4-2011

A 'driving force' in developing the nation's forests: The McIntire-Stennis Cooperative Forestry Research Program.

Steven H. Bullard
Stephen F. Austin State University, Arthur Temple College of Forestry and Agriculture, bullardsh@sfasu.edu

Perry J. Brown

Catalino A. Blanche

Richard W. Binker

Don H. Thompson

A "Driving Force" in Developing the Nation's Forests: The McIntire-Stennis Cooperative Forestry Research Program

Steven H. Bullard, Perry J. Brown, Catalino A. Blanche, Richard W. Brinker, and Don H. Thompson

ABSTRACT

The McIntire-Stennis (M-S) Cooperative Forestry Research Program has provided fundamental support for creating and strengthening forestry research and graduate training efforts at colleges and universities across the nation for nearly 50 years. M-S funding has helped produce thousands of forestry scientists and other research professionals, and M-S–supported research has provided critical basic understanding and applied solutions to extend the benefits that flow from forests and related rangelands across the nation over time. The 1962 legislation that created the M-S program authorized funding of up to one-half of the funds appropriated for federal forestry research conducted directly by the USDA. Throughout the program's history, however, M-S appropriations have been far below the authorized level. In 2012, the M-S program's 50th anniversary will be celebrated. Congress and the President therefore have a truly significant "golden anniversary" opportunity to strengthen the nation's investment in research and training that represents an essential and powerful "*driving force behind progress*" in sustaining forests for ecological, economic, and social benefits for present and future generations.

Keywords: McIntire-Stennis, research, graduate education, formula funding

On Oct. 10, 1962, President John F. Kennedy signed legislation that became Public Law (PL) 87-788, an act "To authorize the Secretary of Agriculture to encourage and assist the several states in carrying on a program of forestry research, and for other purposes". In signing the act into law, President Kennedy was following through on statements he had made in speeches in 1961—Kennedy had specifically stated the need to "Expand forestry research, too long neglected" (Thompson and Bullard 2004). PL 87-788 was later named the "McIntire-Stennis Cooperative Forestry Research Program" after the bill's two primary, bipartisan sponsors in Congress, Representative Clifford G. McIntire of Maine and Senator John C. Stennis of Mississippi (Thompson 2004).

As shown in Table 1, the basic purpose or intent of the McIntire-Stennis (M-S) Cooperative Forestry Research Program was to provide federal funding for forestry research at state-supported colleges and universities; by providing this funding, it would be "recognized that research in forestry is the driving force behind progress in developing and utilizing the Nation's forests and related rangelands."

The act also recognized that forestry research would be more effective nationwide if efforts among state colleges and universities and the federal government were more closely coordinated. The act clearly made individual states and the federal government strong partners in forestry research to develop, use, and sustain the nation's forests.

Finally, a very important purpose of the M-S legislation was to address the nation's need for forestry scientists and other research professionals … "it is further recognized that forestry schools are especially vital in the training of research workers in forestry" (PL 87-788). In speeches and remarks years after the M-S program was implemented nationwide, Senator Stennis specifically mentioned their original intent relating to creating and strengthening graduate

Received May 10, 2010; accepted July 27, 2010.

Steven H. Bullard (bullardsh@sfasu.edu) is dean, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, PO Box 6109, SFA Station, Nacogdoches, TX 75962. Perry J. Brown (perry.brown@umontana.edu) is provost and vice president for academic affairs, University of Montana, 32 Campus Drive, Missoula, MT 59812. Catalino A. Blanche (cblanche@nifa.usda.gov) is national program leader, National Institute of Food and Agriculture, USDA, 1400 Independence Ave. SW, Washington, DC 20250. Richard W. Brinker (brinkrw@auburn.edu) is dean emeritus, School of Forestry and Wildlife Sciences, 3301 Forest and Wildlife Sciences Bldg., Auburn University, Auburn, AL 36849. Don H. Thompson (dhthompson@nemcc.edu) is instructor, Forest Technology Program, Northeast MS Community College, 101 Cunningham Blvd., Booneville, MS 38829. *The authors acknowledge helpful comments made by three anonymous reviewers and by members of the Executive Committee of the National Association of University Forest Resources Programs.*

Left: President John F. Kennedy (r) with Democratic Senator John C. Stennis (l) in February 1961. During his election campaign, President Kennedy pledged to support forestry and forestry research. [Photo courtesy of the Congressional and Political Research Center, Mississippi State University Libraries.] Right: Representative Clifford G. McIntire was a Republican Congressman from Maine from 1951 to 1964. He helped draft legislation later approved by the 87th Congress and submitted for Presidential signature as H.R. 12688. Rep. McIntire considered the M-S legislation the highlight of his political career. [Photo courtesy of the Forest History Society, Durham, NC.]

programs in forestry (Thompson and Bullard 2004).

Reporting on successful passage of the M-S program, Westveld (1963) stated that it was the "hope of those who sponsored the legislation that the Act will do for research and graduate education in forestry what the Hatch Act has done for agriculture." Westveld (1963) also noted that before the M-S program there was a growing national concern over the shortage of trained forestry scientists; he reported that only 7.4% of total spending for forestry research in the United States in fiscal year (FY) 1959–1960 was performed at universities. Nationwide, forestry research was expanding within federal agencies, requiring increasing numbers of highly skilled scientists, but adequate funds were not being dedicated to forest-based projects through the Hatch Act or other federal or state sources.

Specific Provisions and Current Implementation

Fundamental provisions of the M-S Cooperative Forestry Research Program are presented in shaded box on the next page. Highlights of the original legislation and the current M-S program include

- Funding for the M-S program is authorized up to "one-half the amount appropriated for Federal forestry research conducted directly by the Department of Agriculture" during the previous FY. Actual appropriations for the program began at $1 million in 1964, and in FY 2010 the program is funded at $29 million. M-S appropriations have always been far below authorized levels, as summarized in the section, Funding Processes and Funding History.
- After the federal budget process determines the national M-S appropriation each year, state-level funding is determined by a formula with three variables: (1) the area of nonfederal commercial forestland from the latest US Forest Service Forest Inventory and Analysis (FIA) data, where "commercial" implies that the land is available for timber harvest (weighting = 40%); (2) the volume of timber removed from growing stock based on the latest FIA data (weighting = 40%); and (3) total expenditures for forestry research from nonfederal sources (weighting = 20%). A base amount of $25,000 is allocated to each state before applying the formula. Discussions about modifying the formula have taken place in recent years among USDA and university leaders, but no actions have been taken to change the formula or the actual variables used.
- Institutions eligible for M-S program funding include land-grant colleges or experiment stations established under the Morrill Act (1862) and the Hatch Act (1887), as well as "other state-supported colleges and universities offering graduate training in the sciences basic to forestry and having a forestry school." A "forestry school" has been defined as an academic program offering a state-approved curriculum leading at minimum to a Master of Science in Forestry or a Master of Forestry (USDA Cooperative State Research, Education, and Extension Service [CSREES] 2000). In the Food, Conservation, and Energy Act of 2008, eligibility was extended to 1890 land-grant institutions. Although eligible for the program, whether or not they will be participants is still determined by the states.
- Within each state, a Governor's designee certifies which institutions are eligible for M-S funding. If more than one institution is certified, the governor's designee determines the percentage of funds or "proportionate amounts of assistance" to be received by each of the certified institutions in the state each year. Percentages for FY 2009–

2013 are presented in Table 1 for each state with more than one certified institution. Institutional allocations in each of the following states are set on a long-term time frame: Arizona, California, Connecticut, Illinois, Michigan, New York, Texas, and Washington.

• "Forestry research" is very broadly defined in the M-S legislation. The definition specifically mentions reforestation, watersheds, forage for game and livestock, wildlife habitat, outdoor recreation, forest health and protection, wood use, and forest policy; the definition also includes "such other studies as may be necessary to obtain the fullest and most effective use of forest resources".

• The USDA National Institute of Food and Agriculture (NIFA), formerly CSREES, provides fiscal and administrative oversight of the M-S program. This oversight includes applying the funding formula, disbursing funds, reviewing proposed research projects, and reporting to Congress on M-S program impacts and accomplishments (USDA CSREES 2000). Another important administrative role of the NIFA is to help ensure that research projects are not duplicated at various institutions across the states and territories receiving M-S funding each year (Brinker 2007). Institutions within states must develop complementary programs of forestry research for the state.

M-S Program Results and Impacts

One of the most important aspects or results of the M-S program is the fact that state-supported colleges and universities across the nation are provided steady, base funds for forestry-related research and graduate training. Many of these institutions would likely not have forestry research and graduate training programs today if it were not for the M-S program. With M-S funds, however, institutions have an annual funding base for forestry research and graduate training that in most cases is highly leveraged with funds from many sources.

Before passage of the M-S legislation, forestry research was an extremely small part of agriculture-related research programs at state-supported institutions in the United States. In 1952, e.g., agricultural experiment stations at US universities received over $12.8 million, but only $137 thousand, or just over 1%, was devoted to forestry research (Kaufert and Cummings 1955). At four Society of American Foresters-accred-

Key provisions of Public Law 87–788 [87th Congress, H.R. 12688], the McIntire-Stennis Cooperative Forestry Research Program.

Purpose: . . . *It is hereby recognized that research in forestry is the driving force behind progress in developing and utilizing the Nation's forest and related rangelands . . . It is recognized that the total forestry research efforts of the several State colleges and universities and of the Federal Government are more fully effective if there is close coordination between such programs, and it is further recognized that forestry schools are especially vital in the training of research workers in forestry.*

Eligibility: Forestry research assistance shall be in accordance with plans between the Secretary of Agriculture and *(a) land-grant colleges or agricultural experiment stations established under the Morrill Act of July 2, 1862 (12 Stat. 503), as amended, and the Hatch Act of March 2, 1887 (24 Stat. 440), as amended, and (b) other State-supported colleges and universities offering graduate training in the sciences basic to forestry and having a forestry school; however, an appropriate State representative designated by the State's governor shall in any agreement drawn up with the Secretary of Agriculture for the purposes of this Act, certify those eligible institutions of the State which qualify for assistance and shall determine the proportionate amounts of assistance to be extended these institutions.* The Food, Conservation, and Energy Act of 2008 amended the M-S Cooperative Forestry Act to extend eligibility to 1890 land-grant institutions, as discussed in the footnote to Table 1.

Authorized Appropriations: . . . *there are hereby authorized to be appropriated such sums as the Congress may from time to time determine to be necessary but not exceeding in any one fiscal year one-half the amount appropriated for Federal forestry research conducted directly by the Department of Agriculture for the fiscal year preceding the year in which the budget is presented . . . Funds appropriated and made available to the states under this Act shall be in addition to allotments or grants that may be made under other authorizations.*

Requirement of Matching Funds from Non-Federal Sources: *The amount paid by the Federal Government to any State-certified institution eligible for assistance under this Act shall not exceed during any fiscal year the amount available and budgeted for expenditure by such college or university during the same fiscal year for forestry research from non-Federal sources.*

Allocation Mechanism or "Formula": Allocations to States and administrative expenses are determined by the Secretary of Agriculture after consulting with an advisory board. Allocations among States consider *pertinent factors including, but not limited to, areas of non-Federal commercial forest land and volume of timber cut annually from growing stock.* These provisions have resulted in a three-variable "formula," as described in the article text. See Thompson and Bullard (2004, Appendix C) for an example calculation applying the formula to a specific state (Mississippi) in FY 1999.

Advisory Committee: The Act directs the Secretary of Agriculture to appoint an advisory committee with equal representation from *Federal-State agencies concerned with developing and utilizing the Nation's forest resources and to the forest industries.* USDA currently has a 20-member Forestry Research Advisory Council that fulfills this advisory role.

Definition of Forestry Research: The term "forestry research" includes investigations relating to: *(1) reforestation and management of land for the production of crops of timber and other related products of the forest; (2) management of forest and related watershed lands to improve conditions of waterflow and to protect resources against floods and erosion; (3) management of forest and related rangeland for production of forage for domestic livestock and game and improvement of food and habitat for wildlife; (4) management of forest lands for outdoor recreation; (5) protection of forest land and resources against fire, insects, diseases, or other destructive agents; (6) utilization of wood and other forest products; (7) development of sound policies for the management of forest lands and the harvesting and marketing of forest products; and (8) such other studies as may be necessary to obtain the fullest and most effective use of forest resources.*

Table 1. The percentage of state allocation of McIntire-Stennis funds for Federal FYs 2009–2013 in states with more than one institution certified to be eligible for funding.

	Federal Fiscal Year				
	2009	2010	2011	2012	2013
Alabama					
Auburn U.	80	70	60	50	40
AL A&M U.*	10	15	20	25	30
Tuskegee U.*	10	15	20	25	30
Arizona					
Northern AZ U.	50	–	–	–	–
U. AZ	50	–	–	–	–
California					
U. CA, Berk.	70	–	–	–	–
CA St. U., Humb.	15	–	–	–	–
CA Poly. St. U.	15	–	–	–	–
Connecticut					
CT Ag. Exp. Stn.	75	–	–	–	–
U. CT, Storrs	25	–	–	–	–
Delaware					
U. DE	100	90	80	70	60
DE St. U.*	0	10	20	30	40
Florida					
U. FL	100	90	–	–	–
FL A&M U.*	0	10	–	–	–
Georgia					
U. GA	100	90	–	–	–
Fort Valley St. U.*	0	10	–	–	–
Illinois					
U. IL	50	–	–	–	–
Southern IL U.	50	–	–	–	–
Kentucky					
U. KY	90	85	–	–	–
KY St. U.*	10	15	–	–	–
Louisiana					
LA St. U.	70	64.75	61.25	57.75	–
LA Tech U.	30	27.75	26.25	24.75	–
Southern U.*	0	7.5	12.5	17.5	–
Maryland					
U. MD	100	100	90	80	70
U. MD, E. Shore*	0	0	10	20	30
Michigan					
MI St. U.	33.3	–	–	–	–
MI Tech U.	33.3	–	–	–	–
U. MI	33.3	–	–	–	–
Mississippi					
MS St. U.	100	80	–	–	–
Alcorn St. U.*	0	20	–	–	–
Missouri					
U. MO	100	90	–	–	–
Lincoln U.*	0	10	–	–	–
New York					
SUNY, Syr.	75	–	–	–	–
Cornell U.	25	–	–	–	–
Tennessee					
U. TN	100	90	85	–	–
TN State U.*	0	10	15	–	–
Texas					
S. F. Austin St. U.	50	–	–	–	–
TX A&M U.	50	–	–	–	–
Virginia					
VA Tech	90	–	–	–	–
VA St. U.*	10	–	–	–	–
Washington					
WA St. U.	45	–	–	–	–
U. WA	55	–	–	–	–
West Virginia					
WV U.	100	90	–	–	–
WV St. U.*	0	10	–	–	–

–, the same percentage allocation shown for the previous FY.
* Section 7412 of the Food, Conservation, and Energy Act of 2008 (the 2008 Farm Bill) amended Section 2 of the original McIntire-Stennis legislation to make 1890 land-grant institutions eligible for M-S funding. In early 2009, USDA Cooperative State Research, Education, and Extension Service (CSREES)/National Institute for Food and Agriculture (NIFA) contacted the Governor's office in each state with an 1890 institution, requesting that they specify the State-certified institutions for Federal FY 2009 and beyond, and their associated percentages of M-S funds. USDA guidelines limit the degree of change in funding for any one state or university each year, so in some states it will take more than one year to implement the full percentage change(s) for the 1890 institution(s). The percentages shown for each FY are based on USDA NIFA information dated November 17, 2009.

ited forestry schools, the forestry research budget in 1951 was less than 0.5% of the agricultural experiment station budget (Westveld 1954).

Since 1962, however, the M-S Cooperative Forestry Research Program has supported thousands of forestry research projects, and the program has helped produce thousands of trained scientists and other forestry research professionals. The total impact of these projects and trained graduates is immeasurable, because of the diversity and scale of projects over time, because many project-level benefits are diffuse and difficult to quantify, and because M-S funds are often base funds (they may be used for salary or other support that enables projects to be accomplished, but the funds are commingled with state funds, grant funds, and financial support from many sources).

USDA CSREES/NIFA does, however, report significant accomplishments and impacts of the M-S program. The most recent report (USDA CSREES 2007) includes one-page impact statements presented by state/territory and university. The report includes summaries of a vast and diverse array of M-S projects and impacts, including

• In Arizona, management recommendations have been developed to reduce the impacts of human activities on ecologically important areas that receive more than 4.1 million visitors each year and cover an area of over 1.1 million ac across the southwest.

• In Hawaii, research has developed termite prevention and control approaches that have been widely adopted; cost savings for the state's residents are estimated at over $30 million/year.

• Peregrine falcons have been successfully reestablished in cliff habitats in Kentucky, the first successful nesting pairs since 1939.

• Glue laminated beams can now be reinforced using lower-grade wood from smaller trees, providing improved forest management opportunities and saving $60 million/year in raw material costs in the Pacific Northwest.

• Invasive plants, insects, and pathogens are being reduced in the state of Washington through more careful practices for horticultural plant introductions.

• In the Mississippi Delta region, over 300,000 ac of bottomland hardwoods have been restored using guidelines developed through M-S research.

These are only a few examples of the hundreds of forestry research projects supported by M-S funds in recent years. In FY 2010 alone, e.g., M-S funding is supporting 670 research projects at 77 universities in

Table 2. The Federal FY 2010 allocation of McIntire-Stennis funds to eligible authorized institutional units, with totals by state or territory (Beachy 2010).

1. Georgia	**$972,526**	**18. Minnesota**	**$674,022**	**39. Utah**	**$ 287,726**
U. Georgia	875,273	U. Minnesota		Utah State U.	
Fort Valley State U.	97,253	**19. Tennessee**	**$656,463**	**40. Kansas**	**$ 287,726**
2. North Carolina	**$937,406**	Tennessee	590,817	Kansas State U.	
North Carolina State U.		Tennessee State U.	65,646	**41. Nebraska**	**$ 270,166**
3. Alabama	**$919,848**	**20. Alaska**	**$638,905**	U. Nebraska	
Auburn U.	643,894	U. Alaska		**42. Connecticut**	**$ 270,166**
Alabama A&M U.	137,977	**21. Pennsylvania**	**$638,904**	CT Ag. Exp. Stn	202,624
Tuskegee U.	137,977	Pennsylvania State U.		U. Connecticut, Storrs	67,542
4. Oregon	**$919,846**	**22. Missouri**	**$603,786**	**43. New Jersey**	**$ 252,608**
Oregon State U.		U. Missouri	543,407	Rutgers State U.	
5.Mississippi	**$902,290**	Lincoln U.	60,379	**44. Wyoming**	**$ 235,049**
Mississippi State U.	721,832	**23. Kentucky**	**$603,786**	U. Wyoming	
Alcorn State U.	180,458	U. Kentucky	513,218	**45. Hawaii**	**$ 217,490**
6. Washington	**$884,730**	Kentucky State U.	90,568	Hawaii	
Washington State U.	398,129	**24. Idaho**	**$586,227**	**46. South Dakota**	**$ 182,372**
U. Washington	486,601	U. Idaho		South Dakota State U.	
7. Louisiana	**$832,053**	**25. West Virginia**	**$551,110**	**47. North Dakota**	**$ 164,813**
Louisiana State U.	538,754	West Virginia U.	495,999	North Dakota State U.	
Louisiana Tech U.	230,895	West Virginia State U.	55,111	**48. Nevada**	**$ 147,255**
Southern U.	62,404	**26. Montana**	**$551,110**	U. Nevada, Reno	
8. Arkansas	**$814,495**	U. Montana		**49. Delaware**	**$ 112,137**
U. Arkansas Ag. Exp. Stn.		**27. Oklahoma**	**$515,992**	Delaware	100,923
9. Texas	**$814,494**	Oklahoma State U.		Delaware State U.	11,214
Stephen F. Austin St. U.	407,247	**28. Ohio**	**$498,433**	**50. Rhode Island**	**$ 112,136**
Texas A&M U.	407,247	Ohio Ag. Res. and Dev. Ctr.		U. Rhode Island	
10. Michigan	**$814,494**	**29. Indiana**	**$480,874**	**51. Puerto Rico**	**$ 94,578**
Michigan State U.	271,498	Purdue U.		Puerto Rico	
Michigan Tech U.	271,498	**30. Arizona**	**$463,315**	**52. Virgin Islands**	**$ 59,459**
U. Michigan	271,498	Northern Arizona U.	231,658	College of the Virgin Islands	
11. Virginia	**$796,934**	U. Arizona	231,657	**53. Guam**	**$ 59,459**
Virginia Tech	717,241	**31. New Hampshire**	**$428,197**	U. Guam	
Virginia State U.	79,693	New Hampshire		**54. American Samoa**	**$ 59,459**
12. California	**$796,934**	**32. Illinois**	**$428,197**	Am. Samoa Comm. College	
CA Poly. State U.	119,540	Southern Illinois U.	214,099		
CA State U., Humboldt	119,540	U. Illinois	214,098		
U. California, Berkeley	557,854	**33. Vermont**	**$393,079**		
13. New York	**$779,376**	Vermont			
Cornell U.	194,844	**34. Colorado**	**$393,079**		
SUNY, Syracuse	584,532	Colorado State U.			
14. Florida	**$761,818**	**35. Iowa**	**$375,520**		
U. Florida	685,636	Iowa State U.			
Florida A&M U.	76,182	**36. New Mexico**	**$340,403**		
15. Maine	**$744,258**	New Mexico State U.			
U. Maine		**37. Massachusetts**	**$340,403**	Total Payments to States	$27,389,470
16. South Carolina	**$726,699**	New Mexico State U.		Federal Administration (3%)	870,000
Clemson U.		**38. Maryland**	**$322,843**	Small Business Set-Aside*	703,250
17. Wisconsin	**$674,022**	U. Maryland		Biotech Risk Assessment*	37,280
U. Wisconsin				Total Appropriation	$29,000,000

* Congressional Mandates in Total = 3%

54 states and territories. The M-S program supports a vast array of projects that are geographically diverse and broad in scope, because the program allows and encourages research that addresses critical issues at state and regional levels. Although the total impact of all current and past M-S–supported projects is immeasurable, the level of graduate student support can be reliably estimated using USDA CSREES/NIFA data. Since initial funding in 1964, the M-S program has provided over 24 thousand years of graduate student support—producing 8,110 master's degrees and 2,438 doctoral degrees—an estimated 37% of all graduate degrees in forestry in the United States.

Another important result of the M-S program is the extent to which federal funds are leveraged with nonfederal funding sources within states and within individual colleges and universities. The program requires that federal funds be matched at least one-to-one with funds from nonfederal sources. In a 2002 survey of institutions receiving M-S funds, one-half of the 40 respondents reported that federal M-S funds were less than 10% of their total research budget; another 9 reported that M-S funds were less than 20% of their budget (Thompson 2003). The degree of leveraging of M-S funds is a highly successful result of the M-S program, because base support has been critical to the very existence of forestry research capacity at many state-supported colleges and universities across the United States.

Finally, the M-S program is implemented in different ways at colleges and universities across the nation. The result has been an array of program management practices and models from which other states and universities may learn. For example, the University of Montana uses a competitive program to award M-S funds to potential projects, the University of Maine uses M-S funds for faculty salary support, and Oregon State University uses M-S funds as base support for its Forest Research Lab. The flexibility of program implementation at the uni-

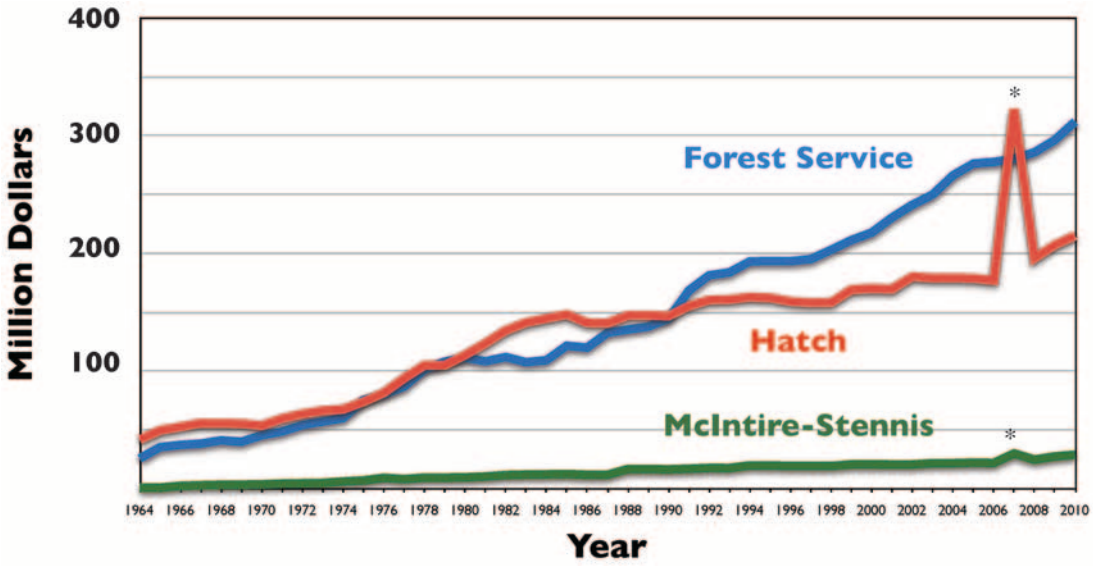

Figure 1. Research funding for the US Forest Service, the Hatch Program, and the McIntire-Stennis Program for Federal fiscal years 1964–2010. [Sources: USDA NIFA Current Research Information System (2010), the US Forest Service (2010) and Thompson and Bullard (2004).] * In FY 2007, significant increases are shown in both Hatch and M-S funding. This is due to a change made in 2007 only, where Federal "earmark" programs in agriculture and forestry were defunded and specific earmarked appropriations were added to the formula fund programs.

versity level has resulted in customization that best fits nuances and needs at the local level.

Funding Processes and Funding History

The M-S program is an example of a federal "formula" funding program. Other federal formula fund examples include: Hatch Act funds for State Agricultural Experiment Stations associated with 1862 land-grant institutions; Evans-Allen Program funds supporting 1890 land-grant institutions; and Smith-Lever Act and Renewable Resources Extension Act funds, both for cooperative extension activities (Schimmelpfennig and Heisey 2009).

Each FY, the federal budget process determines the total appropriation for M-S and other programs and as outlined earlier, a formula is then used within the NIFA to allocate the M-S appropriation among the states and territories. The FY 2010 M-S allocations for 54 states/territories, and for each institution receiving funding, are presented in Table 2. The FY 2010 allocations range from Georgia with $972,526, to the Virgin Islands, Guam, and American Samoa, each with an allocation of $59,459. The institution-level funding shown in Table 2 reflects the percentages shown in Table 1 for FY 2010, in states with more than one certified institution.

In recent years, there has been much debate about whether formula-based funding or competitive grant funding is preferable for federal support of agricultural and forestry research (Ho 2009). The basic case in favor of competitive grant funding contends that public resources are allocated more effectively and efficiently when competition takes place among scientists, university programs, and agencies. Huffman and Evenson (2006) described the following issues regarding formula and competitive grant funding sources for federally sponsored agricultural research:

- Formula funds provide steady funding that can be used to support "core, basic, or foundation" research that may take decades to complete.
- Formula funds have very low overhead. These funds bear no general university indirect costs, which means that 97% of federally appropriated funds are directly applied to research support (3% of funds are used for USDA NIFA's administrative support).
- Competitive grant funding tends to favor institutions with relatively large research infrastructure.
- Competitive grant programs tend to reallocate research resources within land-grant universities away from research that may be important in individual states and toward projects with greater national appeal.

In general, formula-based funding has come to be viewed as promoting geographically specific applied research. Meanwhile, federal emphasis has increased the priority of more basic research, primarily funded through competitively awarded grants (Schimmelpfennig and Heisey 2009).

Historically, M-S appropriations have been far below the authorized level of one-half of the appropriation for forestry research conducted directly within USDA. In fact, as shown in Figure 1, funding for the M-S program has been far below funding for forestry research in just one USDA agency, the US Forest Service. Figure 1 also shows significant increases in both US Forest Service and Hatch Act funding for research, with generally flat funding for the M-S program.

Today's Challenges and Priorities

There are many critical challenges confronting society today that involve both the ecology and the economy of forests and their use. To help identify these challenges and provide a national agenda for forestry research and graduate education under the M-S program, the National Association of University Forest Resources Programs (NAUFRP) prepared and published a Strategic Plan titled, "Sustaining Healthy and Productive Forests: An Investment in America's Competitive Position in the Global Marketplace" (National Association of University Forest Resources Programs [NAUFRP] 2007). The NAUFRP Strategic

Plan was based on a 2006 conference of 100 scientists and other forestry leaders from academic, agency, nonprofit, and industrial sectors.

The NAUFRP Strategic Plan highlights critical, forest-based challenges that include "climate change, invasive species, exotic pests, wildfire, forest fragmentation, urban sprawl, and globalization, along with dwindling forest research capacity in our agencies and universities." These and other issues were identified as major threats to "the vitality and resiliency of our forests and our nation's competitive position in the global community." To address major new challenges, NAUFRP (2007) presented a "bold new agenda" for M-S research that includes two major components: "foundational areas of knowledge" and "emerging and integrative areas of knowledge."

Foundational Areas of Knowledge

The NAUFRP Strategic Plan calls for "fundamental research on individual species, soils, hydrology, invasive species, pathogens, and wildfire"—topics that are "still critical to our understanding of forests, watersheds, and global functions." Fundamental research is also recommended in the social, physical, engineering, and material sciences, particularly where new knowledge is "instrumental in decisionmaking, developing new products, and utilizing natural resources more effectively in environmentally and socially sound ways."

Emerging and Integrative Areas of Knowledge

We have modified the seven emerging and integrative areas of knowledge of the M-S Strategic Plan into the following five categories that reflect current issues in forestry and natural resources

A New Science of Integration. This new, important, and developing area of science involves whole system analysis—crossing biophysical boundaries, ownerships, and agency jurisdictions. The goal is to develop theories, models, and tools that integrate geophysical, ecological, socioeconomic, and cultural dimensions of natural resource issues, management, and policy. This part of the NAUFRP agenda for M-S programs is an excellent example of what has come to be called, "A New Biology for the 21st Century" (National Research Council 2009), which specifically recommends transdisciplinary research that addresses major societal challenges.

Ecosystem Services. M-S program research will continue to develop a more comprehensive understanding of ecosystem functions, processes, and services. This work includes quantifying and valuing forest benefits such as clean water and air, carbon sequestration, biodiversity, and erosion control, and also helping develop viable markets that reward producers of these benefits.

Climate Change. M-S research will continue to quantify climate change indicators and verify mitigation, management, and adaptation efforts such as carbon "cap and trade" strategies to reduce greenhouse gas emissions.

Energy Independence. M-S research is critical for developing economically viable and ecologically sustainable ways to use forest biomass for bioenergy, while also sustaining existing industry sectors.

New Technologies and Products. M-S program research is developing and applying nanotechnology, biotechnology, and spatial and engineering technologies to create jobs, reduce costs, increase forest productivity, and ensure sustainability. Current projects are developing bio-based polymers, alternative fiber products, renewable energy, and bioremediation to create jobs and support a sustainable industry.

NAUFRP has also recognized that implementing a new M-S agenda will require increased collaboration among universities and agencies, as well as "changes in graduate education and in funding for research infrastructure and equipment" (NAUFRP 2007).

The 100 participants in the 2006 NAUFRP-led conference concluded that natural resource scientists of the future will need to understand specializations other than their own, apply analytical thinking and problem solving in a broad context, communicate through a wide range of media and to a variety of audiences, and exhibit strong leadership through ethical practice as well as scientific vision (DeHayes et al. 2006).

The need continues to be critical for graduate-level training that is highly focused and specialized. Today and in the future, however, it is also essential that forestry researchers have greater breadth of knowledge, as they help interpret and apply new knowledge, understanding, and technologies to complex, transdisciplinary social and biological issues and challenges.

M-S Program Outlook and Opportunities

The M-S Cooperative Forestry Research Program has had, and continues to have, strong positive impacts on economic well-being and quality of life of current and future generations. The program is a partnership between states and the federal government—a public investment in sustaining forests and related natural resources for economic, ecological, and social benefits across the nation over time.

Public-sector investments in forestry research and graduate training in the United States are made for both economic and sociopolitical reasons (Bullard 1986), and in the case of annual investments in the M-S program, throughout its 48-year history the program has truly been a "driving force behind progress," as noted in its legislation. Research has shown the program to be effective in achieving its goals and objectives over time (Thompson and Bullard 2004).

An extremely important part of the outlook for the M-S program is whether funding will be enhanced in the future, to be nearer the level authorized in 1962 and to reflect the increased demand for M-S funds with the eligibility authorization for 1890 institutions in 2008. The M-S program is legislatively authorized for annual funding of $150 million—a very conservative estimate based on the current level of research funding in the US Forest Service and other agencies performing forestry research within the USDA. The FY 2010 appropriation for M-S is $29 million, or no more than 19% of the authorized level.

A significant factor is whether the upcoming 50th anniversary of the M-S program will be legislatively recognized with increased funding. Since 1962, the only two significant increases in M-S funding were at the program's 10th and 25th anniversaries (Thompson and Bullard 2004). After the 10th anniversary of the program in 1972, e.g., M-S appropriations were increased each year for 4 years, by a total of 50% by 1976. After the 25th anniversary in 1987, M-S program funding was increased by 29% in 1 year, from less than $12 million in 1987 to nearly $17 million in 1988.

In recent years, the formula for allocating M-S funds among states has been discussed as a potential vehicle to achieve broader political support for the program. The M-S legislation states that the formula

must consider "pertinent factors including, but not limited to, areas of non-Federal commercial forestland and volume of timber cut annually from growing stock". One of the ideas advanced in recent years is that broader criteria in the formula will be necessary to achieve broader political support for M-S program funding, particularly from states with strong urban forest interests and states where nontimber benefits from forests are dominant compared with goods and services from commercial timber harvesting. This topic is important, but merits careful investigation because modifying the formula's criteria would impact funding in all states and institutions.

The 50th anniversary of the M-S program in FY 2012 will be a significant "golden anniversary" opportunity for legislative leadership. Forests today face intensified pressures and forest-related issues are increasingly complex. The need for science-based understanding, viable solutions, and highly trained professionals for research and management continues to be essential to long-term well-being throughout society at local, state, and national levels. To address issues of high national priority such as bioenergy and climate change through a proven, "driving force behind progress," NAUFRP's current funding request for the M-S program includes $50 million for the 50th anniversary year. FY 2012 represents an outstanding opportunity for new legislative champions to step forward in the active, bipartisan leadership roles that Representative McIntire, Senator Stennis, and President Kennedy provided nearly 50 years ago.

Literature Cited

BEACHY, R.N. 2010. *Distribution of the McIntire-Stennis Cooperative Forestry Act Funds for Fiscal Year 2010.* Memo, NIFA Director to A-TRs, Apr. 15, 2010.

BRINKER, R.W. 2007. The McIntire-Stennis Act: Federal support for forestry research. *For. Landown.* 66(1):17–18.

BULLARD, S.H. 1986. Potential reasons for publicly funded forestry research as reflected in the USA experience. *For. Ecol. Manag.* 17:53–59.

DEHAYES, D.H., P.J. BROWN, M.R. GALE, AND J.M. KELLY. 2006. *Redefining the future of forest research—Summary of outputs from the summit Forest Research for the 21st Century.* NAUFRP, Falls Church, VA. 27 p.

HO, M.D. 2009. *Agricultural research, education, and extension: Issues and background.* Congressional Res. Serv. Rep. for Congress, 7-5700. 19 p. Available online at www.crs.gov, R40819; last accessed Oct. 5, 2010.

HUFFMAN, W.E., AND R.E. EVENSON. 2006. Do formula or competitive grant funds have greater impacts on State agricultural productivity? *Am. J. Agric. Econ.* 88(4):783–798.

KAUFERT, F.H., AND W.H. CUMMINGS. 1955. *Forestry and related research in North America.* Society of American Foresters, Washington, DC.

NATIONAL ASSOCIATION OF UNIVERSITY FOREST RESOURCES PROGRAMS (NAUFRP). 2007. *Sustaining healthy and productive forests: An investment in America's competitive position in the global marketplace.* McIntire-Stennis Strategic Plan, NAUFRP, Falls Church, VA. 20 p.

NATIONAL RESEARCH COUNCIL (NRC). 2009. *A new biology for the 21st century.* National Academies Press, Washington, DC. 98 p.

SCHIMMELPFENNIG, D., AND P. HEISEY. 2009. *U.S. agricultural research: Changes in funding and shifts in emphasis, 1980–2005.* Econ. Inform. Bull. 45, USDA Economic Research Service. 34 p.

THOMPSON, D.H. 2003. *History and evaluation of the McIntire-Stennis Cooperative Forestry Research Program.* Unpub. PhD dissertation, Mississippi State Univ., Mississippi State, MS. 324 p.

THOMPSON, D.H. 2004. Senator John C. Stennis, champion of forestry. *Forest History Today*, Spring/Fall Issue, 27–34.

THOMPSON, D.H., AND S.H. BULLARD. 2004. *History and evaluation of the McIntire-Stennis Cooperative Forestry Research Program.* Res. Bull. FO 269, Forest and Wildlife Research Center, Mississippi State Univ., Mississippi State, MS. 57 p.

WESTVELD, R.H. 1954. Forest research in colleges and universities offering forestry education. *J. For.* 52(2):85–89.

WESTVELD, R.H. 1963. Opportunities for research and graduate education in forestry. *J. For.* 61(6):419–421.

USDA COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE (CSREES). 2000. *Administrative Manual for the McIntire-Stennis Cooperative Forestry Program.* Cooperative State Research, Education, and Extension Service, Washington, DC. 23 p. (plus 16 Appendices).

USDA COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE (CSREES). 2007. *McIntire-Stennis Cooperative Forestry Research Program, Accomplishments Compiled by Performing Institution*. Cooperative State Research, Education, and Extension Service, Washington, DC. 280 p.

USDA NIFA CURRENT RESEARCH INFORMATION SYSTEM. 2010. Available online at cris.nifa.usda.gov; last accessed Oct. 5, 2010.

US FOREST SERVICE. 2010. Available online at www.fs.fed.us/aboutus/budget/; last accessed Oct. 5, 2010