SMART PARTNERS: Innovations in Environment Canada–University Research Relationships

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OVERVIEW OF ENVIRONMENT CANADA'S COLLABORATIVE ACTIVITIES WITH UNIVERSITIES

Traditional collaborative arrangements

Environment Canada has long benefited from strong and varied links with Canadian universities.

Environment Canada believes that working in partnership with a wide variety of groups such as communities, industry, aboriginal peoples and scientists, is an effective and efficient way of fulfilling its mandate. It is also an important element of EC's strategy for conducting science and technology (S&T). Through S&T partnerships, the Department builds synergy with other organizations, levers resources, enhances human resource development, promotes the use of R&D results, and draws on S&T expertise in other sectors.

In particular, EC has a long and productive history of working closely with university colleagues in areas of mutual interest. A recent bibliometric study of peer-reviewed environmental research articles published between 1980 and 1998 showed that Environment Canada is the largest producer of published research in a number of environmental fields. Moreover, the study showed that EC is the main partner of each of the other nine top producers of environmental research articles in Canada, of which six are universities.

We recognise that partnerships and networks with academic researchers are of mutual benefit. Environment Canada benefits from improved effectiveness in fulfilling its mandate. Working closely with university colleagues not only helps to keep our scientists up-to-date with current scientific thinking but also provides them with direct access to graduate students, tomorrow's environmental researchers. And it is not just in research that we benefit from these close ties. Environment Canada benefits as well from the work of numerous summer students, co-op students and graduates. Some will become the next generation of EC employees. Universities benefit from increased research opportunities, high-calibre teaching and research supervision for their students, and access to EC's unique facilities and specialized equipment.

University-government collaborations began as informal, one-off joint projects undertaken by individuals who happened to have complementary research interests. Such simple relationships have evolved and now encompass many and varied forms of partnerships and networks. Some remain essentially informal, while others are highly organised and quite

complex. A few of these types—some traditional, some more innovative—are described briefly here.

Together, Environment Canada and Canadian universities are much more effective at generating, acquiring, organizing, applying and sharing scientific knowledge to inform environmental decisions and to serve Canadians, than we could be working separately. There is more widespread use of integrated scientific teams from multiple partner organizations addressing important environmental science issues. We see the spread of new technologies providing ways to reduce the environmental impact of human activities. Environmental scientists enjoy a high level of trust by Canadians, who use our knowledge as a reliable base for their environmental decisions. And, these partnerships provide a larger community of environmental scientists doing world-class science to serve the public good more effectively than ever before.

Traditional EC collaborative activities include the involvement of students in EC work, the appointment of EC staff as adjunct professors and student supervisors, collaborative projects with university professors and the support of research chairs at individual universities.

People. Perhaps the simplest of our connections with universities is the involvement of individuals. EC is an active participant in student placement programs, benefiting from the work of summer and co-op students, and graduates. These young people carry our issues back to the university community. They may also return as the next generation of EC employees. In 2003-04, the Department employed between 250 and 300 students.

Many of our research scientists hold adjunct appointments at Canadian universities, often co-supervising students with university colleagues in areas of mutual interest. Environment Canada employees hold about 200 collaborative positions in Canadian universities. Often a rather simple adjunct professorship at a university becomes the germinating ground for more complex collaborative relationships.

Collaborative projects. Other simple partnerships involve individual EC research scientists working on collaborative projects with university professors. These arrangements have the flexibility of being developed with the most appropriate co-workers to address certain issues, and are often relatively easy to establish.

Research chairs. A single-university research chair with small self-contained staff is a very effective research unit to address a group of related issues. By sponsoring a chair, EC is able to influence the direction of the research and

possibly to add expertise in areas that would contribute to EC research. The mandate of a chair can be clearly described; its relatively tight focus makes for a cohesive inter-related research program. This approach is most suitable where there are reasons to support a research program at one academic institution. This mechanism fosters synergy between the mission-oriented research and management policies of EC and the basic research agenda of the university. It is also a mechanism for securing and pooling funds from various sources: EC's Meteorological Service of Canada helped to sponsor a research chair in oceanography at Dalhousie University which brought together funds from EC, from the private sector, and from NSERC.

Innovation in collaboration

Environment Canada is an innovator in facilitating collaboration across the environmental sciences and technologies in Canada.

The CSTA's BEST report urged the government to implement and fund new models for S&T that emphasize a horizontal (across government and the innovation system), competitive, multi-stakeholder approach. This recommendation was very welcome at Environment Canada as it reinforced directions we were already taking. In addition to the traditional types of interaction, EC is experimenting with a number of new and innovative types of linkages with universities.

To be able to address increasingly complex environmental issues requires the best use of existing resources and horizontal approaches across institutions and disciplines. It means greater connections between environmental networks to encourage more multidisciplinary approaches and to benefit from the creativity, thoughts and approaches of diverse disciplines. And implicitly, this means increased connections and collaborations between Environment Canada and universities.

Below are a few of the innovative types of collaboration that EC has initiated with universities. Specific examples of each type are provided in tabular form in Appendix A, but since the novelty of these connections lies in the history and the details of each individual case, the stories of the development of eight different collaborative arrangements are provided in the next section. These stories describe their chance beginnings, their fertile synergies, and their promise of research successes.

Co-location of individual scientists or facilities. Where individual Environment Canada staff or EC facilities are co-located on a university campus, the

opportunities for partnerships are enhanced simply by physical proximity and the ease with which connections can be made. These arrangements offer increased opportunities for research collaboration and other shared activities, access to facilities, and to students at the local level. Through these contacts greater connections with the broader academic community are possible. In the case of Environment Canada's climate modelling team, relocation to the University of Victoria campus as the Canadian Centre for Climate Modelling brought the climate modellers together with the thermal oceanographic modelling expertise that was essential for the progress of their research.

Research networks can be described as formal collaborative activities by a group of researchers located in more than one location. Networks offer expanded opportunities for multidisciplinary collaboration at the highest levels to address complex environmental issues or the concentration of the best researchers focused on a scientific issue of critical concern. The development of networks requires a greater effort and commitment of personal attention, but provides many benefits in return, such as bringing universities into a co-operative rather than competitive posture with government, with concomitant opportunities for both EC and university researchers.

Regional research networks are effective ways of addressing issues in a geographic region. For EC, that means the five regions supported by departmental regional offices (Atlantic, Quebec, Ontario, Prairie and Northern, and Pacific and Yukon regions). Not only do regional networks offer exposure to a variety of expertise, they also serve to better connect EC with local universities and other government organisations (federal, provincial and local) in the region. EC scientists benefit by having access to partnerships and opportunities to address regional environmental concerns in a collaborative way. Currently, the Atlantic Environmental Sciences Network (AESN) is forging connections between varied research groups in the region to facilitate multi-disciplinary and multi-sectoral research initiatives.

National research networks. EC is also an active participant in national research networks: partnerships connecting similar types of expertise across the country at the highest level. These networks allow EC to influence research directions and to ensure that we are current with new directions emerging from the academic community. EC is a prime mover in some networks. It also participates in several NSERC networks and four Networks of Centres of Excellence.

Funding programmes. In the past, EC has been instrumental in the development and implementation of a number of innovative funding programs, including the Eco-research Program and the Toxic Substances Research Initiative.

The future

EC will continue to develop innovative approaches to working with universities, to assess the outcomes and to adjust our course accordingly. Such experimentation will ensure continuing adaptation to the Canadian R&D landscape, help the Department to fulfill its mandate, and ultimately serve to strengthen the environmental sciences in Canada while delivering environmental and sustainability benefits to Canada and to Canadians.

STORIES OF INNOVATION

An Atmosphere of Change

Adaptations and Impacts Research Group at UBC

What is the leading cause of climate change? Is it greenhouse gases such as CO2 that are produced by burning substances containing carbon? That would be the obvious answer. But when Roger Street and his colleagues at the Adaptation and Impacts Research Group (AIRG) in the Meteorological Service of Canada[1] pondered the question in 1995, they came up with a different answer ... people. Sure, scientific consensus was building that greenhouse gases were the immediate cause of climate change, but the AIRG team realized that it was people who were making the decision to burn the various substances that produced the culprit emissions — oil, gas, coal, etc. They also reasoned that if society was going to reduce its output of greenhouse gases then people would have to change their behaviour.

Established in 1994, the Adaptation and Impacts Research Group's mandate is to conduct research on the impacts of weather, climate and air quality on human health and safety, economic prosperity and environmental quality. Its primary goal is to ensure that information is available to decision and policy makers on the environmental, social and economic impacts caused by vulnerabilities to atmospheric change, variability and extremes; and options to respond to them. Housed at MSC's headquarters in Downsview, the group had a largely science and technology focus. Most of the staff had weather or climate research backgrounds. They were relatively unequipped to deal with the social aspects of climate change. And, with Program Review on the horizon, there was little hope of getting additional resources to explore the human aspect of climate change.[2] So, Street and the MSC management thought that they might gain access to the expertise they needed in partnerships with universities.

One of the first places they looked was the Sustainable Development Research Initiative (SDRI) at the University of British Columbia. SDRI was established in 1991 to foster policy relevant research on sustainable development. It encourages interdisciplinary collaboration among the faculty, departments and centres at UBC, as well as other institutes and programs undertaking sustainable development research in Canada and around the world. In August 1995, AIRG and SDRI entered into an innovative five-year

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[1]Then called the Atmospheric Environment Service of Canada.

[2]MSC lost nearly 40% of its positions under Program Review.

research partnership to explore environmental adaptation topics. A second five-year agreement was signed in August 2000.

The joint work is attempting to see how society adapts in the long term to atmospheric stresses. In particular the research is using interdisciplinary methods to study the interconnections between ecological, economic and social systems. Examples of projects include:

* The Canadian Climate Change Calculator. This is an interactive software tool designed to raise people's awareness of the greenhouse gases they produce through their daily activities and lifestyle choices. This Canada-specific tool will help people of all ages learn about their contributions to greenhouse gas emissions and will suggest measures they can take to reduce emissions.

* Canada Country Study: Climate Impacts and Adaptation. This is a national study intended to evaluate the impacts of climate variability and change on Canada as a whole, and to identify and evaluate adaptive responses. The study was initiated by Environment Canada (EC) and is being carried out under the lead of the AIRG. Among the participants are representatives of various levels of government, the university community, the private sector and non-governmental organizations.

SDRI provides AIRG with two important things: infrastructure (offices) and students. Once the AIRG staff had relocated to UBC they quickly acquired Postdoctoral Fellows and graduate students, whose research they supervised. The collaborative model was so successful that AIRG structured similar arrangements with the Institute for Environmental Studies at the University of Toronto, Faculty of Environmental Studies at York University, and the Faculty of Environmental Studies at the University of Waterloo. Each arrangement is based on a Memorandum of Agreement with a five-year term. The agreements identify the objectives of these partnerships and co-location:

* to achieve a high level of interaction between the activities of the Group and the university's faculty and students; and

* to promote and undertake high-quality research and related activities, including collaborative research, on adaptive response of natural and human ecosystems to major atmospheric and related environmental stresses.

It is expected that these co-location partnership arrangements will result in positive benefits for both AIRG and the universities. For the AIR Group the benefits are:

* engagement of researchers with expertise beyond that available within the AIR Group itself, particularly those from the human/social sciences; and,

* increased networking and collaboration with university researchers and students.

For the universities, the benefits are expected to include:

* opening up of new research areas and exposure to a broader range of ideas as a result of contact with Environment Canada researchers;

* participation of AIR Group researchers in university seminar series, teaching, advising students, and other university activities; and

* an increased degree of credibility of the university with "applied" clients.

Supplementing the four university arrangements (UBC, York, U of T, Waterloo) is another arrangement with UQAM (Université du Québec a Montréal) where AIRG has a "release time" arrangement with the university. AIRG provides funds for the university to hire a replacement for a talented researcher to devote herself to impacts and adaptation research issues. This arrangement has established a "virtual research chair" at UQAM.

When asked what factors were responsible for these successful collaborations, Street mentions four. First, the individuals involved wanted it to work. Secondly, strong support from MSC senior management was essential. Thirdly, all parties involved foresaw mutual self-interest in the arrangements. And finally, Street says, "patience." Ten years later AIRG has a strong contingent on four different campuses and a wealth of interactions that are contributing to its mandate.

EC and Carleton University Tie the Knot

Environmental Technology and Training Institute

It is hard to resist the metaphor that Environment Canada and Carleton University are tying the knot after a 10-year informal relationship. For Dave Thornton it is high time to set the productive relationship on a recognized footing. He is working with Carleton University's Vice President of Research and International Affairs, Dr. Feridun Hamdullahpur, to establish a new Environmental Technology and Training Institute (ETTI) that will be based at Carleton.

Thornton is director of the Environmental Technology Centre (ETC) at Environment Canada. ETC provides specialized scientific support and undertakes research and development for the department's environmental protection programs. The Centre focuses on four main areas: technologies for measuring air pollutants in ambient air and from mobile and stationary sources; analysis of organic and inorganic compounds; assessments and clean-up of contaminated sites; and prevention of and response to pollution emergencies such as oil and chemical spills.

Relations between ETC and Carleton have flourished for many years, but for every new project, a new agreement had to be struck.

For over a decade, staff at ETC have worked closely with colleagues across town at Carleton University on many environmental projects. Together, they have studied motor vehicle emissions and their effect on air quality. They have developed a database of vehicle-related air toxics. They have established a series of training courses. And, they have developed protocols to assess the survival in soil of bacteria and fungi that are on the designated substances list of the Canadian Environmental Protection Act. Some of the work has involved grants or contracts to Carleton researchers, while other work has simply involved sharing of facilities and expertise.

According to Thornton, the relationship has been mutually beneficial. Four ETC staff work as adjunct professors or sessional lecturers at Carleton. And a Carleton professor (Dr. Deniz Karman) is working at the ETC while on sabbatical leave from the university. Over the years, numerous Carleton students have worked at the ETC while conducting research to earn their degrees. For Thornton and Hamdullahpur, the next logical step was to work with Carleton to establish the Environmental Technology and Training Institute (ETTI).

ETTI won't be a bricks-and-mortar institute. Instead, it will be a research network that brings together researchers from EC and Carleton to work on projects of mutual interest concerning research, development, demonstrations and training in areas related to environmental protection. Thornton is looking forward to the time when ETTI is up and running. It will increase the number of collaborative projects between EC and Carleton. In particular, it will make it easier for Carleton faculty and students to work with researchers at ETC, and bring their knowledge and enthusiasm to bear on the kinds of research problems facing ETC.

And here's where the tying-the-knot metaphor comes into play. Relations between ETC and Carleton have flourished for many years, but on a largely ad hoc basis. Each interaction had to be negotiated anew; for every new project, a new agreement had to be struck. Paperwork could delay the work for weeks or months and consume significant management time and attention. Something as simple as having Carleton students working at ETC — a government facility — became a complex administrative headache. Better, Hamdullahpur and Thornton reasoned, to have an umbrella framework under which a variety of different activities could proceed. In other words establish a formal agreement so that ETC and Carleton could settle down together.

Months of talks between Environment Canada and Carleton produced a Memorandum of Understanding to establish the Environmental Technology and Training Institute. Once signed, the first activity under the MOU will be an annual planning meeting to identify potential joint projects and review ongoing issues for collaboration. The MOU includes opportunities for increased Carleton collaboration with other elements of the Environmental Technology Advancement Directorate, including the Technology & Industry and Technology Transfer Branches in Hull, Quebec, and the Wastewater Technology Centre in Burlington.

Thornton is hopeful that the ETTI arrangement will prove the model for future agreements between Environment Canada and the university sector. He points out that ETTI will improve research both at ETC and Carleton. Each party has access to research funds from different sources. Now it will be possible to combine their efforts and establish critical mass in fields of research that are important for environmental protection. The plan is to review the arrangement in three years and make any necessary adjustments that are required.

Looking back, would Thornton have done anything differently? "Yes, we would have put this arrangement in place much sooner," is his reply.

Climate Modellers are Drawn to the Sea

Canadian Institute for Climate Studies

It was the early 1990s and Environment Canada had a dilemma. Its climate modelling and analysis team had worked for years to develop a very good low resolution computer model of the climate. It included a comprehensive model of the atmosphere (similar to the models used for weather forecasting) but only simplified representations of the land surface and the upper part of the ocean. Although some parts of the model were not yet refined, it could be used — and was used — to predict some aspects of climate change. In particular, in a future when greenhouse gas concentrations reached a new, stable level that is double the current level.

But there were problems with this approach to predicting the future: the timing of the future greenhouse gas doubling is uncertain, and once the concentrations have stabilized it will still take the climate a long time to adjust. So the path between a future, doubled greenhouse gas climate, and the present climate remained very unclear. MSC's climate modellers realized that to go further, they would have to account for the entire ocean in their model rather than just including the thin upper layer of the ocean, because the ocean is in effect the climate's heat reservoir, or thermal flywheel.

To go farther the climate modelling team would need new expertise on the ocean, and the sea-ice modelling side of the equation. Trouble was, government was downsizing and the prospect of acquiring new positions was slim at best. It was also proving to be almost impossible to attract ocean modelling scientists to Toronto, which is a long way from the essential element that drives their curiosity — the ocean!

The solution that eventually emerged was to move Environment Canada's climate modelling team to Victoria, where it could access expertise that was available at University of Victoria (UVic) and the Department of Fisheries and Oceans' Institute for Ocean Sciences.

The leadership at UVic was intrigued with the proposition and quickly warmed to the idea of hosting a government research lab at the university. Ultimately, most of the climate modelling team moved to Victoria and set up shop on campus as the Canadian Centre for Climate Modelling and Analysis (CCCma).

At the same time Environment Canada created the Canadian Institute for Climate Studies (CICS) as a not-for-profit research corporation, with additional funding from the Province of British Columbia. CICS' purpose was

to develop a private sector market for value-added climate information and to manage the Climate Research Network (CRN) under contract to Environment Canada, as part of Canada's Green Plan. The CRN was used to support climate research at universities across Canada that was contributing to Environment Canada's research objectives. A lot of that research was focussed directly on CCCma's climate model. So began a fruitful relationship among CCCma, UVic and climate researchers in other Canadian universities. This helped to position MSC — and Canada — among the world leaders in climate modelling.

According to Francis Zwiers, Senior Research Scientist and current Chief of CCCma, the move to UVic has produced tremendous results. First, CCCma was able to gain access to the expertise that resided in Victoria. This has greatly benefited its modelling objectives. Furthermore, Zwiers and a number of his colleagues hold adjunct professor appointments to UVic. This brings them into direct contact with graduate students and postdocs, many of whom are working on leading-edge research projects that are of direct interest to climate modellers. The CCCMa team also contributes its time and expertise to mentoring the students, so there is a two-way benefit.

The relocation has produced some added unexpected benefits. One is that by being in Victoria, Zwiers' group has also developed a productive working relationship with the federal Department of Fisheries and Oceans. DFO has actually assigned two of its employees to work alongside the MSC researchers to provide additional ocean science expertise in an important emerging area of climate science. The team of 13 individuals who originally relocated from Downsview to Victoria has grown into a research consortium numbering around 35 people from different organizations, all working together to better understand the climate and improve Canada modelling capabilities. MSC personnel are still the largest single component, but the addition of personnel from DFO, and postdocs and students who are supported by externally funded research grants, has yielded a critical mass of research expertise that MSC could never have built itself in the early 1990s ... or subsequently, for that matter.

The effectiveness of the national climate research enterprise has also been strengthened by CCCma's involvement in the CRN, and subsequently, in a variety of university climate research networks that are funded by the Canadian Foundation for Climate and Atmospheric Science, some jointly with NSERC. CCCma's participation in the multi-university (and increasingly multi-disciplinary) research consortia have enabled it to focus a good part of the climate research expertise housed at universities, on its own research objectives. As a result, there are teams across the country that are working

on various research projects that promise to improve CCCma's climate model.

Thinking back on what factors led to the success of CCCMa's relationship with the university community, Zwiers argues that in order for these kinds of relationships to work — to leverage the capacity of other organizations — the federal partner needs to bring substantial amounts of real expertise to the table. "It's not enough just to show up with some financial support, you have to be a valued and involved research partner," he says.

A New Lease on (Wild)life

National Wildlife Research Centre

When officials of Health Canada's occupational health and safety office delivered the bad news in 1998, Dan Bondy was a little surprised and disappointed. Bondy had only recently arrived to head up the National Wildlife Research Centre. The HC officials had identified a multitude of health and safety problems at the aging NWRC building, which was located in Hull (now Gatineau) Quebec. Long ignored, the problems threatened to force the closure of NWRC. Equally worrisome to Bondy was that NWRC had previously lost a great deal of critical research mass, due to the elimination of many research and technical positions in the 1990s. The double blow of condemned facilities and declining capacity represented the greatest challenge in Bondy's short tenure.

Quickly, he created a management team and set to work to identify a number of options to take forward to senior management. One obvious one was to renovate the existing NWRC facilities so that they would meet health and building codes. But engineering studies estimated that the cost of renovating was likely to be considerably higher than the cost of a new building. It would also mean a lengthy disruption to research activities while the work was underway, plus two moves (one out to temporary facilities and one back to the new ones). Despite these disadvantages NWRC officials were prepared to put the renovation option forward.

A second option for new research facilities had been under discussion at Environment Canada for some time. This option was to build, renovate or expand lab research facilities at the department's Environmental Technology Centre in the south end of Ottawa and relocate NWRC office staff to EC's Place Vincent Massey office in Hull. Although this option was technically viable, it would mean splitting NWRC personnel into two parts, which did not appear to be the most attractive option for the tight-knit team with already declining critical mass.

In total, Bondy and his team outlined six different options for consideration by senior management and the minister's office. The option that had the most appeal to EC and to Treasury Board represented a significant departure from the norm. "Why not," Bondy reasoned, "build a new NWRC on the campus of a university that is a potential partner in wildlife research?" This approach could solve a number of problems. First, the cost of building a new NWRC on a university campus would be comparable to building it anywhere else.

Second, if the new building were built at the same time as a university facility it might be possible to share in the cost of the infrastructure — for instance land, heating and electrical plant — and on a variety of design and construction costs. But most importantly, Bondy and his team realized that by co-locating with a university that also had wildlife research strengths, it might be possible through enhanced collaboration to re-build the critical research mass that NWRC had lost over the years. Such a partnership would essentially create a virtual centre of research excellence, with benefits to both sides. EC management was quick to recognize the benefits of the co-location option. By 2000 a Treasury Board submission was prepared and the Board indicated it was prepared to allocate $10 million to a new NWRC. EC committed to find the additional funds to cover the difference. All that was needed now was a university partner.

The NWRC plan coincided with an unprecedented wave of building and staffing activity at Canadian universities. This was fuelled by capital grants from the Canada Foundation for Innovation and new research and teaching funds from the Canada Research Chairs program, together with enhanced research budgets at the three Granting Councils. NWRC officials quickly put their plan in place. They developed a document that put forward a long-term vision of wildlife research. Next, they outlined their needs to two local universities in a series of meetings and in-depth planning workshops. Following this they invited formal proposals from the universities to host a new National Wildlife Research Centre.

In the end, Carleton University put forward an attractive proposal. The university would pay for and construct the NWRC as a satellite facility of its biology building, which was in any event scheduled for renovation. Moreover, the two buildings would be physically joined to encourage the free movement of people, and, more importantly, ideas. NWRC would pay an annual rent and operating costs, and after a period of time, could choose to own the facility outright. But more than a simple real estate transaction, NWRC and Carleton officials envisage a much broader-ranging scientific collaboration.

Plans were developed, subject to available funding, to link the NWRC and Carleton research communities together. One initiative called for NWRC and Carleton to create a joint Institute for Wildlife Science with one or more endowed research chairs. NWRC set aside space in its new facility to house 24 student work stations, 13 of which were filled within a year of NWRC's opening in November 2002. Close collaboration between Carleton students and professors and NWRC researchers would help the flow of scientific ideas between the two communities. Carleton biology students could orient their thesis projects toward important wildlife issues at the same time "mining"

NWRC's huge wildlife databases. NWRC staff would help to supervise their research. Although to date a shortage of funds has prevented these initiatives from being fully realized, the structure of collaboration is in place and implementation can be accelerated when resources become available.

This innovative research collaboration combined a physical solution to NWRC's building problem together with a knowledge-oriented solution to its critical mass problem. A willingness on the part of EC and government officials to consider a non-traditional approach to building and operating new facilities was essential to the success of the experiment. The breakthrough was the realization that by working closely with a university that EC could achieve multiple objectives: not just acquire a much-needed facility at lower cost than going it alone, but develop a close scientific research relationship and train the next generation of wildlife researchers.

While the NWRC-Carleton experiment is widely acknowledged to be a successful venture, Bondy freely acknowledges that it could have achieved more. Had the project been seen from the start as an integrated activity combining facilities and knowledge generation, then some of the important add-ons — research chairs, collaborative projects, student places, etc. — would have been fully funded as part of the original planning. By treating the research collaborations separately from the physical construction, then some of the potential synergy was lost — or at least delayed to a future date.

Nevertheless, the NWRC-Carleton partnership stands as a shining example for future research collaboration between the federal government and the university sector.

Meteorologists and Oceanographers hook up for Storm Forecasting

Centre for Marine Environmental Prediction

In 1996 Hal Ritchie had no idea he was about to revisit his academic roots in the Maritimes. After graduating from Mount Allison university, Ritchie had risen to the position of research scientist in the numerical weather prediction group at the Meteorological Service of Canada (then called the Atmospheric Environment Service) — the weather office. It was in a casual conversation with his Director General of research, Phil Merilees, that the seeds for Ritchie's return to the Maritimes were planted.

Program review the year before had severely cut MSC's resources and the service was struggling to reinvent itself in the new era of fiscal restraint. The numerical prediction group to which Ritchie belonged was charged with building the computer models that take data from a variety of sources and provide tools for forecasters to make accurate weather predictions. But cutbacks meant fewer people — and less expertise — to help build the models. Merilees and Ritchie talked about a new way of gaining access to the kind of specialist expertise that they required but had no hope of hiring themselves.

Both of them were aware that university and other government researchers in the Halifax area had established a critical mass of research that was of interest to MSC, in particular, in storm surge prediction. Ritchie and Merilees kicked around the notion of working more closely with Halifax-area researchers. Not only for storm surge research, but in other areas where atmospheric and oceanographic science overlapped. At the end of the conversation they decided to investigate the possibilities in person. Early in 1997, Ritchie was dispatched to tour universities and other government sites around Halifax to see if there was in fact a basis for collaboration. He returned to Dorval to report that indeed much was taking place there — especially at Dalhousie University — that could be of help to MSC.

MSC had considerable numerical modelling expertise on the atmospheric side of the equation, but was lacking expertise on the oceanographic side.

Over the years researchers at Dal had build an excellent reputation in various fields of oceanography. Especially in coastal regions, local weather conditions are a product of atmospheric changes combined with ocean conditions. MSC had considerable numerical modelling expertise on the

atmospheric side of the equation, but was lacking specialist knowledge of the oceanographic side. Ritchie reasoned, and Merilees agreed, that by combining the institutions' research forces, better forecasting models could be produced – and likely faster than MSC could produce on its own.

But fostering a close working relationship would be difficult working out of Dorval. Moreover, Ritchie and Merilees determined that it was necessary to have some form of formal arrangement with Dal, so that an institutional relationship could be established to complement and facilitate future research relationships. As it happened, on his tour Ritchie had established a good rapport with Dal's Dean of Science. That led to an invitation to Ritchie to become an adjunct professor in the Department of Oceanography at Dal. In that capacity he would conduct research and supervise graduate students. He would also have an office at Dal, which would make his liaison job easier than if he spent all his time at MSC's local office in Dartmouth. Fortuitously, around this time MSC was able to scrape enough money together to co-fund an NSERC Industrial Research Chair at Dal, along with a local firm, MARTEC. The timing was obviously good because the Chair represented a significant enhancement to Dal's resources.

Before the end of the year Ritchie found himself relocated on a part-time basis to Halifax, spending part of his time at MSC's regional office in Dartmouth and the other part at Dal. (He still maintained an office in Dorval, where he continued to manage his research group at MSC.) His mission was to forge closer working relations with Dalhousie and other local partners. He quickly struck up a working relationship with Prof. Keith Thompson in Dalhousie's Department of Oceanography. Thompson and his team, particularly Josko Bobanovic who was a bright young graduate student at the time, had been working on a computer model that would predict storm surges. With advance warning of impending storm surges, people and animals could be evacuated from low-lying areas, emergency services could be alerted to stand by, and a great deal of property damage avoided. But for the model to operate optimally it would need to be closely linked to a weather model — just the kind of model that Ritchie and his group specialized in.

Within a couple of years the Dalhousie team has refined the storm surge prediction model to the point where it could be driven by the MSC's numerical prediction model. The first test of the partnership came in 2000 when an experimental version of the enhanced model system was running as a storm surge struck Charlottetown, Prince Edward Island. The system provided MSC forecasters with a "heads up" that the flooding would be significant, but it was not yet fully developed enough to meet all their needs. Impressed by the systems potential, they moved ahead and prepared an

automatic storm surge prediction and water level alert system for various sites in Atlantic Canada. Another test came the next year, when the model correctly alerted forecasters to another storm surge on the coast of PEI. This time though, the early warning helped emergency measures staff to alert residents. Advance notice also helped shopkeepers (and their insurance companies) to avoid a certain amount of property loss by such simple measures as piling goods on tables.

Ritchie is proud that MSC's partnership with Dalhousie yielded a result that was both academically satisfying and had practical benefits for people. Although the Dalhousie storm surge prediction system might eventually have been incorporated into MSC's forecast system, the close proximity and working relationship they established accelerated the adoption of the storm model, possibly by years.

But Ritchie's presence had an additional benefit for MSC and the local university community. It was one of the factors that has led to the establishment of CMEP, the Centre for Marine Environmental Prediction. The Centre's mission is to: develop new technologies for observation, prediction and visualization of the marine environment; test the new technologies in the real world; transfer the technology; train highly qualified personnel; and educate the public. CMEP includes researchers from Dalhousie, Fisheries and Oceans Canada, and of course, MSC. CMEP includes seven government partners and three corporate partners.

To date, funding for an active research program is in place at CMEP. The Canada Research Chairs program is providing key personnel, in addition to the government and industrial collaborators. Prof. Keith Thompson has been awarded a Tier 1 Chair. Dalhousie has allocated a Tier II Chair and is contemplating a second such chair. A committee has been struck (including Environment Canada, DFO, and Dalhousie) to make recommendations on a long-term activity to develop and implement an operational Canadian atmosphere–ocean-ice modelling system. This is an important new initiative that may include a significant role for CMEP.

At the present time, CMEP researchers are at work in Lunenburg Bay. They are integrating real-time information streams from ocean observatories, together with the existing land-based and satellite-based observation networks, and newly developed atmosphere–ocean numerical prediction systems to improve local weather and storm forecasts. Simultaneously, a group of researchers from the Department of Oceanography at Dalhousie University, MSC, and the Department of Fisheries and Oceans are working together to develop the capability for real-time forecasting of physical,

chemical and biological conditions in the coastal marine environment. The Lunenburg project promises benefits for climate change studies.

Partnership Tackles River Pollution

National Water Research Institute at UNB

Joseph Culp is an expert on river pollution. He is interested in how the quality of rivers is affected by agricultural runoff and contaminants that accumulate from activities such as mining or pulp making. Chief of the Cumulative Effects on Aquatic Biodiversity Project at the National Water Research Institute, Culp now makes his home at the University of New Brunswick in Fredericton where he is a Fellow of the Canadian Rivers Institute. While UNB is his job location, Culp is actually part of Environment Canada's National Water Research Institute.

The National Water Research Institute (NWRI), Culp's employer, is Canada's largest freshwater research facility, with centres in Burlington and Saskatoon. NWRI conducts ecosystem-based research and development in the aquatic sciences. In 2000 Culp was working at NWRI's laboratory in Saskatoon, when he willingly became the subject of an experiment in university collaboration. NWRI executives were looking for a way to tap into university expertise in different parts of the country. NWRI had no permanent presence in Atlantic Canada, but it knew that important research was being undertaken there. Discussions were also under way at the time to establish the Canadian Rivers Institute, and NWRI knew it had to be involved in this important initiative.

Around then Culp was looking for a new mid-career challenge. Over a period of 4 or 5 years Culp and his team had conducted a great deal of research. In one project they developed a "mesocosm," or artificial stream system. The purpose of the device is to tease out the effects of multiple stressors, such as nutrient-contaminant / metal-contaminant interactions, and multiple metal contaminant interactions. The mesocosm allows researchers to examine the effects of individual stressors and also to evaluate their combined effects.

The mesocosm system bridges the gap between laboratory studies, where variables are strictly controlled, and the natural world, where researchers have very little control over factors affecting their experiments. It consists of a series of artificial circular streams — the originals had a volume of approximately half a cubic metre each — that are transported to the riverside on a flatbed truck. Under ambient light and temperature conditions, river water is pumped through the mesocosm to simulate the river current. Substrates, or stream beds, are created using local rocks and other river materials, and a "biofilm" of sediment and tiny organisms that have settled out of the water, is given time to develop before benthic, or bottom-dwelling, invertebrates and small fish are introduced. In effect, the

mesocosm functions like a canary in a mine — it alerts researchers when trouble is brewing with river quality. What better place to put the technology to work than Atlantic Canada, with its dense network of productive rivers that are under stress from human activity?

As luck would have it, in December 2000 the University of New Brunswick formally established the Canadian Rivers Institute (CRI). The mandate of the CRI is to carry out multi-disciplinary basic and applied research focussing on rivers ecosystems, including their land-water linkages, for the purpose of conservation and habitat restoration. The CRI initiative was bolstered when UNB allocated two of its Tier I Canada Research Chairs to Dr. R. Cunjak and Dr. K. Munkittrick to lead the CRI.[1]

Just around that time NWRI officials initiated talks with UNB about a possible research partnership. Soon after, the talks led to an extremely generous offer. UNB proposed to provide a laboratory for Dr. Culp in its Department of Biology. From that base he could work closely with the CRI, which was headquartered in Fredericton and Saint John. In return, Culp would be appointed a research professor, in which capacity he would help teach a graduate courses in ecology and supervise graduate students. The details were formalized in a memorandum of understanding. With NWRI's blessing, in August 2002 Culp left Saskatoon and set up shop at UNB in Fredericton. Including Culp, there are now 4 NWRI staff working in the lab. One of Culp's NWRI colleagues, Donald Baird, a Research Scientist, is also cross-appointed to the University, and Culp and Baird have 2 support staff working with them.

According to Culp, one of the advantages of his UNB location is that he and his team can work closely with university researchers who are receiving financial support from NSERC and CFI. Another benefit of the relocation from Saskatoon to Fredericton is that he has been able to make ties to researchers from Agriculture and Agri-Food Canada, who are interested in the impact of agriculture on river environments. Culp has also observed that his team's applied research orientation helps his university colleagues to see the practical side of academic research.

From NWRI's perspective, establishing the lab at UNB both provides a window on Atlantic university science, and an opportunity to apply its expertise on the ground ... or on the water. For Culp, the relocation means the opportunity to form "a strong network of interactive researchers." During

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[1]In March 2004 CRI received additional support from The Canada Foundation for Innovation; CFI awarded the University of New Brunswick $1,794,202 for infrastructure in support of research at the Canadian Rivers Institute.

the peak summer field season there can be 10-20 people working out of Culp's lab on a variety of water and river issues. Culp's lab is becoming in effect a mini-NWRI for Atlantic Canada.

Prototype Network Becomes Model for Regional Research Cooperation

Atlantic Environmental Sciences Network

According to Linda Cooper, "it's all about people." Cooper was describing the factors that are contributing to the success of the emerging Atlantic Environmental Sciences Network (AESN), which she coordinates. AESN is a partnership of 12 universities, federal and provincial governments, industry and community groups in Atlantic Canada. Its mission is to facilitate excellence in cooperative and strategic environmental research, development and training, by creating and exploiting effective partnerships in Atlantic Canada. The overall network objective is to develop enhanced capacity in the region. Ms. Cooper reports that building trust and respect among the people involved in research networks such as AESN is key to their success.

AESN will build the capacity of Atlantic universities to undertake environmental research that addresses the region's problems.

AESN is a research network that aims to bring together regional science and technology expertise in order to tackle environmental problems in Atlantic Canada. To date, AESN has set its sights on six thematic areas and has established research "cooperatives" in each: Biodiversity, Watersheds, Climate Change, Environment and Human Health, Environmental Engineering, and Marine Life. All are important issues for the region's environmental future. The cooperatives emphasize policy and socio-economic issues, in addition to the traditional S&T research perspective.

The inspiration for AESN came from a previous successful regional network that had been fostered by George Finney, one of Environment Canada's regional directors, headquartered in Sackville, New Brunswick. The Atlantic Cooperative Wildlife Ecology Research Network (ACWERN), which provided the model for AESN, is focused on wildlife ecology in the marine, coastal and terrestrial ecosystems of Atlantic Canada. ACWERN researchers study fundamental and applied problems in wildlife ecology and habitat relationships. ACWERN research takes place at Acadia University, Memorial University of Newfoundland, University of New Brunswick, and at Environment Canada's Canadian Wildlife Service.

ACWERN was organized around three research chairs (one at each of the participating universities) that were established with financial support from EC and NSERC, another ACWERN partner. In the early 1990s EC had a small amount of money available from Green Plan resources ($200,000) that it

wanted to use to establish a research chair in wildlife ecology at an Atlantic university. It used this money to leverage the additional investment from NSERC and other partners, ultimately creating three Chairs at different institutions. The advantage of NSERC's Industrial Chair program is that it allows researchers to concentrate on full-time research. The Chairs in turn attracted many graduate students, who aligned their thesis research with wildlife issues.

ACWERN provided a vehicle that allowed Environment Canada researchers to more formally collaborate with their university counterparts at an institutional level. Whereas EC researchers had a long history of collaboration with university researchers in Atlantic Canada, this collaboration was occasional and peer-to-peer (one government researcher to one university researcher). ACWERN permitted research relationships to be institutionalized. This in turn allowed for the scale and scope of the work to be expanded and for research teams and groups (as opposed to individuals) to get more involved.

One of the value-added aspects of research networks such as ACWERN and AESN is that they bring together researchers from different departments within a university who might not otherwise work on similar issues. For example, they might enable biologists to work with foresters to assess the health of a marine ecosystem. Research networks provide both the organizing theme — a large research theme such as wildlife — and the "glue" — additional financial resources — so that individual researchers and research teams can work together and concentrate on multidisciplinary projects. Similarly, they encourage researchers from different institutions (in Atlantic Canada) to collaborate. Critically, research networks provide an administrative and management framework for the research. For example, networks typically organize annual scientific meetings at which faculty, student and government researchers can report the progress of their research and coordinate and plan future activities. Finney reports that one factor that is contributing to ACWERN's success is that it is "administratively easy" for researchers and administrators alike. In other words, ACWERN reduces red tape.

Finney confides that had ACWERN had access to more money to directly fund research it could have achieved even more. Most of ACWERN's research funding came from third parties, such as the federal Granting Councils, and this support was inevitably limited due to high demand elsewhere in the system. Nevertheless, the basic networking model is working well. To date, over 100 students have graduated with ACWERN experience. The network is currently working on research projects valued at $1.2 - 1.4 million.

It was the success of ACWERN in delivering research results and promoting collaboration that helped George Finney to attract broadly-based support for AESN. AESN extends the ACWERN model so that researchers can address additional environmental issues (Biodiversity, Watersheds, etc.) in a larger and more multidisciplinary way than they could undertake individually. Importantly, AESN also coordinates the activities of multiple research funders, notably ACOA, universities, and Environment Canada itself. Instead of each organization funding small-scale individual projects, smaller individual funds can be combined to underwrite larger team-oriented research programs.

One of Finney's first actions was to hire Linda Cooper to manage the development of the network. In the spirit of partnership, 60% of her salary comes from Environment Canada, through the Environmental Conservation Service, and the other 40% is contributed by Mt. Allison University. With an extensive background in partnership development as well as university teaching experience, Cooper was the ideal candidate for the job. To start, Finney and Cooper organized a workshop to which they invited representatives of regional universities, provincial governments, ACOA, NRC, industry associations, community organizations and other groups interested in fostering environmental research in the region. This meeting helped to elaborate the AESN model and to build support for the concept. Many of those who participated in the early discussions were already familiar with the success of ACWERN and believed that the ACWERN model could be successfully adapted to broader environmental issues.

The workshop participants agreed to constitute a Board of Directors to oversee AESN, and 15 individuals representing different stakeholder groups agreed to join the Board. To date, AESN is involving 12 different Atlantic institutions, making it one of the most extensive research collaborations of its type. Environment Canada, Sackville is AESN's administrative headquarters. The initial planning workshop also determined the initial six research themes (or "cooperatives") that AESN would concentrate on. The cooperatives are not yet set in stone: depending on how much research support they attract from funders the cooperatives may go forward or may be replaced by others.

AESN is still in development, but prospects are bright. Without Environment Canada's leadership — first to establish ACWERN and then to extend the model further — AESN would still be an idea. AESN's participants and backers are convinced that it will build the capacity of Atlantic universities and partner institutions to undertake environmental research that addresses the region's problems. ACWERN built a record of research success and trust among institutions. High-level support for the follow-on AESN concept within

EC, universities and other research funding organizations was key to AESN moving forward. Much work still needs to be done; according to Linda Cooper, for AESN to succeed each of the six research theme areas will require at least a half-time coordinator, and funds or in-kind resources will need to be found to staff these positions.

For Environment Canada, AESN represents a powerful resource to achieve the government's strategic environmental research and policy objectives. It is an excellent way of engaging multiple stakeholders, including: other federal departments, research funders, economic development agencies, universities and community groups. What advice does Cooper have for other federal departments contemplating expanding their links with universities? "Give it a try."

Toward a National Environmental Research Agenda

Canadian Environmental Sciences Network

As Canada's leading environmental steward, Environment Canada has a special interest and role to play to ensure that national research efforts are focused on Canada's major environmental problems and opportunities. The federal government annually spends millions of dollars to advance our understanding of environmental science and technology, and how they can be used to deal with Canada's current (e.g. air pollution) and future (e.g. global warming) environmental problems. Many different federal departments and agencies are engaged in funding or performing research that has an environmental objective. The list of major funders includes: NSERC, CIHR, SSHRC, NRC, CFI, Industry Canada, DFO, NRCan, AAFC and Environment Canada. And yet, there is no national environmental research strategy to guide various investment decisions. Each research funder or performer makes its own investment decisions. Often these are based on the current interests of its research community, rather than on a set of national priorities.

In addition to the dispersed nature of government environmental research, there is the matter of Environment Canada's own budget for environmental research, which is comparatively small. With its present resources and capacity it could never hope to cover all the important research bases on its own. How, then, to see that research to address Canadian needs is being undertaken at home, when EC's own resources are limited? That was the dilemma facing senior EC management in 2001.

EC's Deputy Minister at the time, Alan Nymark, had recently arrived from Health Canada. There he had observed the creation of the new Canadian Institutes of Health Research (CIHR). He was impressed with how CIHR had organized its research into theme areas that related to human health problems — cancer, heart disease, women's health, and so forth — rather than on traditional medical disciplinary lines. Mr. Nymark believed that a similar approach could be used to better focus environmental research, by concentrating on larger themes that addressed Canada's environmental problems. But he realized that Environment Canada was limited in how much it could do on its own. The key, he believed, was expanded partnerships with the university sector and the development of a voluntary coordinated national environmental strategy.

Encouraged by EC's many years of successful partnerships with universities, Mr. Nymark realized that the university sector could fill in many of the research gaps that the thinly-stretched department could not. University personnel could undertake research that was relevant to the mission of the department. And, in the course of the research they would be providing training experiences for the next generation of environmental researchers. University research would never be a replacement for in-house research, but it could be an important complement.

Good fortune meant that Prof. John ApSimon, recently retired from his post as Vice President of Research at Carleton University, was available to take on the new position of *Special Science Advisor to the Deputy Minister*, aimed at improving EC's interactions with the university sector. ApSimon was recruited to find a way to better link EC's research efforts with those of the university community and to see if by working together and with other stakeholders, it would be possible to develop something along the line of a voluntary national environmental research agenda. While a formal national environmental research plan was considered too ambitious, an informal arrangement in which research funders and performers agreed on some major directions and initiatives and coordinated their activities, was viewed as achievable.

From 2001 to 2003 Dr. ApSimon worked with the major federal Granting Councils — CIHR, NSERC, SSHRC — and the Canada Foundation for Innovation (CFI), other government departments, leading universities, and other stakeholders, to explore the potential of collaboration. In the first instance, the idea was to see what improvements could be made without injecting new funds, by simply better coordinating plans and priorities.

All the major federal university granting organizations were eager to cooperate. To begin the process they each organized exploratory workshops that brought stakeholders together to discuss the basic idea of improved planning and increased collaboration for environmental research. For instance, with financial support from Environment Canada and SSHRC, the National Round Table on the Environment and Economy was invited to convene 2 workshops. NRTEE produced a report titled *Nature and Society: Environment and Sustainability Research Program*. This report recommended a number of objectives for SSHRC's *Nature and Society Program*, especially for capacity building and knowledge development. The report also recommended a research focus and agenda for four categories of programs: investigator-driven research, targeted research, advanced training and communication and knowledge transfer. It will form the basis for future SSHRC initiatives in social science research for the environment.

The Canadian Institutes of Health Research has a mission to encourage research on the health of populations, societal and cultural dimensions of health and environmental influences on health. Partly as a result of the encouragement it received from Dr. ApSimon and Environment Canada, CIHR is proposing to develop a National Research Agenda on the Environmental Influences on Health, in collaboration with their partners and stakeholders. The proposed National Research Agenda will contain research priorities that address major issues and emerging trends in environmental health in Canada and internationally, as well as Canada's areas of excellence. Examples of possible national research priorities include: children's environmental health; bioregional research on health and the environment; genetic susceptibility to environmentally-mediated diseases; aboriginal health and the environment; and the health effects of global ecological change.

A similar approach by Dr. ApSimon to the Natural Sciences and Engineering Council also met with a positive response. EC and NSERC agreed to co-sponsor a *Survey of NSERC Funding for Environmental Science Research at Canadian Universities* to support the development of a national environmental research agenda. EC and NSERC were both interested in getting a handle on university research capacity in the natural sciences and engineering. The survey concluded that "The creation of a Canadian Environmental Sciences Network might ... be beneficial to promote continued cooperation between agencies, both at the federal and provincial level, and to ensure that areas of environmental research important to Canada are not overlooked and that they are studied under all their facets, whether they be related to social, health or science and engineering issues and adopted whenever warranted." This study is now leading NSERC to develop environmental research priorities in the natural sciences and engineering.

The Canada Foundation for Innovation has a mandate to strengthen the capability of Canadian universities, colleges, research hospitals, and other not-for-profit institutions to carry out world-class research and technology development in a variety of areas, including environmental research. In partnership with EC, CFI also organized a workshop in 2002 to explore whether and how CFI might do more to support environmental research. CFI is using the workshop discussions to consider how to encourage universities to put forward more proposals for environmental research infrastructure.

Promoting the organic development of a national environmental research agenda was the first part of a two-pronged initiative spearheaded by Dr. ApSimon. Because his remit from the Deputy Minister allowed him to focus exclusively on collaboration with the university sector, and not be diverted by day-to-day policy or administration issues, he was also able to concentrate on creating the Canadian Environmental Sciences Network. The CESN approach recognized that a growing number of local, regional and national environmental research networks had sprung up. Many of these were offshoots of EC investments in university research. But EC could no longer afford the time or money to be at the centre of every research network. CESN aims to build on current strengths in environmental networking and collaboration in Canada, using a "network of networks" approach to improve links between environmental science networks across the country. Its members would be networks of scientists working in all aspects of environmental sciences.

CESN has three major goals. The first goal is to better connect those who create, apply and fund environmental knowledge. Using existing networks and partnerships as a foundation, the Network is reaching out and building links where none exist today. It will improve network-to-network communication and co-operation. It will provide a forum for sharing information on approaches and results, identifying common concerns and strategies, and targeting complementary opportunities. The second goal is to help environmental scientists collaborate across the boundaries of discipline and

geography. A "network of networks" will accelerate the generation of environmental knowledge by promoting opportunities for greater integration and collaboration within the environmental sciences community. It will promote cross-disciplinary exchanges between institutions in such areas as training, R&D, monitoring, commercialization, and the provision of services. It will also champion the role of environmental knowledge in Canada.

Above all, the Network will help those who care about the creation and use of environmental knowledge to forge a unifying vision for environmental knowledge in Canada. This vision will be the starting point for creating a national action agenda and strategic investment strategy for Canada's environmental sciences.

ApSimon was instrumental in bringing a wide range of university-based environmental research networks into the Canadian Environmental Science Networks. Prominent members include:

- **Alberta Cooperative Conservation Research Unit (ACCRU)**
The Alberta Cooperative Conservation Research Unit (ACCRU) is a multi-institutional research and learning centre dedicated to the generation and communication of reliable scientific knowledge to drive effective stewardship and wise use of wildlife and fisheries resources.

- **AquaNet**
AquaNet is the NCE for Aquaculture in Canada, providing research in the natural, applied and social sciences capable of supporting an aquaculture industry that is productive, environmentally sound and acceptable within the context of social, cultural and political values of Canadian society.

- **Atlantic Cooperative Wildlife Ecology Research Network (ACWERN)**
ACWERN is a research network focused on wildlife ecology in the marine, coastal and terrestrial ecosystems of Atlantic Canada.

- **Atlantic Environmental Sciences Network (AESN)**
AESN is a network of universities, federal and provincial governments, environmental industry associations, and NGOs. Its mission is to facilitate excellence in cooperative and strategic environmental research, development, and training, thereby building effective partnerships and enhancing knowledge-based environmentally sustainable economic development in Atlantic Canada.

- **British Columbia Environmental Sciences Network (BCESN)**
BCESN is being formed to: facilitate the establishment of science priorities and objectives; enhance scientific community understanding of government science needs; foster collaborative research; encourage integrated ecosystem oriented approaches to environmental science in B.C.; and establish a "connector hub" to facilitate improved access to national environmental science networks. The network will be made up of partners from federal and provincial government, academia, industry, ENGOs and First Nations.

- **Canadian Biodiversity Information Network (CBIN)**
The CBIN is the Canadian node of the International Clearing House Mechanism (CHM) of the UN Convention on Biodiversity (CBD), and the window for parties and partners in Canada working to facilitate implementation of the Convention.

- **Canadian Climate Impacts and Adaptation Research Network (C-CIARN)**
C-CIARN is a national network that facilitates the generation of new climate change knowledge by bringing researchers together with decision-makers from industry, governments, and non-government organizations to address key issues.

• **Canadian Climate Variability Research Network (CLIVAR)**
This research network aims to clarify the physical mechanisms responsible for natural climate variability on various time scales and improve understanding of how much of the observed and predicted global warming is attributable to green house gases, as opposed to natural climate variability.

• **Canadian Cooperative Wildlife Health Centre (CCWHC)**
The CCWHC is an organization linking Canada's four Veterinary Colleges that coordinates Canada's national program of wildlife health surveillance and provides educational programs, information and consultative advice to government and non-government agencies and to the public.

• **Canadian Environmental Technology Advancement Centres (CETACs)**
The three CETACs — CETAC-West, OCETA, and EnviroAccess — are private-sector, non-profit corporations whose goal is to help small and medium sized enterprises (SMEs) develop and commercialize innovative environmental technologies through the provision of a broad range of services.

• **Canadian Network of Toxicology Centres (CNTC)**
The CNTC is a national network of collaborating institutions — government, academic, and industry — that conducts interdisciplinary environmental health-related research.

• **Canadian Water Network (CWN)**
The Canadian Water Network develops and supports diverse, multidisciplinary projects addressing the critical water issues facing Canada. Its principal role is to foster an integrated national vision for water management, and to provide the sound research foundation needed to contribute effectively and objectively to national policy deliberations and the development of regulations.

• **Canadian Weather Research Program (CWRP)**
The CWRP is an evolving partnership for knowledge exchange and sharing of expertise among universities, government and the private sector, with the aim of better predicting, and reducing the impacts of extreme weather.

• **Climate Research Network (CRN)**
The CRN contributes research to the World Climate Research Program. Its research focuses on developing computer models of the climate system, understanding atmospheric processes that need to be incorporated in climate models, and assessing the nature of climatic variability on a variety of time scales.

• **Climate System History and Dynamics (CSHD)**
CSHD is a multidisciplinary collaborative effort to integrate and develop national expertise in paleoclimate modelling and reconstruction.

• **Coasts Under Stress**
Coasts Under Stress, a five-year project that started in April 2000, is an experiment in interdisciplinary research. Using a set of complementary case studies on the East and West Coasts of Canada, it is analysing the long- and short-term impacts of socio-environmental restructuring on the health of people, communities and the environment.

• **Collaborative Mercury Research Network (COMERN)**
COMERN aims to provide an integrated research effort that will improve our general understanding of how mercury is transmitted and accumulates in our ecosystem. It was established through the financial support of the Natural Sciences and Engineering Research Council of Canada.

• **Ecological Monitoring and Assessment Network (EMAN)**
EMAN is a national, decentralized network of organizations and individuals involved in ecological monitoring in Canada to better detect, describe, and report on ecosystem changes.

• **Fluxnet-Canada**
Fluxnet-Canada is a national research network bringing together university and government scientists to

study the influence of climate and disturbance on carbon cycling along an east-west transect of Canadian forest and peatland ecosystems.

- **Mackenzie Global Energy and Water Cycle Experiment (GEWEX)**
The Mackenzie GEWEX Study is a set of coordinated process, remote sensing and modeling studies of the behaviour and the connections between the atmospheric and hydrologic (water) systems of the Mackenzie River Basin in northern Canada. It is being conducted by a network of Canadian government and university scientists.

- **Metals in the Environment Research Network (MITE-RN)**
The MITE network aims to understand the sources of metals in the environment, how metals move and transform within the environment, and how they can affect ecosystems and human health.

- **National Air Pollution Surveillance Network (NAPS)**
NAPS is a joint federal, provincial, territorial and municipal network monitoring and reporting on air quality and providing data to a broad range of actors.

- **National Hydrometric Network**
This is a network operated by Environment Canada in partnership with the provinces and territories that collects reliable, high quality data on water levels and related information across Canada.

- **Network of Environmental Technology Innovation (NETI)**
NETI is a network of technology developers, equipment manufacturers, incubator centres (CETACs), R&D organizations, financial institutions and governments.

- **Sustainable Forest Management Network (SFM)**
The SFM Network provides interdisciplinary research on the management of the forests of Canada.

- **Upper Lakes Environmental Research Network (ULERN)**
ULERN is a non-profit organisation that facilitates collaborative Aquatic, Terrestrial, and Atmospheric Research throughout the Upper Great Lakes Basin.

What factors contributed to the success of the project? One is that Environment Canada researchers had a lengthy record of scientific and technical collaboration with their colleagues in universities. In fact, many EC researchers held adjunct teaching positions at local universities. Many others were co-located at universities, working side-by-side with university personnel. These relationships helped to establish the department's own research credentials and paved the way to further cooperation.

As a respected individual who had spent many years as an active researcher and university administrator, Dr. ApSimon was an ideal representative of Environment Canada among his peers in the university system. The fact that he enjoyed the support of Environment Canada's Deputy Minister meant that he was able to speak with authority inside and outside the department. Dr. ApSimon also had small amounts of money that he could use to seed priority setting and networking activities. Although he could not fund research directly, he was able to engage senior officials in granting agencies and universities in a high-level dialogue that cleared the way for change.

More than anything, by appointing Dr. ApSimon to handle the university collaboration file, Environment Canada sent a strong message to the university sector that it was serious about developing partnerships with the university sector. Over the months and

years to come the department - and the country - will benefit from the seeds sown by Dr. ApSimon.

APPENDIX A

Examples of EC Collaborative Activities with Universities, by type

Collaborative Activity	Connections/advantages	EC Examples
People Students at EC	Student placement programs. Cross-pollination. Potential future employees.	250- 300 students at EC in 2003-04
Adjunct Professors	Co-supervision of graduate students. Access to colleagues and facilities.	EC scientists hold about 200 collaborative positions
Collaborative Projects Shared projects	Flexible arrangements. Connects with most appropriate university colleagues on specific issues of mutual interest.	Between 1990 and 1998 about 1/3 of EC publications in refereed scientific journals were co-authored with universities (includes co-authorship with supervised students)
Research Chairs	Self-contained research units. Address interrelated research program. EC support means direct influence on the research program.	EC, through NWRI, is a partner in the United Nations University Chair on African Great Lakes and Rivers, established at the University of Waterloo in co-operation with the International Network on Water and Environment and Health (INWEH) of the United Nations University to help resolve water use conflicts and improve water quality in Africa. The Canadian Wildlife Service established two chairs in collaboration with NSERC in the early 1990's, one at the University of New Brunswick (UNB) and the other at Simon Fraser University (SFU). The SFU position and associated Centre for Wildlife Ecology has become a substantial and successful enterprise with an annual budget of over $2M supporting research associates, post-doctoral fellows and graduate students. Renewed funding for this endeavour was announced by the Minister for the Environment in September 2003. See below under networks for information on the UNB chair.

Collaborative Activity	Connections/advantages	EC Examples
Co-location: Individuals	Provides access and facilitates greater collaboration with university colleagues	The National Water Research Institute has been active in placing its staff in university positions to encourage greater interaction, partnerships and training for students in areas of interest. For example, NWRI staff are currently working on aquatic ecosystem quality at the University of New Brunswick, climate change impacts on hydrology and aquatic ecosystems at the University of Victoria, and lake management research at the University of Calgary. Since 1997, our Meteorological Service's Adaptation and Impacts Research Group has had a co-location partnership arrangement with the University of Waterloo, under which members of the group have been located at the Faculty of Environmental Studies. The group also has co-location arrangements at the University of Toronto and the University of British Columbia. These research partnerships aim to is to broaden the research agenda beyond physical sciences to include resource management, social, economic and communications research.
Co-location Facilities	Provides easier access and facilitates greater collaboration with university colleagues access to university facilities, possibility of shared facilities	Our National Wildlife Research Centre recently relocated to the campus of Carleton University. This move will assist in realizing our vision for NWRC as a world class centre for wildlife science and a central node for a national wildlife research network involving researchers from universities and government. The centre has increased its number of adjunct professors, has greater access to students and is developing some shared facilities with the university. The academic interchange provides a stimulating environment.

Collaborative Activity	Connections/advantages	EC Examples
Networks Regional Networks	Access to partnerships across the region. Opportunities to address regional environmental concerns in a collaborative way.	EC investment in a chair at UNB in conjunction with associate chairs at Acadia and Memorial University of Newfoundland has served to form the basis of a network, the Atlantic Cooperative Wildlife Ecology Research Network (ACWERN), addressing regional wildlife research and conservation priorities through multidisciplinary scientific approaches to problems in wildlife ecology and habitat relationships. We are currently building the Atlantic Environmental Sciences Network (AESN), a multidisciplinary and multi-sectoral network of networks. Small research networks are addressing research priorities in six areas: biodiversity (building on ACWERN), watersheds, climate change, environment and human health, environmental engineering and marine life. AESN is building effective partnerships and enhancing knowledge-based environmentally sustainable economic development in Atlantic Canada. Efforts are underway to build regional networks in each of EC's regions. It is anticipated that each will be unique, dependent on the priority environmental issues, universities, and the how each region finds it best to organise
Networks National Networks	Connections to the best researchers in the field. Opportunities to get the best minds working on issues of direct policy relevance.	The Canadian Cooperative Wildlife Health Centre (CCWHC) was formed in 1992 as a network of Canada's four veterinary colleges. The CCWHC was set up on this model to benefit from expertise at Canada's veterinary colleges in addressing EC's gaps in the science of wildlife health and disease. This network supplemented existing knowledge in this field at the four sites to the mutual benefit of the host universities, Canadian Wildlife Service, provincial wildlife agencies and other partners. Focused networks such as this can be set up and maintained with relatively few resources. EC has been a prime mover and co-investigator in the NSERC Metals in the Environment Network (MITE-RN). This multi-stakeholder effort allows EC to work collaboratively to gain additional information for assessing impacts and risk assessments under the Canadian Environmental Protection Act. The Canadian Network of Toxicology Centres, which EC has long supported, provides the secretariat for this network.

Collaborative Activity	Connections/advantages	EC Examples
Funding Programs	Provides opportunity to influence the direction of many researchers to address issues of direct policy relevance.	When the Eco-research Program was launched in the early 1990s, its innovation lay in its involvement of EC with all three granting councils (NSERC, SSHRC and MRC). Funding supported cross-disciplinary research on ecosystem-level issues, integrating expertise from the social, health and natural sciences and engineering. The Toxic Substances Research Program was developed to enhance and accelerate science capacity and information on toxic substances related to environment and health. The program encouraged partnerships between federal scientists and others.

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