Canadian Environmental Sciences Network (CESN) Discussion Paper

Working Paper No. 22

Science Policy Branch
Environment Canada

Document de travail n° 22

Direction de la politique scientifique
Environnement Canada

Working Papers *are interim reports on work of the Science Policy Branch, Environment Canada. They have received only limited review. These reports are made available, in small numbers, in order to disseminate the studies, promote discussion and stimulate further policy studies.*

Views or opinions expressed herein do not necessarily represent those of Environment Canada or of the federal government.

Comments or questions should be addressed to:

Director
Science Policy Branch
Environment Canada
8th floor
351 St-Joseph Boulevard
Hull, Quebec K1A 0H3

Telephone: (819) 994-5434

The French version of this publication is available on demand by contacting philip.enros@ec.gc.ca.

Les ***documents de travail*** *sont des rapports intérimaires sur le travail effectué par la Direction de la politique scientifique, Environnement Canada. Ils n'ont été examinés que de façon limitée. Ces rapports sont distribués en nombre restreint pour diffuser les études, promouvoir la discussion et favoriser la réalisation d'autres études d'orientations.*

Les opinions exprimés dans ce document de travail ne reflètent pas nécessairement celles d'Environnement Canada ou du gouvernement fédéral.

Veuillez transmettre vos questions ou commentaires au :

Directeur
Direction de la politique scientifique
Environnement Canada
8e étage
351, boul. St-Joseph
Hull (Québec) K1A 0H3

Téléphone : (819) 994-5434

La version anglaise de cette publication peut être obtenue sur demande en communiquant avec philip.enros@ec.gc.ca

CANADIAN ENVIRONMENTAL SCIENCES NETWORK (CESN)

DISCUSSION PAPER

MARCH, 2001

SCIENCE POLICY BRANCH
ENVIRONMENT CANADA

TABLE OF CONTENTS

1.0 INTRODUCTION

Environmental knowledge is critical to making sustainable development a reality. Environmental knowledge is needed to make responsible decisions about the environment; to ensure accountable policy-making; and to enable actions which will sustain the environment for future generations. Science and technology (S&T) provide a means for assessing, as well as predicting, the state and functioning of the earth's environmental carrying capacity. Through contributions to knowledge used for technical change, innovation and better decision-making, science and technology offer the potential for allowing economic and population growth to continue within the limits of the earth's environmental carrying capacity. Science and technology also underlie the generation and dissemination of information that enables community-based capacity building and local-level decision-making in support of sustainable development.

Science and Technology for the New Century - A Federal Strategy recognized three broad goals for S&T - job creation and economic growth; improved quality of life for Canadians; and advancement of knowledge. It also emphasized the importance of institutional diversity and dynamic interplay between institutions in Canada's national innovation system, including federal S&T departments and agencies.[1]

The federal S&T Strategy re-enforced the accountability of federal science-based departments and agencies for providing direction to (and obtaining results from) their S&T activities while emphasizing the need for increased horizontal coherence in federal S&T priority setting and governance. The S&T Strategy also set key directions for S&T, such as improving the effectiveness of federally supported research; capturing the benefits of partnerships and networks; and emphasizing S&T for preventative approaches and sustainable development.

> We must build the institutions, partnerships and networks needed to link individual skills and talents. At the heart of our ability as a nation to meet these challenges lies the creation of a more effective, integrated innovation system, which recognizes the interdependence and interconnections between wealth and job creation, quality of life and advancement of knowledge.
>
> Science and Technology for the New Century - A Federal Strategy, 1996.

In their recent report *Building Excellence in Science and Technology (BEST): The Federal Roles in Performing Science and Technology*, the federal Council of Science and Technology Advisors (CSTA), re-affirmed the roles of the federal government in performing S&T in Canada. At the same time, however, they noted that that federal science-based departments need to invest greater

1 The national innovation system is broadly conceived as the various institutions and actors who conduct and support the advancement of science and technology.

efforts in co-ordinating efforts across their respective innovation systems.

The BEST report noted,

> *We strongly believe that there is a critical role for the federal government in performing S&T to fulfil the mandates entrusted to it by the Canadian people. We also believe that there is a need for a more horizontal approach to S&T priority setting in government and departments, as well as across the innovation system. The approach should bring together stakeholders for cooperative planning, execution and valuation.*[2]

Canada's environmental science and technology efforts are currently at a crossroad.[3] After more than two decades of steady growth, from the 1970s to the mid-1990s, Canadian investment in environmental science has levelled off or is starting to decline. The demand for environmental knowledge, however, continues to grow. While unique institutional arrangements, in the form of environmental science networks, have been developed to improve the mobilization of Canadian scientific talent for addressing specific environmental issues, the overall Canadian environmental sciences community is relatively fragmented, uncoordinated, and lacking in common direction. There is no common vision, science agenda, or institutional framework to guide the environmental sciences in Canada and the notion of a Canadian environmental innovation system exists only in conceptual, rather than in concrete terms. Concern is mounting that Canada's environmental sciences community, as currently organized and funded, will not be able to meet the expanding demands to provide the knowledge needed to support environmental decision-making, public policy development, environmental services, or new technologies in support of sustainable development.

2.0 DIAGNOSTIQUE

Canadians value human health and environmental quality as important facets of their quality of life and as the basis for a high standard of living. Maintaining and improving environmental quality is directly connected to the sustainability of our health and economic prosperity. The environment is an extremely complex and inter-connected system which supports and bears the effects of human activities. Canadians want to improve their understanding of environment and environmental problems. Canadians also want Canada to be recognised internationally as a leader in the advancement of environmental knowledge and an effective contributor to sound environmental decision-making.

---

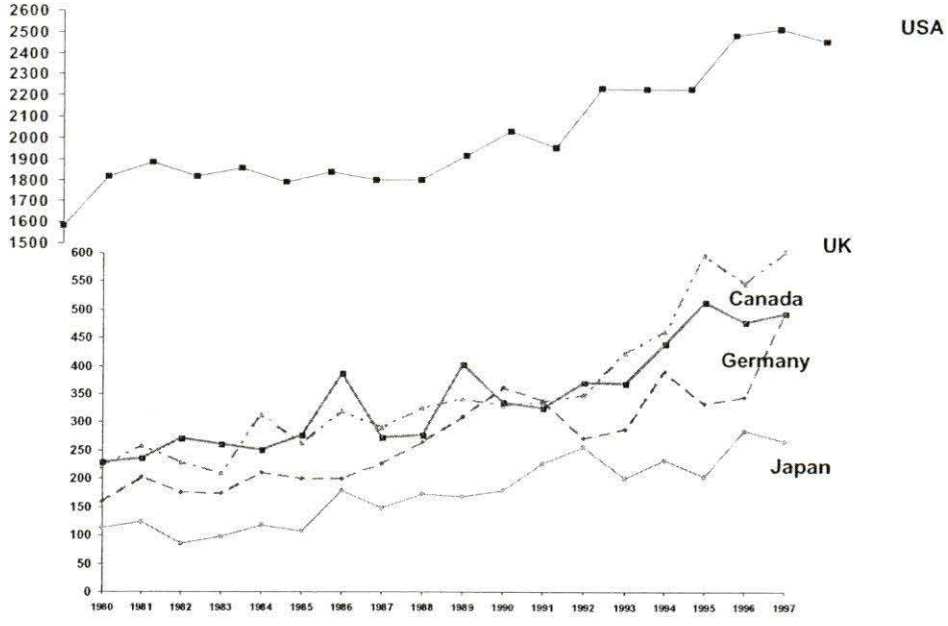
2 Council of Science and Technology Advisors. 2000. Building Excellence in Science and Technology (BEST): The Federal Roles in Performing Science and Technology.

3 For the purposes of this document, science refers to research and development (R&D), as well as monitoring, scientific assessment, data collection, and reporting of information.

The environmental sciences covers a broad range of scientific disciplines - including the natural, physical, social, engineering sciences, and humanities. Environmental science activities are not easily classified. They are often transdisciplinary and undertaken or financed by many different institutions including government departments and agencies, universities, colleges, non-government & Aboriginal organizations, community groups, and private sector companies.

Canada has historically been a world leader in the generation of environmental knowledge. A recent study of environmental scientific outputs in the natural, physical and engineering sciences indicated that Canada is consistently within the top four nations in the world in terms of production (Figure 1). At some points in the recent past, Canada has been the second most productive nation in these areas of the environmental sciences.

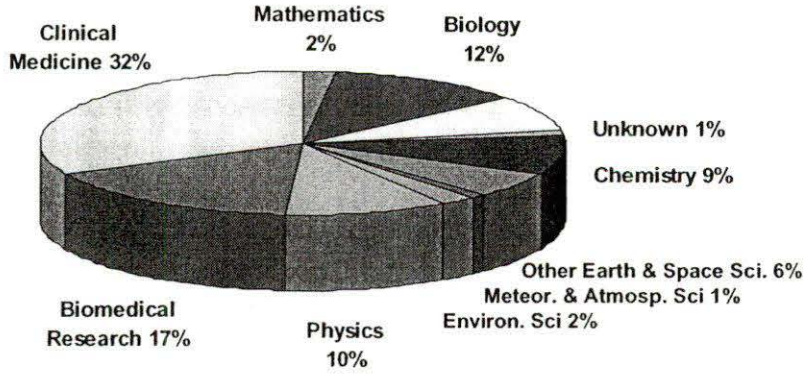
Figure 1: Top 5 countries for environmental science - as measure by research publications in the natural, physical and engineering sciences.[4]



In terms of Canada's total scientific output, the environmental sciences are a relatively small area of activity. In 1997, the environmental sciences comprised approximately 3% of Canada's total output in the natural, physical and engineering sciences.

4 Results drawn from a bibliometric database containing publications from some 4,000 scientific journals indexed by the Institute for Scientific Information. These are the most important and prestigious peer-reviewed journals. They reflect the most significant scientific achievements and are also the most widely cited (they comprise 80% of the world's citations). The results do not capture the social sciences and humanities, highly specialized journals, strictly Canadian journals or "grey literature" (conference proceedings, research reports, internal periodicals, etc.).

Figure 2. 1997 distribution of Canada's natural, physical and engineering scientific output by field.



The environmental sciences contribute significantly to the high quality of life enjoyed by Canadians. Environmental knowledge identifies threats to ecosystem and human health; provides support for decisions and actions on environmental issues; and underlies public awareness of environmental and health issues, selection of policy instruments, services for Canadians, support for remediation and adaptation. The environmental sciences also provide an essential knowledge base to support investment decisions, commercial activities, and technological innovation.

Some Impacts of Canadian R&D on the Depletion of Stratospheric Ozone

- Significant impact on the development of the Montreal Protocol to phase out ozone depleting substances worldwide.
- Led to the development of the UV Index & commercializable technologies, such as refrigerant substitutes and the Brewer spectrophotometer.
- Benefits far exceed the costs of research. Environment Canada spent $108M from 1975-1997. Each R&D $ will generate $7.90 in avoided health care costs (to 2060), $3.03 in environmental benefits, and $1.94 in economic benefits.

The long-term nature of most environmental issues and the policy responses to them tend to generate a cumulative need for knowledge. On the demand side - environmental issues are increasing in both number and complexity. Demands from government and policy systems are growing - a recent article in the journal *Nature* documented a 6-fold increase in the S&T content of Parliamentary Business in the UK in the 10 years between 1989-1999. Many of the most consuming issues on the public agenda today are

complex science-based concerns such as global climate change, the impacts of toxic substances on human health and the environment, urban air quality, water quality, and ecosystem integrity.

As Canada's economy expands, so does the demand for environmental knowledge. The growth of new economic sectors, such as biotechnology, has created new demands for environmental knowledge. As the economy diversifies, our scientific capacity and knowledge base must become increasingly diversified and sophisticated in order to monitor and assess ecosystem health and integrity. The growth of environmental knowledge-based industries and businesses is also expanding the demand for underlying environmental knowledge and access to expertise. Between 1996-98, nineteen Canadian knowledge-based firms working in the water resources sector attracted $20 million worth of contracts from the World Bank alone. Survey results indicate that these companies are heavily dependent upon the Canadian environmental knowledge base to support their international competitiveness.

International environmental knowledge demands are also growing. Over the past twenty years, there has been exponential growth in the number of international environmental agreements, all of which are based on science. This has a cumulative impact on the demand for knowledge, since these agreements are rarely terminated. Finally, public expectations have grown. While the public expects credible science to provide answers and management solutions to increasingly complex environmental problems, the science underlying these efforts is often contested and challenged. The complexity of issues and their socio-economic consequences has increased the demand for transdisciplinary knowledge integration. And new collaborative approaches are needed to improve the credibility of scientists and their interactions with the public. Major scale science assessment exercises, such as those mounted by the Inter-governmental Panel on Climate Change, are becoming more pervasive.

The Canadian environmental sciences community and its underlying funding infrastructure has not kept pace with these evolving demands. The federal government, which currently produces approximately ½ of Canada's environmental scientific knowledge in the natural and physical science areas, has significantly reduced its scientific capacity since the mid-1990's.[5] The provinces have also significantly reduced their expenditures on the environmental sciences over the past decade.

5 A recent study of Canada's research publications in 1995 showed that: 25% of Canada's environmental and 34% of Canada's atmospheric research publications were authored or co-authored by Environment Canada scientists. See *Environment Canada's Scientific Research Publications 1980-1997.* Working Paper No. 6, Science Policy Branch, Environment Canada.

Provinces Expenditures on Environmental Issues R&D 1992/93 and 1998/99

According to Statistics Canada information, provincial government spending on environmental issues R&D has been cut by more than 50% between 1992/93 and 1998/99:

- In Alberta, overall funding for environmental issues research decreased by 69%.
- BC decreased R&D on environmental issues by 67%.
- Ontario's overall decrease in environmental issues R&D was 16%.
- Quebec decreased both extramural spending (78%) and intramural spending (45%) on environmental issues R&D, for an overall decrease of 72% in this area.
- Saskatchewan is the only province reporting an increase in expenditures on environmental issues R&D (Saskatchewan increased its expenditures in this area by 90%). Extramural spending more than doubled, while intramural spending decreased by 23%.
- Manitoba drastically reduced its overall expenditures on environmental issues R&D from $769,000 to $13,000 (a 98% reduction).
- Between 1992 and 1998 in Alberta, BC and Quebec overall R&D expenditures remained relatively constant or increased, while expenditures on environmental issues R&D were dramatically reduced.

While some new federal investments in some specific environmental science initiatives (e.g. Toxics Substances, Climate Change) have helped off set these decreases, evidence suggests that some major new sources of S&T funding have yet to reinvigorate the Canadian environmental sciences community. For example, despite being singled out as a priority area for attention by the new Canada Foundation for Innovation (CFI), the environmental sciences have managed to secure only 4.2% of total funding allocated to date. In the 1998 reallocation exercise held by the Natural Sciences and Engineering Research Council of Canada (NSERC), the environmental sciences made some gains under the evolution and ecology theme, but these were more than offset by significant decreases in other areas (particularly earth and atmospheric sciences and engineering themes). The environmental social sciences are not currently a strategic priority for attention within the Social Sciences and Humanities Research Council of Canada (SSHRC) - although some innovative network-based initiatives are under development in areas such as ocean and forestry management.

Only two of 22 Networks of Centres of Excellence funded by the federal government is dedicated to the environmental sciences - while no fewer than 7 focus on human health issues. Moreover, these NCEs tend to exclude environmental scientists from federal and provincial government organizations (in Canada approximately 50% of all environmental science is generated by the federal government). In Australia, a similar program of Cooperative Research Centres (CRC's) has dedicated approximately 1/3 of these networks to the environmental sciences, funding collaborative arrangements between government, university and private sector scientists. In the US, environmental science, technology and engineering have risen to the very top as a funding priority. An environmental S&T strategic plan has been developed by a special National Science Foundation (NSF) Task Force - with a plan to triple the NSF's investment in environmental sciences from $600 M US to $1.6 Billion US over the next five years.

Significant changes in the way that Canada's environmental sciences efforts are organized and funded are necessary to continue meeting environmental challenges, demands for knowledge, and delivering on obligations within the global community. Requests for investment of public money to re-establish lost or build new science capacity is a difficult case to make, even if knowledge gaps and clear deliverables for the future can be demonstrated. To find ways of increasing the mobilization of a diverse range of institutions and resources comprising Canada's environmental science effort, a number of significant problems require resolution. The most striking problems are:

2.1 Fragmentation

Canada's environmental science efforts are widely dispersed among a broad range of different institutions and actors. Environmental science is conducted by several federal government departments and agencies, provincial and territorial government departments, universities, non-government organizations, community groups, and Aboriginal organizations. Moreover, environmental science is not a homogeneous discipline, rather it spans the physical, natural and social sciences. Within a single university environmental science is often conducted in separate departments of biology, chemistry, engineering, economics, geology and earth sciences, physics, geography, atmospheric sciences etc.

Current approaches to partnerships and networks achieve limited integration across natural, physical & social sciences. A relatively fragmented Canadian environmental sciences community at the macro-level has been unable to take full advantage of recent innovation investments (e.g. the Canada Foundation for Innovation). From a Canada-wide perspective, moreover, there is a lack of structure and leadership regarding the common direction and organization of our environmental science efforts. While strategic efforts and science agendas have been set for areas such as biotechnology, agricultural science, forestry research, telecommunications science, and the development of advanced materials, no similar approach has been attempted with respect to the environmental sciences in Canada. Fragmentation of effort and the lack of integrated, multi-disciplinary approaches to environmental science has led to a situation where it is difficult to know if

serious knowledge gaps exist, where they exist, and where future science efforts should be directed.

2.2 Inadequate Research Environment

The relative fragmentation of the Canadian environmental science system has failed to provide the profile needed to demonstrate the strength and impacts of Canada's efforts in this area or ensure that Canadian environmental scientists can meet their full potential. Canada does not possess a mechanism through which efforts can be undertaken to attract and retain top scientists to work in the environmental sciences. Many distinct environmental science programs and funding initiatives, and the lack of a national focal point for the Canadian environmental sciences community, have reduced the overall profile of Canada's environmental science efforts relative to other scientific areas.

2.3 Underfunding

Despite being an area of historic strength and leadership, Canada's current environmental S&T infrastructure and resources are in a state of rust out and decline. National facilities, scientific equipment, and important environmental monitoring systems maintained by Environment Canada and other federal departments have fallen into disrepair. Environment-specific university funding initiatives, such as the Eco-Research Program, have been discontinued, and government S&T spending for environmental science has been scaled back at both the federal and provincial levels. New investment is required to enhance Canada's environmental science effort - strengthening human resources, facilities and equipment for environmental science, environmental science programs, reporting, and efforts to make more effective use of environmental knowledge.

2.4 Inadequate Application of Knowledge

Insufficient attention has been paid to the use of environmental knowledge as a means for improving the environment or the health of Canadians. The result is confusion about where Canadians can get sources of environmental knowledge in a form that is readily useable. Environmentally sustainable economic development and job creation opportunities which can result from Canadian efforts in environmental science are not being fully realised. Canadians are not as well informed on environmental issues and decision-making as they could be.

3.0 INSTITUTIONAL ROLES IN ENVIRONMENTAL S&T

The Federal S&T Strategy recognized that a strong and dynamic national S&T system in Canada requires strength in all three of the key S&T institutional sectors - universities, government and industry - as well as interactions among and between these three sectors. The federal roles in environmental S&T are significant. The federal government provides national vision, leadership

and ensure the relative strength of S&T institutions which produce environmental knowledge. The federal government also supplies environmental funding support to non-federal S&T institutions including universities and the private sector. Finally, the federal government is a significant performer of environmental S&T in Canada - much more so than in some other important "public good" science sectors such as the health research sector.

There are historical, economic and political reasons for the strong federal role in environmental S&T. Significant investments in environmental S&T were made in the early 1970's, at a time when university-based environmental science was not very well developed. In many cases, the federal government has been uniquely situated to undertake environmental S&T roles which would otherwise be missing from Canada's S&T system or which no other national S&T institution could/would manage (e.g. environmental monitoring; establishment of large scale inter-disciplinary studies). Increasingly, the roles of universities and the private sector have become more important in the Canadian environmental sciences community. University research capacity has increased significantly over the past two decades and special schools of environmental studies have been established at most Canadian universities. New university-based networking initiatives, such as the establishment of the Canadian Consortium for Sustainable Development Research (CCSDR), have been established. Universities also collaborate extensively with the federal government in the environmental sciences; environmental science networks such as the Climate Research Network, the Metals in the Environment Research Network, and the Atlantic Cooperative Wildlife and Ecology Research Network were specifically established to foster university-government and in some cases university-government-private sector research collaboration.

> Canada's innovation system -- its S&T institutions and the linkages between them which, together, provide the knowledge needed for a progressive society and economy -- is dependent on having complementary strengths in three key sectors: the private sector, universities and governments.
>
> Council of Science and Technology Advisors, *Building Excellence in Science and Technology.*

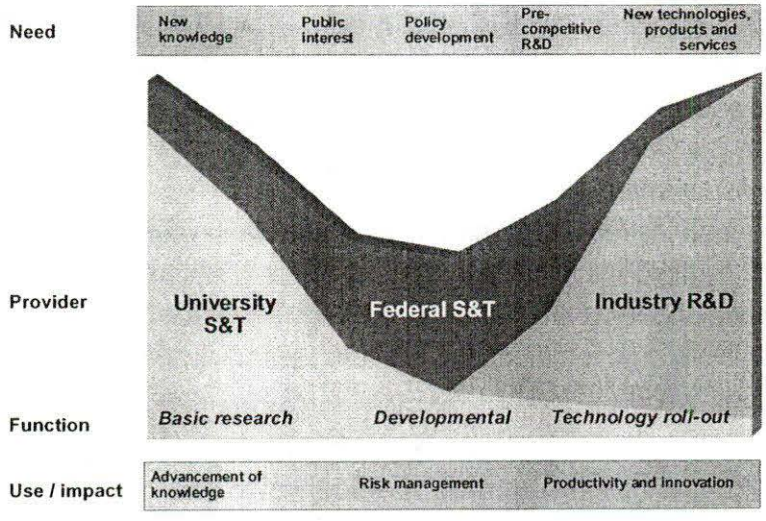
Institutional Innovations: Environmental Science Networks

- Collaborative mechanisms linking different organizations or individuals.
- Encourage sharing of information, exchange methodologies and forms of practice.
- Undertake collaboration on initiatives such as training, R&D, monitoring and data collection, commercialization, & provision of services.
- Each has a unique governance structure, functions, organization, funding arrangement.

The private sector has also become a key performer of environmental science to augment core business functions or to serve as a core business function (e.g. environmental consulting or technology firms). New environmental industry associations, such as the Canadian Environmental Industries Association (CEIA), have been established. The Environmental Science and Technology Alliance of Canada (ESTAC) is a unique Canadian organization established to foster environmental research partnerships between sponsoring members from the private sector and universities which conduct environmental research. The Canadian Environmental Technology Advancement Centres (CETACs) were established under the Green Plan to help facilitate the commercialization of environmental technologies in Canada. The private sector is a key supporter and participant in environmental research consortia and networks such as the Canadian Pulp and Paper Research Consortium the Metals in the Environment Research Network.

Today, the federal government's environmental S&T role is complementary to the roles performed by the university and private sectors (Figure 3).

Figure 3. Complementary Roles of Universities, the Federal Government and the Private Sector in Environmental S&T



A recent bibliometric study of Canadian research publications in 1995 found that Environment Canada is still the most significant performer of environmental research in Canada in the natural, physical and engineering science areas. EC scientists were authors or co-authors on 25% of Canada's environmental research publications and 34% of Canada's atmospheric research publications in 1995. Moreover, the study found that EC occupies this significant position within the Canadian environmental research community because it has built significant research networks across the country. Almost 50% of EC's research output in 1995 was conducted in collaboration with external researchers.

New demands and expectations are being placed on government science in the aftermath of issues like the collapse of cod stocks and the Krever Commission on blood safety. Special areas of federal activity, such as conducting risk assessments, require new skills to determine things like the ecosystem effects of genetically modified crops and aquaculture operations. In a world with increasing routes for scientific information, the public is increasingly looking to the federal government to provide credible and unbiased scientific information, assessments, and advice. Canadians also expect world class environmental services, such as weather forecasts, emergency response, and hazard prediction - all of which are dependent upon environmental knowledge and S&T activities. Increasingly, these activities are being conducted through networks of environmental scientists from various institutions and disciplinary backgrounds. Assisting with the coordination of such networks has become a key function and competency of many federal scientists and research managers.

> There is a significant and growing gap between the demands placed on (federal) departments to provide and use scientific information and a federal infrastructure that is increasingly ill-equipped to do so.
>
> Report of the Commissioner of the Environment and Sustainable Development, 1999

Public good investments by the federal government in environmental S&T have had significant and far-reaching effects.[6] Federal S&T has provided support for Canadian leadership in the development of important international protocols and agreements on acid rain, the reduction of (stratospheric) ozone depleting substances, the protection of migratory birds, and global production of persistent organic pollutants. Federal environmental science has informed environmental regulations and helped protect Canadian trade to foreign markets. It supports critical environmental prediction services which Canadians and Canadian industry (e.g. airlines, shipping companies, farmers etc.) depend upon.

The federal government also provides important research facilities and infrastructure for Canadian environmental science efforts and networks. Examples include the Meteorological Service of Canada Supercomputer which is shared extensively with the Canadian university community, the

6 In two R&D impact studies conducted for Environment Canada, consultants found that the public good benefits of federal investments in pulp and paper effluent research and research on stratospheric ozone depletion far outweighed the costs of this research. Ground-breaking research on pulp and paper effluent conducted by the federal government has helped protect Canada's access to foreign markets, saved industry from high expenses to comply with inappropriate regulations (based on foreign R&D), and yielded many other benefits (monitoring measures, knowledge of other pulp & paper emissions, science capacity, etc.). The R&D cost of $13M (over 9 years) had an impact on Canada's GDP of approximately $546M. Environment Canada's stratospheric ozone research had a significant impact on the development of the Montreal Protocol (contributions of Canadian negotiators), led to the development of the UV Index (which has changed the behaviour of Canadians), and led to the development of the Brewer spectrophotometer which has been successfully commercialized. This research (which cost $108M over 28 years) has yielded $7.90 in health benefits, $3.03 in environmental benefits, and $1.94 in economic benefits per dollar expended.

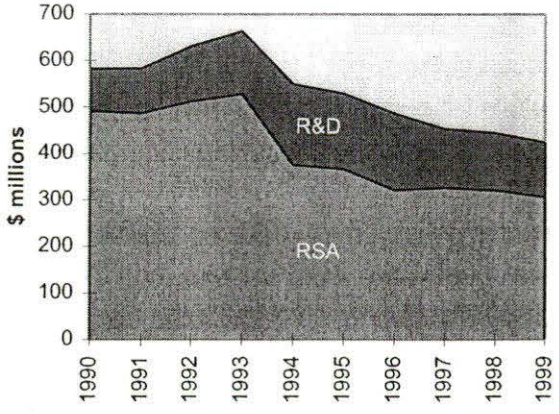
National Laboratory for Environmental Testing at the Canada Centre for Inland Waters, and the Eureka Environmental Observatory in the high Arctic. Federal researchers are often adjunct professors and supervise a large number of graduate students and post-doctoral fellows at Canadian universities.

3.1 Federal Expenditures on Environmental S&T

Environmental S&T can be divided between spending directed towards research and development (R&D) and that directed toward related science activities (RSA). Spending on total R&D within Environment Canada reached a high of $174 million 1994 and has fallen steadily since. Funding for RSA has also risen and then fallen dramatically through the 1990s - reaching a high of $528 million in 1993, but dropped to $306 million by 1999 (Figure 4).

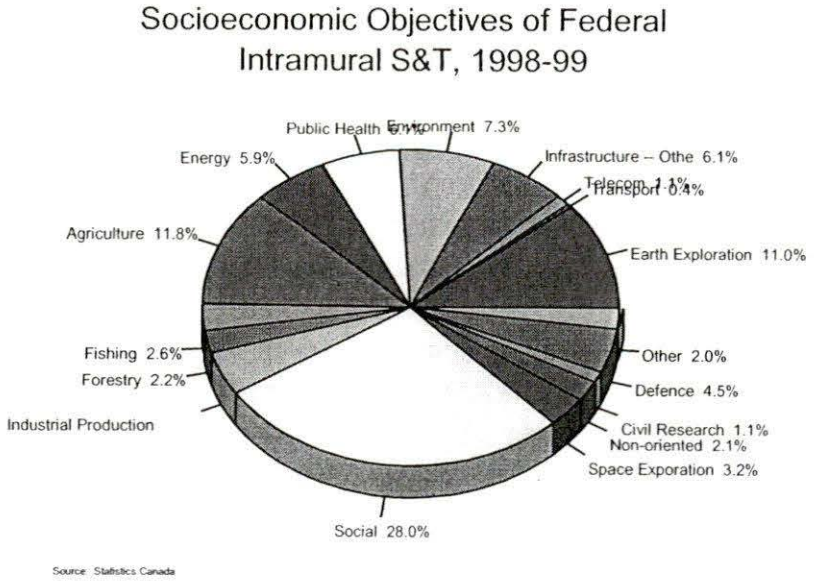
In 1999-2000, Environment Canada's S&T expenditures were about 36% lower than their highest levels during the previous decade; R&D spending had fallen by 29%, and Related Scientific Activities (RSA) had been decreased by 43%. Staffing for S&T fell by about 1,100, which mirrored spending cuts. Environment Canada has not been alone in being faced with budget reductions for S&T. Most federal science-based departments and agencies conducting environmental S&T confronted similar cuts.

Figure 4: R&D & RSA Spending at Environment Canada - 1990-1999.



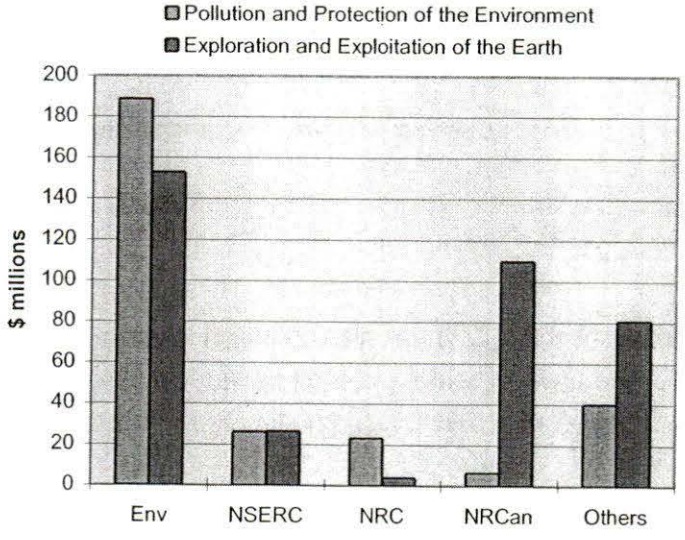
Federal S&T resource allocations are also classified according to standard socio-economic objectives. There are thirteen of these categories, as can be seen in Figure 5 below. In 1998, Environment Canada's S&T expenditures were wholly located within three socioeconomic objectives: Pollution and Protection of the Environment with 55% of expenditures, Exploration and Exploitation of the Earth with 44%, and Industrial Production and Technology with 1%.

Figure 5. Federal S&T Expenditures by Socio-Economic Objectives, 1999.



While a number of other departments and agencies within the federal government contributed towards S&T on Pollution and Protection of the Environment, the vast majority of the federal S&T effort for this socio-economic objective comes from Environment Canada (Figure 6).

Figure 6: Federal S&T Expenditures for Pollution and Protection of the Environment, and for Exploration and Exploitation of the Earth, 1998.



Environment Canada also plays a central role in the federal government's S&T expenditures for Exploration and Exploitation of the Earth. The total amount spent in this area in 1998 was $376 million, of which $152 million was spent by EC. Natural Resources Canada was the second largest source of expenditures in this area, with $109 million.

Provincial governments are another key performer and supporter of environmental S&T. Provincial governments spent a total of nearly $100 million on S&T activities in support of environmental issues (air, land, water, other) in 1994-95, although this amount has fallen since that time due to substantial budget cutbacks in most provincial government environment ministries.

Canada lacks a clear definition of what constitutes the "environmental studies" and hence cannot accurately determine the expenditures that are being made on the environmental sciences in Canadian universities or the private sector. However, some summary information is available. In the 1998 reallocation exercise of the Natural Sciences and Engineering Research Council (NSERC), the environmental sciences were predominantly covered by two areas - Evolution and Ecology and Earth and Atmospheric Sciences. Table 1 shows the results of the reallocation exercise. The evolution and ecology area received increased funding as a result of this exercise, while earth and environmental sciences were decreased in funding.

Table 1. Results of the 1998 NSERC Reallocation Exercise (all figures in $M)

	A Preallocation Budget (1998-99)*	% of Total	B Reallocation contribution (10% of A)	C Funds reallocated as the result of the submission**	% of Total	% of Preallocation Budget (C/A x 100)	Net change as a result of the submission*** (B+C)
Evolution and Ecology	12.174	5.9	-1.217	1.775	7.0	14.6	0.558
Other Life Sciences	46.579	22.8	-4.658	6.435	25.4	13.8	1.777
Solid and Environmental Earth Sciences	16.752	8.2	-1.675	0.962	3.8	5.7	-0.713
Other Physical Sciences	50.498	24.7	-5.050	6.589	26.0	13.0	1.539
Mathematics and Statistics	12.264	6.0	-1.226	1.937	7.6	15.8	0.711
Engineering	53.483	26.1	-5.348	5.295	20.9	9.9	-0.053
Computing and Information Science	12.910	6.3	-1.291	2.365	9.3	18.3	1.074

*Does not include a general Federal Budget increase of 10% for 1998/99

**Does not include approximately $5M distributed proportionally among all GSCs

***Does not include either the general Federal Budget increase for 1998/99 or the proportional distribution

The Canada Foundation for Innovation (CFI) has also compiled information on expenditures by area of mandate (Table 2). The environmental sciences have received a relatively small amount of total CFI funding - despite being identified as a high priority for attention.

Table 2. CFI Funding to date by mandated area.

	% of funds awarded	% of projects
Engineering	**14.2**	**21.7**
Environment	**4.2**	**9.8**
Health	**41.1**	**41.7**
Science	**24.1**	**26.5**
National Projects*	**16.4**	**0.3**

* - Canadian Light Source and National Site Licensing Project

4.0 LESSONS FROM RECENT FEDERAL S&T POLICY

The federal government has clearly made S&T investments a priority since the release of the Federal S&T Strategy in 1996. Significant new funding has been directed to the federal granting councils, as well as to new S&T institutions such as the Canada Foundation for Innovation, the Canadian Institutes for Health Research, and Genome Canada. Federal funding for research at universities, in particular, has been increased substantially (Figure 7) - a trend which is also evident in other key countries - but most prominent within Canada (Figure 8).

Figure 7

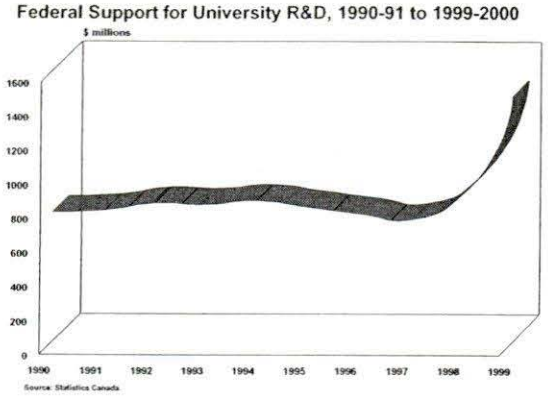
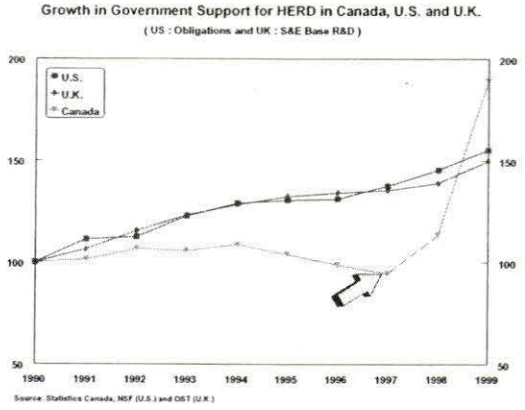


Figure 8



The Government has shown a high degree of interest in new S&T initiatives which promote strategic S&T networking and has establishing permanent funding for the Networks of Centres of Excellence program. A recent announcement pledged $750M in new funding for the Canada Foundation for Innovation (bringing the total invested in CFI to $3.15 Billion since 1997).

R&D conducted by the federal government, on the other hand, has declined in absolute terms, as a share of the national S&T effort, and as a percentage of national output (Figure 9 and 10). Investments in the federal government's in-house scientific activities have not kept pace with the growth in the other S&T sectors (universities and the private sector). From a peak in 1996-97, in-house federal R&D investment has dropped, on average, 3.2% each year. While this trend has been seen in a number of OECD countries, the drop has been quite dramatic in Canada.

Figure 9

Federal Intramural R&D Performance, 1990-91 to 1999-2000.

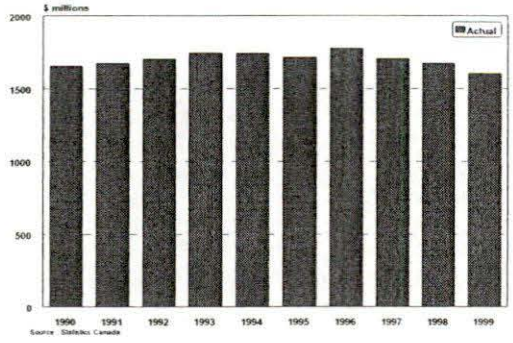
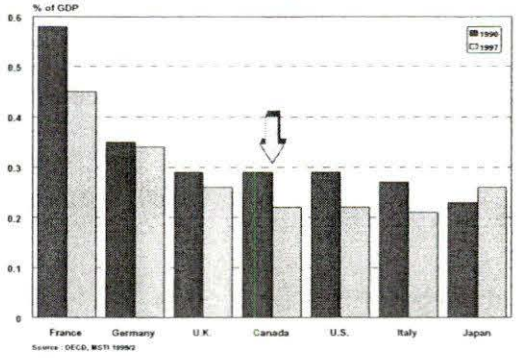


Figure 10

Government R&D as a Percentage of GDP, 1990 and 1997



In recent years, the government has made a very select number of investments to strengthen specific federal in-house scientific capabilities, including funds for biotechnology research and regulation, health, geographical information, toxic substances in the environment and space. Most of these investments were for innovative S&T initiatives that deliver knowledge through new governance mechanisms linked to the broader science community. Examples include the Toxic Substances Research Initiative (TSRI); Geoconnections; and the Canadian Biotechnology Strategy. The Canadian health research sector, moreover, has been significantly transformed by the development of the Canadian Institutes for Health Research (CIHR); the Canadian Health Services Research Foundation; the Canadian Health Network; and the Canadian Institute for Health Information (CIHI). The CIHR expanded and built upon the Medical Research Council, as well as provided new opportunities for the development of strategic health science networks.

In June, 2000 the Minister of Industry gave a presentation to the federal Cabinet outlining the key roles of the federal government in the knowledge-based society, and emphasized that partnerships are increasingly the way of life for science (to meet shared objectives & responsibilities; to share knowledge; to make best use of unique facilities; and to access knowledge and technology from elsewhere; and to share costs and risks.

> Collaboration among universities, federal research establishments, other levels of government and private industry creates synergies that increase the effectiveness of our S&T activities by capitalizing on the special strengths and expertise that each partner brings to the effort."
>
> Science and Technology for the New Century -- A Federal Strategy, 1996

These federal S&T roles were also outlined by the Council of S&T Advisors (CSTA) in their report *Building Excellence in Science and Technology (BEST)*. The BEST report noted the need for federal science departments to become more closely integrated within innovation system networks, and partnerships with institutions outside government.

There is a common view among federal science-based departments that science activity in the federal government should receive long-term attention; have adequate resources to fulfill the roles outlined in the BEST report; and be integrally networked with other partners in ways that recognize the wide variety of contributions of federal S&T to the innovation system. Environment Canada is well-positioned to take a leadership role in moving the Canadian environmental science community in a new direction which reflects these needs.

EC has recently appointed a new Science Advisor, as well as a new S&T Advisory Board. The primary function of the new Science Advisor is to foster S&T partnerships between the Environment Canada and universities involved in the Canadian environmental innovation system. The S&T Advisory Board has taken a keen interest in the Canadian environmental innovation system and the development of a new vision to strengthen this system. Discussion papers proposing the formation of Canadian Environmental Sciences Network have been prepared and discussed by the S&T Advisory Board. EC's Atlantic Region is facilitating the development of a Atlantic Environmental Research Network (AERN) - building on the existing Atlantic Cooperative Wildlife and Ecology Research Network (ACWERN). The Meteorological Service of Canada is taking steps fo develop an integrated Canadian Network of Atmospheric and Climate Research Institutes - a cluster of environmental science networks built around existing networks and institutes such as the Climate Research Network. Environment Canada has been instrumental in the development of significant environmental sciences networks including the Climate Research Network, the Ecological Monitoring and Assessment Network, and the Canadian Network of Toxicology Centres. New environmental sciences networks are currently under development - including a national Wildlife Research Network, a Canadian Water Research Network, and a national Air Quality Research Network.

Some Current Environmental Science Networks

- Atlantic Canada Ecology & Wildlife Research Network
- Canadian Biodiversity Information Network
- Canadian Climate Impacts and Adaptation Research Network
- Canadian Cooperative Wildlife Health Centre
- Canadian Environmental Technology Advancement Centres
- Canadian Network of Toxicology Centres
- Canadian Weather Research Network
- Climate Research Network
- Ecological Monitoring and Assessment Network
- National Hydrometric Network
- Metals in the Environment Network
- National Air Pollution Surveillance Network
- Canadian Forest Service Networks
- Sustainable Forestry NCE

The Atlantic Cooperative Wildlife & Ecology Research Network (ACWERN)

- $200K core funding from EC with equal match by NSERC for first 5 years (now in year 7).
- As of January, 31 2000:
- Over 40 research projects initiated; 45 students graduated; 32 current students (10 PhD, 18 MSc, 4 BSc); 2 PDFs.
- Over 35 papers accepted,15 in press; total ACWERN budget close to $1.2M.
- Knowledge contributions in areas such as effects of oil at sea on birds, effects of landscape change on frogs.

Climate Research Network

- Created in 1994 as a comprehensive collaborative research network.
- Consists of several Collaborative Research Groups focused on specific elements in a common research agenda. Involves 16 universities across Canada and supports over 100 researchers, students and support staff.
- Coordinated by the Canadian Institute for Climate Studies, University of Victoria. Cost-shared funding arrangement between Environment Canada (MSC) and leveraged resources from scientist participants.
- The Meteorological Service of Canada investment of $2.6M in 1996/97 leveraged an additional $2.95M.
- Research outputs from the CRN has allowed Canada to make significant contributions to the Intergovernmental Panel on Climate Change (IPCC) and the Kyoto process.

4.1 Opportunities for Action

There are significant opportunities to enhance and strengthen the effectiveness of the Canadian environmental sciences, given the government's commitments to S&T. Opportunity for All - the Liberal Red Book III committed to making Canada one of the top five countries in the world for research and development performance by 2010 by at least doubling federal expenditures on R&D.

By 2004 - the government will have increased R&D expenditures by at least $1 Billion. The January Speech from the Throne, the government reiterated its commitment to investing in R&D, innovation and the environment. In a recent speech to the Canadian Society of New York - the Minister of Finance emphasized R&D as an area where Canada must play catch-up, and highlighted the government's commitment in this area.

To take advantage of these opportunities, the environmental sciences community needs to reflect and build upon Canadian strengths and practices in environmental sciences networking and collaboration. The development of formal knowledge networks is an area where we have a strong story to tell. Canada leads the world in the formation of these types of networks (according to the International Institute for Sustainable Development) and has developed many different models and approaches. To move forward, however, a new mechanism is needed to:

- Enhance cross-disciplinary environmental knowledge integration and scientific collaboration.
- Provide a single national point of contact between providers and users of environmental knowledge.
- Increase the institutional connections (cohesion) within the overall Canadian environmental sciences community.
- Develop a Canadian Environmental Sciences Agenda and a rationalized government Investment Strategy for the environmental sciences.

5.0 A NEW VISION FOR ENVIRONMENTAL SCIENCE IN CANADA

As Canada prepares to tackle an increasingly complex environmental agenda, our national investment in environmental science and technology will play a central role in setting goals and enhancing performance. Many unresolved issues (such as small particle emissions or non-point sources of pollution) and emerging concerns (such as global climate, endocrine disruption and genetically modified organisms) defy easy answers and institutional mandates. They can be managed effectively only if the best scientists in the public and private sectors work together on the long-term research necessary to assess each issue objectively, if transdisciplinary and integrative approaches are brought to bear on common issues and challenges, and if the power of the entire innovation system is harnessed to achieve technological changes and innovations that generate environmental improvements without harming economic growth or the quality of life.

The capabilities of Canada's national environmental science institutions have not kept step with the growing need for good data and rigorous analysis to support decision-making or innovation.

Canada has not taken steps to needed to engage effective public-private collaboration in setting a national environmental sciences agenda, developing a national investment plan for the environmental sciences, and establishing adequate incentives for business to invest in developing and diffusing environmental technologies. The complex challenges of global climate, biodiversity, and other emerging issues require integrated assessments that draw on a range of disciplines, including science, technology, economics and public policy. The success of these efforts will depend on the long-term involvement of leading experts from the academic community, government and the private sector and on their effective collaboration in defining research needs, interpreting data as it emerges, characterizing the weight of scientific evidence and communicating their findings to agencies and the public. Improving the assessment process for emerging environmental issues will require upgrading the quality and relevance of government research programs on the environment and public health.

To move ahead in step with the overall direction of federal S&T policy and capture the benefits of recent federal investments in the national innovation system, a new vision for Canada's environmental science and technology system is needed. Such a vision needs to include two complementary elements:

1. The need to raise the profile of, and re-build "investor confidence" in, Canadian environmental science. Investors comprise the public and private sectors, and include institutions managing resources used to fund and conduct science.

2. The need to increase the mobilization and collective direction of existing resources within the Canadian environmental science system.

Canada's environmental science community will also require an effective, fully integrated research planning and management process with strong leadership. Partnerships and networking will continue to be key mechanisms through which the capacity of many environmental science institutions can be harnessed - so that the whole is larger than the sum of its parts. Older models of independent centres of S&T excellence are giving way to "networks of centres of excellence" and "virtual institutes". The networking of resources "horizontally" across a sectoral innovation system allows each institution to reinforce its inherent strengths and contribute its capabilities to those of the entire system. The International Institute for Sustainable Development (IISD) has recognised Canada's world-leading efforts in the creation of formal knowledge networks - many of these have been formed in areas of environmental sciences.

5.1 Canadian Environmental Sciences Network (CESN)

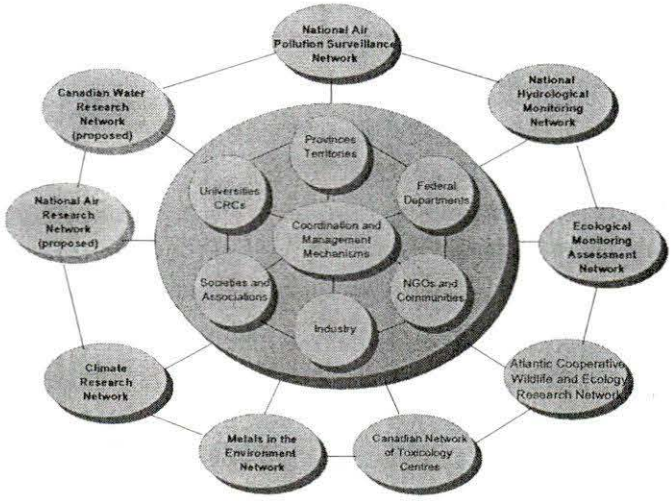
Environment Canada has proposed the creation of a Canadian Environmental Sciences Network (CESN) as a means for strengthening and enhancing Canada's environmental sciences efforts and community. The CESN would comprise a "Network of Networks" (Figure 11) and provide a new

horizontal approach for building on current areas of environmental science networking in Canada. CESN would provide a mechanism for strengthening and accelerating the production and use of environmental knowledge in Canada, thereby improving the ability of all Canadians to make informed decisions about the environment. CESN would also strengthen the science foundation for Canada's environmental knowledge industries (e.g. engineering, consulting) and contribute to a higher standard of living by strengthening the environmental research dimensions of the Canadian innovation system.

While the current state of environmental science networks is relatively fragmented with some loose linkages, a more integrated and coherent environmental sciences community would result from the establishment of CESN.

Current State of Environmental Science Networks in Canada

Figure 11. CESN Conceptual Model: A Network of Networks



CESN would address institutional , organizational and integration challenges by creating a national network of environmental sciences networks, working to achieve integration across institutions & disciplines, and providing links between knowledge providers & users. CESN would also address environmental sciences investment challenges through national environmental sciences agenda-setting; knowledge gap identification, and the development of a rationalized environmental sciences investment strategy for Canada.

The CESN would serve as a national focal point for the environmental sciences in Canada. Collective efforts to strengthen the capacity and quality of environmental sciences, and the use of environmental knowledge would be undertaken. CESN would link to and draw upon the key environmental sciences funding institutions and mechanisms in Canada (e.g. federal departments, the Canada Foundation for Innovation, the Natural Sciences and Engineering Research Council of Canada, the Social Sciences and Humanities Research Council of Canada, the Canada Research Chairs Program etc.). Moreover, the entire range of environmental sciences - from the natural and physical environmental sciences to the social sciences would be covered by this initiative.

The CESN would be a made-in-Canada approach towards conducting environmental science in support of sustainable development. Inter-disciplinary approaches would be encouraged and networks could serve as models of international excellence. Above all, the CESN would serve to significantly improve the quality of life of all Canadians by strengthening our knowledge and decision-making capabilities on environmental issues.

5.2 Potential Environmental Sciences Network Constituents of CESN (CESN Membership)

Possible environmental sciences networks which could comprise the CESN could include (this is not an exhaustive list):

- Atlantic Cooperative Wildlife and Ecology Research Network (ACWERN)
- Canadian Biodiversity Information Network (CBIN)
- Canadian Climate Impacts and Adaptation Research Network (C-CIARN)
- Canadian Cooperative Wildlife Health Centre
- Canadian Environmental Technology Advancement Centres (CETACs)
- Canadian Network of Toxicology Centres (CNTC)
- Canadian Weather Research Network
- Climate Research Network (CRN)
- Ecological Monitoring and Assessment Network (EMAN)
- National Hydrometric Network
- Metals in the Environment Network (MITE)
- National Air Pollution Surveillance Network (NAPS)
- Alberta Cooperative Conservation Research Unit (ACCRU) (under development)
- Canadian Air Quality Research Network (under development)

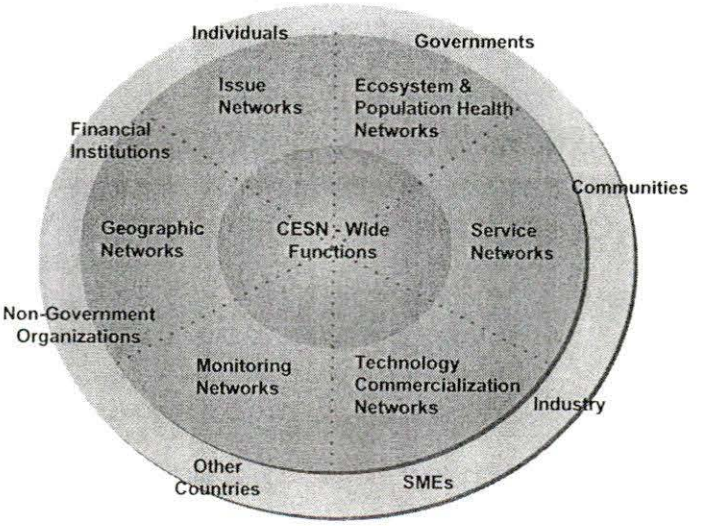
- Atlantic Environmental Research Network (AERN)
- Canadian Biodiversity Network (under development)
- Canadian Water Research Network (under development)
- Canadian Wildlife Research Network (under development)
- Children's Environmental Health Network (under development)
- National Integrated Monitoring Network (under development)
- Sustainable Development Policy Research Network (under development)

National and international environmental sciences associations and professional societies which could be included in CESN could include:

- Canadian Consortium for Sustainable Development Research (CCSDR)
- Canadian Federal of Biological Societies
- Canadian Foundation for Climate and Atmospheric Science (CFCAS)
- Environmental Science and Technology Alliance of Canada (ESTAC)
- International Institute for Sustainable Development (IISD)

The scope and boundaries of CESN membership will have to be determined at some point. Initially, CESN should be ***inclusive*** (i.e. open to all environmental sciences networks). There has been strong suggestions that the effort should encompass the environmental sciences - reflecting a network of natural, physical, engineering and social sciences networks. A further consideration is the nature of different types of environmental sciences networks. Several clusters of networks can be identified - some focused on environmental science services, others on collaborative research, others on environmental monitoring and surveillance; and others on technology development and commercialization (Figure 12).

Figure 12: Potential Clusters of Environmental Sciences Networks under CESN and Linkages to Key Knowledge Users



At this point, CESN should not be restricted to certain types of environmental sciences networks, or define characteristics which would be required of member networks, but remain concerned with the full range of scientific functions (applications, technology transfer, communications). This approach recognizes that environmental problems are multidisciplinary, and that CESN should help integrate disciplinary approaches to environmental problems. It also recognizes the need to potentially address the entire range of environmental sciences - including research, monitoring, technology development and commercialization. It is recognized, however, that there are many different types of environmental sciences networks that that these different networks may have somewhat different needs, perspectives, and capacities. Possible clusters of networks could include academic-based research networks and/or knowledge expansion networks; public good research and service-based networks, and technology transfer networks.

5.3 Possible CESN Vision

Elements of a vision for CESN could potentially address:

- the role of the environmental sciences in supporting decision-making and effective conservation and protection of the environment (e.g. environmental stewardship), to support environmental innovation in Canada, and to support effective environmental services for Canadians;

- the need to enhance the collective mobilization and integration of Canada's environmental sciences efforts;

- the need to strengthen and maintain the strength of Canada's environmental sciences efforts - including promotion of cross-disciplinary approaches and dynamic interplay between institutions involved in environmental sciences;

- to ensure that Canada is recognized as a world leader in the environmental sciences.

A possible vision statement for CESN might be:

The vision of the Canadian Environmental Sciences Network (CESN) is to strengthen and enhance Canada's environmental sciences activities in order to promote the highest degree of informed decision-making with respect to stewardship of the natural environment.

5.4 Possible CESN Goals

Possible goals of the CESN might include:

- Strengthening and enhancing the quality of Canadian environmental sciences;

- Enhancing the relevance of Canadian environmental sciences to environmental issues;
- Breaking down "solitude's, stovepipes and silos" within the environmental sciences community in Canada - developing an national focal point for the environmental sciences community in Canada;
- Increasing the environmental literacy among decision-makers and the public;
- Improving the opportunities for young scientists and researchers to pursue career opportunities in the environmental sciences;
- Increasing the profile of the environmental sciences in Canada - with the public and with funding agencies;
- Attracting investors and additional funding to the environmental sciences;
- Sharing information on the environmental sciences activities, impacts etc.;
- Communicating the benefits of environmental sciences to Canadians, including the work of the members of CESN;
- Enhancing the effectiveness of CESN's member environmental sciences networks;
- Enhancing the quality of environmental sciences in Canada;
- Improving the integration of environmental sciences activities in Canada;
- Improving the linkages between different environmental science networks in Canada and with international environmental science programs; and
- Enhancing Canada's participation in, and input to, international environmental science programs and networks.

5.5 Possible CESN Functions

It has been suggested that CESN should do what is not currently being accomplished by existing environmental sciences networks. CESN could provide an integrated, mutually reinforcing, coherent approach to the work of its member networks, as well as a strategic organization acting as a national focal point for environmental sciences agenda setting and planning. A key function which is not being served by any institution or institutional arrangement concerns the need for a focal point for the environmental sciences community. Such a focal point - or hub - would have to recognize and reflect the diversity of the environmental sciences community.

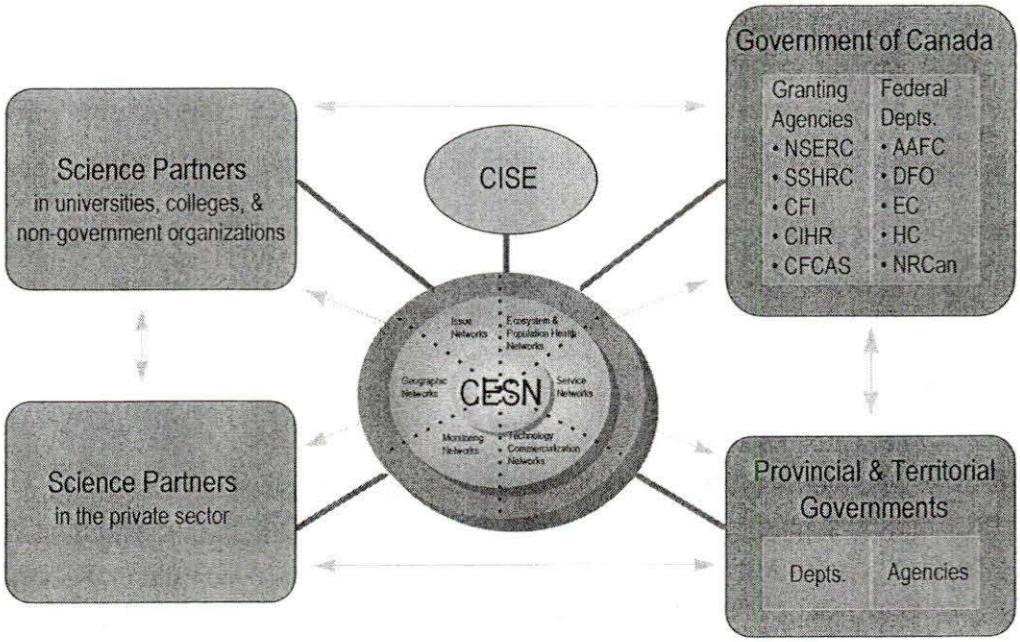
As a national focal point for the environmental sciences, the hub of CESN could carry out functions that increase efficiency, productivity and quality of member networks and enhance the overall quality and efficacy of the environmental sciences in Canada. Some specific potential functions include:

- Network-to-network liaison.
- Liaison between environmental science networks and key knowledge users.
- Facilitating and supporting environmental science networking (e.g. planning meeting, development of new environmental science networks, efforts to strengthen and expand existing environmental science networks).

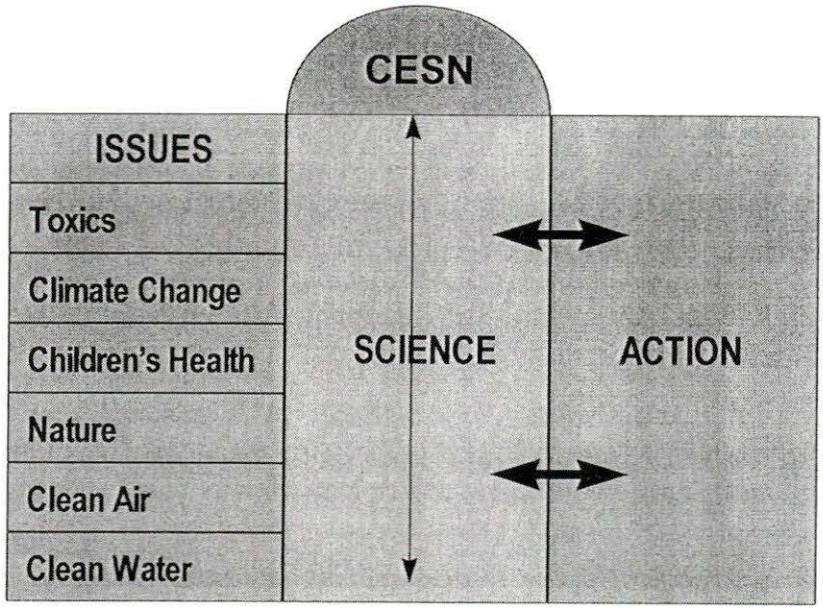
- Assist in identifying synergies and opportunities for collaboration between environmental science networks.
- Clearing house for sharing of environmental sciences information - e.g., who's doing what, sources of funding, impacts of environmental science networks, state of environmental sciences in Canada, how networks can access key funding programs, forum for helping networks take advantage of funding opportunities and initiatives.
- Creating greater awareness of the work of environmental science networks.
- Integration of information across the various areas represented by CESN member networks.
- Communication of benefits of work of CESN member networks to decision-makers and the public.
- Synthesizing and integrating environmental sciences to inform decision makers.
- Facilitating Canada's involvement in international environmental science programs.
- Development of a national environmental science agenda for Canada.
- Development of a rationalized environmental sciences investment strategy for Canada (federal government; provincial & territorial governments; private sector).
- Hosting of a national conference on the environmental sciences.

5.6 Where will CESN Fit ?

The Canadian Environmental Sciences Network (CESN) would be a key element of a new environmental innovation agenda for Canada - since fundamental objectives would be improving the production and use of environmental knowledge. As such it would provide linkages to all of the key environmental science producing and funding institutions in government, universities, the private sector, and non-government organizations. A key linkage between CESN and the nascent Canadian Information System for the Environment (CISE) is envisioned.



CESN will also be a key element of Environment Canada and the federal government's efforts to integrate science and action of environmental priorities such as clean air, clean water, nature, children and environmental health, and climate change. As new science-based proposals come forward to establish environmental science networks concerned with these issues, each can be linked into a broader system of environmental science under the CESN.



6.0 NEXT STEPS

Some environmental science networks which potentially could be included under a CESN umbrella already exist - including the Climate Research Network (CRN), the Canadian Network of Toxicological Centres (CNTC), the Metals in the Environment Network (MITE) and the Atlantic Cooperative Ecology and Wildlife Research Network (ACWERN).

6.1 Initial meeting of CESN Network Representatives (January 26th, 2001)

To begin discussions on the development of CESN, representatives from selected environmental science networks involving Environment Canada were brought together on January 26th to share experiences and perspectives, discuss the potential benefits of a "network of networks", and discuss options with respect to next steps. Selected representatives from other environmental science and technology networks or associations were also be invited to this initial meeting, but future meetings and discussions on CESN will bring additional network representatives (e.g. from other federal department-based environmental science networks or non-government-based environmental science networks) and environmental science stakeholders together in a more comprehensive manner.

6.2 *Continued discussions on CESN concept with environmental science stakeholders.*

Environment Canada should continue initial discussions and consultations on the CESN concept with environmental science network representatives, universities, government departments and agencies, the private sector and non-government organizations. Part of this effort should include further investment in policy research concerning the state of the environmental sciences in Canada, and needs analysis concerning the development of CESN.

6.3 *Develop a Policy Proposal for CESN*

Preparation of a formal policy proposal which would seek to establish seed funding for the development of CESN.

6.4 *Establish an interim coordination and governance structure for CESN.*

It is proposed that an interim governance and coordination structure be established for CESN - along the lines of similar models done during the creation of the Canada Foundation for Innovation; the Canadian Institutes of Health Research; and Genome Canada.

The interim management and coordination structure would comprise an interim Board of Directors and an interim CESN Secretariat. Both would be appointed with a 12-18 month mandate and terms of reference, with the expectation that more formal governance and coordination structures would be established following the end of these interim mandates.

The interim Board of Directors would be drawn from selected high level directors of current environmental science networks, as well selected senior stakeholders in the Canadian environmental sciences community (federal and provincial government departments and agencies, university community, non-government organizations, professional scientific associations etc.).

The key activities of the interim Board of Directors would be as follows: interim coordination of and liaison with existing CESN networks; undertaking policy research and analysis needed to support the permanent establishment of CESN (e.g. organizational design, governance structures, CESN vision and goals, proposed CESN functions, permanent location for CESN), consultations and discussions on the development and organization of CESN (including possibly a national conference on environmental science networking), and preparation of a CESN long-term plan.

The interim CESN Secretariat would provide policy, management, and logistics support to the interim CESN Board of Directors - and would provide a series of shared services to all member networks (e.g. liaison, information exchange, communications etc.). It would be located within a suitable existing organization (e.g. a non-government association institution). Interim staff could be seconded from federal departments or other institutions and organizations.

6.5 *Establishment of a CESN Foundation*

It is proposed that the federal government establish, through an initial financial contribution of $20 Million, a Canadian Environmental Science Networks (CESN) Foundation. The income derived from this initial investment in the CESN Foundation would be expended over a five-year period to support CESN activities - including transition to a formal governance structure for the CESN. In the short-term, funding from the CESN Foundation would support activities of the interim CESN Board of Directors and Secretariat (e.g. coordination and management of existing CESN networks; undertaking policy research and analysis needed to support the permanent establishment of CESN, consultations and discussions on the development and organization of CESN, and preparation of a CESN long-term plan).

In the longer-term, funding from the CESN Foundation would provide support for core CESN functions, including activities such as: CESN planning and development; review of proposals for new CESN networks; gap analysis; provision of seed funding for networking and science agenda setting; development of a rationalized investment strategy for the environmental sciences; supporting inter-network linkages; network impact studies; development of a Canadian environmental sciences strategy; pursuing collective efforts to promote increased funding for environmental sciences through existing and new funding mechanisms; strategic communications and information dissemination; hosting a national environmental science conference; liaison with key environmental knowledge user institutions; and fostering Canada's involvement in international environmental science programs.

The CESN Foundation could be established within an existing suitable organization external to the federal government, or created as a new institutional entity. In it's start-up phase, for example, the CESN could be hosted by an existing third party mechanism such as the Canadian Institute for Advanced Research (CIAR) or the Canadian Consortium for Sustainable Development Research (CCSDR). Seed funding would provide financial and human resources to develop and launch CESN in partnership with other groups and organizations. Initial work could include undertaking a comprehensive review of existing environmental science networks and research activities; bringing together the existing environmental sciences community to identify gaps and opportunities to build a more cohesive approach to environmental sciences activities; developmental of a comprehensive environmental sciences research agenda; identification of existing sources of research funding so as achieve efficiencies and build a more cross-discipline approach to environmental science work.

6.6 *Rationale behind the Creation of CESN:*

- **The development of the CESN would become a key instrument in establishing Canada as an environmentally innovative society.** The establishment of the CESN would promote networked partnerships between institutions involved in the production of environmental knowledge in Canada, as well as with users of environmental knowledge. It would enhance the

production and dissemination of environmental knowledge. CESN would provide Canadian-based incentives to encourage collaboration among the very best environmental scientists and social scientists.

- **The development of the CESN would be a mechanism to strengthen and accelerate the production of environmental knowledge in the Canadian environmental innovation system.** This would improve the ability of all Canadians to make informed decisions about the environment and would support innovation in support of sustainable development.

- **The development of the CESN would represent a new and innovative means for addressing federal S&T capacity issues in the environmental sciences**. It would simultaneously address the recommendations of the Council of Science and Technology Advisors in their report, *Building Excellence in Science and Technology.*

- **The development of CESN would be consistent with the general direction of federal S&T policies and investments.** For example, it is envisaged that mechanisms would be established to link CESN to the Canada Foundation for Innovation; NSERC, SSHRC, the CIHR, the Networks of Centres of Excellence Program; the Canada Research Chairs Program; the new Climate and Atmospheric Research Foundation etc.

- **The development of the CESN would be consistent with the goals and principles of *Science and Technology for the New Century - A Federal Strategy***, and would promote dynamic interplay of all key stakeholders involved in the environmental sciences in Canada.

- **The development of CESN would be an effective complement to the Canada Information System on the Environment (CISE).** A National Task Force on CISE has been established to design of an integrated knowledge management system for environmental information in Canada. The National Round Table on the Environment and the Economy is leading a complementary multi-stakeholder initiative to develop, pretest, and promote indicators of sustainable development that integrate consideration of environmental, social, health and economic factors. Each of these two activities will draw upon the work and progress of the other and would be complemented by an effort through the CESN to address the production of environmental knowledge in Canada.

7.0 SUMMARY

Environmental knowledge needs and the expectations on government to provide leadership in fulfilling these needs continue to grow. The recent direction and lessons from federal S&T policy suggest a need to rethink the roles of federal S&T from the perspective of the broader S&T community, and propose new mechanisms which would enhance the dynamic interplay and synergies between the diverse range of institutions involved in environmental science. Environment Canada has an important leadership role to

play in fostering a strengthened environmental science community in Canada. Other federal science departments and agencies will also be critical partners in this effort.

By proposing a significant new collaborative environmental science initiative in the form of a Canadian Environmental Sciences Network, the federal government would lend positive influence to a new "public good" innovation system model which would involve all key partners in the Canadian environmental S&T community and enhance Canada's production and use of environmental knowledge.

7.1 Results of Transition to CESN- a 2 year timetable:

- ***A new national focal point for environmental sciences in Canada***, including a broad range of environmental science networks comprised of different science institutions crossing professional and disciplinary boundaries, and spanning a spectrum of environmental science interests from the social sciences to technology development and transfer. This new national focal point could serve as a mechanism to lead collective efforts to raise the profile of environmental sciences in Canada; undertake strategic communications, information dissemination and policy development; lead the development of a national strategy for the environmental sciences in Canada; and act as a key liaison point with environmental knowledge user institutions.

- ***A series of reports outlining the state and health of environmental sciences in Canada,*** including information and analysis on key funding sources for environmental science in Canada; distribution of environmental science efforts; key areas of Canadian environmental science effort; regional and national dimensions of environmental science efforts; institutional capacities for environmental science in Canada (human resources, facilities, equipment, operational funds, monitoring efforts, research efforts etc.); new environmental science capacity needs in government and other institutions; roles and health of environmental sciences facilities; current environmental science networking arrangements in Canada; other models for sectoral science networking; international trends and activities in other countries with respect to organization and delivery of environmental science and environmental science agenda setting.

- ***Establishment of an interim leadership and management structure for Canadian Environmental Science Networks.*** Including an interim Board of Directors with a clear mandate and terms of reference, an interim CESN Secretariat to provide policy analysis support, management and logistics support, and coordination/consultations support.

- ***A proposed approach/set of recommendations on the creation, design and functioning of the CESN***. Outlining proposed boundaries (scope of activity) for CESN; governance structure for CESN; operational structures; operational principles; network seed funding mechanisms and criteria; general structure and functioning of individual networks under CESN; relationship

between CESN networks; proposed transitional steps and timeframes to establish CESN and/or new networks under CESN.

- ***A formal CESN launch strategy and implementation action plan.*** Developed in collaboration with existing environmental science networks, including final design, governance structure and functions. Coordinated with the development of specific newly proposed networks, such as a Canadian Water Research Network or Canadian Air Quality Research Network, which would have network-specific governance structures and funding mechanisms. Finalization of a five-year plan to bring CESN fully on-line, including a permanent management and coordination organizational structure, transitional funding to support networking and inter-network linkages, reference to proposed specific new CESN Networks (e.g. a Canadian Water Research Network), and proposal of longer term efforts for the development or enhancement of CESN networks through existing funding mechanisms.

7.2 Longer term results (2-4 years):

- Better overall environmental sciences effort in Canada via improved institutional collaboration & cross-network linkages.

- Preparation of a Canadian Environmental Sciences Agenda.

- Preparation of a rationalized environmental sciences investment strategy for Canada - a 10 year plan.

    - New single national focal point for the users and providers of environmental sciences in Canada.

ANNEX 1:REPORT OF AN INITIAL MEETING TO DISCUSS THE DEVELOPMENT OF CANADIAN ENVIRONMENTAL SCIENCES NETWORK (CESN)

January 26th, 2001
Canada Centre for Management Development, Ottawa, Ontario

FORMAT OF THE MEETING

Full-day meeting on Friday, January 26th 2001.

Over 40 participants, including representatives of some key environmental science and technology associations and research consortia – such as the Environmental Science and Technology Alliance of Canada; the Canadian Consortium for Sustainable Development Research; the Canadian Meteorological and Oceanographic Society; and the International Institute for Sustainable Development.

The meeting was chaired by Dr. John ApSimon, Special Science Advisor to the DM of Environment Canada.

Bob Slater, Senior ADM for EC opened the meeting. He reviewed the recent history of federal S&T policy, highlighted the current challenges facing environmental sciences in Canada, and outlined some desirable outcomes which could be targeted to improve the situation.

The meeting heard from over a dozen network representatives about what their networks do, the benefits and challenges of networking, and lessons they have learned.

Mr. Alan Nymark, Deputy Minister for Environment Canada was the guest speaker at lunch. He challenged the group to think collectively about ways that the environmental sciences in Canada could be strengthened and enhanced. He outlined possible elements of a new vision for the environmental sciences in Canada, as well as a possible model for a network of Canadian Environmental Sciences Networks, and indicated some potential objectives. He emphasized the need for a champion, or champions, who could spearhead the development of the network, and referred to the experience of the CIHR and the energy and vision of Dr. Henry Friesen.

The meeting also discussed possible goals for a network of Canadian Environmental Sciences Networks (CESN) and what next steps should be to develop this concept. The following sections focus on these discussions.

GENERAL OBSERVATIONS

Participants were, **in principle, interested in the concept** of CESN (it was apparent that the notion or concept of CESN has a certain "intuitive attractiveness" even if CESN's functions cannot be explicitly defined at this particular time). There was full participation throughout the day (despite the significant volume of information presented, and the general lack of time for substantive discussion on possible goals, objectives, and possible next steps).

There was a cautious consensus that **we should move forward** with establishing CESN. Participants explained the value of networking and indicated that credible networks have tremendous power and are perceived as good advisors by the government. The idea of CESN as a focal point for the environmental sciences - and environmental sciences networks was appealing. There was an acknowledgement that networks can be pathways to unexpected achievements. Participants indicated that there will be a need to determine the concrete outputs from the umbrella CESN network in proportion to the inputs of investment of time and resources being asked of member networks. There was a suggestion that significant progress towards establishing CESN should occur within a year. In the words of Bob Slater, "This will not be a ride for the faint-hearted. It will be very demanding, but potentially very rewarding."

A **huge amount of information and a lot of perspectives were shared** about existing networks during the meeting. It was evident there was considerable expertise at network building among those present. At the very least, we should be doing more to make the work of these environmental sciences networks known to Canadians. Network builders may also be effective champions for CESN - able to draw on their own experiences.

There was a consensus that an interactive, draft **website** - an electronic work space - would be immediately useful for communication and sharing information. Such a draft site could have confidential and public elements to permit ongoing discussion. This draft might be superseded by a more exciting and elaborate Web site when the CESN is publicly launched in a year's time or so. A point was made that other forms of communication were also required (e.g. face to face meetings) and that a Web site and communication tools such as Email was not adequate for full discussion of the development of CESN.

This was **an initial meeting**. Participants were still mainly at the stage of sharing the experience of their own networks. Moving beyond this, to a discussion of an umbrella network or meta-network will take a number of meetings and focused activities. Other meetings should take place in conjunction with scheduled network meetings (e.g. EMAN Science Meeting).

The meeting was **an important, and in some cases first ever, networking opportunity** for the participating networks.

SYNTHESIS OF DISCUSSION

Suggested CESN Goals

- Strengthen and enhance the quality of Canadian environmental sciences.
- Enhance the relevance of Canadian environmental sciences to environmental issues.
- Break down "solitude's, stovepipes and silos" within the environmental sciences community in Canada.
- Increase environmental literacy among decision-makers and the public ("render evolving knowledge accessible to agents of change for public policy, business strategy, and creative decision-making").
- Increase profile for environmental sciences - with the public, with funding agencies.
- Attract investors / additional funding to the environmental sciences.
- Share information.
- Communicate the benefits of environmental sciences to Canadians, including the work of the members of CESN.
- Enhance the effectiveness of CESN's member networks.

Scope of CESN

- There was a consensus that the name should be environmental sciences to reflect the fact that this was a network of natural, physical, engineering and social sciences.
- Several participants called for a CESN that was not restricted to research, but also concerned itself with the full range of scientific functions (applications, technology transfer, communications). "What can CESN do to rejuvenate less glamorous scientific activities such as monitoring and surveillance?"
- Environmental problems are multidisciplinary, for the most part our scientific efforts are not. CESN should help integrate disciplinary approaches to environmental problems.

- It was noted that "environmental sciences" includes many areas that are the domain of several federal departments, not just those pursued by Environment Canada. As a result, there will be a need to broaden the reach.

- Several participants spoke of the desirability of including an economic dimension, of including environmental industries and industry associations.

- At the same time some concern was expressed about dilution of efforts.

Suggested CESN Functions

There seemed to be consensus that CESN should do what is not currently being accomplished by existing networks. It should provide an integrated, mutually reinforcing, coherent approach to the work of its member networks. Acting as a focal point seemed to have resonance. The CESN must carry out functions that increase efficiency, productivity and quality of its member networks – it must, eventually, enhance their operations, not add another level of work, by finding economies of scale for shared activities and reducing transaction costs of information sharing. Whatever these functions are, must be identified and articulated by the constituent networks. Some specific suggestions included:

- Network-to-network liaison.

- Assist in identifying synergies and opportunities for collaboration.

- Clearing house for sharing of information - e.g., who's doing what, what's going on in environmental sciences in Canada, sources of funding. How networks can access key funding programs. Forum for helping networks take advantage of funding opportunities and initiatives.

- Create greater awareness of the work of the networks.

- Integration across the various areas represented by CESN member networks.

- Communication of benefits of work of CESN member networks to decision-makers and the public.

- Emphasize the policy relevance of the work of CESN members.

- Synthesize and integrate environmental sciences to inform decision makers.

- CESN should NOT be involved in member-network management.

CESN Organization

- There was a consensus that the CESN umbrella network needed a center - some type of structure and/or secretariat. At the same time there was no desire for a command and control type of center, rather several participants called for a center "with a light touch". "The center shouldn't be everything."

- It was suggested that the CESN center be independent and be located outside of government.

- The center was variously described as: an incubator, a catalyst, a connector of distributed networks, a knowledge broker, a navigational guide to relevant networks.

- It was suggested that, "A good net has knots of equal size". In other words - all members networks should be treated as equivalents under the umbrella network.

- There were some questions as to what (resources, time, people, other commitments) individual networks would be willing to contribute to the CESN. It was suggested that members have to be willing to, "put something on the table", to participate, but that this would not necessarily have to be a "membership fee". Other mechanisms such as seeking dedicated funding for the CESN centre could be pursued (which would not require existing networks to contribute financial resources) ?

CESN Membership

- Young professionals should be sought out and involved in determining the shape of CESN. Perhaps a forum could be developed to collectively engage young scientists involved in a variety of environmental sciences networks.

- There was a consensus that, at least for the moment, all environmental sciences networks could be members of CESN. However, there was a suggestion that there were different types of member networks present at the meeting, and that these could be identified. It was understood that these members may have somewhat different needs, perspectives and resources to share. Possible clusters of networks included academic-based research networks and/or knowledge expansion networks; public good research and service-based networks, and technology transfer networks.

- At the same time, it was recognized that membership diversity is a good thing. It was suggested that eclectic membership works well for umbrella networks.

CESN Website

- A web site should be created to post and exchange information about the creation of CESN

Challenges facing CESN

Participants raised a number of challenges and questions facing the development of CESN, including:

- The need to develop an **overarching vision** for CESN. This will take considerable effort, but will be worth the trouble. In particular, CESN needs a "bumper sticker", a simple statement of what it is all about (e.g., stewardship of the environment). It was emphasized that the "vision" for CESN should not be about attracting more funding, but that increased funding or enhanced capacity would be the natural result of a strong vision focused on the role the environmental sciences plays in stewardship.

- The need to show CESN's relevance in order to gain **investors' confidence** and support.

- How to create and fund the **CESN center**? Where should it be located?

- The need for scoping or discussion papers on relevant topics such as the definition of what constitutes the "environmental sciences", the state of environmental sciences in Canada, and the experience of environmental sciences networks in Canada.

- A number of needs have been identified (support for science, increased visibility, training scientists, educating the public, etc.). Should CESN deal with all of these? How can CESN be **designed** to meet these needs?

- What **services / products** will CESN provide to its member networks?

- Friday's meeting was an initial meeting, with a selected group of "friends". How should we move forward to **engage other relevant groups and organizations**?

- Is there a Henry Friesen for the environmental sciences? Is there a natural **champion**? Who can be involved as **informal advisors** or a group of champions to help define CESN? Perhaps there are several champions - rather than a single one.

- **What steps should be taken over the next year** towards establishing a CESN?

LIST OF PARTICIPANTS

Chair- Dr. John ApSimon

Environmental Science Network Representatives

Atlantic Cooperative Wildlife and Ecology Research Network (ACWERN)
Tony Diamond, UNB; Alex Bielak, Atlantic Region

Atlantic Environmental Research Network (AERN)
Linda Cooper, Atlantic Region

Canadian Biodiversity Information Network (CBIN)
John Herity, BCO; Guy Rochon, BCO

Canadian Cooperative Wildlife Health Centre
Ted Leighton, U of Saskatchewan

Canadian Environmental Technology Advancement Centres (CETACs)
Ed Mallett, OCETA; Joe Lukacs, CETAC West; Manon Laporte, Enviro-Access

Canadian Network of Toxicology Centres (CNTC)
Karsten Liber, U of Saskatchewan; Len Ritter, U of Guelph

Canadian Weather Research Network
Jim Abraham, MSC

Climate Research Network (CRN)
Doug Whelpdale, MSC; Ian Rutherford, CICS

Ecological Monitoring and Assessment Network (EMAN)
Hague Vaughn, ECS; Peter Hall, NRCan

Environmental Adaptation and Impacts Research Network
Roger Street, MSC

National Hydrological Monitoring Network
Dave Harvey, MSC

Metals in the Environment Network (MITE)
Robert Garrett, NRCan

National Air Pollution Surveillance Network (NAPS)
Dave Thornton, EPS

Environmental Sciences Associations and Professional Societies

Canadian Consortium for Sustainable Development Research (CCSDR)
Ann Dale, Royal Roads University

Environmental Science and Technology Alliance of Canada (ESTAC)
Jack Pasternak

Canadian Foundation for Climate and Atmospheric Science (CFCAS)
Dick Stoddart

International Institute for Sustainable Development (IISD)
Heather Creech

Environment Canada

Alan Nymark
Bob Slater
Karen Brown
Michel Beland
Bill Jarvis
Ken Sato
Gerry Frappier
Rod Allan
Don McKay
Abe Finkelstein
Philip Enros
Richard Isnor
Phil Blagden
Mark Cantwell
Caroline Ladanowski
Jane Inch

Health Canada

Mark Raizenne

Parks Canada

Nik Lopoukhine

Equilibrio Consulting

Margaret (Meg) Barker

Science Policy Branch - Environment Canada

Working Paper Series

1 *Environment Canada's Scientific Research Publications in 1995*

2 *Science for Sustainable Development*

3 *Communicating Science at Environment Canada: A Brief Review of Lessons Learned from Communications on Acid Rain and the Depletion of the Stratospheric Ozone Layer*

4 *The Precautionary Principle, Risk-Related Decision Making, and Science Capacity in Federal Science-Based Regulatory Departments: A Discussion Document*

5 *Strengthening Environmental Research in Canada: A Discussion Paper*

6 *Environment Canada's Scientific Research Publications 1980-1997*

7 *Research & Development and Related Science Activities at Environment Canada*

8 *Measuring The Impacts Of Environment Canada's R&D: A Case Study of Pulp & Paper Effluent Research*

9 *Measuring The Impacts Of Environment Canada's R&D: A Case Study of Stratospheric Ozone Depletion Research*

10 *Measuring The Impacts Of Environment Canada's R&D: Notes On Methodology*

11 *Science Advice in Environment Canada*

12 *Environment Canada University Research Partnership Expansion Strategy: A Discussion Paper*

13 *Environment Canada's S&T: Expenditures & Human Resources, 1990-1999*

14 *National Environmental R&D Agenda-Setting: A Commentary on Issues, Options, and Constraints*

15 *Science in the Public Interest: Values and Ethics in the Management, Use and Conduct of Science at Environment Canada*

16 *Bibliometric Profile of Environmental Science in Canada: 1980-1998*

17 *Implementing the Principles and Guidelines of the Framework for Science and Technology Advice: A Guide for Science and Policy Managers*

18 *Role of a Renewed 5NR MOU in the Evolving Spectrum of Horizontal Federal S&T Management*

19 *Toward a Canadian Stewardship Framework for GMOs - A Discussion Paper*

20 *S&T Excellence in Environment Canada: A Self-Assessment Tool based on the CSTA STEPS report*

21 *Environment Canada's Research Laboratories: Institutional Change and Emerging Challenges - Three Case Studies*

22 *Canadian Environmental Sciences Network (CESN) – Discussion Paper*