KENTUCKY AGRICULTURAL EXPERIMENT STATION

University of **Kentucky**
College of Agriculture, Food and Environment

MCINTIRE-STENNIS PROJECTS

McIntire-Stennis, a USDA National Institute of Food and Agriculture administrated program, provides universities with capacity building funds to cultivate and deliver forestry and natural resource innovations for a better future. By advancing research and education that increases the understanding of emerging challenges and fosters the development of relevant solutions, the program has ensured healthy resilient forest and communities and an exceptional natural resources workforce since 1962.

This report provides a 2019 summary of the impacts of established and emerging McIntire-Stennis supported projects administered by the University of Kentucky, College of Agriculture, Food and Environment's Kentucky Agricultural Experiment Station.

McIntire-Stennis projects are 5 years in duration and are subjected to a review process to assure their scientific credibility and potential to generate knowledge useful in understanding and managing our forest systems and aligned resources. The individual McIntire-Stennis project reports compiled in this document encompass both established projects with significant accumulated impacts and descriptions and potential contributions of emerging projects.

IMPACTS OF UNIVERSITY OF KENTUCKY PROJECTS

INDIVIDUAL PROJECTS

Water Quality and Aquatic Biology

Two projects focus on the protection of our water resources and aquatic species encompassing improved harvesting and reclamation practices and the conservation of important aquatic species.

Forest Management, Ecology and Economics

Our upland oak forests are economic and ecologically important. The timber resources they provide directly contribute over $6 billion dollars to Kentucky's economy. They also occupy a significant portion of our landscape, are critical to wildlife populations and recreation, and provide significant eco-system services such as clean water to all Kentuckians. Two projects are designed to provide an understanding of the growth and development of our oak forests and provide management options to improve their vitality and value.

Wildlife and Conservation Biology of Key Species

Wildlife play an important role in the fabric of our society providing hunting, fishing, and recreational opportunities and the protection of threatened species, while ensuring continued use of our forests, is a critical challenge to Kentucky. Two wildlife focused projects are aimed at providing valuable insights to help us manage and conserve critical wildlife in Kentucky including elk an important game species for eastern Kentucky and imperiled bat species that have significant consequences for landowners and the forest, mining, and transportation industries in Kentucky.

Forest Health and Disturbance

Our forests are under constant threat from invasive insects and diseases and damage from storms and other disturbances such as wildfire. Two of our projects are aimed at developing cutting-edge technologies to both combat pests as well as track and assess the health and disturbance of our forests.

MCINTIRE-STENNIS
Research at the University of Kentucky

University of Kentucky
College of Agriculture, Food and Environment

McIntire-Stennis provides capacity funding used at the University of Kentucky to drive significant work by 11 researchers to address issues critical to the conservation and use of Kentucky's forests and natural resources. This research effort also results in the development of graduate students providing scientific expertise to industry, agencies, non-profits, and universities to address issues critical to our state's environmental and economic well-being.

ECONOMIC AND ENVIRONMENTAL IMPACTS

Long-term McIntire-Stennis projects at the University of Kentucky's College of Agriculture, Food and Environment have focused on forest, water, and wildlife issues important to Kentucky, resulting in significant environmental and economic contributions.

125 million trees
planted using improved practices to reforest surface mines and abandoned agriculture lands

3,319 streams
annually afforded protection through the use of scientifically developed timber harvesting best management practices

$5.3 billion
in annual economic contributions positively impacted by research used by forest industry and in wildlife management

About McIntire-Stennis

USDA

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251,200 acres
of privately owned forest land in Kentucky annually improved or positively impacted

13 million
acres of public land in 8 states including Kentucky using research-based management

TRAINING PROFESSIONALS AND VOLUNTEERS

McIntire-Stennis projects at the University of Kentucky, while yielding impactful science, also produce highly skilled post-baccalaureate professionals working in Kentucky and throughout the US, providing critically needed expertise to deal with mounting pressures to our forests and natural resources. The projects also provide undergraduates, high-schoolers, and resource professionals with exposure to scientific insight and significant opportunities for advancement. Projects have resulted in:

- 103 post-baccalaureate PhD and masters trained professionals
- 819 undergraduate students
- 20,000 volunteers engaged
- 4,100 forest and natural resource professionals trained in the use of practices that were developed using science generated from McIntire-Stennis projects at the University of Kentucky.

SUMMARY

Every dollar in McIntire-Stennis funding received by the University of Kentucky has been matched by 3 dollars in state, grant, and gift funding, resulting in a total research allocation of over $2 million annually.

As can be seen by these accomplishments the McIntire-Stennis program provides research capacity funding that has, and continues to be, fundamental to generating meaningful science and trained professionals. This combination allows us to tackle real world problems and improve the economic and environmental benefits from our forests and aligned natural resources.

BEST PRACTICES FOR MANAGING WATER RESOURCES IN APPALACHIA

A McIntire-Stennis supported project

University of Kentucky

Forestry and Natural Resources
College of Agriculture, Food and Environment

The extraction of coal, gas, and timber has been the primary economic driver for the Appalachian region for more than a century. Although these activities provide jobs and revenue, the on-going degradation of water quality and aquatic habitat as well as compromised water supplies from resource extraction have been clearly documented. The potential consequences from global climate change along with disturbances from resource extraction result in a high degree of uncertainty for the region's water resources. Management solutions developed to protect water resources from these issues has been a focus of major research in the University of Kentucky's Department of Forestry and Natural Resources.

McIntire-Stennis supported research aims not only to develop best management practices (BMPs) for protecting watersheds from resource extraction, but research has also developed and demonstrated practices for restoring watershed health in historically impacted systems. Research in this area has informed policy development, provided professional and traditional outdoor teaching laboratories, and contributed to the protection and restoration of thousands of acres of Appalachian forests and their water resources.

COLLABORATION

Researchers at the University of Kentucky are working in partnership with the USDA Forest Service, US Geological Survey, US Department of Interior's Office of Surface Mining Reclamation and Enforcement, USDA Natural Resources Conservation Service, Appalachian Regional Commission, Kentucky Department of Fish and Wildlife Resources, Kentucky Division of Forestry, Kentucky Department of Natural Resources, National Fish and Wildlife Foundation, Arbor Day Foundation, Sierra Club, and numerous regional conservation organizations.

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USDA

IMPACT

In Kentucky, information from this research has been used to revise state mandated timber harvesting BMPs used to protect water quality. Over five PhD degrees, 26 MS degrees, hundreds of undergraduate students, and more than 20,000 volunteers have been engaged in this research.

125 million

trees have been planted in Appalachia to restore surface coal mining sites using new BMPs derived from this research.

3,319 streams

annually afforded protection using BMPs directly informed by this research.

$4.9 billion

of annual economic contribution is generated from the 215,000 acres of private forest land harvested using the required BMPs derived from this research.

CONSERVATION AND MANAGEMENT OF AQUATIC AND RIPARIAN WILDLIFE

A McIntire-Stennis supported project

University of Kentucky

Forestry and Natural Resources
College of Agriculture, Food and Environment

The occurrence and health of aquatic animals and those living in close proximity to water, known as riparian species, act as barometers of the impacts of land use on ecosystems. In some instances, these species become threatened or endangered due to negative impacts associated with land use. Understanding threats to aquatic and riparian biodiversity, quantifying how populations respond to these threats, and developing conservation and/or management strategies to bolster populations is a focus of work at the Department of Forestry and Natural Resources at the University of Kentucky. Specifically, our McIntire-Stennis supported research has examined the response of salamanders to land-use reclamation, quantified the impacts of emerging infectious disease on snake populations, examined the causes of unknown declines in freshwater mussels, and evaluated the effectiveness of wetland restoration on imperiled amphibians.

Results from this research assist with the development of management tools and provide decision support for natural resource managers. Additionally, the project provides educational and research opportunities for undergraduate and graduate students as well as the general public.

COLLABORATION

This research requires a broad range of partners including the USDA Forest Service, US Fish and Wildlife Service, US Geological Survey National Wildlife Health Center, University of Kentucky Center for Applied Energy Research, Kentucky Department of Fish and Wildlife Resources, and Smithsonian Institution.

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USDA

IMPACT

This emerging research on aquatic and riparian species is providing critical information to inform practices to allow for sustainable use of forest resources.

28 students & 32 publications
that in the last 5 years have been developed to directly aid in the management of our forests and rural landscapes.

$740,000
of competitive research funds have been secured to address critical species work.

3,500
K-12 students educated in the last 5 years in Kentucky.

INFORMING OAK SILVICULTURAL PRACTICE THROUGH STUDY OF GROWTH AND REGENERATION

A McIntire-Stennis supported project

University of Kentucky

Forestry and Natural Resources
College of Agriculture, Food and Environment

Oaks are responsible for generating billions of dollars to the economy of Kentucky and surrounding states. Oak is used in a wide range of products, from paper and pallets to bourbon barrels, the latter produced from white oak, a dominant species in the central hardwood region and a focus species of research at the University of Kentucky Department of Forestry and Natural Resources. Unfortunately, inadequacy in the natural regeneration of several oak species, including white oak, are predicted to result in long-term issues with the sustainability of oak forests, the availability of oak timber, and a reduction in a valuable food for wildlife.

McIntire-Stennis supported research aims to develop management (silvicultural) practices to directly enhance the sustainability of oak forests. Our work focuses on foundational stand yield relationships and the development of thinning and regeneration practices. Our science can be applied at key phases of an oak forest's lifecycle to have an immediate impact on stabilizing the growth and drain of our oak resources.

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USDA

COLLABORATION

The work is endorsed by the White Oak Initiative and completed in partnership with the USDA Forest Service Southern Research Station, USDA Forest Service Northern Research Station, USDA Forest Service Daniel Boone National Forest, Forest Health Research and Education Center, Berea College, and the University of Vermont.
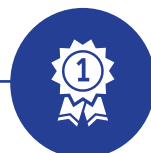
IMPACT

Science has resulted in the development of advanced techniques to culture oaks and is building our foundational understanding of oak regeneration, growth, and development.

Advanced Practices
developed including gap-based systems and how to apply shelterwood techniques to enhance oak regeneration.

Leading
long-term evaluation of individual tree and stand response to thinning within the Central Hardwood Region.

1,200 acres
annually being managed using scientifically based practices developed or investigated by this project.

UNDERSTANDING THE ROLE OF FIRE IN UPLAND HARDWOOD FORESTS

A McIntire-Stennis supported project

University of Kentucky

Forestry and Natural Resources
College of Agriculture, Food and Environment

Managers responsible for maintaining the diversity and productivity of central and southern Appalachian forests are increasingly turning to fire as one of several valuable tools for managing upland oak-dominated forests. McIntire-Stennis supported research at the University of Kentucky Department of Forestry and Natural Resources has helped to pioneer our understanding of the multifaceted roles of fire in this region by examining forest response to repeated prescribed fire, the combined use of prescribed fire and other practices in oak woodland restoration, and the impacts of accidental wildfire.

Results from 25 years of research point to the importance of using repeated fire followed by a fire-free interval to allow oak regeneration to establish and grow into saplings that are necessary to maintain oak in future forests and that excluding fire can lead, over time, to an increase in competing tree species that can limit oak regeneration. Research has also informed landowners and managers on the challenges of managing sites burned by wildfire.

COLLABORATION

This research is a long-term collaboration between researchers at the University of Kentucky, Department of Forestry and Natural Resources, USDA Forest Service Daniel Boone National Forest and Bent Creek Experimental Forest, aided by resources from the USDA-USDI Joint Fire Science Program.

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USDA

IMPACT

This research has informed forest management approaches to the use of fire throughout the central and Appalachian hardwood forest regions by addressing underlying ecological implications of fire, and the absence of fire, as disturbance agents applied to forest ecosystems where fire was used for millennia by Native peoples before being restricted for the past century.

12, 350+ and 100+

The number of graduate students, undergraduate students, and professional foresters trained in science-based understanding of the role of fire in central and Appalachian hardwood.

Leading

the region for 25 years in implementation of ongoing research on the use of prescribed fire in oak dominated upland forests used in management of public and private forests.

ECONOMIC VALUATION AND POLICY DEVELOPMENT OF FOREST ECOSYSTEM SERVICES

A McIntire-Stennis supported project
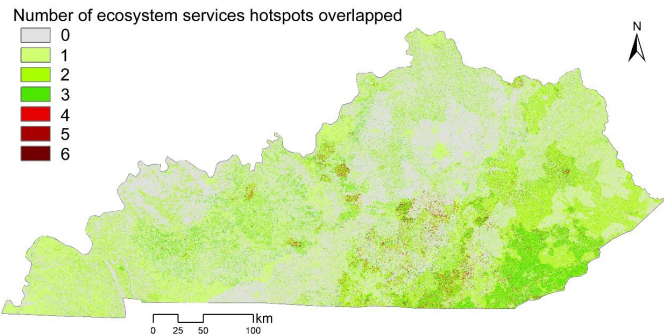*Emerging Project*

University of Kentucky

Forestry and Natural Resources
College of Agriculture, Food and Environment

Forests, as natural systems if properly managed, yield a stream of benefits which are vital to society, such as timber, water purification, recreation, and wildlife conservation. While the economic contribution of timber resources is understood, the full extent of the economic values derived from ecosystem services generated by forests is not. Accounting for all of these values is critical to ensure effective policy decisions. This project is designed to quantify the full economic value of forests, providing the information necessary for making wise forest management decisions to provide maximum benefits to society.

This emerging McIntire-Stennis supported project develops an integrated environmental-economic framework, incorporating the value of forest ecosystem services into the economic valuation of the forest sector. This is accomplished through "tradeoffs simulation scenarios analyses" and provides robust and economically realistic data needed for forest management and policy decision-making.

Number of ecosystem services hotspots overlapped
- 0
- 1
- 2
- 3
- 4
- 5
- 6

Concurrence of the seven ecosystem services hotspots in Kentucky

COLLABORATION

This is a high-skill, data-intensive and long-term project that brings together expertise in both geospatial analyses and economic modeling. Researchers at the University of Kentucky are working in partnership with USDA Forest Service Southern Experiment Station, Kentucky Division of Forestry, and Kentucky Geological Survey.

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USDA

IMPACT

As this emerging project develops, it will provide more inclusive value of our forests and show us where our forests provide the most valuable ecosystem services, helping to ensure their proper management and protection. It will show how land use change affects our economy, where water can best be protected, the relationship between economic growth and ecosystem services and help answer a host of critical economic and environmentally related issues.

12 Million
The number of forest acres in Kentucky that are providing ecosystem services that will be economically accounted for.

Highly Skilled
Students will be developed that can help answer the tough economic questions facing society.

ECOLOGY AND POPULATION DYNAMICS OF ELK IN FRAGMENTED FORESTS OF APPALACHIA

A McIntire-Stennis supported project

University of Kentucky

Forestry and Natural Resources
College of Agriculture, Food and Environment

Elk were common to the eastern U.S. prior to 1800, but hunting and other pressures caused their demise. There is now significant interest and activity in reintroducing elk to many states to provide recreational and economic opportunities and return an important species to the ecosystem. In the absence of large predators like the gray wolf, rapid population growth of elk in states like Kentucky have posed challenges to management of this wide-ranging species, particularly where high population densities occur. Populations must be managed to ensure that recreation and economic opportunities are sustained while minimizing negative impacts to the environment and humans.

McIntire-Stennis supported research at the University of Kentucky Department of Forestry and Natural Resources aims to quantify important aspects of reintroduced elk populations that are important in managing the species in the Appalachian region. Research is also characterizing the ecological impacts of elk including the browsing of tree seedlings that impedes the regeneration of native forests and reclaimed surface mines, spread of invasive species, and human-elk interactions.

COLLABORATION

Researchers have worked in partnership with Kentucky Department of Fish and Wildlife Resources, Morehead State University, University of Tennessee, USDA Animal Parasitic Diseases Laboratory, and the Rocky Mountain Elk Foundation to advance elk reintroductions and population management.

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USDA

IMPACT

20 years of research continues to inform management of elk in Kentucky and characterize important ecological impacts of this large herbivore on forest communities and reforestation sites.

$1.5 million
in competitive grant funds for elk research in Kentucky.

22 and 400
graduate students with published science and undergraduate students involved in elk research and education.

1 and 3.5 million
annual economic contribution of elk hunting in Kentucky and the number of acres in Appalachia that this on-going research impacts.

ECOLOGY AND CONSERVATION OF FOREST-DWELLING NORTH AMERICAN BATS

A McIntire-Stennis supported project

University of Kentucky

Forestry and Natural Resources
College of Agriculture, Food and Environment

Threatened and endangered species, including a number of forest dwelling bats, are an important ecological concern and also pose challenges for forest operations throughout the US, potentially impacting economically feasible access to billions of dollars in timber assets. Bats are experiencing significant declines from disease, climate change, pesticides, wind power development, and a host of changes to our forested landscapes. McIntire-Stennis supported research at the University of Kentucky Department of Forestry and Natural Resources has focused on management of forested landscapes for bats, addressing timber extraction, prescribed fire, and impacts from white-nose syndrome, a disease specific to populations of bats in Kentucky and the eastern US.

Research efforts have been directed at understanding specific dietary, roosting, and foraging requirements of bats, and how these needs are influenced by changes in land use practices. The goal of this research is to educate management efforts for imperiled bat species by providing a better understanding of the ecology and habitat requirements of these bats and how they are likely to be affected by proposed and existing forest management policies.

COLLABORATION

Researchers at the University of Kentucky are working in partnership with US Fish and Wildlife Service, US Forest Service, National Park Service, Bureau of Land Management, Kentucky Department of Fish and Wildlife Resources, Kentucky Nature Preserves, and Industry TIMOs.
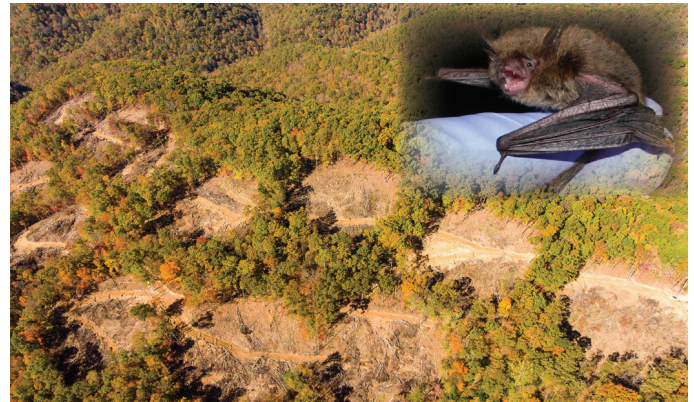
Imperiled northern long-eared bat and research in eastern Kentucky using timber harvesting to systematically create forest openings where bat use is being investigated.

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USDA

IMPACT

Understanding the biology and requirements of imperiled bat species along with their response to forest use and change allows us to develop better management strategies and help inform policies that can aid in benefiting these species and help ensure continued conservation and use of our forests.

68 and 100+

students, undergraduate and graduate, trained and scientific publications generated from this on-going research.

13 Million

acres of forest lands spanning 8 states in eastern, Midwestern and northwestern US, have instituted management changes to improve bat habitat.

EXPLORING THE POTENTIAL OF RNA INTERFERENCE TO MANAGE WOOD-BORING FOREST PESTS

A McIntire-Stennis supported project
Emerging Project

University of Kentucky
Entomology
College of Agriculture, Food and Environment

Both exotic and native insects are increasingly altering forest ecosystems and causing unprecedented economic losses. Innovative approaches to these problems are a focus of work at the University of Kentucky's Department of Entomology. One of these approaches, gene silencing, is being investigated to provide an alternative approach to traditional forest pest management. Direct suppression of forest insect pests is often impractical, unsustainable, and slow acting, and broadscale forest pest management is currently reliant on species selection and maintaining tree vigor. But these techniques are less and less effective in our rapidly changing forests, creating new challenges that warrant innovative approaches to pest management.

In response, this new project is evaluating the use of gene silencing as a means of suppressing forest pests. We've shown that gene silencing through RNA interference (RNAi) can cause rapid and extensive mortality of tree-killing beetles, and we're currently evaluating practical production and delivery approaches.

COLLABORATION

Researchers from the University of Kentucky are working in partnership with the USDA Forest Service Southern Experiment Station, the Forest Health Research and Education Center, and the University of Georgia.

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USDA

IMPACT

Developing innovative approaches using RNA interference could help manage native and exotic pests, potentially saving millions of trees and protecting tree and forest resources in the US.

> 85%
the rate of emerald ash borer mortality that could be avoided using RNAi to save trees and protect future forests.

Patent
under development for use of RNAi for emerald ash borer suppression.

Southern Pines
are under evaluation. RNAi can cause >75% mortality of southern pine beetle, potentially saving millions of hectares of southern pine forests.

LANDSCAPE-SCALE EVALUATION OF FOREST HEALTH AND RESPONSE TO DISTURBANCE

A McIntire-Stennis supported project
Emerging Project

University of Kentucky

Forestry and Natural Resources
College of Agriculture, Food and Environment

Appalachian forests provide a wide range of economic and ecosystem services to the people of Kentucky, ranging from wood products to carbon sequestration, biodiversity, and water quality. However, with changing land use and climate the forests face an intensified disturbance regime, which may cause deterioration of forest health resulting in a host of ecological ramifications. This new McIntire-Stennis supported research at the University of Kentucky Department of Forestry and Natural Resources has focused on quantifying the spatial patterns of forest disturbance and its impacts to forest landscape structure and ecological integrity in Appalachian forest of eastern Kentucky and beyond.

This emerging research project uses satellite imagery and other remote sensing data to determine the extent of forest disturbance and characterize several critical measures of forest health. Models are being developed to correlate satellite and terrestrial data to use in defining changes to our forests due to human activity such as surface mining and timber harvesting as well as wildfires and natural disturbances such as storms and droughts.

Central Appalachian counties with percentage area mined and contrasting topographies

COLLABORATION

Researchers from the University of Kentucky are working in partnership with the USDA Forest Service Southern Experiment Station, Daniel Boone National Forest, Kentucky Department of Fish and Wildlife, Kentucky Geological Survey, and Chinese Academy of Sciences.

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IMPACT

This emerging research is aimed at producing and developing technologically advance tools that can be used to efficiently track forest disturbances, both human-caused and natural, and determine changes that these disturbances have on forests.
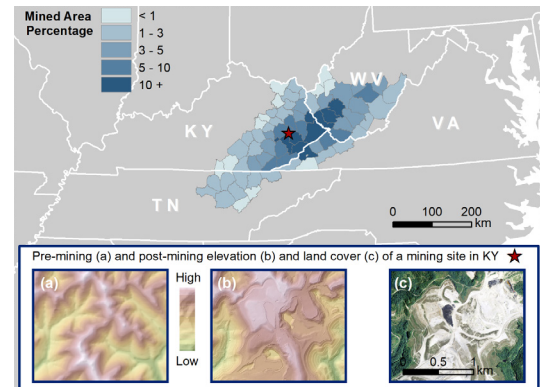
5
post-doctorate scholars and students engaged in the project.

Recognition
of this work as featured cover article in the internationally prestigious *Frontiers in Ecology and the Environment.*