Citations, Publications, and Perceptions-Based Rankings of the Research Impact of North American Forestry Programs

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ABSTRACT

Using the online citation service available through the Institute for Scientific Information and publication records, we constructed rankings of 53 North American forestry programs based on (1) total citations to the scholarly contributions of current faculty, (2) citations per research faculty member, (3) total number of publications in five top forestry journals, (4) total number of pages, (5) total number of publications per research faculty member, and (6) total number of page per research faculty member, from January 1997 to December 2001. We then compared these results against a ranking of the top forestry schools, based on perceived research profile, as indicated by survey responses from deans and department heads.

Keywords: program rankings, research impact, citations, publications, forestry programs

In a 2000–2001 college football bowl game, a promotional clip for a university claimed that its forestry program was the second best in the United States. Ignoring for the moment the issue of how "best" was defined, we found this claim eye-opening because we are aware of little-to-no basis for it. Unlike other disciplines such as economics, which have well-established institutional rankings of academic programs (Davis and Papanek 1984, Laband 1985, Bairam 1994, Scott and Mitias 1996, Dusansky and Vernon 1998, Thursby 2000), we are aware of no peer-reviewed rankings of forestry programs, certainly not within the past 10 years. *The Gourman Report: A Rating of Undergraduate Programs in American and International Universities* (Gourman 1996) did not cover forestry for many years and was controversial even when it covered forestry programs because it did not reveal the criteria it used to rank these programs.[1]

Such rankings serve a variety of purposes, depending on the criteria used to develop the ranking. Our goal was to develop a ranking of North American forestry programs based on established research performance of the faculty. Such a ranking will be of interest to prospective graduate students hoping to develop their research skills and to postgraduate students seeking an academic career that includes a research emphasis. In addition, such a ranking may help employers of forestry students economize on information costs with respect to the relative caliber of the academic programs whose graduates they are interviewing. Likewise, such a ranking also may convey useful information to demanders of research services produced by academic scholars (in the form of technical analyses, expert witness services, and a variety of other professional consulting services) regarding where to find desired expertise.

The principal criteria used to indicate the research profile enjoyed by an academic program include (1) surveys of department heads regarding their perceptions of the "quality" of each program included in the survey (Thursby 2000), (2) faculty publications in a specified set of scientific journals over a defined period of time (Graves et al. 1982, Laband 1985, Scott and Mitias 1996, Dusansky and Vernon 1998), and (3) citation counts (Gerrity and McKenzie 1978, Rushton and Roediger 1978, Davis and Papanek 1984).[2] Publication counts measure potential impact on the scientific commu-

[1] The Introduction to the 9th edition (1996) identifies 18 general criteria that "are taken into consideration" (p. 2). This is followed immediately by the disclaimer that ". . . because different disciplines vary in their educational methodology, the significance given each criterion will vary from the rating of one discipline to the next; however, our evaluation is consistent for all schools listed within each field of study." No specific information about the construction of the rankings of undergraduate forestry programs is provided.

[2] In their unpublished analysis, Thompson and Koenig (1984) rank Society of American Foresters–accredited forestry programs on the basis of program head percep-

nity, whereas citations are a measure of the actual impact of an individual's contributions on the scientific community and recently have been made available through the Institute for Scientific Information's (ISI) online service (Web of Knowledge; ISI 2005). Because citations can be attributed correctly to each author of a coauthored article, they have become the standard mechanism for constructing rankings of academic journals (Leibowitz and Palmer 1984, Laband and Piette 1994) and provide a compelling means of ranking the research profile of academic units and individuals (Roche and Smith 1978).

In this article, we provide rankings of North American forestry programs, based on citations (identified by the ISI's [2005] online citation data bases), to scholarly articles published by their faculty and on publications in five top forestry journals. Then, we examine how consistent the citations-based and publications-based rankings are with a ranking of the top forestry programs based on responses by deans and department heads to a survey asking about their perceptions of the research profile of each school. Oregon State University is indicated by deans and department heads as the institutional location of the top forestry program in North America (in terms of research profile), which matches our findings from analysis of the total citations impact of the research produced by faculty in North American forestry programs. However, citations per research faculty-based rankings are different from the total citation-based ranking. Similarly, publications per research faculty-based rankings are different from total publications-based rankings. The next section describes our definition of forestry faculty and methodology, followed by findings. The final section presents some caveats and final qualifications to this research.

Methodology

A recently published *Dictionary of Forestry* (Helms 1998) defines forestry as "the profession embracing the science, art, and practice of creating, managing, using, and conserving forests and associated resources for human benefit, and in a sustainable manner to meet desired goals, needs, and values." As the profession evolves in responding to societal demands, diverse forest education programs emerge in universities and colleges across North America (Miller and Lewis 1999, Sample et al. 2000).

Our sample of forestry programs included the Society of American Foresters accredited forestry programs in universities in the United States and Canadian Forestry Accreditation Board accredited forestry programs in universities across Canada where English is the official instructional language. There were 47 US programs, as reported in the September 1999 issue of the *Journal of Forestry*, plus six additional programs based in Canadian universities: Lakehead University, the University of Alberta, the University of British Columbia (UBC), the University of New Brunswick, the University of Northern British Columbia, and the University of Toronto, for a total sample size of 53.[3] We obtained the names of program faculty current to Feb. 1, 2002 from each institution's website and then confirmed the accuracy of our faculty rosters via correspondence with program heads, directors, and deans. Our response rate for accuracy check of forestry faculty rosters was 100%.

Because forestry schools and departments are relatively heterogeneous in terms of programmatic composition and include many subdisciplines, we debated at length on the criteria to apply when defining forestry faculty for the purpose of inclusion in our analysis. To make our task manageable and our definition of forestry consistent across programs, we decided to focus our analysis narrowly on four subdisciplines of forestry faculty—forest science/biology, forest operations, forestry-related social sciences, and wood products.[4] Forest science/biology includes forest biology, forest ecology, forest pathology and entomology, tree physiology, tree genetics, forest soils, forest biometrics, forest measurement, geographic information systems, remote sensing, timber procurement, fire, and urban forestry. Forest operations cover timber harvesting, forest engineering, road design and construction, and mapping. Forest-related social sciences cover forest economics, finance, management, business, policy, law, and sociology. Wood products include wood science, wood chemistry, wood processing, wood engineering, wood composites, sawmill management, and forest products marketing. We did not include faculty listed in fisheries, wildlife, park management, and paper science.[5]

Because we were interested in the research profile of each institution, what we wanted ideally was the number of full-time employees (FTE) who were members of the forestry faculty in each institution. To adjust for the fact that most faculty have split appointments, in fall 2004 and spring 2005 we obtained the average percentage research appointment for each program in 2002. We then used it to get the average number of citations and average number of publications for a program. In other words, we created a research-appointment weighted citation/publication index for each FTE in forestry research. Furthermore, we included forestry faculty who may have a joint appointment with a nonforestry department/program as long as their forestry-related appointment was 50% or more. In other words, we excluded faculty whose forestry-related appointment was less than 50% of their workload.

Most accredited forestry programs (at least 35 in the United States and 1 in Canada) include extension faculty, and most extension faculty have split appointments (research or teaching). We included extension faculty that had formal extension appoint-

tions, total publications in 1982, publications per faculty, and publications of graduates.

[3] The majority of these institutions offer bachelors, masters, and doctorate degrees. Some only offer bachelors degrees. Three institutions (Duke University, Yale University, and the University of Toronto) only offer masters and doctoral degrees. Although the forestry program at the University of Vermont has not been accredited since 2003, it was accredited in 2002. In contrast, Alabama A&M University has been accredited since 2003. The University of Michigan was accredited in 2002 but had not had an active forestry class for several years before 2002. Because our faculty rosters were developed in the spring of 2002, we included Vermont but excluded Alabama A&M and Michigan. The two French-speaking forestry programs—in Laval Université and Université du Moncton—were excluded as well.

[4] Most forestry programs have one or a few wood products faculty, and nine institutions have a wood products program accredited by the Society of Wood Science and Technology. Including wood products as part of a forestry program is consistent with the traditional view of forestry education—forestry students need to have some knowledge of wood products.

[5] With the exception of North Carolina State University, the University of Minnesota, and the University of Washington, paper science and manufacturing programs are not part of forestry departments and schools in North American universities. Excluding paper science faculty from this study makes our database manageable. The same logic is used in excluding wildlife faculty although forest resources cover wildlife.

ments for the same reason we included teaching faculty. Other accredited forestry programs in Canada and the United States do not have any extension faculty per se, but some faculty members at these institutions provide extension and outreach services. However, we did not include extension faculty who are county and regional extension specialists.[6]

Finally, we included only tenured/tenure-eligible or permanent faculty, not nontenure-track lecturers, research associates, research scientists, associate research scientists, postdocs, research fellows, senior research fellows, adjunct professors, affiliated professors, visiting professors, professors emeritus, and undergraduate program directors or faculty on less than 50% appointments within the forestry program. These nontenure-track faculty could have made contributions to the research programs at an institution. However, these faculty are relatively more mobile and unstable, and their impact is less clear and less direct than tenured or tenure-track faculty. We included in our sample individuals (typically extension faculty) who were not tenured or tenure eligible but who nonetheless were in permanent positions.

We obtained citation counts for each faculty member by using the ISI's (2005) online citation service, with the citation searches covering all three available databases: the *Science Citation Index*, the *Social Science Citation Index*, and the *Arts and Humanities Index*. For each individual, we recorded citation counts covering the 5-year period 1997–2001[7]; i.e., we identified all ISI-indexed citations accorded to a specific individual during the noted time period to publications he or she had produced at any time previously. For any given individual, a single citation search was conducted, based on his or her last name and *all* initials.[8] This is by no means an exhaustive list of all citations to each individual's previous scientific contributions. Rather, it is a list of only those citations that appeared in journals indexed by the ISI. At the time we were collecting the citations for this study, several forestry journals—notably, *Northern Journal of Applied Forestry*, *Southern Journal of Applied Forestry*, *Western Journal of Applied Forestry*, *Journal of Forest Economics*, and *Forest Economics and Policy*—were not being indexed by the ISI. However, because the ISI indexes over 8,000 periodicals, including all major scientific journals, we are confident that our citation counts capture the vast majority of the scientific community's response to each individual's scientific contributions. In addition, although our methodology may understate a specific individual's true scientific impact, there is no reason to believe that this undermeasurement is biased across programs.

We then identified all research articles published in *Forest Science*, the *Canadian Journal of Forest Research*, *Forest Ecology and Management*, the *Forest Products Journal*, and the *Journal of Forest Engineering* as well as their author(s) and total number of pages for each article from 1997 to 2001. Arguably, these are the top five forestry journals that match our four broad disciplines, even though we did not include any forestry-related social science journals. For each article with multiple authors, we assigned an equal weight ($1/n$), where n = number of authors, to determine the contribution of each author. For each author of these articles who was on one of our forestry faculty rosters, we compiled his or her total number of publications as well as total number of pages (in this set of forestry journals). Finally, we compiled the total number of publications and the total number of pages for each program.

Our perceptions-based ranking was done via a survey of 53 forestry deans, directors, and department heads in North America. In July 2002, we sent out a two-page survey (with a short explanation and a list of all 53 forestry programs in alphabetical order) via e-mails and faxes to these program leaders. We followed up with two phone calls, one after 2 weeks of initial e-mails and faxes, and another after 4 weeks of initial e-mails and faxes. In the survey, we asked for the program leaders' ranking of these programs based on "perceived quality of research and eminence of research faculty." We stressed this rank should be based on forestry research only (not teaching, extension, or outreach, even though most forest programs have faculty and teaching and extension appointments). We only collected 18 responses, representing a response rate of 34%. Some 10–12 additional respondents declined to participate, based on their sense of having incomplete information about other programs or their belief that such a ranking would not provide meaningful information or positive results for their programs.

Findings

Our citations-based ranking of the relative research impact of North American forestry programs is reported in Table 1. Programs are ranked in terms of total citations; we also identify the citations per research faculty member for each program, during the period in question. Table 2 presents our ranking of forestry programs based on publications.

We found that most of the top 25 programs in terms of total citations are in states or provinces that have rich forest resources such as the Pacific Northwest, US South, and the northern United States. The top 10 ranked programs are located at Oregon State University, Duke University, the University of Washington, the UBC, the University of Wisconsin–Madison, University of New Hampshire, North Carolina State University, the University of Minnesota, Michigan Tech, and the University of Alberta.

The total citations-based ranking conveys useful information about the collective research expertise available in each program. However, this ranking likely reflects, in part, the sheer number of faculty in a program. The ranking based on citations per research faculty eliminates the potential bias associated with faculty size in a program. Comparing the ranking based on per research faculty citation (column 7 in Table 1) with that based on total citations is revealing in several respects. First, six programs are consistently on the top 10 in both rankings—Washing-

[6] Two universities—Texas A&M University and University of New Hampshire—do not grant tenure to extension faculty who often have 100% extension appointment. To make our database comparable, we included extension faculty from these two universities and extension faculty in other institutions who might have a 100% extension appointment in our database. An institution could assign a faculty with 100% extension or teaching and let other faculty do more research. If we exclude faculty with 100% teaching or extension from our database, institutions with split faculty appointment would be put at a disadvantage.

[7] The online citation service permitted identification (and use) of citations to *all* authors of an article, unlike the hard copy citation indexes that identify citations by first author only.

[8] Thus, our citation counts underreport the true impact of an individual who routinely published using one initial only. If the tendency of individuals to publish using different sets of initials than the ones reported on departmental/school websites varies significantly across the institutions we examined, our findings may be biased. However, it seems unlikely to us that there is significant variation across institutions with respect to this tendency.

Table 1. Citations-based rankings of North American forestry programs.

Program location	Total citations	Rank based on total citations	Number of faculty	Average research appointment	Citations per research faculty*	Rank based on per research faculty citation	Two-faculty concentration ratio (%)	Five-faculty concentration ratio (%)**
Oregon State University	6,026	1	62[a]	0.85	114.3	28	25.3	49.5
Duke University	5,144	2	13[c]	n/a	n/a	n/a	47.9	n/a
University of Washington	4,360	3	28[d]	0.33	471.9	3	50.7	73.3
UBC	3,945	4	50[b]	0.38	207.6	12	25.9	47.1
University of Wisconsin–Madison	3,746	5	19[e]	0.56	352.1	4	36.7	66.7
University of New Hampshire	3,406	6	14[j]	0.50	486.6	2	70.8	n/a
North Carolina State University	3,346	7	45	0.50	148.7	19	35.7	58.7
University of Minnesota	3,329	8	33[g]	0.45	224.2	9	56.1	77.8
Michigan Tech	2,651	9	14[f]	0.36	526.0	1	43.2	n/a
University of Alberta	2,232	10	22	0.42	241.6	7	35.0	64.6
University of Florida	2,127	11	26	0.56	146.1	21	36.3	64.6
University of Montana	2,110	12	26	0.41	197.9	13	72.7	84.6
Virginia Tech	2,041	13	40	0.39	130.8	24	27.9	51.3
University of Georgia	1,916	14	30	0.46	138.8	22	34.7	60.8
Michigan State University	1,720	15	20	0.52	165.4	15	47.9	78.3
University of California–Berkeley***	1,606	16	21[h]	n/a	n/a	n/a	32.3	56.0
Pennsylvania State University	1,596	17	22[i]	0.45	161.2	16	42.5	69.3
Colorado State University	1,532	18	17	0.40	225.3	8	59.3	79.0
Northern Arizona University	1,394	19	19	0.29	253.0	6	50.7	85.6
Utah State University	1,387	20	16	0.44	197.0	14	33.7	70.0
Auburn University	1,193	21	23	0.56	92.6	35	23.1	53.5
University of Massachusetts	1,186	22	13[k]	0.33	276.5	5	52.0	n/a
University of Idaho	1,076	23	27[n]	0.41	97.2	34	36.6	59.7
University of Toronto	1,053	24	16	0.45	146.3	20	38.2	74.0
Washington State University	1,031	25	14	0.33	223.2	10	54.0	n/a
University of Maine	1,018	26	25	0.49	83.1	36	32.3	63.6
Iowa State University	949	27	14	0.45	150.6	18	48.4	n/a
University of New Brunswick	947	28	22	0.36	119.6	26	34.3	67.9
University of Missouri	893	29	15	0.46	129.4	25	49.9	72.8
University of Illinois	871	30	7	0.57	218.3	11	76.0	n/a
Clemson University	852	31	25[m]	0.60	56.8	39	42.5	74.1
Yale University	845	32	11[l]	0.50	153.6	17	46.2	n/a
SUNY–Syracuse	806	33	30	0.20	134.3	23	42.1	67.4
Mississippi State University	727	34	40[p]	0.52	35.0	46	26.1	50.9
University of Vermont	724	35	14	0.45	114.9	27	52.5	n/a
University of Kentucky	713	36	12	0.52	114.3	29	51.2	n/a
Texas A&M	668	37	17[o]	0.55	71.4	37	59.0	91.8
Purdue University	564	38	16	0.32	110.2	31	45.0	79.1
LSU	440	39	16	0.60	45.8	41	41.8	81.6
University of Northern British Columbia	419	40	9	0.44	105.8	33	66.1	n/a
University of Alaska	389	41	7	0.52	106.9	32	74.8	n/a
Oklahoma State University	302	42	13	0.54	43.0	42	46.4	n/a
Lakehead University	297	43	14[q]	0.42	50.5	40	45.1	n/a
University of Arkansas	262	44	10	0.45	58.2	38	77.9	n/a
University of Tennessee	235	45	14	0.47	35.7	45	52.8	n/a
Stephen F. Austin University	229	46	17[r]	0.37	36.4	44	39.3	71.2
Humboldt University	168	47	10	0.15	112.0	30	61.9	n/a
West Virginia University	151	48	11	0.35	39.2	43	32.5	n/a
Southern Illinois University	134	49	10	0.45	29.8	48	65.7	n/a
Louisiana Tech	80	50	10	0.26	30.8	47	58.8	n/a
Ohio State University	69	51	6	0.46	25.0	49	94.2	n/a
University of Wisconsin–Stevens Pt.	59	52	11[s]	0.00	n/a	n/a	55.9	n/a
Cal Poly San Luis Obispo	28	53	9	0.38	8.2	50	67.9	n/a

*Total no. of citations/no. of faculty/average research appointment.
**Only applies to institutions with 15 or more forestry faculty.
***Did not respond for our repeated request for an average research appointment for their faculty.
[a] Excluding 14 county or regional forest extension agents.
[b] Excluding two wildlife faculty and two aquatic ecology and stream-riparian ecosystems faculty.
[c] Our correspondent at Duke University indicated that these faculty are involved in forest-related teaching and research. Most of these faculty list ecology, tropical ecology, biology, and environmental policy as their primary area of interests on their web pages. Although we are doubtful that all these faculty have at least 50% of their workload as forestry-related appointment, which is our definition of forestry faculty, we had to use the list of faculty provided by our correspondent. One internal and several reviewers thus indicated that Duke University is an outlier in this study. Thus, we did not pursue the average research appointment and the per research faculty-based ranking in both citations and publications
[d] Excluding three wildlife faculty and six paper science faculty.
[e] Including two USDA employees who are tenured at this institution.
[f] Excluding two wildlife faculty and one policy faculty who has 33% appointment in forestry.
[g] Excluding two paper scientists.
[h] Including three faculty who list rangeland ecology and management as their first areas of interest and whose forestry-related appointment is 50% percent or more, according to the correspondent at this institution.
[i] Include one tenured lecturer who was reclassified as assistant professor shortly after Feb. 1, 2002.
[j] Include three forestry extension specialists who have a 100% extension appointment and are not eligible for tenure.
[k] Excluding five wildlife biologists.
[l] Excluding all faculty in environmental sciences.
[m] Excluding four wildlife faculty.
[n] Excluding a university vice president whose academic unit is in forest products department.
[o] Including three forest extension specialists who have a 100% extension appointment and are not eligible for tenure.
[p] Including one research associate professor who has tenure.
[q] Excluding two wildlife management faculty.
[r] Excluding one wildlife management faculty.
[s] Excluding the Dean of Natural Resources. Because our correspondent indicated the average research appointment is zero for their faculty, no per research faculty-based citations and publications are generated.
n/a, Not available.

Table 2. Publication-based rankings of North American forestry programs.*

Program location	Total no. of publications	Rank based on total no. of publications	Total no. of pages	Rank based on total no. of pages	Publications per research faculty	Rank based on per research faculty publications	Pages per research faculty	Rank based on pages per research faculty
Oregon State University	48.47	1	419.60	1	0.92	24	7.96	25
Virginia Tech	34.37	2	293.60	3	2.20	2	18.82	1
UBC	31.02	3	298.09	2	1.62	7	15.61	5
University of Minnesota	23.63	4	132.04	6	1.59	8	8.89	21
Auburn University	21.24	5	171.36	4	1.65	6	13.30	8
Louisiana State University	19.92	6	122.64	8	2.07	3	12.78	10
University of Alberta	16.82	7	164.15	5	1.82	4	17.77	2
North Carolina State University	14.03	8	127.76	7	0.63	32	5.72	29
University of Georgia	13.90	9	117.56	11	1.02	19	8.61	22
University of Maine	13.89	10	81.34	19	1.14	16	6.68	27
Pennsylvania State University	13.82	11	109.31	13	1.40	11	11.04	15
University of Florida	12.80	12	120.37	10	0.88	26	8.27	23
Mississippi State University	12.18	13	70.58	22	0.59	33	3.39	42
University of Washington	12.12	14	113.19	12	1.31	14	12.25	12
Michigan State University	10.70	15	83.35	18	1.03	18	8.01	24
University of Wisconsin–Madison	10.65	16	121.65	9	1.00	20	11.43	14
University of Idaho	10.00	17	106.17	14	0.90	25	9.59	18
West Virginia University	9.15	18	65.42	24	2.38	1	16.99	3
Purdue University	8.62	19	63.57	26	1.69	5	12.45	11
University of California–Berkeley***	8.28	20	84.47	17	n/a	n/a	n/a	n/a
SUNY–Syracuse	8.19	21	93.38	16	1.36	12	15.56	6
Yale University	8.12	22	101.50	15	1.35	13	16.92	4
Colorado State University	7.79	23	75.17	20	1.22	15	11.74	13
University of New Brunswick	7.58	24	72.92	21	0.96	22	9.23	20
University of Montana	7.28	25	63.03	27	0.68	30	5.91	28
University of Northern British Columbia	7.00	26	63.92	25	1.43	10	13.09	9
University of Arkansas	6.97	27	62.33	28	1.55	9	13.85	7
University of New Hampshire	6.45	28	67.48	23	0.92	23	9.64	17
Clemson U.	6.33	29	59.50	29	0.42	40	3.97	37
Northern Arizona University	5.35	30	57.62	30	0.97	21	10.46	16
Michigan Tech	5.23	31	48.15	31	1.04	17	9.55	19
University or Toronto	5.14	32	36.39	33	0.76	28	5.39	31
Oklahoma State University	4.67	33	40.17	32	0.66	31	5.71	30
University of Illinois	3.39	34	26.89	36	0.85	27	6.74	26
Southern Illinois University	3.08	35	22.00	40	0.69	29	4.89	32
University of Missouri	2.95	36	27.15	35	0.43	39	3.92	38
Stephen F. Austin University	2.92	37	22.58	39	0.44	37	3.41	41
University of Kentucky	2.79	38	23.88	37	0.45	36	3.86	39
Iowa State University	2.48	39	13.21	45	0.39	41	2.10	46
Lakehead University	2.25	40	20.83	41	0.38	42	3.52	40
University of Massachusetts	2.00	41	18.50	42	0.51	35	4.67	33
Duke University	1.89	42	28.04	34	n/a	n/a	n/a	n/a
Texas A&M	1.62	43	15.42	44	0.17	48	1.65	47
University of Alaska	1.58	44	16.42	43	0.43	38	4.51	34
Utah State University	1.58	45	23.08	38	0.23	46	3.29	43
Louisiana Tech	1.48	46	11.12	46	0.57	34	4.28	35
University of Tennessee	1.37	47	10.80	48	0.21	47	1.64	49
Washington State University	1.23	48	7.57	51	0.27	45	1.65	48
Ohio State University	1.00	49	11.00	47	0.36	43	3.99	36
University of Wisconsin–Stevens Pt.	0.84	50	8.43	50	n/a	n/a	n/a	n/a
Cal Poly San Luis Obispo	0.58	51	9.00	49	0.17	49	2.63	44
Humboldt University	0.33	52	3.00	52	0.28	44	2.50	45
University of Vermont	0.25	53	2.25	53	0.04	50	0.36	50
Average	0.93	8.10						

*Only five top forestry journals are covered. See text.
**Total no. of publication/no. of faculty/average research appointment. pages per research faculty are calculated in similar way.
***Did not respond for our repeated request for an average research appointment for their faculty.
n/a, Not available.

ton (3rd and 3rd), University of Wisconsin–Madison (5th and 4th), New Hampshire (6th and 2nd), Minnesota (8th and 9th), Michigan Tech (9th and 1st), and Alberta (10th and 7th). The four other top 10 programs based on per research faculty citations are Massachusetts (5th), Northern Arizona University (6th), Colorado State University (8th), and Washington State University (10th; excluding Duke and University of California–Berkeley). Second, three of the top 25 ranked programs based on total citations are not in the top 25 based on per faculty citations. Finally, some 15 programs are in the bottom in both rankings.

Table 1 also presents the top two and top five faculty concentration ratios, which are defined as the percentage of a program's

Table 3. Perceptions-based ranking versus citation- and publication-based rankings of the 25 top North American forestry programs.

Program location	Perceptions-based composite score	Rank	Citations- and publications-based index	Rank
Oregon State University	4.15	1	80	8
Virginia Tech	6.00	2	45	3
North Carolina State University	6.05	3	102	13
University of Georgia	8.10	4	97	10
University of Washington	10.30	5	58	5
University of Minnesota	10.50	6	56	4
SUNY—Syracuse	12.15	7	111	19
UBC	13.25	8	33	1
University of Florida	15.30	9	103	14
Pennsylvania State University	16.20	10	83	9
Auburn University	16.65	11	79	7
Colorado State University	18.40	12	97	10
Michigan State University	18.80	13	105	16
University of Maine	19.30	14	134	24
University of Wisconsin—Madison	19.55	15	68	6
Clemson University	19.95	16	@	@
Purdue University	20.20	17	130	22
Mississippi State University	20.50	18	@	@
Texas A&M	20.90	19	@	@
Duke University	21.45	20	@	@
Uale University	22.20	21	@	@
University of California—Berkeley	22.50	22	@	@
University. of Montana	22.75	23	135	25
University of Idaho	25.05	24	131	23
LSU	27.50	25	107	17
University of Alberta	#	#	35	2
University of New Hampshire	#	#	99	12
Michigan Tech	#	#	108	18
Utah State University	#	#	116	20
Northern Arizona University	#	#	122	21

@, These programs ranked among the top 25 in terms of perceptions, but not in terms of our composite citations/publications index; #, these programs ranked among the top 25 in terms of our composite citations/publications index, but not in terms of perceptions.

total citations accorded to the top two (five) faculty with the most citations. The top five faculty concentration ratio was applied only to programs with 15 or more faculty. These measures reveal information on the effect of "superstar" faculty and on the distribution of individual contributions to research. The top two faculty concentration ratios range from 23 to 94%, with a mean of 48.2%. The top five faculty concentration ratios range from 47 to 92%, with a mean of 68.1%. These results, which we also observe with respect to publications, show that in a number of instances a few highly productive individuals make significant contributions to the research profile of a forestry program. We view this as completely normal. It does suggest, however, that the rankings we have produced may be sensitive to the movement of individuals from one program to another, faculty retirements, and the like.

The top-10 ranked programs based on total number of publications in the five forestry journals are Oregon State, Virginia Tech, UBC, Minnesota, Auburn, Louisiana State University (LSU), Alberta, North Carolina State, Georgia, and Maine (Table 2). The top 10 ranked programs based on total number of pages published in these journals are similar to those based on total number of publications—only Georgia and Maine dropped out (to 11th and 19th, respectively) and Wisconsin–Madison and Florida (to 9th and 10th) moved in. The top 25 programs and the bottom 15 programs based on these two ranking methods are similar (Table 2).

In contrast, the top 10 and top 25 programs are somewhat different when ranking is based on total number of publications per research faculty and total number of pages per research faculty in the five forestry journals. The top 10 programs based on total number of publication per research faculty member are West Virginia, Virginia Tech, LSU, Alberta, Purdue, Auburn, UBC, Minnesota, Arkansas, and Northern British Columbia. The top 10 programs based on total number of pages (published in the five journals) per research faculty are Virginia Tech, Alberta, West Virginia, Yale, UBC, State University of New York (SUNY), Arkansas, Auburn, Northern British Columbia, and LSU. The order of top 25 programs based on these two ranking methods is quite different from the total number of publications and total number of pages. On the other hand, the bottom 15 programs seem to be at the bottom no matter which publication-based ranking method is used.

If these six ranking methods measure "objectively" parts of the research impacts of each forestry program in North America, a composite index that covers all these rankings may present a broader picture. To this end, we created such an index by adding all the rankings of each program based on these six methods—the program with the lowest score in the composite index is the highest ranked—and presented the top 25 in Table 3.

In Table 3 we also identify the top 25 forestry programs in North America, based on responses received from 18 of the 53 program heads and deans. These responses are purely ordinal (i.e., the top program was given a value of 1, the second-best program received a score of 2, and so on). Although our response rate is low, it may be revealing to provide at least some evidence of the degree to which the subjective ranking presented in Table 3 is (in)consistent with the objective ranking presented in Tables 1 and

2 (and the citations- and publications-based index represented in Table 3).

There are notable differences between the objective rankings based on citations or publications and the subjective ranking, with respect to identifying the top research programs. Nonetheless, 7 of the top 10 programs appear in both rankings: Oregon State (1st and 8th, respectively), Virginia Tech (2nd and 3rd), Georgia (4th and 10th), Washington (5th and 5th), Minnesota (6th and 4th), UBC (8th and 1st), and Penn State (10th and 9th). Three programs that are in the top 10 objective ranking but not in the top 10 subjective ranking are Alberta (2nd and 40th), Wisconsin–Madison (6th and 15th), and Auburn (7th and 11th). Three programs that are in the top 10 subjective ranking but not in the top 10 objective ranking are North Carolina State (3rd and 13th), Florida (9th and 14th), and SUNY (7th and 19th).

Variations also are apparent between the objective and the subjective rankings of the top 25 programs. Five programs that do not show up in the perceptions-based top 25 rankings are among the top 25 in citations- and publications-based rankings. They are Alberta (2nd), New Hampshire (12th), Michigan Tech (18th), Utah State (20th), and Northern Arizona (21st). Thus, the citations- and publications-based appraisal of established research performance identifies Alberta (40th in perceptions-based rankings), New Hampshire (46th), Michigan Tech (26th), Utah State (29th), and Northern Arizona (34th) as having achievement in excess of their reputation. On the other hand, Clemson, Mississippi State, and Texas A&M are not among the top 25 based on citations and publications rankings.

Although we are reluctant to draw strong conclusions from the admittedly small sample of respondents that form the basis for the subjective ranking, it does seem safe to conclude that perceptions may not always be well grounded in reality.

Final Thoughts and Caveats

We have developed a research-based ranking of North American forestry programs based on the likely impact of the research produced by faculty at each school of the scientific community, as measured by the citation record and publications in five top forestry journals. We recognize that citations by other scholars and publications in the five journals constitute a limited set of the possible measures of research productivity. We did not consider impacts that result from books published, papers presented, students graduated, patents granted, products developed, and businesses established. However, we think it is reasonable to suggest that these (and perhaps other) measures of faculty research output likely are highly (positively) correlated with publications and citations. If so, then even though our rankings are based on only two of several possible measures of research performance, they arguably would be highly consistent with rankings based on a wider spectrum of research outputs.

Our rankings are based on a single point-in-time snapshot of research faculty and their publications and citations by others. Thus, with changes over time in faculty rosters (and especially the emergence and disappearance of "superstar" faculty), our rankings might exhibit change as well. To pursue any meaningful sample of citation information necessarily requires that the faculty snapshot be somewhat dated. Given subsequent lags in the peer review and publication process, it is highly probable that citations-based rankings reflect faculty compositions that approach 10 years old. For this reason, rankings based on program heads' perceptions of faculty research profile may provide a more current barometer of the top programs.

Our ranking based on the number of faculty publications only covers a set of five journals, and our response rate in the perception-based ranking is low. Citations are not a *sine qua non* for impact. The research of scientist A may cause scientist B to dramatically revise his or her own thinking on a subject, leading to significant advancement of the corpus of scientific knowledge, even though B does not cite A specifically. Moreover, the ISI (2005) does not collect citations information from every possible source, which implies that by relying on the citations information provided by ISI, we have underreported the true impact of scholars' influence. However, while we acknowledge these shortcomings, there is no reason to believe that either drawback differentially affects certain forestry programs more than others. Therefore, although it must be recognized that citations are not perfect, we also believe that our use of the citations metric does have merit and does not lead to biased rankings.

We do acknowledge that our citation count methodology favors programs in which faculty are engaged in team production of research over programs that house collections of sole principal investigators. This is because we count citations to individuals rather than citations to papers. This said, our publications methodology adjusts for coauthorship and the rankings that we compiled are broadly consistent with the rankings based on citations. One interpretation of this finding is that the distribution of coauthorship within a faculty does not differ significantly across programs. Of course, this does not preclude the potential relevance of other explanations.

We note also that our rankings focus specifically on research, rather than on teaching or extension. To the extent that certain schools are more concerned with producing these other products, they are not likely to fare well in our ranking. This should not be interpreted as suggesting that these programs are poor-quality programs. Our ranking is based on several unidimensional measures of research recognition. Of course, forestry programs may be highly regarded for reasons other than research and their reputation for excellence in these areas should not be less by virtue of a relatively weak showing in our rankings.

Finally, we remind readers that a number of the forestry programs identified in Tables 1–3 include components that we explicitly omitted from our analysis—wildlife, fisheries, park management, and paper science. Institutions may have strong and highly regarded research programs in these areas, even if they are relatively weak in terms of the ranking we have developed.

These caveats notwithstanding, this is a first attempt to rank forestry programs based on several measures and our methods are replicable. The conclusions derived from rankings such as this one are determined both by the methodology used to construct the ranking and by the readers' interpretations. Provided that neither the authors' nor the readers' interpretations or conclusions stray beyond what is justified by the data, rankings convey useful information. Because our ranking focuses exclusively on academic research, we encourage future contributions in this genre to focus on other aspects of research or on aspects of teaching or extension.

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