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National Institute of Food and Agriculture

Final Report

Review of McIntire-Stennis Cooperative Forestry Research Program

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Executive Summary

In 1962 the McIntire-Stennis Cooperative Forestry Research Act became law (PL87-788). Commonly referred to as the McIntire-Stennis (M-S) program, it provides land grant and other public universities federal funds to conduct forestry research in eight areas ranging from reforestation and forest management to forest health, utilization, and policy. Graduate training is also a desired outcome. A 2007 Strategic Plan that reframes its potential to address current challenges in sustainability, ecosystems, and managing complexity also guides implementation.

Currently, 78 institutions receive M-S support, of which 13 are 1890 universities, which totals just under \$33 million annually. The USDA National Institute of Food and Agriculture (NIFA) administers the program.

In early 2012, the Forest Research Advisory Council (FRAC) requested a review of the M-S program to coincide with its 50th anniversary. The scope of this review is to assess graduate education and forestry research impacts (i.e., success stories), since 2000. Primary data were collected through a web-based survey, to which over 90% of institutions responded.

Key findings

- 51 institutions directly support graduate students, accounting for over 1,800 MS and PhD degrees conferred from 2000 through 2011. These students have gone on to successful careers in academia, government, and the private sector.
- Ecology, management, forest health, and utilization of forest systems, with strong integration among these, form the core research emphases. Human and social aspects receive lesser attentions.

Recommendations:

1. **Advocate for increased appropriations.** New appropriations would permit a nationally competitive program to emerge that could do much to advance forestry research.
2. **Explore mechanisms to increase interactions among M-S supported researchers.** Regional or national coordination likely would yield benefits and reduce redundancy.
3. **Stress the importance of M-S to graduate training.** Not all institutions use M-S to directly support graduate students, but most do, supporting ≈100 per year. M-S is the only federal mechanism in place to ensure that a future cadre of researchers who study forestry and forest systems.

Introduction

In 1962 Congress passed and President Kennedy signed the McIntire-Stennis Cooperative Forestry Research Act (PL87-788). The resulting program, commonly referred to as the McIntire-Stennis (M-S) program, provides land grant and other public universities federal funds to conduct forestry research. It is administratively housed in the USDA National Institute of Food and Agriculture (NIFA). M-S funds are distributed to each state based on a formula that considers three factors: non-federal commercial forestland area, annual timber harvest volume, and total non-federal forestry research expenditures (i.e., the match). The legislation specifies forestry research in eight areas¹:

1. Reforestation and management of forests,
2. Forested watersheds and waterflow,
3. Forest and related rangeland for domestic livestock forage, and wildlife food and habitat,
4. Outdoor recreation,
5. Protection against fire, insects, diseases, or other destructive agents,
6. Utilization of wood and other forest products,
7. Forest policy, and
8. Other such studies as may be necessary.

Program funding has grown (Figure 1), as have the number of participating institutions. In 1999, just under \$21 million were distributed to participating institutions. This remained relatively constant until 2007, when distributions grew to \$30 million and then to \$32.9 million in 2011 and 2012. The spike in 2007 reflects a one-time shift of forestry-related congressional earmarks to the M-S program.

The M-S legislation requires the Governor or Governor's Designee in each state to designate the institutions that are to receive M-S funds and, if more than one, the proportion of the state's allocation that goes to each M-S named institution. Until 2008, 55 institutions received M-S funds. The 2008 Farm Bill made the 1890 land-grant institutions eligible to receive M-S funds. The Secretary of Agriculture wrote to the Governors in the states with 1890 institutions, informed them of this new eligibility, and requested notification of any revised proportional allocations that include 1890 institutions. Currently, 78 institutions receive M-S funding support, of which 13 are 1890 universities.

¹ See Appendix A for full text of PL87-788.

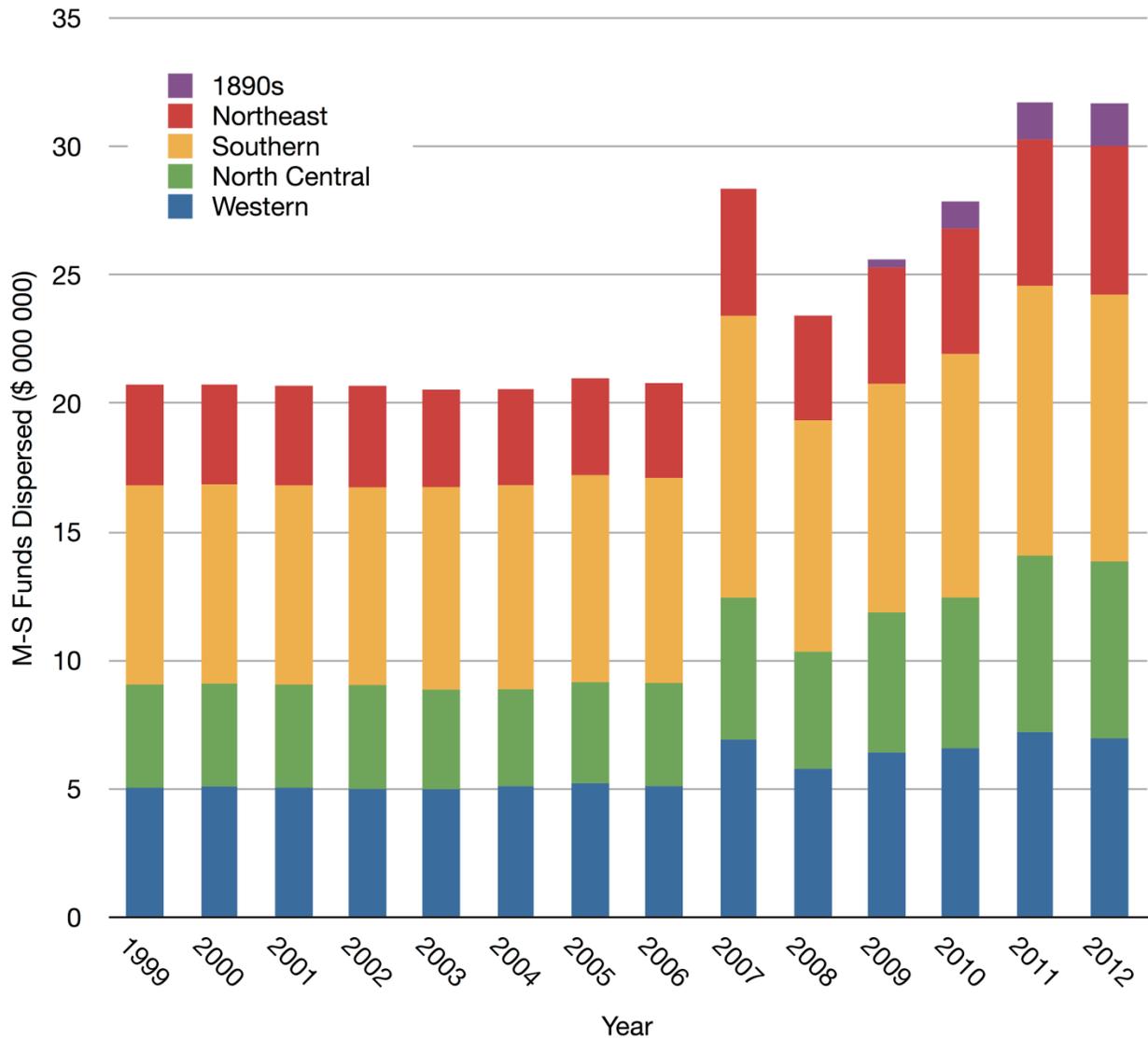


Figure 1: McIntire-Stennis funds distributed by region, 1999-2012

Strategic direction

The purpose of M-S is threefold:

1. Increase forestry research on forest productivity, utilization, and protection;
2. Train future forestry scientists; and
3. Cooperate with states in forestry research.

M-S has a dual focus on foundational and applied research.

In 2007, the National Association of University Forest Resource Programs (NAUFRP), partially funded by NIFA, convened a M-S strategic planning workshop with its members, external

partners (industry, NGO's), and other federal agencies including the National Institute of Food and Agriculture (NIFA, formally CSREES) and USDA Forest Service to develop a Strategic Plan for the M-S program². That document identified six crosscutting, contemporary issues that are common to all, or unique to some, of the priority areas in the legislation. NIFA reviewed the plan and accepted the seven issues as valid priorities that are consistent with the legislation and communicated its expectation to the M-S institutions that these be incorporated into their M-S program. The seven high priority issues are:

1. Science of integration;
2. Forest ecosystem services;
3. Human attitudes and behaviors;
4. Conflict, uncertainty, and decision-making;
5. Technological advancements, productivity, and forest applications;
6. New applications for forest products; and
7. Urban ecosystems.

In 2010, the M-S strategic plan was updated to reflect “changes that have occurred in research, graduate education and funding since the plan.”³ Of particular note was the added high priority issue of graduate education: “a hallmark of the McIntire-Stennis Program for nearly 50 years has been developing the future forestry research and outreach workforce for the Nation. With the myriad issues facing society today, we must prepare a workforce to meet the challenges outlined in the above recommendations.”

In addition to ensuring that M-S funded projects comply with the legislative priorities, the M-S program fits those of the broader USDA and the Research, Education, and Economics (REE) Mission Area⁴ within USDA. Within the USDA Strategic Plan (FY 2010-2015)⁵, M-S most closely addresses Strategic Goal 2, “Ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources.”

This strategic goal has four objectives:

- 2.1—Restore and conserve the nations’ forests, farms, ranches, and grasslands

² *Sustaining Healthy and Productive Forests: An Investment in America’s Competitive Position in the Global Market Place (McIntire-Stennis Strategic Plan)*; National Association of University Forest Resources Programs, 2007 <http://www.naufrp.org/pdf/M-S%20Plan.pdf>.

³ McIntire-Stennis Strategic Plan: An Update, This two-page update appears in most PDF versions of the document cited in footnote 2 above.

⁴ For further details on REE Mission Area visit REE website at <http://www.ree.usda.gov/about-ree> and <http://www.usda.gov/documents/usda-ree-science-action-plan.pdf> for the action Plan

⁵ See <http://www.ocfo.usda.gov/usdasp/sp2010/sp2010.pdf>.

- 2.2—Lead efforts to mitigate and adapt to climate change
- 2.3—Protect and enhance America’s water resources
- 2.4—Reduce risk from catastrophic wildfire and restore fire to its appropriate place on the landscape

Regarding the 2012, REE Mission Area Action Plan, M-S efforts more directly address Goal 2—Responding to climate and energy needs—and Goal 3—Sustainable use of natural resources, and their respective sub-goals:

- 2A—Responding to climate variability
- 2B—Bioenergy/biofuels and bio-based products
- 3A—Water availability: quality and quantity
- 3B—Landscape-scale conservation and management

Scope of review

In early 2012, the Forest Research Advisory Council (FRAC) requested a review of the McIntire-Stennis Cooperative Forest Research Program to coincide with its 50th anniversary. Prior reviews were conducted in 1986⁶ and 2004⁷. The scope of this review is to assess the effectiveness of the program on graduate education and forestry research.

Survey of participating institutions

Existing NIFA data sources in some cases make it either difficult or impossible to collect certain data and outcomes. For example, degrees awarded are not collected in NIFA’s existing reporting system, Current Research Information System (CRIS). Moreover, even if it was, it would likely underreport such outputs, as graduates students are often funded on multiple projects of which M-S might be only one component. In addition, student timelines do not always align with project end dates. Hence, it was decided to conduct a survey of institutions receiving M-S support to gather two types of data:

1. Student numbers and graduate degrees conferred, and
2. Success stories of both students and research impacts.

⁶ *A Quarter Century of Progress: The McIntire-Stennis Cooperative Forestry Research Program, 1962-1987*; National Association of Professional Forestry Schools & Colleges and USDA CSREES, 1986

⁷ *History and Evaluation of the McIntire-Stennis Cooperative Forestry Research Program* (Thompson & Bullard); Mississippi State University Forest and Wildlife Research Center Bulletin FO269, 2004

Data collection

Between December 2012 and April 2013, we conducted a web survey of NAUFRP contacts and the M-S Administrative-Technical Representatives (ATRs)⁸. The questionnaire consisted of four items⁹ covering M-S activities from 2000 through 2011. Response was exceptional: 73 of 78 institutions responded (94%). When weighted by 2011 M-S funds received, 98% of the distributed dollars are represented in the survey results.¹⁰

Results

Graduate student support

Fifty-one institutions (70%) currently use at least some portion of their M-S funds to directly support graduate students (e.g., salary and fringes) over the study period (Table 1). These institutions account for 70% of the 2011 M-S funds in this survey. One institution, The Pennsylvania State University, reported ending direct graduate student support after 2002.

Table 1: Number and percentage of responding institutions that currently using M-S funds to directly support graduate students

Region	Current Graduate Student Support		Portion with current support
	YES	NO	
North central	13	2	87%
Northeast	11	2	85%
Southern	10	6	63%
West	12	5	71%
1890s	6	7	46%
Total	51	22	70%

For those who did not use M-S to directly support graduate students, it is still central to graduate education, as one institution noted in its comments,

⁸ NIFA requires that each M-S institution appoint an ATR. The responsibilities of the ATR include: determining the research to be conducted, carrying out the purpose of the Act, and complying with rules and regulations. ATR's are often Agricultural Experiment Station Directors, and in some cases forestry deans, directors and department heads. A list of ATRs is available in Appendix B.

⁹ See Appendix C for text of questionnaire.

¹⁰ See Appendix D for tabulation of institutional responses.

Most of our [McIntire-Stennis] funds are not used for graduate student stipends and hourly wages, but rather for other things that ultimately benefit graduate students in their research and our academic-unit research productivity overall. Examples include undergraduate lab and field assistants, equipment, etc. By not allowing for the inclusion of these "other things" [in this survey] the full benefits of McIntire-Stennis funds to graduate student research and academic unit productivity are not being captured.

Another institution addressed this impact directly,

Although McIntire-Stennis funds are not used to directly support graduate students...they are used to support the salaries of faculty who supervise graduate students. These faculty have graduated 91 MS and 51 PhD students over the years in question (2000 – 2011).

Hence, institutions depend on M-S funds to do different things that ultimately contribute to the advancement of forestry research and graduate training. Moreover, the enabling legislation does not prescribe graduate education, although it acknowledges the importance of “training of research workers in forestry”¹¹ and the 2010 update to the Strategic Plan added “graduate education” as a high priority. Reduced or contingent state support for higher education may necessitate different funding portfolios to support forestry programs. Whether direct or indirect support is preferable is a separate question that is beyond the scope of this review. However, we would note that there isn’t a clear impact on of one approach on overall research productivity. Of the 9 M-S institutions with a “high rank” of 5th or better for research productivity¹² in the most recent National Research Council rankings, 6 currently use M-S funds to directly support graduate students (Table 2). This is similar to the overall distribution.

Table 2. Nine M-S institutions with NRC “high research” productivity by whether M-S is used currently to directly support graduate students; institutions listed alphabetically, not by rank

Direct support of graduate Students	No current direct support
Colorado State University Michigan Technological University University of Georgia University of Idaho University of Missouri University of Wisconsin	Oregon State University The Pennsylvania State University Texas A&M University

¹¹ Text of PL87-788, see Appendix A.

¹² Research productivity here is from the column “Research High” which is “derived from faculty publications, citation rates, grants, and awards.” See <http://chronicle.com/article/NRC-Rankings-Overview-/124731/>. We would note that our use of the NRC rankings is not an endorsement of those rankings or the NRC methodology.

Direct support and degrees

From 2000 through 2011, responses indicate that, on average, 316 graduate students per year were directly supported by M-S funds (Figure 2). However, that number likely underestimates support as many respondents reported difficulty in finding complete data for all but the most recent years (gray line, Figure 2). For 2010 & 2011, when the number of respondents was highest (n = 46 & n = 47, respectively), M-S supported an average of 485 students per year. The average number of graduate students supported by M-S funds hovered between 8 and 11 per year per institution (black line, Figure 2). Regional data and trends are provided in Figure 3.

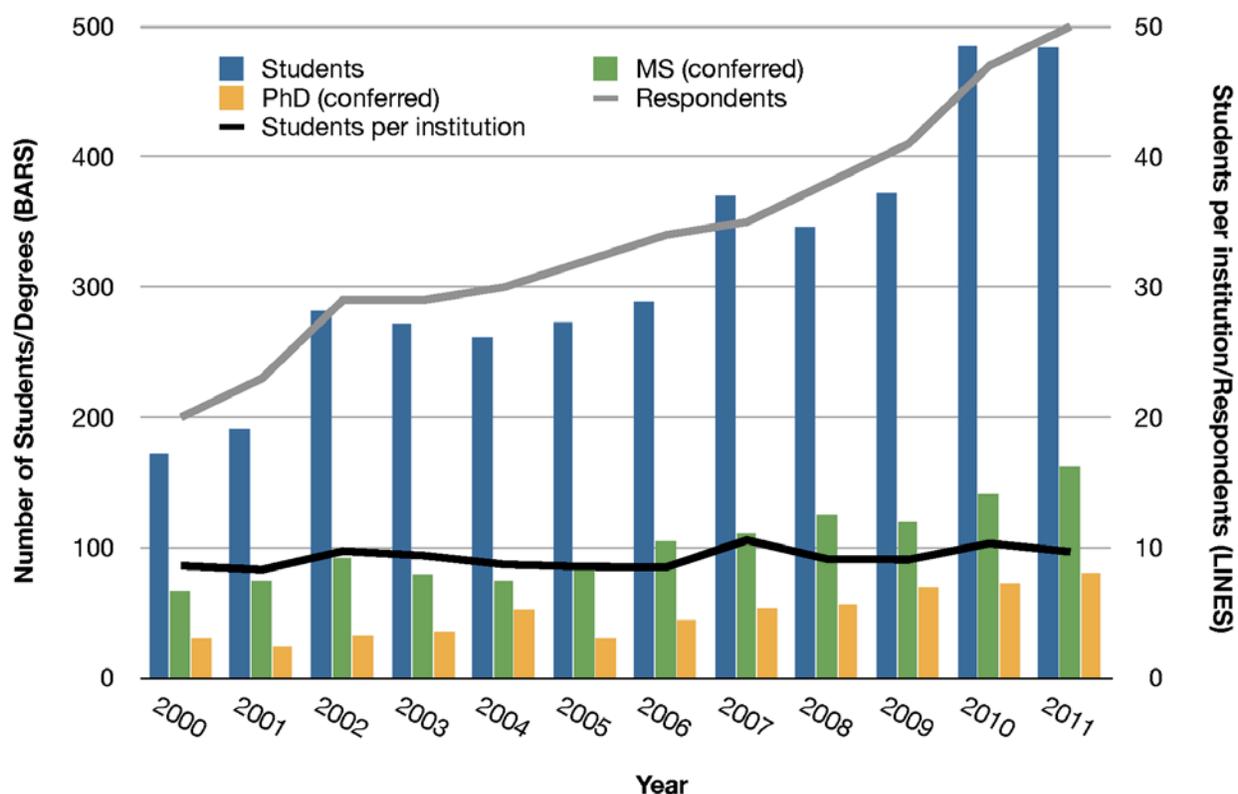


Figure 2: Students supported, MS & PhD degrees conferred, institutional responses by year, and average number of students supported per year, 2000-2011

Over 1,800 post-baccalaureate degrees were conferred over the period that included some level of direct M-S support to the student (Table 3).

The number of degrees conferred is a lower bound, as there are both missing data (described above) and lags in reporting. An example of a lag would be a student starting a PhD program in 1998 with M-S support, may have moved to other funding by 2000 and graduated in 2002. It is

unlikely that this degree would have been captured in this survey, as human resources records and graduation records are separate domain according to many respondents.

By region (Figure 3, next page), the data indicate that the North Central, Northeast, and Western regions have similar numbers of students and degrees, particularly in latter years when more institutions report data. For example, these three regions report roughly 90-100 students supported per year in 2010 and 2011. The Southern region offers stark contrast with over 180 students in both those years. Given the recent inclusion of 1890 institutions in the M-S program, no clear trends are evident.

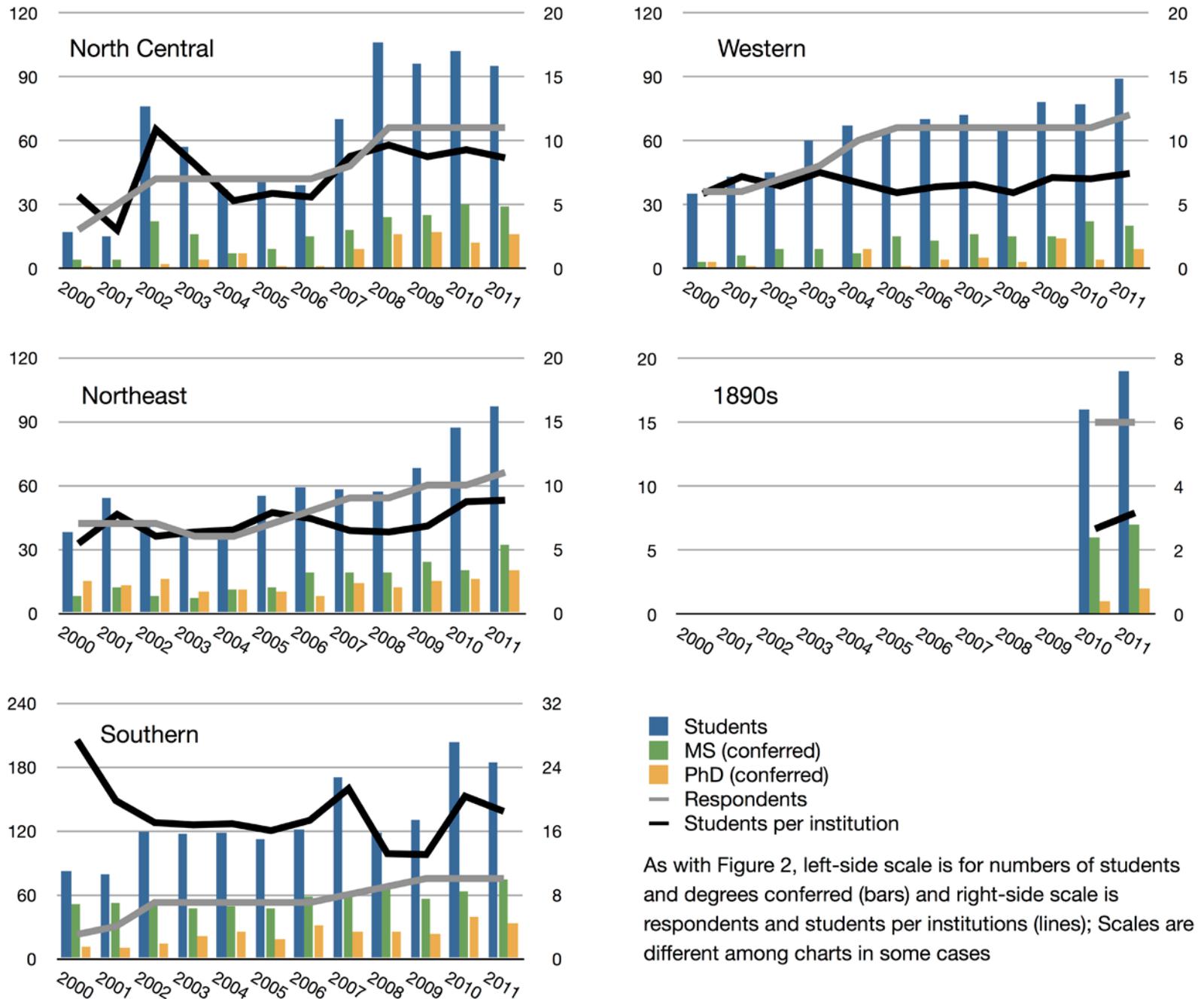
McIntire-Stennis Supported Students are...

- **Faculty in the USA and abroad**
 - University of Kentucky
 - Colorado State University
 - Chinese Academy of Sciences
- **Government scientists**
 - US Navy Facilities
 - Los Alamos National Laboratory
 - USDA Forest Service
 - USDA Office of the Chief Scientist
 - US Army of Corps of Engineers
- **Public & private sector professionals**
 - WA & WI Departments of Natural Resources
 - USDA Forest Service National Forests
 - Private Consultants

Table 3: Degrees conferred by type and region, 2000-2011

Region	Degree conferred		Total
	Masters	Doctorate	
North Central	203	86	299
Northeast	191	160	351
Southern	675	275	950
Western	150	53	203
1890s	13	3	16
Total	1,232	577	1,809

Figure 3: Students supported, MS & PhD degrees conferred, institutional responses by year, and average number of students supported per year by region, 2000-2011



As with Figure 2, left-side scale is for numbers of students and degrees conferred (bars) and right-side scale is respondents and students per institutions (lines); Scales are different among charts in some cases

The Southern region does receive the largest share of M-S funds annually (Figure 1), but those additional resources only partially explain the higher number of students and degrees. In addition to student numbers, and degrees conferred, the on-line questionnaire also sought data on full-time-equivalents (FTEs)¹³. While the data reporting and quality on this variable were inconsistent, the data do suggest that several Southern region institutions typically fund small portions of graduate students (< 0.25 FTE), while other regions are more likely to fund “full” assistantships, which typically equates to 0.50 FTE.

Graphically this is evident on Figure 3 by comparing the “students per institution” black line. Since 2007, the North Central and Northeast regions have ranged between 6 and 10 students per institution; and the Western region between 6 and 7. The Southern region has ranged between 15 or 20 students per institution. Other non-Southern region institutions also allocate M-S graduate student funding in this way, so this is not peculiar to one region.

These two approaches (i.e., low versus high per student support) have two important and perhaps competing implications. The “low per student support” increases the number of students supported by M-S and, by extension, the numbers of degrees conferred—important metrics for assessing M-S program impact. However, the direct impacts and contributions of M-S support may be diluted or less clear. The “high per student support” might permit clear signals of the direct impacts and outcomes of M-S support. E.g., this student, who received all their funding their M-S, did this research and these findings and products emerged.

Based on national statistics from the USDA Food and Agricultural Education Information System (FAEIS)¹⁴, NAUFRP institutions conferred on average 347 MS and 118 PhD degrees per year in forestry and wood science/products from 2004¹⁵ through 2011 (Figure 4). Expanding to the broader natural resources conservation group within FAEIS, 1,389 MS and 399 PhD degrees were conferred per year. Missing data in early years limit direct comparisons, but in 2010 and 2011, 151 MS and 76 PhD degrees were conferred to students supported by M-S. Clearly, it might be safe to assume that most students supported by M-S funds are in the “traditional” forest-related domains. As such, M-S supported students likely make up a large portion of the forestry and wood science/products degrees conferred in the US. However, M-S also likely supports students in a broad array of natural resource domains that relate to forests and their

¹³ FTEs indicate what portion of an individual is committed and/or funded by an award. For example, a ½-time graduate assistantship equates to a 0.50 FTE.

¹⁴ <http://faeis.usda.gov>

¹⁵ 2004 was the earliest date for which data were available on the web-based table maker.

sustainable management—a broadening perspective consistent with the complex knowledge challenges that face forest ecosystems and human connections to them.

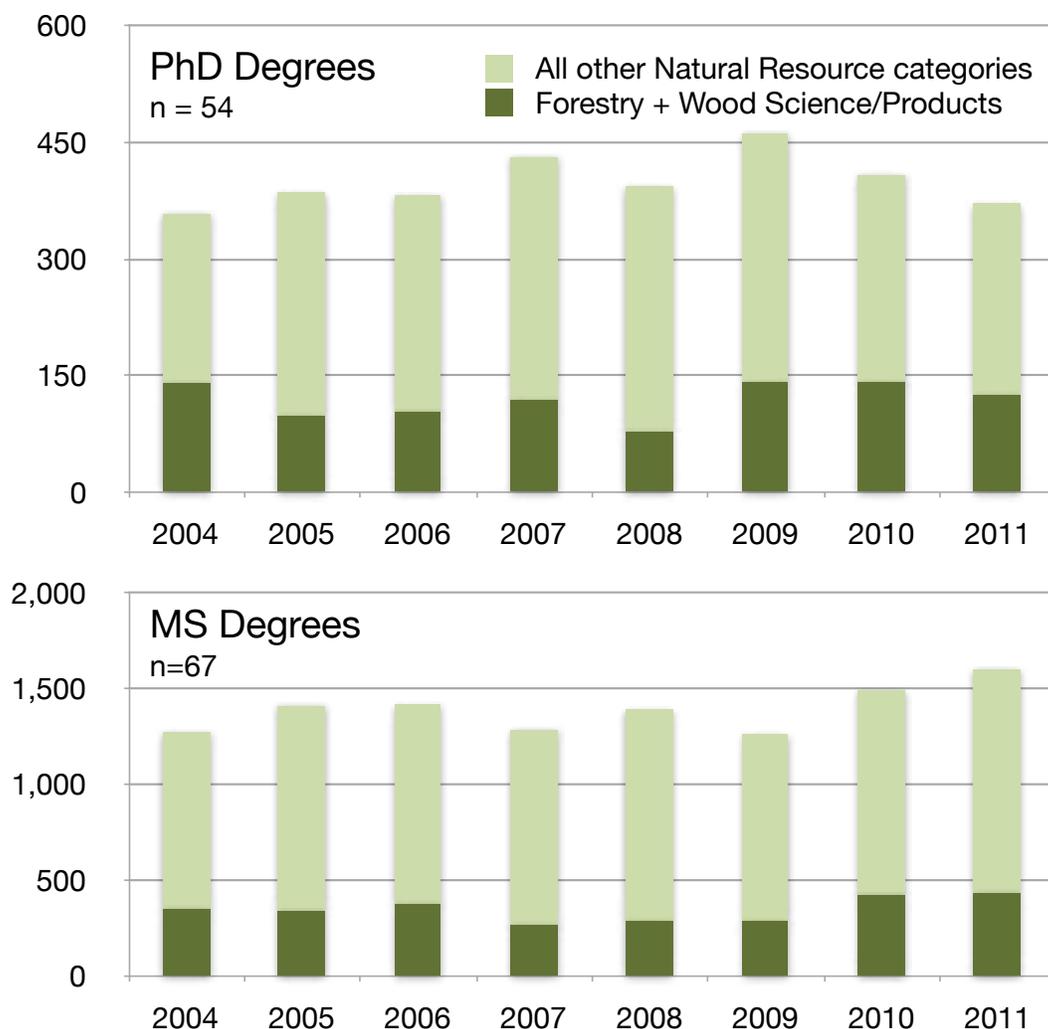


Figure 4. Graduate degrees awarded NAUFRP in “natural resources and conservation”¹⁶, 2004 - 2011. Source: USDA Food & Agricultural Education Information System

Success story analysis

Respondents provided over 200 success stories¹⁷ demonstrating the impact of M-S support from 2000 through 2011. About one-quarter of the stories reflect the experience of students

¹⁶ Academic areas within this grouping include Environmental Science and Studies, Fisheries and Wildlife, Forestry, Natural Resources Conservation and Management, Natural Resources Recreation, Range Science and Management, Watershed Science and Management, and Wood Science/Products.

who have moved on to successful careers in natural resources and academia. In order to make sense of these success stories, we used a standard qualitative analysis technique, called coding. Two coding, or categorization, schemes were used. First, we assigned a code to each story as to how it met the legislative intent of the M-S (Table 4). Second, we then assigned a code to each story as to how it fit the priorities of the M-S strategic plan (Table 4).

The purpose of both categorizations was to explore whether and to what extent the program has covered the topical areas that key stakeholders have identified as important.

Table 4. Crosswalks from legislative intent and strategic plan foci to qualitative code names (labels) used in Figures 4 and 5.

Legislative Intent		Strategic Plan Foci	
Description	Code	Description	Code
Reforestation and management of forests,	Management	Science of integration	Integration
Forested watersheds and waterflow	Water	Forest ecosystem services	Services
Forest and related rangeland for domestic livestock forage, and wildlife food and habitat	Animals	Human attitudes and behaviors	Humans
Outdoor recreation	Recreation	Conflict, uncertainty, and decision-making	Decisions
Protection against fire, insects, diseases, or other destructive agents	Protection	Technological advancements, productivity, and forest applications	Productivity
Utilization of wood and other forest products	Utilization	New applications for forest products	Products
Forest policy & markets	Policy	Urban ecosystems	Urban
Other such studies as may be necessary	Miscellany		

Under each scheme, at most two codes could be assigned to any single story. This allowed us to reflect interdisciplinary work. Limiting each story to two codes greatly simplified coding decisions and analysis. Using matrix and network concepts, Figures 5 and 6 reflect both the relative weight of each code (circle size) and the connections among them¹⁸. Line thickness

¹⁷ See Appendix E for all success stories by state.

¹⁸ Matrices that form bases for Figures 3 and 4 are provided in Appendix F (Table F.1 & F.2).

reflects the number of stories sharing the same codes. A total of 186 success stories could be categorized under both schemes. The few that we weren't able to code were typically student success stories that didn't include the student's research focus.

We use success stories as proxies for overall M-S topical focus. A full-blown analysis of all M-S final reports in the CRIS reporting system would have required substantial inputs of time and effort. Our intent was to understand the broad dynamics in the program that might suggest broad themes and directions.

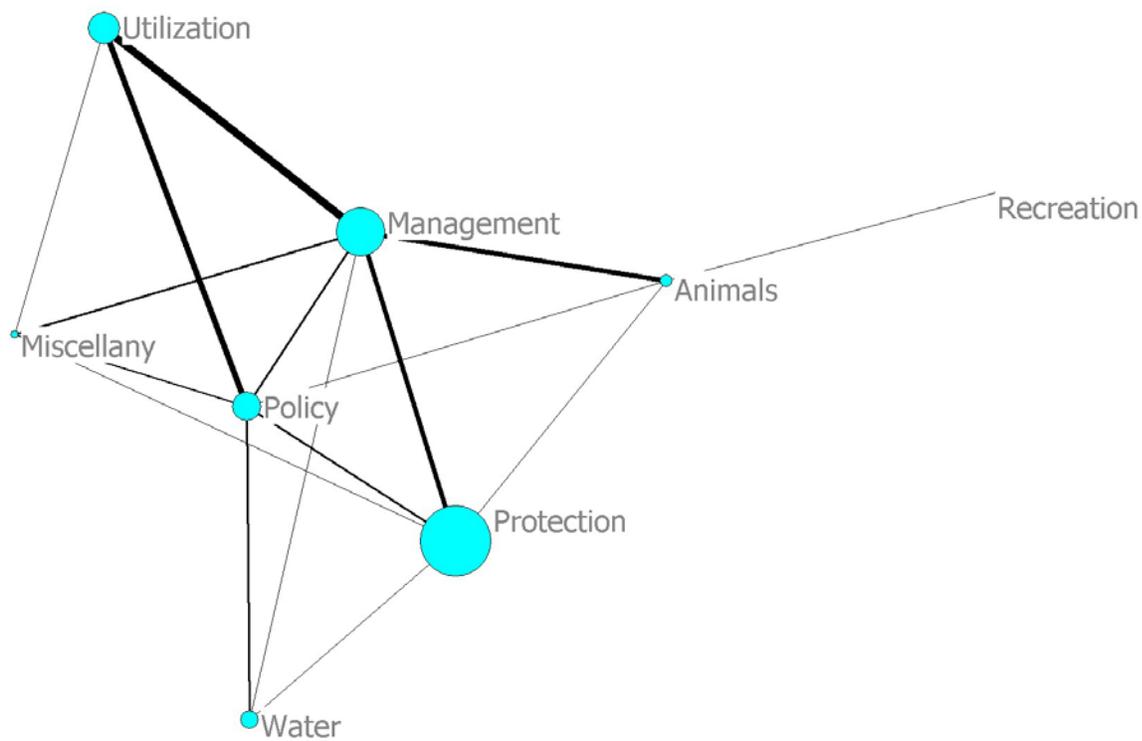


Figure 5. Success stories coded by M-S legislative intent; Circle size and line thickness reflect relative distribution

Figure 5 indicates that success stories emphasize forest protection from wildfire, insects, and other threats, followed by those that focus on reforestation and forest management and wood and forest products utilization. Wildlife habitat and rangeland grazing and outdoor recreation were minimally noted, as was the catchall category of “other such studies as may be necessary”.

The range and distribution of success stories are not particularly surprising given the composition of most forestry faculties. Faculties tend to be populated by those with interests in forest ecology and management. Moreover, some universities dedicate entire departments to wood products and utilization. It may seem somewhat surprising that forest protection was more common than reforestation and management, but forest protection includes wildfire, a key topic. In addition, threats and a focus on ecology may make better success stories (and perhaps funding success) than more traditional forestry management topics.

In terms of dual-foci success stories, the strongest links are primarily on how management relates to utilization and wildlife. Secondary relationships of importance appear between wood utilization and policy and markets, and between forest protection and policy and markets. Of note on Figure 5, reforestation and management and forest policy and markets hold central roles. This would seem consistent with the applied research agenda that is at the core of the M-S program.

Coding success stories by the 2007 strategic plan foci was more challenging. As the strategic plan was not widely available until 2008, we had some concern that its priorities might not be integrated or evident in the success stories provided. In reviewing the success stories, we found coding was possible; first because the strategic priorities are relatively broad, and second because most success stories appear to have been drawn from more recent projects. However, this analysis is intended as neither a formative nor a summative evaluation of M-S strategic plan implementation. It is simply another useful way to understand the array of projects within the M-S portfolio.

The science of integration, and technological advancements, productivity, and forest applications were the two dominant strategic plan priorities evident in the success stories (Figure 6). The first of these is, by its very nature quite broad, while the second mapped most closely to two legislative intents: reforestation and management and forest protection. These were followed by new applications for forest products and forest ecosystem services. It may be a bit surprising that ecosystem services didn't occur more frequently, but we took a narrow slice on the code that required the success story to reflect an ecosystem services perspective as opposed to reading into the story or its implications. Decision-making, human attitudes and behaviors, and urban ecosystems were infrequent topics of success stories.

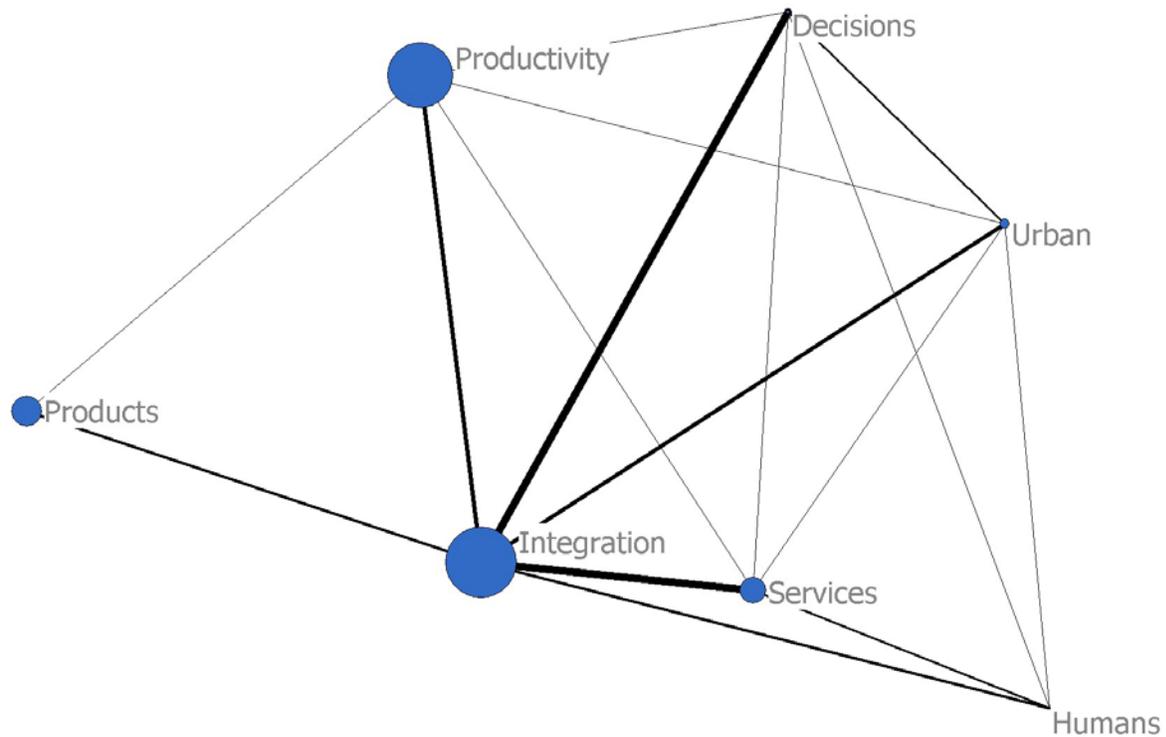


Figure 6. Success stories coded by M-S strategic planning foci; Circle size and line thickness reflect relative distribution

The science of integration, not surprisingly, was also at the center of the dual-foci success stories, linking to all other foci and most often with decision-making and forest ecosystem services. The remaining foci were linked to four or five others, with the exception of products, which co-occurred with only the science of integration and productivity.

It may seem odd that the science of integration was the most common priority and it didn't share more connections to other priorities. In reviewing the coding rules we used, it appears that this reflects the more focused language of the other foci. For example, a study that combined forest practices and wildlife, without a specific reference to ecosystem services.

Lastly, we found that 16 success stories related to agroforestry. This compares to 18 that focused on urban ecosystems.

Conclusions and recommendations

Our review suggests that M-S continues to be a driving force in shaping forestry research and graduate trainings at public universities. Research findings impact forest practices and policy, while graduate level trainees go on to shape the intellectual foundations of forestry, natural resources, and beyond. Moreover, it has been the beneficiary of increased funding in the recent past. However, M-S, like all formula fund programs, remains a target for critics. There are perceptions that (1) accountability is lacking, (2) allocation is inefficient, and (3) resources aren't targeted toward national priorities. We will consider each of these in turn.

Accountability

Formula funds are inherently a different way to allocate federal money to conduct forestry research. Participating institutions have wide discretion in how the funds may be applied and to which research questions and problems, so long as they fall within the legislative intent and NIFA rules. M-S institutions have taken advantage of that inherent flexibility to craft institutional forestry research portfolios that fit the complex fiscal environments they inhabit. Some institutions have found it necessary to fund base faculty salaries, others spread very small portions across many students and projects, and still others fund very targeted research projects that closely resemble those in competitively-funded programs. Such approaches need not be any less accountable, but the trend in recent years has been away from formula funds toward competitive programs. Competitive programs are seen as the “norm” and include stronger elements of peer-review that may be less evident (or absent) in institutional allocation decisions.

Those with an interest in preserving and growing M-S are well aware of this critique, but are also sensitive to the diverse needs of the participating institutions. The most recent NAUFRP-led M-S Strategic Plan¹⁹ argues that a significant portion of any future increased appropriations should be dedicated to competitive funding. In the current federal fiscal environment such goals, while laudable, have limited traction. Hence, perceptions remain unchanged.

Inefficient Allocation

Each year between 100 and 140 M-S projects terminate and about the same number of new projects begin. Administratively, this requires considerable effort by NIFA National Program Leaders (NPLs) and staff to approve, process, etc.—particularly given the limited forestry capacity within the agency. Whether processes can be streamlined is a broader agency issue,

¹⁹ See footnote 3.

but M-S from an external perspective appears comprised of small, unrelated projects (again contrasting the broader research trend). While these projects collectively have and do advance forestry knowledge and practice and train future researchers, these important outcomes are difficult to discern, evaluate, or are simply lost. Hence, M-S impacts and, more importantly, the coherent narratives to communicate them are absent from dialogues about the program.

Meeting National Needs

M-S is a cooperative research program in which the federal government and states partner toward forestry research topics of mutual interest. The legislative sideboards are broad and permit nearly anything one might study in relationship to forests and their value to people. There is also reference to the importance of training future researchers to continue our collective understanding of forest systems (i.e., graduate education). The Strategic Plan reiterates this importance, but also place M-S in the context of sustainability, complexity, and ecosystem services. Our data speak most directly to these issues.

In terms of graduate education, FAEIS data suggest that M-S plays a very important role in training the forestry researchers of the future both through direct (i.e., salary, fringe benefits) and indirect support (e.g., maintain core faculty competency, data collection support, etc.). Whether there are too many, too few, or just enough remains an open question. Broader employment among foresters and conservation scientists is expected to grow slower than average between 2010 and 2020 (5%); however, environmental scientists and specialists and agricultural and food scientists are expected to grow at 24% and 10%, respectively, over the same period²⁰.

That M-S plays a core role in graduate education is consistent with NIFA's role in advancing the three traditional land grant missions of research, teaching, and extension. Graduate education is a critical connection between research and teaching, and one that tends to be of lesser importance to other mission-oriented federal funding agencies (e.g., US Department of Energy, USDA Forest Service, US Environmental Protection Agency, National Aeronautic and Space Administration). Indeed, there is a trend within the research community to prefer post-doctoral researchers to the graduate students given the rising costs associated with research and tuition.

In addition, M-S likely acts as a critical anchor that tethers the forestry discipline in state research universities. This is particularly true in state's where forestry programs are not part of colleges of forestry and/or natural resources (e.g., they are parts of colleges of agriculture). M-S

²⁰ Bureau of Labor Statistics Occupational Outlook Handbook (<http://www.bls.gov/ooh>)

provides incentives for those institutions to maintain forestry and/or natural resource programs that often include not just graduate education, but also undergraduate programs. This preserves a pipeline of future graduate students and maintains a culture that values forestry and natural resources.

In terms of meeting its legislative intent, analysis suggests that, at least in what is defined as successful stories, outdoor recreation, wildlife habitat and range forage, and water-related research are less common topics than those that might be described as “traditional forestry” (Figure 5). That regeneration, silviculture, and utilization are central is not surprising, particularly in the absence of other consistent federal resources for forestry research by public or other universities.

This is evident in mapping success stories to the M-S Strategic Plan priorities (Figure 6), where the key human-related priorities (i.e., attitudes and behaviors and decision-making) are peripheral and were cited in success stories much less frequently. A bias of using success stories as a data collection lens might lead to an underrepresentation of M-S social research, but it is also true that research capacity to investigate the social and economic aspects is small compared to that for ecology and management. Moreover, as public universities respond to reduced support and/or increased reliance on external resources, will capacity exist to directly address the social science challenges surrounding forest systems? For example, some institutions limit who can access M-S funds, even those awarded through internal competition. Can those with the necessary expertise access M-S funds, and ultimately advance M-S goals (e.g., can those in a psychology department use M-S resources to study landowner decision-making)? Changing what institutions currently do with M-S funds will be difficult, but the addition of a nationally competitive pool could more easily broaden the range of expertise available to M-S research objectives.

Recommendations

1. **Advocate for increased appropriations.** New appropriations, consistent with those in the M-S Strategic Plan, would permit a nationally competitive program to emerge that could do much to advance forestry knowledge and research capacity. Formula funds could be leveraged as match for competitive funds, which would increase the impact of those competitive funds and toward national priorities. In the absence of new resources (or Congressional action), significant or comprehensive change is unlikely as universities have wide latitude in how they use M-S support.

2. **Explore mechanisms to increase interactions among M-S supported researchers.** In the absence of (or in addition to) new appropriations, regional or national coordination likely would yield benefits and reduce redundancy. Opportunities for coordination are highly scalable and may not be resource intensive. Some examples include...
 - Host M-S symposia at national and regional meetings. If such events were in conjunction with related events such as those hosted by NIFA, NAUFRP, or Society of American Foresters (SAF), or others, costs could be minimized and exposure increased.
 - Use shared faculty or sabbatical arrangements to actively build research networks among M-S researchers. For example, NIFA could host a hardwood silviculturalist to synthesize M-S projects in that area and identify gaps for future study. Another portion of their responsibility would be to network with other researchers to either coordinate future research or submit proposals to relevant requests for applications (RFAs). This would need to be targeted to national priorities, but could demonstrate the collective impact of the M-S portfolio. This would permit stronger policy narratives to develop that could foster additional appropriations.
 - Multi-state projects, similar to those under the Hatch Act, are allowable under M-S, but are rarely, if ever, used. Multi-state projects provide some degree of institutional support and longevity. They also foster interactions across state lines and reduce redundancy. Coordination might yield clearer connections among on-going M-S projects and competitive multi-institution proposals that leverage previous M-S work.
3. **Stress the importance of M-S to graduate training.** Not all institutions use M-S to directly support graduate students, but most do, supporting ≈ 100 per year. Even those that don't directly support students noted that their allocation decisions benefitted graduate students. The tie between M-S support and graduate training should be encouraged. M-S is the only federal mechanism in place to ensure that researchers who study forestry and forest systems will be there in the future. In addition, NIFA, as federal stewards of the land grant mission, has a vested interest in teaching that differs from other federal and state research agencies.
 - Could FRAC, NIFA, and/or NAUFRP annually recognize an M-S supported student through national and regional awards? This would bring positive attention to M-S and

highlight up-and-coming scientists and professionals. This could be part of the symposia described above.

- Develop or upgrade curricula to address changing needs for traditional and non-traditional training with forestry sub-disciplines (e.g., social forestry, communications, advanced modeling, etc.). Using M-S funds to directly support graduate student recruitment, education or extension proposals are similar ideas. The latter would build important capacity of future land-grant faculty and staff.
- Enhance the capacity of existing reporting systems to track outcomes as opposed to outputs. For example, the newest reporting system for NIFA tracks and quantifies effort and outputs closely. However, it does not provide a simple mechanism for tracking outcomes beyond those of traditional academic interest (i.e., publications, patents, etc.). The inclusions of graduate training outcomes (e.g., degrees conferred) or other land-grant-relevant outputs and outcomes would better document M-S (and other program) impacts. If this is not feasible, is additional reporting needed, justified, or viable?
- Lastly, recognize the links among M-S research support, graduate training, and undergraduate forestry instruction. M-S provides base research capacity in forestry research that incentivizes land-grant universities to maintain faculty expertise that allows them to maintain undergraduate programs that provide a professional forestry workforce. In the absence of M-S, it is likely that a number of smaller forestry programs would end. Even larger programs would suffer as faculty may face significant hurdles in maintaining forestry-centric research programs.

Appendices

This report has six appendices that follow.

- A. Copy of law (2 pages)
- B. List of Administrative-Technical Representatives (ATRs, 9 pages)
- C. Questionnaire (3 pages)
- D. Response table (2 pages)
- E. All success stories by state (43 pages)
- F. Success story matrices (1 page)