United States Department of Agriculture
Cooperative State Research, Education, and Extension Service,
Office of the Administrator

Self-Review for 2005 Portfolio Review Expert Panel

Portfolio 5.1 Natural Resources: Forest, Range, Fish, and Wildlife

Supporting Objective 5.1: to provide science-based knowledge and education to improve the management of forests and rangelands

CSREES Goal 5: Protect and Enhance the Nation's Natural Resource Base and Environment

Executive Summary

In response to a directive from the Office of Management and Budget (OMB), the USDA Cooperative State Research, Education, and Extension Service (CSREES) prepared a set of self-review documents on the Relevance, Quality, and Performance of its Research, Education, and Extension programs that support its strategic goals. The purpose of these self-reviews is to provide concise yet comprehensive insight into activities so that the Panel may assess whether CSREES is fulfilling OMB's requirement for relevance, quality, and performance. This is one of two self-review documents addressing Goal 5 (Protect and Enhance the Nation's Natural Resource Base and the Environment) prepared by national program leaders in the Natural Resources and Environment (NRE) unit, which is primarily responsible for work under this Portfolio. This report specifically focuses on work supporting CSREES Strategic Objective 5.1: Provide science-based knowledge and education to improve the management of forest and rangelands. It includes all of the agency's programs, functions, and funding related to this objective and is part of the total Program Portfolio that encompasses forests, range, fish and wildlife resources. The report's timeframe is 1999-2003. The self-review document on Portfolio 5.2 (Management of Soil, Air, and Water) has also been prepared by CSREES and will be reviewed by another panel.

CSREES-sponsored research, education, and extension work is funded from multiple authorities and funding sources. To fully appreciate this integrated, mission-focused work, portfolios of topically-linked issues are aligned with the five USDA Strategic Goals, and fourteen CSREES Strategic Objectives. Objective 5.1 is composed of seven related Problem Areas (PAs) that integrate research, education, and extension activities, depending on funding line and authority. The portfolio and its related PAs demonstrate the complementary nature of research, education, and extension to solve national problems and to ensure that public investment is effective and efficient. The portfolio report provides detailed descriptions of PA activities.

The conclusion of this self-review is that CSREES' efforts under Portfolio 5.1 are relevant, of high quality, and high performance in addressing the national problems, needs, and concerns identified. The resounding theme of all descriptions of work in Problem Areas in Portfolio 5.1 is that CSREES is engaged, through a unique partnership with agencies, states, institutions, and the private sector, in solving forest, rangeland, fish and wildlife resource problems. The predominant partnership is the CSREES-land grant university partnership. CSREES funding supports research, extension, and education programs at these institutions.

Work in this portfolio has benefited the natural resource base, landowners, and the general public. A few examples of significant accomplishment include: a forest growth and production model that improved the economic potential for timber management by $4.5 million annually; the genetic improvement of loblolly pine trees to address disease and insect resistance in the South; the establishment of a cooperative that specializes in hormone-free, antibiotic-free, low-fat beef products has resulted in $50 million in revenues; and the biocontrol of the invasive species leafy spurge successfully decreased the area of infestation through the use of two species of fleabeetles.

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Section II – USDA Goal 5 and the CSREES Goal 5.1 Portfolio

USDA Goal 5: Mission Area and CSREES-Specific Program Portfolio

One of the five goals established by USDA in the department's current strategic plan is to protect and enhance the nation's natural resources base and environment. This portfolio supports CSREES Objective 5.1, which uniquely support USDA Goal 5 by production and dissemination of knowledge.

In the current CSREES Strategic Plan, the work of Goal 5 is divided into two objectives:

- Objective 5.1: provide science-based knowledge and education to improve the management of forest and rangelands and,
- Objective 5.2: provide science-based knowledge and education to improve the management of soil, air and water to support and enhance the environment.

This section provides an overview summarizing the important natural resources and environment issues as they relate to Goal 5, Objective 5.1: **provide science-based knowledge and education to improve the management of forests and rangelands**. The overall portfolio accomplishments in research, education and extension programs during FY1999-2003 are contained in this section of the report. Section III provides more comprehensive analyses of the seven Problem Areas that comprise the programs of CSREES efforts under Portfolio 5.1.

An Overview of Natural Resources and the Environment for the United States

All human inhabitants of the planet require clean air, clean and sufficient water, soil, healthy forests and rangelands, and appropriate land use that provides living space, food, fiber and forage production areas and wilderness areas. The nation has long benefited from an abundance of natural resources. The relationships between natural resources, environmental sustainability, and human well-being have often been taken for granted.

Today, the pressures on land and the natural resource base are increasing, competing, and more frequently, conflicting. Demographic changes and changing social values bring new challenges. Ecosystems that produce food, fiber, forage and forest products are increasingly fragmented as land use priorities change. Urbanization and ecosystem fragmentation have major impacts on natural processes, structure and function. Public demand for natural resources products and services – timber, recreation, fish and wildlife, soil and water, open space and the beauty of the land – continues to grow.

The relationship between agriculture and natural resources is also changing. Farming is no longer the largest element in the economic base of most rural communities. Natural resource values and income opportunities are becoming more important to farmers, ranchers, other landowners, and communities. The future sustainability of the nation's natural resource base will increasingly depend on the use and management decisions made by individual private landowners who collectively control more than two-thirds of the nation's land and water resources and by public land managers.

Communities need to make land-use decisions based on the best scientific knowledge available – the knowledge that enables them to identify and manage their environmental resources, understand ecosystem processes, and recognize the long-term impact of economic trade-offs that may erode the quality and quantity of existing resources. More than ever, people need to

understand the issues, the implications, and their options. Research on the use and management of natural resources and extension programs focused on decision-making and consensus-building are critical investments that can help ensure a sustainable future. CSREES-sponsored higher education programs will help ensure that a new generation of scientists, educators and extension personnel will be available to help future generations of Americans manage and sustain the natural resources.

CSREES and Natural Resources and the Environment

CSREES programs are based on a dynamic and vibrant relationship with university and private sector partners. The forest, rangeland, fish and wildlife Portfolio demonstrates the linkages, interdependence and connectedness between the federal and state components of a broad-based, national, agricultural research, education and extension system. The agency's mission is carried out through this dynamic partnership. This partner-based system is critical to ensuring performance, relevance and quality of the programs administered and led by the agency to protect and enhance the nation's natural resource base and environment. CSREES program leadership serves as both the catalyst and focal point for national research, education and extension programs in the natural resources and environment arena that are conducted by our partners.

The National Program Leaders (NPLs) in the Natural Resource and Environment (NRE), Competitive Programs, and Science Education and Resource Development Units maintain strong linkages with other USDA agencies (e.g., Agricultural Research Service (ARS), Natural Resources Conservation Service (NRCS), and Forest Service (FS)), other federal agencies such as the U.S. Environmental Protection Agency, and national organizations that serve as connections to large groups of stakeholders. Strong collaboration, linkage and integration of programs in research, education and extension among the USDA agencies ensure the well-being of not only the American public, but also the larger global society. These inter-agency connections are critical because ARS and FS provide the in-house research component; university partners are heavily involved in education and outreach activities as well as research; and NRCS and FS provide technical assistance directly and through state-based partners. All of these programs combined result in the discovery, dissemination and application of new knowledge. No single federal agency and/or its partners are able to accomplish the entire task. Similarly, EPA's role in regulation helps to protect the natural resource base and environment at the local, regional and national levels.

Natural resources and environment programs encompass a broad emphasis area with potential for major impact on the quality of the environment. CSREES national leadership integrates research, education and extension expertise to address contemporary environmental and natural resource problems with new approaches that are economically sound, socially acceptable and environmentally advantageous. NRE programs strengthen the nation's capacity to address critical environmental priorities and contribute to improved air, soil, and water quality; fish and wildlife management; enhanced aquatic and other ecosystems; the sustainable use and management of forests, rangelands, watersheds, and other renewable natural resources; and a better understanding of global climate change, including its impact on the diversity of plant and animal life. NRE programs also demonstrate the benefits and opportunities of sustainable development, and contribute to the economic viability of agriculture and rural communities realizing the impact of environmental policies and regulations. With agriculture no longer the largest element in the economic base of most rural communities, natural resource wealth and income opportunities are becoming more important to farmers, ranchers, other landowners, and communities.

Research to discover new, improved ways to use and manage natural resources and educational programs that transfer research findings and teach conservation practices to professional lay

audiences will enhance environmental and economic benefits, as well as human well-being. These CSREES activities are critical investments for the future.

CSREES supports integrated education, research, and extension programs to fully understand the complex environmental interrelationships affecting agriculture, forest, and range production practices; improve scientific understanding of soil, water and air to better manage production; and minimize adverse environmental impacts.

CSREES and its partners collaborate with industry and other interested parties to develop and disseminate knowledge and methods to provide and evaluate ecosystem management strategies that generate long-term benefits, including the mitigation of global change through buffering from public and private lands.

Stakeholder Input and Feedback to Ensure Relevance

The Goal 5.1 Portfolio addresses critical issues, needs and priorities related to these critical natural resources on the local, regional and national levels. Extension and education programs are driven by knowledge and information garnered from the conduct of scientific research. Just as research programs are required to demonstrate relevance, quality and performance standards, this is also a requirement for extension and education programs. The Natural Resources and Environment (NRE) leaders have close working relationships and links to various stakeholder partners including research, education and extension scientists and educators at the universities and colleges, other federal agencies, county agents, advocacy organizations, professional societies, advisory groups, and Congress. CSREES uses formal and informal processes to gather stakeholder input, including but not limited to stakeholder listening sessions, workshops, symposia, peer panel recommendations, Request for Applications solicitations, white papers, Presidential directives, and regulatory policies that impact natural resources and the environment. It is through these stakeholder interactions, whether directly or indirectly, that CSREES obtains feedback which is instructive in identifying needs and establishing priorities that are relevant to the Mission and to the Portfolio. CSREES also ensures stakeholder relevancy through requirements that research and extension plans of work and annual reports address specific processes through which in the funding recipients solicit and consider stakeholder input. These reports are reviewed by NPLs, thus providing continuous monitoring and dialogue to ensure that interactions with stakeholders occur and that top priority issues are being addressed. Similarly, relevant emerging issues are identified and subsequently addressed through this process.

Cross-cutting Programs

The NRE work outlined in this portfolio often cuts across jurisdictional lines within USDA and with other federal agencies, and state, local and private partners. This table lists the primary partnerships that enable CSREES to reach the desired outcomes.

Table 1. CSREES Partnerships

FEDERAL AGENCIES	EXTERNAL ORGANIZATIONS
USDA agencies: • Natural Resources Conservation Service • Forest Service • Farm Service Agency • Economic Research Service • Agriculture Research Service • National Agricultural Statistics Service Other federal agencies: • U.S. EPA • USDI – Fish and Wildlife Service • USDI – Bureau of Indian Affairs • USDI – National Park Service • USDI – Bureau of Land Management • USDI – Bureau of Reclamation • USDI – Geological Survey • US Department of Energy • US Department of Commerce – National Oceanographic and Atmospheric Administration • Army Corps of Engineers • Federal Emergency Management Agency • National Aeronautical and Space Agency • National Science Foundation	• National Council for Science and the Environment • National Association of Conservation Districts • American Forest and Paper Association • Professional societies (e.g., Society of American Foresters, Society for Range Management, The Wildlife Society, American Fisheries Society) • Southern Forestry Research Partnership • National Association of State Universities and Land Grant Colleges • National Association of Professional Forestry Schools and Colleges • National Association of University Fisheries and Wildlife Programs • State/territory departments of natural resources and environmental protection • Soil and water conservation districts • Resource Conservation and Development councils • Tribal governments

CSREES Objective 5.1 – Provide science-based knowledge and education to improve the management of forests and rangelands

Portfolio vision

CSREES leads the nation in the discovery and application of new knowledge for sustainable environmental practices in forest and range resources through university partnerships that provide research, education and extension programs.

Portfolio mission

Provide science-based information to guide forest and range resource decision-makers regarding production, management practices, and policy alternatives for the sustainability of public and private lands.

Portfolio overview

The CSREES Portfolio 5.1, although residing largely within the Natural Resources and Environment (NRE) Unit, encompasses agency-wide activities, because these are the fundamental natural resources necessary to support agricultural productivity and resilient rural and agricultural communities. It is for this reason that the NRE Unit leadership initiated and implemented the Environment and Natural Resources (ENR) working group. This is an agency-wide group that

takes into consideration the interconnectedness of all programs, functions, funding resources and program leaders involved in research, education and extension activities. ENR is comprised of individuals from each program unit within the agency in order to take a more comprehensive and integrated approach to the programs that comprise this portfolio.

This CSREES portfolio has been defined as those research, extension and education programs aligned with seven Problem Areas (PAs) to provide science-based knowledge and education to improve the management of forests and rangelands. This portfolio was prepared using the agency-wide ENR working group which is also being utilized to plan, develop and implement natural resource and environment related programs at the agency level.

This integrated systems approach takes into account that the ability to sustain production while growing the economy requires more efficient production practices and better management of the resource base and finding uses and markets for raw materials. There is also a need to restore degraded lands to some level of productivity through reclamation and remediation. Understanding how these natural systems respond to cultivation and introduced species is critical for maintaining environmental quality and conserving the resource. Additionally, science-based knowledge is needed on how best to protect these resources to promote a sense of well-being and security for our citizens. Because of industrialization and land use and land cover change, our planet is changing. Understanding global change and the effects on climate and production practices are critical to sustainability and our agricultural economy. Better understanding is needed on the role of forests and rangelands in the production and offset of greenhouse gases and the implication to national policy in a global environment. The portfolio encourages interdisciplinary approaches to address the issues. Similarly, many of the activities are integrated in nature, encompassing research, education and extension components.

This portfolio consists of the following Problem Areas (PA):

PA 121 - Management of Range Resources
PA 122 - Management and Control of Forest and Range Fires
PA 123 - Management and Sustainability of Forest Resources
PA 124 - Urban Forestry
PA 125 - Agroforestry
PA 135 - Aquatic and Terrestrial Wildlife
PA 136 - Conservation of Biological Diversity

Indicators are defined as “guidelines, rules, characteristics, or dimensions that are used to judge the quality of portfolio performance.” By Problem Area, the performance indicators are:

- 121 - Management of range resources: 5.1.1. Identify and understand biological processes and ecological relationships to improve rangeland management techniques and improve appraisals of range conditions for production of livestock, forage, wildlife habitat and water yield.
- 122 - Management and control of forest and range fires: 5.1.2. Develop new wildfire prevention methods; technology for fuel hazard reduction; improved systems for wildfire prediction, detection, and effective attack; and suppression technologies.
- 123 - Management and sustainability of forest resources: 5.1.3. Improve management of forest plants and trees, forest ecosystem ecology, breeding, forest nursery practices, and silvicultural techniques.
- 124 - Urban forestry: 5.1.4. Improve urban and suburban environments and enhance visual screening, noise suppression, air quality improvement, shade, and beautification through tree plantings.

- 125 - Agro forestry: 5.1.5. Improve the integration of trees in farmland and rangeland to improve agricultural production.
- 135 - Aquatic and terrestrial wildlife: 5.2.10. Determine biological and ecological needs of species, factors affecting population dynamics, maintaining and enhancing habitats, and managing for sustained wildlife harvest, population, species and community viability.
- 136 - Conservation of biological diversity: 5.2.11. Preserve, enhance and restore natural biodiversity to levels compatible with societal uses of natural resources.

Research Programs

Continuous research findings are needed to increase our understanding of the nation's natural resources. New knowledge answers the immediate questions of professionals, policy makers, landowners, and the public. The CSREES research investments and number of projects, by problem area, funding source and year are detailed in Tables 2 - 5. Table 6 shows the small amount of research investments in this portfolio as a proportion of the agency's research budget.

Table 2. CSREES Funded Research Projects for FY1999-2003, by Problem Area.

Problem Area	Number of Projects				
	1999	2000	2001	2002	2003
121- Management of Range Resources	179	175	159	203	155
122- Management and Control of Forest and Range Fires	23	29	42	73	52
123- Management and Sustainability of Forest Resources	558	562	580	742	593
124- Urban Forestry	32	33	31	55	41
125- Agroforestry	43	45	48	64	68
135- Aquatic and Terrestrial Life	306	312	303	333	385
136- Conservation of Biological Diversity[1]	0	0	0	0	0

Note 1: This Problem Area code did not exist in the Manual of Classification for this portfolio reporting period.

Table 3. CSREES Research Funding for Portfolio 5.1 for FY1999-2003, by Source.

Funding Source	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
Hatch	4,310	4,549	4,499	3,995	4,219	21,572
McIntire-Stennis	11,932	11,756	11,903	10,877	11,410	57,878
Evans Allen	1,174	884	1,103	525	460	4,146
Animal Health	26	26	6	4	11	73
Special Grants	1,911	2,447	2,460	3,896	4,612	15,326
NRI Grants	3,804	2,720	3,176	2,367	5,103	17,170
SBIR Grants	128	500	612	547	1,206	2,993
Other CSREES	2,224	10,500	8,479	1,297	3,187	25,687
Total CSREES	25,511	33,381	32,238	23,507	30,208	144,845

CSREES support for research is critical in advancing knowledge in agriculture and natural resources. The Agency provided support through four mechanisms: formula-based funding, competitive funding (peer reviewed), cooperative agreements, and special grants. McIntire-Stennis funds (formula-based) remain the main source of support for Portfolio 5.1 (Table 3), although funding has generally been flat for the period 1999-2003. Competitive funding through NRI and SBIR has increased in general, with SBIR dramatically increasing at an annual average of 105% despite a 10% decline in 2002. NRI funding fluctuated from year to year with a large increase (115%) in 2003 which partially compensated for the loss of funds from the Initiative for Future Agriculture and Food Systems (IFAFS), a competitive program that was discontinued by Congress in 2002. With the implementation of the IFAFS program, Portfolio 5.1 had significant increases (372% and 281%, respectively) in funding in 2000 and 2001 relative to 1999 funding of $2.2 M (Table 3, Other CSREES). Of particular note in this portfolio was the Special Grants funding which had an average yearly increase of 26 percent. This funding has targeted issues of state and/or regional importance. Projects funded through Special Grants included: 1) sudden oak death research in California, 2) sugar maple research in Vermont, 3) urban silviculture in New York, and 4) tillage and silviculture research in Louisiana.

Table 4. CSREES research funding for portfolio 5.1 for FY1999 - 2003, by problem area

Problem Areas	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
121- Management of Range Resources	2,222	3,766	6,039	2,384	3,376	17,787
122- Management and Control of Forest and Range Fires	410	527	2,515	957	1,450	5,859
123- Management and Sustain-ability of Forest Resources	14,921	16,691	15,005	12,187	16,679	75,483
124- Urban Forestry	617	525	861	1,056	889	3,948
125- Agroforestry	526	4,978	968	1,598	1,796	9,866
135- Aquatic and Terrestrial Life	6,814	6,893	6,850	5,325	6,019	31,901
136- Conservation of Biological Diversity[1]	0	0	0	0	0	0
Total	25,510	33,380	32,238	23,507	30,209	144,844

Note 1: This Problem Area code did not exist in the Manual of Classification for this portfolio reporting period.

Of the seven problem areas (PA) in this portfolio, PA 123 (Management and Sustainability of Forest Resources) received the most funding, approximately $75.5 million during the reporting period (Table 4). Distributed across 3,035 projects, the average project CSREES funding was $24,870. The least-funded Problem Area was PA 124 (Urban Forestry) with a total funding of $3.95 million over five years which supported 192 projects with an average funding per project of $ 20,552. Funding for PA 136 (Conservation of Biological Diversity) was zero because this PA did not exist for this portfolio reporting period.

Table 5: Research funding for Portfolio 5.1 for FY1999-2003, by Source.

Sources of funding	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
CSREES	25,511	33,381	32,238	23,507	30,208	144,845
Other USDA	10,923	12,124	13,224	18,257	18,500	73,028
Other Federal	32,130	34,902	38,123	80,158	50,657	235,970
State Appropriations	78,738	87,049	89,130	95,639	91,531	442,087
Private or Self Generated	8,439	10,033	12,070	10,101	12,211	52,854
Industry Grants & Agreements	10,745	11,752	14,499	19,232	18,204	74,432
Other Non-Federal	27,169	27,721	25,983	29,689	25,692	136,254
Total	193,653	216,961	225,267	276,584	247,002	1,159,467

Total federal investment in natural resources (Portfolio 5.1) from 1999- 2003 was slightly higher ($453.89 million) than state-appropriated support ($442.08 million) (Table 5). These two sources represented 78 percent of the total investment ($1.16 billion). Industry support for this portfolio steadily increased from $10.7 million in 1999 to $18.2 million in 2003. CSREES contribution to the total funding varied from year to year but on the average represented 12.5 percent of the total investment. The year 2002 was an atypical year where CSREES contribution was at its lowest but other USDA, other federal, state appropriations, industry support and other non-federal support (Table 5) were at their highest. Although CSREES contribution to this Portfolio is only 12.5% of the total research investment, its impact in providing a steady source of funds for basic and long-term research is significant. CSREES funds are critical in maintaining the research viability of many institutional natural resources research programs across the country. If, for instance, the McIntire-Stennis program was eliminated, many forestry research programs at universities would terminate permanently.

Table 6. Portfolio funding for research by CSREES as a proportion of the agency's total budget, by year.

	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
Portfolio 5.1 Research Allocation	25,511	33,381	32,238	23,507	30,208	144,845
CSREES Research Budget	449,368	535,191	640,061	530,979	584,557	2,740,156
Percent Portfolio 5.1 of CSREES Total	5.67%	6.24%	5.04%	4.42%	5.17%	Mean = 5.29%

Over the five-year reporting period, CSREES support for research in this portfolio was only 5.29 percent of the total research budget ($2.74 billion) of CSREES (Table 6). CSREES support increased in 2000 and 2001 due to IFAFS and declined significantly in 2002 when IFAFS was discontinued. After 2002, funding was enhanced by the NRI, SBIR and Special Grants.

Education programs

Education efforts are an important part of CSREES operations. There is direct funding for scholarships and funding for projects that support students in continuing their education. Unfortunately, the ability to track these investments by specific Problem Areas is currently limited. The information below provides an overview of natural resources education programs and investments by CSREES into formal education activities. Educational programs at land grant universities are enhanced by CSREES academic program reviews, multi-state administrative

committees, and coordination with national associations. These programs enhance teaching excellence, as well as support undergraduate and graduate students. It should be noted that the bulk of instructional funding is typically derived from tuition, state appropriations, educational grants, and other federal sources.

Natural resource higher education programs

The preparation of the next generation of scientists, educators, extension agents, and decision-makers is critical to the evolution of our understanding, protection, and appropriate utilization of our natural resources. Nation-wide there are a number of institutions educating future natural resource professionals. Through the Science and Education Resources Development (SERD) unit, CSREES is leading USDA's commitment to human capital development. Through a variety of competitive grant programs targeted at specific populations and for specific purposes, SERD's grant programs strengthen agricultural and science literacy in K-12 education, influence students' career choices toward agriculture, strengthen higher education in the food and agricultural sciences, prepare graduate students, and train master's and doctoral-level students as future scientists. SERD also provides national leadership for revitalizing curricula, recruiting and retaining new faculty, expanding faculty competencies, using new technologies to improve instruction delivery, attracting outside scholars, developing research and teaching capacity at minority-serving institutions, and increasing the diversity of the food and agricultural scientific work force.

Although SERD awards are not coded by Problem Area, they are clustered in general topical areas related to natural resources and environment. Table 7 details the funding for the Conservation and Renewable Resources and Environmental Science Management projects provided by SERD programs. Due to the manner in which projects are categorized and clustered, and the integrated nature of the projects, there is unavoidable overlap with Portfolio 5.2 problem areas. Appendix XX provides a listing of 56 projects funded by SERD programs for the portfolio reporting period.

Table 7. Funding for higher education programs related to natural resources, by program area.

A. Conservation and Renewable Resources (includes Forestry and Ecology)

	FY Awarded ($)					
Program Area	1999	2000	2001	2002	2003	Grand Total
1890 Capacity Building Grants Program	179,958	698,164	537,738	195,484	1,188,008	2,799,352
Alaska Native and Native Hawaiian-Serving Inst.	0	0	957,888	900,762	923,432	3,763,661
Challenge Grants Program	320,731	0	171,987	533,388	506,695	1,532,801
Hispanic Serving Institutions	0	0		299,947	596,319	896,266
Multicultural Scholars Program	166,984	0	370,000	0	235,000	771,984
National Needs Graduate Fellowship Grant Program	0	0	0	897,000	0	897,000
Secondary Agriculture Education Challenge Grants Program	15,000	0	0	79,646	22,425	164,502
Tribal Colleges Research Grants Program	0	40,963	258,467	0	0	299,430
Total	682,673	739,127	2,296,080	2,906,227	3,471,879	11,124,996
B. Environmental Sciences Management						
1890 Capacity Building Grants Program	393,644	97,481	588,768	597,315	199,806	1,877,014
Challenge Grants Program	90,000	710,619	137,736	0	250,000	1,188,355
Hispanic Serving Institutions	0	0	149,726	0	442,027	591,753
Multicultural Scholars Program	100,000	0	0	0	0	100,000
Secondary Agriculture Education Challenge Grants Program	0	0	0	0	39,963	77,993
Tribal Colleges Research Grants Program	0	150,000	199,412	0	0	349,412
Total	583,644	958,100	1,075,642	597,315	931,796	4,184,527
Total (Parts A & B)	1,266,317	1,697,227	3,371,722	3,503,542	4,403,675	15,309,523

Table 8. Portfolio funding for education by CSREES as a proportion of the agency's total budget, by year.

	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
Portfolio 5.1 Education Allocation	1,266	1,697	3,372	3,504	4,404	15,310
CSREES Education Budget	27,726	28,033	34,957	35,435	39,564	165,715
Percent Portfolio 5.1 of CSREES Total	4.57%	6.05%	9.65%	9.89%	11.13%	9.24%

The proportion of portfolio education funding was greater than the research proportion over the reporting period. The actual dollars as well as the percentage of the overall education allocation has increased every year during the reporting period. Because all of the education programs are competitively funded, these increases may have been the result of simply more forest, range, fish and wildlife resources education proposals being submitted and/or better and more competitive proposals being submitted. With more accurate PA classifications being used by the SERD unit over the last two years, more accurate data will be available for future portfolio reviews.

Examples of higher education success stories:

- The University of Florida - School of Forest Resources and Conservation, assisted by the University of Georgia and Auburn University, has developed Internet-delivered agroforestry courses to increase the number of students able to experience agroforestry practices and improve the level of scientific understanding of eco-tourism/environmental issues. These courses reach a wider potential base of students than traditional, resident-instruction courses. By the end of the project, 120 students are expected to have enrolled in the newly-developed courses. Agroforestry demonstration sites will be visited by four University of Florida undergraduate classes per year to reinforce class material and to observe actual, on-the-ground practices. Student satisfaction with the course delivery and content, to date, is represented by student evaluations of 4.7 out of 5.0 which is very high relative to most other courses. In 2005 and 2006, the course will be repeated in May as an intensive 3-week course, and in the fall as a regular semester course. A new wildflower experiment will be installed on the University of Florida agroforestry demonstration site in late 2004, and an explanatory kiosk and signs will be installed in late 2004 or early 2005. As a preliminary assessment, several of the students completing the course have indicated they will go on to graduate school in environmental science or management.

- Researchers within the Department of Fisheries and Wildlife Sciences and the Department of Wood Science and Forest Products at the Virginia Polytechnic Institute and State University will undertake a 3-year initiative to improve critical thinking and problem-solving skills in undergraduate students. Specifically, at the end of the 3-year funding period, investigators intend that a minimum of 25 natural resources-focused case studies be developed, tested, modified, and re-evaluated under actual classroom conditions. Case studies will be developed specifically within the fisheries management, wetland management, non-timber forest products, and role of science in management subject areas; an evaluation protocol, with associated performance measure indicators, suitable for use in post-secondary education to assess a student's critical thinking/problem solving capacity; selected classroom assessment techniques (CATs) suitable for use to monitor the progress of case study implementation; training sessions or one-day workshops in case study methods and case development for faculty interested in learning more about this pedagogical approach; and journal articles

tailored to education and natural resource professionals. The use of case studies will not replace entirely other teaching approaches used in these classes; rather, the heavy reliance on case study and collaborative learning approaches will supplement and enhance traditional pedagogical methods. In addition to improving the educational quality of these courses and enhancing the life-long learning skills of students enrolled in them, investigators intend to make the educational resources and evaluation methods developed from this project available to instructors in natural resources programs at other institutions. Finally, the co-investigators will conduct instructional seminars or training workshops for interested faculty, both from within and outside the home departments, on: case study teaching, development and evaluation of case study modules, and assessing overall improvement of student skill building. Although still too early to cite observed impacts, preliminary results of research on effective pedagogy to improve reasoning and critical thinking skills in higher education students, suggests noticeable improvement through reliance on case study approaches.

- University of Florida, School of Forest Resources and Conservation, Auburn University, School of Forestry and Wildlife Sciences, and Mississippi State University, Department of Forestry, are developing lecture and lab materials for a restoration ecology course to be offered simultaneously at the three institutions. The project will result in: (a) a set of high quality VHS videotapes that contain all the lecture materials, (b) a CD-ROM virtual tour of prominent longleaf pine restoration sites in the Southeast, (c) a 4-day field tour to introduce students to prominent restoration sites across the southeast, (d) a Restoration Ecology of Longleaf Pine Ecosystems web site, and (e) a much needed textbook / handbook on restoration ecology of longleaf pine ecosystems. Further, course related performance goals expected of students include: (1) an in-depth analysis and synthesis of the ecological and economic importance of longleaf pine ecosystems, (2) theoretical and technical knowledge from ecology, soils and other bio-physical sciences to form the intellectual foundation of ecological restoration, (3) knowledge of variables that led to longleaf pine replacement and barriers to restoration, (4) techniques used in ecological restoration, and evaluation and monitoring, and (5) socio-economic, policy and political dimensions of ecological restoration. The major product of this project will be workforce-ready graduates who can help the efforts of natural resource agencies in restoring the damaged longleaf pine ecosystems and similar ecosystems elsewhere in the country. For some students this course may serve as a stepping-stone to graduate programs in restoration ecology.

Extension Programs

Various state and federal government agencies have extension/outreach agendas but their capacity to deliver programs is extremely limited or nonexistent and thus they look to the Cooperative Extension System (CES) as a partner in their outreach efforts. CES retains its comparative advantage for delivering science-based consumer-driven programs to help individuals and communities adopt new practices and respond to change.

The Extension system is built on a unique infrastructure that includes the presence of local educators, county agents and specialists, in rural, urban and suburban communities across the country and their partnerships with land-grant universities, state government and the federal government. For example, Hamilton and Biles (1998) reported that 268 of 644 full time positions devoted to RREA programming between 1992 and 1997 were focused on forestland. This effort resulted in improved practices on nearly 90 million acres. According to the December 2003 salary analysis of Cooperative Extension Service professionals, there are 5,643 specialists (4,170 full-time equivalents) and 8,987 (8,790 full-time equivalents) agents/educators in the country. These professionals are responsible for local, state and regional programs.

It should be noted that extension programs in states are primarily funded through state, county, and grant funds; the CSREES portion typically comprises 5 to 25 percent of states' extension budgets (see Evidentiary Materials). However, CSREES plays a key role in the land-grant extension mission by distributing annual congressionally appropriated formula funding. CSREES affects how these formula funds are used through national program leadership to help identify timely national priorities and ways to address them. Thus, while CSREES collaborates as a full partner with state extension services, outcomes and impacts reported here are only partially attributable to CSREES funding. The reporting of this information, however, demonstrates the value of leveraged, matched and blended funding approaches that result in greater impact than what would be accomplished without the federal contribution. Reporting these data only demonstrates that CSREES and its partners are attempting to establish monitoring and evaluation systems that facilitate the dissemination of information in a timely manner to inform policy and decision-makers and the public at large. Most of the credit is directly attributable to our implementing partners.

Because extension funds are not awarded or tracked by Problem Area, overall budgets are not available for extension investments in Portfolio 5.1.

Integrated Programs

Integrated programs include those that incorporate at least two of the three functions of CSREES programs – research, education and extension. In this portfolio, we have attempted to show an integrated effort in each problem area. It is difficult to extract any funding data for integrated efforts, so what is available is included in the tables in the research area above.

Portfolio 5.1 Plan and Description

Introduction to the Logic Models and Honeycombs

This discussion explains how the programs described above are organized at the Portfolio level of conceptualization. The previous material on partnerships and funding lines described the "inputs" and major components of the Portfolio "outputs" while this section discusses how all these are drawn together in achieving outcomes.

The self assessment document follows the outline of the logic model both in textual and graphical format. The discussion on the Portfolio and its major components and their integration and flow to produce results is organized according to nine major heading as follows:

- Overview
- Situation
- Major themes
- Assumptions
- External factors
- Inputs
- Outputs
- Outcomes
    - Short
    - Medium
    - Long term
- Performance indicators
- Success stories
- Future directions

The logic model is a conceptual tool for both planning, accountability and evaluation. It displays the programmatic sequence of events that take place in the program development that encompasses needs assessment, program planning, program delivery, and program evaluation. Each section comprises a series of actions that generate a result which feeds into or serves as a substrate for the next sequence. The framework demonstrates the extent to which elements of the logic model are tied into a problem or a situation for which there is a legislative or administrative authority, money obligated and specific program activities for which performance measures and performance indicators have been identified. These activities are then implemented from which data are generated to demonstrate the extent to which meaningful progress is taking place, leading toward solving the problem for which funds were obligated.

While every attempt has been made to follow the conceptual framework of the logic model, the External Review Panel is reminded that the review is focused on activities that took place from 1999 through 2003. As such, the model represents a robust framework that was not used as a program development tool during the assessment period; the model, however, is a very effective method for describing the theory upon which a program is developed and conducted. Future programming efforts will be based on this conceptual framework and to that extent it will be much more useful for assessments to be conducted in the next cycle. The "honeycomb" models graphically display the connectivity between major program themes that are currently being addressed and those new directions which need to be pursued. The portfolio logic model follows. The PA logic models are found in Section III of this document.

The following description is the portfolio logic model in narrative form:

Situation
Management decisions on the nation's forests and rangelands have economic, social and environmental effects. These lands provide clean air and water, fish and wildlife, timber and forage products, and recreational opportunities. Land management agencies, as well as private owners, need access to research-based information to continue, develop, and implement sound management programs. The consequences of sound programs include sustained productivity, improved water quality, reduced effects from drought and flooding, sustainable fish and wildlife populations due to maintained or enhanced habitat, increased species diversity, potential decrease in the number of threatened and endangered species, decreased risk of catastrophic fire, and decreased number of sites with accelerated soil erosion rates.

Major Themes *(listed in order from species, to communities, to management)*
- Biology of flora and fauna species and communities (evolution, classification, distribution, morphology, physiology, fecundity, migration, dispersal, mortality, cycles and modeling).
- Structure and function of terrestrial and aquatic ecosystems.
- Ecosystem disturbances (fragmentation, fire, insects, disease, invasive species, weather and climate extremes)
- Resource inventory, monitoring, assessment and management (fish, wildlife, forest, range and water resources)
- Conservation and sustainability of biodiversity (genetic, species, community and ecosystem scales)
- Ecosystem restoration (forest, range, and urban)
- Agroforestry practices (alley cropping, silvopasture, windbreaks, riparian buffers/buffer strips, forest farming)
- Urban forest environmental factors and species compatibility

Assumptions
- Funding recipients will utilize the formula, competitive, and special grant funds for their intended purposes and will report progress and impacts under the terms and conditions of the funding.
- There is a need to collaborate with lateral "partner" organizations and agencies.
- The portfolio will consist of both disciplinary and multi-disciplinary approaches as needed and appropriate.
- The portfolio will consist of both single and multi-functional approaches as needed and appropriate.
- CSREES personnel have established professional and institutional networks and provide the necessary leadership and management to ensure the conduct of comprehensive research, extension, and education programs.

External Factors
- CSREES has the funds and personnel to provide leadership and management of funded programs.
- Biological and environmental factors that result in ecosystem stresses (e.g, insects, diseases, invasive species, drought, temperature extremes)
- Emergent and unpredictable weather and other natural disturbances (e.g, fire, hurricane, ice storms, floods) either necessitate changes in priority programs and/or present unique opportunities for scientific inquiry.

- Economic conditions affect: 1) financial abilities of forest and rangeland owners/managers to implement practices, 2) ability to sell products.
- Available funding from various local, state and federal sources changes from year to year and results in shifts in program priorities.
- Responsibility for resource management is shared among multiple federal agencies in USDA, USDI, US EPA with inefficient coordination mechanisms.
- Political priorities (e.g. 2002 Farm Bill), national initiatives (e.g., Greening of America, Urban Tree House), and organizations (e.g., International Society of Arboriculture, The Wildlife Society, Society of American Foresters, National Arbor Day Foundation) change the direction and extent of forest, range, fish and wildlife programs.
- Human population growth and changes in societal values and attitudes.

Inputs

- Total CSREES research funding for Portfolio 5.1 (Tables 4-6) was $144,845,000.
- Total CSREES education funding for Portfolio 5.1 (Table 8) was $15,309,523.
- Total CSREES extension funding for Portfolio 5.1 is complicated due to the nature of the reporting systems and the fact that the CSREES funding is blended with state and local funding to make up the entire budget for a state/institution. Renewable Resources Extension Act (RREA) funding, specifically focused on extension forest and range resource programs was $17,975,000.
- Other funding sources include federal agencies, state, and grants and contracts.
- Personnel inputs include CSREES National Program Leaders, administrative support, research and extension faculty based at universities, teachers, para-professionals, stakeholders (both industry and non-governmental organizations), and volunteers.

Outputs

- Mission-relevant problems, opportunities, and issues requiring federal attention and support are identified;
- Networks and collaborations with partners and stakeholders are in place;
- Programs and activities respond to existing or emerging problems, opportunities, and issues through the development and application of science-based knowledge;
- Programs and activities are administered and managed in order to develop and apply science and knowledge; and,
- Methodologies are being developed to evaluate and assess the quality, outcomes, and impacts of these programs.

Outcomes

Short-term

- New research findings and discoveries are evidenced.
- Research findings are used to guide extension and education programs.
- Grantees and partners have increased awareness, knowledge, and skills.
- Increased scientific understanding and dissemination of knowledge makes it possible to sustain and enhance the nation's forest, rangeland, fish and wildlife resources.
- National Program Leaders are connected to research, extension, and education activities nation-wide.

Mid-term

- Research findings, through extension and education programs, result in management changes for producers, agencies, and the interested public.
- Science based information is delivered to decision makers.

Long-term

Research, extension, and education activities result in:

- Rangeland and forest ecosystems are managed on an improved and sustainable basis.
- Increased public awareness and understanding of issues related to natural resources.
- Acceptance and use of best management practices.

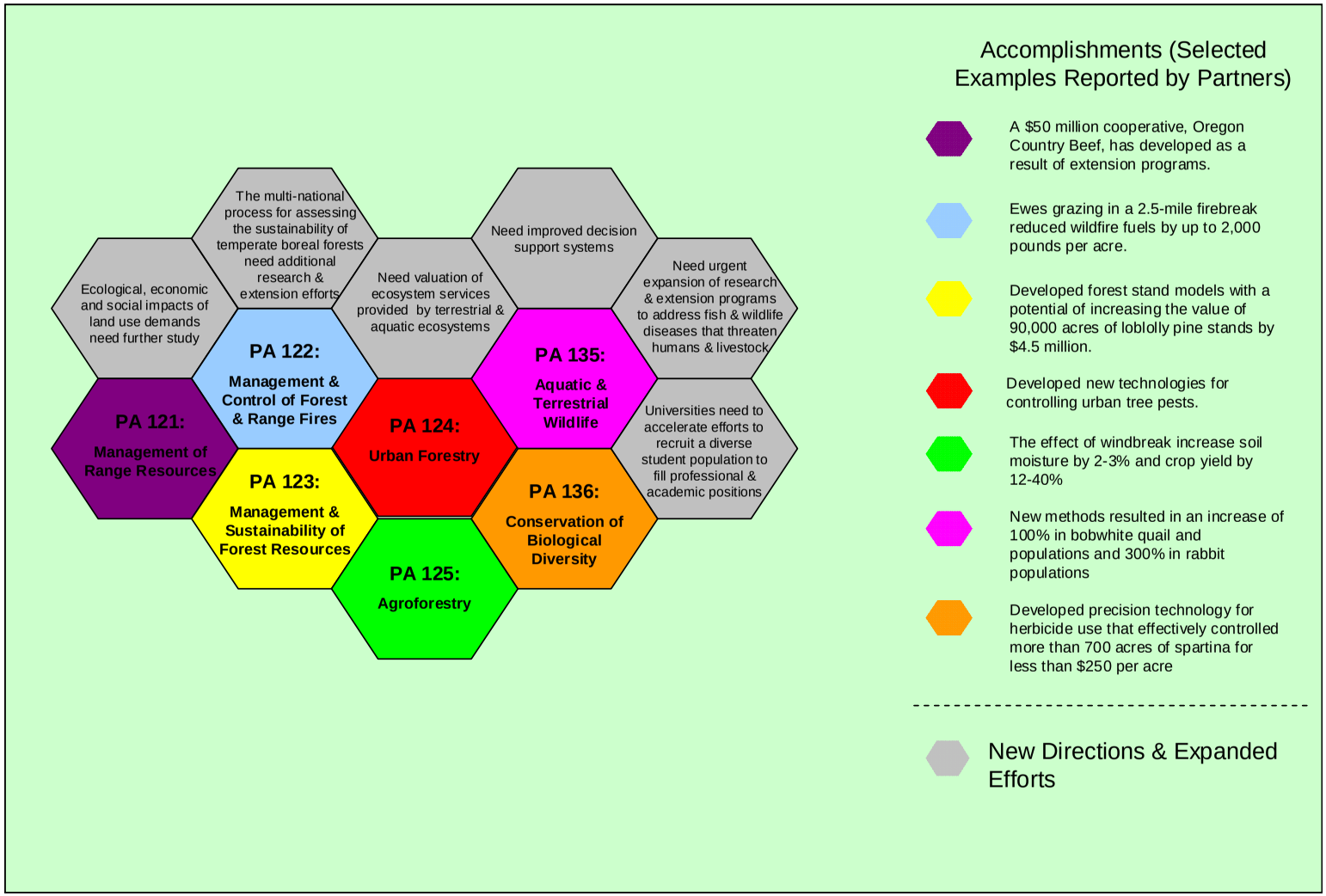
Performance Indicators

- Educational materials developed and distributed to target audiences.
- Graduates in forest, range, fish and wildlife who are prepared for careers as natural resource scientists, educators and professionals.
- Obtaining and disseminating new research findings through academic, professional and general public venues.
- Public understanding of forest, range, fish and wildlife resource issues and participation in relevant policy and decision-making processes.
- Development and implementation of forest and rangeland stewardship/management plans.
- Dollars leveraged from other sources using federal funding as the base.
- Community and individual awareness of risks and trade-offs of forest and rangeland management options.

Success Stories

The success stories that illustrate the accomplishments of this portfolio are best understood at the Problem Area level. Because there are neither national-level extension program curricula nor specific national-level research questions, the impacts of this portfolio are realized at the state, local and institution levels within the scope of each problem area and thus, are described below in the individual Problem Area summaries.

Portfolio 5.1: Problem Areas and Research Needs



New Directions

Several new directions and expanded efforts are needed in both the content and administration of work in this portfolio. The programs in this portfolio need to expand in the following areas:

- Ecosystem fragmentation and land conversion – Ecological, economic, and social impacts of land use decisions need further study, including economic analyses that contribute to policy alternatives.
- Frameworks for describing, assessing and evaluating sustainable resource management – The multi-national process for assessing the sustainability of temperate boreal forests to which the U.S. is a signatory and the public and policy discussions about national environmental indicators need to be under-girded with additional research and extension efforts.
- Valuation of ecosystem services provided by terrestrial and aquatic ecosystems, including urban forests – Valuation requires the integration of ecology and economics and is a complex challenge when ecosystem services do not typically have markets or market prices. Global climate change and approaches for dealing with it will likely result in markets for ecosystem services. Public policy, such as Farm Bills that provide financial incentives to landowners whose private land activities provide public benefits, may incorporate valuation of ecosystem services into determining payments to landowners.
- Decision support systems – Production systems such as agroforestry and plantation forestry are complex and can be improved with new models that provide yield predictions over a wide range of conditions.
- Detecting, identifying, assessing and responding to fish and wildlife diseases that threaten humans and livestock – The current world situation involving overseas conflicts, terrorism, and discoveries of animal-transmitted disease requires urgent expansion of research and extension programs to address this issue.
- Changing natural resources workforce – Large numbers of natural resources professionals, scientists and educators will retire within 5-7 years. Universities need to accelerate efforts to recruit a diverse student population interested in natural resource careers in order to have a sufficient number of students in the "pipeline" to fill professional and academic positions.

Several new program administration efforts need to be considered:

- Multi-state single- and multi-functional (research, education and extension) committees - Currently there are no formally organized multi-state research or multi-state integrated forest resources committee. These committees are an effective mechanism to expand the reach of single state programs as well as to enhance multi-disciplinary approaches to research and education.

- Regional and multi-state extension natural resource educators - Currently only one region, the Southern Region, supports a multi-state extension forester. This effort has resulted in significant impacts across 13 states using various media to conduct programs that simultaneously reach several thousand landowners and professional foresters.

- Equitable support for the 1890 institutions - The 1890 institutions were incorporated into the RREA program in 2002 but receive such minimal funding that it is very difficult to ascertain program outputs, let alone, outcomes. In order to meet the unique needs of the clientele of these institutions, equitable support needs to be provided.

- Full incorporation and inclusion of the 1994 institutions - The 1994 institutions are not

currently eligible to receive RREA or McIntire-Stennis funding. With the passage of recent legislation there is increased interest in forests on Native American lands and reservations. Moreover, these lands are now factored into the formula for RREA allocations resulting in increased funding to states with these lands, but the funding is distributed to the 1862 land grant institutions. The 1994 institutions should be incorporated into the RREA funding when the legislative authority and funding permit.

- Strategic planning - Strategic plans with performance indicators provide a programmatic roadmap with associated measures to assess accomplishments. The RREA program is currently the only forestry program with a recently completed five-year plan. A similar plan is needed for the McIntire-Stennis program and possibly the National Research Initiative.

- Program accountability - There is increased emphasis on the relevance, quality and performance of all federal programs. Program accountability processes need to be assessed as to their adequacy and inclusiveness in order to improve the guidance to partners in reporting the impacts of the programs they conduct with CSREES funds.

- Strengthened coordination between federal agencies - In USDA there are two agencies with significant forestry research portfolios, CSREES and the Forest Service. There are opportunities for better coordination between the two agencies in order to better integrate and maximize the research resources that are available. This is a major finding of a recent National Research Council report.

Section III – Problem Area Descriptions

Problem Area 121 - Management and Sustainability of Rangeland Resources

Overview

This problem area is comprised of research, education and extension programs that address current and emerging issues related to the management and sustainability of the nation's rangeland resources. Rangelands are those areas which are unsuited to intensive cultivation for reasons of soil, climate, or location, yet they provide a vast array of products, services and benefits for society, including: water and watershed values, forage for herbivores, timber, wildlife habitat, and recreational opportunities.

Rangelands are vast. About 40 percent of the United States of America's land base is classified as rangeland. It is owned and/or managed by a variety of public and private agencies and landowners. Roughly one third of the nation's land is public rangeland, managed as part of the public domain by the USDI Bureau of Land Management, USDA Forest Service, and various state agencies. Historically, rangelands were viewed as marginal lands which were to be "passed over" by immigrants and settlers on their way west in search of more promising futures. In the past century, however, society has learned to value these harsh and often fragile landscapes for the reasons noted above.

Land ownership patterns have often resulted in unique issues and challenges in managing the nation’s rangelands. Generally, homesteaders and ranchers claimed and patented those lands which had available water, resulting in a pattern of private lands being those associated with hay meadows and flowing rivers, creeks, and springs. The publicly- owned lands were most frequently those areas which were rocky, dry, cold, and/or otherwise inhospitable. Complicating the situation, in some areas this pervasive pattern is coupled with a "checker board" pattern of every other section (one square mile) in private ownership. This seemingly odd pattern of early land allocation is based upon land grants made to the railroads during the period of railroad expansion as an incentive to railroad executives to risk the capital and labor necessary to establish railways across hundreds of miles of isolated and uninhabited lands. Today, these complex and convoluted land ownership patterns create management problems for rangeland managers. Perhaps the most obvious and one of the most vexing problems associated with mixed ownerships is that of habitat fragmentation. As roads, human access, and subdivision development occur erratically across what was once wildlife habitat, migration and habitat patterns are disrupted; wildfires, often human-caused, are more frequent and economically more devastating; weed and invasive species problems are increased; and watershed, water quality, and water quantity issues are exacerbated.

Despite these issues and challenges, the nation's rangelands are in better condition today than they have been in a century. At the turn of the last century, the rangelands had been overused and abused to the point that wildlife habitat was nearly lost, the Dust Bowl and its subsequent wind and water borne soil losses were beginning, and water quality, particularly that associated with high sediment loading, was severely degraded. Because of forward-looking programs such as the establishment of the USDA Soil Conservation Service (now Natural Resources Conservation Service), public education, continuing education of rangeland resource professionals, land-based research into rangeland ecosystems, and the establishment of the Cooperative Extension System, the ecological condition of these lands is now improving. The question at the moment is whether

or not this positive trend can continue in the face of increasing human population, greater demands for resources, increasing consumption patterns, habitat fragmentation, wildland fires, and invasive species.

The role that CSREES plays in the sustainability of rangeland resources is critical. The agency and its program partners are involved with land resource (including rangeland) issues in all states, territories and protectorates. Each land grant university partner, through program coordination and funding from CSREES, is able to bring a combination of research, education and extension programs to local land owners/managers, citizens and policy makers. These programs take the form of: classic, scientific inquiry to explore the physical and biological aspects of ecology; non-formal education programs and demonstrations of research-based findings conducted with youth and adult learners; and formal academic preparation of future land owners/managers and natural resource professionals.

The goal of this program area is:

> *To enhance the rangeland resource and better the lives of the people associated with them.*

Work in this area focuses on:

- Determination of types of information needed and standards of estimation.
- Improvement of rangeland evaluation methods to reduce costs and increase the usefulness of information obtained, including aerial photography, geographic information systems (GIS), trend projections, and computers for data analysis.
- Appraisal to provide up-to-date information on the quality, quantity, and productivity of range resources.
- Appraisals for use in development of resource programs.
- Projecting future demand for range forage and other benefits normally related to the wise use of rangelands.
- Physiology and ecology of rangeland plant communities.
- Range characteristics, including identification, physiological requirements, and nutritive value of forage plants.
- Understanding range ecosystems and their biotic and physical components.
- Improvement through breeding and selection of browse plants for forage, protection, and aesthetic purposes.
- Revegetation of deteriorated areas by seeding desirable species.
- Systems for managing rangeland including fertilization, mechanization, grazing pressure, and drainage to increase yields.
- Management practices that harmonize grazing with timber growing, wildlife, recreation, and other land uses.
- Riparian areas and wetlands associated with rangeland habitats and their importance to these ecosystems.
- Forested range management.
- Protection against insects and diseases.
- Invasive/alien plant deterioration of rangelands.

Situation

Rangeland ecosystems and their managers/owners are facing increased pressures as the population grows and demands for production, clean water, recreation and wilderness experiences, and wildlife habitat simultaneously grow. Coupled with these challenges of priority and efficiency are degradations which threaten the ecological integrity of the resource. These include:

- catastrophic wildfire
- urban encroachment and habitat fragmentation
- weed and invasive species encroachment
- erosion resulting from inappropriate off-road vehicle and other recreational uses and from cases of abusive herbivory

Major Themes

- Grazing on public lands - Since the turn of the last century the federal government has regulated the use of forage by domestic livestock on public lands through the issuance of grazing permits. These permit programs are administered by the Bureau of Land Management, the Forest Service, and in the case of some national monuments, the National Park Service. As with other permitted uses of these lands such as commercial river running, park concessions, and hunting, the permitees of grazing allotments must comply with federal regulations including numerous environmental restrictions. There has been increased conflict and debate over public lands grazing in the past ten years.

- Wildlife and endangered species - Rangelands provide habitat for thousands of species of mammals, birds, reptiles, fish, and amphibians, some of which are only found on these lands. This biodiversity performs critical ecological services such as nutrient cycling and soil formation. Today, human population growth and its associated activities threaten the viability of many rangeland species. Some species are now federally protected through designation as threatened or endangered status. Concerns include the jurisdictional issues involved in management of listed species, wildlife-livestock interactions, and animal damage control.

- Rangeland transition and fragmentation - One of the concerns in the western U.S. is the rapidly growing metropolitan areas, where, as more people have chosen to create their own one- to forty-acre "home on the range", a new geography is emerging. This rapid transition from rural rangeland to residential and commercial space threatens the very values that draw people to the region. When land areas are designated as wilderness, people are actually enticed to build next to it, knowing that it is likely to remain “forever wild.” At this interface, wildlife habitat is fragmented and natural disturbances such as wildfire become more dangerous due to threats to life and property. Additionally, quality of life declines with increasing traffic and air pollution.

- Invasive species - Noxious, invasive plants are harmful non-native species that are regulated by state and federal laws because they threaten agriculture, navigation, fish, wildlife, or human health on both public and private lands. They threaten both urban and rural values because they may: be poisonous, displace native plant species and lessen biological diversity, increase erosion and degrade watershed values, eliminate threatened and endangered species, create problems for recreationists, and negatively impact wildlife habitat and other aesthetic qualities of land or water resources. Noxious weeds have been

shown to displace native flora and fauna causing serious economic and ecological problems on rangelands throughout the western United States and Canada.

- Recreation and wilderness - The demand for recreational opportunities on rangelands, especially in the western U.S., has skyrocketed over the past two decades. Hikers, birders, and rock hounds share the range with mountain bikers, off-road vehicle (ORV) operators, and ranchers' livestock. In recent years advocates have also sought the designation of millions of acres of mostly Bureau of Land Management rangeland as wilderness. The divergent goals of these many rangeland users inevitably results in conflict. Motorized recreation and livestock grazing alter the pristine character and solitude sought by some, while restricting areas to primitive, low-tech uses limits access by others.

- Resource management conflicts - Land management agencies struggle to resolve conflicts among constituents and still protect the natural resource base. The cumulative impact of so many activities on the land can be significant. Some activities, such as unrestricted ORV use can be more deleterious than poor grazing management. Other pursuits, while seemingly harmless, may, in sufficient numbers, disrupt wildlife breeding, feeding, and migration. Agencies are faced with the need to increase monitoring, education, and regulation, which also increases costs. Some agencies have resorted to recreational fees to off-set costs, a controversial policy wherever it is employed. The social, ecological, and economic aspects of rangeland recreation and the controversy over rangeland wilderness designation are issues of concern.

- Water and riparian areas - Much of the nation’s water supply originates as rainfall or snowmelt on rangeland watersheds. In addition, the riparian areas along rangeland streams and rivers provide critical habitat for wildlife, fish, and plants. The running water and lush vegetation of these areas often serve as focal points for livestock and for recreation. Concurrently, the nature of many rangelands makes them highly susceptible to erosion. Upland activities that significantly diminish vegetative cover can lead to increased runoff and sedimentation. Heavy use of riparian areas can destroy aquatic habitat and undermine the ability of these systems to filter pollutants. As a result of rising concern over non-point source pollution, the Environmental Protection Agency through the Clean Water Act has begun monitoring rangeland waterways and looking for ways to improve water quality.

Assumptions

Management of private and public rangelands requires a systems approach that integrates the objectives of the land users, be they traditional ranchers, homeowners, or “hobby farmers.” These objectives often include sustaining economic benefits, preserving life style, and conserving open space, water and biological resources. This requires the coordination of research scientists in a user-driven program to provide relevant knowledge, products, and tools for natural resource management, and the training of natural resources extension educators to ensure relevance, diffusion and use. This necessitates an integrated research, extension and education program in which natural resource and land managers identify needs that in turn inform research agendas.

CSREES does not conduct actual rangeland research, extension or education programs but rather helps fund these efforts at state and local levels and provides national program leadership for those functions.

External Factors

Several factors affect the performance, outcomes, and CSREES program attributions that are achieved in this problem area:

- Emerging and unpredictable problems such as plant disease outbreaks, catastrophic wildfire, weather patterns (particularly drought), and periodic herbivore die-offs.
- Political issues of funding, readjudication, and ramifications of related legislation (e.g., Endangered Species Act, Clean Water Act, and state and local land use laws).
- Economic conditions which dictate research, education and extension funding success and therefore on-the-ground programming.
- Public perception that erroneously links range to a land use (livestock grazing) rather than rangelands to an ecologically driven land base with accompanying challenges for air, land, and water interrelationships.

Inputs

CSREES provides program inputs in two forms: funding and personnel. Human capital input consists of CSREES personnel. During four of the five years of this portfolio review (1999-2002) there was no official rangeland personnel presence at CSREES in the form of a National Program Leader (NPL) or support staff. Rangeland program leadership and administration was erratic and provided primarily as an extra duty for one of the forestry NPL's with oversight from an agency assistant administrator. In 2003, a shared faculty agreement was executed with Oregon State University to hire, on a part time basis (.2 FTE), a faculty member to provide program leadership and agency representation at various forums. Approximately .1 FTE of staff support was also supplied (Table 9**).**

Table 9. CSREES personnel resources (full time equivalents), by year and category.

	1999	2000	2001	2002	2003
National Program Leader	0.85	0.15	0.20	0.15	0.20
Program Analyst/Specialist	0.03	0	0	0	0.08
Administrative Support	0.03	0.03	0.03	0.03	0.08
Other (IPA, Shared Faculty, etc.)	0	0.03	0	0	0.15
TOTAL	0.91	0.21	0.23	0.18	0.51

The number of projects and funding has remained relatively constant over the five year reporting period as shown in Table 2.

The funding inputs include: McIntire-Stennis Cooperative Forestry Research, Renewable Resources Extension Act, Hatch Act, Smith-Lever Act, National Research Initiative, Small Business Innovation Research, and multiple Higher Education Program funds. The funding for rangeland research is shown in Table 10.

Table 10: CSREES Research Funding for PA 121, by Source.

Funding Source	Fiscal Year *($ in thousands)*

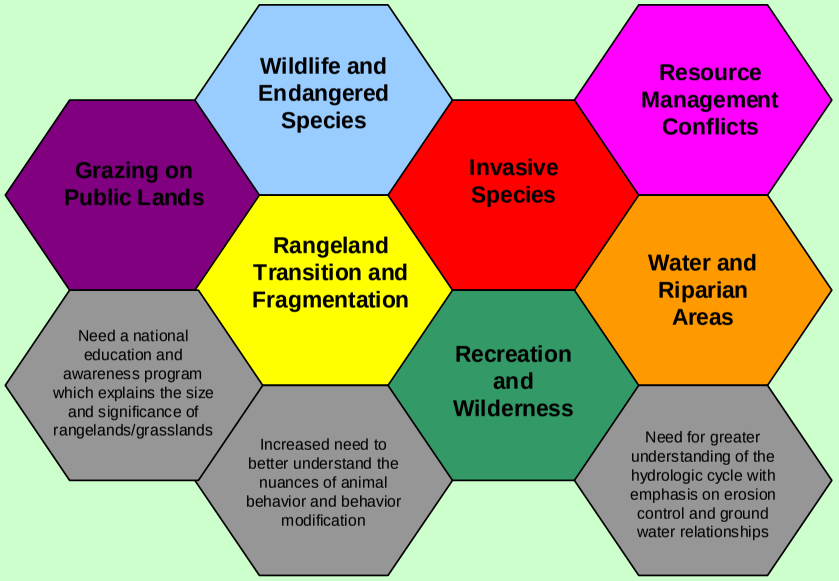
	1999	2000	2001	2002	2003	Grand Total
Hatch	1,154	1,148	1,047	785	560	4,694
McIntire-Stennis	157	272	281	347	335	1,392
Evans Allen	105	0	0	0	0	105
Animal Health	0	0	0	0	0	0
Special Grants	197	901	486	879	1,133	3,596
NRI Grants	611	944	410	255	676	2,896
SBIR Grants	0	0	70	80	289	439
Other CSREES	0	501	3,748	38	380	4,667
Total CSREES	2,224	3,765	6,039	2,383	3,373	17,784

The overwhelming conclusion concerning the vast, yet poorly recognized area of ecologically managing the nation's rangelands is that it is funded at very low levels. In the five-year reporting period of 1999-2003, a total of approximately $17.8 million dollars have been spent on research programs.

While CSREES provides financial resources to its implementing partners in the land grant university system to conduct research, education, extension and integrated programs to solve problems of national significance, extension programs are primarily funded through different mechanisms and are implemented at the county, town, and parish level. CSREES funding comprises 5-25 percent of states' extension budgets. While CSREES collaborates as a full partner with the state extension services, outcomes and impacts reported here are only partially attributed to CSREES funding. The reporting of this data, however, demonstrates the value of leveraged, matched and blending funding approaches that result in greater impact than what would be accomplished without the federal contribution. Other funding sources that states utilize include state and local government funding, industry, foundation and other non-profit grant-making organizations.

Problem Area 121: Management of Range Resources

Major Themes Funded by CSREES and Research Needs



Accomplishments (Selected Examples Reported by Partners)

- The Oregon State University Cooperative Extension Service formed a $50 million cooperative, the Oregon Country Beef (OCB) organization that produces a hormone-free, antibiotic free, low fat humanely raised product a reasonable price
- The National Conservatory, Oregon Agricultural Experiment Station, and Oregon State University established a Coordinated Resource Management Plan on the Sycan Marsh in southern Oregon.
- Arizona Cooperative Extension implemented RangeView, a GIS technology, and Rangelands West , a web resource, to model rangeland characteristics and uses to better serve rangeland students and land managers.
- North Dakota's Cooperative Extension Service and Ag. Research Center proved and demonstrated that properly managed animals could provide a low cost, highly effective control for leafy spurge, an invasive species.
- The Cooperative Extension Service in Montana embarked on an educational program called "Undaunted Stewardship" for collaborative conflict resolution.
- Colorado State University research scientists, education and extension personnel developed Colorado's Range Management School, which introduced science-based monitoring techniques to be adopted.
- Nevada's Agriculture Experiment Station and Cooperative Extension followed research initiatives and have conducted workshops to demonstrate issues of water and watershed management in concert with demanding issues of water quality and stream classification

New Directions

Outputs

The outputs from the programs funded in this problem include:

Research:

- From 1999-2003, 871 research projects were started or completed.

Education

- CSREES outputs include the external university program reviews that are requested by academic units. Annually, CSREES solicits requests for program reviews from land grant institutions. These requests are assigned to appropriate National Program Leaders who work with the requesting institution to identify and recruit an external review team. Based on the request that is received, the review will encompass some or all of a units academic, research, and extension program. Most commonly, these reviews are comprehensive in nature. During this portfolio reporting period, the following CSREES Review was conducted:
    - 2000 – Department of Rangeland Resources, Oregon State University

Extension:

- Rangeland monitoring workshops address both consumptive and non-consumptive uses of natural resources on rangelands and consider the unique blend of biological and political constraints that occur across watersheds. Monitoring data provide the quantitative information that resources managers need to ascertain whether natural resource objectives are being met. An example is the RangeView website (http://rangeview.arizona.edu) which provides applications for viewing, animating, and analyzing satellite imagery in order to monitor vegetation dynamics through time and across landscapes.

- Seminars and websites are similar in their concept. They may be used to provide scientific, technical information or to describe protocols (such as weedmapper.oregonstate.edu). Research and demonstration projects range from paired plot research dealing with Cryptosporidium contamination in grazed watersheds (California research on the San Francisco City watershed) to establishment of native perennial grasses as a competitive control of medusa head wild rye invasions (Oregon demonstrations concerning invasive species).

- The RangeView website (http://rangeview.arizona.edu/) provides applications for viewing, animating, and analyzing satellite imagery in order to monitor vegetation dynamics through time and across landscapes. RangeView is simple to use and valuable for natural resource managers, land owners, educators, and researchers.

Outcomes

Outcomes which result from work in this problem area have commonalities across the functional areas of research, extension and education.

Short-term

- Oregon County Beef, a $50 million rancher organization/cooperative, gives extensive credit to Oregon State University Extension in helping them increase their understanding of marketing, management and ecology.
- The RangeView website using GIS technology has received 1.1 million hits in 2003 from ranchers seeking range management information.

- By understanding the differences between various stream reaches in Nevada watersheds, ranchers learned about the purposes of stream classification and the potential for habitat improvements and methods for water quality monitoring.

Medium-term

- The Burgerville hamburger restaurant chain contracted with Oregon County Beef to use its beef exclusively in its restaurants.
- In cooperation with The Nature Conservancy, a Coordinated Resource Management Plan for Sycan Marsh in southern Oregon was implemented.
- Sheep and cattle grazing at the right time of the year has been demonstrated as a low cost, highly effective control for leafy spurge.
- "Undaunted Stewardship", a Montana Cooperative Extension Service program, provided a setting for landowners, ranchers, grazing permittees, agency personnel and the general public to learn about and practice conflict resolution techniques.
- Ranchers adopted science-based range monitoring techniques after attending a Range Management School.

Long-term

- The hydrologic and habitat functions of Coyote Creek in southern Oregon have been restored and it is now a rearing stream for the endangered bull trout.

The short-term outcome is that a positive change in attitude, knowledge, skill and motivation has occurred in the targeted audiences of landowners, agency personnel, policy makers and the public(s) associated with rangeland resources. Research projects result in the accumulation of new knowledge concerning the physical and biological aspects of this resource.

Medium-term outcomes are changes in behaviors, often observed through the implementation of new practices and techniques. The intermediate outcomes associated with research projects are the accumulation of new knowledge which facilitates the inquiry of higher level questions and promotes a positive spiral of understanding.

The long term outcome is the sustainability of the nation's rangeland resources as measured in biological diversity, soil stability, resource production, and human welfare. The examples of outcomes, by major themes, as reported by funding recipients include:

Performance Indicators

- Educational information and materials distributed to target audiences.
- Graduate students and interns trained
- Research results published and made available to other scientists and to the public
- Extension demonstrations and field plot work publicized and visited as part of community-wide extension education efforts

Success Stories

A number of success stories, by major theme, demonstrate the strong links between research, education, and extension. The land grant university system is unique among institutions of higher education across the country in that it fosters this holistic approach to education. Scientific inquiry is rigorously pursued and reported; the research findings are transferred through formal

and non-formal education programs that utilize bulletins, websites, workshops, and field demonstrations.

Grazing on public lands

The Oregon State University Cooperative Extension Service, a state partner to CSREES, worked with a group of struggling ranchers in central Oregon. The struggles dealt with low commodity prices, high cost of production, and a public perception that livestock grazing is ecologically unsustainable. After numerous meetings and conflict resolution processes based upon understanding other people's perceptions of rangeland resources and livestock production, a rancher organization called Oregon Country Beef (OCB) was formed. OCB decided to base its premise on two fundamental concepts: 1) the idea of a hormone-free, antibiotic-free, low fat product for which they charged a fair price that included cost of production and a reasonable rate of return, and 2) if the OCB monitored its members and certified that all livestock under their control was raised in a humane way and grazed using sustainable rangeland management practices, the members would have a marketable product of which they could be proud. The public has embraced this concept and this past year the Burgerville hamburger chain contracted to use OCB exclusively---joining upscale markets and restaurants who prior to that marketed the beef. Oregon Country Beef is currently a $50 million dollar cooperative that gives extensive credit to the OSU Cooperative Extension Service for increasing their understanding of marketing, management, and ecology, all of which they have blended to create a healthful, sustainable, and profitable product.

Wildlife and endangered species

The Nature Conservatory, in cooperation with the Oregon Agricultural Experiment Station, OSU Department of Rangeland Resources, and OSU Cooperative Extension Service, established a Coordinated Resource Management Plan on the Sycan Marsh in southern Oregon. One of the tributary streams to the marsh is called Coyote Creek. At the time the plan was established, Coyote Creek was a depauperate, down-cut stream which had lost most of its hydrologic form and function. Through the management prescriptions for livestock grazing which focused on the appropriate time of grazing for plant physiology enhancement, the stream regained much of its hydrologic and habitat function and is now a rearing stream (small stream which the fry use as they develop and grow) for the endangered bull trout.

Rangeland transition and fragmentation

In Arizona, RangeView and Rangelands West have been implemented by the Arizona Cooperative Extension. RangeView is a GIS-based technology which enables researchers and practitioners to model rangeland characteristics and uses. Rangelands West is an informational web resource which was developed as a multi-state collaborative effort. Over the past eight years the Arizona sites have been regularly updated and expanded both in content and design to improve their ability to serve rangeland students and land managers. The sites include more that 350 features. The Arizona extension personnel recognized that rangelands and environmental issues do not stop at political boundaries and are attempting to bring this information to the attention of people involved on policy issues such as endangered species, invasive species, and wildlife habitat. The sites received over 1.1 million hits in 2003.

Invasive Species

Leafy spurge is an invasive species which out-competes native vegetation and in turn changes the habitats, soil holding capacity, water relationships, and the economic viability of the land. North Dakota's Cooperative Extension Service and Agricultural Research Center experimented with the concept of using both cattle and sheep as biological control agents for leafy spurge. By combining the concepts of timing of herbivory and preferential grazing habits of two species (sheep and

cattle) they were able to prove, and then demonstrate that properly managed animals could provide a low cost, highly effective control for this difficult invasive species. As a result, habitat is being restored, an economic value has been received, and sustainability and biodiversity of the area's native plant communities is rebounding.

Recreation and Wilderness
In Montana, the Cooperative Extension Service has embarked on an educational program called "Undaunted Stewardship". This program is essentially a conflict resolution approach which encourages land owners, grazing permitees, agency personnel and members of the public who are interested in preservation and wilderness to gather together, learn from one another, and plan for the future in a rational, logical manner. Lawsuits and rancor have been reduced in this atmosphere where mutual trust and respect are gained.

Land Management
Colorado's Range Management School, developed by research scientists, educators and extension personnel at Colorado State University, has brought new perspectives to the controversial realm of land use. Land owners doubted the logic and veracity of certain land management agencies' monitoring protocols and the agencies frequently doubted the sincerity of the land owners. By creating the Range Management School, science-based monitoring techniques were introduced and adopted. The School basically insured that everyone understood the goals, objective, technique, strengths and weaknesses, of each technique. Consequently, these individuals are now able to rationally discuss and trust each other's judgments.

Water and Riparian Areas
Nevada's Agriculture Experiment Station and Cooperative Extension have been researching and demonstrating issues of water and watershed management in concert with demanding issues of water quality and stream classification. Through the research initiatives, classification of the state's wildland streams was possible. With an understanding of the radical differences between various stream reaches, the Extension Service conducted workshops and field days demonstrating the criteria for classification, the potentials within each classification for habitat improvement and methods for monitoring water quality improvements.

Timing of Burning Affects Ecosystem Productivity
Sage brush steppe ecosystems in Wyoming are subject to burns to improve forage quality and maintain sustainability. Timing of these burns affect loss of water to the system and productivity of grasses and shrubs. Research has also indicted that shrubland ecosystems are potential carbon sinks. Using a vector based approach, this study will identify management models to improve growth of grasses for forage, most efficient water usage for plant growth, and enhance carbon sequestration.

New Directions

In addition to the ongoing research, education, and extension challenges noted previously as "major themes" in this document, several upcoming issues loom on the horizon and offer significant benefits in terms of resource management and sustainability if adequately addressed. These new and/or expanded program directions consist of:

- A national education and awareness program which explains the size and significance of the rangeland/grassland resource. To meet the challenges and demands of the 21st century, this resource must be understood and valued in keeping with its significance.

- There will be an increased need to better understand the nuances of animal behavior and behavior modification. As ideas such as "horse whisperers" gain public acceptance, it is appropriate to look to issues of livestock and wildlife behavioral issues. GPS technology to track animal movements, activities, and behavior is rapidly coming to a degree of sophistication where, with collared or tagged animals, movements, locations in relation to water, feed, shelter, and/or responses to other activity (such as hunters or off-road vehicle) can be traced. An understanding of herbivore motivation in terms of feed availability, palatability, and/or nutrition at different times of the year or at differing periods of their life cycle can be enhanced with this technology. Through research and demonstration programs, more efficient, productive, and ecologically sensitive management of grazing systems for both domestic and wild herbivores is possible.

- There is need for greater understanding of the hydrologic cycle with emphasis on erosion control and ground water relationships. Erosion control has long been a goal of natural resource professionals and particularly rangeland resource managers. With increased research and demonstration of possibilities concerning surface flows, interflows, hyperhic flows, and groundwater relationships, the knowledge of the role and importance of upland watershed and riparian zone management can be greatly expanded. The logical outcome of such research and demonstrations will be to show the cause and effect relationship between land uses and water quality, specifically sediment loads, bacteria and Cryptosporidium contamination, and nutrient and toxin levels.

Problem Area 122 - Management and Control of Forest and Range Fires

Overview

This problem area is comprised of research, education and extension programs that address current and emerging issues related to the management and control of forest and range fires. Forest and range fires are phenomena that can be either beneficial or catastrophic, depending on the size, intensity and duration of the fire. Aggressive fire suppression policies has resulted in ecosystems that are burdened with excessive fuels, stagnant forest stands, fire-prone invasive species, and dead standing trees resulting from insect and disease infestations. Compounding the potential for catastrophic fires has been a continuing severe drought throughout the West during the last 5 to 7 years. When ignited by lightening or human activity, what would normally be a fire of "typical" intensity explodes into a conflagration that destroys millions of acres of forests and ranges and hundreds of structures, and often results in loss of life.

Through the mechanism of existing legislation, CSREES supports three critical functions in carrying out its mission:

Research - There is an urgent need to identify new solutions and answers for addressing the immediate and long-term consequences of catastrophic wildfire. Research inquiries are needed in order to produce decision-support tools for natural resource managers and to better understanding the barriers to individual and community readiness to deal with wildfires. New issues continually arise that need systematic inquiry to develop scientifically sound wildfire prevention and suppression programs.

Education - Ensuring an adequate workforce of scientists and natural resource professionals is the goal of CSREES education programs. These programs enhance teaching excellence and academic programs and support undergraduate and graduate students in their education and research pursuits. Emerging knowledge needs to address the complexities of managing, using and reacting to fire through the interdisciplinary and visionary education programs at the nation's forestry and natural resources programs at colleges and universities.

Extension - The sustainability of the nation's forest resource is largely dependent on the actions of nearly 11 million private owners, ranchers, farmers and land managers. These groups represent the target audience for extension education programs. A key feature and goal of these programs is to enable them to more effectively and efficiently utilize USDA conservation programs. It is often the case that once a landowner is ready to adopt the management practices they have learned about through their participation in extension programs, they then need to access the technical and financial assistance programs offered by other USDA and state agencies. Thus, extension programs serve as the "primer" for actual on-the-ground implementation.

The goal of this program area is:

> *To reduce the catastrophic impacts of wildfire and to improve the use of prescribe fire through increased understanding of the human and natural factors that affect forest and range fire and their impacts on ecosystems and to bring about changes in practices that reduce or ameliorate those aspects of fire that are deleterious to both the forest resource and society.*

Work in this area focuses on both wildfire and prescribed fire. It includes the development of new wildfire prevention methods; new technology for fuel hazard reduction; improved systems for wildfire prediction, detection and effective attack; and suppression technologies. Prescribed fire is used to maintain fire-dependent ecosystems without endangering resources and facilities. Work in this area focuses on where, when and how to utilize prescribed fire.

Areas of work include but are not limited to:

- Fire-related biology and ecology of plants and animals.
- Atmospheric and ecosystem dynamics, patterns, and characteristics.
- Physics and chemistry of combustion.
- Behavior of fire as influenced by fire-starting agents, atmospheric circulation, and local weather, fuels, and topography.
- Fire intelligence systems, including electronic methods, remote sensing, automatic measurement of fire environment, and computer integration of these factors into a fire danger rating system.
- Reduction of fuel hazards through physical, chemical, and prescribed fire treatments.
- Use of fire-resistant plants in home and building landscaping.
- Creation of defensible space around homes and buildings.
- Aerial and ground procedures for fighting fires.
- Integrated prescribed fire control and forest management systems which minimize wildfire losses.
- Use of prescribed fire to maintain the integrity and function of range ecosystems.

Situation

From 1999-2003, 475,009 wildfires burned 29,495,000 acres and cost $5.791 billion (federal funds only) in suppression efforts. During this period, there were several fires of historical significance:

- August-November 1999 - Big Bar Complex Fire - CA - 140,947 acres - A series of fires caused several evacuations during a 3 1/2-month period.
- September-November 1999 - Kirk Complex Fire - CA - 86,700 acres - Hundreds of people were evacuated for almost three months.
- May 2000 - Cerro Grande Fire - NM - 47,650 acres - Originally a prescribed burn, this fire went out of control, destroyed 235 structures and damaged the Los Alamos National Laboratory.
- 2002 - Oregon, Arizona and California recorded their largest fires in the last century in a fire season that nationally destroyed 2,381 structures and cost $1.6 billion (federal funds only) for suppression efforts.
- 2003 - More than 60,000 fires burned about 3.9 million acres and culminated in the disastrous fires in southern California. Suppression costs exceeded $1 billion, and 39 firefighters and residents lost their lives.

Although the number of fires remains reasonably constant from year to year, the burned acreage has been double the 10-year average in three of the last four years. The trend is toward increasingly larger annual burn area. The increasing volume of fuel combined with the severe summer droughts is a critical factor in the spread of wildland fires and their resistance to control. Coupled with the increasing number of primary and secondary homes that are being built with little regard to fire safety in fire-prone forests, the scenario is complete for catastrophic and life-threatening fires.

Major Themes

The impacts of forest and range fires are addressed at several scales: individual trees, forest and range ecosystems and their flora and fauna, and watersheds. The major themes of this problem area are:

- Living with fire - individual and community awareness and action.
- Fuel inventory, mapping and treatment.
- Detecting, tracking and suppressing wildfire.
- Post-fire restoration.
- Fire behavior prediction and modeling.
- Fire-impacted watershed processes.

Assumptions

- The unique mission of CSREES is to advance knowledge for agriculture, the environment, human health and well-being, and communities by supporting research, education, and extension programs in the Land-Grant University System and other partner organizations.
- CSREES does not conduct actual forest and range fire research, education, and extension programs but rather helps fund it at the state and local level and provides program leadership in these areas.
- Independent scientists at universities and natural resource agencies identify pressing forestry research questions in conjunction with stakeholders.
- Universities are the appropriate setting for research, extension and education programs.
- Funding recipients use interdisciplinary approaches to plan, implement and evaluate research, education and extension programs.
- Funding recipients utilize established networks and create partnerships to accomplish program goals and objectives.
- In the pursuit of new knowledge, forestry research findings may lead to new questions.
- The exact course, progress and end result of scientific inquiry is not predictable.
- The transfer of new knowledge to the research community, natural resources professionals, policymakers and lay audiences (e.g., public and private forest owners/managers) is an integral step in moving research findings to application on the ground.
- Research findings provide answers to those who need them.
- The pursuit of new knowledge and its transfer involves the academic preparation of the next generation of forestry scientists and educators.
- Multiple funding sources are employed by universities in the development and delivery of forestry programs and that CSREES funding will at times serve as the major funding, seed funding, or leveraged funding for various research, education and extension projects.

External Factors

Several factors affect the performance, outcomes and CSREES program attributions that are achieved in this problem area:

- Other agencies will continue to provide significant resources ($71.4 million from FY1998-2003) to support fire science research, including the Joint Fire Science Program, a partnership of six federal wildland management and research agencies.
- Many of the direct causes of fire and the circumstances that contribute to wide to larger and more destructive fires are the results of natural process (e.g., lightning, drought,

insect and disease infestation) and thus the severity of individual fire seasons will vary; fire will always be a major disturbance that needs to be address, however.

- Universities have the personnel and facilities to accomplish CSREES-funded projects.
- Political priorities and policy initiatives such as the Healthy Forest Restoration Act of 2003 that identify forest and range fire issues and mandate new programs and approaches to address the issues.
- Multiple sources of information that target audiences access. Community leaders and organizations that are responsible for fire preparedness and private forest landowners receive information from mass media (print, radio and television), other agency programs (e.g., FireWise) and organizations, other forest landowners, family members, and professionals.
- Significant USDA resources are targeted to fire suppression activities and research with minimal support for non-formal education programs through the Cooperative Extension System.
- Multiple funding sources. In addition to federal extension, technical assistance and financial support programs, individual states, counties, parishes, and villages provide significant funding for suppression activities.

Inputs

The resources that are allocated to this problem area must to be considered at two levels: 1) those which are provided by CSREES and, 2) the transformation of those resources by program partners and funding recipients into different resources that are directly applied to programs and projects.

CSREES provides two resources: funding and personnel. The funding inputs include: Cooperative Forestry Research, Renewable Resources Extension Act, Hatch Act, Smith-Lever Act, National Research Initiative, Small Business Innovation Research, and multiple Higher Education Program funds. The funding for forest and range fire research is shown in Table 11.

Table 11: CSREES Research Funding for PA 122, by Source during 1999-2003

Funding Source	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Grand Total
Hatch	21	33	31	28	63	176
McIntire-Stennis	172	191	290	497	581	1,731
Evans Allen	68	67	65	83	0	283
Animal Health	0	0	0	0	0	0
Special Grants	0	0	0	0	0	0
NRI Grants	88	0	240	0	245	573
SBIR Grants	64	235	430	350	282	1,361
Other CSREES	0	0	1,459	0	280	1,739
Total CSREES	412	526	2,515	958	1,450	5,861

While CSREES provides financial resources to its implementing partners in the land grant university system to conduct research, education, extension and integrated programs to solve problems of national significance, extension programs are primarily funded through different mechanisms and are implemented at the county, town, and parish level. CSREES funding comprises 5-25 percent of states' extension budgets. While CSREES collaborates as a full partner with the state extension services, outcomes and impacts reported here are only partially attributed to CSREES funding. The reporting of this data, however, demonstrates the value of

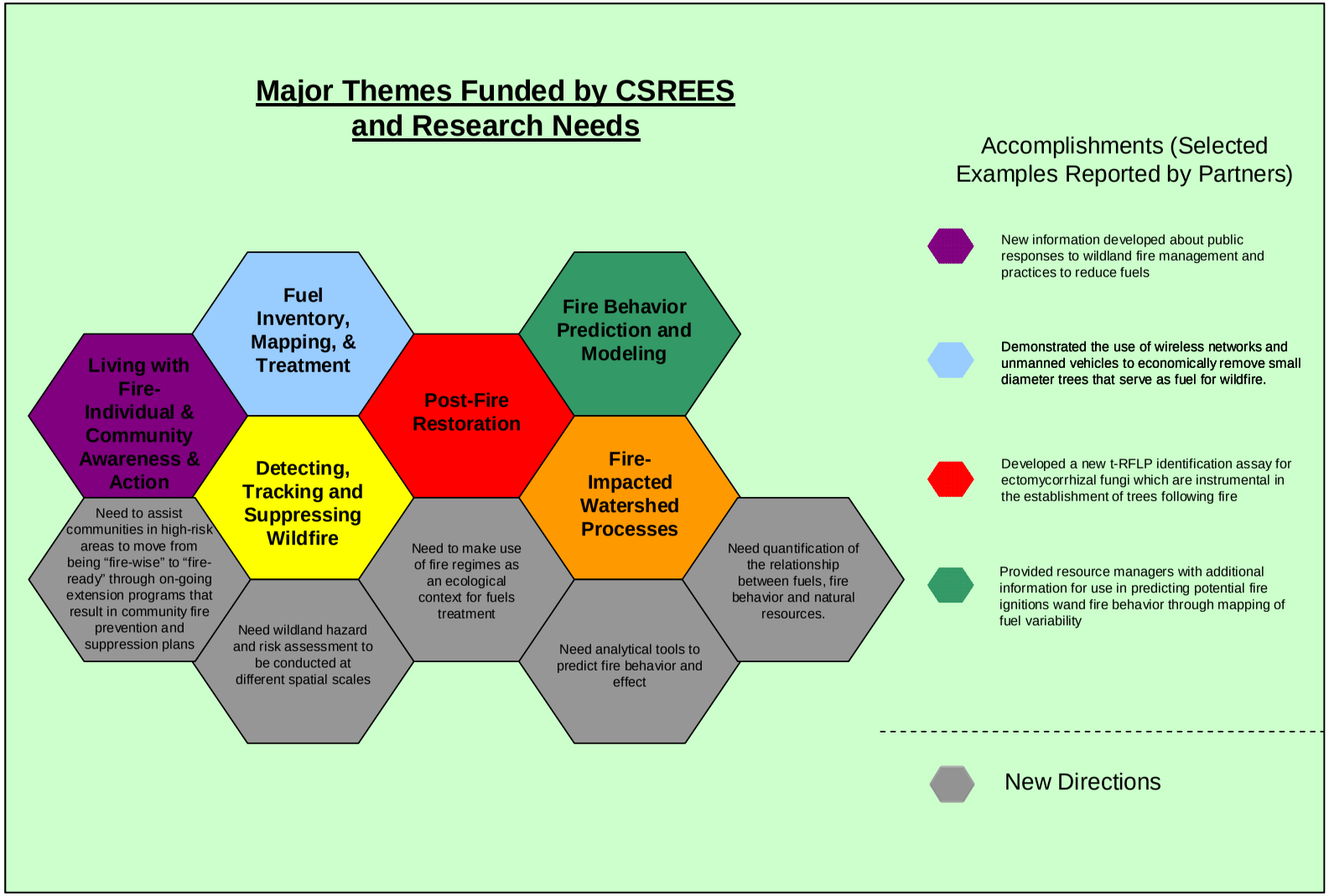
leveraged, matched and blending funding approaches that result in greater impact than what would be accomplished without the federal contribution. Other funding sources that states utilize include state and local government funding, industry, foundation and other non-profit grant-making organizations.

Personnel resources at CSREES that are allocated to this problem area are shown in Table 12.

Table 12. CSREES personnel resources (full time equivalents), by year and category.

	1999	2000	2001	2002	2003
National Program Leader	0.13	0.13	0.13	0.33	0.33
Program Analyst/Specialist	0	0	0	0	0
Administrative Support	0.03	0.03	0.03	0.03	0.03
Other (IPA, Shared Faculty, etc.)	0	0	0	0	0.03
TOTAL	0.16	0.16	0.16	0.36	0.39

Problem Area 122: Management and Control of Forest and Range Fires



Outputs (examples)

The outputs from the programs funded in this problem include:

Research

- From 1999-2003, 188 research projects were started or completed.

Extension

- In 2002, 6 Arizona Firewise Communities workshops in Gila, Pima and Santa Cruz counties were conducted with 642 individual participants that included homeowners, educators, community leaders, fire professionals, real estate professionals, insurance company representatives, city and county planners, and architects.
- In 2002, while wildfires raged over 700,000 acres of forest and rangelands in Montana, the Montana State University Extension Service organized six workshops in locations most affected and provided seminars and publications that helped landowners better understand the effects of wildfire on rangelands and forests, how to assess the severity of the burn, and how to plan and implement restoration treatments Two additional workshops were conducted for the Montana Logging Association and the Montana Nursery Growers Association. More than 400 landowners and local natural resource professionals attended the workshops. Many commented that they had felt helpless and frustrated, but that the workshops provided exactly the information that they needed to assess and restore their lands.
- Educational information and materials distributed to target audiences.
    - Distributed 31,700 Arizona Firewise extension publications in 2002 through County Extension Offices, local businesses, community and county fairs, local fire departments, and city offices.
    - In 2002, more than 130,000 Arizona residents were reached through media (newspapers, newsletters, magazines, journals), radio and television segments, billboards, and the internet.

Education

CSREES outputs include the external university program reviews that are requested by academic units. Annually, CSREES solicits requests for program reviews from land grant institutions. These requests are assigned to appropriate National Program Leaders who work with the requesting institution to identify and recruit an external review team. Based on the request that is received, the review will encompass some or all of a units academic, research, and extension program. Most commonly, these reviews are comprehensive in nature. There are no specific university departments that specifically address fire science. Thus, fire science would be included in overall forestry departmental reviews, where present.

Outcomes (examples, by theme)

Living with fire - Individual and community awareness and action have increased as a result of the following projects:

- New information was developed about public responses to wildland fire management and practices to reduce fuel
- Fire management agencies will be better able to anticipate local community reaction to proposed fire management activities based upon local community demographics and fire history, thus allowing agencies to increase the probability of successful program implementation.
- In Arizona, new partnerships have been developed with community groups (local fire

departments, city and town offices), national companies (Allstate Insurance, State Farm Insurance, The Home Depot) and state, federal and tribal agencies.

Fuel inventory, mapping, and treatment – Research projects create new tools:

- Demonstration of wireless networks and unmanned vehicles to economically remove small diameter trees that serve as fuel for wildfire.
- Greater understanding among researchers, managers, and lay persons about the overall sustainability of expanded fuel treatment programs, such as mechanical thinning and prescribed fire. Further, the Collaborative Learning Workshops provide tools to land managers for communicating and working with the publics affected by proposed expansions in fuel treatment programs, including better understanding of public perceptions regarding wildfire and fuels management.
- Information on the responses of native vegetation to fire, grazing and introduced species helps land managers to make informed decisions about prescribed burning, stocking rates of cattle, and control measures to reduce undesirable plant species.
- Enhanced understanding and ability of mangers to assess the efficiency of alternative fuels treatment methods with respect to costs, benefits, and effectiveness in achieving management objectives.
- Scientists who develop models for general forest management planning have additional information about the adaptations that are needed in order to include prescribed fire and fuel treatments.
- Per-acre costs of fuels treatment are higher in wildland urban interface areas for both mechanical fuels reduction and prescribed burning methods. Additionally, per-acre costs were found to be higher in areas of concern for smoke management or near population centers.
- Controlled grazing by sheep created a fire break along the urban-wildland interface, and sheep were used to determine if they can be used to control annual weeds and increase planted seedling survival following a wildfire.
- Landowners implemented restoration treatments following wildfire.

Post fire restoration – Research efforts result in new discoveries:

- Development of a new t-RFLP identification assay for ectomycorrhizal fungi which are instrumental in the establishment of trees following fire.
- Understanding controls over post-fire N losses in order to predict long term consequences of altered fire regimes.
- The BEHAVE Model has fundamental problems in its use in applying the model in circumstances for which it was not specifically developed, and/or with the characterization of wildland fuels. Because of its increasing usage, these problems need to be addressed by further exploration of the range of conditions under which the model can be applied.
- Fundamental knowledge about how to restore fire regimes in pine-dominated ecosystems in the Lake States.
- Limited range of typical fuel reduction treatments result in a wide range of predicted fire behaviors that reflect differing post-treatment fuelbed structures.

Fire behavior prediction and modeling - New models assist resource management agencies:

- Mapping of fuel variability provides resource managers with additional information for use in predicting potential fire ignitions and fire behavior.
- Land managing agencies better understand the impacts of fire prevention and suppression

on forest condition by assessing changes in fire regime for a particular forest type which provides the information needed to help them decide on remedial fuel treatments.

- New methodological tools to evaluate, in a relatively inexpensive way, the spatial distribution of fuel loadings based on remotely sensed data and models.
- Soil moisture probes can be used to study soil fungi following prescribed burning to study fire behavior and predict future fire danger.

Please see the Evidentiary Material for more information.

Performance Indicators

- Reduction of areas and structures burned through implementation of fire prevention and management activities.
- Increased use of prescribed fire to reduce fuel loads.
- Development and use of spatial and behavior models to assess wildland fire susceptibility.
- Increase in the awareness of communities and individuals about fire risks and prevention strategies.
- Increase in the number of communities and structures protected as a result of community-wide planning and structure fire-scaping.

Success Stories

Fire Research Findings Used to Update National Monument Fire Plan

The research findings from an Oregon State University project related to woodland expansion, fire history and plant community response following fire have been directly implemented into National Park Service, Bureau of Land Management, Forest Service and U.S. Fish and Wildlife Service operations in southeast Oregon, northeast California, and northwest Nevada; this affects millions of acres. Examples are: 1) The Lava Beds National Monument has incorporated the findings into their 10-year fire plan. The work is being used to develop fire prescriptions for different plan communities, 2) The Paisley district of the Forest Service has implemented an aggressive fuels reduction program based on the fire history findings. Although the Winter Fire threatened the area, treated areas were easy to defend and would have burned at low intensity, and 3) BLM in Oregon has implemented a fire program on Steens to enhance aspen recruitment and reduce the abundance of young juniper.

Fire Exclusion and Forest Structure

The Greater Yellowstone Ecosystem has demonstrated through fire exclusion during the 20th century a resulting change in forest structure in the lower forest zones. Temporal and spatial changes have been shown in the Douglas-fir forests. Evaluating fire frequency, climatic variability, and fir exclusion changes on aboveground carbon pools over the past 100 years will provide optimal strategies for future ecosystem management.

Prescribed Fire Burning Association Grows Out of Research Project

Findings from a Texas A&M research project have been used to increase the use of prescribed fire on Edwards Plateau rangelands. A prescribed fire burning association has been established to allow landowners to pool their labor, equipment and experience when conducting prescribed fires. Over 100 land owners who represent over 500,000 acres of rangeland are now members of the association. The integration of prescribed fire and goats have provided an effective, sustainable method to manage noxious brush.

"Only Ewes Can Prevent Forest Fires"
On C-Hill, Carson City, Nevada, sheep were introduced to create a fuel break. Three hundred fifty ewes grazed a 200-foot wide, 2.5 mile long corridor divided into 20 mini-pastures for one month in spring and fall. As a result of the controlled grazing of sheep, wildfire fuel reduction ranged from 700-2,000 pounds per acre. In addition, 71-83 percent of fine fuels (which contribute wildfire flame length)were removed and cheatgrass was trampled, also reducing the fire hazard. Nearly 90 percent of adjacent homeowners supported the project and preferred the sheep to other methods of creating fuel breaks. This project received a USDA Secretary's Honor Award in 2003.

Woodland Fire Arson Prevention Program
Prior to 1990, southwest Louisiana had more arsonist-started fires than all the rest of the country combined and approximately 95% were caused by woods arsonists. Since 1990 when the forestry interest groups founded the Woods Arson Prevention Program, numerous education programs, workshops, radio and TV spots, and fair exhibits and through 2001, the number of arson fires was reduced by 52 percent and the average number of acres burned was reduced by 46 percent.

Manipulating Species Composition to Understand Climate Change and Disturbance Regimes
Recent climate warming trends and an increase in human activities have led to increases in fire occurrence in North American and Eurasian boreal forests. Boreal forests are nitrogen-limited and increases in fire frequency causes N loss. By having a diversity of plant species that initially colonize the burned ecosystem, carbon and nitrogen accumulation can be enhanced. This study will manipulate plant species composition to help in understanding the long-term productivity of boreal forest in the context of climate change and altered disturbance regime.

New Directions

Several new directions and/or expanded efforts are needed in this Problem Area:

- Assisting communities in high-risk fire areas to move from being "fire-wise" to "fire-ready" through on-going extension programs that result in community fire prevention and suppression plans.
- Wildland hazard and risk assessment at different spatial scales.
- Use of fire regimes as an ecological context for fuels treatment.
- Analytical tools to predict fire behavior and effect.
- Quantification of the relationship between fuels, fire behavior and natural resources.

Problem Area 123 - Management and Sustainability of Forest Resources

Overview

This problem area is comprised of research, education and extension programs that address current and emerging issues related to the management and sustainability of the nation's forest resources. These forests provide a vast array of products, services and benefits to society. Those which are most relevant to the work that is accomplished in this problem area include: source of wood and non-wood products (e.g., medicinals, foods, decorative flora); diverse habitats for flora and fauna; climate stabilization and carbon sequestration; recreational opportunities and aesthetic enjoyment (e.g., vistas, solitude); genetic reserves; watershed functions; and physical, biological and chemical processes that undergird ecosystem processes. Thus, the management and sustainability of America's forest resources are critical components of the nation's environmental quality, economic vitality, and quality of life for its citizens.

The forests of the United States are vast, diverse, and dynamic. Forests are a dominant land cover (749 million acres) that comprise one-third of the land area. Conifer forests cover 412 million acres in the U.S. and are found predominantly in the West (315 million acres) and South (67 million acres). Broadleaf forests cover 273 million acres, and are located predominantly in the North and South (223 million acres). These forests continue to undergo radical changes as a result of human and natural disturbances. Native Americans burned the forests to clear land, harvest game, and rid it of pests; 200 million acres were cleared for agriculture between 1850 and 1900 and millions of additional acres were severely degraded as they were cut over for fuelwood to support the Industrial Revolution. More recently introduced invasive pests (plant, diseases and insects) have changed forest ecosystems. During the 1999-2003 period, 29,495,000 acres were burned, much of it by catastrophic wildfires.

Land ownership patterns result in unique issues and challenges in managing the forest resource in a sustainable manner. Private, non-industrial ownerships make up 58 percent (291 million acres) of timberland (capable of producing in excess of 20 cubic feet per acre per year and not legally withdrawn from timber production) and are the predominant ownership category in the East and South. Public forest land is the dominant holding in the West. As a result of changes in public policy, timber harvesting on public lands has nearly ceased while harvesting on private lands has increased by about 46 percent between 1986 and 2001. Industrial private forests account for 13 percent of timberland and public forests comprise 29 percent of timberland.

Despite the increase in harvests, the national data indicate that wood and fiber growth have exceeded removals for both softwoods and hardwoods. In 2001 the Nation's forest inventory accrued 33 percent more volume than was lost through mortality and harvest. However net growth rates have not been increasing as rapidly as in the past, while harvest levels have remained relatively stable since 1986. The result is that additional forest product demands have been met by increased imports.

The role of CSREES in sustainable forest management is to support independent, peer-reviewed research, the transfer of new knowledge generated by research to other scientists, natural resource professionals, and lay audiences who own or otherwise influence the condition of the forest resource. National leadership by the agency includes:1) identification, development and funding of priority issues for research, education and extension; 2) review and assess programs in the context of nationwide forest resource issues; 3) active participation in multi-state and regional

research and extension activities; and 4) administration of formula, competitive and Congressionally-directed line items.

Through the mechanism of existing legislation, CSREES supports three critical functions in carrying out its mission:

Research - Continuous research findings are needed to inform the management and sustainability of the nation's forests. Increasing human population with its subsequent demand for more goods and services requires intensive inquiry into the impacts of these demands on the ability of the resource to meet those demands in the context of sustainability. New knowledge answers the immediate questions of professional foresters and loggers, policy makers and forest landowners; provides early indications of conditions and trends that need further inquiry; and provides the discovery mechanism for new processes that produce the desired goods and services in an environmentally-benign or enhancing manner.

Education - Ensuring an adequate workforce of scientists and natural resource professionals is the goal of CSREES education programs. These programs enhance teaching excellence and academic programs and support undergraduate and graduate students in their education and research pursuits. Emerging knowledge needed to enhance forest resource sustainability is met through the interdisciplinary and visionary education programs at the nation's forestry and natural resources programs at colleges and universities.

Extension - The sustainability of the nation's forest resource is largely dependent on the actions of nearly 11 million private owners, ranchers, farmers and land managers. These groups, along with natural resource professionals, represent the primary target audiences for extension education programs. A key feature and goal of these programs is to increase their management knowledge and skills. It is often the case that once a landowner is ready to adopt the management practices they have learned about through their participation in extension programs, they then participate in the technical and financial assistance programs offered by other USDA and state agencies. Thus, extension programs serve as the "primer" for actual on-the-ground implementation.

The goal of this program area is:

> *To enhance the sustainability of the forest resource through increased understanding of the human and natural factors that affect forest ecosystems and to bring about changes in practices that reduce or ameliorate those factors which are deleterious to both the forest resource and society.*

Work in this Problem Area focuses on the biology of forest plants and trees; ecology of forest ecosystems; tree breeding; forest nursery practices; silvicultural techniques to improve and regenerate forest stands; and assessing, modeling, monitoring and forecasting forest ecosystems. Forest resources include both wood and non-wood products, often referred to as non-timber forest products or special forest products. Sustainable forest management criteria and indicators are outlined in international protocols.

Situation

The nation's forests are under many pressures, both natural and human-induced, that cause policy makers and natural resource professionals to seek and apply new knowledge in order to ensure the sustainability of the resource. The most pressing issues that constitute the work of many partners include:

- Catastrophic wildland fires caused by drought, high fuel loads, and human activity that result in devastation of ecosystem processes, loss of property and life, and severe economic consequences.
- Accelerated soil erosion from unsustainable resource management practices, including inappropriate logging, unmanaged recreation, and weather-related disturbances.
- Encroachment and invasion of highly competitive non-native plants which displace native vegetation and fish and wildlife habitats.
- Fragmentation of forest ecosystems and parcelization of forested areas that have negative effects on natural processes and management opportunities.
- Growing per capita consumption of wood and fiber at rates that are higher than any other nation in the world.
- Decreased timber harvesting on public lands that results in greater demand on private forests as a critical source of the nation's wood supply.

Major Themes

Sustainability and management of forest resources is addressed at several scales: cellular, organism, population, community, and landscape. The major themes of this Problem Area, encompassing all scales, are:

- Biology and physiology of forest trees and plants.
- Genetics, selection and breeding of forest trees.
- Ecology of forest ecosystems.
- Structure, function and management of forest ecosystems.
- Fish and wildlife habitat establishment and management.
- Insect and diseases of forest trees.
- Woody biomass conversion and utilization.
- Native and non-native invasive species (flora and fauna).
- Appraisals, inventories and models of forest resources and ecosystems.
- Forested watershed processes, conditions, and best management practices.

Assumptions

Several assumptions are understood in the overall development, implementation, and monitoring of this Problem Area:

- The unique mission of CSREES is to advance knowledge for agriculture, the environment, human health and well-being, and communities by supporting research, education, and extension programs in the Land-Grant University System and other partner organizations.
- CSREES does not conduct actual forestry research, education, and extension programs, but rather helps fund it at the state and local level and provides program leadership in these areas.
- Independent scientists at universities and natural resource agencies identify pressing forestry research questions in conjunction with stakeholders.
- Universities have the personnel and facilities to accomplish CSREES-funded projects.
- Universities are the appropriate setting for research, extension and education programs.
- Funding recipients use interdisciplinary approaches to plan, implement and evaluate research, education and extension programs.
- Funding recipients utilize established networks and create partnerships to accomplish program goals and objectives.

- In the pursuit of new knowledge, forestry research findings may lead to new questions.
- The exact course, progress and end result of scientific inquiry is not predictable.
- The transfer of new knowledge to the research community, natural resources professionals, policymakers and lay audiences (e.g., public and private forest owners/managers) is an integral step in moving research findings to application on the ground.
- Research findings provide answers to those who need them.
- The pursuit of new knowledge and its transfer involves the academic preparation of the next generation of forestry scientists and educators.
- Multiple funding sources are employed by universities in the development and delivery of forestry programs.
- CSREES funding will at times serve as the major funding, seed funding, or leveraged funding for various research, education and extension projects.

External Factors

Several factors affect the performance, outcomes and CSREES program attributions that are achieved in this problem area. These include:

- Emerging forest insect and disease problems that are discovered, including emerald ash borer, sudden oak death syndrome, and bark beetle infestations.
- Political priorities and policy initiatives such as the 2002 Farm Bill Forestry Title that identify new issues and mandate new programs and approaches to address the issues.
- Multiple sources of information that target audiences access. Private forest landowners receive information from mass media (print, radio and television), other agencies and organizations, other forest landowners, family members, and professionals.
- The USDA "Triad of Services." In addition to extension education programs, private forest owners are eligible for and receive financial assistance and incentives to assist with the costs of implementing forest management practices, and technical assistance that provides detailed, one-on-one aid to landowners.
- Multiple funding sources. In addition to federal extension, technical assistance and financial incentive programs, individual states, counties, parishes, and villages; non-governmental organizations; and the forest industry provide various types of assistance programs.
- Economic conditions. Economic growth or lack thereof is a trigger for multiple events that impact the forest resource. These events include: parcelization of large tracks into small tracts by landowners seeking additional income; impromptu timber harvests to provide much-needed income; and creation of new small-scale forest-based enterprises that result in modification of the forest resource at various scales.
- Forest product markets. The strength of the U.S. dollar changes the nature of international timber markets and the competitiveness of U.S.-grown and produced forest products.
- Natural disasters, such as the 1998 ice storms in the northeastern U.S., result in catastrophic changes to forest ecosystems, huge financial losses for forest owners, and markets flooded with downed timber. CSREES program partners react to these situations by directing programs and resources to address these emergencies.
- Changes in funding that result from federal administrative actions can result in program funding extremes, ranging from the termination of funding (e.g., Forest Land Enhancement Program) to huge increases (Environmental Quality Incentives Program) with resultant changes in the adoption of forest management practices.

Inputs

The resources that are allocated to this problem area must to be considered at two levels: 1) those which are provided by CSREES and, 2) the transformation of those resources by program partners and funding recipients into different resources that are directly applied to programs and projects.

CSREES provides two resources: funding and personnel. The funding inputs include: Cooperative Forestry Research, Renewable Resources Extension Act, Hatch Act, Smith-Lever Act, National Research Initiative, Small Business Innovation Research, and multiple Higher Education Program funds. The funding for research is shown in Table 2.

While CSREES provides financial resources to its implementing partners in the land grant university system to conduct research, education, extension and integrated programs to solve problems of national significance, extension programs are primarily funded through different mechanisms and are implemented at the county, town, and parish level. CSREES funding comprises 5-25 percent of states' extension budgets. While CSREES collaborates as a full partner with the state extension services, outcomes and impacts reported here are only partially attributed to CSREES funding. The reporting of this data, however, demonstrates the value of leveraged, matched and blending funding approaches that result in greater impact than what would be accomplished without the federal contribution. Other funding sources that states utilize include state and local government funding, industry, foundation and other non-profit grant-making organizations.

Two specific funding sources support, in part, the work in this problem area: the McIntire-Stennis Cooperative Forestry Research Act and the Renewable Resources Extension Act. The McIntire-Stennis Act provides funding to 65 state-governor designated forestry schools to conduct research in seven broad areas. This legislation requires a 1-to-1 match of state funds, but the total leveraging exceeds that significantly as shown in Table 13.

Table 13. Federal and Leveraged Funds and Ratio, by Year.

	Fiscal Year *($ in thousands)*				
	1999	2000	2001	2002	2003
McIntire-Stennis Funds	20,733	20,688	20,686	20,641	20,651
Leveraged Funds	102,198	109,606	115,245	162,047	157,660
Total	122,931	130,294	135,931	182,687	178,312
Ratio of M-S to Leveraged Funds	4.93	5.3	6.57	8.85	8.63

The Renewable Resources Extension Act of 1978 (RREA) has provided focused and designated federal funding that targets forest and rangeland resources. CSREES provides funding to 72 land grant institutions where the federal funds are leveraged with state, territory, institutional, and local funds to engage a wide variety of partners to deliver educational programs to forest and rangeland owners and manages. For example, in 1999, $3.192 million in RREA funding was supplemented by more than $30 million from other sources.

Table 14. RREA Funding from FY 1999 – 2003.

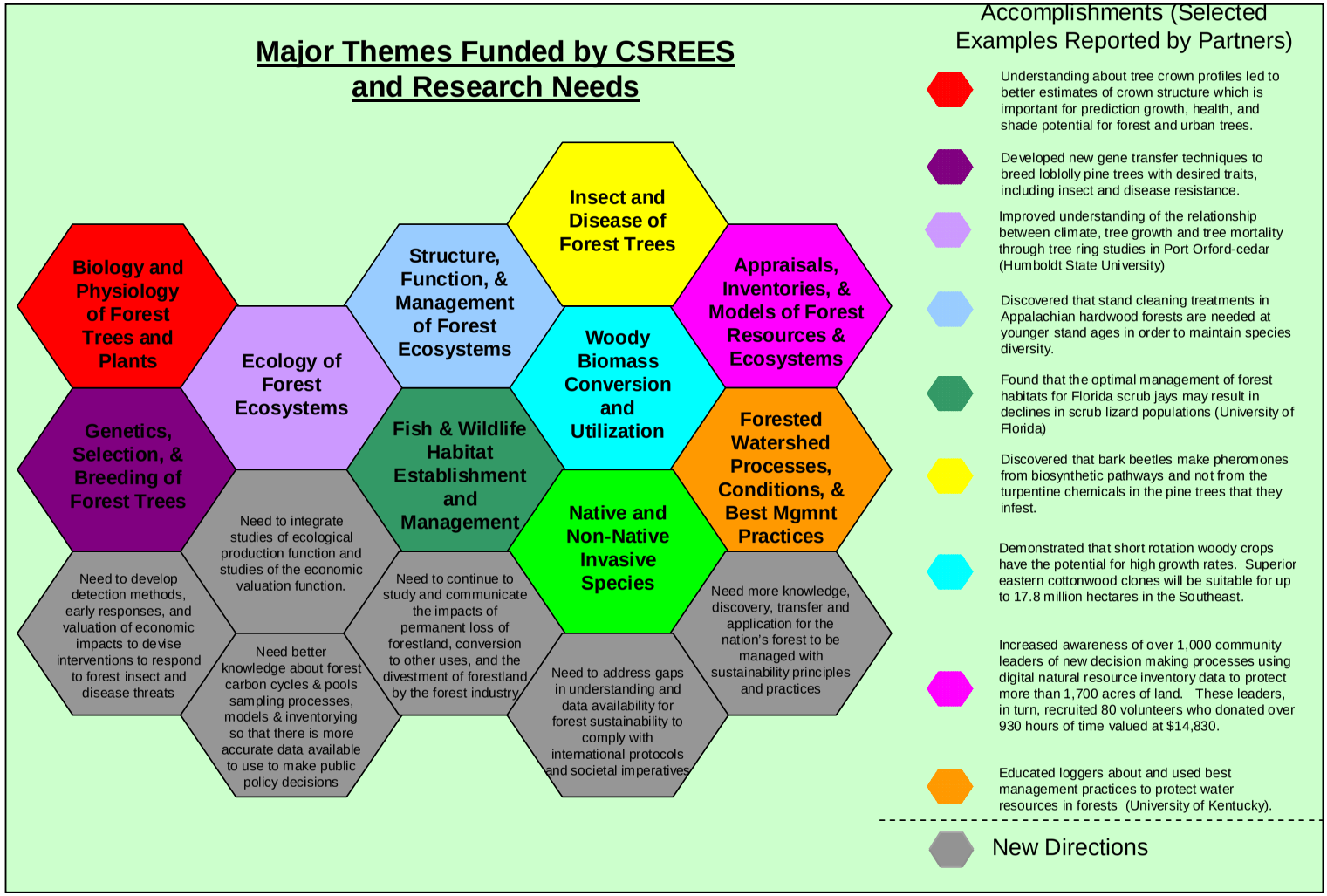
Fiscal Year *($ in thousands)*					
1999	2000	2001	2002	2003	Total
3,192	3,192	2,982	4,093	4,516	17,975

Personnel resources at CSREES (Table 15) that are allocated to this problem area consist of National Program Leaders, Program Specialists/Analysts, Administrative Support, and other personnel that are added for specific projects, such as an IPA in 2001 to work on Farm Bill issues that would be addressed in 2002.

Table15. CSREES personnel resources (full time equivalents), by year and category.

	1999	2000	2001	2002	2003
National Program Leader	1.2	1.4	1.4	2.7	2.15
Program Analyst/Specialist	0	0	0	0.35	0.75
Administrative Support	0.85	0.85	0.85	0.8	0.8
Other (IPA, Shared Faculty, etc.)	0.5	0.4	1.4	0.2	0
TOTAL	2.55	2.25	3.65	4.05	3.7

Problem Area 123: Management of Sustainability of Forest Resources



Outputs

The inputs into this problem area result in multiple outputs.

Research:

- Scientist-years of effort.
- Research findings that are disseminated via research publications (Table16).
- Graduate degrees awarded.
- Patents awarded; and conferences and symposia that are conducted.
- National Research Initiative grants to eligible institutions.

Table 16. McIntire-Stennis Publications and Scientist-Years, by Year.

	Fiscal Year				
	1999	2000	2001	2002	2003
McIntire-Stennis Research Publications	1254	1229	927	1596	1875
McIntire-Stennis Scientist Years (SY)	406	420	406	368	393
Publications/SY	3.09	2.93	2.28	4.34	4.77

Extension:

- Education programs and publications that transfer research findings to end users;
- Volunteers recruited and trained;
- Mass media and other information dissemination efforts.

Education:

- New or modified curricula,
- Student scholarships and stipends,
- Professional development for faculty members,
- Development of new teaching methods.
- CSREES outputs include the external university program reviews that are requested by academic units. Annually, CSREES solicits requests for program reviews from land grant institutions. These requests are assigned to appropriate National Program Leaders who work with the requesting institution to identify and recruit an external review team. Based on the request that is received, the review will encompass some or all of a units academic, research, and extension program. Most commonly, these reviews are comprehensive in nature. During this portfolio reporting period, the following CSREES Reviews were conducted:

    - 1999
        - School of Natural Resources, University of Vermont
        - School of Forestry and Wood Products, Michigan State University
        - School of Forestry, Auburn University
        - Department of Natural Resources, Cornell University

    - 2000
        - School of Forestry, Wildlife and Fisheries, Louisiana State University (included multiple disciplines)
        - School of Natural Resources, The Ohio State University

- 2001
  - School of Natural Resources, University of Missouri

- 2002
  - Department of Forest Resources, Oregon State University
  - Department of Forest Ecology, University of Wisconsin
  - School of Renewable Natural Resources, University of Arizona
- 2003
  - Department of Forest Management and Department of Forest Ecosystem Science, University of Maine
  - School of Natural Resources, University of Nebraska-Lincoln
  - Division of Forestry, West Virginia University

Outcomes (Examples, by major theme)

Biology and physiology of forest trees and plants.

- The concept of "miniature plantations" with tree seedlings at spacings as close as 4 inches may be able to shorten the time line from 20-30 years to 3-5 years in order to obtain research results.
- Understanding about tree crown profiles led to better estimates of crown structure which is important for predicting growth, health, and shade potential for forest and urban trees.

Genetics, selection and breeding of forest trees.

- New gene transfer techniques were developed to breed loblolly pine trees with desired traits, including insect and disease resistance.
- Virtually all tree planting on commercial forest lands in Florida and parts of Alabama use genetically improved seedlings. Recent slash pine improvements include: 1) decreased time interval between generations of improvements from 34 years to 12 years, 2) decreased the number of genetic tests needed per generation from 640 tests to 10 tests, 3) decreased the number of trees measured per generation from 1.25 million to 0.04 million, 4) decreased disease incidence over unimproved plantations from 10-38 percent, and 5) increased productivity from 9-23 percent over unimproved plantations.

Ecology of forest ecosystems.

- Tree ring studies in Port Orford-cedar have improved the understanding of the relationship between climate, tree growth, and tree mortality.
- By understanding the impact of the cessation of fire regimes on the Kaibab Plateau, researchers have concluded that reinstituting a more natural fire regime would likely reduce aspen recruitment.
- Changes in CO_2 and O_3 experimental atmospheres modify soil food webs and ecosystem processes in predictable ways, thus providing new understanding of the effects of rising atmospheric CO_2 and O_3 on the composition and functions of forests in the upper Lake States region.

Structure, function and management of forest ecosystems.

- Researchers discovered that standard cleaning treatments in Appalachian hardwood forests are needed at younger stand ages in order to maintain species diversity.
- Landowners learned how to develop their own forest stewardship plans.
- Landowners implemented stewardship plans resulting in: tree plantings to reestablish

forest canopy cover; road, bridge and culvert installations to protect water quality; forest stands thinned and harvested; and wildlife habitat created for species at risk.

- Information on forest stewardship practices helps resident and absentee forest landowners make informed decisions to meet their forest management goals and objectives.
- Research findings related to the ecological foundation for the management of giant sequoia stands were used by the FACA Science Advisory Board for the Giant Sequoia National Monument-Environmental Impact Statement and for the development of management practices for the Monument.

Fish and wildlife habitat establishment and management.

- The optimal management of forest habitats for Florida scrub jays may result in declines in scrub lizard populations.
- Research findings have demonstrated that a one-time application of silvicultural herbicide in mature pine systems in the Southeast can be used to renovate forest stand conditions and improve habitat for early successional wildlife species such as the northern bobwhite, and that the herbicide savings from only needing one application is $450/acre over a 20-year period, or $10 million across the South.
- The American marten, previously thought to be confined to undisturbed, old growth forests can also thrive in managed forests as long as some vertical structure is maintained. This new information provides managers with the tools needed to develop landscape-scale conservation strategies.
- Studies of the impact of forest management (pine-grassland restoration) for red-cockaded woodpecker habitat and northern bobwhite indicate a high degree of compatibility. Thinning of mature hardwoods and pine followed by prescribed burning on a three-year rotation benefitted both species.

Insect and diseases of forest trees.

- Researchers discovered that bark beetles make pheremones from biosynthetic pathways and not from the turpentine chemicals in the pine trees that they infest. The key enzyme that regulates pheromone production in bark beetles is the same one that regulates cholesterol production in humans.
- New research findings showed that adding an enhanced virus (Blankophor BBH) to previously recommended virus strains resulted in a more effective treatment against gypsy moth. This find resulted in no needed spraying vs. 67,000 acres treated prior to this discovery, resulting in a $2 million savings to taxpayers in a single state, and a $10 million savings when adjoining states were included.
- Results of research studies have produced a detailed GIS data base for the distribution of hemlock wooly adelgid in the Great Smoky Mountains. From this data, a predictive spread model that outlines the likely annual extent of the insect provides managers with a basis to direct their prevention measures.

Woody biomass conversion and utilization.

- Short rotation woody crops have demonstrated potential for high growth rates. Superior eastern cottonwood clones identified in research studies will be suitable for up to 17.8 million hectares in the Southeast.
- New varieties of shrub willow developed through controlled breeding will lower production costs by about 13 percent for every 20 percent increase in yield, thus stimulating adoption and commercialization.

Planning, appraisals, inventories and models of forest resources and ecosystems.

- Over the course of two years, more than 1,000 community leaders have become aware of new decision-making processes using digital natural resource inventory data to complete new Conservation Commissions and to protect more than 1,700 acres of private open space. These community leaders, in turn, recruited 80 volunteers who donated 930 hours of time valued at $14,830.

Forested watershed processes, conditions, and best management practices.

- Loggers learned about and used best management practices to protect water resources in forests.
- Research findings about the impacts of harvesting in redwood - Douglas-fir forests in the Coastal Mountains of California yielded information that was useful to the local timber industry and regulatory agencies.
- Limiting summer grazing in wooded draws has favored restoration of tree cover: 75 percent increase in basal area; 37 percent increase in tree density; 45 percent increase in sapling density; and 16 percent in upslope spread. Results were published in a restoration guidebook for which there have been more than 6,500 requests.
- Giant cane and forest riparian buffers in southern Illinois significantly reduced surface runoff, nutrient and sediment concentrations, and groundwater nitrate concentrations in a relative narrow width (20 feet).

Please see the Evidentiary Materials for more information.

Performance Indicators

- Improved forest health, resilience and productivity.
- Increase in development and use of forest management plans.
- Increase in implementation of forest management activities.
- Increased achievement of landowner/manager goals and objectives.
- Amount of volunteer hours provided.
- Increase in the number of educational materials developed and provided to target clientele.

Success Stories

- Forest growth and production models developed by Virginia Tech researchers result in approximately $50/acre increase in net present value when used instead of stand stocking tables to determine management practices. With 90,000 acres of loblolly pine plantations in Virginia, the potential economic impact of improved timber management from using the models is $4.5 million per year.

- Biotechnology represents the best hope for meeting the urgent needs of tree breeding programs, preservation of gene pools of wild relatives, and the development of elite cultivars in a short time. Researchers at Oklahoma State University have used gene transfer technology to develop improved loblolly pine genotypes with desired traits such as disease and insect resistance. Lastly, the identification of a novel anti-microbial peptide holds promise in the development of new pest management products that could combat pest problems in plants, animals and humans.

- Developmental pressures on the Montana's Flathead County have resulted in the harvesting of old growth forest, alteration of rivers by hydroelectric power development, pollution of lakes and streams from agricultural and urban runoff, degradation of wildlife habitat, loss of native biodiversity, and air pollution. The goal of a University of Northern Iowa project is to develop a landscape modeling system that will enhance the capacity of stakeholders to evaluate the ecological and economic impacts of past and future landscape changes. Four landscape modeling systems will address the needs for future land requirements through 2030 that will balance economic demands and ecological sustainability of diverse land use practices.

- A study site in Michigan offers an exceptional opportunity to study a large managed forest ecosystem used for timber harvest and deer hunting. This study will look at multiple components of forest functions, including tree production, supporting wildlife populations, economic value of these services, and the effect on ecological and economics under different management scenarios. This will allow land owners to better understand the economic trade-offs among various forest products and ecosystem services and ways to optimize management choices.

- The species composition of the central hardwood forest in the Appalachian region is changing in a manner that results in fewer species regenerating naturally. This loss of species diversity influences the quality of wildlife habitat and decreases the economic value of the forest. A research project at West Virginia University is studying the changes that occur and calculating species diversity indices before and after clearcutting. The results of this study emphasize the need for early silvicultural treatments such as cleanings in order to maintain species diversity. Further, the results show that these cleanings need to occur at about 10 years post-harvest, not the 12-20 year timeframe that has been the standard.

- From 1991-2003, Montana State University Extension conducted 80 workshops involving 2,000 landowners. As a result of these workshops, 950 Stewardship Plans have been written by the landowners and 460,000 acres have been certified. Fifteen percent of the workshop graduates are out-of-state absentee landowners who spent two weeks learning about their Montana forest property. A 1999 independent survey of program graduates showed that 87 percent had implemented their stewardship plan. The specific actions taken include: 4,000 acres of forest had been thinned; 4,000+ acres had been treated for weeds; 9,000,000 board-feet of timber and 9,000 tons of pulp had been harvested; 48 miles of new roads were built, including 107 drainage culverts and 11 bridges; over 3,000 acres of wildlife habitat established; and 4,000 acres had been planted with trees. The survey also indicated that 76 percent of the program participants had changed their thinking about natural resources management.

- A seven-night forest landowner short course (21 total hours) was broadcast live from Clemson University and down-linked to nine locations across Tennessee and involved 85 participants owning 32,000 acres of forest. In addition to the potential impact on the forest resource, this program was successful in that 50% of the participants had never attended an Extension program; 60% had never attended any type of forestry education program; and 35% were absentee landowners.

- As a result of Washington State Extension programs on special forest products, 38 new family businesses were organized in Washington, Idaho, Oregon, Alaska, Montana,

California, and British Columbia. Using mushrooms, greenery, wild edibles, craft materials and native landscape plants, entrepreneurs have developed a wide array of products, including holiday wreaths, wild berry juices, dog beds, preserved floral products, fresh mushrooms, fence rails, carving stock, and essential oils. The gross annual income of these firms exceeds $1.3 million. An organization, the Northwest Research and Harvesters Association with 51 full-time members working with 11 researchers was established. The members have produced over $210,000 of raw products and established 26 permanent research plots. Association members entered into an export agreement with a Korean food buyer to supply 60 tons of fiddlehead ferns as part of an eventual purchase of 560 tons per year.

- More than 1,300 loggers have been trained in the Kentucky Master Logging Program. These loggers accounted for harvesting timber on more than 522,648 acres and nearly 1.6 billion board feet of timber. As a result of the impacts, this program received the Governor's Environmental Excellence Award in 2003.

- Michigan State University Cooperative Extension provided intensive education to a group of forest landowners through the Master Woodland Manager Program. Of the 183 participants, 100 survey respondents reported that they contributed 2,300 hours of volunteer service in extending forestry education to others. Additionally, 15 percent of the respondents earned more than $5,000 each from management activities of their own property since completing the program and 82 percent had implemented at least one management practice.

- New Hampshire Cooperative Extension provided on-site assistance to 1, 853 landowners who collectively control 42,950 acres. Over 2,000 forest stewardship plans have been developed since 1990. These plans cover 520,000 acres or approximately 15% of the private forestland in the state. Extension provided over 310 forestry or forestry-related seminars, workshops and programs throughout the state, reaching nearly 14,000 people. Forty-seven of these programs were conducted for natural resource professionals who, in turn, reach another 2,300 forestland owners. Additional educational information was provided via 10,000 website inquiries, a newsletter that reached 4,000 natural resources professionals and newsletters that collectively targeted 35,000 to 40,000 people.

New Directions

Several new directions and/or expanded efforts are needed in this Problem Area:

- Detecting, identifying, assessing and responding to forest insect and disease threats - Significant increases in the movement of humans and trade goods among nations and their ecosystems have coincided with the transport of plant and animal species to new ecosystems where they often proliferate to damaging and sometimes catastrophic levels. Detection methods, early responses, and valuation of economic impacts are needed in order to devise appropriate interventions.

- Valuation of ecosystem services provided by forests - Valuing ecosystem services requires the integration of ecology and economics. This is a complex challenge in that translating ecosystem structure and function into goods and services and combining that with lack of markets or market prices makes the quantification extremely difficult. Studies of the ecological production function need to be integrated with the studies of the economic valuation function.

- Forest carbon cycles and pools - Forest ecosystems and forest products represent 90 percent of all the carbon sequestration in agriculture and forests. Better knowledge is needed about sampling processes, models and inventorying in order to have more accurate data which may be used in public policy decisions.

- Forestland fragmentation, conversion, and divestment - The impacts of permanent loss of forestland, conversion to other uses, and the divestment of forestland by the forest industry are not fully known. These trends will continue and need to be studied and communicated to local, state and national policy makers.

- Frameworks for describing, assessing and evaluating sustainable forest management - Sustainability is a concept that is receiving increased attention and discussion. The 2002 National Report on Sustainable Forests — 2002 has raised as many questions as it answered. Numerous gaps in understanding and data availability were identified and need to be addressed in order to comply with international protocols and societal imperatives.

- International and global implication for U.S. forests - Invasive species, trade, competition, and climate change have major implications for the U.S. forest sector. More knowledge discovery, transfer, and application are needed in order for the nation's forests to be managed with sustainability principles and practices.

Problem Area 124 - Urban Forestry

Overview

Urban forestry is the art, science and technology of managing trees, forests and open spaces to support healthy cities and towns. It is, in essence, bringing the forest to the people. The principal purpose of urban forestry is preservation, as opposed to traditional forestry's main purpose of production.

The nation's 69 million acres of urban forests provide environmental, economic and social benefits. Environmentally, a primary benefit of healthy urban trees is clean air and water. Trees absorb air pollutants and act as natural filters to deliver clean air. Trees soften and filter rainfall to reduce storm water flow and modulate the urban environment's air temperature. Economically, urban trees and forests increase property values and reduce city maintenance. Trees around homes and buildings reduce energy use and costs. The cooling effects of trees help reduce the need for utilities to increase power generation capacity to meet peak energy load demand. Nationally, about 900 million metric tons of carbon are stored in the country's urban forests --- contributing to the reduction of greenhouse gases responsible for global warming. Socially, healthy urban trees and forests help strengthen communities by reducing crime and revitalizing neighborhoods. Trees enhance our quality of life and make our cities and towns better places to live, work and play.

One of the most important but least recognized benefits of the urban forest is its power to improve physical and mental health. There is evidence that the urban forest helps combat obesity, improves cardiovascular health, increases longevity and enhances physical development in children. Healthy trees deliver powerful environmental benefits for 45,000 communities where 80 percent of Americans call home. Can we afford to risk the benefits of our urban forests valued at over $400 billion? The urban forest is an integral part of city infrastructure and requires budget and research attention similar to health, utilities and education.

The goal of this problem area is:

> *To enhance the sustainability, health, and diversity of the urban forest through research, teaching and education programs.*

Situation

Urban forestry is a relatively new research program area (1998), but it is gaining significant interest in federal, state and local government sponsored programs. Many academic institutions are adding urban forestry to their instructional and research portfolio. Additionally, many private organizations and non-profits are increasingly engaged in the practice of urban forestry, including establishment, maintenance, restoration, design, protection and growing of urban trees and forests. The discovery of new knowledge is essential to enhance the health and sustainability of urban forests.

The vitality of this resource is at risk. Urban trees have been shown to have significantly shorter life span than their counterparts in the rural forests. This may be due to environmental stresses (pollution, flooding, drought, high temperature), biological stresses (injuries inflicted by humans, pests, diseases, invasive species), and site factors (limited soil volume, poor soil quality, soil contamination, etc). Research attention is needed to increase our understanding of how this resource can be sustained to its highest vitality. Extension programs are needed to deliver this information to the appropriate audience.

A key factor limiting the progress of urban forestry work is the low number of people working in this discipline; scientist years range from ten to sixteen per year, with personnel scattered across universities and private institutions. Support for graduate students is minimal; thus the next generation of researchers and educators is not being trained.

A cursory look at the CSREES investment in urban forestry reveals that for the past five years (1999-2003), the agency provided total funding of $3.95 million for 59 projects. This was effectively leveraged by non-federal funds totaling $12 M. While relatively low, this investment has allowed urban forestry to slowly move forward in addressing critical research, education and extension needs.

Major Themes

The major themes include:

- Urban environment (soils, water, air, contaminates)
- Biological damage and urban forest health (pest, diseases, invasive species, humans)
- Species diversity and plant evaluation for the urban landscape (selection, establishment and maintenance)
- Genetic improvement of urban plants (genetic engineering, biotech, classic breeding and tree improvement)
- Tree growth regulation (vegetative and reproductive growth)
- Social aspects of urban forestry
- Wildlife and urban land use

These major themes represent a cross section of urban forestry research supported by CSREES from 1999 to 2003. The themes also illustrate the multi-disciplinary nature of urban forestry, encompassing everything from planting and care of individual trees to regional and national issues of forests' role in storm water runoff, changing land use, forest and habitat fragmentation, air quality, human health, species selection and invasive species. The identification of these issues is mainly attributed to the management priority needs of urban forests and the expertise of urban forestry researchers.

Assumptions

- Based on national, state, and local priorities, USDA CSREES supports urban forestry research and education through various funding mechanisms that include the McIntire-Stennis Cooperative Forestry Research Program, Hatch Act, National Research Initiative, Small Business Innovation Research, Evans-Allen, and Special Research Grants.
- The Agricultural Research, Education and Extension Reform Act of 1998 requires recipients of formula funds from CSREES to collect stakeholder input and describe how this input is used.
- The bulk of actual urban forestry activities and programs are supported by USDA Forest Service through the State and Private Forestry-Urban and Community Forestry Program with a dedicated funding from Congress. The Research and Development Unit contributes to the research effort via its Centers of Excellence. The National Urban and Community Forestry Advisory Council recommends projects to be funded under the Urban Forestry Challenge Cost Share Grant Program.
- State Urban Forestry Councils, City Green organizations, volunteer groups and non-profits provide grassroots support for urban forestry.

- The 80 percent of the population that live in urban areas are the direct beneficiaries of the urban forest. This diverse population represents a huge clientele base that can move urban forestry to higher levels of visibility and funding.

External Factors

The initiation, performance, outputs and outcomes of projects in urban forestry are influenced by a number of factors among which are:

- Institutional commitment and technical capacities of partners to engage in urban forestry research, education and extension affect the kinds of projects to be done and the extent of success to be achieved. Urban forestry is a relatively new discipline and therefore has limited capacity.
- Funds to support urban forestry work are limited. Federal, state, and local appropriations vary significantly from year to year, resulting in some critical issues unattended. Also, limited funding does not allow for broad-based collaborative efforts needed to examine the complexities of the different levels of interaction in an urban forest ecosystem.
- The amount of volunteer and nonprofit participation influences the extent and sustainability of urban forestry work. Urban forestry in the past has been substantially reliant on volunteer work to accomplish much of its work.
- National initiatives such as the Greening of America, Urban-Rural Interface, Urban Tree House, and organizations such as the American Forests, Alliance for Community Trees, National Tree Trust, International Society of Arboriculture, National Arbor Day Foundation, and others immensely influence the direction and extent of urban forestry activities.
- The USDA Forest Service Urban and Community Forestry Program (funding of $30-36 million per year) directs and funds the majority of urban forestry activities.
- The National Urban and Community Forestry Advisory Council (NUCFAC) provides guidance to the Secretary of Agriculture on an annual basis, develops a national urban and community forestry action plan, and administers a challenge cost share grant ($1million per year).
- The harsh urban environment (temperature extremes, impervious structures, flooding, drought, pollution, toxic wastes, salt, vandalism, pests and diseases) impacts the survival, health and sustainability of the urban forest.

Inputs

Program inputs to urban forestry (Problem Area 124) for the period 1999-2003 consist of program funds, personnel, partners' time and expertise, matching funds, and graduate student efforts. Total funds committed by CSREES for this period amounted to $3.95 million. The breakdown of sources on an annual basis is presented in Table 17.

It is interesting to note that while McIntire-Stennis provides the largest share of funding, Evans-Allen (an 1890 version of the Hatch Act) came out second. This demonstrates that the 1890 institutions are providing a significant investment in urban forestry research. The other CSREES funding ($ 589,000) came from the Capacity Building competitive grant program for the 1890 institutions to build capacities in research and education. One 1890 institution (Southern University and A&M College) prides itself in having the first and only degree granting program in urban forestry in the nation. This program has trained minorities in urban forestry that are now successfully managing and tending city and town forests across the country. Special research grants ($35,000) in 2003 funded the urban silviculture research objective, addressing the

quantification, deposition and retention of PM 2.5 particulates by tree foliage. All these funds supported 39 to 50 research projects per year during 1999-2003.

These CSREES funds are leveraged by state and other nonfederal sources by as much as 3 times. The total match for this same period was $12.0 M. The other sources of funds are reflected in Table 18.

Table 17. CSREES funding for PA 124: Urban Forestry, by source and year.

Funding Source	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
Hatch	62	98	257	186	140	743
McIntire-Stennis	206	309	356	256	274	1,401
Evans-Allen	270	82	249	249	218	1,068
Special Grants	0	0	0	0	35	35
NRI Grant	80	36	0	0	0	116
SBIR Grant	0	0	0	0	0	0
Other CSREES	0	0	0	365	224	589
Total CSREES	618	525	862	1,056	889	3,952

Table 18. Funding for PA 124 by year and funding categories from 1999-2003 (X $1000).

Funding Source	Fiscal Year *($ in thousands)*				
	1999	2000	2001	2002	2003
CSREES	618	525	862	1,057	889
Other CSREES	380	243	279	325	362
Other Federal	129	197	208	319	204
Non-federal Match	1,298	2,052	2,556	3,092	3072
Leveraging (Match/CSREES)	2.1	3.9	3	2.9	3.5
CSREES as % of Total	36.8	22.8	30.4	30.9	25.8

While the state contribution to urban forestry research funds increased, the CSREES share declined proportionately (Table 16).

Urban forestry is conducted in the federal government by several agencies, including USDA Forest Service, USDA-CSREES, US Environmental Protection Agency, US Department of Energy, USDA Agricultural Research Service(National Arboretum), and USDI National Park Service and Fish and Wildlife Service.

The USDA Forest Service Research and Development Unit has conducted urban forestry research for over 20 years. Fund allocation has grown steadily from about $1 million in 1992, to $2.6 million in 1997, to $3.5 million in 2003. Although these amounts are less than one percent of the total USDA Forest Service research and development budget ($250 million), it has increased

moderately over the years and is projected to grow to $12 million in 2008 and $24 million in 2013.

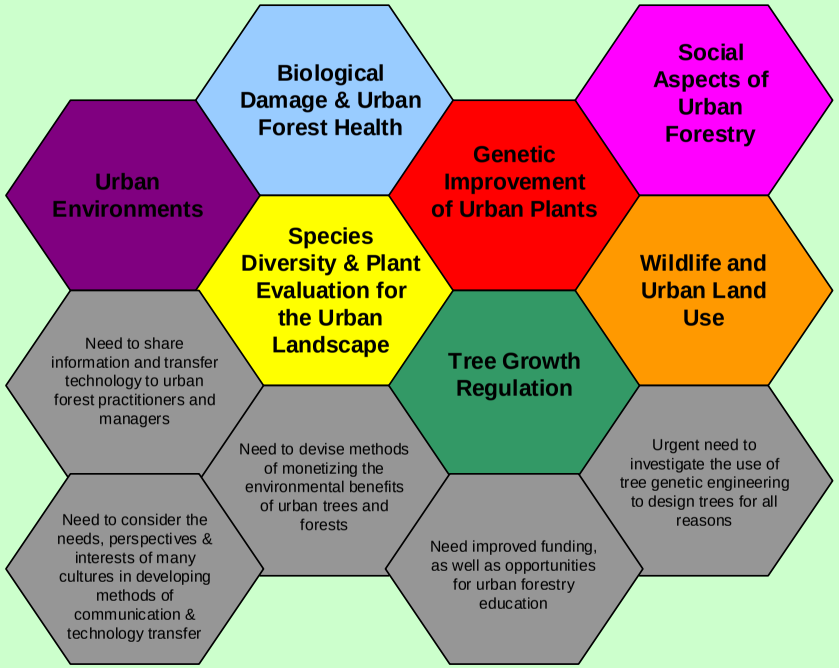
The US Congress appropriates approximately $30 to 36 million a year for the USDA Forest Service State and Private Forestry's Urban Forestry Program. This funding is primarily distributed to the states through the State Forester's office using a formula allocation.

Table 19. CSREES personnel resources (full time equivalents), by year and category.

	1999	2000	2001	2002	2003
National Program Leader	0.25	0.4	0.4	0.4	0.4
Program Analyst/Specialist	0	0	0	0	0
Administrative Support	0.1	0.1	0.1	0.1	0.1
Other (IPA, Shared Faculty, etc.)	0	0	0	0	0
TOTAL	0.35	0.5	0.5	0.5	0.5

Problem Area 124: Urban Forestry

Major Themes Funded by CSREES and Research Needs



Accomplishments (Selected Examples Reported by Partners)

- Showed that tree foliage is ineffective in trapping of PM2.5. This led to development of extension programs in New York.
- Found that a high volume and low concentration injection performed best compared to low volume and high concentration injection.
- Evaluated 750 trees and information was provided to communities and nurseries for guidance in species selection
- Identified two separate genes for Dutch elm disease resistance in American elm.
- Discovered that the gibberellin synthesis inhibitors paclobutrazol and flurprimidol significantly reduced elongation growth of branches and apical shoots
- Discovered that minorities in the profession have a higher income than either white males or females.
- Image classification and analysis showed that , between 1984 and 1994, the total acres of urban or developed areas increased by 21%.

New Directions

Outputs

Outputs from CSREES funded projects include:

Research:

- Results are delivered to technical, scientific, and decision-making audiences using different kinds of media (technical publications, extension bulletins, databases, poster and oral presentations in conferences).
- New technologies, patents and new practices for urban forest management and culture.

Education:

- Training of graduate students (number of graduates)
- Number of interns trained
- Enriched curricula
- CSREES outputs include the external university program reviews that are requested by academic units. Annually, CSREES solicits requests for program reviews from land grant institutions. These requests are assigned to appropriate National Program Leaders who work with the requesting institution to identify and recruit an external review team. Based on the request that is received, the review will encompass some or all of a unit's academic, research, and extension program. Most commonly, these reviews are comprehensive in nature. There are no specific university departments that specifically and singularly address urban forestry. Thus, urban forestry would be included in overall forestry departmental reviews (listed in PA 123), where present.

Outcomes

Short term

- Dollar leveraging. The federal funds invested for urban forestry were significantly leveraged by non-federal funds by as much as 2 to 4 times. This is considerably higher than the amount required by law (100%) for matching funds. This indicates the growing interest of cities and towns in investing in the forest urban resource.
- Addressing national goals and priorities. All the urban forestry studies conformed to the CSREES Strategic Plan.
- Increase in urban forestry knowledge base. The number of studies completed, journal articles, technical publications, extension bulletins, databases, poster and oral presentations at conferences indicate an increased scientific understanding of the urban forest.
- Increase in research capacity and number of educated urban forestry personnel. There is an increase in research capacity from 10 Sys to 16 Sys (CRIS Database data) in a span of five years. Increasing numbers of professionals, as well as urban residents, have received research-based information on the forest resource.

Mid-term

Outcomes include: changes in technologies for controlling pests and diseases of urban trees, development of "designer" trees that can adapt to a wide range of urban environment, a more diverse and educated workforce, effective deer repellants to control damage due to browsing, and development of semiochemicals to disperse bark beetles and protect pine trees.

Long term
The overall outcome of these investments, activities, results, knowledge and technologies will be a healthy, livable and sustainable urban forest ecosystem. (See Figure XXX. Logic Model for Problem Area 124 – Urban Forestry).

Sample activities and research results, based on major theme, are highlighted below.

Urban environments
A study to determine the PM (particle matter) 2.5 trapping ability of tree foliage and human health relationships was conducted. Tree foliage has been shown to be ineffective in trapping PM2.5. As a result, extension programs in New York were developed and delivered, using a "researchers in training format" to involve young adults in learning experimental techniques.

Biological damage and urban forest health:
Numerous studies have been conducted regarding pests, diseases, invasive species, and the effect of human activity of urban trees. For example, a study to compare two different treatments for fungicide injections in live oak show that a high volume and low concentration injection performed best compared to low volume and high concentration injection. An investigation for control of euonymus scale showed that a high pressure horticultural oil spray gave the best control. These research findings will result in improved pest control and decreased pesticide use in urban trees.

Species diversity and plant evaluation for the urban landscape
Various applied studies, conducted to evaluate which species perform best under local conditions, will enable extension as well as landscape professionals to make appropriate recommendations. Seven hundred fifty trees were evaluated for urban plantings and results were provided to communities and nurseries for guidance in species selection.

Genetic improvement of urban plants
Research in disease resistance is essential to improving the health of our urban trees. For example, two separate genes were identified for Dutch elm disease resistance in American elm. This research may lead to the re-introduction of this tree in landscapes.

Tree growth regulation
Both basic and applied research has been funded, including analysis of fertilizer application and study of gibberellins synthesis inhibitors and their effect in controlling height growth of trees near power lines and other structures. The gibberellin synthesis inhibitors paclobutrazol and flurprimidol significantly reduced elongation growth of branches and apical shoots.

Social aspects of urban forestry
In a study examining the role of women and minorities in the urban forestry profession, it was found that minorities in the profession have a higher income than either white males or females.

Wildlife and urban land use
GIS technology is being used to map land use changes in urban landscapes. In a Florida study, image classification and analysis showed that, between 1984 and 1994, the total acres of urban or developed areas increased by 21%. Studies such as this can assist land use planners in making appropriate decisions.

Performance Indicators

Performance indicators for urban forestry are based on the funding segment (the portions that are in control of the land grant university) and also on the implementation portion of the grant (results). Long term outcomes are projected, although data may not be collected.

- Dollar leveraging
- Addressing national goals and priorities
- Increase in urban forestry knowledge base
- Increase in research capacity, number of formally educated and trained personnel

Success Stories

- Planting trees around homes and buildings reduces energy use and costs. Extension programs in many states, often in cooperation with utility companies, have resulted in the significant reduction of energy use. A home shaded by as few as three trees strategically located can cut summer cooling bills in half. Homes sheltered from wind have winter heat savings of as much as 10.3 thousand BTUs or approximately $52 annually.
- The Urban and Community Forestry Program of the Arkansas Forestry Commission has successfully launched a "Shade Trees on Playgrounds (STOP) Skin Cancer" program. Through STOP, nine schools welcomed new trees with hundreds of school children, and many local leaders participated in the school-based events. Schools were selected for this program based on their lack of shade trees and their participation. A curriculum was prepared for the teachers and used for designing posters, and in some schools incorporated into benchmark education programs. Students were also assigned the responsibility of caring for the trees, ensuring a lasting achievement for which they can be proud.
- Urban forestry professionals, volunteers, arborists, consulting foresters and community forestry leaders are searching for ways to build successful urban forestry programs that will create better relations between tree farmers and the environment. As key urban forestry partners, they need clarification on their roles and responsibilities as well as tools they can use to prevent and manage tree health problems.

New Directions

In the past decade, the majority of urban forestry efforts have been in the inventory and assessment of existing urban forests. Other activities include extensive tree planting in areas that are strategically in need of canopy cover, formulation and establishment of tree ordinances and enabling legislation to empower communities to practice and regulate urban forestry processes and services, and the development of decision support tools such as Tree Keeper and City Green for evaluating benefits of urban trees.

Today's urban forestry practitioners and managers need information, technology and education in order to manage urban forests in a sustainable manner. There is a need to share the information and transfer the technology that has been recently developed. For instance, the old practice of tree cavity filling with concrete is still widely practiced despite the fact that this has been found to be detrimental to the tree's health and structural integrity.

The diversity of audiences for urban forestry presents significant challenges. Research must include the needs, perspectives and interests of many groups. Technology transfer must reach groups of people with diverse language and cultures. Methods of communication and technology transfer that are targeted and more easily accessible to all audiences should be developed.

The economic value of environmental benefits of urban trees and forests must be determined if urban forests are to receive the attention they deserve as providers of essential services. This can lead to increased funding by city managers and legislators.

The urban forest is too valuable to be left to the untrained. Additional for urban forestry research and education is sorely needed.

There is an urgent need to investigate the use of tree genetic engineering to design trees with desirable attributes, such as growth control and flowering behavior, to maximize their benefits.

Problem Area 125 - Agroforestry

Overview

This Problem Area consists mainly of research and technology transfer programs with limited education and extension components. This is a relatively new discipline in the U.S. and a new area of forestry/agricultural research. In fact, agroforestry did not exist as a reportable Problem Area in the CSREES Manual of Research Classification until 1999. Its value as an alternative management system can be seen in the benefits it can bring to landowners such as reduced soil erosion, improved water quality, wildlife habitat and a variety of high value products harvestable at different times in addition to the timber that will come years later. Its sustainability and viability dimensions at any size scale make it very attractive to many landowners.

Agroforestry as defined by the International Center for Research in Agroforestry (ICRAF) is a collective name for land use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc) are deliberately used on the same land management unit as agricultural crops and /or animals, either in some form of spatial arrangement or temporal sequence. It is intensive land use management that optimizes the benefits when trees are combined with crops or livestock. The four key "I" words that characterize agroforestry principles and practices are: intentional, intensive, integrated, and interactive. Agroforestry in its many forms has been practiced in the Tropics and Southern hemisphere for a long time but only recently has been getting greater attention in North America and, in particular, the United States. Agroforestry in the United States can be traced back to 1870 when the U.S. government first recognized the planting of trees on the prairies under the Timber Culture Act of 1870. In the 1930's the conservation benefits of windbreaks were widely touted and landowners were encouraged to plant them following the "Dust Bowl" of the 1930s. The driving forces behind the adoption of agroforestry practices around the world can be summed up in two factors: improved economic gain, and environmental protection.

The goal of this Problem Area is:

> *To provide landowners/farmers with innovative and sustainable ways to produce additional income in order to remain economically viable in support of the food, fiber and environmental quality needs of the nation.*

Situation

In the US, there are five recognized agroforestry systems (practices) that have found their niches in specific geographic regions of the country. These five systems are:

- Alley cropping (Midwest)
- Silvopasture (Southeast)
- Riparian Buffers (Midwest and West)
- Windbreaks (Great Plains)
- Forest Farming (Northeast)

The application and adoption of these practices are limited and scattered in a few states despite their attractiveness as land use options. Their contribution to national food and fiber needs has not been quantified nor has the extent of their application on forest, range and open lands been assessed. Many basic and applied research questions have not been addressed to provide bases for greater application of the different agroforestry systems.

The last decade is characterized by an intensive investigation of the different agroforestry practices relative to their performance in specific sites and regions. But there remains a

tremendous amount of knowledge to be gained in order to enhance profitability, usefulness and sustainability, not to mention its environmental advantages.

An examination of CSREES investment in agroforestry shows that for the past five years (1999-2003), the agency provided $9.86 million which was leveraged by non-federal funds amounting to $12.86 million. All the studies addressed one or more of the five agroforestry practices or systems.

Major Themes

The five major themes described in this report correspond to the five recognized agroforestry practices the United States. These are:

- Alley cropping (growing crops such as corn, wheat, soybeans, or biomass crops in alleys to provide annual cash flows).
- Silvopasturing (allows livestock grazing under tree crops like pecan, walnut, or loblolly pine planted under wide spacing).
- Windbreaks (planted for the purpose of increasing crop yields, feed efficiency of livestock).
- Riparian buffers/buffer strips (suitable plants are used/grown adjacent to streams to prevent erosion and farm runoff).
- Forest farming (producing high value crops such as golden seal, ginseng, Echinacea, and gourmet mushrooms in forest environments created by thinning or other forest management techniques).

Assumptions

- Agroforestry systems are sustainable, productive and profitable.
- Agroforestry provides landowners and farmers more viable options to using their land.
- Agroforestry is adaptable to any size tract of land.
- Agroforestry provides valuable environmental benefits.
- Agroforestry is an attractive program growth because it can contribute to sustainability of forest and rangelands.
- Because of its hybrid characteristic, programmatic efforts are much easier to house in academic institutions.
- Because of its potential (economic, ecological and environmental), agroforestry will continue to attract considerable funding.

External Factors

The implementation and the intended outcomes of agroforestry projects are influenced by a number of factors, among which are:

- Available funds to support agroforestry research, education and extension are limited and vary from year to year, and therefore the kinds and extent of projects conducted are constrained. Macro-scale projects mimicking even the smallest farm could not be done with funding limitations; these are the kinds of studies that needed to be carried out in order to better understand the different agroforestry systems and practices.
- Changing priorities of the agencies involved in agroforestry work such as the CSREES, ARS, NRCS and Forest Service can impact agroforestry activities.
- Farm Bills can change directions, depth, and breadth of agroforestry research and extension.

- Institutional capacities and interest of land grant universities will influence the amount of activities in this problem area.
- Landowners' interest in adopting any of the practices can impact the direction and amount of activities.

Inputs

Program inputs to PA 125: Agroforestry for the period 1999-2003 consists of program funds, personnel, partners' time and expertise or scientist years (SYs), matching funds and graduate students' efforts. Total funds committed by CSREES for this period amounted to $ 9.8 M. The breakdown of this funding is presented in Table 20.

Table 20. CSREES research funding for PA 122, by source and year ($ in thousands).

Funding Source	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
Hatch	71	63	82	75	120	411
McIntire-Stennis	433	455	439	518	680	2,525
Evans-Allen	0	0	0	0	0	0
Special grants	0	60	139	564	497	1,260
NRI Grant	20	0	307	191	0	518
SBIR	0	0	0	0	0	0
Other CSREES	0	4,400	0	250	497	5,147
Total	524	4,978	969	1,599	1,795	9,865

CSREES funds supported 90 projects from 1999-2003. The high level of support in 2000 (Table 21) resulted from competitive funding from the Initiative for Future Agriculture and Food System (IFAFS) Program which was discontinued by Congress. Those funds (approximately $4 million) supported the establishment of the Center for Sub-Tropical Agroforestry at the University of Florida. This was a consortium of land grant universities that included The University of Georgia, The University of Virgin Islands, The University of Florida, and Florida A&M University. The increase in funding for 2002 and 2003 from other USDA is attributed to a special grant through ARS earmarked for the University of Missouri Agroforestry Center.

Agroforestry research is being conducted by USDA Agricultural Research Service (ARS) mainly at the ARS Small Farms Research Center in Arkansas and the ARS Appalachian Research Center in West Virginia, Natural Resources and Conservation Service (NRCS) through its RC&D, the USDA Forest Service, USDA Foreign Agriculture Service (on occasional basis), CSREES and the National Agroforestry Center (a joint effort between the Forest Service and NRCS).

Table 21. Funding for PA 125 by year and funding categories from 1999-2003 (X $1000).

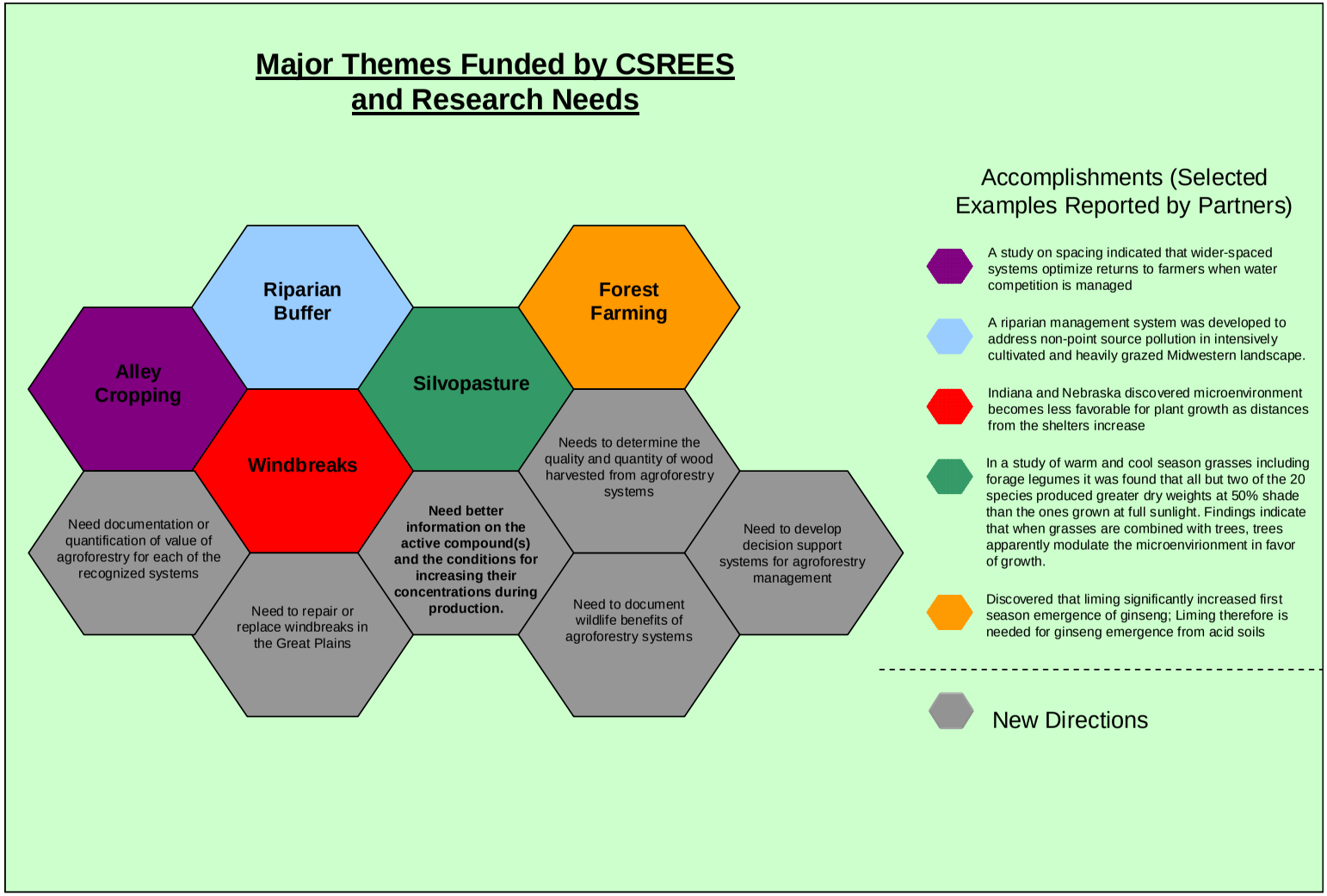
Funding Source	Fiscal Year ($ in thousands)				
	1999	2000	2001	2002	2003
CSREES	524	4,978	969	1,599	1,765
Other CSREES	394	822	578	2,339	2,597
Other Federal	276	398	1,035	851	805
Non-federal Match	2,153	1,895	1,991	3,072	3,749
Leveraging (Match/CSREES)	4.1	0.4	2	1.9	2.1
CSREES as % of Total	15.6	61	21	20	20

There was a steady increase in the overall funding for agroforestry by CSREES during the last five years except for an abnormal big jump in funding in 2000. This was due to an IFAFS consortium grant that was intended to establish a center for subtropical agroforestry.

Table 22. CSREES personnel resources (full time equivalents), by year and category.

	1999	2000	2001	2002	2003
National Program Leader	0.1	0.2	0.2	0.1	0.15
Program Analyst/Specialist	0	0	0	0	0.05
Administrative Support	0.2	0.2	0.2	0.2	0.2
Other (IPA, Shared Faculty, etc.)	0	0	0	0	0
TOTAL	0.3	0.4	0.4	0.3	0.4

Problem Area 125: Agroforestry



Outputs

Research

- New technologies, patents and new practices.

Education

- Graduate students and interns trained.
- Enriched curricula and extension programs.
- CSREES outputs include the external university program reviews that are requested by academic units. Annually, CSREES solicits requests for program reviews from land grant institutions. These requests are assigned to appropriate National Program Leaders who work with the requesting institution to identify and recruit an external review team. Based on the request that is received, the review will encompass some or all of a unit's academic, research, and extension program. Most commonly, these reviews are comprehensive in nature. There are no specific university departments that specifically and singularly address agroforestry. Thus, agroforestry would be included in overall forestry departmental reviews, where present.

Extension

- Research results which are delivered to landowners/farmers and to technical, scientific and decision-making audiences through technical publications, extension bulletins, databases, and presentations at conferences.
- Enriched extension programs.

Outcomes

Short term

- Dollar leveraging. The federal funds invested for agroforestry were significantly leveraged by non-federal funds by as much as 1.9 to 4.1 times except for 2000 where the leveraging was lower than what is required by law. Because there was an IFAFS competitive grant, there was not requirement for matching funds. The level of matching is considerably higher than the amount required by law (100%) for matching federal funds. This indicates growing interest in these land use systems by institutions.
- Addressing national goals and priorities. All the agroforestry studies conducted contribute to the CSREES Strategic Plan.
- Increase in agroforestry knowledge base. The number of studies completed, journal articles, technical publications, extension bulletins, databases, poster and oral presentations at conferences indicate an increased scientific understanding. Extension bulletins are extensively distributed and workshops are conducted with greater frequency.
- Increase in research capacity and number of educated agroforestry personnel. There is an increase in research capacity from 14 scientist-years to 20 scientist-years over a span of five years. Increasing numbers of professionals, as well as agroforestry practitioners, have received research-based information on this land use system.

Mid-term

Outcomes include: changes in technologies for implementing agroforestry systems, more precise selection of species using some decision support systems, better knowledge of growing conditions of the different systems, and more diverse and educated landowners and farmers.

Long term
The overall outcome of these investments, activities, results, knowledge and technologies will be: ecologically well designed, viable and healthy agroforestry systems in support of the food and fiber needs of the nation

Sample activities and research results, based on major themes, are highlighted below.

Alley Cropping
A study on spacing indicates that wider-spaced systems optimize returns to farmers when water competition is managed. Grasses grown in combination with hardwood trees compete aggressively and better with trees than legumes with respect to moisture. This should help in species selection for alley cropping systems. A study looking at the insect population, revealed that when alfalfa was intercropped with walnut, the walnut supported twice as many predators and parasitic hymenoptera and half as many herbivores than did alfalfa alone. This has valuable implications to biological control.

Riparian Buffer
A riparian management system was developed to address non-point source pollution in an intensively cultivated and heavily grazed Midwestern landscape. Results demonstrated that riparian forest buffers trap over 80% of the sediment from surface runoff. Soil aggregation was dramatically improved leading to improved infiltration. Groundwater tests revealed that nitrate was reduced by as much as 90% below the buffer. After eight years of monitoring these buffers, their maximum potential has not yet been reached. In another study, contour tree buffer strips were shown to be more effective in controlling soil erosion compared to row cropping and strip cropping.

Windbreaks
Field data on biomass and yield for corn and soybeans were collected at various distances from shelterbelts in Iowa, Indiana and Nebraska. Meteorological data and other environmental variables were measured at different distances. Crop yields decline as the distances from the shelter increases. Microenvironment becomes less favorable for plant growth as distances from the shelters increase. This can have some implications in designing more effective windbreaks. A study to evaluate the effect of root-pruning to control competition for soil moisture at the windbreak interface showed that soil moisture increased by 2 to 3% and crop yield increased by 12 to 40%. This provides a basis for a new technique for controlling soil moisture.

Silvopasture
Several warm and cool season grasses including forage legumes were evaluated for their shade tolerance for several years. All but two of the 20 species produced greater dry weights at 50% shade than the ones grown at full sunlight. Cool season grasses produced 47% greater weight at 50% shade than at full sunlight. The warm season grasses produced 14 to 20% more dry weight at 50% shade than those grown at full sunlight. This means that when grasses are combined with trees, trees apparently modulate the microenvironment to favor growth. Also, shade caused nitrogenous compounds concentration to increase, thus increasing forage quality.

Forest Farming
A study was conducted to evaluate the effect of mulching with pine straw. Mulching had mixed results on seedling emergence. Liming significantly increased first season emergence of ginseng. Liming increased pH and Ca in soil. Liming therefore is needed for ginseng emergence from acid

soils. Another study was conducted to evaluate variations in the ginsenoside content of a collection of ginseng germplasm in the northeast. Results showed significant qualitative and quantitative variations among the collection, thus allowing selection as an effective means of improving the genetics of American ginseng population. Another study demonstrated that bloodroot, a medicinal plant that is harvested in the wild, can be grown under artificial environment mimicking the wild forest environment by altering the soil pH, calcium, and planting date. The quality of the active compounds has not been evaluated, but the plant can be successfully grown under artificial environment which is a precursor to field trails under natural conditions.

Performance Indicators

Performance indicators for agroforestry are based on the funding segment (the portions that are in control of the land-grant university) and also on the implementation portion of the grant (results). Long term outcomes are projected, although data may not be collected.

- Dollar leveraging.
- Addressing national goals and priorities.
- Increase in urban forestry knowledge base.
- Increase in research capacity, number of formally educated and trained personnel.

Success Story

- The establishment of a Center for Subtropical Agroforestry. This was funded by CSREES through the IFAFS program. The Center was established and operated as a consortium effort of several land grant universities: University of Florida, University of Georgia, Auburn University, Florida A&M and University of the Virgin Islands. The outreach objectives of the Center are: 1) to provide relevant information and tools regarding agroforestry practices, economics, and funding opportunities for extension agents, natural resources professionals, educators and landowners, 2) to facilitate communication among agroforestry stakeholders through an interactive agroforestry network and 3) to increase dissemination of agroforestry awareness through the establishment of various demonstration sites on public and private properties for field tours.

  Among the accomplishments in a three-year span are:
  - The Center has developed a multi-media Agroforestry Curriculum Guide and interactive CD that contained educational tools.
  - Several in-service training workshops for extension professionals have been conducted for a total of 45 county agents, educators and landowners.
  - A 4-H project book for agroforestry has been developed.
  - Southeastern Agroforestry Decision Support System, a web-based tool that assists in planning and tree/shrub selection.
  - A Southeastern Agroforestry Network of Demonstration Sites (SANDS) has been formed and will initiate the establishment of demonstration sites.
  - Over a three-year period, Center personnel, graduate students and cooperators published 43 refereed publications, mostly in international journals.
  - Developed 17 extension publications that were distributed in the Southeastern U.S. and Virgin Islands.
  - Successful integration of hot pepper and medicinal and culinary herbs with rows of *Morinda citrifolia* and *M. oleifera*.
  - Organized a two-day FAO study tour for foresters from India.

- The Center was heavily involved in the organization of the 1st World Congress of Agroforestry held in Orlando, Florida in 2004.
- The Center contributed to a better understanding of alleycropping and silvopasture as applied to sub-tropical environment.

New Directions

The environmental value of agroforestry is a very strong selling point for its adoption by landowners. However, there is a very limited documentation or quantification of this value for each of the recognized systems. For instance, there is a consensus among practitioners and researchers that riparian buffers are very effective in reducing water pollution and pesticide contamination but quantifications do not exist. Also, riparian buffers are well known for their environmental remediation capacities and erosion control but more efficient designs of buffers including the best species of plants to use have not been explored nor inventoried. The value of riparian buffers for carbon sequestration and air quality enhancement should also be assessed.

The windbreaks of the Great Plains were established during the Depression and are aging very fast. There is an urgent need to repair or replace these to maximize the benefits accruing from them. More windbreak plantings are needed to provide a suitable environment for maximum crop production in the Great Plains and other parts of the country with a similar wind environment. Expanded research efforts are needed to determine if current species recommendations are current and if new species that can better adapt to the environmental stresses should be used; expanded extension efforts are needed to assist landowners in assessing the condition of their windbreaks and determining renovation strategies.

The production of high value crops (ginseng, golden seal, echinacea, etc.) in forest farming continues to grow as demand for these botanicals increases. Better information on the active compound(s) in these plants and the conditions for increasing their concentrations during production is needed.

The wildlife benefits of agroforestry systems have always been assumed because of the greater plant biodiversity in these systems. Efforts should be expended to document this benefit.

The wood products coming from these systems are at best projected in this part of the world. Currently, there is no hard information on the quality of wood that comes out of an agroforestry system. Measure of quantity and quality needs to be collected and disseminated.

Because agroforestry systems are more complex than traditional agricultural systems, development of decision support systems will facilitate management. Development of model systems using simulation can help in predicting yields of the different agroforestry components.

Problem Area 135 – Aquatic and Terrestrial Wildlife

Overview

In the United States, wildlife is regarded, culturally and legally, as a publicly-owned renewable resource. As such, the resource serves to supplement the diets of many citizens, affords recreational and aesthetic benefits, and generates income to landowners and businesses. For example, annually more than 80 million Americans fish, hunt, or watch wildlife, spending about $110 billion in the process. Wildlife is an inherent element of natural and managed ecosystems, including those of forestry, range, and agriculture. The fledgling nation utilized wildlife as a seemingly inexhaustible resource. As its human population grew, however, wildlife and societal interests, especially those of agriculture, increasingly conflicted, and many wildlife stocks became threatened by over-harvest, deliberate extirpation, habitat alteration, environmental pollution, and other factors. By the early-20th century, professional wildlife management became established to sustain the resource while minimizing its deleterious impacts on agriculture and other human endeavors. Today, governmental agencies, from municipal to federal levels, share this management responsibility.

CSREES chiefly partners with land-grant universities, providing funds and coordination for wildlife research, education and extension programs. In various ways, it also partners with other federal agencies which have wildlife-related missions, especially the USDA Forest Service, Natural Resources Conservation Service and Farm Services Administration; the U.S. Department of Interior Fish and Wildlife Service and Geological Survey; and the National Oceanographic and Atmospheric Administration Sea Grant.

For organizational purposes, this portfolio report focuses on goals of PA 135 which are:

- To enhance the sustainability of fish and wildlife resources through increased understanding of the natural and human factors that affect them, with emphasis on those inhabiting agricultural, forest, and range ecosystems.
- To influence changes in practices that reduce or ameliorate those factors which are deleterious to the wildlife resource and its societal relationships.

Situation

America's wildlife resource affects, and in turn is affected by, its human population in numerous ways, as reflected in the CSREES strategic plan criteria and program areas noted above. These situations cause policy makers and wildlife resource professionals to seek and apply new knowledge in order to ensure the sustainability of the resource. Among the most pressing issues are:

- Maintaining an educated and experienced professional management work force in view of anticipated massive retirements among the current generation
- Ensuring public understanding of wildlife issues among a population that is becoming increasingly urban and isolated from nature
- Resolving conflicts over wildlife values among differing segments of society
- Ameliorating or preventing alteration or destruction of wildlife habitat
- Endangerment of the continued survival of some wildlife stocks and species from such causes as habitat alteration, overharvest, genetic swamping, and competition from invasive species
- Mitigating damage to humans and human property by wildlife
- Controlling spread of diseases that affect both human and wildlife health.

Major Themes

Sustainability and management of fish and wildlife resources is addressed at several scales: organism, population, species, community, and ecosystem. The major themes of this problem area, encompassing all scales, are:

- Organismal biology (food, growth, diseases, and parasites)
- Population biology (fecundity, migration, dispersal, mortality, dynamics, cycles, theory, and modeling) and species biology (evolution, classification, distribution, genetics, morphology, physiology and behavior)
- Ecology (ecosystem structure and processes, communities, assemblages, predator-prey relationships, exotic and invasive species)
- Habitat (aquatic and terrestrial, ecotones, and local to landscape scales) and responses to environmental disturbance (climate change, drought, pollution, agricultural and urban)
- Resource management (consumptive and non-consumptive uses, stock monitoring, assessment and enhancement, harvest regulations, and habitat management), conservation (including genetic integrity) and restoration (depleted stocks, endangered species)
- Wildlife impacts on humans (disease transmission, predation on livestock and crops, aesthetic)
- Human dimensions (policy, economics, education, conflict, and collaboration)

Assumptions

Beliefs

Wildlife is an economically, socially and environmentally critical renewable resource in the United States and worldwide. To maximize its value to human society and ensure its sustained well-being, the resource must be actively managed. This management requires application of science-based knowledge, which must be continually developed, refined and communicated to resource stakeholders. Professional wildlife managers in government agencies and the public share responsibility and must work cooperatively to sustain the resource for use by future generations.

How the program works

The unique mission of CSREES is to advance knowledge for agriculture, the environment, human health and well being, and communities. This is accomplished by supporting research, education and extension programs in the Land-Grant University (LGU) system and other partner organizations.

- Through research at over 60 LGUs and their cooperators, relevant science-based knowledge concerning wildlife is obtained, organized and shared with the natural resources management community.
- Through LGU instructional programs, students are prepared for careers as professional wildlife conservationists and managers.
- Through LGU extension, science-based information is used to achieve public understanding and support of wildlife conservation and management principles and procedures is achieved.

External Factors

Several factors affect the performance, outcomes and CSREES program attributions that are achieved in this problem area. These include:

- CSREES serving only a supporting role in the conservation and management of wildlife , complementing the efforts of municipal, state and other federal agencies which have legislated authority and responsibility in this area.
- Wildlife considerations tending to be generalized or minor elements in legislation affecting CSREES responsibilities and activities.
- CSREES 1997-2002 strategic plan lacking direct mention of wildlife.
- Wildlife responsibilities concentrating on the shoulders of a single National Program Leader, but that individual not being able to directly manage either formula or competitive grant funds within CSREES
- Human population growth and changes in cultural and environmental conditions affecting wildlife are occurring rapidly and are widespread. An increasingly urban public has limited direct knowledge about wildlife related issues.
- Multiple and changing stakes of society in wildlife leading to strongly held and often contrasting opinions among different public sectors and to shifting policies among governments at local, state and national levels.
- Recent national economic turndown resulting in sharply reduced government support of public higher education institutions and wildlife management agencies, resulting in some relevant program reductions and reorganization of institutional/agency support in wildlife-related programs.

Inputs

The resources that are allocated to this problem area must be considered at two levels: 1) those which are used by CSREES for administration and those provided to cooperators, and 2) the transformation of those resources by program partners and funding recipients into different resources that are directly applied to programs and projects.

Historically, CSREES has dedicated personnel to its wildlife mission in the form of a single National Program Leader who received secretarial support. This arrangement pertained during calendar years1999 and 2000, each position providing 1.0 FTE service (Table 23). The NPL retired at the end of 2000 and was temporarily replaced with a semi-retired forestry NPL at 0.5 FTE. In 2003, that individual fully retired and the position was again filled on a temporary, but full-time, basis through an Intergovernmental Personnel Act Agreement by a LGU faculty member. In the interim, secretarial service was reduced to access to the NRE secretarial pool but additional support was added in the form of a Specialist at 0.10 FTE.

Table 23. CSREES Fish and Wildlife National Program Leader and Support Staff, 1999 – 2003 (FTEs).

	1999	2000	2001	2002	2003
National Program Leader	1.0	1.0	0	0	0
Program Analyst/Specialist	0.1	0.1	0.1	0	0.1
Administrative Support	1.0	1.0	0.5	0.25	0.1
Other (IPA, Shared Faculty, Etc.)	0.0	0.0	0.5	0.5	1.0
TOTAL	2.1	2.1	1.1	0.75	1.2

CSREES provides funding for its wildlife mission to cooperators chiefly for research. During the five years of FY99 through FY03, this funding was $31.9M, about 22% of the $144.8M total provided for all of Goal 5.1 projects (Table 24). There was an average of 328 CSREES-supported projects per year in PA 135 and this was a little over one-quarter of the Goal 5.1 project portfolio.

Table 24. CSREES Research Projects and Funding for Problem Area, by year.

	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
Number of Projects	306	312	303	333	385	1,639
Funding	6,814	6,893	6,850	5,325	6,019	31,901

The bulk (61.1%) of the funding was derived from four formula funds: Hatch - $10.4M (32.7%), McIntire-Stennis $7.1M (22.4%), Evans-Allen (5.8%), and Animal Health (0.2%) (Table 25). The competitive National Research Initiative and Small Business Innovation Research grant programs accounted for 7.1% and 1.0%, respectively, although it should be noted that SBIR wildlife grants were first available only in 2003. Special Congressionally mandated grants accounted for 4.2% of wildlife research supported during the five-year period. One-quarter (26.7%) of the funding was derived from all other CSREES sources. According to CRIS data, a sharp turndown in CSREES funding occurred in the final two years, chiefly in the "Other" category. The cause of this is not readily identifiable. It may simply represent CRIS accounting changes. For all practical purposes, the formula funding base remained level.

Table 25. CSREES Research Funding for PA 135 by Source during 1999-2003.

Funding Source	Fiscal Year *($ in thousands)*					
	1999	2000	2001	2002	2003	Total
Hatch	2,181	2,180	1,916	2,008	2,134	10,419
McIntire-Stennis	1,365	1,516	1,569	1,351	1,333	7,134
Evans Allen	504	509	548	86	190	1,837
Animal Health	27	26	5	4	11	73
Special Grants	45	218	233	678	171	1,345
NRI Grants	469	3	183	633	964	2,252
SBIR Grants	0	0	0	0	333	333
Other CSREES	2,225	2,443	2,397	565	882	8,512
Total	6,813	6,894	6,852	5,325	6,017	31,901

During the past five years, total CRIS-reported funding for wildlife research from all sources increased nearly 30%, from $67.7M in FY99 to $87.1M in FY03 (Table 26).

Table 26. Comparison of funding sources for PA135 wildlife research projects recorded in CRIS database, 1999 and 2003 ($ in millions).

Funding Source	Fiscal Year *($ in thousands)*				
	1999	2000	2001	2002	2003
CSREES	6,810	6,890	6,850	5,330	6,020
Other USDA	2,050	2,460	2,760	3,390	3,720
Other Federal	15,490	16,310	17,910	21,520	25,880
State	25,370	28,200	25,840	28,590	27,990
Self-Generated	1,860	2,540	4,430	3,040	2,940
Independent Grant	3,090	3,610	4,940	6,690	6,970
Other Non-federal	13,030	13,720	1,260	15,090	13,550
Total	67,700	73,760	75,330	83,650	87,070

In general, CSREES provides only a small fraction of the wildlife research funding included in the CRIS database, and this contribution declined over the reporting period, proportionally and in real dollars from 10% and $6.81M in FY99 to 7% and $6.02M in FY03 (Table 26). This decline was more than offset, however, by other USDA and other federal funding which, combined, increased by 69% over the five years. States annually accounted for about one-third of the funding, probably mostly in the form of salaries at LGUs. Non-governmental support grew from less than $18M in FY99 to over $23M in FY03.

While there is no clear trend of either increasing or decreasing wildlife project numbers, when all relevant projects in the CRIS database are considered a somewhat different picture emerges. During those five years, the total number of projects increased by 17% (Table 24), and the human resources invested in research increased nearly 34%, from about 932 personnel years to over 1200 personnel years (Table 27). As noted previously, this increase in research activity is probably attributable to funding from sources other than from CSREES.

Table 27. Comparison of personnel years involved in PA 135 wildlife research recorded in CRIS database, 1999 - 2003.

Fiscal Year	Scientist Years	Support Staff Years
1999	170.1	761.7
2000	195.4	832.7
2001	179.2	787.0
2002	196.1	925.6
2003	206.3	1041.1

As noted earlier, a significant input by CSREES to enhance educational quality is to conduct program reviews at partner land-grant institutions. During the past five years, CSREES reviews of wildlife-related programs were conducted as follows:

- 1999
  - Department of Wildlife Ecology, University of Maine
  - School of Natural Resources, University of Vermont
  - Department of Natural Resources, Cornell University

- 2000
  - School of Forestry, Wildlife and Fisheries, Louisiana State University
  - Department of Wildlife Ecology and Conservation, University of Florida
  - Division of Biology, Kansas State University

- 2001
  - Department of Wildlife and Fisheries Sciences, South Dakota State University
  - School of Natural Resources, Ohio State University
  - School of Natural Resources, University of Missouri

- 2002
  - Department of Wildlife Ecology, University of Wisconsin
  - School of Renewable Resources, University of Arizona

- 2003
  - School of Natural Resources, University of Nebraska

CSREES interacts in various ways with administrators of university wildlife academic programs. One is through coordination with the National Association of University Fisheries and Wildlife Programs, which has a liaison in Washington DC. The Fish and Wildlife NPL typically attends the Association's annual meeting. Important announcements to the academic community are provided by CSREES through e-mail. In the north-central region, the NCA23 coordinating committee of LGU fish and wildlife program administrators meets annually, and the NPL normally participates.

Although CSREES does not provide formula funding to LGUs for resident instruction, partner institutions are eligible to apply for SERD-managed competitive grants. Minority-serving university and college wildlife-related programs, especially, have opportunities to apply for instructional and curricular improvement support through a number of CSREES competitive grant programs. During the 5-year period, FY99 to FY03, these programs awarded grants

totaling $9.96 million for educational projects in conservation and renewable resources. Of these, six projects, totaling $1.29 million, directly concerned wildlife education, according to their titles.

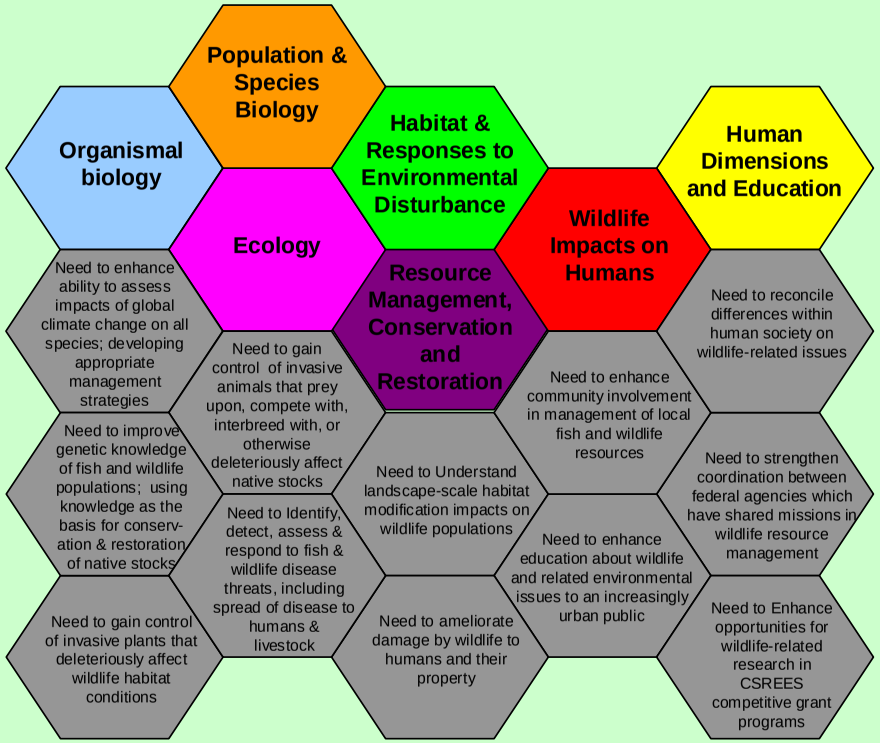
Most states have one or more extension educators who specialize in fish and/or wildlife programming. CSREES enhances this programming in several ways:

- Maintenance of a listserve for the extension professional community and for communication of information from the national level
- Periodic publication of a state personnel directory of extension professionals in fisheries, wildlife and related natural resources fields
- Sponsorship of a triennial extension wildlife, fisheries and aquaculture conference, including publication of its proceedings
- Organization of informal gatherings of extension personnel at annual meetings of the American Fisheries Society and of The Wildlife Society.

Funds provided through the Renewable Resources Extension Act (RREA), administered by CSREES, provide for expanded and comprehensive extension education programs for forest and rangeland renewable resources including those of fish and wildlife. During the period 1996 to 2000, RREA appropriations averaged a little more than $3 million annually. A CSREES survey covering 1996-2000 determined that 30 states used RREA funds for fish and wildlife management activities but a detailed accounting is not available.

Problem Area 135: Aquatic and Terrestrial Wildlife

Major Themes Funded by CSREES and Research Needs



Accomplishments (Selected Examples Reported by Partners)

Iowa State University scientists developed an improved procedure for obtaining relatively pure neutrophil samples from the fathead minnow. This technique provides a valuable tool for conducting research on fish stress physiology.

Research in Maine found that the pine marten can also thrive in managed forests as long as some vertical structure is maintained. Results will allow for evaluatation of the ecological influences of shifting their management from clearcut harvesting to selective harvesting across large areas and will be used to develop specific management plans.

University of Wisconsin wildlife specialsts offer an educational program for landowners who want to practice forest stewardship, and share their knowledge. Over a five-year period, 125 land-owners who control more than 100,000 acres were trained in forest stewardship.

Research in Tennessee demonstrated the value of planting warm season grasses in pastures. Bobwhite quail populations increased an average of 100% and rabbits increased 300%.

Quality Deer Management Programs conducted by extension officers in Tennessee reduced herd numbers, improved the population sex ratio and age structure, increased individual fitness and fawn survival, and reduced deer damage to crops and ornamentals.

In Connecticut, researchers are giving bucks a sclerotinizing agent to block the epididymus by scar formation and prevent sperm flow as an attempt to develop a humane sterilization method to control deer population size. The technique is now being used in management trials in several states.

Annually, more than 300,000 boys and girls participate in the 4-H National Shooting Sports Program, a nationally coordinated extension wildlife education program, and over 10,000 youth participate in the Wildlife Habitat Evaluation Program every year.

New Directions

Outputs

Research

Keywords were examined in titles of about 78 Hatch and McIntire-Stennis wildlife projects that were initiated in FY03 and FY04. The term Ecology was the most frequently used title word, occurring in 24% of these project titles. Others which appeared prominently, in about 10% to 20% of the cases, were Management, Landscape, Habitat, Population, and Dynamics. Somewhat less common were the terms Conservation, Restoration, Resources, Biodiversity, and Ecosystem. Collectively, these words convey the general flavor of current wildlife research conducted by cooperators.

Among 48 new and revised Hatch projects in FY03, overall activities were investigator-categorized as about 42% basic science, 55% applied research, and 3% developmental. About half of the projects were cited as 50% basic, 50% applied, or nearly so. In general, research in species biology and ecology tends to be basic, management and societal-oriented research tends to be applied, and habitat studies may be either.

Publication records from CRIS project annual reports were examined for 17 Hatch projects which were revised and reauthorized in 2003 and 2004 (Table 28). Overall, their investigators produced 289 scientific publications based on project research during 1999 to 2003. Stated in another way, on average, about 3.6 publications were produced annually from a typical project's research findings. From Tables 24 and 28, it is estimated that the total number of wildlife projects produced about 1180 research publications annually, and about 5900 during over five years.

Table 28. Number of Publications Produced From 17 Wildlife Hatch-funded Projects Renewed in 2003 and 2004.

Publication Year	Total Number	Yearly Range	Yearly Average
1999	48	0 – 10	3
2000	54	0 – 11	3.6
2001	53	0 – 8	3.31
2002	64	0 – 8	3.76
2003	70	1 – 11	4.38
	289 Grand Total		3.61 Overall Average

The regional experiment station system supported three multi-state research committees during this period, which met annually to promote research and extension on wildlife damage and management. Collectively, over 30 states participated in these projects:

- NE 1005, Management of Wildlife Damage in Suburban and Rural Landscapes
- NC 1005, Landscape Ecology of White-tailed Deer in Agro-Forest Ecosystems: A Cooperative Approach to Support Management
- WCC 095, Vertebrate Pests of Agriculture, Forestry and Public Lands.

Extension

Fish and wildlife extension activities vary considerably from state to state because they primarily reflect local needs. In general, however, they involve conducting school, youth and adult public education programs, advising property owners on wildlife habitat and damage issues, facilitating

public participation in community wildlife and related environmental issues, and assisting in wildlife-related enterprises. Extension educators frequently partner with state, county, and municipal agencies and non-governmental organizations in programming activities.

- Within the Cooperative Extension system, 4-H is an important collaborator with wildlife extension in several regional and national programs:
    - In the National 4-H Shooting Sports Program, youth learn marksmanship, the safe and responsible use of firearms, and the principles of hunting and archery.
    - The National Wildlife Habitat Evaluation Program (WHEP) is a 4-H youth natural resource program dedicated to teaching wildlife and fisheries habitat management to junior and senior level (ages 8-19) youth.
    - Annually, six outstanding adult volunteers are honored for their service to youth in 4-H fisheries and wildlife programs. Volunteers are nominated by state extension staff, and selections are made by a CSREES-U.S. Fish and Wildlife Service team. The awards are made at the annual North American Wildlife and Natural Resources Conference.

- The thirty states that reported using RREA funds for wildlife activities during 1996 to 2000 indicated that the most common topics were habitat management, animal damage control, and biodiversity. Over 75,000 staff hours and nearly 420,000 volunteer hours per year were reported as being partially supported from RREA funds.

- "Master" volunteer and train-the-trainer programs are a long-standing staple of the Cooperative Extension system. Through selecting quality representatives from the public and expanding their understanding of issues and management concepts, extension can leverage its outreach to other citizens and landowners. Extension wildlife specialists commonly contribute to Master Gardener, Master Woodland Owners and similar programs in their states. Additionally, in many states, programs exist that are primarily wildlife-oriented:
    - Coverts projects train volunteers to promote wildlife habitat conservation and forest stewardship in 14 northeastern and midwestern states. Volunteers practice stewardship on their own property and encourage other landowners to do the same.
    - Master Naturalist programs work on similar principles. Participants receive in-depth training in wildlife and natural resource management. In return, they provide their community with volunteer service in the form of educational activities, projects or demonstrations, and forge local partnerships.
    - NatureMapping is a growing program in a number of states. It trains volunteers to accurately identify wildlife species in the field, and to record and report the sightings to scientific and wildlife management agencies for purposes of monitoring biodiversity.

- Written bulletins are a time-tested, effective means of providing Extension information to public audiences. Most state Extension services produce such bulletins and often use those of others which are relevant. For many years, CSREES joined with the US Fish and Wildlife Service and the US Environmental Protection Agency to produce a printed bibliography of Cooperative Extension Service Literature on Wildlife, Fish, and Forest Resources. The current version is produced on-line and provides users with direct access to over 500 on-line bulletins developed by state Extension programs.

Outcomes (examples, by major theme)

Organismal Biology

- University of California research determined that recent declines of Pacific sea otters along the California coast were largely attributable to encephalitis caused by toxoplasma parasites in shellfish eaten by otters. This is leading to development of tests and treatments for parasite infections and determination of the source of parasites.
- Despite many years of management effort, re-establishment of self-sustaining lake trout populations in Lake Michigan has not been achieved even though re-establishment has occurred in Lake Superior. University of Minnesota researchers found that trout from Lake Michigan consistently had lower levels of thiamine in their blood and eggs than did trout from Lake Superior. A thiamine destroying enzyme, thiaminase, contained in the predominant forage items of trout may be the cause. Thus, lack of successful natural reproduction by Lake Michigan lake trout may be related to their reduced thiamine nutritional status.
- Neutrophil cells are an important component of organismal defense against many bacterial, viral and fungal infections, and the evaluation of neutrophil function is valuable for assessment of health status. Iowa State University scientists developed an improved procedure for obtaining relatively pure neutrophil samples from a commonly used research organism, the fathead minnow. This technique provides a valuable tool for conducting research on fish stress physiology.

Population and Species Biology

- Modeling by University of California scientists showed that low rates of straying between Pacific salmon populations can make them much more persistent and less likely to collapse in response to deleterious oceanic environmental shifts. Research results provide a basis for understanding how salmon population sizes and catches vary from year to year. These results have been applied in the design of effective marine reserves along the California coast.
- The giant Canada goose has risen, through restoration efforts, from near extirpation to status as a major nuisance in many areas. Scientists at South Dakota State University are studying goose behavior and movements by use of biotelemetry. Research results will be used to manage goose populations to lessen crop predation while still allowing sufficient numbers to satisfy needs of hunters and wildlife watchers.
- The pine marten was previously thought to be confined to undisturbed, old growth forests. Research was done in Maine to avoid a confrontational situation between the timber industry and environmental organizations. The results show that the pine marten can also thrive in managed forests as long as some vertical structure is maintained. Results will allow industrial land managers to evaluate some of the ecological influences of shifting their management from clearcut harvesting to selective harvesting across large areas. University of Maine researchers will develop specific recommendations so landowners can retain enough mature structural features in partially harvested forests for martens and other wildlife that rely on mature forest

Ecology

- The last 150 years have seen significant, widespread, and ongoing changes in Great Basin vegetation that have resulted in serious losses of livestock forage and wildlife habitat. This loss of native habitat means loss of wildlife species and possible listings under the U.S. endangered species act, reduced livestock grazing, unstable watersheds and degraded water quality, fewer recreational opportunities, and more dangerous and costly

wildland fire fighting. A multidisciplinary team from the University of Nevada, Reno, is analysing the changes in the Great Basin ecosystems, and establishing a baseline by which current management approaches and future changes can be gauged.

- About two-thirds of Wisconsin's land is privately owned, and much of the state's wildlife depends on private land for habitat. Millions of acres of forested tracts across the state are maturing and their value to different types of wildlife communities is changing. Landowners need to understand these ecological relationships to make informed decisions on managing their properties for the wildlife communities they value. To help landowners make land management decisions, University of Wisconsin wildlife specialists offer an educational program for landowners who want to practice forest stewardship, and share their knowledge with neighbors and friends. Over a five-year period, 125 landowners who control more than 100,000 acres were trained in forest stewardship. Follow-up surveys indicate that they impact five times that acreage as ambassadors for the project.
- The Oregon State University Department of Fisheries and Wildlife is giving students a big-picture view of coastal marine environment management issues via a special intensive 2-week Coastal Ecology and Resource Management course. The class, and associated short courses, provides students with a diverse array of hands-on educational experiences aimed at "total immersion" learning of the ecology and management of coastal marine and freshwater ecosystems and natural resources.

Habitat and Responses to Environmental Disturbance

- Research in Tennessee demonstrated the wildlife habitat value of planting warm season grasses in pastures. Bobwhite quail populations increased an average of 100% and rabbits increased 300%. Forage production compared favorably with fescue, producing over 10,000 pounds per acre.
- A 1998 survey on Coverts projects in participating states determined that 1,770 cooperators had been trained over 14 years. These individuals owned or managed 1,900,000 acres. They have passed along management information to 110,000 landowners who own or manage 1,600,000 acres.
- Oklahoma landowners get prescribed fire information to restore their land to productive and biologically diverse states through an Oklahoma State University educational program conducted at six demonstration sites. In the past five years, more than 200 field days have been presented based on this program attended by more than 10,000 participants. During this time, the number of acres burned in Oklahoma's forested habitat has increased by more than 100 percent to approximately 800,000 acres. This increase has resulted in improvement of habitat for two endangered species, red-cockaded woodpeckers and black-capped vireos, and economically important wildlife such as the wild turkey and white-tailed deer. Well over one million acres of prairie and shrublands have been burned this period. This has resulted in removing invasive plants such as eastern redcedar and improving habitat for lesser prairie chicken (a declining species), mule deer, white-tailed deer, bobwhite quail, and beef cattle.

Resource Management, Conservation and Restoration

- Quality Deer Management Programs conducted by Extension for landowners in Tennessee are credited with reducing herd numbers, improving the population sex ratio and age structure, increasing individual fitness and fawn survival, and reducing deer damage to crops and ornamentals.
- The value of stocking for enhancing fish populations is often debated because stocked fish often have low survival. Minnesota researchers developed genetic techniques to

help evaluate the worth of stocking. Results indicated that more than 60% to 80% of young in a walleye population were progeny of stocked fish.

- A research team at the University of Missouri developed population models that assess the likelihood of endangered piping plovers surviving under the current conditions compared to a proposed management strategy of excluding predators at nesting areas. The results suggest that active management of plover breeding sites can be effective in slowing the decline of the Great Plains population and even reversing the trend. This result may encourage management agencies and managers to adopt the new approach.

Wildlife Impacts on Humans

- Crop damage by deer is a serious concern in many parts of the country. In Kentucky a Cooperative Extension program on deer management on farms attracted 33 participants who later indicated that program content was worth an average of $5000 to them.
- Connecticut researchers are working to develop a humane sterilization method as a tool for controlling deer population size. Bucks are given a sclerotinizing agent to block the epididymus by scar formation and prevent sperm flow. The technique is now being used in management trials in several states.
- Farmers in New York were surveyed to gain estimates of damage by deer to agricultural crops. It was determined that statewide damage in 2002 was approximately $58.8 million. This represents about 1.7% of the value of the state's agricultural production. About a quarter of the responding farmers considered that damage averaging an estimated $11,000 that they suffered was unreasonable.

Human Dimensions

- Nationally-coordinated extension wildlife education programs reach many thousands of youth and adults. Annually, more than 300,000 boys and girls participate in the 4-H National Shooting Sports Program, while over 10,000 youth participate in the Wildlife Habitat Evaluation Program every year.
- The Texas Master Naturalist program began in 1998 and in five years trained over 1,650 volunteers, who have dedicated 66,000 service hours a year to community natural resource projects. These projects have impacted over 341,000 youth, adults, and private landowners, and some 29,000 acres of habitat. Over 244 local organizations have partnerships with local Texas Master Naturalist chapters. The efforts of these volunteers have extended the budgets of the Texas Parks and Wildlife Department and Texas Cooperative Extension by $2.7 million.
- Research in Massachusetts is being directed toward increasing the efficiency and effectiveness of wildlife agency staff interactions with community stakeholders. The work is providing direction for involving community participation in deer management, for streamlining the management process, and creating a more mutually beneficial atmosphere for a wide array of stakeholders. Results are pointing to effective ways of communicating the realities of wildlife management in areas of high human densities and identifying management models for meeting goals for wildlife control and public involvement and acceptance.

Outcomes Summary

Short-term

- $32M of allocated formula funds resulted in partial support of 300 to 400 research projects at LGU's and were used to leverage an additional $356M in research support.

- Basic and applied research was conducted one relevant and timely issues on organism, population and species biology; ecology; resource management; conservation and restoration; and human dimensions.
- Research results were reported in an estimated 5900 reports and publications and at numerous scientific conferences and professional meetings.
- New research-based information was communicated to state extension wildlife specialists and to academicians.
- Formula funds provided partial base support of wildlife extension programming in states.
- NPL was connected to wildlife research, extension and education activities through participation in scientific and professional meetings, conducting university program reviews, and other contacts.

Mid-term

- New science-based information is incorporated into LGU educational and extension programming.
- Students, landowners, resource managers, public, and policy makers gain additional knowledge on wildlife issues on forest, range, and agricultural lands through educational and extension programs.
- Increased dialogue on wildlife issues encompasses a broader variety stakeholder audiences, including wildlife management and conservation agencies and organizations.
- Landowners apply improved habitat management practices on their properties and exert leadership to encourage others to do similarly.
- Increased citizen involvement in community- and agency-sponsored wildlife monitoring, management, and conservation, including landscape-scale habitat improvements.

Long-term

- Improved management of rangeland, forest and agricultural ecosystems resulting in improved environmental quality and enhanced sustainability of wildlife populations and species.
- Increased public understanding of wildlife resource issues and participation in community-based wildlife conservation and management.
- Reduced conflicts between wildlife and human culture.
- Enhanced economic and other quality of life benefits associated with wildlife accruing to landowners and communities.
- Sustained professional wildlife management cadre that is highly qualified scientifically, technically, and socially.

Performance Indicators

Adding knowledge on the biology and ecology of fish and wildlife species, improving management and sustainability of wildlife resources through a competent professional workforce,

and achieving greater harmony between interests of wildlife and society are the performance indicators for this problem area. Examples of these indicators are:

- Obtaining new research-based knowledge on interrelationships of wildlife to environmental factors in natural and human-influenced ecosystems.
- Developing improved methods for censuring and regulating the size of wildlife populations.
- Producing well-qualified graduates at baccalaureate and graduate degree levels in sufficient numbers to replace the current professional wildlife management cadre.
- Reducing damage by wildlife to agricultural crops.
- Ameliorating the spread of disease to livestock and humans through wildlife vectors.
- Achieving greater public understanding of wildlife issues and participation in wildlife policy and decision making.

Success Stories

Native grasslands represent one of the most endangered ecosystems in North America, and wildlife associated with them are threatened by this habitat loss. Wildlife species of economic significance, such as the northern bobwhite quail, have experienced significant population declines over the past 30 years. Developing proactive management strategies is desirable before such species become endangered and management options become more limited. University of Tennessee researchers studying grassland birds on a military reservation where habitat has remained largely intact have found that populations there are being sustained despite widespread declines elsewhere in the region. Their results suggest that landscape-scale management approaches are needed to restore and maintain grassland bird populations. This study provides wildlife managers and landowners with a context for sustaining these forms of wildlife and focuses attention on the landscape context and provision of native grasslands as important habitat considerations for management success.

Much attention is being given by researchers and extension educators to considerations of wildlife habitat within agroecosystems. In eastern North Carolina, populations of bird species associated with farm lands have been declining at a rate of about 3% per year for more than three decades. Researchers at North Carolina State University are working to determine the reasons for this downward trend and to develop cost-effective, environmentally beneficial methods of improving wildlife habitat to reverse the trend. The research has shown that the suspicion that modern pesticides have caused the demise of the birds is probably false. It also appears unlikely that predators are a major cause of depressed populations of game birds, such as bobwhite quail. Instead, habitat loss, especially that of naturally vegetated field borders, is implicated as a significant factor. Properly managed field borders afford food and shelter to wildlife without sacrificing crop production. This effort has shown how agricultural operations can be managed to improve wildlife habitat conditions without causing negative economic consequences to farmers.

Conservation buffers are gaining widespread acceptance as tools to help control soil erosion and improve soil and water quality. Scientists at Mississippi State University are conducting research about buffer impacts on wildlife, especially regarding reproductive performance of birds in field borders planted to native warm-season grasses and legumes. Their results show that native, herbaceous field borders increase local abundance of bobwhite quail, general avian diversity during summer and winter, and abundance of some songbirds which are in regional decline. The intentt is to demonstrate that properly managed crop field buffers can have multiple benefits for natural resources conservation.

The University of Maine - Cooperative Extension's "Enhancing Backyard Habitat" program delivers workshops and educational materials and consultations to landowners. Program evaluation revealed that nearly half of participants have made changes in use of their property that resulted in the occurrence of new wildlife species on the land and generally increased use of their land by wildlife. Also nearly half consciously avoided planting invasive non-native plants, while nearly 20% reduced or eliminated the use of pesticides on their land. More than 1,000 acres were enhanced as habitat and managed with ecologically sound landscaping practices.

Concerns about damage to property caused by wildlife are growing. Active intervention is required to minimize human-wildlife conflicts, and researchers and extension educators at LGUs are playing an active role in this effort. In recent decades, some wildlife species that have rapidly increased in population size and geographical distribution have been a focus of concern. The white-tailed deer is one of the most prominent of these because of its great potential for crop damage and involvement in vehicular accidents. Researchers at the University of Tennessee have completed preliminary investigations using remote sensing technology to learn more about deer habitat use and movements, particularly in agricultural environments. This research is significant because it prescribes powerful new approaches to quantify deer damage. These tools, when used for managing herds and making land use decisions, will reduce the economic impact of deer to America's farmers, and deaths and vehicle damage on the nation's highways.

Disease can decimate wildlife populations, and some forms can be transmitted to humans and livestock with serious health consequences. Some forms of wildlife-borne diseases, such as rabies, have been known for many years, and effective policies and practices of public and livestock disease control have been developed. But in recent years, a spate of new forms of wildlife diseases have appeared, and LGU researchers have responded with needed research and public education programs. Some of these diseases are known to have originated from alien organisms. Deadly heartwater disease has spread from Africa and the Caribbean region where it threatens livestock and wildlife. The disease is spread by a tropical bont tick that attacks blood vessels, particularly in the brain. Although it is not known to affect humans, up to 90% of infected animals die. Researchers at the University of Florida are concerned that the disease may spread to the southeastern United States where it might seriously affect cattle, sheep, goat and wild deer populations. To prevent this event, the Florida researchers have developed two new vaccines and established measures to prevent tick invasion and check health of potentially exposed livestock. The impact of this work is to greatly reduce or eliminate the concern that this disease has caused for livestock producers and wildlife managers.

Educators at LGUs are increasingly taking innovative approaches to attract a qualified and diverse student body and prepare them for present and future challenges in their careers in fisheries wildlife management. Historically, the number of African-Americans and other minorities enrolling in natural resource related fields has been low and even declining over the past two decades. This is believed to be partly because of negative perceptions about the career field. In an effort to recruit more minority students to the area, South Carolina Cooperative Extension conducts a summer Natural Resource Career Camp for high school students. At camp, students are exposed to a wide variety of environmental and natural resources fields, including that of wildlife management. Pre- and post-testing indicates that the camp is effective in raising student knowledge and interest in obtaining education in natural resources.

Many LGU wildlife academic programs have instituted "capstone" courses which simulate real-world conservation situations. At Oregon State University, for example, this takes the form of a three-term course called Group Problem Solving (GPS). Working in teams of 6 to 10 people

under supervision of a faculty mentors, the students learn teamwork processes and dynamics as they move through stages of problem analysis, solving, and synthesis and develop an end product. The products have included Extension Service bulletins and other educational materials, along with wildlife and environmental management plans.

New Directions

Several new directions and/or expanded efforts are needed in both the content and administration of work in this problem area.

- Identifying, detecting, assessing and responding to fish and wildlife disease threats, including spread of disease to humans and livestock
- Improving genetic knowledge of fish and wildlife populations and using such knowledge as the basis for conservation and restoration of native stocks
- Enhancing the ability to assess impacts of global climate change on fish and wildlife populations and species and developing appropriate management strategies
- Control of invasive plants that deleteriously affect wildlife habitat conditions
- Control of invasive animals that prey upon, compete with, interbreed with, or otherwise deleteriously affect native stocks
- Understanding landscape-scale habitat modification impacts on wildlife populations
- Ameliorating damage by wildlife to humans and their property
- Enhancing education about wildlife and related environmental issues to an increasingly urban public
- Reconciling differences within human society on wildlife-related issues
- Enhancing community involvement in management of local fish and wildlife resources
- Strengthening coordination between federal agencies which have shared missions in wildlife resource management
- Enhancing opportunities for wildlife-related research in CSREES competitive grant programs

Problem Area 136 – Conservation of Biological Diversity

Overview

Biological diversity, or biodiversity for short, refers to the variability of living organisms and the ecological complexes of which they are a part. It is the total variety of genetic strains, species and ecosystems. Human culture has largely prospered on the basis of its ability to utilize biodiversity. Conservation and management of genetic diversity within domesticated plant and animal species, for example, have been improving agricultural production for millennia, but diverse natural biotic populations have been providing food and other products and services to humans for much longer.

A wide range of species provides many products through agriculture and from the harvest of natural populations. High production levels are sustained through maximizing the beneficial impact of ecosystem services for agricultural and natural ecosystems. Moreover, a diverse range of resident organisms contributes to ecosystem resilience -- the capacity to recover from environmental stress and the ability to evolve. Essential functions such as nutrient cycling, decomposition of organic matter, degraded soil rehabilitation, pest and disease regulation, water quality, and pollination are maintained by a wide range of biologically diverse populations in ecosystems.

Maintaining this diversity of species and building on and enhancing ecosystem functions reduces external input requirements by increased nutrient availability, improved water use and soil structure, and natural control of pests. A range of populations needed by agriculture such as pollinators and beneficial predators need habitat diversity to survive. Agriculture, therefore, provides incentives to preserve natural areas and biotic diversity. A large part of the knowledge of biodiversity has been gained and will continue to be gained across human cultures through agricultural and natural resource management practices. The importance of this legacy was recently highlighted by the UN FAO October 16, 2004 World Food Day theme: "Biodiversity for Food Security." It is also recognized that biodiversity has important implications for human, plant and animal health, including factors affecting the spread of infectious diseases and potential medicines derived from biotic materials.

Situation

Currently there is great concern over the increasing impact of human actions on biodiversity. Resulting from an array of human-induced threats, rates of biotic species extinction are now estimated to be between 1,000 to 10,000 times greater than in the geological recent past. It is tabulated that worldwide, 484 species of animals and 654 plants have become extinct since 1600 AD. There are scientific estimates that one-third to two-thirds of all species of plants, animals, and other organisms on the planet may be lost by the end of the next century, if current trends persist.

Several primary causes are implicated in the rapid loss of biotic diversity globally: habitat degradation and destruction, climatic change, overexploitation, and introduction of alien organisms. Historically, the greatest factor has been the loss and fragmentation of natural habitats. This includes clearing forests for timber or agricultural cropping, overgrazing, draining wetlands, and urbanization, among a long list. In the past century, for example, the amount of North American land converted for agricultural uses from natural habitat increased 53% (from 133 to 203 million hectares), a modest change compared to that elsewhere, such as Latin America (+330%). Tropical forests are being destroyed at the rate of 0.8% to 2.0% per year. A 20-year

study has shown that deforestation and introduction of non-native species has led to about 12.5% of the world's plant species to become critically rare.

Another form of habitat change, environmental pollution, also degrades biota over much of the world. Pesticides, sewage, oil, combustion emissions, acid rain and other waste products of human culture contaminate soils, freshwater, oceans and air. An alarming effect of atmospheric pollution is that of accelerating changes in climatic patterns to which ecosystems are evolutionarily adapted. Anticipated consequences include dramatic changes in the geographical distribution of biota, leading to ecosystem imbalance, and the extermination of some species. Recent analyses suggest that 15–37% of a sample of 1,103 land plants and animals would eventually become extinct as a result of climate changes expected by 2050.

Past overexploitation has extirpated some animal species, and the persisting problem has pushed some others to the verge of extinction, particularly in the world's developing countries. In the oceans, industrialized fishing has contributed importantly to stock collapses despite repeated international attempts at limiting the fishing. A new global study concludes that 90 percent of the biomass of large predatory fishes has disappeared from the oceans in the past half century, as a result of industrial fishing. In addition to having enormous economic impacts, this massive loss of predators is likely to cause multiple complex imbalances in marine ecology.

The significant threat to biological diversity caused by alien invasive species is now acknowledged by scientists and governments globally. The impacts of invasive organisms are immense, insidious, and usually irreversible. They may be as damaging to native species and ecosystems worldwide as the loss and degradation of habitats and of climatic change. The natural barriers of oceans, mountains, rivers and deserts provided the isolation essential for unique species and ecosystems to evolve. In just a few hundred years these barriers have been rendered ineffective by major global forces that combine to help organisms travel vast distances to new habitats and become invasive species. The globalization and growth in the volume of trade and tourism, coupled with the emphasis on free trade, provide more opportunities than ever before for species to be spread accidentally or deliberately. Customs and quarantine practices, developed in an earlier time to guard against human and economic diseases and pests, are often inadequate safeguards against species that threaten native biodiversity. Thus the inadvertent ending of millions of years of biological isolation has created major ongoing problems that affect developed and developing countries.

Alien invasive species are found in all taxonomic groups: they include introduced viruses, fungi, algae, unicellular and higher plants, invertebrates, and vertebrates. They have invaded and affected native biota in virtually every ecosystem type on Earth. The ecological cost is the irretrievable loss of native species and ecosystems. In addition, the direct economic costs of alien invasive species run into many billions of dollars annually. Invasive weeds reduce crop, livestock, forest and rangeland yields and increase production costs; weeds degrade catchment areas and freshwater ecosystems; tourists and homeowners unwittingly introduce alien plants into wilderness and natural areas; humans and wildlife suffer health impacts, etc. The degradation of natural and agricultural ecosystems, and climatic change that has occurred throughout the world has made it easier for alien species to establish and become invasive.

No one knows what will be the result of a rapid extinction rate and decrease in biotic diversity. What is known, for sure, is that the planet's ecological system has been kept in balance through a complex and multi-facetted interaction between a huge number of biotic species. It is predicted by many scientists, therefore, that the situation may eventually precipitate collapses of ecosystems at a global scale, promoting massive disease outbreaks and creating large-scale

agricultural problems, threatening the health and food supplies of hundreds of millions of people. Recognizing these potential catastrophic consequences, and the commitment of the environmental science and management communities to stem biodiversity declines, CSREES proposed the addition of Conservation of Biological Diversity as an Agency priority program area (PA136) in 2004.

Major Themes

The major themes of this problem area are:

- Understanding the role of biological diversity in maintaining ecosystem integrity, structure, and function, including that of agro-ecosystems
- Surveys and assessments of biodiversity
- Conservation and sustainability of biodiversity at genetic, species, community, and ecosystem levels, including organisms of agricultural interest
- Restoration of biodiversity in human-impacted environments
- Control of invasive organisms
- Recovery of threatened and endangered species

Assumptions

- Conservation of biotic diversity has been a growth area among federal and state natural resources agencies over the past two decades and will continue to receive significant attention for the foreseeable future. But there is little prospect for the proposed National Institute for the Environment which would be the logical home for a national, coordinated biodiversity program. So this area will continue to be worked on by a number of federal agencies, with various degrees of collaboration.
- This will continue to be an international issue for a long time but its future is unpredictable because of unstable world politics and economies.
- Conservation Biology, the scholarly field concerning biodiversity, is now an established and increasingly influential scientific discipline. Most major universities and federal agencies now have personnel who work in this field. State agencies are staffing in this area more modestly.
- The public is growing increasingly knowledgeable about the issue through extension programming, television etc. and is becoming increasingly supportive of agency biodiversity conservation programs. Numerous private conservation organizations regard this as a priority issue and have staff specialists working on it.
- College students are quite knowledgeable about the issue because of what they have learned in school and from television; they are very interested in courses and programs of study in this area, and many hope to eventually have careers related to it. Over the past decade, conservation biology academic programs have tended to attract as much or greater student interest than traditional natural resources programs, e.g. forestry, range, and wildlife.
- Agricultural interests were often suspicious of the issue but are gradually understanding its significance, especially to their self-interests, and are slowly becoming more supportive of conservation efforts.
- The general industrial and business community still views this negatively and will tend to oppose federal biodiversity legislation and policy that is perceived as detracting from business interests.
- Because this is now an established CSREES Problem Area, a National Program Leader provides leadership for it and there will be some active programming.

- Biodiversity research based partly on CSREES formula funds to LGUs will continue to increase and there will be increasing need for federal competitive grant opportunities.
- Extension educators will give this area more attention, in part, through the spread of "master naturalist" and similar programs among them.

External Factors

Several factors affect the performance, outcomes and CSREES program attributions that are achieved in the problem area. These include:

- Although the term biodiversity is a relatively recent addition to the scientific and environmental lexicon, its conceptual underpinnings are much older. Federal legislation relating to the concept dates back well over a century, and today the body of legislation is diffuse.
- Because of this legislative history, responsibility for biodiversity management is shared among a number of federal agencies, notably the US Forest Service, Natural Resources Conservation Service, Bureau of Land Management, National Park Service, Fish and Wildlife Service, Geological Survey, and Environmental Protection Agency, in addition to CSREES. Most states and numerous local and national and local non-governmental organizations also have active biodiversity programs.
- With the exception of growing interagency coordination on invasive species control, there is, nevertheless, little direct cooperation among federal agencies on broader biodiversity issues.
- USDA's obligation to biodiversity programming has increased with each successive Farm Bill since the 1985 Bill's Swampbuster provisions penalized farmers for wetland conversion to cropland or grazing land.
- In addition to federal laws, the United States is party to a number of international agreements to conserve and protect wildlife.
- The country's forests and rangelands are an enormous component of the national biodiversity reservoir.
- The CSREES strategic plan for 1997 to 2002 included several objectives that included "conserving, maintaining, and protecting ecosystem integrity and biodiversity." Nevertheless, biodiversity was not formally identified as an Agency problem area until 2004, after the time period covered by this portfolio. Moreover, the CRIS database does not specify biodiversity as Research Problem Area
- Two Research Program Areas within the CSREES National Research Initiative may be considered, in particular, to offer research grant opportunities on biodiversity issues: Managed Ecosystems, and Biology of Weedy and Invasive Plants.

Inputs

In general, CSREES manages its program areas through dedication of agency personnel resources to them and by provision of funds to external cooperators for research, education and extension applications. Because this program area was not established until 2004 and there is no coding for biodiversity in the CRIS system, it is challenging to identify and especially to quantify the CSREES inputs to this program area.

Perhaps the CSREES personnel position most directly involved with biodiversity issues in recent years has been the NPL who manages the NRI research program area in Biology of Weedy and Invasive Plants because the invasive plant issue is a major biodiversity concern. During the1999 to 2003 period, this responsibility was treated as a temporary, part-time assignment, and not surprisingly, was held by three different individuals.

The issue of invasive organisms and the gradual growth of federal interagency cooperation concerning it has prompted greater CSREES staff involvement with it in recent years. Several NPLs deal with it in their program areas, and some voluntarily serve on one or more interagency committees. An informal invasive species working group of about ten NPLs was established several years ago. The group has a chairperson and meets more-or-less monthly. Biodiversity is a topic of a growing number of competitive and formula-funded research projects, and so some NPL time is devoted to it in proposal review and post-award management.

Despite the fact that PA 136 is not coded for in the CRIS system, an effort was made to gain some information on biodiversity-related research recorded in the database for the years 1999 and 2003. This was done through a search strategy based on RPA's 101, 102, 103, 104, 121, 123, and 135, essentially the soil, range, forest, and wildlife subject areas. Additionally, several keyword terms commonly associated with biodiversity were used for sorting. The searches were limited to CSREES-supported projects. This procedure produced lists of several hundred projects. Each project description was then read and categorized with regard to relevance to biodiversity. This should probably be regarded as a conservative method for determining CSREES biodiversity research activity.

Table 29 shows that 152 biodiversity projects were identified for 1999, and 210 in 2003, an increase of 38% over the five-year period. Hatch and McIntire-Stennis funds supported the great majority of projects, but the contribution of the NRI is notable.

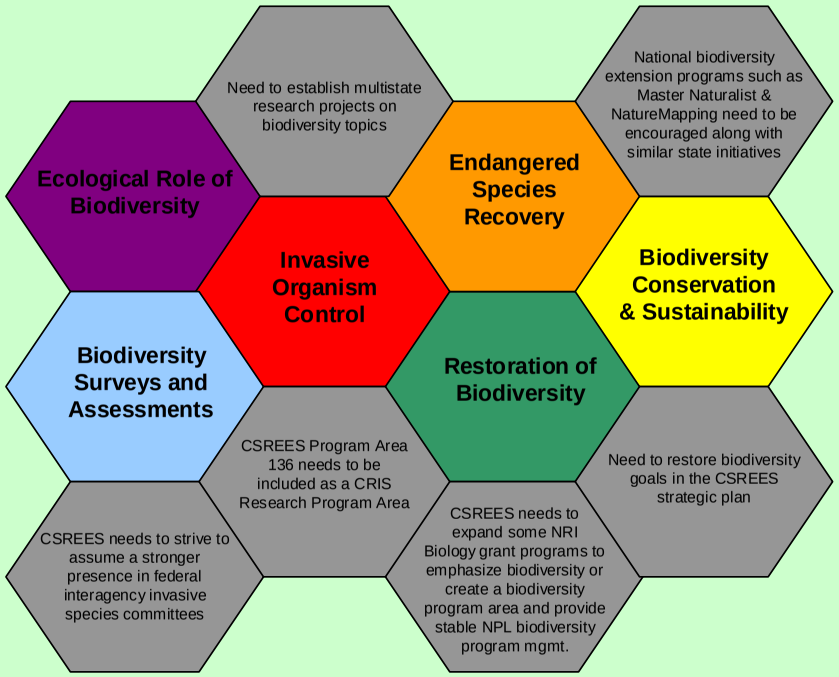
Table 29. Numbers of biodiversity research projects supported by CSREES funding in 1999 and 2003.

Funding Source	Fiscal Year	
	1999	2003
Hatch	70	106
McIntire-Stennis	48	59
Evans Allen	2	1
Special Grants	6	8
NRI	25	30
Other	1	6
Total	152	210

Actual contributions of CSREES formula funding to this portfolio cannot be determined although many Hatch and McIntire-Stennis projects concern biodiversity. However, CRIS records indicate that the 30 NRI biodiversity-related projects funded in 2003 were awarded a total of $7,060,013. It seems reasonable to conclude that overall agency support for biodiversity research currently exceeds $10 million annually.

Problem Area 136: Conservation of Biological Diversity

Major Themes Funded by CSREES and Research Needs



Accomplishments (Selected Examples Reported by Partners)

- University of Maine research showed that rockweed plays a key role in maintaining coastal waters biodiversity. This led to establishment of state harvest regulations and other conservation measures.
- Entomologists at Washington State University conducted a survey of insect diversity. They identified over XX species of unknown insects to science and produced several hundred new state distributional records.
- Oklahoma Cooperative Extension assisted ranchers in releasing thistle-eating weevils. The weevils achieve a 80% to 95% control rate. Tennessee, similar biocontrol rates are occurring using weevils. Savings estimated at $3 million annually.
- Washington State University scientists have a rabbit artificial breeding program in which they study captive bred rabbits released in the wild. Information gained from releases is being used to plan future releases to enhance individual and population survival.
- In Louisiana, local 4-H members and the U.S. Fish and Wildlife Service collaborated to restore coastal areas by constructing sand fencing and planting cypress trees and other vegetation.
- Ohio State University helped establish an Ornamental Plant Germplasm Center to protect and maintain biodiversity for scientists conducting basic research, crop improvement, and new product development.

New Directions

Outputs

In order to gain insight into topical coverage of research pertaining to PA 136, keywords were examined in titles of over 160 Hatch and McIntire-Stennis biodiversity-related projects. Not surprisingly, the word diversity or biodiversity was the most commonly used term, occurring in about one-third of the titles. Other common words, occurring in over 10% of the titles, were Forest, Management, Ecology, and Landscape, or some variant of these words. Occurring somewhat less commonly were Soil, Microbial, Wildlife, Ecosystem, Community, Population, Conservation, Agriculture, Function, Structure, Rangeland, Land Use, Environment, Habitat, and Genetic. Taken collectively, these terms convey something of the flavor of biodiversity research being conducted with CSREES support.

This issue is of research concern throughout the country. By this accounting, in 2003 CSREES supported biodiversity research in all but one state.

Extension is playing important role in educating the public about biodiversity issues. CSREES leadership was provided to the 2003 RREA national strategic planning activity that resulted in an RREA Strategic Plan for FY2005-2009; it identified a number of biodiversity-related issues and goals that represent a charge and action plan for the Cooperative Extension System:

- Issue – Non-native, invasive species are becoming established and spreading at an alarming rate throughout North America.
    - RREA Goal 1 – Forest and rangeland owners and managers will become knowledgeable about the problems caused by non-native species on their lands, and actively work to control the spread of these species.
    - RREA Goal 2 – Partnerships comprised of private groups such as landowner associations, industry, commodity associations, nongovernmental conservation organizations, and state and federal agencies will be formed to develop and deliver educational and technology transfer programs to various audiences.
- Issue – Permanent loss of forests and rangeland is occurring at an unprecedented rate as a result of land conversion to uses that eliminate natural ecosystems.
    - RREA Goal 1 – Improve the ability of landowners and managers to make informed decisions about land-conservation options that minimize conversion and parcelization while retaining important wildlife habitat, productive capacity, and economic viability.
    - RREA Goal 2 – Increase public understanding of the economic, social, and environmental consequences of growth and development on maintaining sustainable and healthy ecosystems.
    - RREA Goal 3 – Decision makers will avoid when possible, and mitigate when necessary, the impacts of growth and development on forest and rangeland ecosystems.
- Issue – Rangeland owners and managers require sound, research-based information and stewardship incentives not only to prevent degradation of rangeland resources and ecosystems but to also enhance these resource values.
    - RREA Goal 7Rangeland owners and managers will actively manage their lands with the knowledge of range ecosystem processes, stewardship practices, and the consequences of alternative management strategies.
- The well-being of many fish and wildlife populations, which provide important societal and environmental benefits, is strongly linked to stewardship of their habitats on private forest and rangelands.

- RREA Goal 8 – Landowners and managers will adopt management practices based on sound ecological principles and research findings that provide habitat for fish and wildlife populations to be healthy, productive, and self-sustaining while meeting landowner objectives.

A number of state extension programs are emphasizing biodiversity education through specialized programs. Master Naturalist programs are thriving in 12 states, and the concept is rapidly spreading to others. These programs train local corps of citizen volunteers to become involved in management of natural resources and natural areas within their communities. In four states, extension works with local natural resources agencies to conduct NatureMapping programs with the goal of "keeping common species common." Citizen volunteers are trained to identify wildlife species in the field, make precise geospatial determinations of the sites, and accurately report the records in formats that can be used by scientists and resource managers.

Outcomes (Examples by major themes)

Ecology

University of Maine research showed that rockweed, a common marine plant harvested for use as fertilizer, plays a key role in maintaining coastal waters biodiversity. This led to establishment of state harvest regulations and other conservation measures.

Biotic Surveys and Databases

Entomologists at Washington State University conducted a comprehensive survey of insect diversity at the 195,000 acre Hanford Nuclear Reservation in Washington State. The research identified over 40 species of insects previously unknown to science and produced several hundred new state distributional records. These results serve as useful references for comparisons with insect fauna in more culturally impacted areas.

Conservation Genetics

Ohio State University has established an Ornamental Plant Germplasm Center to protect and maintain biodiversity for scientists conducting basic research, crop improvement, and new product development. The new Center is collecting, conserving, and assessing herbaceous ornamental plant germplasm and distributing it to scientists and breeders. The Center joins an existing network of about 20 sites in the USDA National Plant Germplasm System where germplasm programs save genes for important economic and agronomic crops.

Invasive Species

Musk thistle is an invasive noxious weed that reduces forage yield and quantity by competing with desirable forage plants. Oklahoma Cooperative Extension has assisted ranchers in releasing over 60,000 thistle-eating weevils on about 5000 infested acres. The weevils are achieving a 80% to 95% control rate. This approach achieves control of a fraction of the cost of herbicide treatment. In Tennessee, similar biocontrol rates are occurring by use of weevils. The savings over herbicide control is estimated at $3 million annually.

Endangered Species and Ecosystems

The pygmy rabbit is a state and nationally endangered subspecies occurring in the sagebrush steppe of Washington, with a wild population of less than 100 individuals. Washington State University scientists are carrying on a rabbit artificial breeding program and have studied the behavior, movements and survival of captive-bred rabbits released in the wild. Information gained from these releases is being used to plan future releases to enhance individual and population survival.

Restoration
In Louisiana, 40 to 50 square miles of coastline are lost annually due to erosion. Local 4-H members and the U.S. Fish and Wildlife Service have been collaborating to restore coastal areas by constructing sand fencing and planting cypress trees and other vegetation. In addition to contributing to ecosystem restoration, participating youth became more environmentally knowledgeable and inclined to become involved in future citizen conservation efforts.

Outcomes Summary
Short-term

- By conservative estimate, CSREES recently supported about 200 biodiversity-related research projects annually with support exceeding $10 million.
- Basic and applied research interest is growing in a wide range of relevant and timely issues
- Research results are reported in scientific research publications and at numerous scientific conferences and professional meetings
- New research-based information is communicated to state natural resources extension personnel and to academicians
- Formula funds provide partial base support of extension programming on biodiversity topics in states

Mid-term

- New science-based biodiversity information is incorporated into LGU educational and extension programming
- Students, landowners, natural resource managers, public, and policymakers gain additional knowledge on biodiversity issues through university educational and extension programs
- Increased dialogue on biodiversity issues encompasses a broader variety of stakeholder audiences, including individual citizens, natural resources and environmental protection agencies and organizations
- Government agencies establish policies, regulations and practices to protect and restore biodiversity
- Landowners apply management practices on their properties which conserve biodiversity and encourage others to do similarly
- Increased citizen involvement in community- and agency-sponsored biodiversity monitoring, management, conservation, and restoration

Long-term

- Improved management of natural and human-impacted ecosystems resulting in conservation and enhancement of biodiversity locally, nationally, and globally
- Increased public understanding of the importance of biodiversity and support for biodiversity improvement programs
- Reduced conflicts over governmental regulations designed to conserve and enhance biodiversity
- Enhanced economic and other quality of life benefits associated with maintenance of native biodiversity complexity and ecosystem health
- Sustained professional natural resource and ecology cadre that is highly qualified scientifically, technically and socially to manage for biodiversity security.

Performance Indicators

Adding science-based knowledge on the biodiversity of the country and of the world and of biodiversity's roles in ecosystem functioning, and improving management for conservation and restoration of biodiversity through a competent professional workforce and the support of an enlightened public are the performance indicators for this problem area.

Examples of these indicators are:

- Surveying and assessing the biodiversity of discrete geographical areas and recording the information in standardized databases that are accessible for scientific applications and public information
- Developing models to explain how changes in biodiversity may affect ecological processes in natural and disturbed ecosystems
- Protecting the genetic variation inherent in natural biological entities
- Implementing management plans that are successful in restoring the viability of endangered species
- Enhancing biosecurity of natural and agricultural ecosystems by controlling the spread of invasive, ecologically harmful species of alien plants and animals
- Producing well-qualified conservation biology graduates at baccalaureate and graduate degree levels who can successfully collaborate with natural resources and other professionals, as well as the public, to achieve sound management for biodiversity goals
- Achieving greater public understanding of biodiversity issues and participation in relevant policy and decision making.

Success Stories

Invasives

At least 2000 exotic plant species have been established in the United States, according to the Office of Technology Assessment. Many have become noxious weeds, causing damage estimated to cost from $3.6 to $5.4 billion per year. Invasive weed species such as spotted, diffuse, and Russian knapweeds; leafy spurge; Canada thistle; and Dalmatian toadflax are difficult or uneconomical to control in western rangelands. Thus biological control programs against these invasives have been initiated. These programs often rely on importing natural enemies from the native range of the plant. Before being released into the environment, the host specificity of these exotic natural enemies must be determined, and suitable agents must be screened for diseases, parasites and other contaminants in a quarantine laboratory. Montana State University has one of the few high security quarantine facilities in the United States. To date, the facility has cleared 40 arthropod species for field releases as weed biocontrol agents, screened 25 others, and evaluated eight parasitoidsd for possible use as insect pest biocontrols. Several of released species have become established and are showing potential for weed control. Biocontrol, when integrated with an overall management program, is a cost-effective, environmentally safe, self sustaining approach to management of problem weeds. It also has potential to improve habitats for domestic animals and wildlife, and for increasing biodiversity by reducing pervasive weed populations which crowd out native plant communities.

Beginning in 1989, the University of Wyoming Cooperative Extension Service assisted with releasing biocontrol agents, two species of fleabeetles, in an area heavily infested with leafy spurge, an extremely tenacious and noxious weed that reduces agricultural productivity and biodiversity on millions of acres in the northern United States and Canada. After a nearly one decade lag phase, as the beetle populations grew and dispersed, researchers began to record a decline in the leafy spurge infestation, and ranchers were reclaiming areas that had been near

monocultures of the weed for decades. UW CES is continuing to work with producers and land management agencies to establish comprehensive weed control programs, including use of herbicides, sheep and goats. At least 30 producers who collectively manage 100,000 acres are using this approach with the result that the infestation is shrinking and the perimeter is being held.

Spartina, an invasive non-native cordgrass, threatens the integrity of intertidal marine communities in Puget Sound and coastal Washington. The plant forms dense stands and colonizes mudflats, displacing native plants and animals. It is threatening the state's important oyster industry. Current mechanical and chemical control methods have not been successful in stopping its spread. Washington State University researchers have developed precision agriculture technologies for herbicide application that are proving effective. In tests at a wildlife refuge, more than 700 acres of Spartina were controlled for less than $250/acre. This was the first successful large-scale Spartina control effort ever achieved in the United States.

Endangered Species

Rapid growth in human populations and accompanying increases in demand for natural resources have placed unprecedented pressures on wildlife species, bringing many to the brink of extinction. At Virginia Tech University, scientists have studied many such species for the purpose of aiding in conservation efforts. For example, bald eagle radio-telemetry demonstrated that eagles avoid developed shorelines, thus underscoring the need for habitat protection. This lead to the creation of refuges such as the James River National Wildlife refuge and Caledon Natural Area in Virginia. Moreover, it led to recommendations for disturbance-free buffers on private and public lands. Because of such management success, the species has recovered to the point that the US Fish and Wildlife Service has proposed removing it from the threatened species list.

Restoration

Federal and many state laws require that lands disturbed by surface mining for coal be returned to their former uses and to their original levels of productivity. In the past, most mined land was sown to grasses and abandoned. Virginia Tech research has demonstrated that productive mine soils and forests can be restored by replacing four to six feet of soil or weathered sandstone overburden on newly reclaimed sites, grading the surface lightly, using native, non-competitive ground covers, and planting a mix of valuable crop trees. Reclamation methods resulting from this work have been incorporated in state reclamation guidelines. Today, 85% of mined land in Virginia and 50% of mined land in Kentucky is now being reforested. These guidelines help mine operators achieve timely bond release to meet legal requirements, landowners obtain productive forests of high value, and adjacent communities benefit from watershed protection, biodiversity and economic value that these new forests provide.

In their original condition, many western ecosystems were adapted to periodic wildfires. With settlement came cessation or at least disruption of natural fire cycles, and gradual development of ecological imbalances among plant and animal communities. Oklahoma State University has established a number of sites to conduct research and demonstration on the use of fire as a land management tool. In the past five years, more than 200 field days have been held at the sites and attended by more than 10,000 participants. During this time, eight prescribed burn associations have been formed among ranchers, and the number of acres submitted to controlled burning in forestlands, prairie and shrublands has increased more than 100% to about 2 million acres. This has resulted in habitat improvement for two endangered bird species and economically important wildlife. This has resulted in removing invasive plants, and improving habitat for wildlife and livestock. Non-burning techniques to reduce eastern red cedar infestations have been developed

which reduced clearing costs from $80 to $11/acre. Moreover, improved water yield and water quality has occurred in burned watersheds.

Sagebrush is an example of a native plant that has expanded in range and abundance as a result of fire suppression in western states. Dense sagebrush stands compete strongly with other plants for water and nutrient resources, thus reducing biodiversity. Managing such situations by thinning sagebrush increases forage for wildlife and livestock and enhances overall biodiversity. Research by University of Wyoming scientists has shown that the pelleted herbicide tebuthiuron can be applied for this purpose. This result was demonstrated in a series of seminars for producers and land management agency representatives. A number of participants now have plans to use tebuthiuron as a land management tool.

The Center for Urban Restoration Ecology (CURE), a partnership between Cook College/New Jersey Agriculture Experiment Station and the Brooklyn Botanic garden, is the first scientific initiative in U.S. established specifically to study and restore human-dominated lands. CURE's work falls under three themes: patterns of urban biodiversity, protocol for successful restoration projects, and management needs for restoration projects. The Center's Fresh Kills Landfill demonstration site on Staten Island and other projects are improving biodiversity, ecological services, and green spaces to urban communities and are establishing a model that can be applied on other landfills and degraded sites. Restored forestland is demonstrating to residents how a biodiverse woodland differs from land degraded by invasive plants and extensive deer browsing.

New Directions

Several new directions and/or expanded efforts are needed in the administration of work in this problem area.

- Biodiversity goals should be restored to the CSREES strategic plan
- CSREES should expand the NRI Biology of Weedy and Invasive Plants and Managed Ecosystems grant programs to place greater emphasis on biodiversity or should create a dedicated biodiversity program area and provide stable NPL biodiversity program management
- CSREES should strive to assume a stronger presence in federal interagency invasive species committees
- The newly established CSREES Program Area 136 should be included as a CRIS Research Program Area so that relevant research can be identified and quantified
- National biodiversity-related Extension programs such as Master Naturalist and NatureMapping should be encouraged along with similar state initiatives
- Multistate research projects should be established on biodiversity topics

Section IV - Criteria and Dimension of Panel Review

Relevance

Scope

Forest, range, wildlife and biodiversity research, education and extension develop and disseminate knowledge and tools for the purpose of managing these enormously valuable public and private natural resources for sustained use by present and future generations. These program areas are closely related in ecological and resource management senses and also in federal legislation. Research and extension on wildfire control and management applications deal with one of the most critical natural resource issues of the day. Failure to adequately deal with the control issue, especially, has catastrophic ecological and sociological consequences to the nation. Fundamental and applied forestry knowledge is being used to develop specialized applications in urban- and agro-forestry that reflect needs and opportunities created by modern societal and agricultural developments. In a very real sense, activities in these program areas concern most of the American landscape (forest, range, agricultural, urban) and directly affect the lives of almost all citizens.

The 48 topical themes covered in Goal 5.1 program areas are listed in Section III. A number of themes that exist in two or more of the Goal's problem areas illustrate where CSREES is contributing to timely, relevant research directed to solving critical problems of national significance. Prominent among these are issues related to ecosystem structure and function, expressed in such terms as forest and rangeland fragmentation, invasive species, and wildlife habitat degradation and loss (see Evidentiary Materials).

Two CSREES funding sources serve the Goal 5.1 portfolio almost exclusively: McIntire-Stennis for research and Renewable Resources Extension Act funds for extension. In FY1999, these and several other formula funds provided 68.4% of the portfolio's budget. In FY2003, they contributed 53.3%. Over the five-year review period, increasing contributions have come from CSREES competitive grants, chiefly the National Research Initiative, and Special Grants allocated by Congress.

In terms of CSREES research funding provided to partners, significant progress for this goal occurred during the five year review period. The Goal 5.1 portfolio expended $25.5 million in FY 1999. This increased to $30.2 million in FY2003, a growth of 18.5% over the five years. Funding for the several program areas representing emerging national priorities especially increased. Support for wildfire control, urban- and agroforestry, increased by 254%, 44%, and 246%, respectively. Moreover, the leveraging power of CSREES support increased during this period. In 1999, every CSREES research dollar was matched with about $6.6 from other sources, and by 2003, this leveraging increased to $7.2 from other sources (Table 5).

In 1999, Goal 5.1 problem areas garnered 5.67% of the total CSREES research budget. By 2003, this proportion had decreased to 5.17%. The Goal's several base programs (PAs 121, 123, and 135) each declined in actual formula dollars over the five year period. A similar situation exists in terms of CSREES personnel resources. In FY1999, the Natural Resources and Environment Unit staff resources devoted to this goal were 6.13 FTEs. These declined to 5.48 FTEs in FY2003, a decline of 11%. Furthermore, the 2003 figure includes 1.4 FTE of temporary professional staff serving the range and wildlife portfolios. In contrast, the interest and ability of

CSREES's partners to expand their programming in this area and obtain greater funding from other sources indicates that larger investments by CSREES are needed (Tables 5, 6)

Extension activities provide additional examples of significant progress during this period. The National Association of State Universities and Land-Grant Colleges – Extension Committee on Organization and Policy's Forestry Task Force was established to promote activities in the forest, range, and wildlife arena and to seek additional funding. Chief among the Task Force's activities has been the revitalization of the Renewable Resources Extension Act (RREA) program. Through the Task Force's influence, Congress doubled the RREA authorization from $15 million to $30 million and increased its appropriation from about $3 million to over $4 million. This permitted bringing the 1890 Universities into the RREA funding stream, and establishing a new web-based National Learning Center for Private Forest and Rangeland Owners. The Task Force also, at the request of the CSREES Administrator, provided leadership for the development of a 5-year RREA Strategic Plan which charts the national priorities for the program (see Evidentiary Materials).

Portfolio Ability to Remain Focused on Critical Needs of the Nation

State partners utilize stakeholder inputs and other relevant information to identify critical needs which may be addressed by application of formula research and extension funds. State processes for critical needs identification and development of appropriate activities and programs are reported to CSREES in mandated 5-year plans of work and in annual reports. CSREES peer review of these as well as review of individual formula-funded research proposals ensures that state programs and activities supported by CSREES funds focus on scientifically critical areas. The requirement that states engage in multistate research, coordinated through regional associations of agricultural experiment station directors, further encourages attention to critical issues that are at least regional in scope. In some cases of extreme emergency or importance, national research projects are established through the regional experiment station system. National extension planning activities also help to guide state Extension programming to contribute to meeting regional and national needs. For example, the recently completed RREA strategic plan gathered input from representatives of 54 land grant institutions in a workshop setting to set a course for extension natural resources programming to meet geographically-broad needs. The planning process resulted in identifying nine strategic issues, 16 goals and numerous action strategies for future RREA-supported programs in the states.

The CSREES competitive review process especially encourages innovative ideas that are likely to open new research approaches to enhancing agricultural and natural resources management. A proven mechanism for stimulating new scientific research, the process increases the likelihood that investigations addressing important, relevant topics using well-designed and well-organized experimental plans will be funded. Each year, panels of scientific peers meet to evaluate and recommend proposals based on scientific merit, investigator qualifications, and relevance of the proposed research to the mission and goals of USDA. Review panels and CSREES staff constantly provide input to competitive grant program managers that results in evolution of program foci that reflect critical needs for new research-based knowledge.

Identification of Emerging Issues Relevant to the Portfolio

Setting priorities is an important means of facilitating the scientific and technological advances needed to meet the challenges facing U.S. agriculture and natural resources management. Congress sets the budgetary framework by providing funds to CSREES. Members of Congress also make recommendations for the scientific and programmatic administration through appropriation language and through their questions and comments during Congressional hearings. Input into the priority-setting process is sought from a variety of customers and stakeholders. The

Agricultural Research, Education, and Extension Reform Act of 1998 formally requires that formula-funded projects reflect stakeholder priorities. The scientific community provides direction through the competitive grant proposals it submits each year as well as through the proposal evaluation and funding recommendations of individual peer-review panels (see Evidentiary Materials).

Participation by NPLs in review panels for competitive programs, federal interagency working groups, stakeholder workshops, and NASULGC programs such as the ECOP Forestry Task Force are important mechanisms for CSREES to identify emerging issues for Goal 5.1 problem areas. NPLs also attend professional and scientific meetings to stay current on scientific trends that should be reflected in CSREES programs and in the coordination of priority setting with other federal agencies. NPLs also participate in meetings with state natural resources Extension personnel, with representatives of the land-grant university community, and with officials of landowner and relevant non-governmental citizen organizations. Through such meetings, NPLs learn of stakeholders' current priorities, and solicit comments and suggestions on ways that CSREES can assist in meeting their needs. In this portfolio, emerging issues are described as "new directions" of the seven program areas (See "New Directions" sections of each Problem Area).

Integration of CSREES Education, Research, and Extension Efforts in the Portfolio

Integration refers to the linkage of the several CSREES missions of research, education, and extension in programs and activities to produce products which reach a wide variety of audiences or stakeholders in appropriate formats, products that might otherwise be disjoint and more narrowly defined. Although CSREES is dedicated to integrative efforts in all its programming areas, there are some challenges to accomplishing this, caused chiefly by outside factors. For example, some legislative authorizations are so specifically defined that they preclude meaningful integration. McIntire-Stennis funds are to be used strictly for forestry-related research. RREA funds are devoted to extension programming alone. Moreover, some CSREES stakeholders have interests which are similarly fixed on single purposes. Such situations require that NPLs must often take the initiative to stimulate and accomplish integration in otherwise focused program areas. While this has been somewhat problematic in the past, significant progress has been made. The ECOP Forestry Task Force is an example of a cooperative, inter-organizational extension activity that has mission integration as a core principal. CSREES also has competitive grant programs that specifically require or encourage integrated programming. The NRI, for example, is now authorized to allocate up to 20% of its annual funding for appropriate integrated projects, and so within it, certain programs are identified as appropriate for this. The Managed Ecosystems Program in the NRI is one so designated and which is particularly well suited for Goal 5.1. Recently the Request for Applications specifically requested proposals dealing with wildland fire control and with wildlife habitat (see Evidentiary Materials).

Multidisciplinary Balance of the Portfolio

Both mission-linked research and fundamental research are supported by CSREES formula- and competitively-funded research. Mission-linked research targets specific problems, needs, or opportunities. Fundamental research involves the quest for new knowledge about important organisms, processes, systems, or products and opens new directions for mission-linked research. Both mission-based and fundamental research are essential to the sustainability of agriculture and renewable natural resources of forest and rangelands. Review of Hatch and McIntire-Stennis funded projects in the Goal 5.1 portfolio reveals that the vast majority typically combine both fundamental and applied approaches. Although single-investigator projects remain the norm, increasingly these types of research are taking multidisciplinary and multi-investigator forms. Additionally, CSREES competitive grant programs are encouraging multidisciplinary research.

Moreover, CSREES requires that 20% of the research formula funding that it provides to states be devoted to multi-state activities, which at least indirectly promotes multidisciplinary approaches. In turn, the regional agriculture experiment station systems use the funds to support multi-state research projects and committees. At any given time, several such projects exist which have objectives related to Goal 5.1, and CSREES NPLs serve as advisors to them (see Evidentiary Materials).

From the Extension perspective, multidisciplinary and sustainability approaches are common in "Master" and "Train the Trainer" programs that are well-established in many states. Examples given in the Goal 5.1 portfolio include such titles as Master Woodland Manager, Master Naturalist, and Master Wildlifer. At the national level, the web-based National Learning Center for Private Forest and Rangeland Owners is a prime example of "one-stop multidisciplinary educational shopping" available to stakeholders (see Evidentiary Materials for examples).

Quality

Significance of Portfolio Outputs and Findings

At the Agency level, all federal funds are leveraged at least by a ratio of $2 of non-federal funds for every $1 of federal funding. This leveraging provides expanded fiscal resources to address programs that are partially funded by CSREES.

All approved McIntire-Stennis projects address any of the eight forestry research areas mandated by law (PL 87-788 of October 10, 1962) (see Evidentiary Materials for the legislation). Projects submitted by each institution (participating) and approved by CSREES constitute the Program of Research for which the funds can be legally used for that fiscal year. McIntire-Stennis funds have contributed to forestry education of 848 Masters and PhD degree holders for a period of 5 years (1997-2001). This is significant evidence of a program that is training the next generation of forest research scientists while simultaneously expanding the knowledge base. Research results and findings have significantly contributed to the accomplishments related to Goal 5 – Objective 5.1. A total of 6,881 publications were generated by the McIntire-Stennis funding for the last five years, resulting in the development of new knowledge and improved forestry practices (see Evidentiary Materials for examples).

CSREES investment in forestry research is highly effective and beneficial. For instance, riparian buffer research in Iowa was funded by the McIntire-Stennis program at $540,000 which resulted in the generation of a benefit-cost ratio of 8 to 1. Another significant study that demonstrates the impacts of CSREES-funded research is deer damage research at the University of Georgia. White-tailed deer damage management research being conducted by wildlife scientists and graduate students in the Warnell School of Forest Resources (WSFR) will potentially provide economic benefits and ecological benefits to citizens in Georgia and the U.S. Current research projects are developing and testing new methods to minimize deer-vehicle collisions and reduce damage from deer browsing to agricultural and household plantings. Nationwide, there are about 1.5 million deer-vehicle collisions in the U.S. each year, with an average vehicle repair cost of $1,500, for a total economic loss of more than $1 billion. Thus, new methods that reduce the number of deer-vehicle collisions could lead to a significant economic savings, not to mention the decreased potential for loss of life. Furthermore, each year deer browsing in the U.S. causes an estimated $100 million in damage to agricultural productivity, $750 million in damage to timber productivity, and $250 million in damage to household plantings. Wildlife scientists and graduate students in WSFR are evaluating non-traditional deer management strategies, based on

current knowledge of deer social ecology, as a means of minimizing deer-human conflicts in localized areas. These scientists also are testing new methods of excluding or repelling deer in these situations to minimize the economic losses from deer browsing. Finally, deer damage to forest ecosystems in Georgia's state parks is also a concern. WSFR scientists and students are working collaboratively with wildlife biologists from USDA-Georgia Wildlife Services to conduct research that is sponsored by the Georgia Department of Natural Resources, State Parks and Historic Sites Division to better manage herds in our state parks to minimize their damage to these protected forest ecosystems. Working on these projects provides students with valuable field experience in resolving real world deer herd management problems.

A McIntire-Stennis forestry research project at Oregon State University developed a hand-held computer system that helps loggers make more efficient cuts. Prior to this research, significant log values were lost because of inefficient cutting (bucking into log lengths) at logging sites. With this development, high quality logs are delivered to the mill, which increases the value of the forest products in Oregon by $60 million annually (see Evidentiary Materials).

Decay of wood utility poles and poor maintenance of electric lines causes shifts toward non-wood materials, which are more expensive and more energy-intensive to manufacture. Development of effective fumigants and improved pole maintenance practices lead to savings in excess of $500 million annually, while insuring a continuing strong market for wood utility poles.

These are a few examples from the more than 700 projects conducted each year with McIntire-Stennis funding. The benefits accruing from this research investment are exceedingly large. Research studies are geared to the needs of all stakeholders: wood industry, private forest landowners, urban residents, policy makers, and just about every person in this country.

An assessment of the quality of outputs and outcomes can only be made on a state-by-state basis. There is no national extension teaching curriculum for, say, forest and rangeland stewardship. Every state that conducts programs on this topic customizes the topics that are specifically relevant and asked for by stakeholders. In fact, at the state level, the topics are customized even further based on county or regional issues. The result, when viewed nationally, is a diverse portfolio of programs with different goals and objectives that necessitate different outputs which result in different outcomes. State-level examples of outputs and outcomes were previously described in each Problem Area in Section III of this document.

The assessment of the quality of outputs and outcomes for research programs can only be made on a state by state, project by project, basis. There are no national research questions, approaches, and data collection and analyses conventions that provide national answers. Each state and project formulates research questions based on need, the expertise of the research scientists, and the capacity of the institution to carry out the proposed scientific inquiry. Examples of research outputs and outcomes were previously highlighted in each Problem Area in Section III of this document, particularly under Outputs and Outcomes.

Stakeholder/Constituent Assessment of the Portfolio

The National Program Leaders have effective networks and mechanisms that assist them in establishing priorities and assuring program relevancy.

The 1998 Agricultural Research, Education and Extension Reform Act (AREERA) requires recipients of formula funds (Hatch, Evans-Allen, McIntire-Stennis and Smith Lever) to collect stakeholder inputs every year and describe the process used to identify individuals or groups as stakeholders. Also each institution needs to describe how these inputs relate to plans of work,

priority setting, immediate needs and long-term goals, guidance on monitoring, and proposed research activities. Stakeholder input is an element in the "Justification" section of every McIntire-Stennis proposal. (See Appendix F of the Administrative Mannual for McIntire-Stennis).

The ECOP Forestry Task Force, comprised of Extension Directors from each of the four geographic regions, the 1890 system, USDA Forest Service, and other strategic partners meets in Washington, DC twice a year and conducts bi-monthly conference calls. A standing agenda item is a CSREES update of the RREA Program, followed by a discussion by the task force members that serves as a forum for the program leader to consider the ideas and observations presented as the program evolves. This Task Force was the source for the National Focus Fund project idea for the National Web-Based Learning Center for Forest and Rangeland Owners. In FY 2004, a second national project was initiated, based on the strategic issue, "Land Conversion, Fragmentation, and Parcelization" contained in the RREA Strategic Plan (see Evidentiary Materials, pp. 15-18 of the Plan).

During 1999-2003 most stakeholder inputs for the McIntire-Stennis program (the largest funding source at CSREES for forestry research) were obtained through college advisory councils, town meetings and survey questionnaires. Additionally, the USDA Secretary's Forestry Research Advisory Council (FRAC) meets one to two times per year and serves as a formal source of stakeholder input. The National Urban and Community Forestry Advisory Council (NUCFAC) meets three times a year to identify program priorities and develop recommendations to the Secretary of Agriculture on priority research and other activities related to technology transfer and education. These inputs are used in prioritizing research and identifying research needs. Stakeholder input reports from McIntire-Stennis recipient institutions are on file at the Planning and Accountability Office of CSREES (see Evidentiary Materials).

Alignment of Portfolio Projects with Current State of Science-based Knowledge and Previous Work

The forestry research priorities for the 1990's were identified by the National Research Council (NRC) through its report "Forestry Research: A Mandate for Change" and the International Society of Arboriculture (ISA) report "A National Research Agenda for Urban Forestry in the 1990s" (see Evidentiary Materials). The National Workshop: Taking an Ecological Approach to Management (in 1992) served as a catalyst for the Forest Service's working theme of ecosystem management. The research activities of the late 1990s and early 2000s were fashioned after the United Nations 1995 Santiago Declaration on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests and 1998 NRC Report on "Forest Landscapes in Perspective." New areas of research in forestry which are in alignment with these national reports are: 1) forest genetic engineering and 2) nanoforestry, such as the pioneering efforts on biodegradable nanocomposites and nanocarbon tubes.

Alignment of research program with current and emerging science could only be effectively implemented through competitive programs (such as the Managed Ecosystems in NRI). As long as the major support for forestry research remains flat and restricted to the McIntire-Stennis program, alignment of the program with current and emerging science will be slow in coming and will be dictated by the desires of individual academic institutions that receive the formula funds.

Appropriate Methodology of Funded Portfolio Projects

From 1999 to 2003, forest and rangelands research was principally funded through the McIntire-Stennis Cooperative Forestry Research Program with additional, minor support from the Hatch Act, SARE, SBIR, the discontinued IFAFS Program, and NRI. Projects funded by the Hatch Act

are peer reviewed by each institution and must agree with the Plans of Work that are approved by CSREES (see Evidentiary Materials).

The quality of experimental results is significantly influenced by experimental methodologies. Appropriate methodology correspondingly produces appropriate results. Appropriate procedures should produce data suitable for statistical analysis.

McIntire-Stennis projects are reviewed for quality in several different ways. Some institutions award these funds through proposal competition. Others have a peer review process where each investigator is asked to present his or her proposal in a seminar attended by faculty and students. Finally, all proposals are reviewed by CSREES and either approved, disapproved, or deferred for revision. These CSREES proposal reviews are conducted using the guidelines for proposal preparation contained in Appendix F of the McIntire-Stennis Administrative Manual

Special research grants are reviewed by the designated project Liaison, then reviewed by a unit reviewer who has expertise in the proposed subject of investigation and finally reviewed for merit by an independent reviewer. All concerns of reviewers must be addressed before a special project is recommended for funding.

NRI and IFAFS projects are/were rigorously reviewed by individual experts and Peer Review Panels for scientific merit, innovation, impact, national significance, and potential for success. SARE and SBIR proposals are likewise reviewed by panel processes that are similar to NRI.

Performance

The performance of the programs funded in this portfolio can be assessed in several dimensions, which, when combined, suggest that overall, the programs are advancing the knowledge and application of science in forest, range, fish and wildlife resources.

Portfolio Productivity
Assessing the overall portfolio productivity is problematic for several reasons:

1) Specific measures of productivity have not been established. Without established criteria to measure against, current productivity and trends over time cannot be tracked,

2) Assessing the productivity of competitively funded programs is relatively straightforward, in that annual and final reports are required. The assessment is more difficult with formula programs, particularly extension, in that states exercise wide latitude in what they report. This is based, in part, on the fact that CSREES is a minority funder in most states. Thus, some states report only those programs "touched" by CSREES funds, while others report the entire state program. In both cases the amount and quality of annual reports vary widely from state to state. The result is that at the national level, there is a very mixed and incomplete picture of the results that emerge from CSREES-funded programs,

3) State extension annual reports most often report only program inputs, audiences reached, and outputs. Evaluating outcomes requires more resources, particularly time, professional evaluation expertise, and money. If program evaluation efforts are not budgeted for, they are unlikely to occur. If evaluation specialists are not available at the universities to assist in the design and

execution of evaluations, many extension educators are left to do what they can without the benefit of experts,

Despite these limitations, several observations and conclusions can be drawn from a review of the work that is accomplished by the university partners (See "Outcomes" in the Problem Area descriptions in Section III):

1) The portfolio can be assessed by examining the sum of its parts. Each Problem Area previously described demonstrates various research, education and extension outputs and outcomes and represent productivity.

2) Research productivity can be measured, in part, by the number of publications that are produced (Output), the number of patents developed (Output), and the actual or estimated economic impact when new practices are adopted (Outcome). This productivity measure exists for the McIntire-Stennis Cooperative Forestry Research Program and is shown in Section III above (See Problem Area 123).

3) Through the mechanism of CSREES Program Reviews led by National Program Leaders, the Portfolio 5.1 Team members have observed and studied programs at universities and have documented the quality and productivity of the programs (partially funded by CSREES) in Program Review Final Reports.

Taken as a whole, it is the assessment of the Portfolio NPL Team that this portfolio of work is productive, although some areas perhaps more so than others.

Portfolio Completeness

Programs in this portfolio meet their intended outcomes at both the individual project level as well as at the state and institution level. In the case of formula funds where broad guidelines are provided to states, "completeness" is largely evaluated by stakeholders who provide input as to what the extension programs need to address. Competitively funded projects result from funding recommendation from Peer Review Panels which make selections on a proposal by proposal basis and do not necessarily consider "completeness" in the suite of proposals recommended for funding. In the case of competitively funded programs, NPL's who serve as Program Directors are responsible for reviewing final reports and comparing the proposed objectives against what was actually accomplished.

Portfolio Timeliness

Assessing the timeliness of the work in this portfolio is largely done by monitoring the submission of final reports or requests for renewal, extension, or budget carryover. These determinations are relatively easy to track for competitive grants and special projects where formal proposals and annual reports are due. Assessing the timeliness of the work accomplished through formula programs, particularly extension programs, has inherent challenges. Research projects have discreet start and completion dates; extension programs may have semi-discreet start dates, but often do not have a completion date, due to the nature of education, which is rarely "completed." For example, there is continual turnover in the extension audiences, be they natural resource professionals, forest and rangeland owners/managers, agriculture producers or policy makers. The "timeliness" criteria become harder to assess. What can be assessed, in place of timeliness, is extension program evolution. As issues change and new knowledge is gained, extension programs are continually evolving to in order to incorporate new considerations. This is monitored, in part, through the state Annual Reports which are reviewed by a cadre of approximately 35 National Program Leaders.

Agency Guidance Relating to the Portfolio

The agency provides guidance in the conduct and assessment of program through several mechanisms:

- Requests for Proposals - Project Directors of funded projects are expected to fulfill the project objectives and to provide annual progress reports and final reports. The requirements that must be fulfilled by the Project Director are clearly spelled out in the Terms and Conditions of the award document that is sent to the performing institution. In this way, CSREES ensures that funding recipients clearly understand their obligations.

- Program of Research - All McIntire-Stennis (M-S) Cooperative Forestry Research proposals require CSREES approval prior to the institution being permitted to draw the funds. By August 15th, each of the 65 M-S institutions is to have submitted all of their proposals for the upcoming fiscal year. National Program Leaders review the proposals and for funding approval or deferral until deficiencies are addressed. At the beginning of the fiscal year, each institution receives a listing of its approved projects; this serves as the institution's Program of Research which has been reviewed and approved by CSREES.

- NPL Management and Leadership - NPL's are responsible for portfolios of work within specific disciplines, funding sources and functions. Within their sphere of influence, NPL's interact with multi-state research committees, ad hoc program committees, strategic planning efforts and other venues with the university community. Part of this interaction involves conveying agency needs and expectations regarding the funding that is provided. This is usually more relevant to formula-funded programs, as competitive grant recipients have formal obligations to complete project objectives for which they were funded.

- Plan of Work Guidance – CSREES provides guidance for the preparation and annual updating of extension plans of work. To ensure that the guidance is followed, these plans are reviewed by two-person teams of NPL's. If plans are deficient, they are deferred until the deficiencies are corrected.

Examples of the various forms of agency guidance are contained in the Evidentiary Materials.

Portfolio Accountability

The work accomplished in this portfolio is monitored by NPL's who are either program directors for competitive grant programs, agency contacts for special grants, or state annual report reviewers. The CRIS system is an informational resource that allows NPL's to track the progress of research and, more recently, education programs. Though not designed to fulfill accountability purposes, CRIS is accessed by NPL's to determine if projects were completed as funded, requests for extensions and budget carryovers are justified and progress reports submitted prior to approving requests for renewals. Extension formula-funded programs are evaluated on a state-by-state basis by the two-member NPL Review Team. These reports are examined for completeness, evidence of impacts, and stakeholder involvement. NPL Reviewers are responsible for the entire state report, regardless of the expertise of the NPL's. A written assessment is completed and returned to each institution. In the event a report has deficiencies, the Lead NPL communicates those deficiencies and awaits additional documentation before proceeding with the review. An example of the latter case existed with the 2003 Annual Report submitted by Oregon State University. Several deficiencies existed, including several from the 2002 report that were

"Required Improvements." The Lead NPL contacted the OSU representative via e-mail and requested further information, which was eventually provided and the Annual Report was accepted. This system is ineffective in that NPL's do not review all of the work being done across the country in her/his discipline. In order for an NPL to find out what all of the states are doing in say, fish and wildlife, the NPL would have to access 50 individual annual reports (narrative reports), and do word searches within the state report.

CSREES is in the process of designing new processes and tools, particularly monitoring and evaluation systems and will train the agency's partners in their use. In an environment in which funding support at all levels is becoming tighter, any activities that strengthen accountability and impacts will likely have greater funding support. This is true of the President's Management Agenda and OMB results-based budgeting processes.