

Appendix 9

Enrollment Trends: Implications for U.S. Research Capacity

Data sources

Programs and students

Research pipeline

References

America's capacity to conduct research related to forestry and wood products may be lagging. This is basically a pipeline issue, driven by enrollment trends in our nation's educational institutions, especially at the graduate level. This appendix summarizes the best available information on graduate enrollment trends and more extensive data on undergraduate enrollment in forestry and natural resources, including wood science and forest products (Sharik et al. 2015).¹

Forestry enrollments at the undergraduate level have declined at the expense of interdisciplinary programs, such as environmental science and natural resources conservation and management. Another concern is diversity. Compared with the other 14 major professional disciplines classified by the federal government, natural resources is a largely white, male vocation: of today's workers with bachelor's degrees, natural resources is second only to engineering in the lowest percentage of females and at the very bottom with respect to race and ethnicity. Moreover, forestry and wood products workers are the least diverse of the various natural resource disciplines. We don't have comparable data for workers with graduate degrees, but the percentage of females and underrepresented minorities in the U.S. Forest Service professional workforce (unpublished data) is virtually identical to the percentage of females and underrepresented minorities among the natural resources undergraduates, suggesting that the situation is similar at the graduate level.

¹ The material in this appendix is drawn from Sharik et al. (2015) and is reprinted here with permission. Please note access to the original article in these appendices.

Data sources

Our data come from the 80 institutions that are members of the National Association of University Forest Resources Programs (NAUFRP), although in 2012, the year of our most recent data, only 76 offered undergraduate degree programs—including six historically black colleges and universities, but no tribal colleges. Of these 76, we have some data for 67, or nearly 90 percent (Sharik et al. 2015, Table 1). Each institution assigned U.S. Department of Education “CIP codes” to its degree programs and submitted enrollment numbers to the USDA Food and Agriculture Education Information System (FAEIS). NAUFRP in turn worked with FAEIS to group these CIP codes into “academic areas” within “natural resources and conservation” (NRC) (Table 1). Some academic areas, such as geography, ecology, and soil science, were omitted because they were considered “basic” and typically reside outside natural resources academic programs. In some instances, the classification of academic areas with FAEIS may not be fine-grained enough to reveal enrollments in specialized fields. For example, Forestry comprises eight CIP codes, from forest biology-related sciences to forest management, and the interdisciplinary area of Natural Resource Conservation and Management (NRCM²) also comprises eight CIP codes, from natural resource economics to conservation biology. Conversely, there is only one CIP code to capture the diverse specializations within Wood Science/Products. The bottom line is that our enrollment numbers by academic area, and thus our conclusions about research capacity, should be considered conservative.

Table 1. NAUFRP institutions used in the 1980–2009 NAUFRP and 2005–2012 FAEIS enrollment analyses by geographic region and institution type.

Institution	Type ^a	Region	Original NAUFRP data set	FAEIS
Alabama A&M University	1890	South	1980–2009	2005–2012
Auburn University	1862	South	1980–2009	2005–2012
California Polytechnic State University, San Luis Obispo	NLG	West	1980–2009	2005–2012
Clemson University	1862	South	1980–2009	2005–2012
Colorado State University	1862	West	1980–2009	2005–2012
Cornell University	1862	Northeast		2005–2012
Delaware State University	1890	Northeast		2005–2012
Florida A&M University	1890	South		2005–2012
Humboldt State University	NLG	West	1980–2009	2005–2012
Iowa State University	1862	North Central	1980–2009	2005–2012
Kansas State University	1862	North Central		2005–2012

² NRC includes all academic areas constituting natural resources and conservation, whereas NRCM is a single, interdisciplinary academic area within NRC.

The Blue Ribbon Commission on Forest and Forest Products Research & Development in the 21st Century

Lincoln University of Missouri	1890	North Central		2005–2012
Louisiana State University	1862	South	1980–2009	2005–2012
Louisiana Tech University	NLG	South		2005–2012
Michigan State University	1862	North Central		2005–2012
Michigan Technological University	NLG	North Central	1980–2009	2005–2012
Mississippi State University	1862	South	1980–2009	2005–2012
New Mexico State University	1862	West		2005–2012
North Carolina State University at Raleigh	1862	South	1980–2009	2005–2012
North Dakota State University	1862	West		2005–2012
Northern Arizona University	NLG	West	1980–2009	2005–2012
Oklahoma State University	1862	South	1980–2009	2005–2012
Oregon State University	1862	West	1980–2009	2005–2012
Purdue University	1862	North Central	1980–2009	2005–2012
Rutgers University-New Brunswick	1862	Northeast		2005–2012
South Dakota State University	1862	West		2005–2012
Southern Illinois University-Carbondale	NLG	North Central	1980–2009	2005–2012
Southern University and A&M	1890	South		2005–2012
Stephen F. Austin State University	NLG	South	1980–2009	2005–2012
SUNY College of Environmental Science and Forestry	NLG	Northeast	1980–2009	2005–2012
Texas A&M University	1862	South		2005–2012
The Ohio State University	1862	North Central	1980–2009	2005–2012
The Pennsylvania State University	1862	Northeast	1980–2009	2005–2012
The University of Montana-Missoula	NLG	West		2005–2012
The University of Rhode Island	1862	Northeast		2005–2012
Tuskegee University	1890	South		2005–2012
University of Alaska-Fairbanks	1862	West		2005–2012
University of Arizona	1862	West		2005–2012
University of Arkansas at Monticello	NLG	South		2005–2012
University of California-Berkeley	1862	West		2005–2012
University of Connecticut	1862	Northeast		2005–2012
University of Delaware	1862	Northeast		2005–2012
University of Florida	1862	South		2005–2012
University of Georgia	1862	South		2005–2012
University of Hawaii at Manoa	1862	West	1980–2009	2005–2012
University of Idaho	1862	West		2005–2012
University of Illinois at Urbana-Champaign	1862	North Central		2005–2012
University of Kentucky	1862	South		2005–2012
University of Maine	1862	Northeast	1980–2009	2005–2012
University of Maryland Eastern Shore	1890	Northeast		2005–2012
University of Massachusetts	1862	Northeast		2005–2012
University of Minnesota-St. Paul	1862	North Central	1980–2009	2005–2012
University of Missouri	1862	North Central		2005–2012
University of Nebraska-Lincoln	1862	North Central	1980–2009	2005–2012
University of Nevada-Reno	1862	West		2005–2012
University of New Hampshire	1862	Northeast		2005–2012
University of Tennessee	1862	South		2005–2012
University of Vermont	1862	Northeast	1980–2009	2005–2012
University of Washington-Seattle	NLG	West	1980–2009	2005–2012
University of Wisconsin-Madison	1862	North Central		2005–2012
University of Wisconsin-Stevens Point	NLG	North Central	1980–2009	2005–2012
University of Wyoming	1862	West	1980–2009	2005–2012
Utah State University	1862	West	1980–2009	2005–2012
Virginia Polytechnic Institute and State University	1862	South	1980–2009	2005–2012
Washington State University	1862	West		2005–2012
West Virginia State University	1890	Northeast		2005–2012
West Virginia University	1862	Northeast	1980–2009	2005–2012

^a 1862, Land Grant; 1890, HBCU (Historically Black Colleges and Universities); NLG, non-Land Grant institutions.

Programs and students

Figures 1–4 show trends in NRC enrollment numbers for undergraduates, master’s students, doctoral students, and total graduate students, respectively. The overall rates of increase

were lower at the graduate level than at the undergraduate level, and as with undergraduates, most of this growth was in interdisciplinary programs, especially NRCM; Forestry decreased and Wood Science/Products remained about the same. These trends are reflected in the proportion of students enrolled in the academic areas in 2012 (Figures 5–8). NRCM accounted for nearly 44 percent of the PhD enrollment—nearly double the proportion at the undergraduate level. Forestry also increased, from about 16 percent of undergraduate enrollment to nearly a quarter of PhD enrollment. Proportional increases in both these academic areas were mostly at the expense of decreasing proportions of Fisheries and Wildlife majors and Recreation majors, and to a lesser extent Environmental Science/Studies majors. Although Wood Science/Products was proportionally highest for PhD students, it still made up only 3 percent of enrollment in NRC. Total graduate enrollment, at about 6,600, was about one fourth that of undergraduate enrollment, about 26,000.

The Blue Ribbon Commission on Forest and Forest Products
 Research & Development in the 21st Century

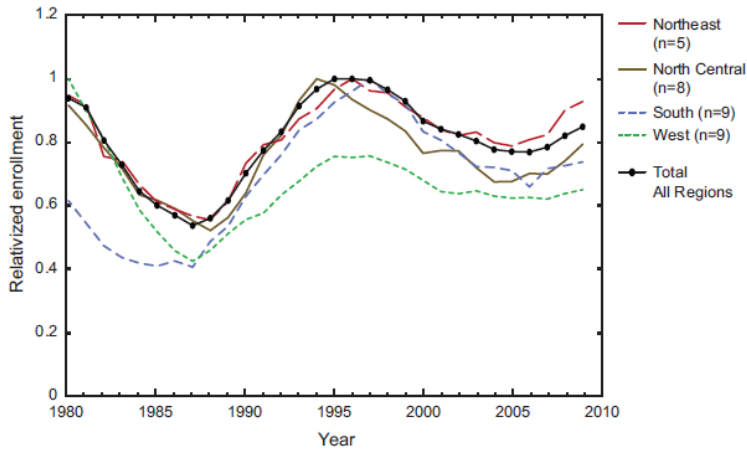


Figure 1. Relativized undergraduate NR enrollment by region for 31 NAUFRP institutions, 1980–2009.

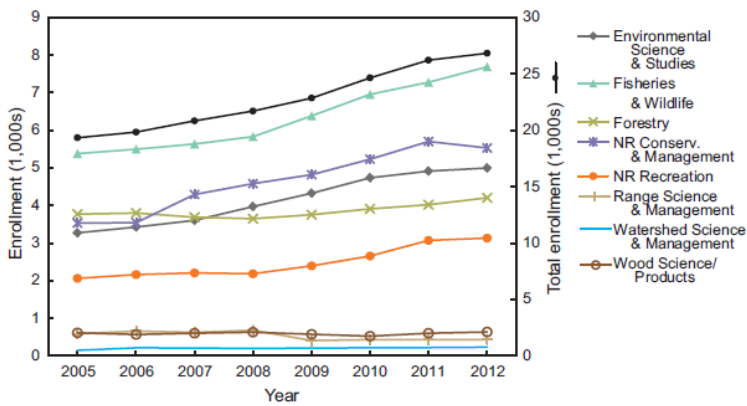


Figure 2. Undergraduate NR enrollment by academic area at 67 NAUFRP institutions, 2005–2012 (FAEIS database, Mar. 9, 2015).

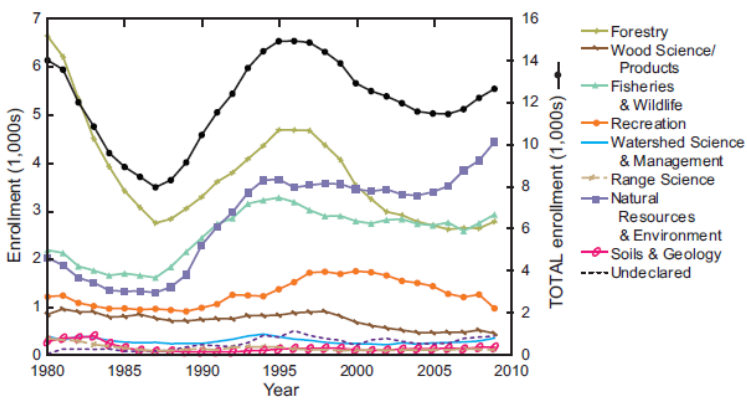


Figure 3. Undergraduate NR enrollment by field of study at 31 NAUFRP institutions, 1980–2009.

The Blue Ribbon Commission on Forest and Forest Products
 Research & Development in the 21st Century

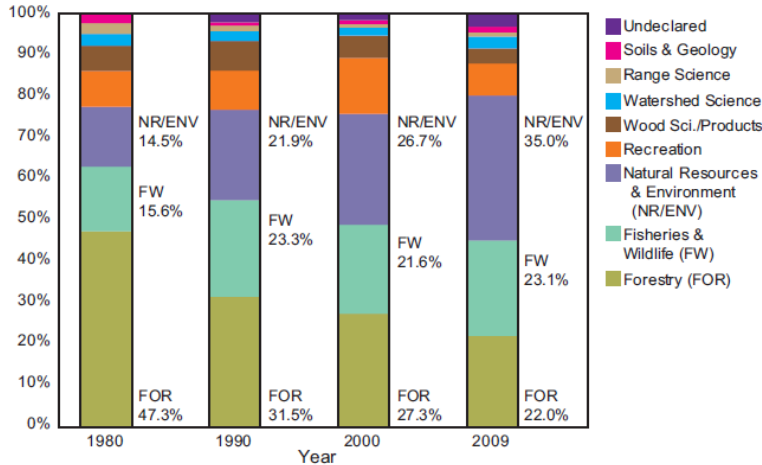


Figure 4. Proportion of undergraduate NR enrollment in various fields of study at 31 NAUFRP institutions for 1980, 1990, 2000, and 2009.

Tables 2 and 3 show natural resources enrollments by gender for undergraduate and graduate students from 2004/05–2012, respectively. In both cases there was a slight increase in the percentage of women over this period. Moreover, the percentage of women graduate students, at 48 percent, was substantially higher than in the undergraduate population, at 41 percent (excluding unknown gender). Indeed, gender balance at the graduate level is approaching that for students averaged across all academic areas nationally.

Table 2. Fields of study for classifying NR degree programs and options at 31 NAUFRP institutions used in the 1980–2009 undergraduate enrollment database.

Field of study	Degree programs and options
Forestry	Forestry, forest science, forest ecosystem science, forest resources, forest management, urban forestry, forest engineering/operations
Wood Science/Products	Wood science, wood products, wood technology, forest products, paper science
Fisheries and Wildlife	
Recreation	Recreation, tourism, parks, interpretation, communications
Watershed Science/Management	Watershed science, watershed management, hydrology
Range Science/Management	Range science, range management, rangeland resources
Natural Resources/Environmental Management	Natural resources management; planning, policy, and economics; environmental management and science; environmental conservation; environmental studies; conservation management; conservation biology; restoration ecology/management; applied ecology; geography
Soils and Geology	
Other	Landscape architecture, GIS, land surveying, spatial science, biotechnology, etc.

The Blue Ribbon Commission on Forest and Forest Products
 Research & Development in the 21st Century

Undeclared

Table 3. Classification of FAEIS Classification of Instructional Programs (CIP) codes into academic areas within Natural Resources and Conservation for aligning with the 1980 – 2009 NAUFRP fields of study categories shown in Table 2.

Academic area	CIP code no.	CIP code title
Fisheries and Wildlife	3.0301	Fishing and Fisheries Sciences and Management
	3.0601	Wildlife, Fish and Wildlands Science and Management
Forestry	26.0709	Wildlife Biology
	3.0501	Forestry, General
	3.0502	Forest Sciences and Biology
	3.0506	Forest Management/Forest Resources Management
	3.0508	Urban Forestry
	3.051	Forest Resources Production and Management
	3.0511	Forest Technology/Technician
	3.0599	Forestry, Other
	14.3401	Forest Engineering
	Natural Resources Conservation and Management	3.0101
3.0199		Natural Resources Conservation and Research, Other
3.0201		Natural Resources Management and Policy
3.0204		Natural Resource Economics
3.0206		Land Use Planning and Management/Development
3.0299		Natural Resources Management and Policy, Other
3.9999		Natural Resources and Conservation, Other
Watershed Science and Management	26.1307	Conservation Biology
	3.0205	Water, Wetlands, and Marine Resources Management
	14.0805	Water Resources Engineering
Natural Resources Recreation	40.0605	Hydrology and Water Resources Science
	3.0207	Natural Resource Recreation and Tourism
	3.0208	NR Law Enforcement and Protective Services
	31.0301	Parks, Recreation and Leisure Facilities Management
Wood Science/Products	31.0399	Parks, Recreation and Leisure Facilities Mgt., Other
	3.0509	Wood Science & Wood Products/Pulp and Paper Technology
Range Science and Management	1.1106	Range Science and Management
Environmental Science and Studies	3.0103	Environmental Studies
	3.0104	Environmental Science
	26.1305	Environmental Biology

When gender differences were examined by academic area in 2012 (Tables 4 and 5), the same general rankings were seen at both undergraduate and graduate levels: the interdisciplinary areas (Environmental Science/Studies and NRCM) had the highest percentage of women, and Forestry and Wood Science/Products, the lowest. The fact that the interdisciplinary programs appeared to attract more women than did Forestry and Wood Science/Products may explain in part why the former are increasing in student enrollment at a faster (Figures 1–4). However, a word of caution is in order: more recent unpublished data and anecdotal information suggest that enrollments in Wood Science/Products have increased substantially since 2012 because these programs have emphasized bio-based products and sustainability. Moreover, the percentage of

women in the overall student population has increased (Goodell 2013; R. Smith, personal communication).

Tables 6 and 7 present natural resources enrollments by race and ethnicity for undergraduate and graduate students from 2004/05–2012, respectively. Over this period, the number of undergraduate domestic minority students more than doubled, while the number of graduate minority students increased by three fourths. In 2012, the percentage of domestic minorities was higher in undergraduate programs, at 12.4 percent, than in graduate programs, at 11.4 percent (excluding non-U.S. students and two or more races). This is in contrast to the gender ratios above, where the percentage of women was higher at the graduate level. Also noteworthy is that international graduate students outnumber domestic-minority graduate students.

Examined by academic area in 2012 (Tables 8 and 9), racial and ethnic differences at the undergraduate and graduate levels were substantial. At the undergraduate level, among the eight academic areas recognized, the interdisciplinary areas (Environmental Science/Studies and NRCM) ranked first and second in the percentage of minority students, Wood Science/Products was fourth, and Forestry sixth. At 13.7 percent, Wood Science/Products was approaching the average; Forestry was below average. At the graduate level, Range ranked first, followed by the interdisciplinary areas and Forestry; Wood Science/Technology was last. Forestry was slightly above the average for all eight academic areas while Wood Science/Technology was substantially below the average.

Taking a closer look at minority students in natural resources, at the undergraduate level we find that Hispanics accounted for the highest number of minority students, followed by Asian, Blacks, and Native Americans, in that order. Recreation programs attracted more Blacks, and Wood Science/Products had more Asian students. At the graduate level, the proportions of minority students were slightly different: Hispanics were most numerous, then Blacks, followed by Asians and Native Americans. Blacks were drawn to programs in Environmental Science/Studies, Forestry, and Recreation. Wood Science/Products, while having the lowest percentage of domestic minorities, had by far the highest percentage of international students, at 64 percent.

Research pipeline

The implications of enrollment trends for research capacity in the natural resources profession, and for Forestry and Wood Science/Products in particular, are not easily discernible. For one thing, good data on demand for graduates, especially those with advanced degrees, are lacking. What data we have at the undergraduate level suggest that supply may be outstripping demand by a factor of 25 to 1 (Sharik et al. 2015). Supply and demand information at the level of subdisciplines (e.g., forest biometrics, forest biology, and forest management, all in the academic area of Forestry) are also lacking.

Diversity is another matter, however: we know that the demand far outstrips the supply (Sharik 2015). The future looks much brighter for women in the natural resources workforce than for domestic minority men, although even here there are greater challenges for Forestry and Wood Science/Products than for other academic areas.

The higher enrollments in interdisciplinary areas compared with Forestry, especially in NRCM at the graduate level, may ultimately not affect future forestry research because academic institutions are rebranding themselves in response to changing societal values and the preferences of potential students. Whereas in the past a student desiring to be a natural resources economist or a management specialist in forest ecosystems might have pursued degree work in forestry, he or she may now enroll in a natural resources program whose faculty serve the needs of all natural resources professions—not just forestry but also fisheries and wildlife, recreation, range, and watershed science and management. A further complication in assessing supply and demand is that some natural resources researchers may be formally educated in the basic sciences outside NRC academic programs.

Terry L. Sharik

School of Forest Resources and Environmental Science

Michigan Technological University

References

Goodell, B. 2013. Greener academics: The evolution of wood science programs at universities in the U.S. *Engineered Wood Journal* 16(2): 36–39.

Sharik, T.L. 2015. Strategies for diversifying student demographics in natural resources. *Journal of Forestry* 113(6) : 579–80.

Sharik, T.L., R.J. Lillieholm, W.W. Richardson, and W.E. Lindquist. 2015. Undergraduate enrollment in U.S. natural resource academic programs: Trends, drivers, and implications for the future of the profession. *Journal of Forestry* 113(6): 538–51.