CANADA

Report of the
National Advisory Board
on Science and Technology

COMMITTEE ON OCEANS AND COASTS

Presented to the
Prime Minister of Canada

OPPORTUNITIES FROM OUR OCEANS

MAY 1994

CANADA

National Advisory Board on Science and Technology

Conseil consultatif national des sciences et de la technologie

The Right Honourable Jean Chrétien, P.C., M.P.
Prime Minister of Canada
House of Commons, Room 309-S
Ottawa, Ontario
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Dear Prime Minister:

We have the honour of transmitting on behalf on NABST the Report of the Committee on Oceans and Coasts entitled Opportunities From Our Oceans.

Geographically, Canada is a maritime nation by any definition. We have the world's longest coastline and largest archipelago. Eight of Canada's ten provinces, and both territories, border on salt water. Our maritime boundaries encompass three very different ocean environments -- the Atlantic, the Arctic and the Pacific.

But while oceans figure prominently on a map of Canada, they have not received comparable policy attention. Throughout our history, ocean policy as been created on an ad hoc basis, responding to issues rather than planning for them. As a result, we have a haphazard regulatory system and a science and research infrastructure that lacks social and economic goals suitable to the distinct needs of each separate ocean region.

This year is a particularly opportune time to begin to chart a new course in ocean policy. The United Nations Convention on the Law of the Sea will come into force in November of this year, allowing Canada to claim almost 5 million square kilometres as its "Exclusive Economic Zone". The collapse of the cod fish industry on the Atlantic coast calls for new economic diversification strategies. Trade opportunities in Asia offer new challenges to maximize our Pacific Rim location. Meanwhile, new government structures in the Arctic are creating new customers for federal science.

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In this Report, NABST develops the case for a proactive oceans science policy system that would respond to the particular opportunities on each of our three coasts by enlisting science and technology in the service of economic development and sensitive stewardship of our marine environment.

Yours sincerely,

Howard Clark
Co-Chair, Committee on
Canada's Oceans and Coasts

Peter J. Nicholson
Co-Chair, Committee on
Canada's Oceans and Coasts

The views expressed in this paper are those of the authors and do not necessarily correspond to the views or policies of the Government of Canada.

NATIONAL ADVISORY BOARD ON SCIENCE AND TECHNOLOGY (NABST)

MANDATE

The Mandate of the National Advisory Board on Science and Technology (NABST) is to advise the Prime Minister on how science and technology can be more effectively utilized in Canada, and specifically to:

- Advise on the appropriate use of government instruments for encouraging the development of science and technology, including statutes, budget measures, and regulations;

- Propose means to sensitize people to the profound changes resulting from the technological revolution, and to help them make the necessary adjustments;

- Identify changes that may be required in the educational and training institutions;

- Develop methods by which government can assist industry in responding to the challenges of international competition;

- Advise on how best to coordinate the efforts of industry, labour, universities, and government in pursuing national goals;

- Recommend priorities for the support of scientific disciplines, strategic technologies, and national programs; and

- Respond to specific questions or tasks requested by the Prime Minister.

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EXECUTIVE SUMMARY

Canada is a maritime nation bordered by three oceans, possessing the longest coastline, the longest inland waterway, the largest archipelago and the second largest continental shelf of any country in the world. During the present year, the United Nations Convention on the Law of the Sea (UNCLOS) will come into force providing Canada with the opportunity to take possession of almost 5 million square kilometres of ocean as its Exclusive Economic Zone (EEZ). With this opportunity comes the responsibility to design a management strategy so that these ocean resources are a sustaining source of environmental and economic wealth.

From our analysis of the oceans related policy initiatives of the past we have determined that policy activity in the national interest has generally been in response to international events. The *Arctic Waters Pollution Prevention Act, 1970*, the 1972 moratorium on offshore drilling in the Pacific, and Canada's active participation in the drafting of the International Convention on the Law of the Sea in the early 1980's have all been in response to international events which called into question our sovereignty and threatened our coastal environments.[1]

Now is the time for Canada to break from the reactive approaches to ocean issues of the past, and take an innovative, proactive step. Rather than merely adjusting existing pieces of legislation to comply with the Convention, this is the time to launch a comprehensive rejuvenation of our ocean policies. The NABST Committee on Oceans and Coasts Science and Technology (S&T) has identified the key elements for such a rejuvenation, and strongly recommends that the government "catch the wave" that this opportunity offers.

The two distinct elements of an ocean management strategy are wealth creation and risk management. Both offer a return on investment to the federal government. Despite evidence recognized in some quarters that commercial fish stocks were seriously declining, the closure of most of the East Coast fisheries has caught us by surprise and is costing over $900 million[2] in crisis management costs. In part, we are paying the price for an inadequate science management system which provided neither a convincing warning that fish stocks were in danger nor an explanation as to why this was happening. We have much research and reexamination to do before we are in a position to operate a sustainable groundfish fishery in Atlantic Canada once again. In its consultations, the Committee was made aware of innovative ocean industrial strategies that are responding to market demand for new technologies and products. These activities illustrate that an investment in an ocean S&T strategy can translate into new jobs and new trade opportunities.

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1 The *Arctic Waters Pollution Prevention Act, 1970*, was in response to a test voyage by the U.S.-based Humble Oil Company's *S.S. Manhattan* through the Northwest Passage without first obtaining permission from the Canadian Government to do so. The moratorium on offshore drilling in the Pacific was created to prevent oil tanker traffic from Alaska from travelling too close to the coast of British Columbia.

2 Northern Cod Adjustment Program (NCARP) projected cost is $920 million. Auditor General of Canada, *Report of the Auditor General of Canada to the House of Commons*, (Ottawa: Supply and Services Canada, 1993) p. 396.

Scientific research and technology development must be key instruments of such a strategy. But to be successful, the strategy must be built on a comprehensive legal framework--**a Canadian Oceans Act**--which establishes a regulatory system equipped to address the needs of ocean frontier development for the present and for the future.

We recommend that this act have four main objectives:

- **establish Canadian sovereignty over the 24 nautical-mile Contiguous Zone (CZ) and the 200 nautical-mile Exclusive Economic Zone (EEZ);**

- **extend environmental regulation to the Exclusive Economic Zone;**

- **create an ocean science management system in support of national and regional goals; and**

- **build on international conventions and cooperative agreements to promote international scientific research in support of a global resource management regulatory regime.**

The idea of an oceans act is not new. It was recommended in 1987 as part of a wide-ranging oceans strategy, approved by Cabinet, that addressed the issues of sovereignty, resource development and environmental protection. This initiative progressed as far as documenting a great many of the good ideas but failed to generate any action to help Canada better manage its oceans. As a result, we continue to be vulnerable to natural and human induced phenomena, and we are not capturing our share of the new markets for marine-based technologies and products.

Other nations have already recognized the importance of an investment in ocean science, technology and development strategies. Norway has developed export markets for its ocean mapping systems and has the world's third largest shipping fleet. The United Kingdom uses its navy and its foreign embassies as marketing agents for British ocean industries. The Australian Institute of Marine Science was founded in 1970 to advance knowledge of the marine environment and to facilitate the development of an ocean industrial sector.

These three countries have economic and political structures and, in the case of Norway and the United Kingdom, climates similar to Canada. Their championing of ocean issues and the policy instruments employed could be successfully adapted to the Canadian condition.

The Atlantic:

Ocean issues in the Atlantic region have been swamped in recent times by the collapse of the groundfish industry, one of the traditional mainstays of the Atlantic economy. Federal policy focus has, of necessity, been on crisis management; however, it is important to recognize that the ocean does represent an opportunity for the Atlantic of the future.

The loss of a significant part of the fishing industry means that the Atlantic economy must restructure to stand on its own. This restructuring must build on the region's comparative advantages which include an excellent government and university science infrastructure, a well established ocean industrial sector and an innovative population as seen in the following examples. The Nova Scotia Council of Applied Science and Technology (CAST) has launched an ocean sector initiative to build on the province's comparative advantage of being home to 30% of Canada's ocean industries and 40% of Canada's ocean scientists and engineers. The Newfoundland Ocean Industries Association (NOIA) acts as an agent for technology diffusion and marketing for its 300 members. New Brunswick is a recognized leader in the aquaculture industry. The University of Prince Edward Island performs leading edge research in commercial fish vaccines. These initiatives, although provincially based, include networking systems that cover the whole Atlantic region and the coastal states of the northern United States.

The Arctic:

The Arctic Ocean has supported a small indigenous population for centuries, but now the Northwest Territories has the fastest growing proportionate population in North America. Northerners are looking for economic development as a means of attaining long term self-sufficiency; however, they want to respect their traditional way of life while sustaining their fragile, low-productivity ecosystem. The Inuvialuit and Nunavut land claims settlements provide for joint management committees to manage renewable ocean resources with the federal government as a partner. The Beluga Management Strategy developed through this system is an example of sustainable development in action. Larger questions, such as the effect of increased ocean traffic on the belugas' habitat, and the impact of a commercial fishery, are recognized but have yet to be addressed. Northerners acknowledge that they need more scientific data to provide answers.

The land claims settlement regions are becoming major decision-makers in Arctic development strategies. As such, they will overtake the Department of Indian and Northern Affairs as the major customer of federal ocean science research. This change may ultimately have an impact on federal S&T priorities for the Arctic region.

The Pacific:

In the Pacific region, the science issues are managing "plenty". Salmon harvests are at all time highs, the Port of Vancouver is the busiest in Canada and ocean-based tourism is increasing every year.

The Science Council of British Columbia has initiated a consortium of academic, government and industry representatives to develop and implement ocean science and technology strategies to maximize the Province's comparative advantage. This group is pursuing the economic potential of trade in the Pacific Rim, new industries for coastal communities, the development of ocean industries and a more efficient port management system. Their marketing strategies include: support for inter-company alliances, and coordinated efforts in the development of systems and applications using emerging and existing ocean technologies. This initiative continues to operate almost solely on private sector volunteers and is a major catalyst for local industry.

These examples illustrate that *regional initiatives* are the catalyst for translating ideas into action and for managing the oceans as a sustainable resource. The best practice in a national oceans policy is to support the regions in their own development decisions through a national policy under a Canada Oceans Act that provides:

(1) national sovereignty over the exclusive economic zones;

(2) scientific information that supports resource management and development decisions;

(3) decisive regulation that protects the ocean environment; and

(4) assistance with technology acquisition and development.

This comprehensive framework will allow each region to champion its own progress. Without such a framework, our approach to our oceans will continue to be reactive and the full value of the new frontier created for us by UNCLOS will not be realized.

1.0 *INTRODUCTION*

Canada is a maritime nation that is bordered by three oceans and possesses the longest coastline (almost 250,000 kilometres including the coastlines of most islands), the longest inland waterway, the largest archipelago and the second largest continental shelf of any country in the world. Under the terms of the 1982 United Nations Convention on the Law of the Sea (UNCLOS) which comes into force 16 November 1994, Canada will have economic and environmental jurisdiction over an Exclusive Economic Zone (EEZ) of almost 5 million square kilometres.[3]

Despite the geographic prominence of oceans and coasts in the Canadian landscape and early economic history, federal policy has pursued economic prosperity by looking landward. As a result, the potential of and the responsibility for the oceans has been largely ignored. Only now is the economic potential and environmental impact on land activity being recognized.

The oceans are not stable environments, as once assumed, but are constantly fluctuating in response to environmental variables, both of natural and of human origin. While it is recognized that global climate change and pollution borne by inland rivers influence ocean ecosystems, little knowledge of the nature and full extent of these influences is available. For example, have the cod stocks declined because of overfishing alone or are unusually cold water temperatures, ice conditions and the presence of contaminants also factors? At present, there are no definitive answers to these basic ecosystem questions. These dilemmas illustrate that science has a key role to play in assisting us to understand our oceans.

As major components of the ecosphere, the oceans of the world are inextricably linked. Beyond domestic interest, Canada has an international responsibility to manage the oceans as a shared global resource.

Regulatory jurisdiction is scattered among numerous departments at the federal level alone, based on specific mandates. Three departments, Department of Fisheries and Oceans (DFO), Transport Canada (TC) and the Department of National Defence (DND), are responsible for approximately 75% of government expenditures on marine activity.

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[3] Canada declared a 12 nautical-mile territorial sea and a 200 nautical-mile fishing zone in 1977. In December of that year, a Report of the Group of Experts on Hydrographic Surveying and Nautical Charting placed Canada's EEZ at 4,697,000 km^2. This figure is revised on an ongoing basis, as amendments such as the resolution of the territorial sea negotiations between Canada and France over St Pierre and Miquelon are received.

The major science-performing departments are DFO, DND and Environment Canada (DOE). DFO has the largest ocean science budget of any federal department. Its science budget is $205 million for 1993/94. For the aforementioned three departments, the emphasis is on four subject areas in budget allocation: the needs of the fishery (29%); navigation (21%); national security (20%); and environmental protection and conservation (15%). The remainder is allocated to mineral resources and "other" (15%). Due to the focus on the economics of the fishery, 49% of science spending is on the Atlantic, 14% on Pacific, 9% on Arctic issues, with 28% for general marine science.[4] In both regulatory and science activity there appears to be no formal mechanism for overall coordination of departmental activity.

Coordinated government action is critically important at this time to take advantage of the opportunities associated with the pending coming into force of the UNCLOS. These include the development of ocean industries, the response to resource management and environmental issues associated with the collapse of the East Coast fishery and the protection of the Arctic.

The Committee's Work Program:

The NABST Committee on Oceans and Coasts consulted widely with experts representing various aspects of oceans S&T and studied numerous documents prepared by governments, universities, institutes and non-governmental organizations. The Committee travelled to each coastline to get on-site input on the S&T needs and requirements of coastal regions.

From this consultation and analysis the Committee developed the following guiding principles upon which its advice is based:

1. **There is a need for a comprehensive policy strategy to manage and protect the marine environment and our ocean resources at the regional, national and international levels.**

OCEAN POLICY STRATEGY MUST BE REGIONAL, NATIONAL AND INTERNATIONAL IN SCOPE

Policy has been created over the years in response to issues as they arose. This has created a fragmented system with no clear goal and no clear leader or champion. There is no comprehensive strategy to provide a management framework for future resource development and to address environmental protection issues. Similarly, accountability for failure to manage or protect the oceans is not identified.

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[4] Interdepartmental Committee on Oceans, *Multi-Year Marine Science Plan*, (Ottawa: Department of Fisheries and Oceans (DFO/4186), 1988), p. 3.

Answers to ocean science questions require a multi-disciplined approach because the oceans constitute an integrated ecosystem that is in a constant state of dynamic change. An understanding of the inter-relationships of all the elements of the ocean environment is essential to make informed decisions on planning and regulation.

2. Each of our three oceans and their adjacent coastal areas are unique in their science policy needs.

EACH OCEAN REGION IS UNIQUE

Each ocean region--the Atlantic, the Arctic, and the Pacific--has different physical characteristics, resources, patterns of utilization, economic aspirations, and social and political structures.

3. The oceans are a shared global resource.

OCEANS ARE A SHARED RESOURCE

As major components of the ecosphere, the oceans of the world are inextricably linked. Beyond the domestic interest, Canada has an international responsibility to manage oceans as a globally-shared public good.

2.0 CANADIAN OCEAN POLICY

Canada's ocean research infrastructure began in 1893 with the establishment of the Board of Management for Fisheries and Marine Research. Since that date there has been a steady development to the pan-Canadian network of research facilities that exist today. Ocean policy development, particularly science policy development, has occurred more sporadically and generally in response to international influences rather than to any internal action plan (*see* Appendix A: Canadian Ocean Policy: Historical Overview).

2.1 The 1987 Ocean Strategy

The most recent comprehensive ocean policy activity occurred in 1987. Cabinet approved an oceans policy, based on extensive public consultation, that addressed economic development, science and technology, environment (managing the ocean resource), and sovereignty. Policy instruments for implementation included a public awareness oceans campaign, industrial development, contracting-out and procurement policies, a legal framework for the strategy (the *Canada Oceans Act*), and an emphasis on enhancing S&T knowledge and capabilities. Conservation was addressed through the policy goals of responsible management of living resources, environmentally acceptable development of non-living resources and protection of the ocean environment.

The following summary is a report card on some of the specific policy activities of the 1987 strategy; most have been discontinued, abandoned or (in the case of the *Canada Oceans Act*) halted due to other priorities:

The National Marine Council:

The National Marine Council was an independent advisory board appointed by the Minister of DFO. Its mandate was to inform and advise the Minister on marine issues and oceans policy, including economic development, S&T, sovereignty and the environment as they relate to Canada's oceans interests. It was to comment on proposed policies and programs, provide feedback as an outside perspective to the Minister and the government, and act as a forum for communicating and harmonizing the views of various interests in the use, development, management and protection of Canada's oceans.

The Council met and reported by letter to the Minister; however, it had no opportunity for significant impact on policy and was disbanded in the April 1993 budget.

The Oceans Mapping Program:

The Oceans Mapping Program was a contracting-out mapping program to be jointly operated by DFO and Energy, Mines and Resources (now Natural Resources Canada -- NRCan). It was designed to explore and map deep ocean areas to obtain geoscience data for strategic, economic and sovereignty purposes; its work would stimulate oceanic firms and hence industrial development.

The program was initially proposed at a budget of $110 million over 5 years (1989-94). Through the federal government's budget process, the program was finally approved at $5.5 million over five years. (To illustrate the comparative value of this program, the ocean mapping and hydrographic investigation for the proposed port at Coppermine has been budgeted at $11.23 million.)

The Ocean Technology Promotion Office:

The purpose of the Ocean Technology Promotion Office, within DFO, was to improve the effectiveness of government assistance programs by providing information to the private sector and facilitating joint ventures involving the public and private sectors (including universities). An information data base on available initiatives for the private sector was to be developed. Existing programs were to be assessed and, in some cases, refined to make their criteria more "user friendly".

The program was established in 1988 at an annual program funding level of $250,000 with contributions through the Unsolicited Proposal Program (UPP). In 1989, this was reduced to $50,000 when the UPP was terminated.

The Arctic Marine Conservation Strategy:

A discussion paper was released by DFO that promoted policies to ensure the future well-being of Arctic marine ecosystems and sustained use of marine resources. Federal and territorial government departments and many Arctic non-governmental organizations and individuals were involved in the consultation process. There has been little activity since the release of the paper in 1988 although some Green Plan initiatives include the Arctic.

Plastic Debris and Driftnets in the Oceans:

As part of its international and science activities, DFO has taken the lead in concluding international agreements on driftnets and in monitoring legislative developments in other countries. The environmental aspects of plastic debris are now a part of the DOE's Green Plan initiative.

North Pacific Marine Science Organization:

The North Pacific Marine Science Organization (PICES) was created through a treaty signed by Canada, the US, China and Japan to promote and coordinate marine science research and the collection and exchange of relevant information and data.

This government-to-government organization was established in 1992. Contracting parties are Canada, China, Japan and the United States. Russia is expected to become a member. Canada's contribution includes accommodation for the Secretariat.

The Canada Oceans Act:

The *Canada Oceans Act* was to serve as the legal foundation for the ocean policy strategy. It was to be a consolidation of the legislative bases for oceans policy which is currently contained in numerous Acts of Parliament[5] and was to provide a legal basis for establishing a contiguous zone and exclusive economic zone.

Work commenced on the Act but, at the request of the then Department of Foreign Affairs and International Trade (DFAIT), the process was halted while negotiations with France regarding the territorial sea around Saint Pierre and Miquelon were ongoing. In recent years, other priorities have prevented the DFO from proceeding with the Act.

The Multi-Year Marine Science Plan:

The Interdepartmental Committee on Oceans (ICO) published its report in 1988.[6] The objectives of the plan were as follows:

- to give an overview of marine science activities in the federal government, their overall strategic objectives, the relevant linkages between departments, and common issues that need to be addressed;

- to provide detailed reporting which would enhance communication and cooperation among member departments of the Intergovernmental Oceanographic Commission (IOC); and

- to inform universities and the marine industries sector of the major marine science initiatives of the federal government.

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5 See Appendix B: Inventory of Federal Oceans-Related Activities from the last comprehensive study prepared in 1989. Department of Fisheries and Oceans, *Canada's Oceans: An Economic Overview and Guide to Federal Government Activities* (Ottawa: Department of Fisheries and Oceans, 1989).

6 Interdepartmental Committee on Oceans, *Multi-Year Marine Science Plan* (Ottawa: Department of Fisheries and Oceans (DFO/4186), 1988).

The ICO has been relatively inactive, not meeting since 1990, although various departments have worked to follow up on the recommendations of the ICO.

2.2 Federal Ocean Policy Organization

Oceans and coasts regulatory jurisdiction is scattered among numerous government departments at the federal level. It has been estimated that 75% of federal marine activity is the responsibility of three departments:[7]

- Department of Fisheries and Oceans;
- Transport Canada; and
- Department of National Defence.

Other departments having an interest in specific areas of ocean and coastal management include:

- Natural Resources Canada;
- Environment Canada;
- Department of Foreign Affairs and International Trade;
- Industry Canada (the former Industry, Science and Technology C anada); and
- Public Security.

Still other departments are involved, peripherally, in marine issues:

- Emergency Preparedness Canada (EPC);
- Human Resources Development Canada (HRDC);
- Indian and Northern Affairs Canada;
- National Research Council (NRC);
- Pilotage Authorities; and
- Revenue Canada (Customs).

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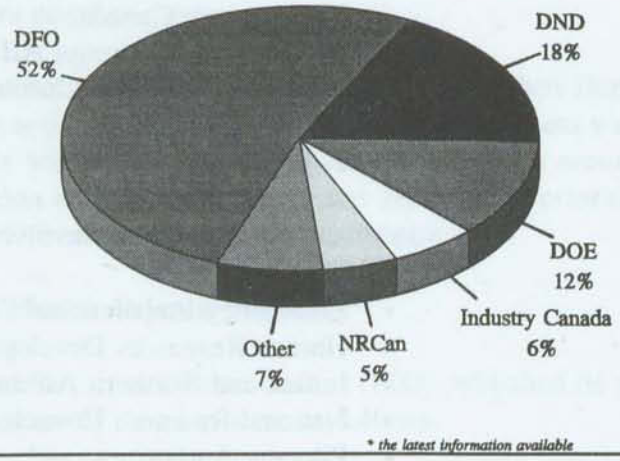
[7] Centre for Foreign Policy Studies, *Canadian Marine Policy and Strategy Report* (Dalhousie University, December 1992).

In 1987-88, the federal government spent $327 million on marine and marine-related science activities.[8] It was determined, at that time, that expenditures would remain constant to 1991 according to departmental operational plans. This cannot be confirmed, however, as accurate marine and marine-related science statistics have not been updated since 1987-88.

The budgetary breakdown for the major science performing departments is presented in Figure 1.[9]

Figure 1
Federal Marine Science Spending
*(Percent of 1987-88 Expenditures)**

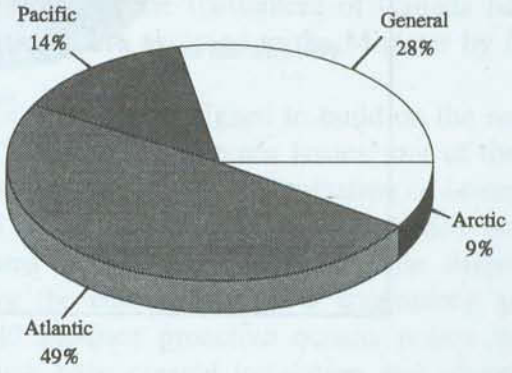


[8] The statistics used in Figures 1 to 4 were compiled by the Interdepartmental Committee on Oceans (ICO) and have not been updated since the publication of their Multi-Year Science Plan in 1988. The Committee still exists but has not met for over four years.

[9] Data presented in Figures 1 to 4 are all taken from Interdepartmental Committee on Oceans, *Multi-Year Marine Science Plan*. This was the last year that figures are available for a total marine science budget.

The distribution of funding among oceans is heavily weighted towards the Atlantic because of the emphasis on the fishing industry, two-thirds of which is located in the Atlantic (see Figure 2--Federal Marine Science Spending: Percent by Ocean)

Figure 2
Federal Marine Science Spending
(Percent by ocean for DFO, EMR, EC, DND 1987-88)



In the 1987-88 period, marine science was focused on the needs of the fishery and on fish habitat management (see attached Figure 3--Marine Science Spending by Oceans Sector; and Figure 4--Marine Science Spending by S&T Category). Since that time, the Green Plan initiatives may have skewed the focus **slightly** in favour of environmental/sustainable development issues; however, the general allocation remains the same.[10]

[10] DFO officials.

Figure 3
Marine Science Spending by Oceans Sector
(Percent of 1987-88 Expenditures)

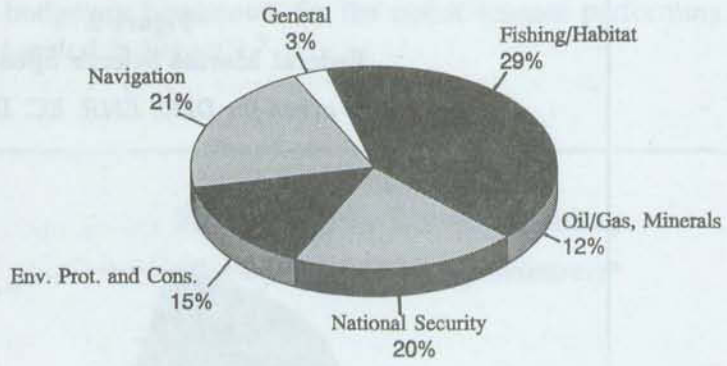
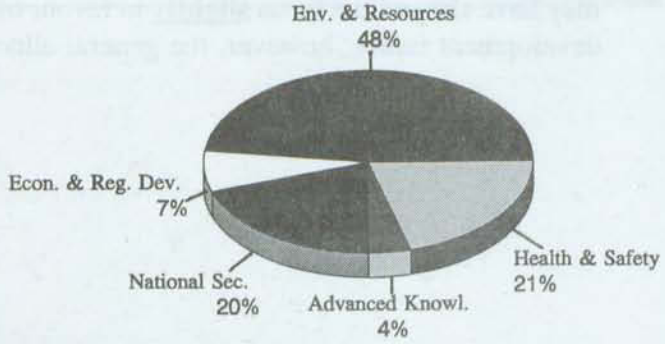


Figure 4
Marine Science Spending by S&T Category
(Percent of 1987-88 Expenditures)



While other federal departments contribute to the management of Canada's aquatic activities, the department with lead responsibility is DFO.[11]

The Department's responsibilities include:

- all matters over which the Parliament of Canada has jurisdiction, not assigned by law to any other department, board or agency of the Government of Canada, relating to: marine and inland fisheries; fishing recreational harbours; hydrography and marine sciences; and policy and programs coordination of the Government of Canada respecting oceans; as well as

- other matters over which the Parliament of Canada has jurisdiction relating to oceans, that are assigned to the Minister by law.

The Oceans Policy of 1987 was designed to build on the residual powers of DFO to create a "Champion of Oceans Issues" out of the Department. The underlying rationale was that an amalgamation of oceans-related acts and regulations and a strengthening of ocean science and technology development programs under the auspices of one department would provide the basis for the coordination of a fragmented and piecemeal system. This would produce proactive oceans policy to replace the reactive policies which have created legislation and programs scattered throughout many departments.

However, the 1987 Ocean Policy has not been effectively implemented and the present orientation of DFO does not suggest that an oceans strategy is a priority for the Department. Few[12] of the 1987 initiatives are mentioned in the Estimates (the Department's annual budget report of proposed expenditures for approval by Parliament) and the Department describes its priorities as:

- reform legislation including structural adjustment policy for the East Coast fishery;

- its role in sustainable development and habitat management issues both nationally and internationally; and

- Aboriginal issues in the fisheries.[13]

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[11] Department of Fisheries and Oceans, *Department of Fisheries and Oceans Handbook 1993* (Ottawa: Department of Fisheries and Oceans, 1993), p. 5.

[12] The Convention establishing the North Pacific Science Organization is noted in the *1993-94 Estimates* and updates are included under driftnet issues.

[13] Department of Fisheries and Oceans, *1993-94 Estimates, Part III, Expenditure Plan*, pp. 9-10 and Department of Fisheries and Oceans, *Factbook*, 1993, pp. 5-7.

These are practical goals given that DFO has been "swamped" in recent years by socioeconomic fishery issues. The fate of the East Coast fish stocks is a metaphor for the ocean environment as a habitat. The conservation and rebuilding of fish stocks will require research of broad ecological and environmental dimensions that will continue to occupy DFO until at least the turn of the century. Although conservation measures have been taken, the Department's response to the collapse of the cod stock is currently more a question of social welfare policy than of science and resource building.

In its consultations, the Committee has consistently heard that federal policy and DFO, in particular, has not adequately focused on ocean S&T and its translation into long term resource management. Industry representatives point out, for example, that there has been almost no support for ocean technology development in such critical areas as ocean transportation technologies. One quarter of Canada's Gross National Product is based on foreign trade and 40% of all private sector output can be accounted for by exports.[14] More than half of this is transported by water.[15] Clearly, ocean transportation technologies and management practices, which include cargo handling systems, information management systems and environmental protection that allows compatible use of other ocean resources, can significantly enhance competitiveness.

As a result of the issues that have driven Canadian ocean policy development, and the current organization at the federal level, the ocean- and marine-related policy environment is fragmented. Legislation, programs and initiatives are scattered among various departments. There has been no champion to pursue the opportunities that the ocean frontier represents nor to respond to challenges of sustainable resource management. This is the essential role for a federal strategy to play while providing enough flexibility to address each region's S&T needs.

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[14] The Liberal Party of Canada, *Creating Opportunity* (Ottawa: 1993), p. 23.

[15] Department of Fisheries and Oceans, *Department of Fisheries and Oceans Handbook 1993*, p. 27.

3.0 OCEAN S&T ISSUES

3.1 The Atlantic

A prominent feature of the Atlantic Seaboard is the massive continental shelf of which the southern, broad section is known as the Grand Banks. Its width varies from 111 to 519 km and the depth varies from 183 to 366 meters at the outer edges. Historically, the area of the continental shelf has been a rich source of valuable biological resources such as fish, crustaceans, marine mammals and seaweed. In addition, the sedimentary formations underlying the shelf are known to contain a variety of mineral resources including petroleum, sand and gravel, silica sands and possibly precious metals. Commercial production of crude oil began in June 1992 in the Cohasset-Panuke oil field located 256 km southeast of Halifax and the giant Hibernia project, on the northeast Grand Banks, 312 km east of St. John's, is scheduled to begin production in 1997.

The Atlantic Ocean and the five provinces that share its coastline make up our oldest commercial region. Canada's pre-confederation national development is based on the economic activity in the Atlantic region and its important links to markets in Europe and the West Indies via the Atlantic Ocean triangle. As the rest of the country developed, the Atlantic remained a major trade centre for the export of staple goods. By the end of the 19th century the economy of the region included, in addition to the Grand Banks fishery, an in-shore cod fishery, mining, forestry, an active port system and a successful ship-building industry. At the time of Confederation, the eastern Canadian sailing-ship fleet was the third largest in the world.[16]

The 20th century has not been so kind to the Atlantic region. The Atlantic as a trade centre has declined in importance with the refocusing of markets and trade in commodities. The sailing ship building industry declined with the introduction of steam technology and the shifting of capital investment to central Canada away from maritime ventures in the early years of the century.[17] The present-day economy is largely dependent on the fishing industry and has been severely destabilized by the collapse of the groundfish industry.

The Atlantic region has a history of stoically getting by and making do through lean years, but the dramatic disappearance of groundfish stocks has created an unprecedented economic crisis. In 1990, the combined Atlantic fisheries had a total production value of $2.09 billion, accounting for 78% of Canada's total landings by weight and 67% by value. The

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[16] Historical Atlas of Canada, *The Land Transformed 1800 - 1891*, (Toronto: University of Toronto Press, 1987), Plate 39.

[17] *Ibid.*

industry generated over 61,000 harvesting jobs and another 60,000 in processing. The fishing fleet included 29,198 vessels of various types and sizes and there were 918 registered processing plants. Groundfish, of which cod is the major species, represented 52% of the total landings by weight.[18] At the present time, the cod fish industry has been virtually shut down by a government moratorium system begun in 1992. It is estimated that northern cod spawning stock is only 5% of its historical average.[19]

The invertebrate fishery which includes shrimp, lobster, crab, scallops and clams is the most valuable. Its 1990 worth was $447.7 million compared to a total groundfish value for the same period of $375.8 million.[20] In the past decade, shrimp and lobster landings have been at an all time high. Shrimp and snowcrab have also shown increases in recent years.

S&T ARE TOOLS TO BUILD THE FUTURE OF THE ATLANTIC

In this crisis management climate it is easy to become swamped with fisheries issues at the expense of a comprehensive analysis and recommendations on the S&T needs of the Atlantic Ocean region of the future. Beyond short term measures to deal with the collapse of the fishing industry there must be a long term plan to restructure the economy of the Atlantic to commercial independence. S&T must address two distinct fundamental issues in the Atlantic:

- the creation of a knowledge base that will allow policy makers to make informed resource management decisions; and

- the development of technological tools to diversify the economy.

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[18] Environment Canada, *The State of Canada's Environment* (Ottawa: Department of Supply and Services, 1991), p. 8-7.

[19] Department of Fisheries and Oceans, *Highlights of the 1994 Atlantic Groundfish Management Plan* (Ottawa: Minister of Supply and Services, December 23, 1993).

[20] *The State of Canada 's Environment*, p. 8-8.

PROVIDE SCIENCE TO MAKE DECISIONS

The collapse of groundfish stocks illustrates the past inadequacy of our scientific information system in predicting and understanding ocean ecosystem behaviour. DFO has a scientific system for fish stock assessment to establish annual total allowable catches (TACs). The scientific methodology is based on an assessment of the total biomass for each species within each of the four fisheries management regions in the Atlantic.[21] It is then determined what percentage of the biomass can be harvested. This activity adds up to be much more than counting fish: it is the prescription for the size of the fishing industry and the value of the maritime economy and, as such, has become highly politicized. Over the years Canadian governments, provincial and federal, have relied on the TACs to accommodate social policy goals regardless of the scientific evidence.[22]

This methodology has come under intense scrutiny by the Fisheries Resource Conservation Council (FRCC) and by the Task Force on Incomes and Adjustment in the Atlantic Fishery which produced the *Cashin Report*.[23] The FRCC points out that uncertainties exist in the scientific accuracy of the stock assessment data which forms the basis for quota setting.[24]

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[21] The Atlantic Ocean is divided into four fisheries management regions for purposes of stock assessment. They are the Gulf, Quebec, Newfoundland and Scotia-Fundy.

[22] The Harris Commission Report of 1988 recommended that the TACs for Northern Cod be reduced from the level of 266,000 metric tones to 175,000 metric tonnes. In the policy balance between the scientific evidence provided by the Commission and the other interests represented, the actual limit was established at 235,000 tonnes for 1989.

[23] Task Force on Incomes and Adjustment in the Atlantic Fishery, Richard Cashin, Chair, *Charting a New Course: Towards the Fishery of the Future* (Ottawa: Minister of Supply and Services, November, 1993) pp. 14-15.

[24] Fisheries Resource Conservation Council, *1994 Conservation Requirements for Atlantic Groundfish--Report to the Minister of Fisheries and Oceans* (Ottawa: Minister of Supply and Services, November 1993), pp. 5-11.

MANAGE THE FISHERY BY STUDYING THE WHOLE ECOSYSTEM

The FRCC has proposed a revised method of stock assessment and TAC quotas based on an ecosystem approach to fisheries management. Under such as system, various elements of ecological knowledge would be used to determine the level of a sustainable harvest. For example, the science of fish counting would include research into the inter-relationship of species, the influence of climate variations in air and water, land based pollution and fishing technology to establish the sustainable harvest for the Atlantic region. The new approach is characterized by:

- addressing the effect of day-to-day activities on the whole ecosystem;
- addressing research questions in multidisciplinary teams;
- understanding better the relationship between fish and fishing;
- involving in fishery science those with practical experience and knowledge in the fishery; and,
- improving the coordination of activities.[25]

ANSWERS TO ECOSYSTEM QUESTIONS REQUIRE A MULTI-DISCIPLINARY APPROACH

The FRCC model has applications beyond surveys of fish populations and recruitment. Fluctuations in fish stocks may be a symptom of larger ecological occurrences that have a major impact on land based activity. There are many interrelationships that scientific models do not explain. For example, was Ontario extraordinarily cold this winter because of changes in the influence of the Gulf Stream and what is the impact of changes in the Gulf Stream on fish stocks on the Grand Banks? Answers to these large ecosystem questions require the integration of multidisciplinary scientific research from both government laboratories and universities, in Canada and internationally.

THE ATLANTIC HAS AN EXTENSIVE SCIENTIFIC INFRASTRUCTURE

The Atlantic region has a large population of ocean science specialists at its universities, the federal government laboratories and in affiliated laboratories. DFO has five research facilities in the Atlantic. They are:

Bedford Institute of Oceanography, Dartmouth
Gulf Region Science Centre, Moncton
Maurice-Lamontagne Institute, Mont-Joli (Quebec)
St. Andrews Biological Station, St. Andrews
Northwest Atlantic Fisheries Centre, St. John's

In addition, the Department of National Defence operates the Defence Research Establishment Atlantic, while the National Research Council operates the Institute for Marine Biosciences in Halifax and the Institute for Marine Dynamics in St. John's. The Department of the Environment has major climate research facilities at Montreal and Halifax, and extensive

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[25] Department of Fisheries and Oceans, *News Release: FRCC Reports to Fisheries and Oceans Minister on Science Priorities for DFO* (January 31, 1994).

sea ice data and forecast activities. Natural Resources Canada operates the Atlantic Geosciences Centre at Dartmouth. All of these are important contributors to Atlantic ocean science.

Universities in the region which carry out research in fisheries and oceans sciences are:

Dalhousie University, Halifax
Université Laval, Quebec City
McGill University, Montreal
Memorial University, St. John's
Saint Mary's University, Halifax
The Technical University of Nova Scotia, Halifax
The Université du Québec à Rimouski, Rimouski
The University of New Brunswick, Fredericton
The University of Prince Edward Island, Charlottetown

The Committee heard that scientific capacity was not an issue but coordination and cooperation among scientific organizations to maximize expenditure efficiency and use of facilities such as ships, laboratories and super-computers was. One of the most contentious issues was the limited amount of research time available to university researchers on federal research ships.

> It is very difficult to study the oceans by standing on the shore. In the Atlantic, the academic research community has suffered from a historical lack of capacity to go to sea. None of the Atlantic universities has its own research vessel and the research time available on government vessels is limited and getting more so.
>
> Dr. Arthur May
> President
> Memorial University

USE TECHNOLOGY AS A DATA COLLECTION TOOL

The partial solution to the problem of expensive ship and human time in collecting data may be in technology itself. For some of the data needed and its updating, remote sensing technologies using acoustics or imaging from airplanes and satellites may be more accurate and efficient at obtaining scientific measurements than people aboard ships. Remote sensing technologies may also have application in the area of surveillance within the 200-mile Exclusive Economic Zone and could be used to offset Canada's and North Atlantic Fisheries Organization's (NAFO) meagre budget for enforcement of fishing restrictions. These technologies do not replace the need for scientists to go to sea, but can greatly expand the scientific effectiveness of doing so.

LOCAL KNOWLEDGE IS A COMPLEMENT TO SCIENTIFIC DATA

In addition to institutional sources of scientific knowledge, there is growing recognition that local knowledge, or traditional indigenous knowledge, can add value to the science base.[26] In the Atlantic region, there are fishing families that have spent many generations living and working with the resources of the ocean. They have amassed an impressive knowledge of currents, water salinity, water depths, water temperature and tides and their relationship to lunar cycles, the behaviour and distribution of fish and other marine conditions which, although site specific, are of tremendous significance in the pursuit of their livelihood. While this local knowledge cannot replace the systematic approaches of our scientific research methodology, it can act as an important complement to the science knowledge base. In many instances the integrated traditional knowledge is a valuable or irreplaceable synthesizer of the artificially compartmentalized scientific physical, chemical and biological data. Government ocean policies to date have not taken into account this traditional or local knowledge, and special innovative efforts are needed to identify it and place it in useful relation to scientific data.

S&T WILL ASSIST DIVERSIFICATION OF THE ECONOMY

The Cashin Task Force concluded that the problems of the fisheries are the result of the destructive combination of overdependence on the resource as an employer of last resort resulting in pressure on the resource which, in turn, created a market for ever more efficient short-term methods of harvesting and processing.[27] The report does not predict when and at what level the stocks will recover; however, it is recognnized that industry employment exceeded the sustainable level for both the resource and the people it employed. A renewed sustainable fishery may employ only half the people that it did in recent years.[28] A comprehensive knowledge base will assist policy makers to determine sustainable limits to fishery capacity and could also serve employment diversification strategies.

The cod fishery collapse is a graphic example of the failings of our science management system to date as a risk management mechanism. A more comprehensive scientific monitoring and analyzing system might have pointed to factors predicting the stock decline, thus allowing policy makers to put management mechanisms in place.

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[26] Hobson, George, "Traditional Knowledge in Science" in *Northern Perspectives,* Volume 20, Number 1, September, 1992.

[27] The Task Force on Incomes and Adjustment in the Atlantic Fishery, Richard Cashin, Chair, *Charting a New Course: Towards the Fishery of the Future*, (Ottawa: Minister of Supply and Services, 1993), p. 14.

[28] Ibid., pp. 19-20.

In its consultations, the Committee was impressed with the innovation and ideas that Atlantic Canadians have for developing their ocean industries (*see* Illustration 1).

ATLANTIC CANADIANS ARE INNOVATIVE

Illustration 1: Business Opportunities from UNCLOS

One Nova Scotia company has entered into an agreement with the Russian Academy of Sciences to form a partnership of Canadian scientists and technology and Russian scientists and research vessels including submersibles, to undertake deep ocean scientific exploration and coastal mapping of exclusive economic zones.

Exploring the deep ocean using Russian research ships and deep diving submersibles will provide a unique platform for Canada to be in the vanguard of deep ocean biological, geological and ecological science and technology. The partnership is also working to develop programs providing opportunities for developing countries to participate, adding to Canada's international recognition on issues related to the high seas and deep ocean science.

Once the United Nations Law of the Sea comes into force, nation states will need to do coastal mapping of the areas they wish to include in their jurisdiction. Most developing countries at present do not have the capacity to conduct this work on their own. Under the program being developed with the Russians, Canadian technologies would be employed to assist developing countries map their extended Exclusive Economic Zones (EEZ).

Most developing countries do not have the financial resources to undertake these programs on their own. This Nova Scotia company is working with international organizations and developing countries to access funding from the family of International Financial Institutions (IFIs) led by the World Bank. The EEZ mapping and the deep oceans research initiative represent direct potential commercial opportunities of $1 to $2 billion for Canadian industry.

Mapping technology is a particular application within the broader technology field of ocean information systems. Ocean information systems include ocean data collection systems and processing of the data into useable forms. Canadian firms and government labs have capabilities in digital data collection, satellite positioning systems and digital management and transmission. In order to address specific market needs, an interdisciplinary team approach may be necessary such as a consortium of complementary companies or the international partnership as in the above illustration.

An example of a Canadian company pursuing opportunities in Newfoundland is NewEast Technologies, (*see* Illustration 2).

Illustration 2: NewEast Technologies

NewEast Technologies Inc. has adapted a ship-to-shore radio business into a cluster of satellite communications firms. NewEast designed and built an improved switch system that routes radio signals to a specific destination once they have been bounced from a satellite.

The NewEast companies now provide radio links for 40 airlines; and track the progress of ocean-going ships. Their next venture will be into the telephone switching equipment market of Hong Kong and China.

The company sees its location in Newfoundland as strategic to its success. Ship-to-shore communications is a natural business for the province and satellite diversification is a logical step. Memorial University provides a supply of talented engineers.

In Nova Scotia, a group of industry leaders has joined forces with the Nova Scotia Council of Applied Science and Technology (CAST) to stimulate the ocean industry in Nova Scotia and to strengthen its wealth generating capacity by raising the awareness of the importance of the oceans to Nova Scotians and to Canadians, by identifying appropriate market areas, by encouraging industry/government/university alliances and by advising the government on the appropriate policy instruments such as tax and procurement policies.[29] Through this process, the member organizations have identified complementary strengths and areas of expertise which they are sharing to form flexible business networks to market their skills cooperatively and compete for contracts.

The Newfoundland Association of Ocean Industries (NOIA), a 300 member organization of ocean sector companies, advises that their team approach to technology development and transfer includes providing a forum for information exchange and education, as well as cooperative trade missions. The technology expertise of the NOIA members covers a broad range including marine communications, remote sensing, geographic information systems (GIS), marine navigation and environmental engineering.[30]

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[29] Nova Scotia Council of Applied Science and Technology, *An Example of an Ocean Industry Strategy* (Halifax: August, 1993).

[30] Industry and Science Canada (Newfoundland), *The Hidden Sector: Ocean Technology in Newfoundland*, (St. John 's: August, 1993), p. 4 and NOIA *Membership Directory 1993*.

Many NOIA member companies provide technology services for the Hibernia offshore oil venture. Hibernia is expected to create 13,000 person-years of employment during the construction phase followed by a further 20,000 during the 20-year production phase.[31]

Technology transfer from government labs and universities is an issue for industry users. Examples exist of cooperative research and development between industry and government, such as C-CORE in Newfoundland, as in Illustration 3.

Illustration 3: C-CORE

C-CORE --The Centre for Cold Ocean Resources Engineering--was established at Memorial University in 1975. Its mandate is to undertake research and development of Canada's ocean environment, and the Centre's expertise now encompasses a broad spectrum of capabilities including robotics, instrumentation, remote sensing, acoustics, geotechnical engineering, ice engineering, signal processing and intelligent systems.

Of the $42 million of operating funds secured by C-CORE since 1975, over 90% has come from outside the Province of Newfoundland and over 30% from industry. Increasing each year is the international component currently at 20% and forecasted to rise to 50% in the next five years. At least 12 Newfoundland high technology companies can trace their roots to C-CORE and many professionals who previously gained experience in the entrepreneurial environment at C-CORE are working in SMEs in Canada.

Recently in an intensive competition among 51 groups for funding from the European Space Agency, a C-CORE proposal (to establish an international consortium to use microgravity (space) to find solutions needed for problems faced by the energy and environmental industrial sectors) was judged to be the winner and was the first funded at approximately half a million dollars. C-CORE's strong ties with the industrial sector greatly contributed to the Centre's success. The work which C-CORE proposes to carry out in space is a logical extension of the Centre's capabilities to work in an extreme (cold ocean) environment and provides opportunities for C-CORE and its SME partners to secure business opportunities in Europe.

[31] Industry Canada, *Notes for an Address By the Minister of Industry, Science and Technology and the Minister of International Trade to a Media Conference Concerning Hibernia Toronto*, January 15, 1994.

Although examples of technology transfer from government labs were acknowledged, some of these were identified as being more cooperative than others.[32] The Committee was advised that access to government laboratory information was a problem. Computer network technology such as Internet or Freenet allow businesses to access university and government laboratory expertise easily. This S&T diffusion mechanism is not being used effectively by Canadian government laboratories:[33]

> My company can access a wide range of networks, from of Hawaii to Australia, but until recently it was difficult to access the Bedford Institute of Oceanography.
>
> In 1994, this situation has improved tremendously. Subscribers of Internet can now access at least eight lists on fisheries and fish-related science. It is still early to determine the relevance of the information contained in those lists, but accessibility has improved markedly.
>
> Mr. Adelard Cayer
> President
> International Marine Biodiversity Development Corporation

CAST provided the following analysis of why government labs were not as industry-oriented as they could be:

- a lack of any knowledge of a clear cut written policy placing industrial cooperation as an important part of the Departmental mandate;
- a perception that the government research staff did not think that their Department would reward personnel engaging in technology transfer and industrial activity; and
- a perception that the government research staff are not as concerned with on-going sales as with the supply of a "one-off" product to the research institute.[34]

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[32] Hugh A. Macpherson, Nova Scotia Council of Applied Science and Technology (CAST), *Ocean Sector Initiative*, (Halifax: January, 1993). *The Canadian Hydrographic Service was singled out as being supportive to industry.*

Note: DFO issued a policy on the Management of Intellectual Property in Feb, 1993 to address this issue.

[33] The software systems at the Beford Institute of oceanography were upgraded on April 20, 1994 as part of an ongoing process to provide greater public access to information.

[34] *Ibid.*, p. 4. It is worth noting that the reward system at one government laboratory, the Bedford Institute on Oceanography, was revised in 1992 to emphasize technology transfer and cooperative research with industry.

The extent to which the Atlantic economy must be diversified to return employment levels to national averages indicates that innovation must permeate all levels of society. Industry and research institutions cannot carry the full responsibility on their own. Industrial development in coastal regions and the adjacent oceans must incorporate the attitudes and values of coastal communities. In many instances this is already happening. The Committee learned that regulation of tourism, aquaculture, sustaining the fishery and human resource skills acquisition vary throughout the Atlantic. These variations have led to different approval processes and organization in each province. For example, an aquaculture licence process is much different on each side of the Bay of Fundy because different provincial systems have been designed to accommodate different local approaches toward coastal land use.

The New Brunswick Conservation Council advocates a system of local decision-making because resource management policy ultimately imposes direct and indirect restriction on users. Without the support of as many interests as possible, there is a greater chance that individuals, or their institutions, will pursue their own short-term interests at the expense of longer-term goals.[35] The obligations and mutual self-interest of a community are often a catalyst for rational long-term decisions.

3.2 The Arctic

The Arctic region of Canada is the country's least developed frontier. Its coastline is the longest of the three Canadian coastlines, with 162,000 kilometres representing just over two-thirds of the country's total. Its fragile, low-productivity environment nonetheless supports varied marine species that are vastly different than those of the south. Characterized by its remoteness and harsh climatic conditions (unlike the Atlantic and Pacific Oceans, the Arctic is ice covered for most of the year), the region presents special challenges for the public policy of managing and utilizing resources in a sustainable manner.

Its indigenous peoples have developed their culture with renewable ocean resources as their major source of sustenance. While it is true that much of Canada has pursued prosperity by looking landward, the Inuit and Inuvialuit communities are rooted in maritime tradition; in fact, most communities in the Inuvialuit and all of those in the Nunavut Settlement regions are located on the Arctic coastline (with the exception of Ennadai and Baker Lake on Chesterfield Inlet in Hudson Bay). Only a minority of these communities are accessible by sea or land year-round, testament to the harshness of the climate and the resourcefulness of their inhabitants.

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[35] L. Felt, "Barriers to user participation in the management of the Canadian Atlantic salmon fishery: If wishes were fishers" in *Marine Policy*, July, 1990, pp. 348-360. As presented to the Committee on Oceans and Coasts by Inka Milewski, Vice-President, Policy, the New Brunswick Conservation Council.

LAND CLAIM AGREEMENTS CREATE NEW CLIENTS AND PRIORITIES FOR S&T

National Arctic S&T issues have focused on sovereignty over the North West Passage which encompasses transportation issues and surveillance technology, and protection of the environment. New issues introduced by the land claims settlements are S&T in support of development decisions and maintenance of traditional cultures. "Sustainability" of resources is the central theme in establishing an S&T management framework for this region.

Canada's North is distinct in its governmental organization from both the Atlantic and the Pacific regions. Territorial governments have no constitutional standing but are structures of the federal government. Their legislative assemblies and commissioners perform duties similar to those of provincial legislatures and lieutenant-governors, but report to the Minister of Indian Affairs and Northern Development (DIAND), who has jurisdiction over renewable and non-renewable resources. DIAND has little direct participation in S&T but is the biggest customer of federal S&T outputs. Besides the Department of Indian Affairs and Northern Development, other federal government departments with an interest in S&T marine and ocean issues in the North include Transport Canada, Environment Canada, Natural Resources Canada, and the Department of Fisheries and Oceans.

INDIGENOUS PEOPLES HAVE A VOICE IN THE PROCESS

The resolution of the land claims in the Nunavut and Inuvialuit settlement areas (the Labrador Inuit claim is still to be settled) introduces yet another level of government with management responsibility for economic development and resource management. Taken together, these two land claim areas include the entire Arctic coastline and are therefore significant in ocean policy considerations. This new government system could create delays based on jurisdictional complexity and conflicts in goals, approaches and priorities; however, it is designed to ensure that the indigenous peoples of the Arctic region have a voice in the policy process, and it is likely to ensure that policy decisions are made in light of resource and environment realities.

The Inuvialuit and Nunavut agreements have been structured around the maintenance of Inuit and Inuvialuit management control over resources. The 3,000 Inuvialuit (Western Arctic Inuit) settled their land claim in 1984. The agreement does not provide the Inuvialuit with significant authority over water/ocean issues; however, they have ownership of lake beds, rivers and bodies of water subject to a 100-foot access strip around the seacoast and shorelines of navigable waters. This strip is intended for travel, recreation and emergency purposes. The Crown retains ownership of the water and the right to control the water and water beds for several purposes: to manage fish and migratory birds, to carry out work required for transportation and navigation purposes, and to protect community water supplies.

In practice, the Inuvialuit Corporation has had a significant impact on ocean policy decisions through its participation on joint management committees for renewable resources. Under this system, a Beluga Management Plan, a fishing registration system and an environmental assessment review process have been developed which recognize the regional interests of the Inuvialuits (*see* Illustration 4).

Illustration 4: Beluga Management Strategy

Under the Beluga Management Strategy, developed jointly by the Inuvialuit Game Council and the Government of Canada, the Inuvialuit have established quotas for different communities in the settlement region based on the stock assessment and the needs of the communities. In all cases the whales are harvested for sustenance only.

The Nunavut Federation management system will take form over the next three years. Special legislation will be put in place to establish a Nunavut Water Board (a licensing Board for inland water), a Land Use Planning Commission and a Nunavut Wildlife Management Board. Provision is further made under Article 15 of the Agreement for the amalgamation of the four boards into a Nunavut Marine Council with power to advise on a broad range of marine issues.[36]

DEVELOPMENT DECISIONS NEED SCIENTIFIC INFORMATION

The Federation faces immediate development decisions such as the mineral development in the NWT and the proposed port at Coppermine. The Nunavut people recognize the opportunities for economic development through job creation and for infrastructure development for their region; however, they wish to maintain the use and control of their traditional uses of the area, for instance hunting and fishing (*see* Illustration 5).

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[36] *Agreement Between the Inuit of Nunavut Settlement Area and Her Majesty in Right of Canada*, Official version for the Inuit Ratification Vote (Ottawa: Minister of Indian Affairs and Northern Development, 1992), pp. 135-136.

Illustration 5: Development Issues

The Metall Mining Corporation proposed to develop a zinc-copper mine at Izok Lake in the NWT. To facilitate the shipment of concentrates from the mine site to the coast, a winter road would be required, running approximately 265 kilometres and operating from January to April. Concentrates would be transported to storage facilities on the coast during those months and shipped out during the summer season (which could last up to 6 months, depending on the icebreaker technology used).

Northerners see employment opportunities in both the mine and the port; however, the Nunavut are concerned at the impact the port may have on traditional uses of the area.

Note: Metall Mining has decided to abandon the proposed mine at Izok Lake, citing infrastructure costs that are too high and an unfavourable zinc market. The Globe and Mail, February 25, 1994.

"ARCTIC" SHOULD BE DEFINED BY ECO-SYSTEM RATHER THAN LATITUDE

In 1970, Canada enacted the Arctic Waters Pollution Prevention Act. It established a 100 nautical-mile pollution control zone adjacent to the Arctic coast. The *Act* was designed to address the special needs of the North as it has been defined for Canadian administrative purposes: at or above the 60th parallel. This demarcation is not useful in sustainable development strategies for marine fish and mammals because of their migration above and below the 60th parallel. For example, the land claim area of the Labrador Inuit of Northern Labrador straddles the 60th parallel and is bordered by the Atlantic coastline (the Labrador Sea). In addition, the Inuit of Northern Quebec are negotiating a marine rights settlement with the federal government. This area, adjacent to Hudson Strait and Ungava Bay, also extends above and below the 60th parallel. Resource management decisions will be complicated by the differences in protection afforded to migratory fish and marine mammals depending on whether or not they are above the boundary of the 60th parallel. A more useful definition of "Arctic" for legislation that creates special status for purposes of environment protection could be based on "ecosystem" or climatic boundaries rather than "latitude" boundaries. Canadian and international attention has been given to this matter. For example, the so-called "Nordenskjold" line is an attempt to define environmental criteria for an "arctic ecosystem" boundary. It is climatically determined[37] and has been used as an ecosystem boundary both on land and at sea.

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[37] Specifically, by the line where the mean temperature of the warmest 30 days plus one-tenth of the mean temperature of the coldest month is 11°C. Further details can be found in "Arctic Environment and Resources," Ed. J. E. Sater et al. (Washington: The Arctic Institute of North America, 1971).

THE ARCTIC PRESENTS SPECIAL S&T NAVIGATION AND SHIPPING CHALLENGES

The Arctic Ocean is the largest water body in the north. Most of its surface is, throughout the year, covered by pack ice which rotates slowly in a clockwise direction. There are a half-dozen areas of restricted size, called "polynyas" within the archipelago, where due to the anomalies of three-dimensional ocean circulation and winds, the sea is free from ice most the year; but extensive open water develops only in late summer off the west coast of Banks Island and in the Beaufort Sea. The polynyas do not impact on shipping, but are of vital importance to arctic marine life. M'Clure Strait, the western end of the Northwest Passage, and the channels separating the more northerly of the Arctic Islands remain clogged with large multi-year ice floes all year round. In the absence of ice-breaking vessels, marine navigation in the Arctic Islands is largely confined to waters south and east of Barrow Strait during August and September. Although there is a slightly longer shipping season in the Beaufort Sea and Amundsen Gulf areas of the western Arctic, access to these areas from southern ports is considerably more difficult than access to Lancaster Sound. Further south, Hudson Bay does not freeze completely until the end of December and begins to clear in June. Navigation and shipping technology for these special arctic conditions are important components of a national arctic S&T strategy.

The Arctic has two unique climatic characteristics. **Ice** is the first distinctive characteristic of the Arctic region. It is classified into two categories: ice of land origin and sea ice (*see* Illustration 6).

Illustration 6: Arctic Ice

Ice of land origin is glacial ice that forms on land or as an ice shelf and reaches the sea. This includes ice islands, icebergs (broken glacial ice floating in the sea) and their derivatives. When glaciers break up into icebergs, this process is called "calving". Icebergs are common in Baffin Bay. Most (90%) originate from the glaciers along the west coast of Greenland; a small percentage come from the Canadian Arctic Archipelago. These icebergs threaten shipping and offshore exploration as they drift south into the Atlantic Ocean. It takes two to three years for an iceberg calved on the west coast of Greenland to drift to the Grand Banks of Newfoundland, for instance, where it melts.

Ice islands are large, tabular-shaped pieces of ice, up to 60 metres thick. They originate from ice shelves along the northern coast of Ellesmere Island. Between August 1961 and April 1962, approximately 596 km^2 of ice at the Ward Hunt Ice Shelf on Ellesmere Island broke off and formed 19 ice islands. Five were between 70 km^2 and 140 km^2. In the 1980s, several islands from the same source drifted southwest close to the outer coast of the Arctic Archipelago and are now situated close to the northern tip of Ellef Ringnes Island. One has been occupied by a Canadian research station.

Sea Ice is ice that forms when sea water freezes. This ice is classified according to age and thickness. It progresses from new ice (up to 10 cm thick) through young ice (10-30 cm thick) to first year ice (greater than 30 cm thick). First-year ice which is smooth and level is typically up to 250 cm thick but may become much thicker when rafted or compressed into ice ridges. When sea ice survives at least one summer's melt, it is called old ice, which can be sub-divided into second-year ice or multi-year ice. Undeformed old ice floes are typically up to 450 cm thick.

Sea ice moves with water currents, tides and winds. Resultant forces and motions create tension and compression within the ice. Pressure ridges, consisting of broken ice several metres high, may form when large ice masses converge. Pressure ridges have deep keels of broken ice extending tens of metres below sea level. Hummocked and rafted ice can also develop when ice floes are forced together. When ice floes drift apart, areas of open water and channels (sometimes called leads) normally develop. The narrow waterways and numerous islands in the Canadian Archipelago restrict the movement of ice and affect its distribution and variability.

In the Arctic Ocean, the sea ice drifts in two main patterns: a large U-shaped circulation from the North Atlantic, eastward past the arctic coast of Russia and across the middle of the Arctic Ocean over the North Pole (the trans-polar drift stream), exiting back into the North Atlantic along the east coast of Greenland; and a huge clockwise rotation moving southwest and west past the Canadian archipelago and through the Beaufort Sea (the Beaufort Gyre) which takes about five years to make a revolution and spills ice and surface currents from its edges into the channels of the Canadian arctic islands, through which the ice moves slowly southeastward toward Baffin Bay. These patterns and rates of movements are of new importance in connection with distribution of pollutants, including radioactive substances, released anywhere in the Arctic Ocean basin.

The second characteristic, *Arctic haze*, is a winter air pollution phenomenon (*see* Illustration 7).

Illustration 7: Arctic Haze

First observed in the 1950s, Arctic haze is reddish-brown, composed of very small solid or liquid particles containing a wide variety of contaminants and natural compounds, including sulphate compounds, soot and hydrocarbons, and natural materials.

In winter, prevailing winds carry contaminants from industrialized regions of Eurasia into the polar region. Arctic haze is most persistent in late winter, spring and early summer. Its main area of accumulation is over the Beaufort Sea, the western Canadian islands, northern Yukon and Alaska. This air mass, along with other winter weather conditions, confines the accumulating incoming pollutants to the lowermost one or two kilometres of the atmosphere. Arctic haze causes reductions in visibility in winter and spring months due to a high particulate load in the atmosphere. It increases the amount of solar radiation trapped in the troposphere (layers of the atmosphere containing about 95% of the Earth's air, extending between 6 and 17 kilometres above the earth) which, together with a slight darkening of the top layers of snow covering the ground, can change the ingoing and outgoing radiation and potentially modify the climate of the northern hemisphere.

The direct effect on arctic biological systems is not known. The concentration of pollutants in most current arctic haze is about that of a light urban smog near major industrial cities, but this is several hundred times higher than natural levels in the atmosphere in these regions.

WE NEED SCIENCE TO PROTECT THE ARCTIC ENVIRONMENT

Protection of the Arctic Ocean from environmental contamination is a major concern for residents of the region and for all Canadians. An attempt to develop a science strategy to deal with environmental protection issues resulted in a discussion paper by the Department of Fisheries and Oceans, *Arctic Marine Conservation Strategy*, in 1987. Many Northern interest groups participated in the extensive consultation process that led to this discussion paper. They have expressed dismay that the "Strategy" never got beyond the discussion phase.

In the meantime studies have found that contaminants are showing up in caribou, seals, polar bear and fish, the traditional staples of the indigenous peoples' diet. An excess degree of contamination must be controlled, and levels must be monitored so that local communities can be assured that country foods are safe to eat (*see* Illustration 8).

Illustration 8: Ramifications of Missing or Partial Information

The level of concern over contamination in the food chain and its implications on how people are managing their lives with the misinformation and partial information available is illustrated in the story of one Inuk mother. She brought her sickly baby to the local nursing station. Concerned that her breast milk might be contaminated because she ate country foods, she had attempted to protect her baby by feeding the child *Coffee Mate* mixed with water.

COORDINATE ARCTIC RESEARCH

There is considerable research ongoing at present in the North but it lacks coordination between government departments, universities and other organizations. Little research is done in consultation with the people of the North and there are no priority setting mechanisms to identify research which addresses the needs of the Northerners.

In recent years there have been numerous research activities in the Arctic by universities, government departments and private organizations. In many cases, the local communities are not informed of the nature of the research activity and this has not created a positive attitude toward research. It is perceived to be solely for the benefit of southern institutions with little input from, and no feedback to, northern communities.

The people of the North see themselves probed and observed with little input into the information's purposes and no access to final reports or data. One early incident has become an allegory for Northerners in explaining this phenomenon (*see* illustration 9).

Illustration 9: "The Ship in the Bay"

In the 1950s, the New York Metropolitan Museum spent the summer conducting scientific research in Coronation Bay, off the coast at Coppermine. No one has ever been able to determine what type of research was done, or what happened to any data that was collected. The local residents still speak of the incident in terms of "the mysterious ship in the Bay".

Northern peoples recognize the job creation opportunities in tourism, commercial harvesting, infrastructure development, and exploitation of mineral resources. They also recognize, however, that they need reliable and comprehensive information to manage development in any of these areas. The information that they need quite often exists but they have encountered problems determining where it is and how to access it.

There are ongoing initiatives to coordinate, focus or manage Arctic research. The Canadian Polar Commission was established by Parliament in 1991 specifically to address this problem. Other international bodies concerned with coordinating arctic research include the International Arctic Science Committee, the UNESCO Northern Sciences Network, the Northern Forum, the Canadian Polar Commission, and the Inuit Circumpolar Conference (ICC). Some of these activities are regarded with apathy by Northerners who, in many instances, have not been included in meaningful consultation processes on these initiatives.

Industry in the North has had similar experiences. Base-line data on ocean resources is necessary for corporate decision-making. Although it often exists in the hands of a federal department or Canadian university, the difficulty is often in determining the source. Part of the difficulty is that agencies or research institutes that have useful information have limited resources or capacity to collate, interpret or prepare it in the form that is most useful to industry; many lack information diffusion funds or strategies.

THE ICC HAS A GOOD S&T PLAN

The work of the Inuit Circumpolar Conference (ICC) stands out as a good example of S&T policy for the North by Northerners. The ICC represents Inuit living in four circumpolar nations (Greenland, Russia, Alaska and Canada). They are involved in four economic and environmental issues: participation in fora and research related to marine mammal harvesting and protection; research into Arctic contaminants now found in the circumpolar environment and food chain but originating elsewhere; issues related to the anti-harvesting movement; and international agreements and conventions which affect Inuit economic and cultural life. Their policy paper, *Principles and Elements for a Comprehensive Arctic Policy*, calls for a "holistic" approach to sustainable development in the Arctic that recognizes the rights of indigenous peoples.

This policy addresses:

- Arctic Policy Goals and Objectives;
- Inuit Rights, Peace and Security Issues;
- Environmental Issues;
- Social Issues;
- Cultural Issues;
- Economic Issues;
- Education and Scientific Issues; and
- Implementation.

THE ICC PLAN COULD BE USED TO PRIORITIZE ARCTIC S&T

The general assemblies of the ICC recognize that their resolutions, or principles, constitute a "living statement" capable of adjustment according to the needs of changes in the Arctic. In general, the document is a statement of what Arctic policy should be in order to accommodate the present and future needs of the indigenous peoples. The ICC organization has used a transboundary approach to policy making, one which is responsive to the present and future needs of Northerners as well as respectful of the need to safeguard renewable and nonrenewable resources. The example of the ICC illustrates how input by the end-users into the development of plans and strategies contributes to their acceptance of these plans and strategies. With declining research budgets, the need to amalgamate, restructure and prioritize scientific research in Canada's North could benefit from this type of approach.

Although DFO is mandated to be the "guardian and surveyor" of Canada's oceans, its ocean research has focused on the Pacific and Atlantic coasts, with only subsequent inferences for the Arctic. For example, DFO operates the Bedford Institute of Oceanography in Nova Scotia, the Maurice Lamontagne Institute in Quebec, the Freshwater Institute in Manitoba and the Institute of Ocean Science in British Columbia. There is no comparable institute or research centre for the Arctic. A second example concerns DFO's recently-proposed licensing board system for fishing zones--there is no licensing board for the Arctic.

The framework for an Arctic region economic development system includes comprehensive land use plans, the establishment of marine conservation areas and the preparation of mariners guides for each development area.

ECONOMIC DEVELOPMENT DECISIONS MUST BE BASED ON LAND USE/ MARINE PLANS

The completion and approval of land use plans that include marine areas, like the Lancaster Sound Regional Land Use Plan, are a first step in an oceans development strategy. The Committee learned that there is a great deal of concern among Northerners that these land use plans are taking too long to complete and are an impediment to development in the meantime. The average length of time for completion of a comprehensive land use plan is two years.[38]

The designation of special marine conservation areas is proposed as a means of providing protected areas where human activity would be restricted in order to safeguard specific endangered species. Examples of possible designated areas and the species that they could protect under such a system are the Beluga whales of the Saguenay and St. Lawrence Rivers, the Killer whales of Robson Bight and the Bowhead whales of

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[38] The Committee did not review the land use planning process in detail and is not in a position to comment on its efficiency.

Isabella Bay. The marine conservation designation system would include a coordinated regulatory system to provide the level of protection necessary for the designated habitat. The design of marine conservation areas could be included in a *Canada Oceans Act*.

Economic prosperity of coastal communities is a goal of an oceans development strategy. At issue in this goal are marine transportation strategies for the resupply of communities and export of goods. The development of these strategies require Arctic Environmental Pilots. An Arctic Environmental Pilot is a mariner's guide identifying the location and timing of environmentally important and sensitive areas and seasonal marine harvesting patterns along navigable routes. These should be completed for all possible shipping routes as insurance against future incorrect development decisions. Once completed, these pilots will provide regulation of most transportation activity. The approval process for certain maritime activity under such a system could be complicated and time-consuming; however, it is important to ensure that all concerns are addressed. A process could be designed as a "one-window" system without any loss of control or accountability.

"GLOBAL CHANGE" IS AN IMPORTANT ARCTIC SCIENCE ISSUE

Of all Canada's ocean and marine regions, the Arctic Ocean and coastline appear likely to be most affected by the probability of rapid climate warming and associated "global change". Considerable changes in arctic resources and their distribution, in conditions for transportation and construction, and the lifestyle of northern residents within the next fifty years appear to be prospective. Some of the arctic research in Canada and much of it throughout the world is devoted to this concern. The Committee, however, did not address this issue directly in its arctic investigations, but did include it in discussions of the Pacific Ocean issues.

3.3 The Pacific

British Columbia has emerged in the second half of the 20th century as one of the leading regions in population growth, economic wealth, and overall growth potential. It is the third most populous province in Canada. Eighty percent of the population lives in the southern part of the province, and approximately 50% live within 50 kilometres of its coastline. That coastline stretches 27,200 kilometres, just over 11% of the country's total.

Its economy is a mixture of public and private enterprise, with key sectors being natural resources (including forestry, agriculture, fishing, energy, mining and manufacturing) and service industries (many serving, or processing the products of, fishing, farming, mining and logging industries).

Its largest city, Vancouver, is home to the busiest port in Canada, the hub in the transportation network linking Canada and North America to Asia and the Pacific Rim countries. The Port of Vancouver is the geographic centre of the North American West Coast. The province of British Columbia, therefore, is in a unique position to benefit from access to two major markets: its neighbour to the north **and** south, the United States, and the Pacific Rim. Unlike the Arctic or Atlantic coasts, Canadian Pacific coast jurisdictional matters involve only one province, British Columbia.

Ocean S&T issues on the Pacific coast focus on environmental research (with special emphasis on climate studies) and industrial development (including coastal zone economic strategy and port development). These issues have implications both regionally and nationally.

SCIENTIFIC RESEARCH MUST ADDRESS THE EFFECT OF GLOBAL CHANGE ON THE PACIFIC

Scientific evidence suggests that ocean surface temperatures are increasing on the Pacific coast.[39] It is not clearly known why this is happening and what effect this has on marine and land-based climate. Factors contributing to the warming of the Pacific appear to be both human-induced and natural. Global environmental phenomenon such as the *El Niño* are impacting on trade decisions such as the salmon quotas between Alaska and BC (*see* Illustration 10).

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[39] *The State of Canada's Environment*, p. 4-22.

Illustration 10: *El Niño*

El Niño, Spanish for boy child, is an oceanographic phenomenon which develops in the Pacific Ocean near the equator. It is associated with abnormally warm ocean water, weak surface winds, heavy rains and cloud cover along the equator and the western coast of South America.*

Scientists say that in 1993, biological productivity on the Pacific Coast was about 1.75 times higher than normal and ocean temperatures were 1.7 to 2.8 degrees warmer than normal. In recent years there has been a more frequent occurrence of the El Niño phenomenon.

Generally, El Niño occurs about once every 10 years. In the last decade, however, there was a dramatic El Niño in 1982-83 and again in 1987. It has re-occurred in the last two consecutive years: 1991-92 and 1992-93.

The El Niño occurrence has global effects. It is likely the common factor in changes to fish populations in both the Atlantic and Pacific waters as well as a contributing factor causing the colder waters off some parts of the Australian Coast. In an El Niño year, salmon swim out away from the Alaska Coast and swim closer into the B.C. Coast. This results in record catches off B.C. and a 'drought' for Alaska. In the long term, during an El Niño, mackerel swim further north up the Pacific Coast in the warmer water. They feed on juvenile salmon and this affects harvest levels in future years.** The salmon quotas between Alaska and B.C. are set annually and the presence of EL Niño is a factor in determining how they are allocated.

Currently, El Niño can be predicted approximately 6 months in advance. Due to international research, the models to predict this phenomenon are becoming more sophisticated and it is believed that we will soon be able to predict an El Niño one year in advance.

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* The Manitoba Co-operator, November 4, 1993, Vol. 51, No. 14.
** *PISCES PRESS*, January 1994, Vol. 2, No. 1, p. 5.

The world's oceans play a formative role in determining the rate of climate change and its regional variations. Of major global environmental concern is the phenomenon of global warming. Concern about global warming is based on observations of increasing greenhouse gas concentrations and our understanding of the climate system, as embodied in global climate models. The oceans play a major role in determining the rate of climate change and its regional variations. The oceans will also be changed by global warming; that is, being warmer means possibly less upwelling, affecting productivity. The oceans now constitute the major "sink" of carbon dioxide, absorbing as much as 50% of human-caused (i.e., anthropogenic) emissions. With global warming, this will likely decrease, as will the oceans' productivity. Thus, much of the environmental research conducted by universities and government researchers on Canada's Pacific Coast concerns climate and related environmental issues.[40]

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[40] Dr. Gordon McBean, Professor of Atmospheric and Oceanic Science and Head of the Department of Oceanography at the University of British Columbia.

INTERNATIONAL S&T COLLABORATIONS CONTRIBUTE TO WORLD GOOD

Environmental research, at the international level, is taking steps toward answering these ocean ecosystem questions. The availability of ocean science data is creating a global information system to which Canadian scientists are major contributors, through such international scientific programs in oceanography as the World Climate Research Programme (World Ocean Circulation Experiment; and the Climate Variability and Predictability Programme), the International Geosphere Biosphere Programme (Joint Global Ocean Flux Study; and Land-Ocean Interactions in the Coastal Zone), and the Ocean Drilling Programme. Through these activities, Canada makes important contributions to "world good" (perhaps akin to peace keeping) as well as developing a positive Canadian image and international connections (see Appendix C: Canada's International Ocean S&T Activities). Canada also benefits from helping to shape and conduct research on questions vital to our country, to which scientists from all other countries bring their attention and expertise. Through new organizations such as the North Pacific Marine Science Organization [PISCES],[41] data is exchanged and strategies for implementing collaborative oceanographic research projects are discussed.[42]

Canada's national and international commitments as active scientific partners require close linkages between federal science infrastructure and the science infrastructure of academia and industry. Concern was expressed by industry groups that the priorities of DFO appear to neglect ocean science and technology policy (including the federal role as guardians and surveyors of the oceans) as opposed to other parts of their jurisdiction.[43] DFO has the largest ocean science budget of any federal department (a projected $205 million for 1993/94).[44] Client communities (including academia and industry) would benefit from greater access to the resources and plant facilities of the federal government.

The research infrastructure which supports Canada's participation in these international studies has both strengths and weaknesses. Canadian universities have excellent, but generally small, programs in oceanography. Universities conducting significant industry-oriented oceanographic research on the Pacific are the University of Victoria, Simon Fraser University and the University of British Columbia. (Similar Canadian

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41 The Convention organizing PISCES came into force in March 1992; member countries are Canada, China, Japan, and the United States. The organization is a broad, multi-disciplinary forum allowing Pacific Rim countries to discuss scientific interests in oceanography, ocean, chemistry, modelling, fisheries, climate and marine environmental quality.

42 North Pacific Marine Science Organization, *PISCES Press*, (January, 1994), Vol. 2, No. 1.

43 DFO, Operational Plan, 1994-95.

44 Department of Fisheries and Oceans, *1993/94 Estimates, Part III Expenditure Plan* (Ottawa: Minister of Supply and Services, 1993).

contributions to international marine research are carried out in the Atlantic and Arctic.) Programs on ocean climate research, however, do not exist because it takes seven to ten years to accumulate the necessary data, and graduate schools cannot sustain students for that period of time. Furthermore, ocean climate studies are not a priority for short-term interests, yet knowledge of it is the foundation for a national oceans strategy (*see* Ilustration 11).

Illustration 11: The Need for Long-Term Studies

Dr. Peter Larkin of the University of British Columbia, was approached in 1992 by a group of United States fishing industry associations with a request that he organize a consortium of Pacific Coast universities to undertake research on marine mammals and their interactions with the fisheries. The associations had in mind a long term program of research to be funded at a level of $300,000 to $500,000 per year (ideally $700,000). The four universities involved (Oregon State University, University of Fairbanks (Alaska), the University of British Columbia, and the University of Washington) are to develop projects to be undertaken collaboratively and the results of the studies will be published in refereed journals.

Funding to date for this consortium has come from the U.S. fishing industry, the U.S. Marine Mammal Commission and various private sector sponsors. Other possible sources are the Alaska Science and Technology Foundation and Canadian industry. An application for a partnerships grant from the Natural Science and Engineering Research Council (NSERC) was denied on the basis that the results of the research would be used for management and regulation of a public resource rather than for private corporate (commercial) purposes.

LIMITED RESEARCH TIME ON GOVERNMENT SHIPS IS IMPEDING SCIENTIFIC INVESTIGATION

DFO participates in oceans science research through three laboratory facilities: the Pacific Biological Station in Nanaimo, the West Vancouver Laboratory, and the Institute of Ocean Sciences (IOS) on Vancouver Island. The research community in British Columbia reports a particularly good relationship with the IOS but this is being compromised. Previously, non-governmental researchers could arrange time on federal research vessels. The introduction of cost recovery for NSERC funded programs; however, means that "ship time" is no longer free. Non-governmental researchers are now being asked to pay for ship time, if and when it is available. The West Coast fleet has been reduced by the relocation of the *Parizeau* to the East Coast and the assignment of the Tully to Arctic research in the 1993 field season.

PRIORITIES MUST BE SET FOR S&T SPENDING

Beyond clearer linkages between DFO federal science and its client community, Canada needs to reshape the future by setting priorities for science spending.[45] This is particularly challenging in the area of ocean science because we must understand the major reason for environmental change (ocean climate change) before we can make policy decisions in all other areas including determining research priorities. The oceans policy initiative of 1987 was meant to create a new way for the federal government to manage oceans but little has changed; the Interdepartmental Committee on Oceans never achieved the coordinating role intended for it in establishing ocean science priorities.

NEW LINKAGES AMONG GOVERNMENT, ACADEMIA AND INDUSTRY WILL CREATE ECONOMIC OPPORTUNITY

In 1988, the BC government determined that in the field of S&T, the academic community, government and the private sector were not working together to maximize economic advancement. Through the Science Council of BC, the government established an initiative entitled **Strategic Planning for Applied Research and Knowledge (SPARK)**. Its report, released in April 1993,[46] addressed provincial issues of economic diversification of coastal communities, development of ocean industries and more efficient port management as a component of infrastructure development. A specific problem for BC is the moratorium on offshore exploration which does not accommodate the development of non-living maritime resources such as oil, gas and minerals.[47]

The major recommendation of the SPARK report is that new, dynamic linkages are required among science, technology, industrial and

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[45] The National Advisory Board on Science and Technology, *Committee on Federal Science and Technology Priorities,* (Ottawa: June, 1993).

[46] Science Council of British Columbia, *Ocean Opportunities for The West Coast of Canada, (SPARK Report)* (Vancouver: April, 1993).

[47] *Ibid*, p. 104.

government partners. Entrepreneurship and innovation are evident on Canada's West Coast and flexible business networks, as described in the following case, are seen as the key to the future (see Illustration 12).

Illustration 12: Flexible Business Networks

Flexible networks are a new model of inter-firm cooperation that is spreading quickly in Europe, Australia and the U.S. Developed in the Emilia-Romanga region of Italy, it is a system of long-term cooperation that allows small firms to achieve economies of scale while maintaining their key strengths--high levels of flexibility, innovation, worker productivity and entrepreneurial drive.

Flexible networks have been credited with the exceptional economic performance of the Emilia-Romanga region. This province, with a population of about 4 million, boasts 325,000 small businesses, or one business for every five active workers. The average Emilia-Romanga firm employs only 7.5 people yet competes globally, producing top quality products with the latest technology. Over the past fifteen years, dramatic improvements in the economic performance of this region have drawn worldwide attention to flexible networks. A region that fifteen years ago was one of the poorest in Italy now has the highest wages and the lowest unemployment in the country, and a general economic performance that challenges the best of the OECD nations.

Source: *Flexible Networks in Theory & Practice: How & Why to Set Up Flexible Networks in British Columbia*, prepared for the Services Branch of the BC Trade Development Corporation, November 1992.

AN OCEANS AND COASTAL FORUM COULD ADVISE ON S&T COORDINATION

Specifically, SPARK recommends that an independent **Oceans and Coastal Forum** be established. This forum would involve federal, provincial, local and First Peoples governments, as well as marine industries and other marine users. Its purpose would be to advise on the coordination of diverse ocean activities, and to develop Ocean Activities Management plans. SPARK further recommends that the government of British Columbia take the lead in establishing such a forum (recognizing that the SPARK initiative was the first step). The federal government would be primarily concerned with long-term policies, priorities and programs linked to clear social and economic objectives. For example, the relevant federal and provincial government agencies could cooperate with the marine technology industry in order to market Canadian marine technology and services in the Asia-Pacific region, much as the United Kingdom has done in the example outlined in Illustration 13:

Illustration 13: Marketing Technologies: The U.K. Example

In the United Kingdom, the equivalents of the Canadian Department of Industry and the Department of National Defence have joined together to provide technology development incentives and marketing assistance for industry. Where the British military used to travel the world showing the flag, they now travel the world showing British technology. The British navy is almost an economic development department. They train foreign fleets on their British equipment. Little wonder that these countries end up procuring the same equipment for their military. (You purchase what you know how to drive.)

The U.K. government has published a catalogue/source book of ocean technologies companies for use in all their embassies.

At the local level, national and provincial governments could also assist in obtaining global contacts for Canadian products and technologies (*see* Illustration 14).

Illustration 14: Market Opportunities: Submersibles

At one time, B.C. had a well-developed underwater vehicle industry providing the first underwater vehicles for use in the North Sea. Today, 85% come from the United Kingdom. The U.K. and Norway have worked hard to define their markets and to develop the technology that is needed.

The 'submersible' industry in B.C. started in the 1960s when International Hydrodynamics was approached by Vickers Oceanics to design and build a submersible vehicle that could function to a depth of 3600 feet. From the beginning, the company had to be international in its approach because there was no domestic market for these products/technologies.

PORT AND TRANSPORTATION S&T ARE KEY TO PACIFIC OPPORTUNITIES

A key component to industrial development opportunities on Canada's coasts is transportation infrastructure; specifically, ports. Many S&T issues for Canada's ports are national. The Committee used the Port of Vancouver as a case study for these national issues.

The Port of Vancouver is one of the busiest in the world. In 1991, Vancouver's total cargo throughput was almost 71 million tonnes; by comparison, Halifax's total throughput for the same year was almost 15 million tonnes, and Montreal (in 1988) was 22.2 million tonnes.[48]

[48] Fairplay World Ports Directory 1993 (UK: Fairplay Information Systems Ltd, 1993), p. 146.

Indicative of the growth position of the province, the container traffic handled by Vancouver has increased, from 2.7 million tonnes in 1990 to 3.5 million tonnes in 1993.[49] Eighty-five per cent of total traffic is bulk cargo such as coal, grain, sulphur and potash.

The competitiveness issues for the harbour are on-site cargo handling and access to markets. The strategy of the Port Corporation is to market Vancouver as a gateway to North America. The Port's comparative advantage is access to the two Canadian continental railways and the rail system of the northern U.S. Its main competitors are the ports of Seattle and Tacoma.

A COMPETITIVE PORT IS PART OF A SEAMLESS TRANSPORTATION SYSTEM

The crucial **off-site** factor in port competitiveness is the existence or creation of a "seamless transportation system" that links the port with on-land transportation to markets. Trucking and railroad connections are essential in delivering goods to their inland destinations, and transpacific vessels coming from Asian countries are looking for the fastest, most efficient routes to transport goods to the North American market. For example, experts estimate that vessels using Deltaport, the new $224-million container terminal being built south of Vancouver, will save as much as four hours on transit time from vessel to market destination.[50]

The most crucial **on-site** factor is that ships must be moved in and out of the harbour as quickly as possible. Waiting time represents lost revenue for the shipping companies. There is a need for leading edge cargo management (electronic data interchange technologies, or EDI) and cargo handling systems.

Most of these technologies have been developed in Germany and Holland. These countries have developed fully automated terminals largely to offset the high cost of labour in Europe. Rotterdam, the largest port in the world, is almost totally automated. Canada has considerable expertise in electronic interchange technologies used to keep track of incoming and outgoing cargo. According to representatives of the Vancouver Port Authority, Transport Canada provides no incentives for technology development or research support programs in these areas. The Committee was advised that these technologies deserve more government support.

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[49] "Ports and Shipping Focus" in *The Financial Post*, March 2, 1994, p. 16-19.

[50] *Ibid.*

3.4 International: Ocean S&T Policies in Selected Jurisdictions

The following section provides a cursory examination of the marine science and technology policies, activities and research structures of Australia, Norway and the United Kingdom (for a more complete examination, see Appendix D: Ocean S&T Policy in Selected Jurisdictions). Like Canada, these countries have small open economies and possess substantial ocean resources. Norway and the U.K. are similar to Canada in terms of climatic conditions, types of marine economic activities and public infrastructure. Australia is comparable in terms of the size of the country, diversity of resources and government structure.

Australia, Norway and the United Kingdom believe that they should fully develop the economic opportunities provided by the oceans, such as aquaculture, offshore mineral and petroleum exploration, and the development of tidal power. Each has made a commitment to the protection and preservation of the ocean environment. To meet these objectives, they rely heavily on the ocean S&T frameworks they have developed. They have strengthened their research capacities in response to new opportunities or in response to perceptions that past efforts in oceans research have been inadequate.

The case studies of Australia, Norway and the United Kingdom illustrate how these countries have recognized opportunities in their oceans.

Australia

Australia's Review Committee on Marine Industries, Science and Technology produced a 1989 report entitled *Oceans of Wealth.* It identified marine industries with commercial opportunity and new national S&T priorities to support them including a proactive approach to encourage marine research. The suggestions build on the existing ocean science infrastructure. (Expenditures for Australian ocean S&T are approximately twice that, per capita, of Canada's). Australia's federal marine research institutions have seen real expenditure increases since 1989.

Most of the recommendations put forth have either been implemented or are currently being considered, including plans to create an Australian Marine Science Industry Council and the release of strategic plans for marine industries. The government has also undertaken a proactive approach in the area of marine research consortia among government, universities and industry. Under the Cooperative Research Centres (CRC) Program, for example, such partnerships have been established, under the auspices of the Commonwealth Scientific and Industrial Research Organization (CSIRO), in several areas such as aquaculture and ocean environments. Industry has also independently sponsored marine research from government laboratories.

Despite these programs, there have been suggestions that the government has not been sufficiently aggressive in providing incentives to industry to foster marine research although this has been blamed in part, on a sense of "non-urgency" in developing marine resources. For example, Australia's huge land-based resources are overwhelmingly larger than its offshore resources and thus less importance has been placed on research related to the latter. This is illustrated in Australia's comparative lack of policies to encourage domestic research in this area. One exception is a cooperative international programme with Canada in the international deep-sea Ocean Drilling Program.

Norway

Norway is economically dependent on its marine industries for its international competitive position: it owns and operates the third largest shipping fleet in the world; its aquaculture and fishing industries are among the most technologically advanced of their kind; and offshore petroleum development has turned this country into a net exporter of oil and gas. It is seeking to develop these and other marine industries in an environmentally sustainable way. Norway has ascribed a great deal of importance to the area of marine S&T which is reflected in its overall S&T spending (marine S&T expenditures have seen real increases since 1987 and have been maintained at constant levels during periods of overall S&T expenditure declines).

A system to identify research priorities has placed three marine sectors (aquaculture, oil and gas, and environmental technology) in the "highest priority" category since 1985. These three areas are administered by separate national steering committees, each of which has prepared a comprehensive national plan for its particular sector.

Actual government research is conducted by the Research Council of Norway. Marine research is conducted in four of the six main research areas including: bioproduction and processing; industry and energy; environment and development; and natural science and technology. The various research activities are coordinated to prevent a duplication of research efforts and to guide research such that the results of one area of study should complement the others. (For example, industry and energy would include environmental considerations). Marine research is supported through a broad network of government laboratories, such as the Marine Technology Research Institute (MARINTEK), and marine research laboratories located in Norwegian universities.

The private sector, in addition to funding their own research facilities, support government facilities through an innovative system known as "goodwill" contributions. Under this system, oil firms "donate" funds to the Norwegian government (for which they earn "points" towards gaining future licensing rounds on the Norwegian Shelf), the funds are then

funnelled to marine S&T institutes. Between 1979 and 1991, the Norwegian government received about Nkr 3.2 billion (approximately CDN $550 million) in donations. Since 1986, the goodwill focus has shifted to an emphasis to foster the active participation of oil companies to collaborate with public research initiatives. Companies are encouraged to identify technological challenges and to work with Norwegian research institutions and private companies to develop the needed technology.[51] Norway also maintains direct regulatory policies to stimulate domestic marine research. For example, those companies that win petroleum exploration licences must carry out, or contract, **domestic** research and development (this is also the policy of the U.K. but is not in place in Canada).

United Kingdom

Like Norway, the U.K. is a maritime nation which is heavily dependent on its marine industries and related research. The U.K. has traditionally placed a high value on marine S&T and continues to make substantial contributions to its development. The U.K. has recognized the commercial potential of UNCLOS which allocates 40% of the world oceans to exclusive economic zones. Countries which have superior marine S&T are in a commercially advantageous position to assist other coastal states. Like Norway, the U.K. is highly dependent on the competitive position of its marine industries, including the development of its offshore oil and gas resources and fisheries. It sees new commercial opportunities in the development of tidal power as a renewable source of non-polluting energy from the sea.

Marine research in the U.K. is extremely fragmented. It is conducted in seven government departments, two research councils, a publicly-funded research firm, 230 higher education institutes, as well as a number of industrial firms. On the public side, the government established the Coordinating Committee on Marine Science and Technology (CCMST) to advise the government on a national marine research strategy and to minimize duplication and gaps in Britain's research efforts.

Much of marine research activities have been geared towards developing commercial opportunities. The Marine Technology Directorate Limited has been created in part to direct marine research toward areas for which there is a "real customer".

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[51] External Affairs and International Trade Canada, *Highlights of the Norwegian Market for Ocean Industries: Notes Prepared for the Europe 1992: Ocean Industry Opportunities Seminar Series, October 22 - November 1, 1991* (Ottawa: 1991), p. 3.

Industry expenditures are roughly equivalent to those of the government although they have different research goals. For example, there is less of an emphasis on basic research within the private sector. Still, the private sector does directly contribute to government marine research activities and participates in government-sponsored cooperative ventures. For its part the government regulates, to some extent, the research activities of firms. Like Norway, it obliges firms who have gained exploration licences for offshore petroleum to conduct research within the U.K. itself.

4.0 CONCLUSIONS AND RECOMMENDATIONS

There are four reasons for the government of Canada to act now to implement an oceans management strategy that includes the enactment of a Canada Oceans Act:

- **to facilitate the growth of the innovative ocean industrial initiatives that exist in coastal regions;**
- **to focus science research on understanding the complex interrelationships of climate change and ocean ecosystem behaviour so that we can make informed decisions regarding resource management;**
- **to revise resource management systems and to create economic diversification strategies in response to the collapse of the groundfish industry on the Atlantic; and**
- **to capitalize on the opportunity of the pending coming into force of the UNCLOS in 1994.**

The Committee recommends an oceans management strategy which establishes a flexible and adaptable policy system that responds to the opportunities that our oceans represent. This development strategy should be structured to recognize the role of S&T in linking the environment, the economy and the well being of society in keeping with the policy issues listed above and the opportunities associated with the pending United Nations Convention on the Law of the Sea.

The United Nations Convention on the Law of the Sea is scheduled to come into effect in November 1994 and represents an opportunity to legislate an oceans management strategy. UNCLOS establishes a comprehensive framework for the regulation of all ocean space. It contains provisions governing: the limits of national jurisdiction over ocean space; access to the seas; navigation; protection and preservation of the marine environment; exploitation of non-living resources; and the settlement of disputes. In addition, it establishes new international bodies to carry out functions for the realization of specific objectives.[52]

The UNCLOS Convention allows for the establishment of a territorial sea of up to 12 nautical-miles in breadth, a Contiguous Zone (CZ) of up to 24 nautical-miles in breadth, and a provision for declaring an Exclusive Economic Zone (EEZ) of up to 200 nautical-miles in breadth for the purpose of economic advantage over fishing and the exploitation of non-living resources. Within the territorial sea, the sovereignty of the coastal state extends to the air space above and the sea bed below. Within the CZ, the coastal state has certain authority to apply its fiscal, immigration and sanitary laws. In the EEZ, the coastal state has sovereign rights for the purpose of exploring and exploiting, conserving and managing the living and non-living resources of the waters superjacent to the seabed, as well as the seabed itself and its subsoil. The coastal state also has jurisdiction with regard to the establishment and use of artificial islands, installations and

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[52] UN Conference on the Law of the Sea, *The Law of the Sea* (New York: 1983). Official Text of the UN Convention with Index and Final Act of the Third UN Conference on the Law of the Sea.

structures, marine scientific research, and the protection and preservation of the marine environment.

Canada was a strong and active supporter of the UNCLOS process and a major beneficiary of its provisions. Part IV, on the sovereignty rights of archipelagic states, reinforces Canada's authority in the Arctic, as does the designation of the 200 nautical-mile EEZ. Part V pertains to the Atlantic and the Pacific. In particular Canada played a leading role in the negotiation of Part XII, Protection and Preservation of the Marine Environment, including Article 234 dealing with ice-covered areas, and Section XIII, dealing with various issues of Marine Scientific Research.[53] These have been followed with the current Canadian lead on the intergovernmental programme "Protection of the Arctic Marine Environment (PAME)" of the eight-nation Arctic Environmental Protection Strategy.[54]

Canada's policy is to enact domestic legislation to comply with international ratification and specifically to support the Law of the Sea.[55] UNCLOS provides Canada with the opportunity to create a sound legislative framework for environmentally sustainable stewardship of its ocean resources in its EEZ which is estimated at approximately 5,000,000 square kilometres in size.

Within the context of the power conferred by UNCLOS, the Committee recommends that Canada enact an oceans act which will:

- **establish Canadian sovereignty over the 24 nautical-mile Contiguous Zone and the 200 nautical-mile Exclusive Economic Zone;**
- **extend environmental regulation to the Exclusive Economic Zone;**
- **create an ocean science management system in support of national and regional goals; and**
- **build on international conventions and cooperative agreements to promote international scientific research in support of a global resource management regulatory regime.**

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53 B. J. Thentenberg, "The Evolution of the Law of the Sea: A Study of Resources and Strategy with special Regard to the Polar Areas", *Natural Resources & Environment Services* (Dublin: Tycooly International Publishing, 1984).

54 Report of the Second Ministerial Conference, *"The Nuuk Declaration on Environment & Development in the Arctic"*, (Copenhagen: Ministry of Foreign Affairs, 1993).

55 Liberal Party of Canada, *Creating Opportunity: The Liberal Plan for Canada* (Ottawa: 1993), p. 109.

More specifically, the Committee recommends that an Oceans Act:

- **DECLARE AN EXCLUSIVE ECONOMIC ZONE AS A BASIS FOR REGULATION.**

A declaration of an EEZ is the basis of the application of the legal rights accorded to coastal states under Part V of UNCLOS. This includes extensive application of existing Canadian laws to the EEZ.

Canada's jurisdiction over maritime zones can be strengthened through the legal declaration of an Exclusive Economic Zone and a Contiguous Zone. Canada declared a 12 nautical-mile territorial sea and a 200 nautical-mile fishing zone in 1977 and has since adjusted numerous pieces of legislation in order to exercise many of the rights accorded under the regime of an EEZ.[56] This has created a piecemeal system that would benefit from amalgamation and refinement under the rubric of a Canada Oceans Act.

- **CREATE AN OCEAN SCIENCE MANAGEMENT SYSTEM.**

A science management system should be the centrepiece of an Oceans Act. This system is a management plan for federal involvement in international, national and regional science activity. It would be designed to ensure the maximum return on investment for science spending. "Return" is seen to include economic benefit, social benefit, and the benefits to Canada from a stronger position in international ocean affairs. With Canada's extensive and diversified coastal economic zones, scientific research and technology development activities are instrumental to realizing the potential of our oceans while respecting the sustainability of their resources at all three policy levels:

International Ocean Science Management:

Canada is an active participant in numerous international science activities (*see*: Appendix C: Canada's International Ocean S&T Activities) and benefits in two ways. As a participant, Canada is a beneficiary of the scientific and technology dividend of the research. In a more general sense, participation in international science promotes research excellence to the highest international standards beyond the scope of the specific research activity. In a climate of spending restraint it is presumed that continued involvement in many of these activities will be reviewed. While the Committee is not in a position to comment on the individual projects, it recommends our participation be in science and research rather than administrative support.

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[56] *The Territorial Sea and Fishing Zones Act* established a 200 nautical-mile fishing zone. *The Canada Shipping Act* extends jurisdiction for controlling marine pollution to the fishing zone. *The Canadian Environmental Protection Act* provides jurisdiction over dumping at sea within the fishing zone. *The Arctic Waters Pollution Prevention Act* establishes a 100 nautical-mile pollution control zone adjacent to the Canadian Coast above the 60th parallel.

National Ocean Science Management:

While each ocean presents unique challenges and opportunities, there is a need for a comprehensive national strategy to provide the framework for local decision-making. This framework includes:

i. The provision of scientific information on ocean ecosystem behaviour including climate change and its effect on ocean dynamics and biological resources. A major ocean S&T goal must be to develop the necessary tools and structures to undertake research that produces answers to the many questions of how our ocean ecosystems behave and what factors influence them.

ii. An information diffusion strategy, based on the Internet system of written communications between computers, to publish research material from government laboratories and universities for use by other researchers, industry, the general public and policy makers.

iii. A revised strategy for sustainable management of living ocean resources based on sound scientific models that are used for environmental regulation, stock assessment systems, international agreements concerning straddling stocks, and species licensing systems for each region.

iv. A strategy for ocean mapping and hydrography as a basis for economic exploration and exploitation of ocean mineral resources.

v. The provision for effective maritime defence and surveillance policies aimed at protecting and managing the EEZ territory.

While these recommendations are aimed primarily at national users, it is recognized that there are international commercial opportunities for S&T developed in support of the above. For example, expertise in hydrography has commercial applications in other countries as does scientifically accurate stock assessment systems.

Regional Ocean Science Management:

The Committee was impressed with the commitment of coastal residents, on all three coasts, to the management of their ocean resources. They are committed to a future that includes the ocean as a source of opportunity. The approach to achieving the goal of wealth creation varied widely, however. The innovative ideas on how the oceans should be managed illustrates that the management of opportunity is most efficient in the hands of the practitioners and end users--the people who live and work in the coastal regions. They are best equipped to champion oceans issues.

The Committee recommends that the role of the federal policy in this process should be to ensure that scientific information is available to the regional decision-makers, that federal laboratories, located in coastal regions, dedicate a portion of their research to the needs of the regional community and that comprehensive national framework policies exist to facilitate decisions based on consensus among users. At the same time, the

federal government must carry the main responsibility for long-term ocean research and data acquisition.

Many of the decisions facing coastal communities relate to sustainable development which requires a range of considerations including environmental, economic and social ramifications. The National Round Table on the Environment and the Economy[57] (NRTEE) model of decision-making is based on the reconciliation of environmental protection and social prosperity and may be adaptable to coastal zone management decisions. On an international scale, the Inuit Circumpolar Conference has successfully articulated the science management issues and development parameters for circumpolar nations based on a similar consensus-building format among end-users. The Committee recommends that ocean resource and coastal zone use decisions be based on a decision making process that includes all stakeholders.

- **MAKE ENVIRONMENTAL PROTECTION OF THE OCEANS A MANAGEMENT PRIORITY**

The Committee has found that on each of the three Canadian coastlines, there is a concern that not enough is being done to protect the ocean environment against land-based pollution of both national and international origin. The Committee recommends that pursuant to *Part XII, Protection and Preservation of the Marine Environment* of UNCLOS, an oceans act contain a comprehensive marine environment strategy similar in scope and regulatory approach to our land based environmental protection scheme.

The Committee also recommends that pursuant to the proposal put forward in the Brundtland Commission report, *Our Common Future,*[58] certain marine areas be designated as "protected zones" as a means of managing them as a safe habitat for living ocean resources. The intent of this recommendation is to provide a regulatory mechanism which could be used by governments to limit, restrict or prohibit all activities in these areas that might endanger the survival or health of certain species. Examples of such protected zones might be the calving grounds of the beluga whale and the over-wintering areas of certain seabirds.

The Committee further recommends that these protected marine zones be designated and the regulatory system designed with the advice of the regional management advisory system recommended above.

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[57] The National Round Table on the Environment and the Economy is a consensual forum involving industry, labour, environmental and government representatives. It promotes the principles and practices of sustainable development in all sectors of Canadian society and in all regions of Canada.

[58] World Commission on Environment and Development, *Our Common Future* (New York: Oxford University Press, 1987), p. 316.

- **BUILD ON INTERNATIONAL COOPERATION TO ADVANCE SCIENTIFIC RESEARCH TO PROTECT OCEAN RESOURCES.**

Parts XIII and XIV of UNCLOS set out a detailed system for the conduct and use of international ocean scientific research, technology development and technology transfer. These two sections of UNCLOS encourage international cooperation for the advancement of knowledge and for the promotion of stewardship of the ocean commons. As research funding is limited, and as it is recognized that the oceans are a global resource, international joint ventures are becoming increasingly important in advancing our understanding of ocean dynamics and designing cooperative solutions. The Committee recommends the continuation of Canadian participation in international science activities.

UNCLOS sets out a cooperative procedure for resource management conservation for fish stocks that straddle either adjoining EEZs or an EEZ and the high seas. The Committee recommends that Canada participate fully in international endeavours as a mechanism to conserve fish stocks whose migratory habits straddle our EEZ and the high seas.

LIST OF ACRONYMS

ACSys	-	Arctic Climate System Study
AEPS	-	Australian Institute of Marine Science (Australia)
AMAP	-	Arctic Monitoring and Assessment Programme
AMOP	-	Arctic Marine and Oil spill Programme
AMSTAC	-	Australian Marine Science and Technology Advisory Committee
ASTEC	-	Australian Science and Technology Council
ATP	-	Advanced Technology Programme (U.K.)
BRITE	-	New Technologies for Manufacturing Industries (under the EC's Third Framework Program in R&D)
CAST	-	Council of Applied Science and Technology (Nova Scotia)
CCG	-	Canadian Coast Guard
CCMST	-	Coordinating Committee on Marine Science and Technology (U.K.)
CCO	-	Canadian Committee on Oceanography
C-CORE	-	Centre for Cold Ocean Resources Engineering
CNEXO	-	Centre national pour l'exploitation des oceans (France)
COGLA	-	Canada Oil and Gas Lands Administration
COSPAS	-	(Russian acronym for satellite system, for which there is no English translation)
CRC	-	Cooperative Research Centres (Australia)
CSIRO	-	Commonwealth Scientific Industrial Research Organization (Australia)
CZ	-	Contiguous Zone
DAFS	-	Agriculture and Fisheries for Scotland (U.K.)
DFAIT	-	Department of Foreign Affairs and International Trade
DFO	-	Department of Fisheries and Oceans
DIAND	-	Department of Indian Affairs and Northern Development
DND	-	Department of National Defence
DOE	-	Department of the Environment (Canada and U.K.)
DPIE	-	Department of Primary Industries and Energy (Australia)
DSTO	-	Defence S&T Organization (Australia)
DTI	-	Department of Trade and Industry (U.K.)
DTp	-	Department of Transport (U.K.)
EA	-	External Affairs (now DFAIT)
EC	-	European Community
EDI	-	Electronic Data Interchange technologies
EEP	-	Environmental Emergencies and Preparedness
EEZ	-	Exclusive Economic Zone
EFTA	-	European Free Trade Agreement
EFZ	-	Exclusive Fishery Zone (Australia)
EMR	-	Energy, Mines and Resources Canada (now NRCan)
EPC	-	Emergency Preparedness Canada

ESPRIT	-	Strategic European Research Program in Information Technologies (under the EC's Second Framework Program in R&D)
EUREKA	-	European Research and Coordination Agency
EUROMAR	-	European Marine Research Program within EUREKA
FAO	-	Food and Agriculture Organization
FCCC	-	Framework Convention on Climate Change
FRCC	-	Fisheries Resource Conservation Council
FTEs	-	full-time equivalents
FUSION	-	thermonuclear research program (under the EC's Third Framework Program in R&D)
GCOS	-	Global Climate Observing System
GESAM	-	Group Experts on Scientific Aspects of Marine Pollution
GEWEX	-	Global Energy and Water Cycle Experiment
GIPME	-	Global Investigation of Pollution in the Marine Environment
GIS	-	geographic information systems
GLFC	-	Great Lakes Fishery Commission
GLOSS	-	Global Sea Level Observing Station
GOOS	-	Global Ocean Observation System
HEI	-	Higher Education Institutes (U.K.)
HRDC	-	Human Resources Development Canada
IAEA	-	International Atomic Energy Agency
ICC	-	Inuit Circumpolar Conference
ICCAT	-	International Convention for the Conservation of Atlantic Tuna
ICES	-	International Council for the Exploration of the Sea
ICO	-	Interdepartmental Committee on Oceanography
ICSU	-	International Council of Scientific Unions
IFCPS	-	International Fisheries Commissions Pension Society
IGBP	-	International Geosphere-Biosphere Program
IGOSS	-	Integrated Global Ocean Services System
IGPRAD	-	Intergovernmental Panel of Experts on Radioactive Waste Disposal in the Sea
IKU	-	Institute for Continental Shelf Research and Petrochemicals Technology (Norway)
IMO	-	International Marine Organization
INPFC	-	International North Pacific Fisheries Commission (currently the North Pacific Anadomous Fisheries Commission)
IOC	-	Intergovernmental Oceanographic Commission
IOS	-	Institute of Ocean Sciences (British Columbia)
IPHC	-	International Pacific Halibut Commission
JGOFS	-	Joint Global Ocean Flux Study
LBSMP	-	Land Based Sources of Marine Pollution
LOICZ	-	Lands-Oceans Interaction in Coastal Zone

MAFF	-	Ministry of Agriculture, Fisheries and Food (U.K.)
MARINTEK	-	Marine Technology Research Institute (Norway)
MOD	-	Ministry of Defence (U.K.)
MOSST	-	Ministry of State for Science and Technology
MOU	-	Memorandum of Understanding
MTD Ltd	-	Marine Technology Directorate Limited (U.K.)
MST	-	Marine Science and Technology
NABST	-	National Advisory Board on Science and Technology
NAFO	-	North Atlantic Fisheries Organization
NASCO	-	North Atlantic Salmon Conservation Organization
NCARP	-	Northern Cod Adjustment and Recovery Program
NERC	-	Natural Environment Research Council (U.K.)
NILU	-	Norwegian Institute for Air Research
Nkr	-	Norwegian Krona
NOIA	-	Newfoundland Association of Ocean Industries
NRCan	-	Natural Resources Canada
NRC	-	National Research Council
NRTEE	-	National Round Table on the Environment and the Economy
NSERC	-	Natural Sciences and Engineering Research Council
NWT	-	Northwest Territories
ODP	-	Ocean Drilling Program
OECD	-	Organization for Economic Cooperation and Development
PAME	-	Protection of the Arctic Marine Environment
PICES	-	North Pacific Science Organization
PSC	-	Pacific Salmon Commission
R&D	-	research and development
RIDGE	-	Ridge Inter-disciplinary Global Experiments
RRETC	-	River Road Environmental Technology Centre
SARSAT	-	Search and Rescue Satellite-Aided Tracking
SERC	-	Science and Engineering Research Council (U.K.)
SPARK	-	Strategic Planning for Applied Research and Knowledge
SPRU	-	Science Policy Research Unit (U.K.)
STEP	-	S&T for Environmental Protection (under the EC's Third Framework Program in R&D)
S&T	-	science and technology
TAC	-	Total Allowable Catches
TC	-	Transport Canada
TEK	-	traditional ecological knowledge
TOGA	-	Tropical Ocean and Global Climate Atmosphere Program
UNCED	-	United Nations Conference on Environment and Development (a.k.a. the "Rio Summit" and the "Green Summit")

UNCLOS	-	United Nations Convention on the Law of the Sea
UNEP	-	United Nations Environmental Program
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
WCRP	-	World Climate Research Program
WHO	-	World Health Organization
WMO	-	World Meteorological Organization
WOCE	-	World Ocean Circulation Experiment

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CANADIAN OCEAN POLICY: HISTORICAL OVERVIEW

The establishment of an oceans research infrastructure began with the Canadian Hydrographic Service in 1883. In 1893, a specialist in fish embryology, Dr. E. E. Price was appointed Canada's Commissioner of Fisheries. Parliament established a Board of Management in 1898 with an appropriation of $15,000 for a marine scientific station. In 1904, the Board assumed responsibility for a freshwater station at Go Home Bay, Georgian Bay, Ontario (this station was abandoned in 1913). In 1908, stations were established at St. Andrews, New Brunswick and at Nanaimo, B.C. In 1912, the Board became the Biological Board, operating under a special Act of Parliament. The Board's membership was broadened in 1924 to include representatives of the fishing industry and a wider spectrum of academic expertise. In 1937, the name of the Board was changed to the Fisheries Research Board of Canada. It continued to manage Canada's federal fisheries research effort until 1973.[1]

National considerations of a Canadian Oceans Policy followed from the 1957 International Geophysical Year when 70 countries participated in an international study which included looking at coordination of ocean scientific research. As a direct result of Canada's participation in that programme and in the United Nations Conference on the Oceans in New York in 1959, the Bedford Institute of Oceanography was established in Bedford, Nova Scotia in 1962. Ten years later, the Centre for Inland Waters was opened in Burlington, Ontario, and the Fisheries and Oceans Freshwater Institute was opened at the University of Manitoba in 1973. In the same year, the laboratories and personnel of the Fisheries Research Board of Canada were integrated with the Department of Fisheries, leaving the Board an advisory role. By the end of the decade, it had been disbanded.[2]

The Northwest Atlantic Fisheries Centre in St. John's, Newfoundland was opened in 1978, the Institute of Oceans Science in Patricia Bay, B.C. in 1979 and the Maurice Lamontagne Institute in Ste-Flavie, (Rimouski), Quebec in 1987. The Department of Fisheries and Oceans was established as a separate department in 1979.[3]

Federal initiatives in ocean policy have generally been in response to international issues. The discovery of oil in Prudhoe Bay, Alaska prompted the Humble Oil Company to make a test voyage (the *S.S. Manhattan*) through the Northwest Passage, as a possible future oil transportation route, in September, 1969 without first seeking approval from Canadian

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1 L. Scott Parsons, *Management of Marine Fisheries in Canada* (Ottawa: National Research Council of Canada and Department of Fisheries and Oceans, 1993), p. 532-534.

2 *Ibid.*, p. 534.

3 Ronald W. Crowley and Raymond C. Bourgeois, "The Rationale and Future Directions of Canada's Ocean Policy: Domestic Aspects" in D. McRae, ed., *Canadian Oceans Policy: National Strategies and the New Law of the Sea* (1989).

authorities.[4] Following public outrage over the issue of sovereignty of the Arctic archipelago and the waters of the Northwest Passage, the government quickly enacted the *Arctic Waters Pollution Prevention Act, (1970).* At the same time, evidence of substantial offshore oil reserves and the potential discovery of mineral deposits were seen as a possible source of economic wealth that could mitigate the uncertainty created by the first oil shocks of the period.

Both events prompted policy attention to focus on the "oceans" as a national territory and as a national resource that needed to be managed and protected.

In 1969, in response to the increasing awareness of the importance of oceans to Canada's economic potential, The Science Council commissioned a study of marine science and technology (Special Study #16, *Ad mare: Canada looks to the sea*). The Science Council also issued Special Study #10, *Canada, Science and the Oceans*, which contained a series of policy statements and recommendations in the area of ocean science and technology. These included establishing a national research and development program--Major Program in Marine Science and Technology--which would focus on the Canadian continental shelves, their superjacent waters, ice-cover and the open oceans in order to respond to the new needs in resource exploitation, fisheries, transportation, recreation, antipollution and climate prediction.[5]

In 1972 Cabinet approved a proposal by the ministers of the Ministry of State for Science and Technology (MOSST) and Environment Canada to review Canada's ocean policies with particular emphasis on ocean science and technology and the development of ocean industry. Cabinet recognized that there were no policies or overall guidelines to govern the actions of the federal departments and agencies with ocean interests at a time when they needed guidance to promote ocean industrial development, resource management and sovereignty.[6]

A Task Force on Ocean Industry, Science and Technology was established with members from the federal departments and agencies who had "ocean" responsibilities. The objectives of the Task Force were:[7]

1. To bring to Cabinet's attention, the strategic significance to Canada of the ocean and its resources.

2 To identify areas of marine science and technology where federal policies are, or will be, inadequate to meet Canada's increasing responsibilities, commitments and opportunities.

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[4] Franklyn Griffiths, ed., *Politics of the Northwest Passage* (Toronto: University of Toronto Press, 1988).

[5] Science Council of Canada, *Report No. 10: Canada, Science and the Oceans* (Ottawa: 1970).

[6] Ronald W. Crowley and Raymond C. Bourgeois, *The Development of Canada's Ocean Policy* (Ottawa: Department of Fisheries and Oceans, 1988).

[7] Ministry of State for Science and Technology, *Canada's Ocean Policy: The Report of the Task Force on Ocean Industry, Science and Technology* Ottawa:1974)

3. To recommend specific policies for ocean science, technology, and industry which could be implemented immediately.

4. To recommend structures and instruments for the formulation, coordination and implementation of Canada's policies for marine science and technology.

The task force conducted studies under five subject areas:

1. Management of non-renewable resources (minerals and petroleum);
2. Management and protection of "biological resources";
3. Ocean transportation;
4. Sovereignty (defence and security); and
5. The preservation of the ocean environment (monitoring and maintenance).

The final report, approved by Cabinet in July, 1973, recommended developing policy aimed at resource management and exploitation through industrial stimulation and the acquisition of scientific and engineering expertise. The Minister of State for Science and Technology announced a National Oceans Policy. Its responsibilities were to:

1. Stimulate the development and most effective participation of Canadian industry in the elements of industrial and technological capability essential to the exploitation of Canada's offshore resources.

2. Review all Canadian legislation relevant to offshore resource development, taking into account the experience of other countries in managing offshore resources.

3. Affirm the intent that Canada develop, within five years, an internationally recognized excellence in operating on and below ice-covered waters.

4. Adopt a policy that Canada develop and maintain a current information base on offshore resources that would be equivalent or superior to that available to large multinational corporation and foreign governments.

5. Give special emphasis to marine science and technology programs which support:

    a. protection and, where appropriate, management of the Canadian marine environment;
    b. development and management of Canada's non-renewable ocean resources;
    c. an adequate response to international and domestic ocean commitments;
    d. management of the estuarine, coastal and near-shore zones;
    e. international scientific programs having clear Canadian concern and in which Canadian resources can be used effectively;
    f. increased development and application of ocean engineering at selected universities and government laboratories; and

g. improved capabilities to predict marine atmospheric and oceanic factors such as weather, sea state, currents and ice.

6. Charge the Minister of Industry, Trade and Commerce to coordinate proposals from all departments for the development and support of Canadian ocean industry.

7. Charge the Canadian Committee on Oceanography[8] to coordinate Canada's programs of marine science and technology and to report to Cabinet through the Minister of the Environment.

8. Charge the Minister of State for Science and Technology to continue the review of policy on ocean industry, science and technology.

The National Oceans Policy emphasized the multidisciplinary, multi-agency nature of ocean science and technology and the need for co-operation and co-ordination:

> It requires the highest level of cooperation within and between governments, and between government and the other sectors of the national economy. This type of multipurpose use and management of our renewable and nonrenewable ocean resources will assure their development for the maximum benefit to Canadians.[9]

Implementation activity focused on the following initiatives: (3) development of operational capability on and below ice-covered waters, (an Arctic sovereignty issue); (6) development and support of a Canadian ocean industry; (7) coordination of Canada's programs of marine science and technology (reporting to Cabinet through the Minister of the Environment); and (8) continuation of the review of policy on ocean industry science and technology, which had begun with the task force, by the Minister of State for Science and Technology.[10]

Industrial policies for ocean resource management and exploitation were the major focus, and environmental protection was secondary. Science and technology development was recognized as the driver of each. Although the notions of coordination and efficiency were issues in the original report, there was no attempt to address this in implementation. Both the Minister of

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8 The Canadian Committee on Oceanography (CCO) was an association of universities, industries and federal government agencies that were directly involved in marine research and its applications. Because of its multisectoral perspective, the CCO was directed by Cabinet to advise the government on the general state of Canada's ocean science and technology, on possible opportunities for participation of Canadian industry in ocean-related programs, and on opportunities for new Canadian initiatives in the development and use of ocean science and technology. It was also the interface agency through which Canada participated in international oceanographic undertakings.

9 Ministry of State for Science and Technology, *Canada's Oceans Policy: The Report of the Task Force on Ocean Industry, Science and Technology* (Ottawa: 1974).

10 *Ibid.*

State for Science and Technology and the Minister responsible for the Environment were given reporting responsibilities for various ocean science issues. The Department of National Defence was the lead department in development of "below ice capabilities" and the Canadian Committee on Oceanography was given advisory responsibilities on the development of science and technology opportunities. The Minister of Industry, Trade and Commerce was given responsibility to co-ordinate item 6--development and support of Canadian ocean industries.

The issue of the oceans remained on the public policy agenda throughout the decade primarily because of new and ongoing international events. In 1967, the United Nations had begun deliberations to establish a Convention on the Law of the Sea, (UNCLOS III). Canada was an active participant in this exercise which produced a Convention signed by 119 countries in 1982.[11]

The 1982 Convention establishes a jurisdictional framework for international management of ocean resources. A coastal state has exclusive rights over the resources within a 200-mile-wide band off its coasts as an Exclusive Economic Zone (EEZ). Canada had established a 200 nautical-mile "Zone" to protect fishing interests as early as 1977.[12] This was not a declaration of an all inclusive EEZ that Canada can claim under the terms of Law of the Sea. The resolution of these major jurisdictional questions shifted the focus of oceans policy from sovereignty rights to domestic regulations and oceans management.

The Department of Fisheries and Oceans was established in 1979. The legislation not only joined the government's fisheries and oceans efforts, which had previously been separate, but articulated the Department's oceans mandate. The *Government Organization Act, 1979* stipulates that the Minister of Fisheries and Oceans has responsibility for "all matters over which the Parliament of Canada has jurisdiction, not by law assigned to any other department, board or agency, of the Government of Canada relating to sea coast and inland fisheries, fishing and recreational harbours, hydrography and marine science and the co-ordination of the policies and programs of the Government of Canada respecting oceans."[13]

In 1985, the U.S. Coast Guard icebreaker *Polar Sea* undertook to cross the Northwest Passage challenging Canada's claim to sovereignty. The Canadian government announced several immediate measures asserting its sovereignty including the drawing of straight baselines around its Arctic archipelago, but this latest intrusion illustrated that we were still vulnerable in ocean sovereignty and management issues.

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11 Donald McRae and Gordon Munro, ed.s, *Canadian Oceans Policy: National Strategies and the New Law of the Sea* (Vancouver: University of British Columbia Press, 1989).

12 Crowley and Bourgeois, *The Development of Canada's Oceans Policy*, p. 171.

13 *Ibid.*

INVENTORY OF FEDERAL OCEANS-RELATED ACTIVITIES * [1]

PROGRAM	DEPT.	LEGISLATION	$ M	PYs
1. Marine Transportation				
Marine Navigation Systems	CCG(TC)	Canada Shipping Act	210	3,300
Marine Regulatory: Ship Safety	CCG(TC)	Canada Shipping Act	23	395
Icebreaking and Other Arctic Operations	CCG(TC)	Arctic Waters Pollution Prevention Act	90	1,025
Harbour Management	CCG(TC)	Public Harbours and Ports Facilities Act	37	90
Hydrography	DFO	Government Organization Act 1979 Territorial Seas and Fishing Act Charts and Publication Regulations	40	585
2. Marine Services				
Search and Rescue	CCG(TC) DND DFO	Safety of Life at Sea Convention Canada Shipping Act	120	1,820
Ice Management/Flood Control	CCG(TC)	Department of Transport Act	6	65
Easter Arctic Sealift	CCG(TC)	Treasury Board Approval (June 1981)	7	11
Marine Architecture and Engineering	PW	Public Works Act	250	340
Dredging and Fleet Services	PW	Public Works Act	17	160
Small Craft Harbours	DFO	Government Organization Act Fishing and Recreational Harbours Act	70	84
Ice Services	DOE	Government Organization Act (1970 & 1979)		

* [1] DFO, Canada's Oceans: An Economic Overview and a Guide to Federal Government Activities (1989), Economic and Commercial Analysis Report No. 43, Minister of Supply and Services.

PROGRAM	DEPT.	LEGISLATION	$ M	PYs
Marine Weather	DOE	Government Organization Act (1970 & 1979)	3.5	29
Marine Climate	DOE	Government Organization Act (1970 & 1979)	1	5
Offshore Surveys	EMR	Canada Lands Surveys Act (1970) Government Organization Act (1970 & 1979) Resource and Technical Surveys Act (1966-67)	0.3	6
Marine Export Transport Services	EA	External Affairs Act (1983)	0.1	2
3. Resource Development and Management (Including environmental protection)				
Fisheries Resource Allocation Licensing and Regulations	DFO	Fisheries Act	13	200
Monitoring, Control and Surveillance, Inshore and Nearshore	DFO	Fisheries Act Coastal Fisheries Protection Act	44	925
Fisheries Enhancement and Development	DFO	Fisheries Development Act	68	420
Habitat Management	DFO	Fisheries Act	6	75
Arctic Marine Conservation	DFO	Fisheries Act		
Petroleum Development COGLA	EMR DIAND	Canada Oil and Gas Act Oil and Gas Prod. and Conservation Act Canada Petroleum Resource Act	6.5	60
Control of Pollution from Land Based Sources	DOE	Government Organization Act (1979) Fisheries Act, Section 36-42 Canadian Environmental Protection Act (CEPA)	2	35
Environmental Protection re. Offshore Petroleum and Mineral Resources	DOE	Government Organization Act (1979) Fisheries Act, Section 36-42 CEPA Part IV	1	9

PROGRAM	DEPT.	LEGISLATION	$ M	PYs
Toxic Substances Control	DOE	Fisheries Act, Section 36-42 CEPA Part IV	1	12
National Marine Parks	DOE	National Parks Act	0.3	3
Control of Ship-Source Discharges	CCG(TC)	Government Organization Act (1979)	0.2	3
Marine Environmental Protection World-wide	EA	External Affairs Act (1982)	0.3	2
Emergencies/Clean-up of Ship Source Pollution	CCG(TC)	Canadian Shipping Act	5	60
Pollution Prevention in Arctic Waters	DIAND	Arctic Waters Pollution Prevention Act Emergency Planning Orders	0.2	4
Framework for Development of Offshore Non-Fuel Minerals	EMR	Energy, Mines and Resources Act	0.3	3
Offshore Geoscience Information	EMR	Resource and Technology Surveys Act Energy, Mines and Resources Act	14	75
4. Sovereignty, Defence and Law of the Sea				
Maritime Boundary Disputes	EA	External Affairs Act (1983)	0.2	5
US-Canada Arctic Cooperation & Coord.	EA	External Affairs Act (1983)	0.1	1.5
Law of the Sea	EA	External Affairs Act (1983)	0.1	1
International Fisheries Agreements (resources shown for External Affairs only)	DFO	Fisheries Act	0.2	6
Maritime Command	DND	National Defence	2260	18448
5. Northern Development				
Northern Land Use Planning	DIAND	Indian Affairs and Northern Development Act	2	22

PROGRAM	DEPT.	LEGISLATION	$ M	PYs
Indian and Inuit Environmental Protection	DIAND	Indian Act	0.5	1
Studies for Northern Oil and Gas Resource Management (NOGAP)	DIAND	Indian and Northern Affairs Act	1	5
Granular Resources and Man-made Islands in Beaufort	DIAND	Public Lands Grants Act	0.4	1
Petroleum and Related Environmental Protection COGLA (resources reported under "C")	DIAND	Public Lands Grants Act		
Arctic Icebreaking (resources reported under "A")	CCG(TC)	Canada Shipping Act Arctic Waters Pollution Prevention Act		
6. Industrial Development				
Action Program	ACOA	Government Organization Act Atlantic Canada 1987	*	*
Newfoundland Ocean Industries Development Agreement	ACOA	Economic and Regional Development Agreement	*	*
Canada-Nova Scotia Development Agreement	COGLA	Federal/Provincial Agreement (1984)	*	*
Canada-Newfoundland Offshore Development Fund	COGLA	Canada-Newfoundland Atlantic Accord-Implementation Acts	*	*
Western Diversification Program	WDO	Western Economic Diversification Act (June 8, 1988)	*	*
Operation and Maintenance of Certain PWC Dry Docks	PW	Public Works Act	4.6	53
International Fish Trade Development	EA	External Affairs Act	0.4	8

PROGRAM	DEPT.	LEGISLATION	$ M	PYs
Program for Export Market Development	EA	External Affairs Act	5	
7. Marine Science and Technology Development				
Fisheries Resource Assessment Research	DFO	Fisheries Act	75	930
Aquaculture Research	DFO	Fisheries Development Act	7	105
Habitat Assessment and Research	DFO	Fisheries Act	8	110
Resource Development Research	DFO	Fisheries Development Act	20	195
Physical Oceanography	DFO	Government Organization Act (1979)	27	361
Chemical Oceanography	DFO	Government Organization Act (1979)	7	107
Marine Ecology	DFO	Government Organization Act (1979)	14	179
Offshore Geoscience Activities	EMR	Resource and Technical Surveys Act Energy, Mines and Resources Act	9	110
Materials for Offshore Structures	EMR	Energy, Mines and Resources Mandate/ PERD	2	9
Remote Sensing Relating to Oceans	EMR	Treasury Board Minute Energy, Mines and Resources Act	0.2	1
Ocean Drilling Program	EMR/ et al.	Cabinet Decision	4	3
Marine Engineering (includes $1.5 M IRAP)	NRC	NRC Act (1966-67)	10	60
Marine Biology and Chemistry (includes $1.5 M IRAP)	NRC	NRC Act (1966-67)	5	
Grant Support to Universities	NSERC	NSERC Act	9.8	
Climate Research	DOE	Government Organization Act (1979)	1	5
Defence R&D[1]	DND	National Defence Act	267[1]	15971[1]

[1] Slightly more than one-third of this program is oceans-related.

PROGRAM	DEPT.	LEGISLATION	$ M	PYs
Arctic R&D	CCG	Arctic Waters Pollution Prevention Act	2	3
Technology Inflow Program	EA		*	
Industrial Research Assistance Program	NRC		*	
TOTAL OCEANS-RELATED ACTIVITIES				
Excluding Maritime Command			1,520	13,682
Including Maritime Command			3,780	32,130

Note: Most of the financial data relates to fiscal year 1988-89.

* These assistance programs and activities are not targeted exclusively at the oceans sector. More detailed descriptions and information on funding is included in the publication entitled "Inventory of Federal Support Available to Canada's Ocean Industries", available from the Department of Fisheries and Oceans.

INTERNATIONAL OCEAN SCIENCE

Summary

Early in its deliberations, the NABST Committee on Oceans and Coasts acknowledged the growing importance of international scientific study of the world's ecosystem. In its consultations on both the Arctic and Pacific coasts, experts reiterated this point with vivid examples, such as the need to understand the *El Niño* phenomenon and its impact on Canada's ocean resources.

The Committee wished to consider various international developments related to oceans and coasts, such as country attitudes, Exclusive Economic Zones (EEZs), and the role of oceans in climate change. The Secretariat undertook to summarize the scope of Canada's involvement, as well as assessing the financial commitments Canada currently makes internationally in ocean science. This proved to be difficult: although Canada is active in advocating conscientious national environmental citizenship, there appears to be no overarching policy governing **ocean** scientific initiatives. Indeed, the amount of information available is sporadic. **The last comprehensive figures on Canada's national marine science expenditures are for the year 1987/88. They were compiled by the Interdepartmental Committee on Oceans, and have not been updated since the publication of their Multi-Year Science Plan in 1988.** Although a Marine Science Strategic Plan was subsequently developed, it has not been published and the Committee appears to have undertaken no further substantial work.

In 1987 Indian and Northern Affairs asked Dr. Fred Roots to chair an inquiry into Canada's polar research and scientific community. The following comments are paraphrased from this report, entitled *Canada and Polar Science*, for their relevance and currency seven years later[14]. Although these comments were originally made with respect to **arctic science**, they are equally applicable to the current situation with respect to **international ocean science**, and hence the latter term has been substituted where the former term originally appeared:

> "Precise figures on the amount of (ocean) science conducted or supported by the federal government are not possible to obtain because it is in many cases not practical or desirable to separate ('ocean') science from science of a national(/international) scope ..., or to separate 'science' from other activities that may include research and development or scientific information, or because definitions of what is ('ocean science') vary from subject to subject and according to the time or purpose of the study." (p. 10)

[14] Dr. F. Roots et al., *Canada and Polar Science* (Indian and Northern Affairs, 1987).

> "Canada's total activity in basic research in (ocean science) is ... quite modest; but Canadian links to and influences on international or world research programs involving (ocean science) are extensive. Those links and influence are due to the efforts and contacts of individuals rather than a formal national policy or deliberate commitment of funds in support of a general national priority. In fact, there is some evidence that a factor encouraging Canadian (marine) scientists to be active in international (ocean science) is the difficulty in obtaining support for domestic (ocean) science; by developing active cooperations with other countries, it has been possible to advance scientific knowledge in areas of interest to Canada at less cost. It may also have been easier to persuade Canadian authorities to support the Canadian portion of international cooperative research than to get support for the same work done unilaterally in Canada." (p. 15)

Among this report's findings, the following are applicable to Canada's current ocean science involvements:

> "...the federal government appears to have re-directed much of its support from long-term, sustained research and systematic data-gathering to the resolution of urgent short-term policy and political problems..." (p. vi)

> "there is little evidence of any collective sense of purpose or direction within the federal government as a whole respecting the promotion, support, and undertaking of activities to increase knowledge of the... (ocean) region." (p. vi)

This appendix, therefore, attempts to isolate Canada's international ocean science activities, and give some indication of the scope of financial commitment. These are Canada's **major** initiatives with respect to the oceans. The nuanced references to ocean-related science within ongoing national activities (such as Environment Canada and the Green Plan) have not been included.

Intergovernmental Oceanographic Commission (IOC)

Canada's involvement in international developments in Oceans and Coasts S&T is coordinated (at the federal government level) through Canada's participation in the Intergovernmental Oceanographic Commission (IOC) of the United Nations.

The IOC is the UN organization dealing specifically with ocean S&T matters. It is functionally autonomous, operating through the collective efforts of the 122 Member States, with a Secretariat housed at the headquarters of the UN Educational, Scientific and Cultural Organization (UNESCO) in Paris and with an annual operating budget of approximately $5-6 million.

Canada is an elected Member of the Executive Council (composed of 35 states) and holds the position of First Vice-Chair. IOC Assembly takes place every two years, with the Executive Council meeting in the intervening year. The annual meetings allow for debate and decisions on ocean S&T issues and national policies to be argued and negotiated. Canada's input into IOC meetings is coordinated by an interdepartmental committee which can include some or all of the following federal departments: Department of Fisheries and Oceans (**lead**); Transport Canada; Natural Resources Canada (NRCan--formerly Energy Mines and Resources); Environment Canada; the Department of Foreign Affairs and International Trade (DFAIT); the Canadian International Development Agency; National Science and Engineering Research Council (NSERC); and the Department of Indian Affairs and Northern Development.

With respect to the United Nations Conference on Environment and Development (UNCED), an interdepartmental working group consisting of representatives of various federal departments within Canada was established to prepare a national strategy in response to the UNCED proposals. The lead department in this effort was Environment Canada. The participating departments include all those listed above, plus the Department of Finance, the Privy Council Office, and the International Development Research Centre (IDRC). The working group prepared a report supporting Canada's Green Plan. On the issue of oceans and coasts, it gave priority to land-based sources of pollution, ocean science and monitoring, living marine resources and coastal zone management.

Canada's International Ocean Science Activities by Department

The following descriptions of Canada's international ocean science activities by department include IOC-related initiatives currently underway.

The Department of Fisheries and Oceans

The Department's forecast for 1992/93 expenditures was $6.668 million in international expenses, "to advance Canada's international fisheries interests in conservation and trade."[15] This includes representing Canada on the following international organizations:[16]

- *International Convention for the Conservation of Atlantic Tuna (ICCAT)*--conservation, restoration, rational management and sharing of tuna-like species in the Atlantic Ocean and adjacent seas (Canada, the US, and Japan, as well as many smaller countries) (1992/93 forecast, $40,000).

- *North Pacific Marine Science Organization (PISCES)*--to strengthen international understanding of fisheries and oceanographic development in the north Pacific (Canada, the US, former Soviet republics, Japan and China) (1992/93 forecast, $88,000).

- *Northwest Atlantic Fisheries Organization (NAFO)*--conservation, restoration, rational management and sharing of fish stocks in the NW Atlantic; international cooperation with respect to the resource (fourteen countries, of which the European Community, Canada and Japan are the major players; the US has withdrawn) (1992/93 forecast, $435,000).

- *North Atlantic Salmon Conservation Organization (NASCO)*--conservation, restoration, enhancement, rational management and sharing of North Atlantic salmon stocks (Canada, Denmark, European Community, Iceland, Norway and the US) (1992/93 forecast, $87,600).

- *Pacific Salmon Commission (PSC)*--conservation, restoration, enhancement, rational management and sharing of Northeast Pacific salmon stocks; establishment of salmon management and enhancement programs to reduce interceptions, to prevent overfishing and to secure, for each country, benefits equivalent to the production of salmon from its own waters (Canada and the US) (1992/93 actual, $786,500).

- *North Pacific Anadomous Fisheries Commission (formerly International North Pacific Fisheries Commission (INPFC)*--conservation and rational management of the high seas salmon stocks of the North Pacific Ocean; reduction of foreign interceptions of North American salmon and curtailment of their sale abroad (Canada, US, Japan and former Soviet republics) (1992/93 forecast, $160,000).

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15 Department of Fisheries and Oceans, *1993/94 Estimates, Part III Expenditure Plan* (Ottawa), p. 82.

16 *Ibid.*, p. 89.

- *International Council for the Exploration of the Sea (ICES)*--encouragement and coordination of studies of the marine environment and living resources of the North Atlantic; provision of scientific advice to member governments or international commissions (Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, former Soviet republics and Great Britain) (1992/93 actual $157,000).

- *International Pacific Halibut Commission (IPHC)*--conservation, restoration, rational management and sharing of halibut resources in the Pacific Ocean (Canada and the US) (1992/93 forecast, $927,000).

- *Great Lakes Fishery Commission (GLFC)*--study of the Great Lakes fisheries; installation of devices and application of lampricides in the Convention area and related tributaries for lamprey control; provision of a forum for the development of fisheries management programs (Canada and the US) (1992/93 forecast $335,000--out of DFO's international administrative component).

- *International Fisheries Commissions Pension Society (IFCPS)*--administration of pension and related benefit policies for employees and dependents of international fisheries commissions established and maintained by Canada and the US are in line with their prevailing employee-benefit plans (no financial data is available).

These expenditures total approximately $3.017 million of Canada's $6.668 million for international initiatives, or approximately 45%. The remaining 55% is applied "primarily to research, consultation and negotiation expenses associated with the conduct of international fisheries relations."[17] International expenditures represent approximately 1% of the Department's total expenditures.

The Department's 1992/93 forecast for total science expenditures is $209.723 million. This is subdivided into biological sciences ($116.445 million), physical and chemical Sciences ($54.337 million), and hydrography ($38.941 million). Although international science expenditures are not isolated, the departmental objective for science is "to ensure that scientific information of high *international* standards is available to the Government of Canada... and to other government departments, private industry and the public."[18] The only other specific reference to international participation is found under hydrography, where "The Canadian Hydrographic Services is responsible for... compiling and publishing... charts and navigational publications of Canadian and adjacent international waters."[19] Hydrography represents approximately 5% of the Department's

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17 *Ibid.*, p. 83.

18 *Ibid.*, p. 33.

19 *Ibid.*, pp. 34-35.

total expenditures. Total science expenditures represent almost 28% of the Department's total expenditures.

The Inventory of Federal Science and Technology Activities in the North (1991-92) reports that DFO spent $4.331 million of the total monies reported for 1991-92 S&T activities in the north. Although much of the S&T activity in the north is international in focus, no total is given for international S&T isolated as such.

The United Nations-sponsored activities for which the Department of Fisheries and Oceans is the lead, or is a participating, department for the oceans component include:

- *Global Ocean Observing System (GOOS)*--as part of the follow-up to UNCED's Agenda 21 (which is the "action plan" of the Rio Summit), it was designed to monitor ocean conditions to benefit coastal zone management, fisheries management, ocean pollution and weather forecasting;

- *Global Climate Observing System (GCOS)*--designed to measure climate variability and change;

- *World Climate Research Program (WCRP)* and the *World Ocean Circulation Experiment (WOCE)*--represent multi-billion dollar programs, scheduled over several years, to answer questions relating to the oceans' role in climate modification;

- *Arctic Climate System Study (ACSys)*--affiliated with the World Climate Research Program (see above) — studying the effect of the arctic on world climate;

- *Tropical Ocean and Global Climate Atmosphere Program (TOGA)*--examines the effects of variations in tropical oceans on global patterns (the *El Niño* phenomenon); Canada supported the project in the set-up phase (i.e., administratively), but did not participate in the project (although *El Niño* has demonstrable effect on Canadian waters);

- *International Geosphere-Biosphere Program (IGBP)*--of which the next two items are the major initiatives related to the oceans. These are programmes of the International Council of Scientific Unions (ICSU):

- *Joint Global Ocean Flux Study (JGOFS)*--studies the changes in carbon-related elements; and

- *Land-Oceans Interaction in Coastal Zone (LOICZ)*--investigates the effects on coastal zone areas of fluctuations from land and freshwater changes, studies coastal zone morphology, including trace gas emissions and the economic and social impact of global changes.

- *Integrated Global Ocean Services System (IGOSS)* (research is conducted in the Institute for Ocean Science, BC)--first attempt to create for oceans what the Meterological Observation Network provides for weather forecasting, that is an arrangement for reporting oceanographic data;

- *Global Sea Level Observing Station (GLOSS)* (research is conducted in the Institute for Ocean Science, BC)--an arrangement to study the sea level changes which can signal climate change (e.g., the *El Niño* phenomenon); and

- *Ridge Inter-disciplinary Global Experiments (RIDGE)* (jurisdiction is shared between Natural Resources Canada and the Department of Fisheries and Oceans ***[the Institute for Ocean Science]***)--studies the effects of spreading centres on ocean floors and ongoing mid-ocean ridge dynamics.

- *Group Experts on Scientific Aspects of Marine Pollution (GESAMP)* a UN body headquartered in Geneva sponsored by IMO/FAO/UNESCO/WMO/WHO/IAEA/ UNGA/UNEP. ***(Fisheries & Oceans is the lead department for Canada, and Environment is also represented)***

Environment Canada

Environment Canada was the lead department in formulating Canada's response to the proposals put forward at the United Nations Conference on Environment and Development. In addition, the Department sought, and is seeking, to strengthen international cooperation through partnership. The Environmental Services sector of Environment Canada is currently involved in international agreements, or negotiations, of agreements for many of its programs. Total estimates for 1993/94 Environmental Services is $671 million. The international ocean S&T activities are not isolated, but some of the key initiatives are noted below.

- *Follow-up plan to Agenda 21*--Canada has contributed $40,000 to assist in this work; the working group described earlier had prepared a draft strategic response that was presented to a special UN Committee established to monitor Agenda 21 responses. Their first meeting in July, 1993 was to establish terms of reference, a process which can take months and sometimes years. The expectation is that reporting will not happen until next year.

- *Global warming*--in 1993/94, the department will spend $9.1 million on this Green Plan initiative, which is to address the issue at both national and international levels, including enhancing global warming science and linkages to international policy development and decision-making.

- *Global Energy and Water Cycle Experiment (GEWEX)*--to better understand and predict changes in Canada's water resources arising from climatic change (1993/94 estimate: $620,000).

- *Global Investigation of Pollution in the Marine Environment (GIPME)* groups of experts assembled through the International Council of Scientific Unions (ICSU); Canada has been represented in this group.

Natural Resources Canada (NRCan--formerly Energy Mines and Resources)

The 1993/94 Estimates for NRCan indicate that "one of (the Department's) principal challenges will be to ensure that its international activities meet client needs." (p. 20) To this end, the Department has been active in global environmental issues. The two primary examples cited were the Department's influence in the negotiation of the International Framework Convention on Climate Change (FCCC--which was signed by the majority of participating countries at UNCED and was ratified internationally on December, 1993), and the implementation of Canada's Green Plan. Its three science sectors have also re-oriented their priorities to focus on environmental issues. The Department conducts research in the physical environment, allowing governments to monitor the impact of certain activities on the environment.

For the last several years, the Department has undergone organizational change. Excellence at EMR is a continuous quality improvement initiative, with the focus on clients and a cooperative approach to S&T. An evaluation of the Geological Survey of Canada is expected to be completed by the end of 1993. Among the issues it addressed was is the importance of the Geological Survey's international role.

The Department's major participation in international programs appears to be limited to the following activity:

- *Ocean Drilling Program (ODP)*--with expenditures of $45 million annually, this program, which is led by the US (which contributes half of the funds) includes the participation of Germany, France, Japan and Australia (Canada's joint venture partner). The program examines modern massive sulphide deposits as they form on the ocean floor and gathers information on climatic changes. Canada (via the Geological Survey of Canada) did not renew its five year term in October, 1993.

The Department of Foreign Affairs and International Trade (DFAIT--formerly External Affairs and International Trade Canada)

DFAIT has initiated the following S&T initiatives on Canada's behalf *(follow-through department is given in square brackets)*:

- *Cooperation in Fisheries and Related Research* (with Norway and the US)--the biology and management of fisheries resources ***(The Department of Fisheries and Oceans)***;

- *International COSPAS-SARSAT Programme Agreement* (with France, the US and former Soviet republics)--ongoing work on satellite systems ***(The Department of National Defence via the National Search and Rescue Secretariat)***;

- *MOU on Scientific Cooperation* (with Finland)--with respect to marine technology ***(Transport Canada)***;

- *Letter of Intent* (with France)--with respect to oceanography, with the Centre national pour l'exploitation des oceans (CNEXO) ***(The Department of Fisheries and Oceans)***;

- *MOU on R&D Cooperation and Info Sharing* (with France)--covering fields of metallurgy, biotechnology and other advanced technologies, pollution abatement technologies and mapping from the SPOT satellite ***(Natural Resources Canada)***;

- *MOU and Exchange of Letters* (with France)--concerning hydrometric data collection from remote sites ***(Environment Canada)***;

- *MOU and Agreement* (with the Netherlands)--concerning wastewater waste leaching research and environmental collaboration ***(Environment Canada)***;

- *Research on environmental effects of fish culture on fjords and coastal zones* (with Norway)--research on marine science and fish diseases ***(The Department of Fisheries and Oceans)***; and

- *Canada-Japan Forum 2000*--joint initiative to establish stronger bilateral partnership in dealing with the international community in general and the Asia-Pacific region in particular (consists of four task forces; Task Force III made recommendations with respect to scientific collaboration); part of the "Going Global" initiative of DFAIT. The Japan S&Tfund for 1991/92 totalled $3.82 million (the marine science portion has not been isolated) ***(The Department of Foreign Affairs and International Trade)***.

Foreign Affairs also shepherds Canada's involvement in the European Community's S&T programs, which are strictly-controlled with respect to non-European participation. Access to these programs is limited to EC Member States; however, certain programs are open to EFTA (European Free Trade Area) countries, who have signed a framework agreement on S&T with the EC. Some programs are open to non-EC and non-EFTA countries if legal instruments exist between the EC and that country. Canada is preparing to negotiate its participation in the Third Framework in R&D:

EC's Second Framework Program in R&D--was considered to be very successful, it includes ESPRIT (Strategic European Research Program in Information Technologies) and BRITE (New Technologies for Manufacturing Industries).

EC's Third Framework Program in R&D--has three major themes: enabling technologies; management of natural resources (including **marine sciences and technologies**); and the management of intellectual resources. Programs in which Canada would like to participate include FUSION (thermonuclear research) and STEP (S&T for Environmental Protection).

Indian Affairs and Northern Development

Through the Northern Science and Circumpolar Affairs Directorate, the Department represents Canada in international fora concerning northern and circumpolar science.

For 1993/94, $2.279 million is allocated to political, scientific and cultural development. This includes grants to 30 Canadian universities in support of northern science training programs, and the publication of (1) a brochure explaining the logistics and realities of travel in Canada's north, (2) a directory of Circumpolar Research Stations, (3) a directory of polar specialists and (4) an inventory of federal science and technology activity in the north. No total is isolated for participation in international science.

International cooperation and coordination have long been features of polar science, and Canada has participated in many international research programs. Current international initiatives with respect to the Arctic include (lead departments are noted in square brackets):

- *Arctic Environmental Protection Strategy (AEPS)*--a circumpolar intergovernmental programme established in 1991 at the initiative of the government of Finland and participated in by all circumpolar countries (Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden, United States); includes Declarations on Protection of the Arctic Environment signed by Ministers in 1991 and 1993, and four technical programmes—Arctic Monitoring and Assessment Programme (AMAP), Conservation of Arctic Flora and Fauna (CAFF), Protection of the Arctic Marine Environment (PAME) and Environmental Emergencies and Preparedness (EEP), as well as international cooperation on Traditional Ecological Knowledge (TEK) and Sustainable Development. All programmes have an ocean or coastal component. Canadian participation is through an interdepartmental (plus territorial) AEPS Committee and separate interdepartmental committees for each programme. Canada, through Environment Canada, provides the international secretariat for CAFF. ***[Indian Affairs and Northern Development;*** *participants include* ***Environment Canada, Natural Resources Canada, Fisheries and Oceans, Transport Canada, Foreign Affairs, National Museums, Health and Welfare, Yukon and NWT Governments***];

- *Canadian Polar Commission*--established in 1991, its primary objectives are "to enhance Canada's international profile in circumpolar science research and represent Canada by membership in such international organizations as the International Arctic Science Council and the Science Council of Antarctic Research." (1993/94 estimates: total of $1.123 million, 6 FTEs, of which $686,000 is allocated to science and professional activities) ***[the Department of Indian Affairs and Northern Development]***; and

- *International Polar Commission*--established by the June, 1992 Canada-Russia agreement on Arctic Cooperation.

OCEAN S&T POLICY IN SELECTED JURISDICTIONS

AUSTRALIA

Australian Overview

Australia's ocean area is of great significance to this continent. In terms of size alone it is impressive: **the length of Australia's coastline totals 27,948.5 km**, while its marine area, located in its Exclusive Fishery Zone (EFZ)[20], approaches that of Australia's land mass (7,006,500 vs. 7,686,900 square km respectively). Economically, marine industries accounted for in excess of A$16 billion annually (approximately CDN$14.4 billion) with substantial growth expected to continue to the year 2000.

A document produced in 1989 by Australia's Review Committee on Marine Industries, Science and Technology entitled *Oceans of Wealth*, outlined those marine industries and commercial opportunities dependent on marine science and technology. Despite the vastly different climatic and geographical conditions of Australia and Canada, the report highlighted a number of areas which the two countries share in terms of similar opportunities. Those identified by Australia included the following:

- fisheries, including aquaculture;
- tourism and recreation;
- offshore oil and gas;
- marine transport and shipbuilding, including defence needs;
- instrumentation, including remote sensing;
- consultancy services;
- improved climate forecasting; and
- environmental management.

The report was successful in identifying Australia's strengths and weaknesses in marine S&T; it also identified imbalances in Australia's marine research. World class S&T has been conducted in the areas of coral reef/tropical marine studies, marine ecology, marine geosciences, physical oceanography, some aspects of fisheries research, remote sensing applications, coastal hydrodynamics, numerical modelling and marine foundations. Areas in which marine S&T have been less successfully applied include aquaculture, chemical oceanography, marine biotechnology, marine chemistry, sea-bed mineral assessment, and ship design and construction.

A number of recommendations were proposed in *Oceans of Wealth* which, in general, called for a proactive approach on the part of the government if the potential benefits of improved marine S&T were to be realized in the future. Among the needs determined by the Review Committee were:

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20 Australia has yet to declare an Exclusive Economic Zone (EEZ). Smith Rea Energy Analysts Limited, *Wealth From the Oceans Advanced Technology Programme* (London: 1989), p. 58.

- a national plan, to ensure that the complex interaction between marine sciences and industries conserves the marine environment while optimizing the benefits to Australia;
- strategic plans for industries in which there are opportunities;
- better co-ordination within particular, and between different, marine industries;
- co-ordination across government agencies;
- improved research infrastructure in specific areas, such as the tidal laboratory and oceanographic data centre;
- increased applied and technological components of Australia's research effort;
- the improvement of interaction between the scientific community and industry; and
- the commercialization of opportunities that were already apparent within the marine sector.

S&T Overview

The importance of marine S&T to Australia was given additional credence in 1978 by the then-newly formed Australian Science and Technology Council (ASTEC) which recommended "with highest priority for urgent action, 'that greater attention be paid to the marine sciences and technologies in Australia than has been to the present time'."[21] ASTEC also recommended the formation of the Australian Marine Sciences and Technologies Advisory Committee (AMSTAC), which would report directly to the Minister of Science. Both recommendations were acted upon: ASTEC was created in 1979, while marine S&T funding, in 1989, in real terms, was almost double that of 1979-80 levels, despite overall financial restraint in Australian S&T expenditures at that time.

Public sector ocean S&T is undertaken by the federal and state governments through a number of different organizations. Two of the primary marine research bodies at the federal level are the Commonwealth Scientific Industrial Research Organization (CSIRO) and the Australian Institute of Marine Science (AIMS), which account for approximately 66% of Australia's total marine S&T expenditures.

Australian Institute of Marine Science (AIMS): Founded in 1970, AIMS is a statutory body whose objectives are to "advance natural knowledge of the marine environment and facilitate the development of the capacity, resources and expertise for transferring knowledge gained into productive applications in support of national interests."[22] The Institute conducts research in four marine areas: coastal processes and resources; reef studies; environmental studies and biotechnology; and marine systems analysis and oceanography. Research is conducted in all regions of Australia's marine environment in accordance with the government's intention that marine science be conducted in a "national manner". Approximately 90% of the Institute's

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21 Department of Industry, Technology and Commerce (Australia), *Oceans of Wealth? A Report of the Review Committee on Marine Industries, Science and Technology* (Canberra: Australian Government Publishing Service, 1989), p. 7.

22 Paul Cunningham and Brendan Barker (ed.s), *World Technology Policies* (Essex: Longman Group UK Limited, 1992), p. 374.

funding is provided by parliamentary appropriation, the remainder coming from non-governmental sources. Past contributors to AIMS have included the Crown of Thorns Starfish Advisory Review Committee of Australia and the U.S. National Cancer Institute.

Commonwealth Scientific Industrial Research Organization (CSIRO): CSIRO is an independent statutory authority and is one of the largest scientific organizations in the world. Its research activities encompass a number of different areas, spread throughout six different "institutes", of which ocean science is one component. Ocean science is centred in the CSIRO Institute of Natural Resources and Environment, which has divisions dealing with atmospheric conditions, fisheries (including aquaculture), and oceanography.

As with AIMS, the bulk of CSIRO's funding is provided by Parliamentary appropriation but is augmented by outside sources (i.e., CSIRO receives business funding, funds from earned revenues such as licensing fees and the disposal of assets and additional Commonwealth support won competitively via the special purpose grant schemes).

Recently, some individuals, among them Senator Schacht, Minister for Science, have proposed that the two marine research divisions of the Commonwealth Scientific Industrial Research Organization (see **Marine Responsibilities--Australia**) separate and create an independent National Marine Research Institute, despite the existence of an analogous body in the Australian Institute of Marine Science. However, this proposal has been met with resistance from CSIRO officials as well as from representatives of Australia's marine industries (which have been generally supportive of the development of a "national oceans policy"[23]). The executive director of the Australian Petroleum Exploration Association commented that his organization "did not consider sufficient case had been made for a new research agency"[24], while the chief executive of the National Fishing Industry Council noted that he had seen "no argument to totally disrupt present marine research arrangements."[25]

Figure 1.1 outlines public budgetary outlays for various Australian research organizations over the last 11 years.

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23 Julian Cribb, "CSIRO chief considers his future," *The Australian*, 4 March 1994.

24 *Ibid.*

25 *Ibid.*

Figure 1.1
Major Commonwealth Research Agencies--Budget Outlays (A$m)

YEAR	AUSTRALIAN INSTITUTE OF MARINE SCIENCE	COMMONWEALTH SCIENTIFIC INDUSTRIAL RESEARCH ORGANIZATION
1982-83	6.4	328.2
1983-84	6.9	331.6
1984-85	7.4	324.9
1985-86	7.6	344.3
1986-87	8.2	367.8
1987-88	9.5	347.8
1988-89	11.0	348.1
1989-90	11.4	375.2
1990-91	13.6	414.4
1991-92	14.2	446.3
1992-93	14.2	456.2
1993-94 (est)	16.9	460.9

Marine S&T is also conducted at the regional level in all of Australia's six states (all of which border on the Indian or Pacific oceans), either through direct state support (individual states account for approximately 25% of Australia's total marine S&T expenditures) or with the support of the federal government working regionally. The venues for much of this research are located in state R&D facilities as well as university establishments. Examples of this type of research include the following:

Northern Territory: the Department of Ports and Fisheries (fisheries division) backs research through the Northern Territory Fishing Industry Research and Development Trust;

Queensland: marine S&T research conducted at the state level in Queensland is primarily carried out in three organizations: the Beach Protection Authority, which collects and analyzes a wide range of data on beach and coastal behavior; the Department of Harbours and Marine; and the Department of Primary Industries which supports a Division dealing with fisheries.

South Australia: the Department of Fisheries is responsible for the management, conservation and regulation of South Australia's fisheries and performs the research to facilitate these activities, while the Department of Supply and Services operates the South Australian Centre for Remote Sensing in Adelaide.

Tasmania: Tasmania's Fisheries Development Authority manages its fast-growing fishing industry and conducts related research.

Victoria: Victoria has three organizations aimed at marine S&T including: the Department of Conservation, Forests and Lands which has its own marine science laboratories and marine environment research facilities; the Environmental Protection Authority also conducts research on the marine environment; and the Department of Industry, Technology and Resources, which undertakes research on offshore petroleum exploration and development.

Western Australia: Western Australia's Department of Fisheries maintains its own laboratories for conducting fisheries research.

Industrial Marine S&T

Despite the fact that, as previously indicated, private capital has subsidized government research, there appears to be a lack of government incentives to promote and foster private marine research activities (industry accounts for approximately 10% of Australia's total marine S&T expenditures), particularly when compared to activities undertaken in other countries. One example of this is in the area of offshore oil exploration. Whereas the United Kingdom and Norway both have policies obliging companies which have won petroleum exploration licences to carry out, or contract, **domestic** research and development, thereby facilitating the development of offshore industries in those countries[26], Australia (and Canada) have not. Consequently, Australia and Canada possess relatively less indigenous research capabilities in this area; however, unlike Norway and the U.K. both Australia and Canada possess an abundance of land-based resources which have reduced the imperative to develop offshore resources. In response to suggestions outlined in *Oceans of Wealth*, Australia is currently considering ways of addressing such shortcomings as indicated in this recommendation made in the report of the Review Committee on Marine Industries, Science and Technology:

> The Commonwealth Government should develop and establish conditions based on those in other countries, requiring a successful bidder to carry out or contract research and development in Australia on petroleum exploration, development and recovery techniques; such conditions should be taken into account when setting excise rates.[27]

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26 Department of Industry, Technology and Commerce (Australia), *Oceans of Wealth? A Report by the Review Committee on Marine Industries, Science and Technology* (Canberra: Australian Government Publishing Service, 1989), p. 50.

27 *Ibid.*, p. 57.

The Australian government has taken several proactive steps, however, to improve marine S&T links between the public and private sectors. For example, 1987 saw a reorganization of CSIRO in order to provide a new structure which "enables it to develop closer links with industry and other end-users of the research."[28] In the same year, the charter of the Defence Science and Technology Organization (DSTO), which itself conducts a great deal of marine S&T--much of it under the auspices of defence purposes although significant commercial applications exist as well--was amended to increase links to industry through an expansion of the contracting out of engineering development work on DSTO products and through the increased commercialization of DSTO research findings. DSTO skills and facilities were also made more accessible to industry.

The Australian government has also taken steps to encourage greater investment by industry in marine S&T. One such initiative is the Cooperative Research Centre (CRC) program. Instituted in 1990, it promotes collaborative work and partnership between industry, universities and other research institutions. CSIRO, for example, is currently involved in four CRCs dealing with marine science (i.e., aquaculture, hydrology and two concerning water pollution), each of which have an annual investment value of approximately A $1.2 million.

Another initiative, one more closely aligned with marine S&T specifically, is the Marine Science and Technology Program which is aimed directly at linking public marine research initiatives with industry requirements, as well as promoting international cooperation in marine S&T. Other means of promoting closer public-private marine research links are currently being considered by Australia's Consultative Group on Marine Industries Science and Technology (CMIST) and the Oceans Australia conference series.

Canada-Australia/International S&T Initiatives

Few cooperative efforts between Canada and Australia in the area of marine S&T exist. Ostensibly there appear to be few areas for such activities given the fact that both countries appear to have similar deficits in certain types of marine S&T and that geographical differences reduce the likelihood of profitably embarking in shared research in fisheries and aquaculture, even though this is a potential growth area for both countries. One joint Australia-Canada project of note is headed by the Marine Geosciences Division of the Australian Bureau of Mineral Resources, which has embarked on "a cooperative initiative with Canada to participate in the international deep-sea Ocean Drilling Program. The Australian Research Council and universities are also contributing to this program, which will yield fundamental offshore geological knowledge."[29]

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28 Organization for Economic Co-operation and Development, *Science and Technology Policy: Review and Outlook 1991*, p. 151.

29 *Ibid.*, p. 119.

MARINE RESPONSIBILITIES -- AUSTRALIA

Fisheries Management:	• Australian Fisheries Service reports to the Department of Primary Industries and Energy (DPIE); authority delegated to states from waters under state control.
Coast Guard:	• State responsibility.
Scientific Research:	• Commonwealth Scientific Industrial Research Organization (CSIRO) including divisions for fisheries research and oceanography and food research; • Australian Fisheries Service; • Australian Institute of Marine Science (AIMS); • Fisheries Development Trust Account and the Fishing Industry R&D Trust Fund which report to the DPIE; and • the states also operate research vessels.
Hydrography:	• Department of Transport and Communications.
Oil & Gas Exploration/ Mining:	• DPIE
Shipping/ Marine Transport:	• Department of Transport and Communications.
Pollution Control:	• Federal Department for the Arts, Sport, the Environment and Territories.
Emergency Response:	• Department of Transport and Communications.
Coastal Zone Management:	• States above low water mark; and • federal government below water mark.
Parks/Sanctuaries:	• Great Barrier Reef Marine Park Authority reports to Department for the Arts, Sport, the Environment and Territories.

NORWAY

Norwegian Overview

Norway is a maritime nation with one of Europe's most extensive coastlines. The length of Norway's coastline, including inlets, is 21,300 km[30], and is extremely rugged, possessing a large number of fjords and excellent natural harbours. Norway has an EEZ of approximately 2,024,800 square kilometres. Water temperatures off the coast of Norway are warmed by the Gulf Stream waters which moderate the effects of Norway's arctic and sub-arctic climatic conditions.

Norway is a nation which relies heavily on its oceans industries. Its impressive level of investment in marine S&T has strongly enhanced its competitive position. One of Norway's primary ocean industries is shipping; it currently owns and operates the world's third largest shipping fleet and provides part of the infrastructure for Norway's other marine activities. Aquaculture and fishing are two of Norway's most important industries and are among the most technologically advanced commercial operations of their kind. Its importance to the Norwegian economy is reflected in the following statistics: 90% of Norwegian fish and fish products are exported; its export value totals Nkr 16,000 million annually representing 11% of Norway's total commodity exports; a total of 27,000 fishermen are employed on the high seas, a further 14,000 people are employed in aquaculture related industries, while fish processing employs an additional 11,000; and a total of 9.2% of the Norwegian population is directly or indirectly employed by the fish industry.

Offshore oil and gas exploration and development is another important component of Norway's economy possessing a strong marine S&T dimension. Since the discovery of petroleum on the Norwegian continental shelf in 1969, this sector has increasingly been the recipient of investment funding to the point where it now receives over 70% of all reported investment in Norway.[31] New discoveries have continued to be found on Norway's shelf contributing to Norway's supremacy over the U.K. in annual oil production, thereby ensuring continued development of this industry.

The topic of environmental protection, for marine and other resources, is of great importance to Norway given the strong public identification with the environment and the international exposure that it received through the efforts of its Prime Minister, Gro Harlem Brundtland, in her role as Chair of the World Commission on Environment and Development, and its subsequent, significant participation in the United Nations Conference on Environment and Development (UNCED). The importance to Norway of protection of the ocean environment is also derived from the fact that as a major European fisheries nation, it is particularly susceptible to pollution-related marine damage. Likewise, offshore oil and gas exploration has potential environmental

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30 Ministry of Fisheries (Norway), *Norwegian Position Paper on Fisheries* (Oslo: 1993), p. 7.

31 Canadian Embassy, Oslo, Norway, *Prosperity Initiative (telex)* (Oslo: 15 October 1992), p. 2.

hazards as does the threat posed by climate change.[32] Consequently, a great deal of research has been undertaken in the environmental aspects of marine science, and Norwegian environmental regulations for offshore oil production and transport are very strict.

S&T Overview

Since 1985, the Norwegian government has had a system of priority area selection to help guide its research activities. Of nine areas noted as having "highest priority", three are directly related to oceans research: aquaculture; oil and gas; and environmental technology.[33] These three areas are administered by separate national steering committees, each of which has prepared a comprehensive national plan for its particular section.

Government funding of Norwegian S&T rose 5% annually, in real terms, between 1990 and 1993. More modest annual increases were seen between 1987 and 1989. In the 1987-1993 period, the percentage of expenditure increases on marine S&T exceeded the percentage expenditure increases in S&T as a whole. There was a period of slight decline in Norway's S&T expenditures prior to 1987, however, during this time maritime research spending levels remained constant.[34]

The administrative structure of marine S&T was simplified last year with the rationalization of Norway's five separate research councils into one agency called the Research Council of Norway which was established on January 1, 1993. The goals of the new Council are to serve as a national executive and advisory body for national research strategies and to increase the "general fund of basic knowledge and shall help to meet society's research needs by promoting basic and applied research in all areas."[35] Marine S&T is conducted by the Council in four of the six main identified research areas including:

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32 Climate change experts predict that countries at mid to northern latitudes, such as Norway and Canada, will be disproportionately affected by global warming through greater-than-average temperature increases. Rising sea levels, a result of melting glacial ice, poses a relatively larger threat to countries which have a substantial proportion of their population living close to the sea, as is the case with Norway. But of particular interest and concern to Norway is the possibility that global warming will alter the path and the strength of the Gulf Stream, which at present maintains northeast Atlantic fisheries.

33 Of a total research budget of Nkr 1,265 million, 105 million is directed towards aquaculture, 130 million to oil and gas and 28 million to environment technology, Organization for Economic Cooperation and Development, *Science and Technology Policy: Review and Outlook, 1991* (Paris: 1992).

34 Research Council of Norway, *The Intelligent Green Ship* (1993), p. 1.

35 Research Council of Norway, *Research Council of Norway: Catalogue of Environmental Programmes* (Oslo: 1993), p. i.

- **Bioproduction and Processing**--supports basic research and research training in fisheries and aquaculture, secures suitable research infrastructures through strategic collaboration with universities and research institutes, supports related government bodies and assists in developing financing programs in cooperation with the private sector;

- **Industry and Energy**--advances development in industrial and energy sectors and supports industry-university/research institute S&T activities;

- **Environment and Development**--supports basic research and research training in marine environment and development studies and strengthens the research infrastructure; and

- **Natural Science and Technology**--backs basic research and research training in marine related S&T and expands knowledge on this topic which is considered fundamental to Norway's commercial and social interests.

Results of each of these areas of study are expected to be "synergistic" in that developments in one should, where appropriate, support the goals of the others, for example, the research activities of the Bioproduction and Processing and Industry and Energy sections should "include environmental consideration in their evaluations and definitions of the problems."[36] Examples of specific programs undertaken by the Council include: the Multispecies Management Programme, which is intended to produce the data and biological knowledge needed for the development of multispecies models of fish resources; the Norwegian Marine Mammals Programme, whose objective it is to provide a scientific basis for the responsible management of stocks of marine mammals and to help build up broadly-based competence in marine mammal research; and the Coastal Ecology of Northern Norway Programme, which seeks to improve the understanding of coastal ecosystems and the causes of current change and provides management with the basis for making ecologically responsible resource management decisions.

Norway possesses a unique system of encouraging private sector investment in ocean S&T in both public sector facilities, such as the Institute for Continental Shelf Research and Petrochemicals Technology (IKU) and the Marine Technology Research Institute (MARINTEK), and private sector research labs. A system of "goodwill" contributions on the part of oil firms have been used to fund such facilities and the development of Norwegian S&T, in exchange, the contributing firms earn "points" towards gaining future licensing rounds on the Norwegian Shelf. Between 1979 and 1991, the Norwegian government's ocean S&T activities were the recipient of about Nkr 3.2 billion (approximately CDN$550 million) though goodwill donations.

Since 1986, the goodwill focus has shifted from the direct transfer of funds to research institutes to an emphasis, on the part of the government, to foster the active participation of oil companies to collaborate in public research initiatives. In order to achieve this goal, such companies are encouraged to identify "technological challenges faced by their Norwegian operations and to work

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36 *Ibid.*, Foreword.

with the research institutions and private companies in Norway to develop and test *in situ* technology which addresses these challenges."[37]

Canada-Norway/International S&T Initiatives

Canada and Norway maintain a strong degree of S&T cooperation in a number of marine sectors, including northern and cold-region research, fisheries, aquaculture and the environment. Activities range from shared projects to information exchange. Collaborative scientific efforts were formally initiated by a 1986 Exchange of Letters on Science and Technology Cooperation which committed the two governments to "facilitating and enhancing S&T exchanges and to holding consultations to review progress at least every two years."[38] It is seen as useful by both parties based on similarities between Canadian and Norwegian cultures, geography and business interests. It should be noted that excellent informal relations exist between the scientific communities of both countries, as well. Examples of past and continuing cooperative activities, both under and outside the auspices of the Exchange of Letters include[39]:

- a provision of the US Coast Guard--Environment Canada Memorandum of Understanding (MOU) concerning research and development cooperation in spill response technology to Norway to be used as a model in developing a similar agreement with Russia;

- in 1991, the River Road Environmental Technology Centre (RRETC) provided Canadian spill tracking buoys as a scientific contribution to an experimental spill in Norwegian waters in exchange for input to the design and access to the experiment's results;

- Norwegian spill-response experts attend the annual seminars produced by the Arctic Marine and Oil Spill Program (AMOP);

- samples of crude oil and spill-treating agents were exchanged between Canada and Norway for mutual testing of quality assurance and information exchange purposes;

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37 External Affairs and International Trade Canada, *Highlights of the Norwegian Market for Ocean Industries: Notes Prepared for the Europe 1992: Ocean Industry Opportunities Seminar Series, October 22 - November 1, 1991* (Ottawa: 1991), p. 3.

38 John M. Harrington, *Northern Perspectives: An examination of S&T Relations Between Canada and Norway Under the 1986 Exchange of Letters* (Ottawa: External Affairs and International Trade Canada, 1991), p. i.

39 Examples are taken from, Environment Canada, *Canada/Norway Cooperation in the Field of Environment: Status Report* (Hull: 1992), pp. 1-2, and External Affairs and International Trade, *Canada/Norway Bilateral S&T Consultations: Ottawa, April 30 1992, Record of Consultations* (Ottawa: 1992), p. 3.

- collaborative efforts in aquaculture research, in particular the recent focus has been on its environmental impacts; and

- ongoing cooperation between the Canadian Hydrographic Service, three Canadian firms, the Norwegian Hydrographic Service and the Norwegian organization DIKAS, a consortium established to develop electronic charts and mapping technologies to support ocean shipping.

Private sector marine S&T activity between Norway and Canada exists primarily through Norwegian investment in Canada in related industries. This is particularly true in the British Columbia aquaculture industry although it is estimated that as much as 50% of the Canadian aquaculture industry overall has some Norwegian involvement, thereby providing an important source of technology transfer in this area.

Internationally, Norway participates in a broad range of initiatives aimed at marine S&T. For example, Norwegian companies have been quite active in the European Marine Research Programme (EUROMAR) of the European Research Coordination Agency (EUREKA) which is a cooperative research venture undertaken by a number of European countries. They have participated in 67 projects with contributions totalling approximately CDN$1 billion. The EUROMAR programme is chaired by the head of Oceanor, a Norwegian firm based in Trondheim.

Norway is also an active participant in a number of international environmentally-related marine research initiatives including the Global Ocean Observation System (GOOS), which is sponsored by the Intergovernmental Oceanographic Committee (IOC), and the Joint Global Ocean Flux Study (JGOFS), both of which are aimed at studying the ocean's role in moderating the effects of global warming. Canada is also a participant in these and other international marine programmes. Both countries are also members of the International Council for the Exploration of the Sea (ICES), as is the U.S. and much of Europe. The Council funds multi-lateral research projects, an example of which is entitled *Cod and Climate Change* which examines the problem of falling cod stocks in the Atlantic. Norway also maintains a series of bilateral marine S&T relations with other maritime countries, one example being with the United Kingdom through the Norwegian Petroleum Directorate's membership in Britain's Marine Technology Directorate Limited (see "U.K. S&T Overview").

MARINE RESPONSIBILITIES--NORWAY

Fisheries Management:	• Directorate of Fisheries, in Bergen reports to the Ministry of Fisheries, Oslo.
Coast Guard:	• Coast Guard reports to Ministry of Defence; and • Directorate of Coastal Administration (Harbours, Lighthouses and Pilotage) reports to the Minister of Fisheries.
Scientific Research:	• Institute of Fisheries and Oceans Research, Council for Fisheries Research, and the Institute for Fisheries Technology Research are private institutes which are contracted by the Ministry of Fisheries and fishermen's associations to conduct research; • Research Council of Norway; • Ministry of Fisheries; • Institute for Continental Shelf Research and Petrochemical Technology (IKU); • Marine Technology Research Institute (MARINTEK). • Norwegian Polar Institute, reports to Ministry of Environment; and • Norwegian Institute for Air Research (NILU).
Hydrography:	• Coast Guard; • Polar Affairs Institute; and • Norwegian Polar Institute.
Oil & Gas Exploration/ Mining:	• Directorate of Petroleum and Energy.
Shipping/ Marine Transport	• Ministry of Trade and Shipping which reports to the Ministry of Foreign Affairs.
Pollution Control:	• Norwegian State Pollution Control Board, reports to Ministry of the Environment.
Emergency Response:	• Norwegian State Pollution Control Board; • Ministry of Foreign Affairs; • Ministry of Defence; and • Ministry of Environment.
Coastal Zone Management:	• Fisheries Directorate; and • Ministry of Defence.
Parks/Sanctuaries:	• Ministry of the Environment.

UNITED KINGDOM

U.K. Overview

Like Norway, the U.K. is a maritime nation. It possesses an Exclusive Economic Zone (EEZ) of 942,600 square km (Canada has an EEZ of 4,697,700 square km) with a rugged coastline similar to that of Norway's. The U.K. has traditionally placed a high value on marine S&T and continues to make substantial contributions to its progress. As was noted by the U.K.'s Natural Environment Research Council:

> The U.K. invests substantially in Marine Science and Technology (MST) because as an island nation dependent on resources from the sea and on maritime trade and defence we are particularly vulnerable to the effects of ignorance about the sea. The results of past research contribute substantially to Britain's defence, economy and social well-being today. But much remains to be discovered, and much of what has been discovered remains unexplained and unexploited.[40]

The continued high investment in marine R&D is justified by the numerous benefits which it affords Britain. In terms of social benefits, higher seawalls have helped to subdue storm surges such as those that killed 3,000 people in 1953. The need for more sophisticated seawalls will be necessary in the future as global warming is expected to accelerate the rise in sea levels[41] which have increased by 30 cm in the last century alone. A technologically advanced seawall, costing £700 million, termed the "Thames Barrier", has served to prevent storm surges from flooding London. Social benefits are also to be accrued from pollution prevention and control, which have the greatest impact on fisheries, local health and tourism.

The international benefits of marine S&T also have great potential significance for the U.K. given that the UN Law of the Sea Convention allocates 40% of the world's oceans to Exclusive Economic Zones thereby putting countries which have superior marine S&T in a commercially advantageous position to assist other coastal states in surveying and exploring their EEZs. The U.K.'s international scientific reputation is also cited by the British as a benefit, albeit one which is difficult to quantify.

The greatest benefits to the U.K. of high quality marine S&T are the economic benefits which can accrue from them, as well as the savings in other areas which can be realized. Again, as is the case with Norway, the U.K. is highly dependent on the competitive position of its marine industries which include, among other things, offshore oil and gas development. The capitalization of other offshore minerals, fisheries management, tidal power (waves and tides

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[40] Natural Environment Research Council, *The Challenge* (London: 1987), p. 7.

[41] *Ibid.* The Cabinet Office has determined that the rise in sea levels in the 21st century would be the most negative impact of global warming.

offer renewable sources of non-polluting energy) and the sale of advanced equipment originally developed for scientific research, tourism and recreation offer further commercial possibilities.

The costs of commercial operations can be reduced through the results of marine S&T; such developments have included ship routing, design and operation of offshore structures, climatological and weather dependent prediction of the marine environment. The costs of government operations and the loss of amenity to the British public, if oceanographic knowledge had not been available, is also significant. Savings have resulted from research in a variety of marine areas including the prevention of and recovery from disaster, routine coastal protection from tides, waves and surges, control of disposal at sea and estuarine discharges. The Natural Environment Research Council's report, *The Challenge*, noted that while a cost-benefit analysis for U.K. marine S&T had not yet been undertaken, it had assessed that the "annual turnover in Britain of activities underpinned by MST R&D in tens of billions of pounds."[42] One example of significant savings can be found with the construction of the North Sea platforms for which research into waves and currents is estimated to have saved £1000 million (with an annual cost of wave research of approximately £0.5 million).

U.K. S&T Overview

Given the several facets of British life which are influenced by the U.K.'s marine environment it is not surprising that related S&T is carried out by a number of different participants, both public and private, in addition to universities and polytechnics. Seven government departments are responsible for conducting marine S&T, as are two research councils, a recently established and largely public-funded company, a number of marine science departments established in Higher Education Institutes (HEI -- 230 British universities and polytechnics have marine S&T departments), and a vast range of industrial firms. In order for the government to deal with this extremely diverse arrangement, a special high level body was established: the Coordinating Committee on Marine Science and Technology (CCMST). The Committee's purpose is to "advise on a national strategy for the support of marine R&D in the United Kingdom."[43] Another, equally important, goal is to attempt to minimize both duplication and gaps in marine S&T activities.

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[42] *Ibid.*, p. 8.

[43] D.E. Lennard, "Marine Science and Technology in the United Kingdom", in *MTS Journal*, Vol. 24, No. 1, March 1990, p. 72.

The public sector participants, and their responsibilities, include the following:

Ministry of Defence (MOD): Has typically accounted for close to one-third of the U.K.'s marine S&T expenditures reflecting Britain's commitment to NATO and its important geographical position in Europe. Its research activities have been aimed less at basic research, focusing instead on "sustaining an underlying scientific and technological expertise."[44] Primary research areas include ships and submarines, signature reduction and human factors.

Fisheries--Ministry of Agriculture, Fisheries and Food (MAFF) and the Department of Agriculture and Fisheries for Scotland (DAFS): Expenditures for these two ministries account for approximately one-fifth of the U.K.'s marine S&T budget. Their primary aims are to encourage the development of the British fishing industry and to protect the living marine resource environment from pollution. Over 90% of their research budget is allocated to in-house R&D, the remainder is commissioned in the Natural Environment Research Council (NERC), in universities and through the Sea Fish Industry Authority.

Department of Energy: Receives roughly one-tenth of the U.K.'s marine S&T funding. It channels its marine S&T resources to three different departmental sections. The Petroleum Engineering Division, which is concerned with geology, enhanced oil recovery, reservoir simulation, and offshore safety. The Offshore Supplies Office is aimed at offshore resource commercialisation through four priority areas: subsea systems and equipment; weight and cost reduction in offshore facilities; improved accuracy in exploitation techniques; and drilling and production technology.[45] The third section is the Energy Technology Division which is responsible for activities related to tidal and wave energy.

Department of Trade and Industry (DTI): Accounting for approximately 5% of the British marine S&T budget, DTI is "responsible for support of R&D with industrial and commercial relevance, including technology not applicable to U.K. waters. With the objective of promoting enterprise and prosperity, the Department encourages the transfer of technologies and cooperative research, and looks for matching funds from the private sector."[46] The U.K., through DTI, has instituted a program, similar to Canada's Strategic Technologies Programme, called the Advanced Technology Programme, which was established to "encourage pre-competitive research by industrial companies in new technologies."[47]

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44 *Ibid.*

45 *Ibid.*, p. 73.

46 *Ibid.*

47 Organisation for Economic Co-operation and Development, *Science and Technology Policy: Review and Outlook 1991*, p. 199.

Eleven ATPs have been approved by 1990, included in these was one termed "Wealth from the Oceans". This programme concentrates on two key technological categories: exploration, surveying and measurement; and subsea operations and associated support technology. Other marine research areas conducted by this department include: ship and boat building, equipment and instrumentation, subsea equipment, submersibles, diving systems and some aspects of offshore oil and gas technologies.

Department of the Environment (DOE): DOE consumes slightly less marine S&T resources than does DTI although it conducts research in a broad array of high priority marine areas including: North Sea related studies; marine emissions of pollutant precursors; climate change; environmental protection technology; planning and development of sea dredged aggregates; hydraulic engineering for coasts and estuaries; deep ocean disposal and coastal disposal of radioactive waste; toxic chemicals in the marine environment; sewage and sludge disposal; and water quality.[48]

Department of Transport (DTp): This department has the smallest marine S&T budget of Britain's public sector institutions. Through its Marine Directorate, it is responsible for research in the following areas: ship safety and health; ship navigation; the prevention of the marine environment from oil pollution; and port clearance and operations. DTp's research is concentrated in government laboratories.

Natural Environment Research Council (NERC): The Council, which possesses the second largest share of British marine S&T funding, has the "national responsibility for ensuring that the U.K. maintains its position among the world leaders in marine science and technology. Council policy is to ensure that there exists in Britain a strong community of marine scientists supplied with the resources and organization needed to initiate and respond effectively to new developments in the rapidly advancing subject."[49] As such, the Council supports a broad range of marine research at HEIs and in its own laboratories and units, including Europe's largest marine research institute for which construction began in 1989 at Southampton at a cost of £35 million. In addition, it operates an extensive fleet of ocean going research vessels.

Science and Engineering Research Council (SERC): This Council's research budget is approximately one-quarter of that of NERC. Its primary role is to support marine S&T in universities and polytechnics, mainly through direct grants. Most of its marine research activities were suspended when the Council's Marine Technology Directorate was abolished and subsequently transferred to the newly created Marine Technology Directorate Limited.

Marine Technology Directorate Limited (MTD Ltd): In the 1980s, the government was of the opinion that their scientists had an excessive amount of leeway in choosing research topics and that such topics were often incompatible with broader national economic goals. Thus the

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48 Lennard, "Marine Science and Technology in the United Kingdom", p. 73.

49 Natural Environment Research Council (U.K.), *The Challenge* (London: 1987), p. 12.

government decided that "there had to be a real customer for any of the research, which ensured that the work was relevant and that everything had to be put up for competitive tender, which showed that they were getting the best value for money".[50] Consequently, the MTD Ltd was created, as a private company, out of SERC. The aims of the organization are to "promote, develop and advance, in the national interest, research, training and information dissemination in marine technology, including all aspects of engineering, science and technology relating to the exploration and exploitation of the sea."[51] The company conducts an extensive research programme, education and training, including pre and post-graduate training and chairs and fellowships, and provides information services, including publications, databases and conferences.

The expenditures of firms on marine S&T is approximately equal to that spent by the government although, for the most part, with greatly differing priorities. As a NERC document observed, the "private sector is normally willing to fund R&D only in those aspects that are directly related to profitable marine industry and commerce."[52] However, as noted above, this is a condition which is increasingly being applied to government research as well.

Deficiencies on the part of private sector marine research activities, such as a lack of basic research, have been observed by the government, and again, public sector research can serve to reduce the resulting imbalances, however, other countries experiences still provide a model for better marine S&T in the U.K.'s industrial sector: "the private sector does a rather poor job of funding long-term research. For example, the fish farming industry, which is highly profitable and growing rapidly, has tended only to fund firefighting research. Norwegian experience suggests that the banks and insurance companies working for the fish farming industry might be prepared to take a more strategic view."[53]

As with Australia and Norway, private sector firms contribute directly to government-sponsored marine S&T; for example, industry has, in the past, financed the bulk of the U.K. Department of Energy's Offshore Supplies Office, which is directly aimed at improving that industry's technological capability and competitiveness.[54] The government provides incentives beyond those provided by the direct funding of government research by industry: for example, DTI stimulates research spending by the industrial and commercial sectors through the partial funding of joint projects under the Oceans of Wealth Programme. The Marine Technology Directorate Limited also engages in joint industry funded projects.

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50 External Affairs and International Trade Canada, *Science and Technology Highlights in Germany, the United Kingdom, Belgium, the Netherlands, the European Communities, and Japan* (Ottawa: October 1992), p. 5 (U.K. Section).

51 Marine Technology Directorate Limited, *About MTD Ltd.* (London: 1990), p. 1.

52 Natural Environment Research Council, *The Challenge* (London: 1987), p. 10.

53 *Ibid.*

54 Lennard, "Marine Science and Technology in the United Kingdom", p. 73.

The private sector also commissions research from NERC; there are cost-effective implications associated with doing so given the Council's huge marine infrastructure, above all in sea-going research vessels and its numerous linkages to marine research institutions. Close government-industry cooperation is encouraged in marine research in the U.K. as there is also a conscious effort on the part of the Council, and other government institutions, to act in a pro-active manner and "encourage U.K. firms to take advantage of any basic science discoveries in the marine field."[55]

Canada-U.K./International S&T Initiatives

Canada and the U.K. participate in a number of bilateral S&T activities of which marine projects form one part. Canada-U.K. linkages in marine science have been, and continue to remain, strong despite the absence of an overall framework-type S&T agreement between the two countries. One of the main reasons behind the strength of Canada-U.K. scientific links is the excellent non-official relations between scientists of both countries: "[t]here exist throughout the UK science establishment an amazingly large number of people with strong ties to Canada. These ties are due to the number of British scientists who emigrated to Canada and the fact a large number of the scientists did their post graduate work together."[56] No decline in commitment from institutions or the scientific community has occurred over the last few years, however, it is possible that this situation may change in the future due to three factors:

- budget restrictions in both countries may necessarily affect the degree of cooperation, regardless of the level of commitment;
- many of the British scientists who emigrated to Canada in the post-war period are either retired or soon will be; and
- British economic affiliation with the EC has resulted in a greater proportion of their international S&T expenditures being earmarked for Europe.[57]

Despite these conditions, Canada-U.K. cooperative efforts in marine S&T are continuing, or has recently been concluded, in the following areas:

- UNCED follow-up actions on Land Based Sources of Marine Pollution (LBSMP);

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55 John R. Botzum, "The British Announced the Approval...", *Ocean Science News* (Washington D.C.: Nautilus Press Inc., 20 March 1989), p. 6.

56 External Affairs and International Trade Canada, *Science and Technology Highlights in Germany, the United Kingdom, Belgium, the Netherlands, the European Communities and Japan* (Ottawa: 1992), p. 1, Canada/United Kingdom S&T section.

57 G.L. Holland, *DFO Relationship with the UK (Memorandum)* (Ottawa: Department of Fisheries and Oceans, 5 May 1993), p. 1.

- an experts meeting on changes to the Montreal Guidelines, the UN Environment Programme (UNEP)\World Meteorologic Organization (WMO)\Intergovernmental Oceanographic Commission (IOC) meeting on Coastal Zone Management;

- the proposed amendment to the London Dumping Convention (1972);

- the final meeting of the Intergovernmental Panel of Experts on Radioactive Waste Disposal in the Sea (IGPRAD), also part of the London Dumping Convention; and

- the Arctic Environmental Protection Program (U.K. observer only) and the continuing global experiments of the World Ocean Circulation Experiment (WOCE), Joint Global Ocean Flux Study (JGOFS) and GLOBEC.[58]

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[58] *Ibid.*, pp. 1-2.

MARINE RESPONSIBILITIES--UNITED KINGDOM

Fisheries Management:
- Ministry of Agriculture, Fisheries & Food (MAFF); also responsible for sea wall maintenance and flood control.

Coast Guard:
- Department of Transport.

Scientific Research:
- Department of Agriculture and Fisheries for Scotland's (DAFS) and Ministry of Agriculture, Fisheries and Food's (MAFF) Directorate of Fisheries Research;
- Ministry of Defence (MOD);
- Department of Energy;
- Department of Trade and Industry (DTI);
- Department of Environment (DOE);
- Natural Environment Research Council (NERC);
- Science and Engineering Research Council (SERC); and
- Marine Technology Directorate Limited (MTD Ltd).

Hydrography:
- Department of Transport.

Oil & Gas Exploration/Mining:
- Department of Energy.

Shipping/Marine Transport:
- Department of Transport.

Pollution Control:
- Department of the Environment;
- Environment, Science and Energy Department of the Foreign and Commonwealth Office is responsible for international marine pollution; and
- Department of Transport.

Emergency Response:
- Department of Transport.

Parks/Sanctuaries:
- N.A.

Aquaculture Leasing:
- Crown Estate Commission; also controls dredge dumping sites.

Ports:
- Department of Transport.