Measuring the quantity and quality of Canadian forestry research through a survey of publications in *Forestry Abstracts*, 1978–1992

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Concerns have recently been expressed that Canada's forestry research effort may have declined in terms of quantity and/or quality of output. To investigate this we conducted a comprehensive survey of all Canadian forestry-related publications listed in *Forestry Abstracts* from 1978 to 1992 inclusive. Results showed that overall Canadian output has remained steady at about 6% of the world total, and that its quality, as measured by the proportion of articles in scientific journals, has increased rather than decreased. Over the 15-year survey period, the most frequent origin of those publications has shifted from the Canadian Forest Service (52% of the total in 1978–82, 29% in 1988–92) to the universities (22% in 1978–82, 48% in 1988–92), and the subject-matter focus of Canadian forestry publications has changed in keeping with new research and operational priorities.

Il semblerait, selon certaines craintes entendues récemment, que la qualité ou le volume de la recherche forestière menée au Canada aurait diminué. Pour clarifier la situation, nous avons fait un relevé détaillé de toutes les publications canadiennes traitant de foresterie mentionnées dans *Forestry Abstracts* des années 1978 à 1992. Les résultats indiquent un nombre plutôt constant, en général, qui équivaut à environ 6 % du total mondial; de plus, la qualité des publications, mesurée en proportion des articles publiés dans des revues scientifiques, s'est plutôt améliorée. Pendant la période étudiée, le principal lieu d'origine des publications canadiennes s'est déplacé du Service canadien des forêts (52 % en 1978–1982, 29 % en 1988–1992) aux universités (22 % en 1978–1982, 48 % en 1988–1992), et les sujets traités se sont adaptés aux nouvelles priorités en matière de recherche ou d'opération.

Introduction

During consultation sessions undertaken as part of a recent review of forestry research roles, responsibilities, and agency interrelationships (Page and Brassard 1993), a number of participants expressed a concern that Canada's forest resources research effort may have declined in recent years in terms of quality and/or quantity of output. In order to obtain an independent measure of whether such concerns are justified, we have conducted a comprehensive survey of all publications of Canadian origin listed in *Forestry Abstracts* from 1978 to 1992 inclusive (CAB International Information Services 1978–92).

Survey

Forestry Abstracts is the only comprehensive worldwide guide to forestry publications, and gives an accurate overall indication of forestry research results on a worldwide basis. The coverage of *Forestry Abstracts* is very thorough for all forestry and forestry-related subject categories and publications; in addition to articles in all forestry, botanical, entomological, conservation, and other journals related in any way to forestry, the coverage includes reports from government agencies (including Canadian Forest Service Information Reports and Technical Notes, and similar material published by Canadian provincial governments), books and conference proceedings, and university graduate theses. Since 1978, forest products research has been excluded from *Forestry Abstracts* and published separately as *Forest Products Abstracts*; forest products research was not included in our survey.

The countries of origin of second or subsequent authors are not recorded in *Forestry Abstracts*, and some research outputs to which Canadians have contributed as junior authors will, therefore, have been omitted from our survey. Conversely, however, articles with a Canadian as first author have been counted as

Canadian publications even though any second or subsequent authors might be from other countries. We would expect the two to more or less compensate for each other over the years.

We tabulated complete information on Canadian publications listed in *Forestry Abstracts* for the 15 years 1978–1992, by agency and by subject matter category. While separate information was obtained and tabulated for each of the 15 years, its year-to-year variability makes a grouping of data into three 5-year periods more useful for interpretive purposes, and the results are presented and discussed here in this summary form.

When interpreting the survey results, it is most important to note that the *lag phase* from the completion of a given piece of research to the listing of resultant publication(s) in *Forestry Abstracts* is normally about 3–5 years; this includes the time it takes to write up the work, submit it for publication, time elapsed between submission and publication of the paper, and the time it takes for *Forestry Abstracts* to include it as an entry. Throughout the following discussion, the dates cited refer to appearance in *Forestry Abstracts*, but should be interpreted as referring to research effort that in most cases would have been completed about 4 years previously. Thus the publications listed in *Forestry Abstracts* from 1978 to 1992 mostly contain the outputs of research completed from about the mid-1970s to the late 1980s.

Results

Canadian and World Outputs

Canada's total forestry resources research publication output remained steady at about 6% of the world total over the 15-year period of our survey (Table 1). In absolute terms, the total number of publications produced in Canada stayed relatively constant during the first 10 years, but increased by about 30% in 1988–92.

Canadian Output by Agency

Over the entire 15-year period (Table 1) the Canadian Forest Service (or its federal forestry predecessors) produced

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Table 1. Canadian forestry publications listed in *Forestry Abstracts*, 1978–1992

Agency	1978–82		1983–87		1988–92		Total, 1978–92	
	Number	%	Number	%	Number	%	Number	%
Federal total	1 127	59	843	47	885	33	2 855	44
Canadian Forest Service ¹	997	52	747	42	788	29	2 532	39
Other Federal agencies	130	7	96	5	97	4	323	5
Universities total	423	22	637	36	1 328	48	2 388	37
Universities — forestry ²	280	15	435	26	769	28	1 502	23
Universities — other ³	143	7	184	10	559	20	886	14
Provinces ⁴	299	15	198	11	336	12	833	13
Others ⁵	77	4	100	6	186	7	363	6
Total (Canada)	1 926	100	1 778	100	2 735	100	6 439	100
Total (World)	30 992		33 551		43 839		108 382	
Canada/World	6.2%		5.3%		6.2%		5.9%	

¹Including federal forestry predecessors.²Universities with forestry faculties or schools.³Universities without forestry faculties or schools.⁴Including provincial government departments and provincial research agencies.⁵Including cooperative research institutes, industry, consultants, and non-governmental agencies.

39% of Canadian forestry publications, other federal government departments and agencies 5%, universities with forestry faculties 23%, universities without forestry faculties 14%, provinces 13%, and other agencies (including industry) 6%. The federal government and universities together have consistently generated over 80% of all forestry-related research publications (excluding forest products) in Canada throughout the survey period. However, these overall averages mask major shifts that have occurred through time in the relative contributions of different agencies to the total output.

Canadian Forest Service and other federal agencies

For the Canadian Forest Service, the absolute number of papers listed in *Forestry Abstracts* was about 20% lower during 1983–92 than it was during 1978–82. As a percentage of the total Canadian output, the Canadian Forest Service's share has seen a steady decline, from more than 50% around 1980 to less than 30% 10 years later. Other federal agencies' numbers and percent share have also declined, and the total federal effort, which accounted for 59% of the total Canadian output at the start of the survey period, accounted for only 33% of it by the end. It is perhaps not coincidental that the period of greatest absolute decline in research output by the Canadian Forest Service followed rather closely the restructuring and substantial downsizing of federal forestry research in late 1970s.

Universities

University forestry output has, by contrast, shown a steady and major increase over the same period. Absolute numbers of papers tripled and the universities' share of the Canadian total rose from 22 to 48%. This increase was similar both in universities with forestry faculties and in those without, but more pronounced in the latter group which, by about 1990, accounted for some 40% of all university forestry publications.

A total of 46 Canadian universities were cited in *Forestry Abstracts* over the 15-year period covered by our survey. However, most of the output was generated by five universities with forestry faculties (University of British Columbia, University of Toronto, Laval University, University of Alberta, and University of New Brunswick), each of which produced an average of 10 or more

publications per year. Six other universities (University of Guelph, University of Calgary, Lakehead University, Simon Fraser University, McGill University, and University of Victoria), only one of which has a forestry faculty, each produced at least five forestry-related publications per year on average.

Provinces

Provincial forestry publication output shows no obvious trends; although absolute numbers were somewhat higher in the last 5-year period of our survey, the percentage of total Canadian output remained at about 13% throughout.

Other Agencies

This category includes the three cooperative industrial research institutes (FERIC, Forintek, Paprican), other industrial laboratories, consultants, and non-governmental organizations, and accounts for about 6% of the Canadian forestry resources publication output. Over the 15-year period, numbers of publications from this group of agencies have more than doubled, representing a small increase in percentage terms.

Canadian Output by Subject Matter

Within Canada, the greatest output of publications (Table 2) was in the fields of *silviculture* and *forest mensuration and management*, which together accounted for 29% of the total; this percentage has remained relatively constant throughout the survey period. The Canadian Forest Service used to contribute about half the total, but more recently this has gone down to about one-third; universities have gone from less than 20% to about one-third; provinces have remained steady, with a contribution of about one-quarter of the output.

Publications on *insects* declined during the survey period from about 20% of the total to 13%, and this category shifted from second-most important to third. The Canadian Forest Service share of the output decreased somewhat over the 15 years, from 80 to 60%, while that of the universities doubled from 14 to 30%.

An opposite trend was apparent in the *plant biology* and *genetics* categories, which collectively increased from 10 to 24%; the absolute number of publications in those two categories more than tripled. The universities' share of the output also tripled,

Table 2. Percentage of Canadian publications in *Forestry Abstracts* by subject matter categories¹

Subject matter category	1978-82	1983-87	1988-92	Total 1978-92
General ²	10	10	8	9
Silviculture	22	19	23	21
Forest mensuration and management	9	10	7	8
Physical environment ³	7	10	11	10
Fire	4	3	2	3
Plant biology	7	9	18	12
Genetics and breeding; variation; evolution	3	5	6	5
Mycology and pathology	8	9	8	8
Insects and other invertebrates	21	19	13	17
Range/game and wildlife/fish	6	2	2	3
Protection/conservation ⁴	4	3	2	3
Dendrochronology and dendroclimatology	<1	<1	<1	1
Total	100	100	100	100

¹Subject-matter categories as defined or delimited by *Forestry Abstracts*.

²Including: General publications and general techniques/general aspects of forestry.

³Including: Climate; pollution; soils; land form; plant water and nutrient relations.

⁴Including: Protection forests; watershed/catchment management; soil conservation/other land use; nature conservation; arboriculture.

from 20 to 60%, while that of the Canadian Forest Service decreased by a similar proportion, from 38 to 13%.

In the *physical environment* category, percentage output increased somewhat, with the Canadian Forest Service share going from about one-third to less than one-quarter, while the universities' output increased from about half to two-thirds of the total.

The output of *mycology and pathology* publications remained steady at about 8% throughout the 15-year period, but the Canadian Forest Service and universities' shares showed similar trends to those of most other categories (Canadian Forest Service from 70 to 33%; universities from 20 to 60%).

The *fire, range/wildlife, and protection/conservation* categories all showed small decreases in output in proportionate terms over the survey period. The relative outputs of the Canadian Forest Service and universities shifted over the 15-year period in much the same way as for the other categories.

Types of Publications

As an additional check to ensure that the data we obtained on absolute numbers of publications were not masking any deterioration in the average *quality* of publications produced, we tabulated the Canadian listings in 3 years of *Forestry Abstracts* (1978; 1985; 1992) by the type of publication. These data showed that in 1978 about 46% of Canadian entries were articles in scientific journals or books, 43% were technical or similar reports produced by the author's own agency, and 11% were in conference proceedings. By 1985 the respective figures were 56%, 31%, and 13%, and by 1992 fully 84% of Canadian entries were journal articles. These shifts are perhaps partly a reflection of the higher proportion of forestry-related publications now originating in universities, which do not usually have their own internal publication series.

Journal articles normally receive a more extensive and rigorous review than technical reports or conference proceedings, and are generally assumed to be of rather higher scientific quality than either of the other two types of publications. By the late 1980s Canadian researchers were publishing a substantially

greater proportion of their output in journal articles than was the case a decade or so previously. There is thus no evidence that research quality has declined over the survey period; indeed, the reverse may be much closer to reality.

Conclusions

Despite the misgivings that exist in some quarters, it is clear that Canada is holding its own as an important player within the world forestry research scene, at least when measured in terms of forestry publications. There is, similarly, no evidence to suggest that the quality of Canada's forestry publication output has decreased in recent years. The shifts that have occurred within Canada between 1978 and 1992, primarily a decrease in the federal government share of the total and a more or less corresponding increase on the part of universities, do not appear to have affected the country's overall stature as a forestry research nation. This conclusion is reinforced by the fact that the subject-matter focus of Canadian forestry research publication has shifted somewhat, in concert with global trends, to focus rather more strongly on such subject-matter categories as plant biology and physical environment.

The changes in relative levels of output that have occurred over the past 15 years among the major Canadian forestry research agencies do, nevertheless, give pause for thought. The increase from Canadian universities is a most encouraging development, as is the increased participation of "non-forestry" universities in forestry and forestry-related subjects. The current ratio in terms of publications, about 60:40, between "forestry" and "non-forestry" universities would appear to be a healthy one in light of the much enlarged and more complex issues that must be addressed by the forest sector.

The substantial proportionate decrease in Canadian Forest Service publication output over the past 15 years undoubtedly reflects both the downsizing and the shifting emphasis of the Service that took place during that time period. Analysis of this trend should, however, be tempered by the fact that the absolute numbers of publications produced by the Canadian Forest Service remained relatively steady over the 1983-92 period (after a decrease in the early 1980s), as well as by the recent increases in research networks and partnerships between the Canadian Forest Service and other agencies. Indeed, part of the increased output of forestry publications by universities may be attributed directly or indirectly to enhanced support from, and collaboration with, the Canadian Forest Service and other federal agencies.

The Canadian Forest Service remains Canada's largest forestry resources research organization, and the relative position of its research program still appears strong both nationally and internationally. However, if the Service is to retain its scientific stature, and a national and international leadership role in forestry research, it is most important that it maintain a significant share of Canadian forestry research output. Clearly, if the trends of the past 15 years were to continue, the Canadian Forest Service's scientific leadership capabilities could be at risk. Careful track needs to be kept of publications and other research outputs to ensure that this does not occur.

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