Is Federal Science Important?

Release of a study on the ranking of Canada's output in environmental research

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CSWA 35th Annual Conference, St. John's, Newfoundland, Canada
June 25, Memorial University of Newfoundland, INCO Innovation Centre

Environment Canada Environnement Canada

Science-Metrix

There's communicating science, and then there's communicating good science...

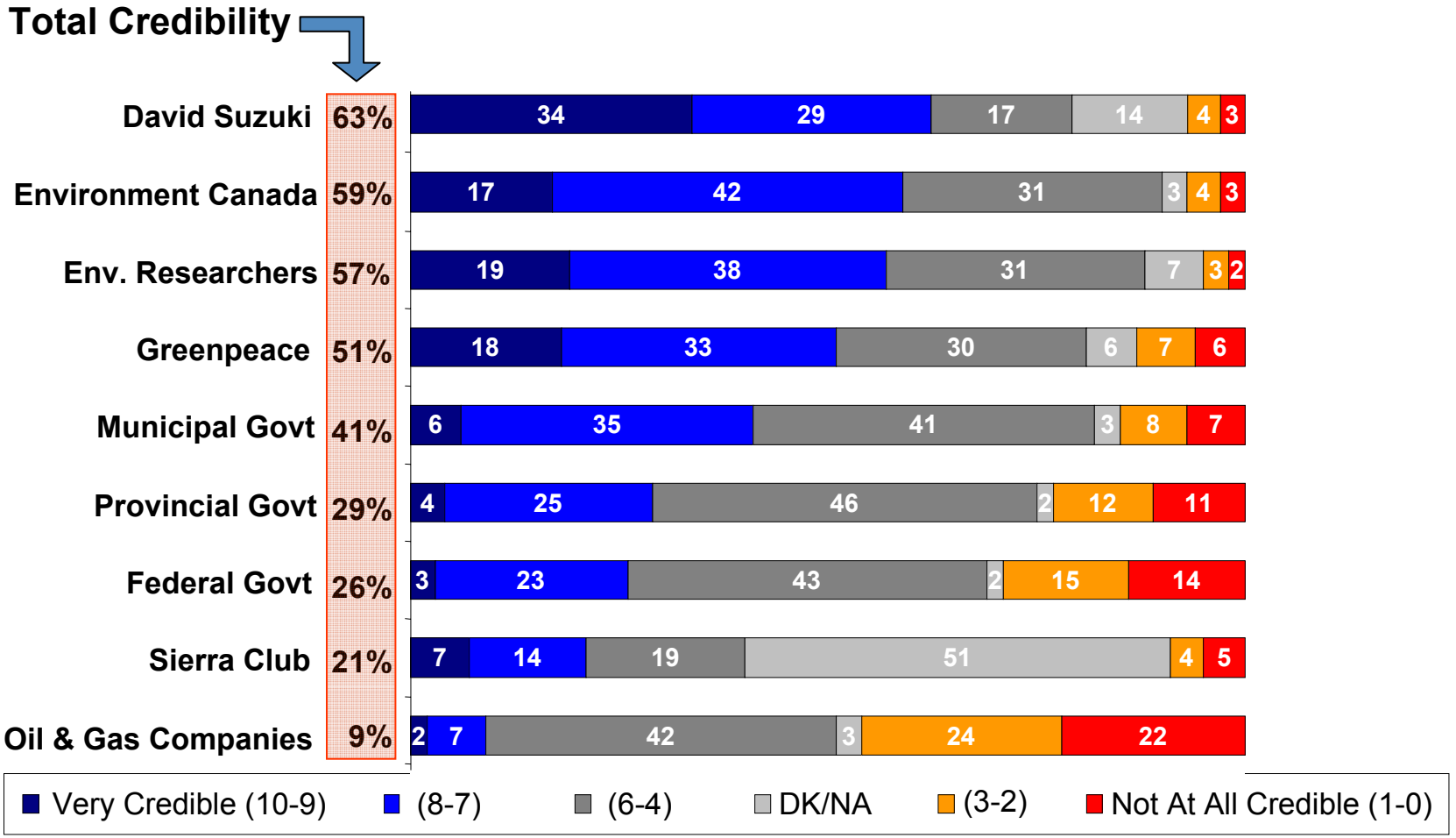
Scientists have discovered that the moon is moving away from the earth at a tiny yet measurable distance every year.

If you do the math, you can calculate that 85 million years ago the moon was orbiting the earth at a distance of about 35 feet from the earth's surface.

This would explain the death of the dinosaurs. The tallest ones, anyway…

So what is good science? What people think …

Ratings of spokespersons for environmental issues (Nov 2005)



Source: Data from an omnibus poll conducted by FH Canada Research, formerly GPC Research

Environment Canada Environnement Canada

Science-Metrix

… or what we can measure?

- **EC mandated Science-Metrix to undertake a bibliometric study on Canadian environmental research**
  - *Study available today (or at www.science-metrix.com)*
  - *Builds on three prior reports since 1995*
  - *Includes far more metrics than we can present!*
- **Because we wanted to see**
  - *In which areas the Department stood as a performer of Environmental Research*
  - *and with who and how we partnered*
    - *Over a 25 year time frame (1980 – 2004)*
    - *Nationally*
    - *Internationally*

What is scientometrics?

- The science of measuring and analyzing scientific activities
- Based on bibliometric methods that allow the delineation of scientific fields through the selection of a set of papers indexed in peer reviewed journal databases
- Once all authors addresses are standardized, several indicators can be produced by counting papers

Method used in this study

1. Citation databases

- ISI Thomson Scientific

  Science Citation Index & Social Sciences Citation Index

- All authors and co-authors addresses are harmonised = precise metrics

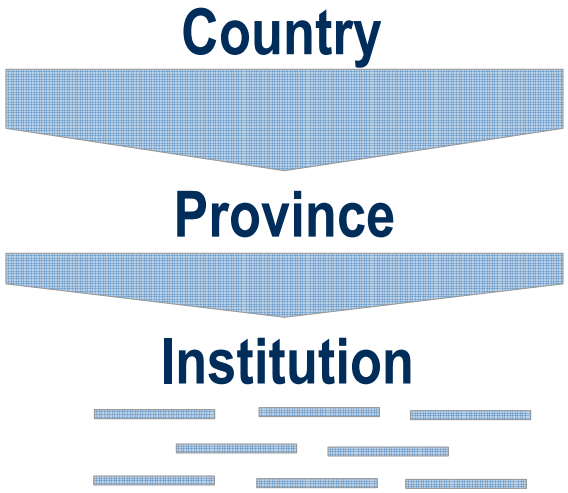
2. Scientific field delineation

- Selection of 434 scientific journals related to environmental research
- 580,500 papers between 1980 and 2004

3. Indicators

- Number of papers
- Level of specialization
- Scientific impact
- International & national collaboration rates

4. Levels of analysis



Scientific Impact and Specialization

- **Scientific impact**
  - *ARIF - Average relative impact factor*
  - *A proxy indicator of the quality of science, and*
  - *an indicator of expected impact of published research*

- **Level of specialization**
  - *SI - Specialization Index*
  - *Percentage of papers in a field in one country to percentage of papers in this field at the world level (134 countries)*

What countries publish the most?

Papers by 13 leading countries by five-year period, 1980–2004

Rk	Country	80-84 No. (Rk)	85-89 No. (Rk)	90-94 No. (Rk)	95-99 No. (Rk)	00-04 No. (Rk)	80-04 No. (Rk)
1	US	41,020 (1)	44,704 (1)	49,476 (1)	57,427 (1)	62,796 (1)	255,423 (1)
2	UK	7,207 (2)	7,825 (2)	9,098 (2)	13,614 (2)	15,547 (2)	53,291 (2)
3	**Canada**	**5,803 (3)**	**7,547 (3)**	**8,609 (3)**	**10,531 (3)**	**11,147 (3)**	43,637 (3)
4	Germany	2,994 (4)	3,664 (4)	5,514 (4)	8,426 (4)	10,763 (4)	31,361 (4)
5	France	1,859 (7)	2,613 (7)	4,160 (5)	6,688 (5)	8,545 (5)	23,865 (5)
6	Australia	2,759 (5)	3,397 (5)	4,140 (6)	5,824 (6)	7,307 (8)	23,427 (6)
7	Japan	1,895 (6)	2,646 (6)	3,746 (7)	5,618 (7)	7,837 (6)	21,742 (7)
8	Netherlands	1,182 (11)	1,905 (10)	3,144 (8)	4,517 (8)	5,212 (11)	15,960 (8)
9	Sweden	1,473 (9)	2,371 (8)	2,982 (9)	4,070 (9)	4,731 (12)	15,627 (9)
10	Italy	1,274 (10)	1,488 (11)	2,482 (10)	3,830 (11)	5,520 (10)	14,594 (10)
11	China	325 (13)	819 (13)	1,480 (13)	3,669 (12)	7,693 (7)	13,986 (11)
12	Spain	326 (12)	842 (12)	2,207 (12)	3,933 (10)	5,893 (9)	13,201 (12)
13	India	1,826 (8)	2,177 (9)	2,324 (11)	2,536 (13)	3,452 (13)	12,315 (13)
	World	**76,881**	**89,716**	**108,273**	**139,780**	**165,796**	**580,446**

Source: Data compiled by Science-Metrix from Thomson-Scientific data

What countries have the highest level of specialization and scientific impact?

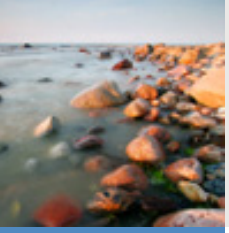
Level of effort dedicated to the field (Specialization index - SI)

		80-84	85-89	90-94	95-99	00-04	80-04
Rk	Country	SI *(Rk)*	SI *(Rk)*	SI *(Rk)*	SI *(Rk)*	SI *(Rk)*	SI *(Rk)*
1	Sweden	1.52 *(2)*	1.59 *(2)*	1.56 *(1)*	1.48 *(2)*	1.52 *(1)*	1.54 *(1)*
2	**Canada**	**1.61 *(1)***	**1.64 *(1)***	**1.53 *(2)***	**1.56 *(1)***	**1.47 *(2)***	**1.54 *(2)***
3	Australia	1.14 *(4)*	1.44 *(3)*	1.48 *(3)*	1.42 *(3)*	1.39 *(3)*	1.41 *(3)*
4	Netherlands	0.89 *(6)*	1.03 *(6)*	1.21 *(4)*	1.23 *(4)*	1.19 *(4)*	1.17 *(4)*
5	US	1.30 *(3)*	1.22 *(4)*	1.14 *(5)*	1.11 *(5)*	1.08 *(6)*	1.14 *(5)*

Scientific impact (Average relative impact factor - ARIF)

		80-84	85-89	90-94	95-99	00-04	80-04
Rk	Country	ARIF *(Rk)*	ARIF *(Rk)*	ARIF *(Rk)*	ARIF *(Rk)*	ARIF *(Rk)*	ARIF *(Rk)*
1	US	1.09 *(1)*	1.09 *(1)*	1.11 *(1)*	1.10 *(1)*	1.08 *(2)*	1.09 *(1)*
2	**Canada**	**1.02 *(3)***	**1.07 *(2)***	**1.08 *(2)***	**1.08 *(3)***	**1.07 *(3)***	**1.07 *(2)***
3	Netherlands	1.08 *(2)*	1.01 *(4)*	1.03 *(3)*	1.08 *(2)*	1.06 *(4)*	1.06 *(3)*
4	UK	1.01 *(4)*	0.98 *(6)*	1.00 *(4)*	1.03 *(5)*	1.08 *(1)*	1.03 *(4)*
5	Sweden	1.01 *(5)*	1.01 *(3)*	0.99 *(5)*	1.00 *(6)*	1.04 *(6)*	1.01 *(5)*

Source: Data compiled by Science-Metrix from Thomson-Scientific data

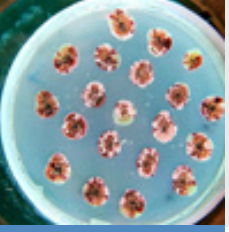


The Federal sector and Environment Canada's place in environmental research

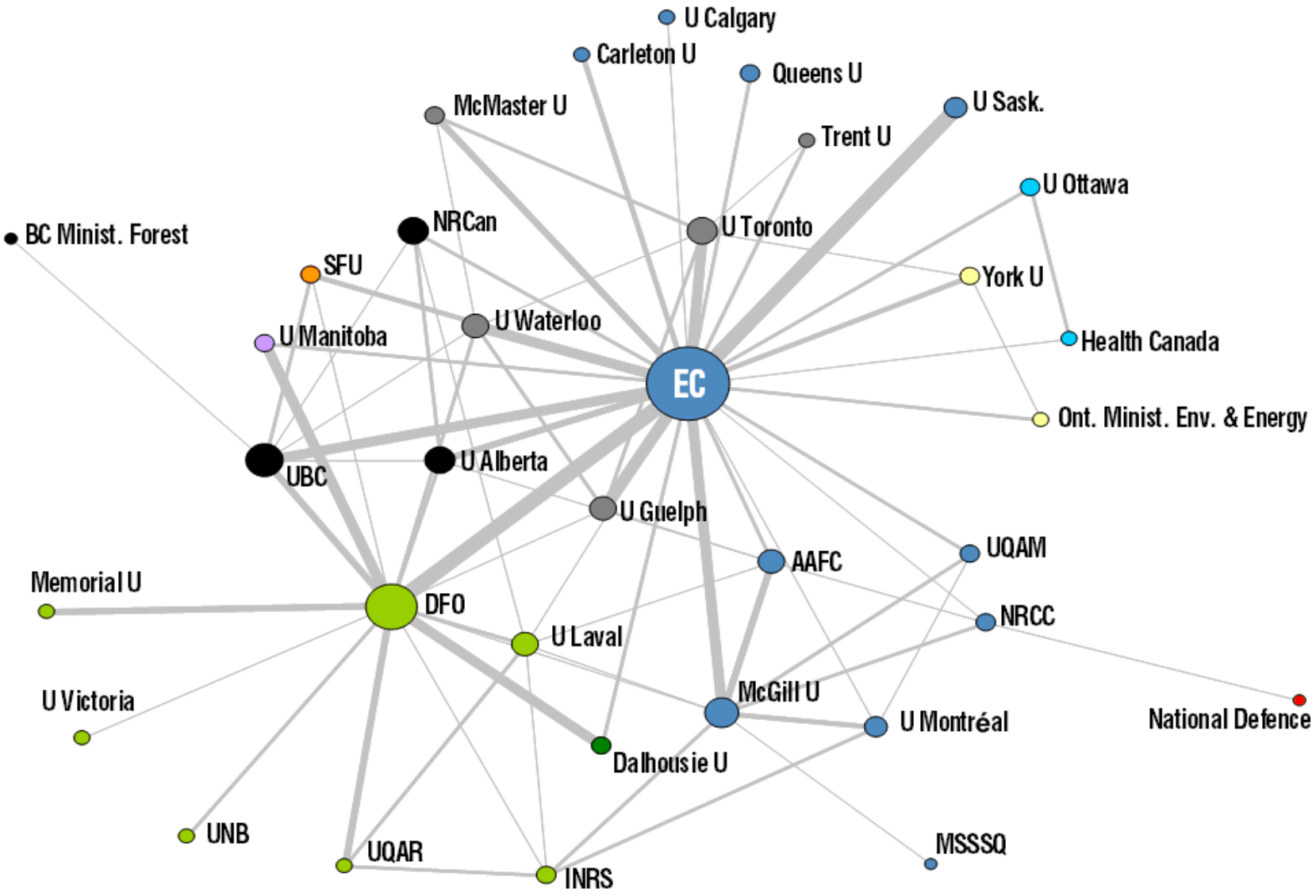
- Federal organizations have contributed to 38% (95-04) of the Canadian output in the field
- Environment Canada represents 43% (95-04) of the Federal output and 14% of Canada's output in the field
- The scientific impact (quality and expected citations) of Federal research is likely the same as academic institutions (9% higher than the world level, 95-04)
- Environment Canada's scientific impact is one of the highest among other leading Canadian institutions (14% higher than the world level, 95-04)

The most productive Canadian institutions in environmental research (1995–2004)

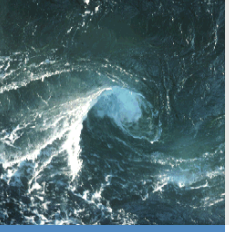
CDN rank	World rank	Institution	Papers 95-04	ARIF 95-04	Int'l collabo	Nat't collabo	*Rank (25 yrs)*
1	7	Environment Canada	3 033	1,14	33,9%	54,7%	*(1)*
2	25	Fisheries and Oceans Canada	1 826	1,16	28,7%	53,4%	*(2)*
3	28	University of British Columbia	1 761	1,11	34,9%	34,0%	*(3)*
4	47	University of Toronto	1 327	1,18	32,7%	35,9%	*(4)*
5	51	McGill University	1 262	1,09	32,6%	43,3%	*(5)*
6	53	University of Alberta	1 149	1,05	26,0%	40,7%	*(7)*
7	79	University of Guelph	968	1,08	29,3%	43,8%	*(6)*
8	82	University of Waterloo	917	1,18	29,0%	43,4%	*(9)*
9	91	Natural Resources Canada	870	1,03	26,6%	53,0%	*(11)*
10	96	Université Laval	832	1,05	26,9%	41,6%	*(10)*
11	110	Agriculture & Agri-Food Canada	751	0,97	21,0%	54,2%	*(8)*
12	140	Dalhousie University	655	1,16	39,7%	37,4%	*(12)*
13	159	Université de Montréal	614	1,06	28,2%	47,4%	*(14)*
14	161	University of Saskatchewan	608	1,01	33,4%	48,4%	*(15)*
15	164	Simon Fraser University	601	1,12	22,6%	38,4%	*(13)*
16	184	McMaster University	540	1,20	33,0%	48,0%	*(16)*
17	>200	University of Manitoba	492	1,02	19,1%	50,8%	*(17)*
18	>200	University of Victoria	472	1,17	34,5%	33,9%	*(26)*
19	>200	Queen's University	467	1,09	24,8%	45,6%	*(19)*
20	>200	York University	452	1,10	36,9%	44,2%	*(24)*
21	>200	University of Ottawa	447	1,11	25,7%	48,8%	*(23)*
22	>200	University of Calgary	432	1,10	41,0%	39,8%	*(18)*
23	>200	Memorial University of Newfoundland	427	1,03	30,4%	41,0%	*(22)*
24	>200	Université du Québec à Montréal	426	1,11	26,5%	54,9%	*(28)*
25	>200	University of Western Ontario	409	0,96	39,1%	36,4%	*(21)*



Environment Canada is the principal hub of environmental research in Canada…



Network of the most collaborative Canadian institutions in environmental research (1995–2004)



Scientific output and scientific impact of the most productive Canadian institutions by area, 1995–2004

Climate, Meteorology & Atmosph. Sci.

Rk	Institution	Papers	ARIF
1	Environment Can	935	1.07
2	McGill U.	268	1.00
3	UBC	202	1.07
4	U. of Toronto	196	1.12
5	York U.	196	0.97
6	U. of Victoria	188	1.28
7	NRCan	175	0.95
8	Dalhousie U.	132	1.05
9	Fish. & Oceans Can	114	0.79
10	U. of Alberta	111	0.93

Environmental Sciences - General

Rk	Institution	Papers	ARIF
1	Environment Can	431	1.22
2	U. of Toronto	247	1.20
3	Fish. & Oceans Can	244	1.09
4	NRCan	197	1.33
5	U. of Alberta	180	0.97
6	McGill U.	153	1.27
7	UBC	151	0.90
8	U. of Waterloo	119	1.39
9	U. of Guelph	108	0.97
10	Trent U.	96	1.28

Ecology & Biological Resources

Rk	Institution	Papers	ARIF
1	Fish. & Oceans Can	956	1.17
2	UBC	605	1.26
3	Environment Can	469	1.15
4	Université Laval	420	1.08
5	SFU	377	1.14
6	U. of Toronto	353	1.31
7	U. of Alberta	345	1.10
8	U. of Guelph	344	0.98
9	McGill U.	325	1.14
10	Dalhousie U.	320	1.27

Pollution, Env. Toxicology & Health

Rk	Institution	Papers	ARIF
1	Env. Canada	587	1.24
2	UBC	244	1.02
3	U. of Toronto	235	1.04
4	Fish. & Oceans Can	224	1.43
5	Health Canada	217	1.04
6	McGill U.	214	1.00
7	U. of Waterloo	206	1.16
8	U. of Guelph	196	1.34
9	McMaster U.	178	1.35
10	U. de Montréal	177	1.00

Water Resources

Rk	Institution	Papers	ARIF
1	Environment Can	379	1.07
2	U. of Waterloo	262	1.24
3	Fish. & Oceans Can	236	1.06
4	UBC	198	1.20
5	U. of Toronto	130	1.18
6	McGill U.	103	1.07
7	U. of Alberta	91	1.16
8	U. of Guelph	87	1.07
9	INRS	85	1.18
10	McMaster U.	75	1.13

Env. Planning, Management & Conserv.

Rk	Institution	Papers	ARIF
1	UBC	218	0.97
2	Agri. & Agri-Food Can	167	1.34
3	U. of Alberta	156	0.97
4	NRCan	149	0.83
5	U. of Guelph	134	1.03
6	Environment Can	130	1.11
7	McGill U.	94	1.29
8	U. of Toronto	82	1.24
9	BC Ministry of Forests	71	0.67
10	University of Sask.	68	0.85

Who does EC work with?

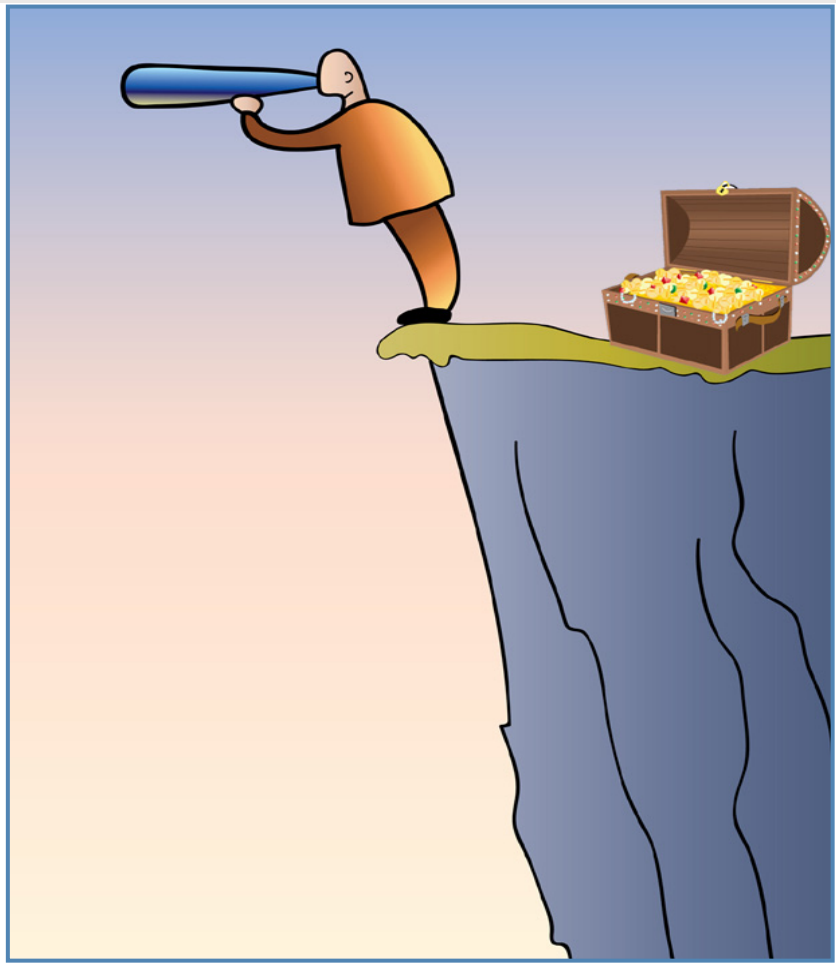
- **EC is the #1 collaborator of almost all of the 14 most productive institutions in environmental research in Canada**
- **Over 80% of EC papers produced in collaboration with external-to-EC scientists**
- **Collaboration rate has risen significantly over the past 25 years**
  - *~25% to > 60% nationally*
  - *~10% to ~35% internationally*
  - *~32% to > 80% overall*

The Bottom Line

- **There's LOTS more in the report, but in terms of environmental research…**
  - ***Environment Canada's research:***
    - ✓ *ranks 1st in Canada and 7th in the world*
    - ✓ *is credible and has high impact compared to the world level*
    - ✓ *is highly connected and collaborative*
  - ***Canadian Federal science is very important, but***
  - ***Canada's position as a global leader over the last 25 years is likely to change in the coming years if additional research efforts are not deployed***

The pitch…

- As Science Writers don't hesitate to make your first call on environmental science issues to an Environment Canada* scientist
- And if they aren't the most appropriate contact they likely know who is!



** And also to scientists from other federal science-based departments such as Fisheries and Oceans Canada, Natural Resources Canada, and Agriculture & Agri-Food Canada. In fact, federal organizations contributed to nearly 40% of the Canadian output in environmental research between 1995 and 2004, and Environment Canada was responsible for 43% of the federal output in the field over that period.*

Thank you …!

Any Questions?

The world's most productive institutions in environmental research (1995–2004)

Rk	Institution	Country	Papers	ARIF	Nat't collabo.	Int'l collabo.	Rk 25 Yrs
1	NOAA - National Oceanic & Atmospheric Admin.	US	4,476	1.14	69.5%	22.2%	*(1)*
2	USEPA- US Environmental Protection Agency	US	3,505	1.17	69.2%	13.4%	*(2)*
3	USDA ARS- Agricultural Research Service	US	3,472	1.10	50.0%	14.6%	*(3)*
4	NASA	US	3,279	1.21	79.0%	32.3%	*(4)*
5	USGS - US Geological Survey	US	3,275	1.18	61.2%	12.5%	*(9)*
6	University of Washington	US	3,142	1.18	52.0%	22.4%	*(5)*
7	Environment Canada	Canada	3,033	1.14	54.7%	33.9%	*(7)*
8	CSIC - Consejo Superior de Investig. Cient.	Spain	2,688	1.11	35.5%	37.7%	*(25)*
9	University of Wisconsin	US	2,662	1.18	51.2%	17.5%	*(6)*
10	University of California, Davis	US	2,640	1.21	43.8%	22.4%	*(8)*
11	University of Colorado	US	2,530	1.17	66.0%	21.9%	*(19)*
12	University of Maryland	US	2,482	1.22	60.0%	21.7%	*(13)*
13	Colorado State University	US	2,269	1.07	55.1%	19.0%	*(14)*
14	University of California, Berkeley	US	2,200	1.23	50.5%	23.0%	*(17)*
15	NCAR - National Center for Atmospheric Res.	US	2,167	1.18	62.7%	33.8%	*(23)*
16	Chinese Academy of Sciences	China	2,150	0.85	32.4%	41.2%	*(43)*
17	Texas A&M University System	US	2,123	1.00	48.8%	17.3%	*(15)*
18	Oregon State University	US	2,119	1.12	56.7%	19.6%	*(16)*
19	Russian Academy of Sciences	Russia	2,044	0.70	17.4%	44.0%	*(12)*
20	USDA FS - Forest Service	US	1,996	0.92	72.1%	13.7%	*(20)*
21	Cornell University	US	1,939	1.18	42.0%	20.4%	*(18)*
22	University of Florida	US	1,850	1.06	45.0%	19.1%	*(21)*
23	University of Arizona	US	1,841	1.16	44.5%	21.2%	*(26)*
24	CSIRO	Australia	1,832	1.06	42.1%	32.4%	*(11)*
25	Fisheries and Oceans Canada	Canada	1,826	1.16	53.4%	28.7%	*(10)*

About some indicators?

- **Level of specialization (SI - Specialization Index)**

- *Percentage of papers in a field in one country to percentage of papers in this field at the world level (134 countries)*

$$SI = \frac{(\#\ \text{Can papers}_{\text{ENV. RES.}} / \#\ \text{Can papers}_{\text{ALL SCIENCE}})}{(\#\ \text{World papers}_{\text{ENV. RES.}} / \#\ \text{World papers}_{\text{ALL SCIENCE}})}$$

- **Scientific impact (Average relative impact factor)**

- *A proxy indicator of the **quality of science** and*
- *an indicator of **expected impact** of published research*
- *It is based on the journal impact factor*