Indicator 7.51:

Development and application of research and technologies for the sustainable management of forests

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What is the indicator and why is it important?

Research and development provide the scientific basis for adaptive, sustainable management of forests. Research is critical to understanding and improving forest conditions, determining compatible human uses, and developing technologies that sustain the availability and productivity of market and nonmarket forest goods and services. This indicator measures the development and application of research and technologies for sustainable forest management.

What does the indicator show?

Policies and laws at the Federal, State, and local levels, such as the Forest and Rangeland Renewable Resources Research Act of 1978, authorize and prescribe forest research and development throughout the United States and internationally. The Federal Government, State forestry and natural resource agencies, universities, nongovernmental organizations, the forest products industry, and large forest landowning firms carry out research and development critical to sustainable forest management (SFM). This research improves scientific understanding of forest ecology and associated socioeconomic conditions and dynamics and is fundamental for meeting society's goals for forests.

In 2014, the U.S. Department of Agriculture, Forest Service had 58 laboratories and research locations, as well as 73 experimental forests and rangelands. Other Federal agencies, such as National Aeronautics and Space Administration, the National Science Foundation, the U.S. Department of Energy, and agencies within the U.S. Department of Agriculture, also contribute significantly to forest-related research through many multimillion-dollar initiatives related to climate change, bioenergy, genomics, and other disciplines. Nongovernmental organizations also spend millions of dollars annually on forest research.

A broad range of individuals and organizations in the United States conduct forest-related research. A 2016 canvass of U.S. forestry schools and programs and Forest Service research stations tallied and categorized SFM research, teaching, and outreach in the United States by full-time scientists and employees of these organizations. Researchers compared these findings with the 2002 National Research Council (NRC) report on *National Capacity in Forestry Research.* In order to provide a clear, replicable data set for this and future efforts, the 2016 survey counted only full-time Ph.D. research scientists or senior research staff in the Forest Service (excluding technicians and analysts) and full-time university tenure track and non-tenure track professors (excluding instructors, emeritus, or adjuncts). The 2002 data included term appointments of post-doctoral students and may have included some technical staff, so the 2002 and 2016 results are not wholly comparable, but still useful. Table 51-1 shows the researchers and employees by category, based on their primary activities aligned with the Montreal Process Criteria:

- Criterion 1—Biological Diversity: genetics, biology, ecology, silviculture, physiology, wildlife, and geography
- Criterion 2—Productive Capacity: forest management, biometrics, geographic information systems, modeling and inventory, quantitative silviculture, and forestry
- Criterion 3—Ecosystem Health: climate change, entomology, pathology, fire, meteorology, and ecosystem health
- Criterion 4—Soil and Water: hydrology and soils
- Criterion 5—Carbon Cycles: carbon pools and fluxes
- Criterion 6—Socio-economics: social needs, perceptions

and values of forest resources, urban forestry, economics, and production and consumption of wood resources
- Criterion 7—Institutional Framework: forest and natural resource policy and planning, economics, stakeholder involvement and coordination, engineering and technology, and property rights

The 2002 data indicate that the Forest Service research program utilized 701 scientist full-time-equivalents (FTEs) (i.e., a year of full-time employment) and expended a budget of $241 million. (Note that more recent reporting from the Forest Service Washington Office indicates that, in 2002, the agency employed 618 full-time research scientists compared to 500 in 2016. For consistency in reporting categories and across criteria, this report reflects the 2002 data referenced above). Accredited forestry schools and programs had 1,361 scientists in 2002. At that time, faculty functions were identified as 44 percent teaching, 42 percent research, and 14 percent extension.

Forest Service researchers preparing this indicator identified 540 full-time scientists (i.e., permanent employees) in the Forest Service in 2016, as listed by regional research stations and the Washington Office. This number is slightly higher than the total reported by the Washington Office, likely due in part to slight differences in categories of scientists. In addition, research stations employ approximately 2,000 technical and administrative staff, totaling about 2,500 people in research and development throughout the agency. Overall, Forest Service research personnel capacity decreased from the 701 scientist-years tallied in 2002 and from the more recent estimate of 618 full-time research scientists active in 2002. In addition, research personnel capacity declined substantially since the mid-1980s when scientists numbered near 1,000. In real terms, research budgets also declined. The Forest and Rangeland Research budget was $291 million in fiscal year (FY) 2016, a nominal increase of $50 million from the FY 2002 amount of $241 million. Adjusted for inflation, however, the FY 2016 appropriations would equal about $217 million in 2002 dollars—about 10 percent lower than the 2002 budget in real terms.

In 2016, accredited forestry schools and programs listed slightly more than twice as many professors as there were scientists in the Forest Service. This included 1,224 persons with Ph.D. degrees or titles of assistant professor, associate professor, or professor who listed their expertise in teaching, research, or extension. This represented a decrease of 137 professors, or 10 percent, from the 1,361 professors tallied in 2002. Based on the 2002 proportions, the 2016 tally would include about 540 research FTEs, 540 teaching FTEs, and 150 extension FTEs. Overall, the total number of research scientists and professors employed by the Forest Service and forestry schools and programs decreased by about 15 percent between 2002 and 2016.

For all forestry research personnel, the distribution among SFM criteria indicate that Criterion 1, Biological Diversity, encompassed by far the largest amount of scientific effort in 2016, with 612 scientists and professors, or 35 percent of all scientists in total. This could be attributed to the focus on biology, ecology, biodiversity, and wildlife as foci for forestry research. Socioeconomics represented a distant second, with 468 scientists and professors, or 26 percent of the total. Additionally, the range of scientists and professors in this criterion was not uniform, with a large split that included forest products and economics research versus a much smaller split that included human dimensions, urban forestry, and recreation research. Ecosystem health had the third largest contingent of scientists with 300 (17 percent). Productive capacity had 11 percent, and soil and water had 9 percent of all scientists and professors, while Legal and Policy and Carbon Cycles had only 3 percent and 1 percent, respectively.

The 2016 distributions of forest research personnel represented a 40 percent increase of about 170 scientists for the biological diversity capacity numbers compared to 2002, and a 50 percent decline in scientists in the productive capacity criterion (fig. 50-1). This reflects the shift in Forest Service scientific disciplines, which were dominated by research foresters typically focused on productive capacity through the late 1990s and now are dominated by research ecologists typically focused on aspects of forest biodiversity. The university sector had a notably greater percentage of its research capacity in biological diversity, productive capacity, and socioeconomics than the Forest Service; the Forest Service had proportionately more scientists in ecosystem health.

The regional distribution of the forestry research capacity indicates that the South has the most professors, with 492, or 40 percent of the Nation's total. The North and West had more Forest Service researchers, however, with 38 percent each, and only 24 percent in the South. These regional differences across sectors are balanced out when university and Forest Service research capacities are considered together, with the South holding 35 percent of the total number of professors and scientists. The North had 33percent, and the West 32 percent of the U.S. total forestry research capacity.

According to the Sustainable Forestry Initiative (SFI), private sector forestry research by SFI program participants was $59 million in 2016, down from $73 million in 2009, reflecting a slow but steady decline in forestry research funding in the private sector. The private sector forestry research personnel also decreased, with the sector not likely to have more than 100 persons by 2016. Timberland investment and management organizations (TIMOs) and real estate investment trusts (REITs) have maintained modest research programs and many are members of university cooperative research programs, which do leverage their private funds with public research personnel and funding. Yet, there were only about half as many private sector scientists in 2016 as there were in 2002, and much of their funds are spent on university research grants and cooperative programs. Overall, the

Table 51-1—U.S. forestry scientists and professors by sector, function, and sustainable forest management (SFM) criterion, 2002 and 2016.

Sector/ SFM Criterion	1: Biological Diversity	2: Productive Capacity	3: Ecosystem Health	4: Soil and Water	5: Carbon Cycles	6: Socio-economics	7: Legal, Policy	Total
2016								
University								
Number	453	141	119	113	8	353	38	1224
Percent	37	12	10	9	1	29	3	100
Forest Service								
Number	159	49	160	41	6	115	10	540
Percent	29	9	30	8	1	21	2	100
Private	-	-	-	-	-	-	-	Na
Total								
Number	**612**	**190**	**279**	**154**	**14**	**468**	**48**	**1764**
Percent	**35**	**11**	**16**	**9**	**1**	**26**	**3**	**100**
2002								
University								
Number	318	221	128	186	77	293	138	1361
Percent	23	16	9	14	6	22	10	100
Forest Service								
Number	122	161	166	92	43	90	27	701
Percent	17	23	24	13	6	13	4	100
University+ Forest Service								
Number	440	382	294	278	120	383	165	2062
Percent	21	19	14	13	6	19	8	
Private								
Number	10	75	5	22	3	10	0	124
Percent	8	60	4	17	2	8	0	100
Total								
Number	**450**	**457**	**299**	**300**	**122**	**393**	**166**	**2186**
Percent	**21**	**21**	**14**	**14**	**6**	**18**	**8**	**100**

Source: 2002 data—National Research Council 2002; 2016 data—data collected from U.S. forestry schools and programs and Forest Service websites (e.g., lists and descriptions of professors and scientists).

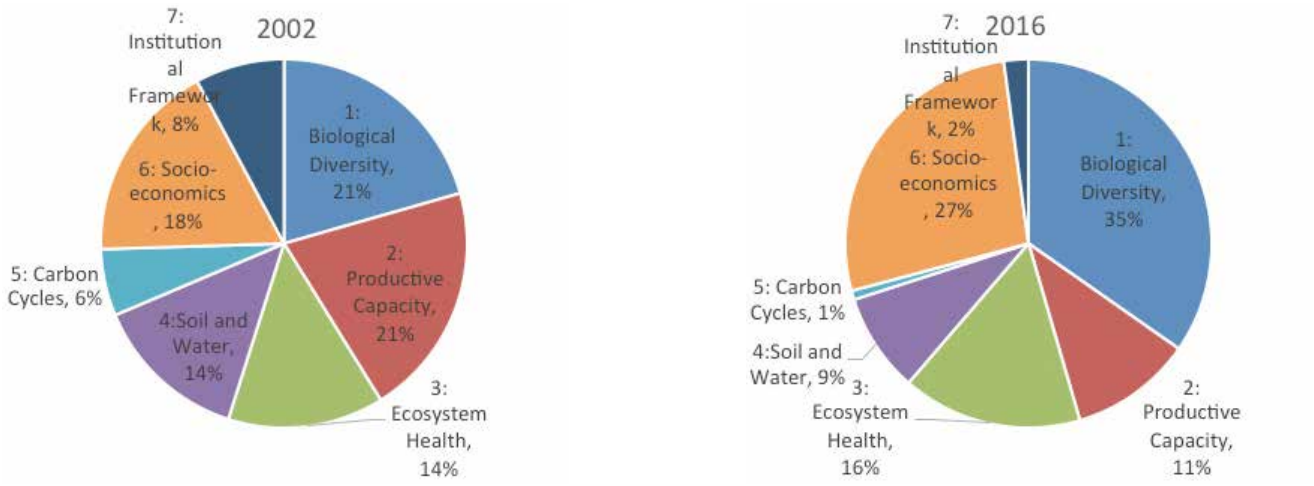

Figure 51-1—Percent of U.S. forestry scientists and professors by sustainable forest management criterion, 2002 (total = 2,186) and 2016 (total = 1,764).

private sector probably contributes less than 15 percent of total U.S. forestry research funding, and less than 5 percent of the total forestry research personnel.

What has changed since 2010?

Public development and application of research and technologies for the sustainable management of forests in the United States has had relatively stable funding in nominal dollars, but slightly declining personnel and funding in real dollars during the last decade. Since 2002, the number of full-time university professors and Forest Service scientists registered about a 15 percent decline, along with more substantial reductions in industry research programs. While the number of Forest Service personnel scientists decreased from 2002 to 2016, they maintain significant capacity for research and probably more technical staff and support than university professors. The number of university research personnel also decreased from 2002 to 2016, and private forestry research and development has declined substantially. In the last 12 years, research capacity focus shifted to biodiversity and ecosystem functions and, to a lesser degree, favored economic and social science research, and away from research directed at productive capacity and competitiveness of timber production on U.S. forests.

References:

National Research Council. 2002. National Capacity in Forestry Research. National Academy Press: Washington, DC. 144 p.