department of the Interior.

We house a U.S. Fish and Wildlife Service Cooperative Unit and every year we invite a review team to evaluate that program. We were told this year that we were considered to be one of the strongest Units in the Nation and that USFWS will consider locating personnel at our Unit and increasing the research funding to the Unit. We have already experienced a large increase in funding for our fisheries and wildlife research.

Key Items of Evaluation

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