Environment Canada's Scientific Research Publications in 1995

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ENVIRONMENT CANADA'S SCIENTIFIC RESEARCH PUBLICATIONS IN 1995

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Summary

- Canada produced 25,882 scientific research publications in 1995, or 4.2% of the world's total.

- Of these, 368 (or 1.4% of Canada's total) can be attributed wholly or in part (through joint authorship) to Environment Canada.

- Environment Canada spent $145 million on its intramural natural science and engineering R&D in 1994-1995. This amounts to about 1.3% of Canada's total expenditures on natural science and engineering R&D.

- A large majority of the 368 publications were in the disciplines of Earth and Space Science (and the subdisciplines of environmental science and of meteorology and atmospheric science), Biology and Chemistry.

- Environment Canada collaborated with scientists from 88 other institutions in Canada on 175 of the 368 publications. This is a collaboration rate of 47.6%; the collaboration rate for the entire federal government is 40.1%.

- Universities are the Department's main partners in these publications, followed by other federal departments, provincial departments and the private sector, in that order.

- 95 (or 26%) of Environment Canada's 368 scientific research publications involved international collaborators. About 31% of all Canadian scientific research publications were written in collaboration with foreign partners.

- The United States was Environment Canada's primary international collaborator in 1995. The United States and western European countries account for almost all of the Department's partnerships in international scientific research publications.

- In 1995, Canada produced 501 environmental science research publications (the third-largest producer, with almost 8% of the world's total) and 197 meteorology and atmospheric science research publications (the second-largest, with over 8% of the world's total). Environmental science, and meteorology and atmospheric science are relatively strong performers within Canadian science, compared to other countries. (In the database used for this report, publications are classified as being in environmental science when they appear in journals that have been designated as environmental science journals.)

- Environment Canada scientists wrote 123, or 25%, of the 501 Canadian environmental science publications in 1995. They also authored 67, or 34%, of the 197 Canadian meteorology and atmospheric science publications. This makes the Department by far the largest contributor to research publications in environmental science and in meteorology and atmospheric science in the country.

Introduction

This paper provides a quantitative overview of Environment Canada's production of scientific knowledge in 1995. Using a database for that year prepared for Statistics Canada, the paper focuses on one important output of the Department's scientific research effort, the scientific research publication. Some examples can be found in Table 1.

It should be noted that the database contains publications from a limited subset (about 3,500) of all scientific journals. However, these are considered to be the most important peer-reviewed journals. They contain most of the cited scientific literature and communicate the most significant advances in science. They provide a good basis for international comparisons.

The publications from Environment Canada found in the database, which are the subject of this report, are a small part of the Department's total scientific publications. They are estimated to be approximately 20-25% of the total, based on a review of the publications of two departmental research institutes. The remainder fall under other categories of scientific literature, such as very specialized journals, strictly national journals and, especially, "grey literature" (papers in proceedings of conferences, technical reports, etc., which are largely oriented to the further dissemination of knowledge).

All of Environment Canada's scientific publications, whether in the database or not, are a major product of the Department's scientific effort. They are the prime mechanism for delivering the results of the Department's research to others. That research is conducted in the public interest, is focused on the environment, and has as its goals the support of public policy, the provision of services to Canadians and the development of environmental technologies. While the scientific research publications in the database are not the only output of the Department's scientific effort, they are one that can be captured quantitatively relatively easily. The results provide ready indicators of the extent of Environment Canada's research effort and of its network of scientific collaborators.

Source of Information

The data used in this paper have been generated by the *Observatoire des sciences et des technologies*, a research group at the Université du Québec. This group has prepared a database of Canadian authors in 1995 for Statistics Canada.

The database includes approximately 2,800 Canadian institutional addresses, and is derived from the *Science Citation Index*, produced by the Institute for Scientific Information. Each year the Institute adds to its databases the contents of the approximately 3,500 scientific journals it assesses as the most prominent. A list of these journals can be found in *Science Citation Index, 1995 Guide and List of Source Publications* (Institute for Scientific Information, Philadelphia, PA).

Table 1: Examples of Environment Canada Scientific Research Publications

Example 1: The Science of the Total Environment 160/161 (1995) 465-472

Preliminary results of fasting on the kinetics of organochlorines in polar bears *(Ursus maritimus)*

S.C. Polischuk*[a], R.J. Letcher[b,c], R.J. Norstrom[b,c] and M.A. Ramsay[a]

[a]Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan S7N OWO, Canada
[b]Canadian Wildlife Service, Environment Canada, Ottawa, Ontario KIA 0H3, Canada
[c]Centre for Analytical and Environmental Chemistry, Carleton University, Ottawa, Ontario K1S 5B6, Canada

Example 2: Water, Air and Soil Pollution 83 (1995) 315-334

Genotoxicity of snow in the Montreal metropolitan area*

Paul A. White and Joseph B. Rasmussen

Department of Biology, McGill University, 1205 Dr. Penfield Ave., Montréal, Québec H3A 1B1, Canada

and

Christian Blaise

The St. Lawrence Center Conservation and Protection, Environment Canada, 1001 Pierre Dupuy Ave., Longueuil, Québec J4K 1A1, Canada

Example 3: Atmospheric Environment 29:21 (1995) 3181-3188

Surface conductances for ozone uptake derived from aircraft eddy correlation data

W.J. Massman*, J.I. Macpherson†, A. Delany‡, G. Den Hartog§, H.H. Neumann§, S.P. Oncley‡, R. Pearson, Jr.||, J. Pederson¶ and R.H. Shaw**

**USDA/Forest Service, 240 W. Prospect, Fort Collins, CO 80526, U.S.A.; †Institute for Aerospace Research, National Research Council, Ottawa, Ontario K1A 0R6, Canada; ‡National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307, U.S.A.; §Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario M3H 5T4, Canada; ||MS-245-5, NASA Ames Research Center, P.O. Box 1000, Moffett Field, CA 94035-1000, U.S.A.; ¶California Air Resources Board, P.O. Box 2815, Sacramento, CA 95812, U.S.A.; **Department of Land, Air and Water Resources, University of California, Davis, CA 95616, U.S.A.*

Example 4: The Science of the Total Environment 160/161 (1995) 167-179

The recent depositional trend of polycyclic aromatic hydrocarbons and elemental carbon to the Agassiz Ice Cap, Ellesmere Island, Canada

Andrew J. Peters*, Dennis J. Gregor', Camilla F. Teixeira, Neil P. Jones and Christine Spencer

Aquatic Ecosystem Conservation Branch, National Water Research Institute, Environment Canada, Burlington, Ontario L7R 4A6, Canada

Environment Canada's Scientific Research Publications in 1995

The database used for this report shows that Canada produced 25,882 scientific research publications in 1995, or 4.2% of the world's total (see Table 6). Of these, 368 can be attributed wholly or in part (through joint authorship) to Environment Canada, or 1.4% of the total produced by Canada.

Environment Canada spent $145 million on intramural natural science and engineering research and development (R&D) in 1994-1995. This accounts for about 1.3% of Canada's total expenditures, or 3.6% of Canadian public sector expenditures, on natural science and engineering R&D.

Publications Sorted by Discipline

Environment Canada's 1995 scientific research publications can be divided into major disciplinary fields, as shown in Table 2. The great majority of the 211 publications in Earth and Space Science are in the two subdisciplines of environmental science, and meteorology and atmospheric science. Those in Biology are mostly in the subdisciplines of marine biology and hydrobiology, miscellaneous zoology and ecology. Those in Chemistry are almost all in analytical chemistry.

Table 2: Distribution by Discipline

Number of Publications	Discipline
211	Earth and Space Science
79	Biology
36	Chemistry
17	Clinical Medicine
9	Biomedical Research
7	Engineering
5	Physics
1	Mathematics
3	Others
Total 368	

Source: *Observatoire des sciences et des technologies.*

National Partners

In 175 of its 368 publications, Environment Canada collaborated with scientists from 88 other institutions in Canada. This is a collaboration rate of 47.6%; the collaboration rate for the whole of the federal government is 40.1%. Universities are the most frequent partner with the Department.

Table 3 lists the number of Environment Canada publications in which each sector is a collaborator. For example, it indicates that one or more universities collaborated with Environment Canada in 123 publications. (The numbers add up to more than 175 because more than one sector can collaborate on one publication.)

Table 3: Collaboration by Sector

Number of Publications	Sector
123	Universities
39	Federal government
23	Provincial government
22	Private sector
10	Others
5	Unknown
3	Hospitals

Source: *Observatoire des sciences et des technologies.*

Table 4 lists Environment Canada's Canadian collaborators. For example, one or more scientists at the University of Alberta collaborated with Environment Canada scientists in 13 publications.

Table 4: Canadian Collaborators

Publications	Institution
13	U Alberta
13	U Saskatchewan
13	U Waterloo
12	McGill U
10	Agriculture & Agri-Food Can.
10	Fisheries & Oceans Can.
8	McMaster U
8	UBC
7	Carleton U
7	Ontario M of E
7	UQAM
6	U Laval
6	U Montréal
5	Macdonald Coll.
5	U Guelph
5	U Ottawa
5	UWO
4	CMNS
4	NRCC
4	York U
3	CCRS
3	CHU Laval
3	EBP Inc.
3	Govt Manitoba
3	Govt Nfld
3	Health & Welfare Can.
3	Macdonald Coll.
3	Ontario MNR
3	Trent U
3	U of T
2	Concordia Sci.
2	École Politechnique
2	Geol. Survey
2	Inst. Oceanog.
2	NRCAN
2	UQAR
2	Simon Fraser U

Publications	Institution
2	Transport Canada
2	U of M
1	Agviron Con.
1	Atm. Env. Res.
1	Atm-Dyn. C.
1	Bedford Inst.
1	Biopath
1	Bovar
1	BC Min. of Forests
1	Canada-Ctr-Ener.
1	Ctr Study Birds
1	Conest-Rivers Ltd.
1	Dept. Can. Heritage
1	Brock U
1	Ducks Unlmtd
1	EarthSyst. Res.
1	Environmega Ltd.
1	Essa-Tech.
1	Evs-Con.
1	Grebe-Inc.
1	Grp-Re-Bio&Env.
1	Unknown
1	Inst. Spa. Sci.
1	IITech.
1	Kraus-Ind.
1	Lake Ont. Fishery Unit
1	Laurentian U
1	Serv Cons. Hardy
1	Lingard Co.
1	Memorial U
1	Metro. T. R.
1	Metro Toronto Zoo
1	Quebec ME
1	Not available
1	Ontario Hydro
1	Ont. Vet. Coll.
1	Queens U

Publications	Institution
1	Raju. Env. Service
1	Rawson Acad. Sci.
1	Redeemer
1	Reg. Munic. Waterloo
1	Res.&Prod. Council
1	Sask. Res. Council
1	St. Lawr.
1	Tekran-Inc.
1	U Moncton
1	UNB
1	U Windsor
1	U Victoria
1	Wilfrid Laurier U
1	BC Ministry of Environ.

Source: *Observatoire des sciences et des technologies.*

International Partners

Collaboration between countries is determined by a combination of key factors such as country size, geographic proximity, history and language. In general, small countries collaborate more than large countries. There is also more collaboration between countries that are geographically or linguistically close, and between countries that have a common history. Worldwide, 14.5% of all scientific publications involve international collaboration.

In 1995, 95 (or 26%) of Environment Canada's 368 scientific research publications involved international collaborators. About 31% of Canadian scientific research publications were written in collaboration with foreign partners.

As Table 5 shows, the United States was Environment Canada's main international collaborator in 1995. The United States and western European countries account for almost all of the Department's partners in international scientific research publications.

Table 5: International Collaboration

Publications	Country
55	United States
11	Germany
8	United Kingdom
7	France
5	Switzerland
4	Japan
4	Sweden
3	Australia
3	Belgium
3	Italy
2	Argentina
2	Finland
2	Greece
2	Netherlands
2	Norway
2	Russia
1	Chile
1	Denmark
1	Israel
1	Mexico
1	New Zealand
1	Slovakia
1	South Africa
1	Spain

Source: *Observatoire des sciences et des technologies.*

Environmental Science Publications and Environment Canada

Definition of Environmental Science

There is no commonly accepted definition of environmental science. The term does not correspond to any single scientific discipline. Rather, it includes those life sciences (biology, forestry, ecology, etc.) and physical sciences (oceanography, geology, atmospheric sciences, etc.) that relate to the environment. Hence, identifying whether a scientific publication or activity is "environmental science" can be a non-trivial exercise, and determining the aggregate environmental science effort can be very complex.

The database used for this paper does distinguish environmental science. It does so by classifying certain journals as environmental and therefore all

publications in those journals as environmental. Environmental science is one of seven subdisciplines under the discipline Earth and Space Science (see Table 2).

Using this approach, 123 of Environment Canada's 368 scientific research publications in 1995 were classified as being in environmental science. Clearly, almost all, if not all, of the Department's publications were devoted to the environment. Nonetheless, the results produced through this journal approach can be used to present a comparative picture of Environment Canada's contribution to environmental science.

Canada's Specialization in Environmental Science

In 1995, Canada produced 501 environmental science research publications — almost 8% of the world's total — and 197 meteorology and atmospheric science publications, over 8% of the world's total. These research areas are ones in which Canada specializes, relative to other countries.

Table 6 indicates the relative strength of various countries in the two subdisciplines. The "Specialization Index" is the ratio between the percentage of a country's publications in a field and the percentage of world publications in that field. The table shows that environmental science, and meteorology and atmospheric science are relatively strong performers within Canadian science, compared with other countries.

Table 6: Specialization Index — Canada's Position in Environmental Sciences at the World Level

Country	Total Publications	Environ. Sci. Publications	Specialization Index — Environ. Sci.	Meteor. & Atmos. Sci. Publications	Specialization Index — Meteor. & Atmos. Sci.
Sweden	11,337	237	1.77	20	0.40
Canada	**25,882**	**501**	**1.64**	**197**	**1.74**
Netherlands	14,103	237	1.42	53	0.86
United States	191,509	2,449	1.08	1,414	1.68
United Kingdom	49,430	542	0.93	184	0.85
Italy	21,477	178	0.70	32	0.34
Germany	44,378	328	0.63	174	0.89
France	34,529	233	0.57	144	0.95
Japan	50,582	202	0.34	53	0.24
Other countries	179,079	2,203	1.04	492	0.63
World	**539,157**	**6,372**		**2,363**	

Source: *Observatoire des sciences et des technologies.*

Table 7 presents the Specialization Index for the Canadian scientific effort. Canada was most specialized in Earth and Space Science (environmental science is part of this discipline), with an index of 1.70, followed by Biology (1.62), Mathematics (1.22) and Engineering (1.11). The country is underspecialized in Physics (0.70), Chemistry (0.72) and Clinical Medicine (0.95).

Table 7: Specialization Index — Canada's Scientific Effort by Discipline

Discipline	Specialization Index
Earth and Space Science	1.70
Biology	1.62
Mathematics	1.22
Engineering	1.11
Biomedical Research	1.03
Clinical Medicine	0.95
Chemistry	0.72
Physics	0.70

Source: B. Godin, Y. Gingras and L. Davignon, "Knowledge Flows in Canada as Measured by Bibliometrics," Statistics Canada working paper, 1998.

Environment Canada's Position in Environmental Science

Environment Canada scientists wrote 123, or 25%, of the 501 Canadian environmental science publications in 1995. (Departmental scientists also authored 67, or 34%, of the 197 Canadian meteorology and atmospheric science publications.) A total of 137 Canadian institutions supported the scientists who produced the 501 publications. This makes the Department by far the largest contributor to environmental science research publications in the country.

Table 8 lists the Canadian institutions involved in the production of the 501 environmental science publications. For example, one or more Trent University scientists were sole or co-authors of 16 publications.

Table 8: Canadian Institutions' Publications in Environmental Science

Publications	Institution
123	Env. Canada
49	U Waterloo
39	U Alberta
29	Fish. & Oceans
24	UBC
21	U of T
19	Agri. & Agri-Food
16	Trent U
15	Health & Welfare
15	U Guelph
14	Canadian F.S.
14	NRCAN
14	Ont. Min. Envir.
13	NRCC
12	U Ottawa
12	UQAM
11	Macdonald Coll.
11	McGill U
9	McMaster U
8	Aecl-Res.
8	Geol. Survey
8	U Saskatchewan
7	Queens U
7	U Manitoba
6	Carleton U
6	Laurentian U
6	Environmega
6	Simon Fraser U
6	U Laval
6	U of Montréal
6	U Sherbrooke
5	U Windsor
5	York U
4	École-Polytech
4	INRS Oceano.
4	Quebec ME
4	Ontario Hydro
4	Royal Mil. Coll.
4	U Regina
4	U Victoria
3	BC Min. of For.
3	CHU-Laval
3	Hydro-Qué.
3	PPRICA
3	Scrbgh Coll.
3	UWO

Publications	Institution
2	Dalhousie U
2	Ont. Min. NR
2	Acadia U
2	Alberta Env. Ctr
2	Alberta Res. Ctr
2	CCMET
2	EBDP Inc.
2	Essa-Tech.
2	Hydromentis
2	INRS-Eau
2	Not available
2	NFWLD RR
2	Sask. Res. Coun.
2	Somer Inc.
2	U Calgary
2	U Northern BC
2	U Winnipeg
2	UQAR
1	Alberta EP
1	Alberta Health
1	Ass-Eng. Alberta
1	Avp Consultants
1	Axys-An-Ser
1	Biowest
1	BC Min. Envir.
1	BC Res. Corp.
1	Brock U
1	CCSP Birds
1	Can Mues-Ntl
1	CRDist.
1	Ch2M-Hill
1	City Cal-WN
1	Concordia Univ.
1	Conestoga
1	Coop-Ctr Me
1	Crealab
1	Cree Board
1	Ctr Tox. Qué.
1	Indian Affairs
1	Ecol-Serv.Pln
1	Elemental R
1	Evs-Consult-Ltd
1	Freshwater-Inst.
1	Gage-Res-Inst.
1	Globaltox.
1	Goldar Ass.
1	Goodfellow

Publications	Institution
1	Govt Manitoba
1	Inst. Ocean-Sci
1	Inst. Rech-Santé
1	Komex Int. Ltd.
1	Labs-Savoie-Duf.
1	Lingard Consulting
1	Ls-McCarty-Sci. R
1	MacDonald-Env.
1	Mawsa-Inc.
1	Memorial U
1	Quebec MLCP
1	Mistik Mgmt
1	Royal Military Coll.
1	No-Enviro
1	Nova-Husky
1	NS Agri. College
1	Novatec Consul.
1	Ont. Forest Res.
1	Ont. Vet. Coll.
1	Parks Canada
1	Pest-Mgmt-Re.
1	Petawawa-Ntl
1	Pj-Usher-Consul.
1	Raju Envir. Service
1	Red Rock Res.
1	Redmeer
1	Reg.Mun. Waterloo
1	Res-&-Productiv
1	Res. Stn
1	Rv-Anderson
1	Sask.Env.Res.Mg
1	Sask. Health
1	Sere-Group
1	St. Lawrence Vall.
1	St. Mary's U
1	Syncrude Canada
1	Tech. U of NS
1	Tekran-Inc.
1	Terr-&-Aquatic-Env
1	UNB
1	Wellington
1	Whiteshell Labs
1	Wilfrid Laurier U
1	Xcg-Consultant Ltd

Source: *Observatoire des sciences et des technologies.*