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August 1977

Northward Looking
A Strategy and a Science Policy for Northern Development

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August 1977
The Honourable Hugh J. Faulkner, PC, MP,
Minister of State for Science and Technology,
House of Commons,
Ottawa, Canada.

Dear Minister Faulkner,
In accordance with Sections 11 and 13 of the Science Council of Canada Act, I take pleasure in forwarding to you the Council's Report No. 26, *Northward Looking: A Strategy and a Science Policy for Northern Development.*

In submitting this Report, the Science Council would like to acknowledge its largely vicarious experience of the North. We hope that in what follows we will be seen to have recognized the challenges, the opportunities, the heartbreaks, and most of all, the future of the North and its importance to all Canadians.
Yours sincerely,

Josef Kates,
Chairman,
Science Council of Canada

25 July 1977

Dr. Josef Kates,
Chairman,
Science Council of Canada

Dear Dr. Kates:

The Study on Northern Development was a 3½ year *process*, of which this Report is the culmination. The Report would be incomplete, therefore, without at least a brief account of the activities preceding its publication. As you know, northern development was first identified as an area requiring Science Council attention in June 1973, a time when many contemporary northern issues connected with the prospect of very large projects were emerging. Between June 1973 and January 1974 when the committee had its first formal meeting, events moved rapidly: the OPEC oil embargo; the formal emergence of the land claim issue in the James Bay area; the first drilling from artificial islands in the Beaufort Sea, and Canadian Arctic Gas Pipeline Ltd.'s preparation to file its application for a pipeline from Alaska via the Mackenzie Valley. At this time, the federal government also underwrote a study to assess the rail alternative for Mackenzie Delta gas reserves, even while the President of Panarctic Oils Ltd. speculated that a pipeline from the Arctic Islands constructed by Polar Gas Ltd. might precede the construction of one up the Mackenzie Valley. This was also the period when the caveat to large sections of the Northwest Territories filed by the Indian Brotherhood of the NWT was under consideration by Judge Morrow of the NWT Supreme Court and when Syncrude Ltd. and the Province of Alberta were negotiating royalty arrangements for an oil sands plant. In retrospect, it can be said that one of the most fascinating aspects of the whole study has been its evolutionary nature, in the wake of rapidly changing economic conditions, as well as new social perceptions.

Clearly, the role of science and technology in northern development is critical. At the Mont Gabriel Seminar on Science in the North, the then Vice-Chairman of the Science Council, A. E. Pallister, identified a related Science Council concern as the time frame, or *pacing*, at which large scale resource developments are to take place. He recognized explicitly that science does not exist in a political vacuum and that political/economic decisions are necessary to provide a framework for scientific and technological activities. He referred to the importance of technology assessment as a means of improving decision making affecting the monitoring and periodic redirection of scientific activities related to northern development.* Implicitly he said that a study on northern development should therefore concentrate on these two areas, which at that time had received inadequate attention.

At the staff level, Dr. Roger Voyer and Dr. Michael Gibbons were engaged in a case study of the technology assessment system for East Coast Offshore Oil development which was later published as Science Council Background Study No. 30. Their technique of identifying the major actors, as well as the peripheral actors who ought to be involved in the technology assess-

* A. E. Pallister, "Commentary", in K. Greenaway (ed.), *Science and the North, Seminar on Guidelines for Scientific Activities in Northern Canada, Mont Gabriel, October, 1972*, Ottawa, 1973, p. 208.

ment system, and their systematic analysis of the types of issues faced in decisions about major projects were of obvious relevance to northern development as well. Drawing upon their methodology, our committee decided to concentrate on four main areas:

- the decision-making processes for northern development
- the policy concerns affecting northern development
- the pacing of northern development, and
- the relationship between the technological, economic, sociological and political aspects of northern development.

At the first meeting, a plan of action was adopted which guided the study for the next 18 months. Based on the assumptions that the very large projects contemplated for Canada's North would cause inevitable discontinuities for the development of the North, two kinds of background work would be undertaken:

1) An Historical Overview – a synthesis of past resource development projects and their impacts and a review of provincial and federal policies which related to this development; as well as a review of the lessons of this experience and some circumpolar comparisons.

2) Case Studies – Accounts of the decision-making process of certain contemporary projects in order to gain an appreciation of the interplay between actors, the information bases, and the available technological alternatives.

It was proposed that this work be synthesized in a Discussion Paper which would be organized horizontally along thematic lines, such as environmental issues, technological issues and so forth.* As a result, we commissioned the following studies which were completed by the winter of 1975.

– *The Political Economy of Northern Development*, by K. J. Rea, Science Council of Canada Background Study No. 36, Information Canada, Ottawa, 1976.

– "Decision Making in the North: Oil Sands Case Study", by Canadian Resourcecon Limited (W. R. Lee, D. K. Strang, G. A. Constable and G. R. Staple). Mimeographed copies are available from the Science Council.

– "Le processus décisionnel dans la conception et la réalisation du developpement nordique au Canada – La Baie de James", préparé par Eric Gourdeau avec la collaboration de Pierre Dansereau, Louis-Edmond Hamelin et Guy Rocher. Mimeographed copies are available from the Science Council.

– "Arctic Mining: A Case Study of Decision Making – The Strathcona Sound Mine – Baffin Island", by R. Gibson. To be published by the Science Council as a Background Study.

– *Northern Development and Technology Assessment Systems: A study of petroleum development programs in the Mackenzie Delta-Beaufort Sea Region and the Arctic Islands*, by Robert F. Keith, David W. Fischer, Colin E. De'Ath, Edward J. Farkas, George R. Francis, and Sally C. Lerner, Science Council of Canada Background Study No. 34, Information Canada, Ottawa, 1976.

– "Offshore Petroleum Exploration on the Labrador Continental Shelf: A Study of Decision Making", by R. D. Voyer. Mimeographed copies are available from the Science Council.

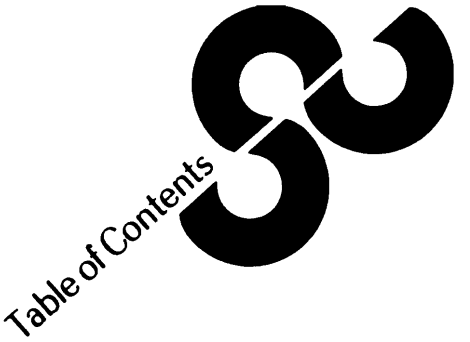
* Science Council Committee on Northern Development, Minutes of First Meeting, Ottawa, 31 January 1974.

The committee then prepared several drafts of a Discussion Paper which synthesized the issues raised by the case studies. The purpose of the paper was to serve as a base document for seminars and as a vehicle to solicit informed opinion from those involved in northern affairs. The paper was completed during the committee's trip to the Eastern Arctic in the summer of 1975. A draft was circulated in the fall which was commented on by over 100 people, some in great detail and most, quite constructively. It was revised for public seminars in Ottawa and Calgary in January, 1976 and in Inuvik in July–August, 1976, and was published by the Council in June 1976 as *Issues 3* (*Issues in Canadian Science Policy*, Ottawa, 1976).

The seminars and response to the discussion paper were of immense assistance to us in framing this final Report. In particular we came to realize that we had perhaps overemphasized the role large projects played in our initial work and that smaller projects also have a critical role to play in the development of the North. Somewhat reluctantly, we also reduced our initial emphasis on decision making. Personally, I believe that science and technology can only make their proper contribution to the development of a region if a decision-making process puts science policy concerns at the centre, not the periphery, of decision making.

Following the seminar in Inuvik, we began the drafting of this Report. The first step was the preparation by Mr. Lewis Auerbach of a compendium summarizing much of the work which the committee had undertaken and perused. This was a very useful exercise and in due course an edited version of this compendium will be published by the Council. During this time we also commissioned an essay by Hedlin Menzies and Associates, Ltd. on "The Role of Canadian Control of Technologies for Northern Development" and sponsored a seminar on "Natural Gas from the Arctic by Marine Mode: A Preliminary Assessment" (available in mimeographed form from the Science Council). These were areas which we felt needed further exploration and which we refer to in this Report as requiring even further attention. Although this Report was completed at a very emotional time – just after the release of the Berger report and before the release of the report by the National Energy Board in favor of an Alcan line – I am confident that its main points support, *and transcend*, the specific northern pipeline decisions of 1977. I hope that others will now pick up the general thrusts and approaches which the Science Council has recommended.

W. H. Gauvin,
Chairman,
Science Council Committee on Northern Development.



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Summary

Chapter I: The North. Northern Canada is distinctively different in terms of climate, vegetation, soil characteristics and ethnic composition from southern Canada. The people of the North are literally few and usually far between. But there is not really just one "North" in Canada, there are many Norths, for the whole area is highly diversified in its natural characteristics and in its cultural traditions.

Chapter II: The North in Perspective. This chapter presents a brief historical review of the political economy and development of scientific knowledge of the North. An international perspective is provided through comparisons of northern areas in other countries. Some current policy issues related to science and technology are reviewed.

Chapter III: Strategy of Mixed Development. Two historical trends are summarized. The first is toward northern development in terms of greater and greater dependence on large scale resource projects. The second is a trend toward smaller scale development focused on renewable resource activity. The Science Council proposes that *a strategy of mixed development incorporating the best of both trends should be pursued.* Although there are already activities which implicitly support the strategy, there is a need for a more explicit science policy to support the strategy. This science policy will require sensitivity to traditional patterns of land use, recognition of a low biological productivity of the North and the role of public participation.

The most significant aspects of this strategy are a greater emphasis on local projects and the implementation of major projects only when they are demonstrably benign, socially and environmentally.

Chapter IV: Principles of a Science Policy for Northern Development. Four basic principles should guide the pursuit of science policies for northern development.

1. Technological sovereignty – the ability of Canadians to control, direct and benefit from technological enterprises which are deemed essential to the country (A national concern)
2. Lifestyle flexibility – the need to allow opportunities for choice of lifestyle (A local concern primarily)
3. Maintenance of the regenerative capacity of the land (Standards of environmental acceptability)
4. Comprehensive and balanced assessment and monitoring of large and small projects (Standards of political acceptability)

The above principles should govern the choice of all research and development initiatives in the North.

Chapter V: Initiatives to Support a Strategy of Mixed Development. For this strategy to be successful, there must be an adequate knowledge base, communication of this knowledge, and education of those involved in making decisions that affect the North. The Science Council recommends that a "University of the North" be established. This facility would provide a focus for the development of northern research activities explicitly designed to solve northern problems and to serve northern peoples.

The Science Council urges that universities play a greater role in solving northern problems and recommends that funds available for Canadian researchers in northern research be reallocated so that grants are emphasized over contracts. The Science Council believes that this would improve both the quality and the independence of Canadian university research in northern matters.

It is essential that a comprehensive knowledge of northern conditions and resources be developed to aid choices among options. Special attention should be given to the assessment of the potential of renewable resources in the North.

As this resource potential is understood, the appropriate indigenous capabilities and the expertise necessary to develop the resources must be developed and nurtured.

To utilize scientific knowledge, appropriate communication technologies and facilities must be made available to northern peoples and northern institutions. Barriers to the flow of government sponsored technical information should be removed. The capacities of legislative bodies and individual legislators to assemble and evaluate technical information should be systematically improved.

Chapter VI: Direction and Control of Development. A number of specific initiatives are suggested and existing institutions commented upon. Technological sovereignty can be most successfully pursued by a firm regulatory environment designed to protect new opportunities for Canadian enterprises. Crown corporations, such as PetroCanada, have a potentially important role to play in enabling Canada to better control the pace of development and choices of technologies relevant to the North. However, they also require firmer regulatory policies.

More successful in promoting technological sovereignty is the practice of contracting out research to relevant organizations. The activities and goals of the Alberta Oil Sands Technology and Research Authority are cited as a positive example of this.

There is a need for northern research development and demonstration projects as determined by local needs. Some of this research must deal with the identification and solution of existing problems in the health area, for instance. Others must be oriented towards community development projects which have as their ultimate goal economic and social self-sufficiency for northern peoples. This means an emphasis on local materials, products, labour and capital. The Science Council endorses the Guidelines for Federal Scientific Activity in Canada's North, especially insofar as they encourage local participation in science policy decisions and scientific activities.

The Science Council urges that large projects, as well as small ones, require an appropriate commitment to assess their feasibility, acceptability and impact. It is the size of the potential impact rather than the size of the project which is critical. The process employed by the Mackenzie Valley Pipeline Inquiry is a good example of a major component of a balanced assessment system. As a result of this and other assessments, it is now clearer that there are a number of problems, economically, environmentally, and socially, with constructing a gas pipeline for gas from Alaska through the Mackenzie Valley, and there are, at this time, insufficient reserves to justify a Maple Leaf line for Mackenzie Delta gas only. While some important data are

still lacking as of summer, 1977, these assessments provided more information upon which to choose a route through Canada to carry Alaskan gas than was available in 1974 when the Mackenzie Valley Pipeline was first proposed. The Council recommends assessments in five other areas which it believes will become important in the process of northern development and will enable Canada to make better use of existing and developing areas of scientific knowledge and technological expertise for the benefit of northern peoples and all Canadians.

I. The North

Canada is the second largest country in the world. Farmland makes up 8 per cent of Canada; productive forest land 27 per cent. The Yukon and Northwest Territories together comprise 41 per cent of the land area of Canada. The northernmost point of land is Cape Columbia on Ellesmere Island at latitude 83°7′. (See Figure 1.) From north to south, Canada measures 2875 miles. Our longest river is the Mackenzie, which flows 2635 miles from the head of the Finlay River at latitude 57° to its mouth at latitude 71°. Canada is a large *northern* country.

Canada ranks 33rd among countries of the world in population. There is no settlement in 89 per cent of our land area. In 1971, our average population density south of 60° was 1024 people per 100 square miles; for Nova Scotia, 3867; for Ontario, 2239. In the Yukon it was 9, and in the Northwest Territories, 3. Half of the people in the Northwest Territories and 60 per cent of those in the Yukon live in *urban* environments. The northern part of Canada is mostly a lonesome place.

These statistics reflect the artificiality of political boundaries, rather than the realities of natural geography. What really counts are the conditions in which people live – the climate, the soil, the vegetation, the remoteness – which vary in complex ways. For example, climate and soil are often thought to be distinctively different in the North, but "northern" conditions extend much further south in central and eastern Canada than in the west, whether the criterion is temperature, growing season, snow and ice cover, or ice breakup in the spring. (See Figures 2 to 5.) The tundra begins north of latitude 69° at the mouth of the Mackenzie River in the west, but extends south in the east to the shore of James Bay at latitude 55° and covers a substantial portion of northern Quebec and Labrador, and almost the entire Labrador coast.

Figure 1 – The Canadian North

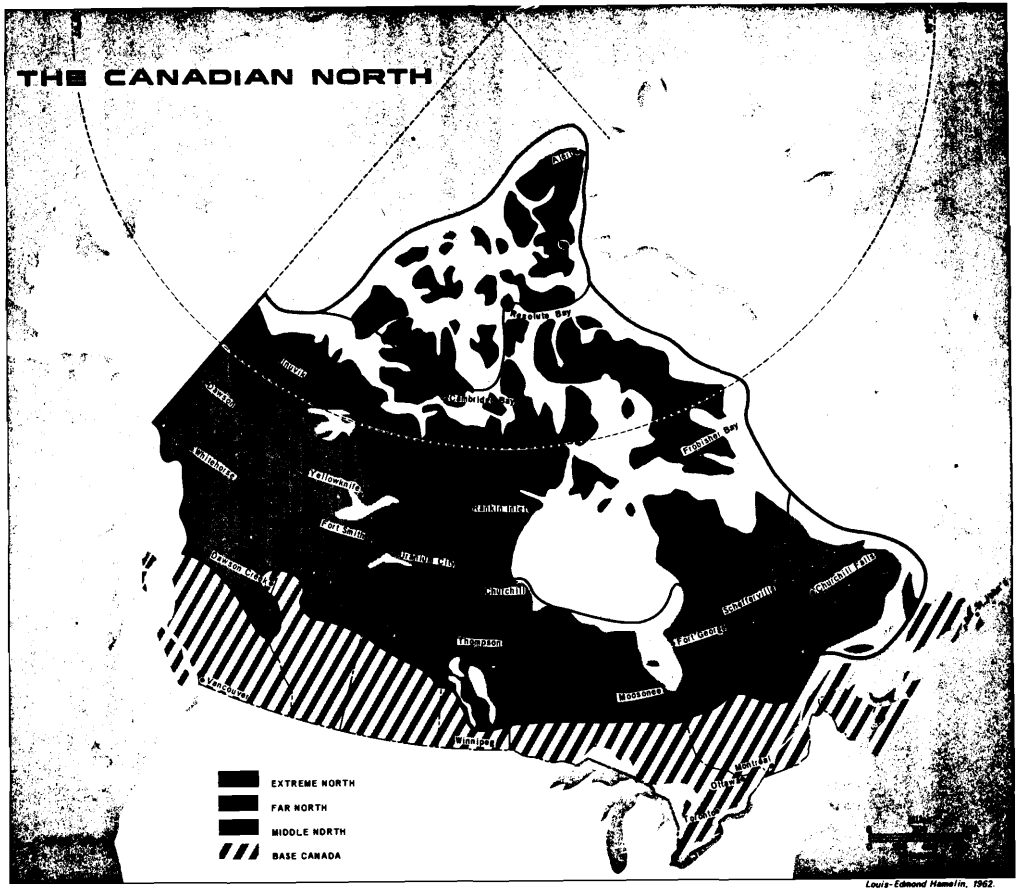
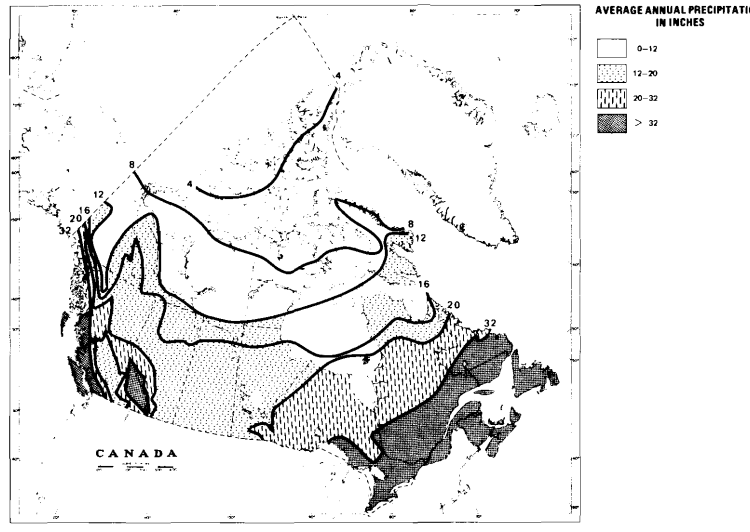
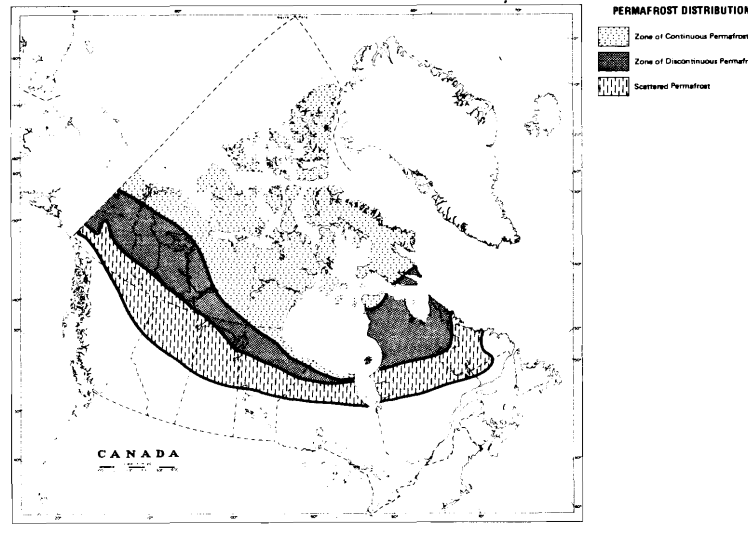


Figure 2 – Average Annual Precipitation in Inches



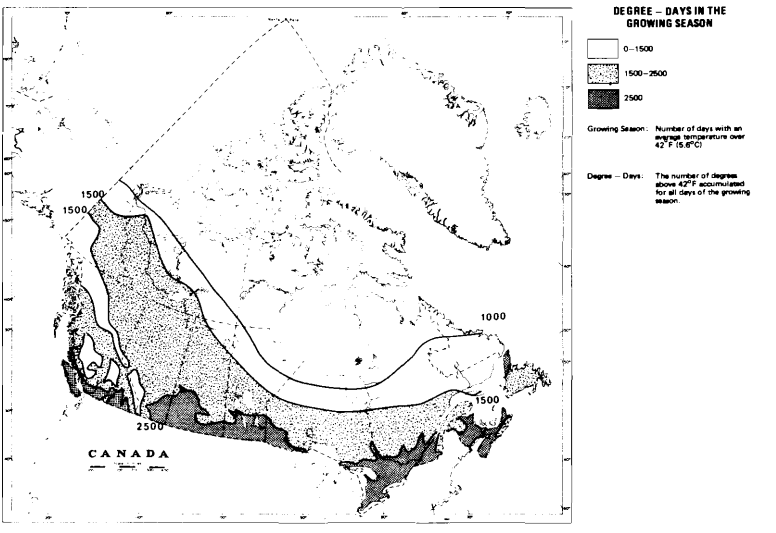
Source: National Atlas of Canada, Ottawa, 1974, p. 48.

Figure 3 – Permafrost Distribution



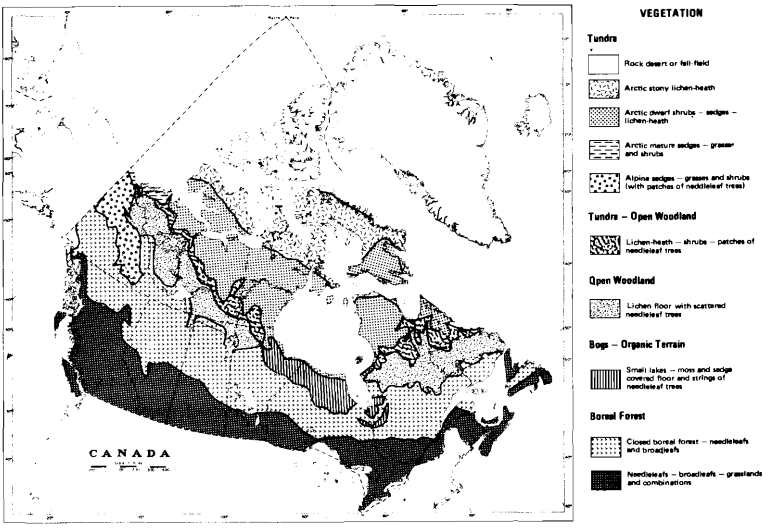
Source: National Atlas of Canada, Ottawa, 1974, pp. 11-12.

Figure 4 – Degree Days in the Growing Season



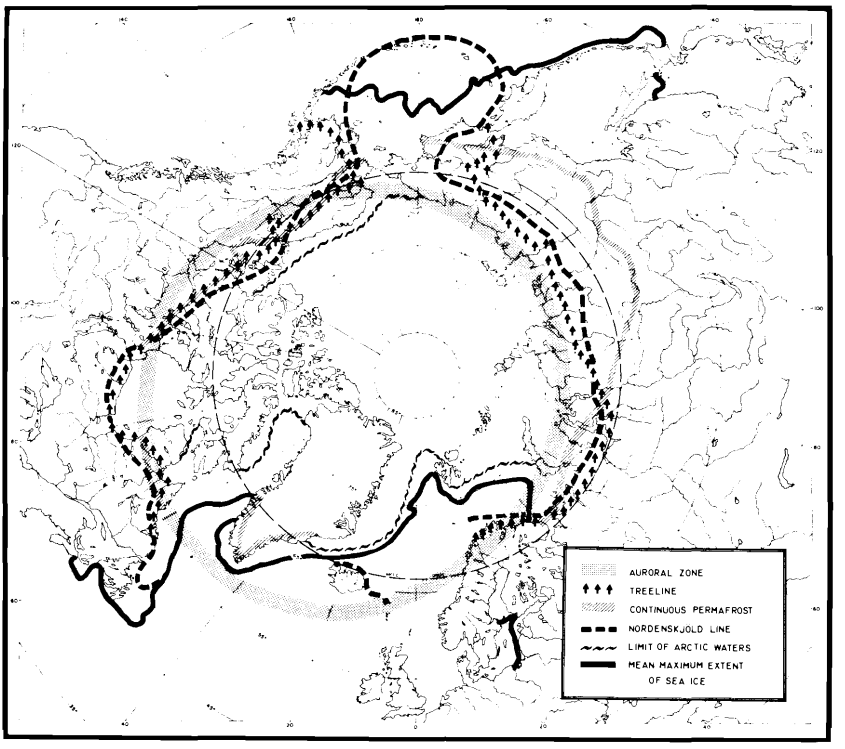
Source: National Atlas of Canada. Ottawa, 1974, p. 50.

Figure 5 – Vegetation



Source: National Atlas of Canada, Ottawa, 1974, pp. 45-46.

Figure 6 – Some Significant Boundaries in the Arctic Region



Source: John E. Sater, A. G. Ron Hovde, and L. C. Van Allen, *Arctic Environment and Resources*, The Arctic Institute of North America, Washington, 1971, p. 3.

The most northern parts of the Arctic have little precipitation. The Arctic Islands, for instance, average less than 200mm of precipitation annually, compared with the Prairies which typically receive over 400mm. The relationship among precipitation, soil temperature, incidence of permafrost, and length of growing season is reflected in the type and distribution of vegetation. The Arctic Islands are primarily a rock desert with little or no vegetation. To the south (in a line from northwest to southeast) lies an area of Arctic stony lichen-heath, which gradually gives way on Banks Island in the west and on both sides of the Hudson Strait in the east to areas of shrubby birch and grasses which are, in turn, replaced by a wide transition zone to the Boreal Forest stretching from the southern Yukon and upper Mackenzie Valley to part of Newfoundland. The transition zone includes much of the land area of the Prairie Provinces, Ontario and Quebec.

It is often thought that conditions at the same latitude in Siberia or northern Sweden correspond to those in Canada. But the tree line in much of Canada is significantly farther south than in Sweden or in the USSR (Figure 6). The only thing about the Canadian North which is exactly the same as the north of Europe and Asia is that beyond the Arctic Circle there is at least one day when the sun does not set and one when it does not rise. Indeed, even well south of the Arctic Circle, the long days of summer and the long nights of winter are a major fact of life in northern latitudes.

There are many ways of defining the "North". For the purposes of this Report the Council has chosen to use a definition of nordicity, derived by L.-E. Hamelin of Université Laval. He uses 10 criteria to yield an aggregate index of nordicity.[1] Hamelin's criteria imply that areas become less "nordic" as they become more industrialized and accessible. For instance, Chibougamau, Quebec, is certainly a much less "nordic" place than it was before mining and associated transportation and other services were set in place there.

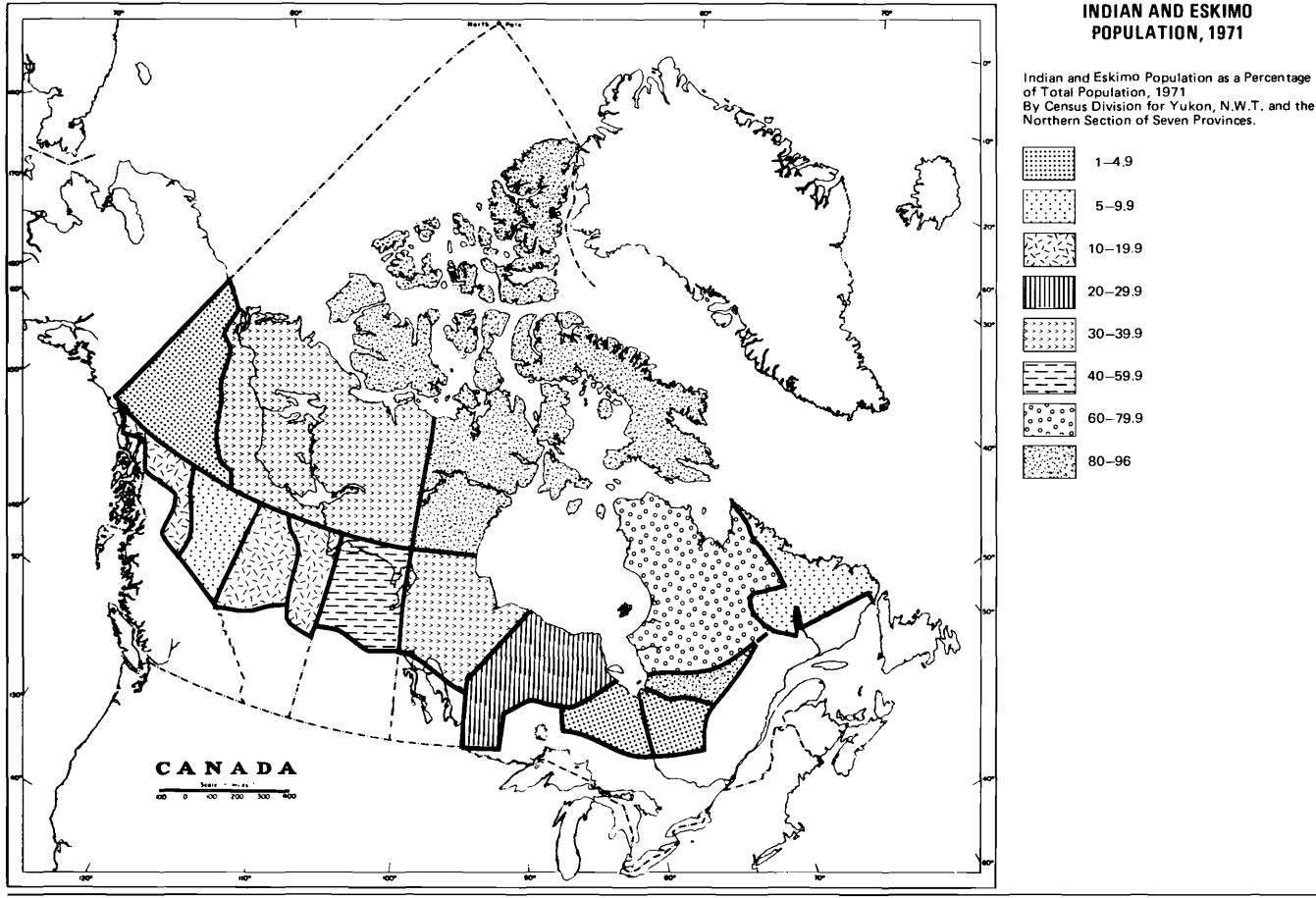
The North, in this Report, includes the "Extreme", "Far" and "Middle North" of Hamelin, (Figure 1). It is characterized by small populations, large distances, relative inaccessibility, a large proportion of indigenous peoples, a short growing season, permafrost, and long, cold, dark winters. The Extreme North and the Middle North are very different. The Extreme North is nearly uninhabited, has very little vegetation, continuous permafrost, ice-infested waters all or nearly all year, and very little precipitation. The Middle North has discontinuous permafrost, is heavily forested, more accessible, and is the focus of resource exploitation at this time. It is the region where the large majority of northern residents now live.

The people of the North are as distinctive as their environment. Not surprisingly, the North presents special problems to demographers. People move over large areas; there are cultural and linguistic differences; many settlements are relatively isolated; demographic statistics of the northern population are accordingly more crude than for the rest of Canada.[2] Indeed, there are, for instance, no accurate population figures on Métis and non-status Indians in Canada. The Native Council of Canada estimates 750 000 people on the basis of three Métis for each status Indian (295 215 in 1971 in all of Canada).

The census divisions in Figure 7 are the nearest approximation to the "Middle", "Far" and "Extreme" North. The population of the North is about 1 million people. Compared with the rest of Canada, people in the North are younger and they have received less formal education. There is a larger component of native people (especially in Saskatchewan, Manitoba, Quebec, and the Northwest Territories), and larger proportions of the population are engaged in forestry, fishing, trapping, and mining than in Canada as a whole; a much smaller proportion is employed in manufacturing, finance, insurance, and real estate. Males outnumber females, although the proportion of females has been increasing rapidly. In the North there are more men than women over the age of 70, whereas elsewhere in Canada the elderly are mainly women (Table 1).

Large communities are not common in the North; in 1971, only 29 per cent of northern residents lived in settlements over 10 000, but for Canada as a whole the figure was 65 per cent.[3] Within the North, a settlement larger than 2000 is a comparatively urban environment. Most of the native people live in small, relatively isolated settlements, while most northern immigrants settle in the larger centres. In the Northwest Territories, for example, 31 per cent of the natives but over 70 per cent of the non-natives live in the five largest communities – Yellowknife, Inuvik, Hay River, Fort Smith, and Frobisher Bay. While native northerners constitute a majority of the population in most of the area of the North, they do not constitute a majority in any major manufacturing, mining, or administrative centre.

Figure 7 – Indian and Eskimo Population



Source: Data are from Statistics Canada.

Table 1 – Age/Sex Breakdown of the Population of the Mid-North, Yukon and N.W.T. in 1971 (per cent of the population in each age cohort by sex)

Age Group	B.C.*		ALTA.*		SASK.*		MAN.*		ONT.*		QUE.*		NFLD.*		YUKON		NWT	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
0-4	11.2	12.4	11.1	11.6	15.8	16.4	14.7	15.6	10.0	10.3	9.5	9.6	14.1	15.4	11.0	12.1	15.7	16.1
5-9	12.8	13.9	13.0	14.2	15.4	16.3	13.3	14.6	11.9	12.3	12.9	13.0	14.1	14.8	12.1	12.9	15.4	15.8
10-14	11.5	12.5	12.3	13.2	13.1	14.0	10.4	11.5	12.2	12.2	13.4	13.6	11.4	12.3	10.2	11.3	11.7	11.9
15-19	9.3	9.7	10.2	10.2	9.7	9.5	8.6	9.3	10.5	10.4	11.2	12.0	9.9	10.6	7.1	8.7	6.4	9.0
20-24	8.5	9.3	7.3	7.6	6.9	8.1	11.8	11.2	8.3	8.4	9.3	9.5	8.4	10.5	9.2	11.0	9.8	10.2
25-34	16.1	16.0	12.7	13.2	12.1	11.6	16.6	15.3	12.3	12.6	14.1	14.2	15.4	14.8	19.4	18.2	16.4	15.6
35-44	13.0	11.2	11.6	10.5	9.3	8.8	9.8	8.6	11.2	10.8	11.2	11.1	10.8	8.7	13.4	11.0	10.8	9.7
45-54	8.5	7.9	8.4	8.1	7.3	7.2	6.4	6.6	9.4	9.7	8.4	8.2	7.5	6.3	8.9	8.1	7.1	6.1
55-64	5.3	4.3	6.4	5.6	5.9	4.6	4.8	4.5	7.4	7.1	5.4	5.0	5.0	3.5	5.4	4.4	4.3	3.3
65-69	1.5	1.1	2.6	2.2	1.9	1.4	1.5	1.1	2.9	2.4	1.7	1.7	1.2	1.2	1.5	0.9	1.0	0.9
70+	2.2	1.8	4.3	3.6	2.7	2.0	1.9	1.6	3.9	3.7	2.3	2.2	2.2	1.9	1.8	1.4	1.2	1.3
Sub-Total (000)	104	93	79	70	11	11	37	32	77	72	228	216	27	23	10	8	18	17
Grand Total		197		149		22		69		149		444		51		18		35

TOTALS	Mid-North		Yukon-NWT		Mid-North, YK & NWT		Canada	
	Male	Female	Male	Female	Male	Female	Male	Female
Sub-Total (000)	563	518	28	25	591	543	10 795	10 773
Grand Total (000)		1081		53		1134		21 568

*Data refer to the northern part of the provinces.

Source: Statistics Canada Catalogue 92-772 (1971).

Table adapted from A Policy Proposal by the Canadian Council on Rural Development, *A Development Strategy for the Mid-North of Canada,* Appendix A, Table 2, p.112, Ottawa, 1976.

Epidemiological data indicate that health standards in the North are lower than in the rest of Canada. Hospitalization rates, death rates, and most generally used indices of health indicate higher incidences of disease and ill health. Examples from the Northwest Territories and Manitoba are shown in Tables 2 and 3. Although the birth rate has now begun to level off, the age structure of native populations in the North resembles that of less developed countries in Latin America or Africa more than that of the rest of Canada.[4] (See Figure 8.)

Twenty per cent of the inhabitants of the Northwest Territories speak neither English nor French. Reflecting the historical isolation of many parts of the North, there are several native dialects. In the Mackenzie River Valley and Delta, there are six native languages: Loucheaux, Hare, Slavey, Dogrib, Chipewyan and Inuktitut.[5] The language differences reflect the variety of cultural traditions. The North has a mosaic of native peoples in which the distinction between Inuit (Eskimo) and native Indian is only a first and very broad classification.

Canada, then, is a northern country. The North extends far south in the central part of Canada. The North has a sparse, scattered population. Moreover, there is not really just one North in Canada, because the whole area is highly diversified in its natural characteristics and in its cultural traditions. The diversity of the North is as striking as its cold.

Table 2 – Vital Statistics of the Northwest Territories, 1975

	INDIANS 1975 Pop. – 7678 (7605)				ESKIMOS 1975 Pop. – 14303 (14117)				QTHERS 1975 Pop. – 16867 (16626)				ALL GROUPS 1975 Pop. – 38848 (38348)				ALL CANADA
	1975		1974	1973	1975		1974	1973	1975		1974	1973	1975		1974	1973	1973
	No.	Rate	Rate	Rate	No.	Rate	Rate	Rate	No.	Rate	Rate	Rate	No.	Rate	Rate	Rate	Rate
Livebirths (a)	198	26.0	23.6	26.0	458	32.4	28.4	32.8	540	32.4	29.3	34.2	1196	31.2	27.8	32.0	15.5
Illegitimate Live Births (b)	107	54.0	49.4	45.6	168	36.6	29.0	30.2	114	21.1	20.3	16.2	389	32.5	28.4	26.3	–
Livebirths born in Hosps, and N/S (c)	196	98.9	97.8	96.9	448	97.8	98.9	97.3	535	99.0	99.0	99.6	1179	98.5	98.0	98.3	99.8
Low Birth Weight Infants (d)	26	13.1	8.9	12.4	25	5.4	8.6	10.9	21	3.8	5.0	4.3	72	6.0	7.0	8.1	–
Stillbirths (e)	5	25.2	0	5.1	4	8.7	20.2	15.6	7	12.9	12.4	7.2	16	13.3	13.2	10.1	10.6
Perinatal Deaths (f)	13	64.0	16.8	25.9	9	19.4	49.5	26.8	10	18.2	24.6	12.7	32	26.4	33.2	20.2	17.6
Neonatal Deaths (0-28 days) (g)	8	40.4	16.8	20.7	8	17.4	40.4	13.4	5	9.2	12.4	5.4	21	17.5	23.7	10.9	10.8
Post Neonatal Deaths (29-365 days) (h)	5	25.2	28.1	10.3	14	30.5	30.3	31.3	2	3.7	6.2	7.2	21	17.5	18.9	16.8	4.8
Infant Deaths (under 1 year) (i)	13	65.6	44.9	31.0	22	48.0	70.7	44.7	7	12.9	18.7	12.7	42	35.1	42.6	27.7	15.5
Total Deaths (Crude Death Rate) (j)	53	6.9	6.2	5.9	87	6.1	6.7	6.1	57	3.4	4.5	5.8	197	5.1	5.7	5.9	7.4
Deaths in Hosps. and N/S (k)	33	62.2	65.9	71.4	46	52.8	48.9	57.1	26	45.6	58.6	47.3	105	53.2	56.0	55.7	–
Natural Increase (l)	145	19.0	17.4	20.1	371	26.2	21.6	26.6	483	29.0	24.7	28.4	999	26.0	22.3	26.1	8.1
Maternal Deaths (m)	0	0	0	0	1	21.8	25.5	0	0	0	0	0	1	8.3	9.5	0	1.1

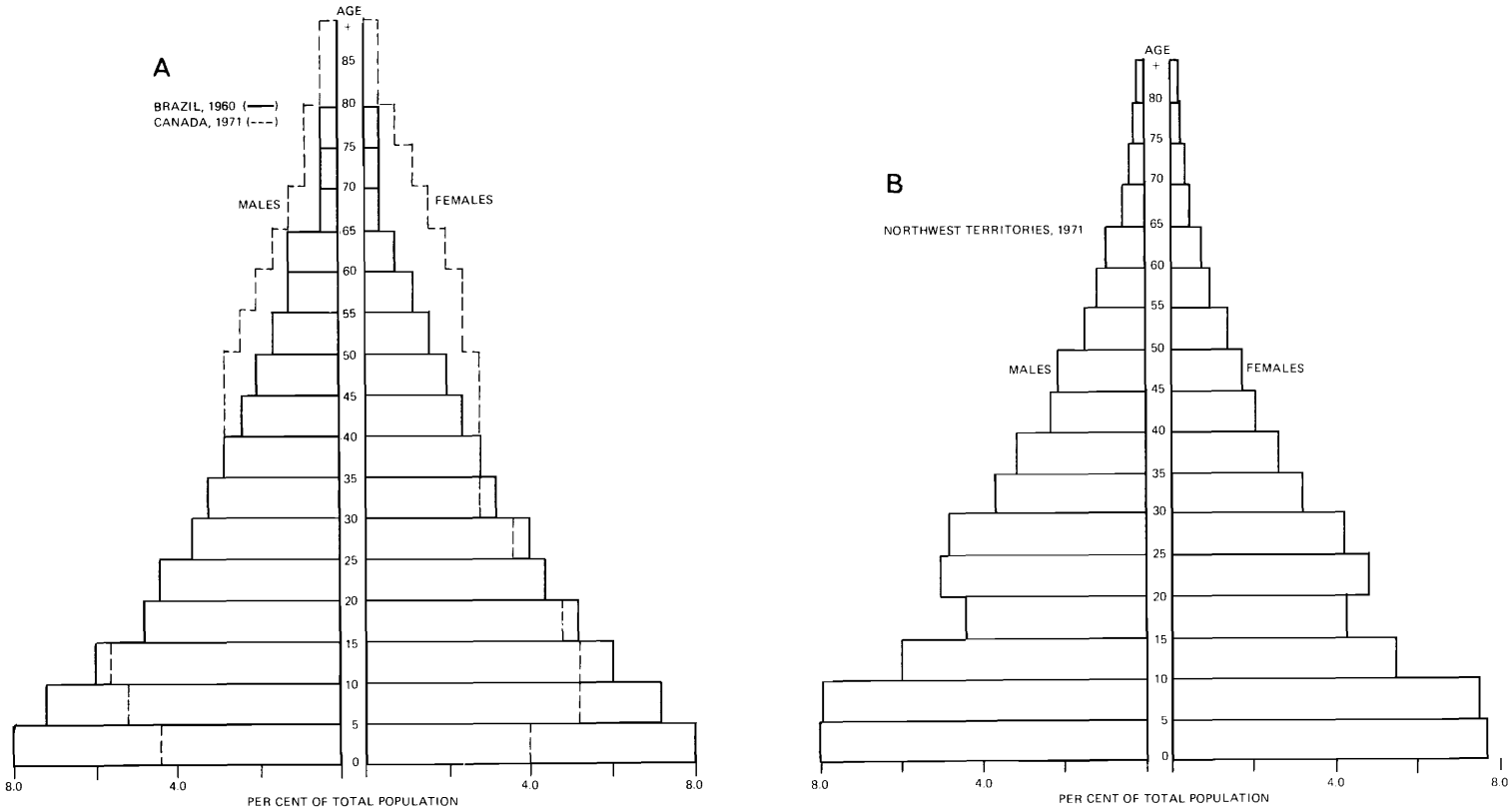
(a) rate per 1000 population
(b) rate per 100 live births
(c) rate per 100 live births
(d) rate per 100 live births
(e) rate per 1000 live births
(f) stillbirths plus deaths 0-7 days per 1000 total births (live births & stillbirths)
(g) deaths 0-28 days per 1000 live births
(h) deaths 29-365 days per 1000 live births
(i) deaths under 1 year per 1000 live births
(j) crude death rate – deaths per 1000 population
(k) rate per 100 deaths
(l) rate per 1000 population
(m) rate per 10 000 live births

( ) Figures in brackets are "mid-year" pop.

N.B. To bring statistics into line with national compilations, rates (a) (j) and (l) have been calculated this year on the mid year calculated populations. In previous reports the end of year population has been used as a basis for calculation. Result is to elevate (slightly) calculated rates.

Source: Chief Medical and Health Officer, Government of the Northwest Territories, *Report on Health Conditions in the Northwest Territories for 1975,* 18 May 1976, p. 7.

Figure 8 – Age/Sex Structure for (A) Brazil and Canada and (B) Northwest Territories



Source: Perceptions 2, Implications of a Changing Age Structure, by L. Auerbach and A. Gerber, Science Council of Canada, July 1976.

Table 3 – Rates of Hospital Discharge per 1000 Population for Selected Diagnostic Code Items, Treaty Indians and Comparison Populations, Manitoba, 1972.

	Manitoba Northern Treaty Indians	Northern Unorganized Territory[a]	Other Northern Manitobans	Other Manitobans
Intestinal Infections	18.3	20.8	7.5	3.9
Tuberculosis	4.0	1.4	0.5	0.4
Streptococceal Infections	–	–	0.5	0.1
Infectious Hepatitis	0.5	0.7	0.7	0.2
Diabetes, Mellitus	2.8	2.2	1.6	1.9
Nutritional Deficiency	1.4	1.6	0.5	0.3
Iron Deficiency Anemia	0.1	0.3	0.1	0.1
Mental Disorders	7.2	7.6	8.9	6.9
Eye Infections	1.7	0.9	0.6	0.3
Otitis Media	5.3	4.6	1.4	0.9
Acute Upper Respiratory Infections	23.1	26.3	13.7	5.9
Influenza	1.2	4.2	1.4	1.3
Pneumonia	32.6	25.5	6.3	5.5
Kidney Infections	2.2	2.7	1.2	0.9
Complications of Pregnancy	17.5	12.0	7.0	3.4
Complications of Delivery	11.9	8.0	6.8	4.7
Skin and Subcutaneous Diseases	10.4	10.2	4.8	2.8
Congenital Anomalies	3.7	2.2	2.2	1.7
Accidents, Poisonings	36.1	35.8	28.6	16.9
All Discharges	**326.5**	**306.4**	**232.8**	**180.1**

[a]Contains a large portion of Métis and non-Status Indians.

Source: Manitoba Health Services Commission as quoted in Canadian Council on Rural Development, *A Development Strategy for the Mid-North of Canada*, A Policy Proposal by the Canadian Council on Rural Development, Ottawa, 1976, p.33.

II. Development or Exploitation

Definitions

Although "development" and "exploitation" are often used interchangeably to describe activities in the North, it is important to distinguish between them.

Development may refer to economic, political, or social features of a country or region. In the context of this Report, development implies that change or growth in one or another of these aspects is associated with opportunities for greater local self-determination. *Exploitation* refers most commonly to economic factors and implies that growth has been determined chiefly by influences external to a region. Development in the North is preferable to exploitation of the North.

Historical Review

Political Economy

Fish, fur, and arctic sea mammals were the first northern Canadian resources to be commercially exploited by Europeans. Fishing off Labrador occurred in the early 16th century; two centuries later, whaling became an important industry along the arctic coasts. In the late 19th century, when whaling deteriorated, some whalers began trading with the native people. This contact had a disruptive effect on the traditional economy of the eastern Arctic, because the whalers not only virtually exterminated the whale population, they also contributed indirectly to the reduction of the wildlife resources upon which the Inuit had been subsisting. Whalers also introduced new diseases and the use of alcohol, both of which further stressed Inuit communities.

At the end of the 19th century, interest turned from fur trading and whaling to mining, logging, and the manufacture of pulp and paper. These activities broadened the resource base of the North, but they did not depend upon the labour of the native people for their financial success.

The essential characteristics of economic activity in the North have changed little over three centuries. Until very recently, "the economy of the North was based on the exploitation of primary resources. . . . Consequently, economic growth has been determined by external forces, notably by demands emanating from western Europe and the rest of North America".[1]

About the time of World War II major changes began to occur in the North. Projects such as construction of the Canol pipeline (between Norman Wells and Whitehorse), the Alaska highway and DEW line sites were unprecedented in their size: the war itself created defence obligations which forced governments to take a more active interest in the North. For both the provincial and federal governments, commercial feasibility was no longer the sole justification for Northern projects.

Since World War II, the relative levels of mineral and forest product activity in the North have been maintained, but hunting and trapping have, in general, declined. A major change has been a spectacular increase in the service sector (i.e., government), in the fields of defence, health, education, transportation, communications, and welfare. Today, there is the possibility that large resource projects, such as James Bay, the Athabasca Oil Sands, or the transportation of northern gas, will have an even greater impact on northern people than government activities of the recent past.

The present century has been characterized by a commitment to growth and a belief in the necessity of resource exploitation for progress. From this perspective, the "problem" of the Canadian North is how to cope with the physical obstacles to the exploitation of resources. Canada, is heavily dependent on foreign capital and foreign technology. Thus, it is not surprising to observe these same characteristics in the northern hinterland. The challenge of northern development is the challenge of development for all Canadians.

Science.

Early travellers to northern Canada described their experiences in general geographical accounts. More complete, precise information began to be accumulated in the late 18th century, when Sir Joseph Banks, a naturalist, visited the coasts of Labrador and Newfoundland. As president of the Royal Society from 1778 to 1820, Banks stimulated British scientific interest in Canada's northern regions.[2]

The need for a wider approach to northern science was not recognized until the First International Polar Year of 1882–3. Three of the twelve stations in the polar regions that were established at this time were in Canada. In the late 19th century Canadian scientific efforts in the North were restricted to practical goals such as resource surveys and investigations of navigation conditions on the Hudson Bay route.

The first major Canadian scientific endeavour was the Canadian Arctic Expedition of 1913–18. Its comprehensive reports on the geography, geology, natural history and Eskimos provided a model for much of the subsequent Canadian scientific work in the North. Between the two World Wars, Canadian scientific work was limited largely to geological surveys and to scientific expeditions conducted from the Hudson's Bay Company ship, *Nascopie*. The *Nascopie*, on her annual voyages, supplied the scattered fur trading posts of the Arctic and carried a government administrative party. The scientific work was necessarily subordinate, largely descriptive and taxonomic. Fortunately, a few federal scientists undertook field investigations and experimental farms were established near Whitehorse and at Fort Simpson. During the Second International Polar Year of 1932–3, the Canadian Meteorological Service established stations at Chesterfield Inlet and Coppermine. For the most part, though, scientific exploration in the North was carried out by scientists from other countries.

Northern science was greatly influenced by World War II defence projects that were on a scale far exceeding anything previously experienced in the North. Aircraft, which had reached into the boreal forest before the war, were now used throughout the Arctic and made all of the North more accessible. After the war, the development of long-range nuclear delivery systems was judged to be a military threat to North America. Thus the North took on strategic significance. Defence forces had to learn how to operate in arctic conditions, a powerful incentive for northern research. The United States was particularly sensitive to the threat of an attack launched from the northern regions and diverted some of its scientific resources to northern problems. In Canada, the Defence Research Board organized an Arctic Research Section, built a laboratory at Fort Churchill (later operated by the National Research Council of Canada), and initiated a series of expeditions to northern Ellesmere Island. These activities provided a focus for northern research and encouraged other government scientific agencies and Canadian

universities to increase their interest in the North. Jointly with the United States Weather Bureau, five meteorological stations were established in the Queen Elizabeth Islands[3] and were used by Canadian scientists as bases from which to carry out scientific work. The development of several mines in the northern parts of the provinces drew attention to the resource potential of the North. The founding of the bi-national Arctic Institute of North America in 1945 also helped to stimulate public interest.

The nature of northern research changed in the post-war period. Descriptive and taxonomic work remained important, but more effort was devoted to ecological studies, tests of equipment at low temperatures, applications of research to northern construction, and practical problems of living and operating in the North. The Arctic was better studied than the provincial northern hinterlands for two major reasons. The first was the continuing lure of the Arctic, as revealed in its climate, remote grandeur, very special biological productivity, and culture. The second was an administrative consideration. The federal government could direct and mobilize scientific activities more easily within its jurisdiction (Yukon and NWT) than in areas where provincial agreement was needed. In general, provinces had fewer scientific resources than the federal government.

The difficulties and high cost of work in the North posed special problems for university research. Work in the North entailed much heavier transportation and other costs, for example, than did similar research done in southern Canada. Failure to recognize these additional financial needs often meant that northern research suffered. A notable exception was McGill University, which established a sub-Arctic research station at Knob Lake on the Labrador-Quebec border and a long-term glaciological investigation on Axel Heiberg Island. Other efforts to improve the situation were made by the Department of Northern Affairs and National Resources. On the advice of the Advisory Committee on Northern Development, small annual grants to universities, specifically for northern research, were initiated. These grants, which are still made today, aided groups in Canadian universities, such as the Boreal Institute at the University of Alberta, the Centre d'Etudes Nordiques at Université Laval, and the Institute for Northern Studies at the University of Saskatchewan. The Advisory Committee on Northern Development also initiated the establishment of the Polar Continental Shelf project by the Department of Energy, Mines and Resources and the creation of northern laboratories, first at Inuvik and two years ago at Igloolik, by the Department of Indian Affairs and Northern Development. The University of Saskatchewan commenced operation of its Arctic Research and Training Centre at Rankin Inlet in 1967 with the help of the Donner Canadian Foundation. In 1977, citizens of Churchill, Manitoba, founded a research station for up to 100 persons with the financial assistance of the Manitoba Communities Economic Development Fund and the Donner Canadian Foundation.

While these measures widened the field of northern research and led to a much greater involvement of universities, the largest programs are still those carried out by scientific agencies of the federal government. Many factors affected the rate of growth of these agencies: the advent of transpolar civil aviation, the increased importance of petroleum exploration, the need for improved surface transportation, and UNESCO support for global scientific studies, such as the International Geophysical Year and the International Biological Program.

In the geophysical and related sciences, particular attention was given to meteorology and ionospheric research, geological investigations, seismic, gravity and magnetic studies, and glaciology. These studies created a need for more mapping, charting, and hydrographic information. Many of these activities occurred within the Department of Energy, Mines and Resources, but the Departments of the Environment, Communications, and Transport, and the National Research Council were also involved. Biological research in the Departments of the Environment and Fisheries increased. Social research did not share this expansion, despite the obvious need and the heavy costs involved in the administration and welfare of the native people. Annual expenditures on research on northern wildlife were and have remained much greater than expenditures on research related to northern people.[4]

New factors have greatly affected both the scale and nature of northern research. Intensified interest in the Athabasca Oil Sands of Alberta, petroleum exploration and proposals for gas and oil pipelines have catalyzed advances in applied research and technology. The prospect of large-scale projects has also created concern about impact on the northern environment and on the life of native people. This concern has prompted a great deal of short-term research directed toward answering specific questions. Unfortunately, much of this work has been of limited significance and has sometimes occurred at the expense of wider-ranging research of more fundamental importance.

Activities in the North have also revealed difficulties in determining the scientific jurisdictions of federal departments. For example, the Department of Indian Affairs and Northern Development was charged with the promotion of commercial development of non-renewable resources, whereas the Department of the Environment was responsible for assessing the ecological impact of projects and for protecting certain renewable resources. Partly because of the diversity of scientific activity in the North, the Advisory Committee on Northern Development convened a conference at Mont Gabriel, in Quebec, in November 1972 to assess the effectiveness of northern research, to determine the directions in which research would be most helpful, and to advise on better coordination and balance in northern research. Four years later, largely as a result of the recommendations of the conference, some general scientific guidelines for research by federal agencies were adopted by the federal government.[5] It is too soon to judge their effectiveness, but the guidelines indicate a desire to implement a national policy for scientific activities in northern Canada.

Circumpolar Comparisons

Sub-arctic and arctic hinterlands occur in all the circumpolar countries (Canada, United States, Iceland, Denmark, Norway, Sweden, Finland, and the Soviet Union). The political economy of Canada's North "has most of the characteristics of an underdeveloped country: extremely high birth rates, declining mortality rates; relatively low incomes; extreme variations in income levels from the highest to the lowest; heavy reliance on imports; little local industry; predominance of natural resource-based industry; a low level of political development, and so on".[6] These features are found in less developed areas elsewhere in Canada, of course, and can be identified in the northern hinterlands of other circumpolar countries. For the purposes of this

Report, the important comparisons between the North of Canada and other countries concern political systems, resources, and land use.

United States (Alaska). Alaska is most similar to northern Canada, particularly the Yukon. The latitude, physical features and resource base are virtually identical. Alaska's history of "colonial" status with respect to the rest of the United States and the emergence of native peoples as a political force to negotiate land claims are two trends that are also evident in Canada's North.

From the 1867 purchase of Alaska from Russia until World War II, trapping, sealing, mining, and fishing were major industries "dominated by private non-resident firms [which] tended to exploit resources, renewable and non-renewable, as though they were alike."[7] The federal government was involved only in a reactive manner, imposing restrictions on resource development.

World War II prompted the construction of an elaborate defence system in Alaska. Government activity in Alaska increased dramatically. The subsequent growth of the public health, education, and welfare sectors in the post-war period made government the largest growth industry. Until the recent oil boom, government was virtually alone in determining the growth of the economy.

Denmark (Greenland). Greenland is a northern hinterland with no direct land connection to its mother country. This physical separation also characterizes Alaska. However, unlike Alaska, Greenland's importance to Denmark has not arisen from an exclusive interest in its economic value as a frontier region. Activities in Greenland have been guided chiefly by Danish concern for the well-being of a predominantly native population. This paternalism was reflected in a policy which emphasized social and cultural factors. It "sought to reserve whatever resource potential the area possessed for the uses of the Greenlanders themselves, the objective being to enable the population to be self-supporting at an "adequate" level of well-being through carefully regulated trade with the mother country. This trade was intended to entail neither profits nor losses for the Danish state, although in practice it appears to have been conducted at a loss."[8]

World War II opened Greenland to new outside influences in consequence of a temporary period of *de facto* U.S. jurisdiction during the war. Large military bases and weather stations were developed; with these came an interest in more materialistic growth. Immigration to Greenland increased, and relatively large investments were made in schools, hospitals, transportation facilities, fish processing plants, warehouses, and telecommunications facilities. Both mining and hydrocarbon exploration were intensified. The Cominco-operated mine, the Black Angel, in Marmorilik illustrates a commercially-successful operation.

Norway. The northern areas of Scandinavia can support more mixed farming than is possible in most of northern Canada. Although small, nomadic native populations still exist (principally the Lapps), the northern areas of Norway have problems more similar to those of the Atlantic Provinces than to those of Canada's North. Like the Maritimes, the hinterlands of Norway have not kept up with the economic development of the rest of the country. Forest products, fishing and, to a lesser extent, farming still predominate. The

government has tried a number of measures to assist development. Norway's attempts to stimulate migration to large centres through direct grants are similar to Newfoundland's efforts in this direction. Norway has also made provisions for the promotion of local development projects and outright subsidization of particular industries. To date, the "oil boom" has not greatly influenced Norway's North because of a deliberate government policy that has limited the exploration and development to the more southerly latitudes.

> "The basic strategy of the oil policy was to keep development under constant restraint, matching the rate of development with Norway's capacity to handle it, both industrially and socially. Although foreign companies played a very large role in this development, overall control is very much in the hands of the state, and its agency, Statoil. In the meanwhile, Norway's ship and machine builders, design engineers, and other industrialists have been able to diversify into the industry in such a way that national control and ownership is confidently maintained.
>
> "Another important lesson of the Norwegian approach is that sectors not directly benefitting from the oil-boom have not been disrupted. The fishing and small labour-intensive industries would have lost their best labour to the high wage oil industry in a full employment economy so that many small towns and coastal communities, the mainstay of Norway's existence, would have had their economic base seriously impaired. At the same time, fast development of oil would have generated enormous inflationary pressures. These considerations were taken into account, and the state not only slowed down the development rate, but also banned drilling north of 60° and put on tight monetary control, giving Norway one of the lowest inflation rates in Europe over the past three years."[9]

Sweden, Finland, and the Soviet Union. These countries have all attempted to "modernize" and foster economic growth in their underdeveloped northern areas. Since the Soviet Union is the only nation that has a comprehensive and sustained policy of economic development in the arctic zones, discussion will concentrate on this country. "The conditions for plant growth are much more favourable in Siberia than at comparable latitudes in Canada. Barley, oats, rye and potatoes can be grown on a commercial scale, together with other cold crops. . . . Thus, Siberia is quite unlike the picture most Canadians have of it. Truly Arctic conditions, or cold deserts, cover only the extreme north, that is, the Arctic Sea coastal belt and Northeast Siberia. In Canada, these conditions begin from as far south as the shores of James Bay."[10]

Historically, despite a period of development using forced labour, Siberia has attracted many people voluntarily. Siberia still offers relatively more freedom, higher wages, wider availability of consumer goods, and faster occupational advancement than the more settled areas. Housing, cultural activities and educational facilities are relatively better than in the rest of the USSR, too, and industrialization is encouraged because maximum value is added locally. Thus Siberian enterprises typically export the finished materials, so that the profits and jobs are retained in the area. A different process occurs in Canada's North. Here the profits and most of the secondary jobs are typically exported with the raw material.

In spite of the government incentives for settlement and growth in northern Siberia, it still contains only 1 per cent of the USSR's total population. In the early 1960s "despite heavy inflows of labour related to oil and gas and other developments, Siberia's population declined, not only as a percentage of the USSR's but absolutely. Some oil field developments have had labour turnovers of 87 per cent."[11]

In common with Canada, then, the frontier activities of other nations have been shaped by the broad impact of industrialism and the need for northern resources. As these effects have been felt in the North, native peoples have become less nomadic and less dominant. Economic growth in the hinterlands has therefore been strongly influenced by external forces. Norway presents some exceptions to this trend. It has attempted to provide economic growth as well as some protection from external pressures. The Norwegian policy is one of the most interesting and promising models of development.

Contemporary Trends

Government and Resource Extraction: During the last 20 years, the scale and complexity of northern resource extraction have increased. With this has come increasing government support in the form of infra-structure and tax incentives to industry. For example, at Cominco's Pine Point Mine, NWT, completed in late 1966, the federal government provided a rail link from Grimshaw, Alberta, a road from the Mackenzie Highway to the mine and a hydro power plant on the Taltson River. The railroad alone cost $86 250 000 while the Talston River installation cost between $9 and $10 million. Government's investment in Pine Point has been quite large; the company's investment to date amounts to $110 million. Also, the company was exempted from taxes for its first three years of operation, during which time it mined 50 per cent combined lead and zinc deposits and paid dividends of $67.5 million; from 1969–76 it paid additional dividends of $172.7 million.[12] In return, total taxes paid to the end of 1976 were $85.3 million, not including employees' income tax, out of total net sales of $590 million. Freight charges of $170 million were paid to the Canadian National Railway, as well, plus $20 million toward the cost of the railway. Over the life of the mine, then, the government's investment in Pine Point will probably have been profitable.[13]

The public tends to believe that the costs and benefits of such projects favour industry, because of the complexity of the situation and the time scale of the operation. The federal government's response to this concern is exemplified by the Strathcona Mine project. Here government obtained, in exchange for its support, not only agreement with respect to environmental regulation and employment goals, but also an 18 per cent equity in the mine. This was a significant advance, from the government's point of view, over the arrangements at Pine Point. But this agreement created several anomalies. For example, a high ranking official from the Department of Indian Affairs and Northern Development (DIAND) sat on the Company's Board of Directors at the same time that his Department was responsible for negotiating the agreement with the company. Thus government was placed in a position of apparent conflict of interest.[14] Since governments will probably continue to be important participants and equity holders in major northern projects, and perhaps many smaller ones as well, this conflict of interest dilemma will likely recur.

Administration of the North and Local Autonomy. Arrangements for governing Canada's North have traditionally located decision- and policy-making power in the southern areas. The Yukon and Northwest Territories are chiefly administered from Ottawa, for instance, northern Saskatchewan from Regina,

Nouveau Québec from Quebec City, and Labrador from St. John's. Communication and transportation lines have also tended to run south-north.

The need for more local involvement in administration and communications within the North is increasingly recognized. Initiatives for local autonomy are evident in recent petitions to close the liquor retail outlet in Frobisher Bay, a request for a liquor quota system for the Dogrib people near Yellowknife, and the use of a referendum to achieve prohibition of alcohol in the predominantly native area of Rae-Edzo and Lac La Martre in the Northwest Territories. The comprehensive claims by native people in the North, and the James Bay settlement, are examples of political initiatives on a broader scale.

Economy. There is a dual economy in the North.[15] That is, there is a traditional sector which is characterized by low incomes (the average per capita income, for instance, of native people in the Churchill River Study Area was $491)[16] and which benefits little from modern industrial activity. Mineral production generates relatively high incomes and large profits that often exist quite separately from a surrounding northern area. This is especially true of projects such as the Pine Point Mine or the Pointed Mountain Gas Pipeline in the NWT: neither project has had any discernible economic benefits in the traditional sectors of the economy.

The "dual economy" also exists in the service sector but in a different form. Although teachers, government administrators, and case workers do interact with members of the local community, their income sources and life styles are typically very different. Mineral production and government spending are, in dollar terms, the most significant components of the northern Territories' economy. Capital flows are typically from south to north, while cash flows are greater from north to south.[17] In other words, a large amount of the money invested in northern Canada actually goes to buy the equipment and other materials from southern Canada needed for northern projects.

Technology and Culture: Health and Housing. Many laudable efforts have been made to transfer the comforts and requirements of southern urban society to northern communities. These efforts have produced some undeniable benefits, such as lower infant mortality. There have also been some unintended consequences, such as alcoholism and certain dental and ear diseases which had never been prevalent before.[18]

Two major issues related to the development of technologies for the North have emerged. The first is whether a new technology will have a net beneficial impact on the native peoples in a northern region. There are usually no clear-cut answers to this sort of question. The second issue is whether a technology will be adequately adapted to the northern physical environment. The inadequacy of housing or the limitations of snowmobile design illustrate failures here. The problem is that the markets for northern technologies are not thought to be sufficiently attractive to warrant expensive development work and the establishment of mass production facilities.

In contrast, defence or large resource projects carry with them enough market power to motivate improved designs of relevant technologies. As a result, a visible manifestation of the "dual economy" has emerged in some northern communities in the form of different standards of housing and waste disposal provided by government and industry for their employees as

opposed to that made available to native people and long-time northern residents. Science and technology for the North need to be fostered, so that northern residents can choose appropriate technologies to complement their chosen life style.[19]

Education. The extension of education to the North has too often been the product of good intentions and direct transfer of southern ways to the North. Subject matter and the language were typically imported without modification. The unfortunate mismatch between educational programs and native cultures in the North has been evident in a high dropout rate of native students. Students who managed to adapt to the education offered often found that they had increased difficulties in communicating with their families, for instance. Forfeiting the northern family culture, however, did not necessarily guarantee acceptance in a southern setting. Usher has noted that relatively few native students tend to obtain jobs in government and industry even though they have learned appropriate skills.[20] On the other hand, it has been argued that native people will not even have the choice of entering into the economy of "mainstream" Canada if they are not exposed at all to the kind of education offered other Canadians.[21]

Recently, an awareness of the need for education that recognizes cultural differences has been developing in the North and elsewhere in Canada. In the North, there are now efforts to employ the native language in schools, and efforts to provide an opportunity to develop skills useful in adapting to the dominant Canadian culture have continued.

The Challenge of Canada's North

Canadians have alternatively, and occasionally simultaneously, viewed the North as a cornucopia of resources, an important strategic military locale, the native peoples' last refuge, a barren wasteland, and as a natural laboratory for biological, physical, oceanographic, and social science.

All of these views have, at one time or another, affected the level and direction of Canada's interest in its hinterland. However, the vision of the North as a cornucopia of natural resources has probably been the most influential. Belief in the presence of large oil and gas deposits in the North has certainly motivated recent interest in the tundra, Arctic Islands, MacKenzie Delta, and off-shore Labrador. Other resources, of course, have also engendered enthusiasms from time to time. Within the last twenty years, John Diefenbaker's "Northern Vision", the optimism of the annual reports from the Department of Indian Affairs and Northern Development, and statements by those interested in promoting northern projects created a situation in which few people seriously questioned the view of the North as a storehouse of resources.

More recently, the cornucopia vision has been tempered by a growing realization of the finiteness of natural resources as well as the relative inaccessibility of the North. Resources which would be extremely attractive if located in southern Canada are seen to be uneconomical in the North. They may not warrant production for a long time.

The belief in a northern repository of riches has also coloured perceptions of the "problem" or challenge of the North, for it has focussed attention on the physical obstacles to resource extraction and the extension of

southern-type settlement and culture. As the cornucopia vision begins to fade, the perception of the challenge also shifts. Today, it seems that Canadians are becoming more aware of the essential nordicity of their nation and the need for its development. The challenge confronting Canada, especially with respect to the North, is to create cohesion among the varied and interdependent regions of the country, while responding to opportunities for regional development in the economic as well as political sense.

III. Strategy of Mixed Development

The recent history of the North has been the product of two major and apparently conflicting trends. The trend that predominates in many discussions of northern development is the thrust toward large scale exploitation of natural resources. The second is the desire to continue traditional resource harvesting activities, such as fishing, hunting and trapping. The latter trend would lead to northern development based on smaller scale projects, locally controlled.

Trend One: Large Projects

The Science Council was initially of the view that the major driving force of recent activity and interest in the North was the possibility of a number of large projects. It was felt, therefore, that decisions associated with such projects deserved closer examination. Case studies were undertaken on hydroelectric projects in James Bay, the Alberta Oil Sands, hydrocarbon exploration and development in the Arctic Islands and in the Mackenzie Valley, hydrocarbon exploration offshore Labrador, and the lead-zinc mine at Strathcona Sound.[1] These case studies represented a spectrum of the types and locations of major resource projects presently initiated or contemplated in the North. All appeared to share the following characteristics:

- Capital intensiveness (A very large amount of capital is required for each new job created, sometimes well in excess of $1 million per job.)
- Large scale
- Long lead time (From initial planning to final completion may require a decade or more. Production of hydrocarbons from offshore Labrador, assuming that sufficient reserves are found, would not begin before the 1990s, for instance.)
- Non-renewable resource extraction (or large hydroelectric project)
- Potentially severe environmental and social consequences
- Government approval and financial support required
- Environmental and social costs that are not quantified and that are usually left out in the "go-no-go" decisions. (These include social dislocation, impact on wilderness, and similar costs.)
- Efforts to improve working conditions in the North, which is reflected in the continuing push to improve, by southern standards, the amenities and living standards in the North, resulting in some attention being given to the technologies related to waste disposal, housing, and health care.
- Greater attention paid to improving transportation and communications services.

Trend Two: Small Projects

The second trend *appears* to be quite different. It is associated with the following:

- Desire for economic self sufficiency of northern peoples.
- Desire to use skills and materials available locally.
- Concern for *long term* environmental protection.
- Desire for local control of education, cultural activities and municipal services, all, for instance, associated with teaching of native languages and culture.

Both trends are evident throughout the North except in areas that are completely committed to the industrial economy, or in villages that still mainly depend on land-based resource activities for subsistence. The first trend is economically more dominant at this time but, in our view, both are important. *What is needed, in the short run, is a transition to a more balanced strategy for northern development.* This transition will inevitably require that a greater emphasis be placed on renewable resource management than is presently the case.

A Strategy of Mixed Development

The Science Council believes that both major trends should be accommodated in a *strategy of mixed development.* Such a strategy would press for more economic and technological self-sufficiency for the North. Activities that can be locally defined and controlled would be favoured over those which tend to increase political and economic dependence, the need for welfare, or other undesirable social conditions. This means an emphasis on relatively low capital, decentralized, and small scale development. The second thrust of the mixed strategy approach is that economically viable (including social and environmental costs), large scale projects can and should take place in the North; Canada will continue to depend on energy and mineral resources for its own use and as a basis for export earnings of further processed materials. The North can contribute to national economic and energy requirements. In so doing it can create a financial basis for small scale projects which, in terms of square miles of land use and the participation of northern peoples, should constitute a major element of northern development.

In the past, the two elements of a strategy of mixed development have usually been in conflict. In some places this has produced social tensions and environmental degradation. But both approaches have a discernible contribution to make to northern development. For instance, if commercial exports to southern Canada were the sole criterion of development, then a caribou meat industry might never become viable due to high transportation costs and a marked preference for beef by the majority of Canadians. However, if native northerners' preference for country foods, i.e., indigenous foods, is acknowledged, then the small market for caribou meat could be developed to utilize the resources of the North without inflicting cultural disturbances on northern peoples. On the other hand, the capital requirements entailed in the development of northern mineral resources cannot be justified in terms of northern markets, though the needs of Canada as a whole do justify them.

Objectives for Northern Development – The Science Council View

The principle objectives of northern development espoused by the Science Council are, therefore, similar to those expressed by the Federal Government.[2]

1. To promote the welfare of northern people, especially the indigenous peoples, through the encouragement of appropriate developments designed to aid, where the people desire this, community development, the retention of traditional life styles and cultures, as well as opportunities for participation in wage activities which support this general objective. This objective encompasses the extension of appropriate health and dental care, housing, and municipal services.

2. To maintain and enhance the regenerative capacity of the environment. This means that environmental considerations, including land use policies, should be important components in the decision-making process for northern projects.

3. Renewable resource development should have a higher priority than at present. The goal is the economic and social sufficiency of northern communities.

4. To encourage economically viable non-renewable resource projects which are in the national interest and which will benefit, or at least not harm, northern residents and the northern environment.

In advocating such a strategy, the Science Council takes a position consistent with the announced intentions of most governments with responsibilities in the North. At present, however, the economic, social, political and science policies to support this strategy have not yet been effectively implemented. In particular, the Science Council believes that a balanced policy for the use of science and technology for northern development must be established at the earliest possible time, in view of the importance of the problems which must be overcome.

To the extent that policies for the use of science and technology for northern development have existed, they have been *ad hoc*, and aimed almost exclusively at supporting large scale industrial development. However, recognition of the need for redressing the balance is already implicit in the establishment by the Department of Indian Affairs and Northern Development of "Guidelines for Federal Scientific Activities in Canada's North" and by the Canadian Council on Rural Development of its policy recommendations for the Mid-North of Canada.[3] These initiatives originated in a recognition of the needs and requirements of northerners, as well as a recognition of the potential contributions which northern resources can make to the nation.

Challenges

The major challenge is to develop policies and programs to implement this strategy. Internal conflicts between large and small scale projects must be minimized and adequate means for resolving remaining conflicts must be devised. A major objective will be to encourage "parallel" development and thereby avoid physical conflict. The proponents of the Mackenzie Valley Pipeline, for instance, were aware of the disruptive effects of construction on northern communities, and they made several proposals which would inhibit interaction between the communities and the work camps.

The "boom-bust" effects of large projects can be minimized for mining and petroleum exploration and operation by more extensive use of transient settlements and commuting of workers from regional centres.[4] The idea of transient settlements is not new. The Commission Counsel's final arguments to the Mackenzie Valley Pipeline Inquiry were also concerned with this question.[5] One of the strongest recommendations was related to the necessity of isolating transient pipeline workers from the community. Another recommendation was based on the observation that resource harvesting activities can be compatible with participation in wage employment. It was urged that a balance between the two kinds of activities could be achieved by wage employment schemes which are sensitive to the components of the subsistence cycle and which accommodate seasonal events like hunts, maintenance of trap lines, etc. The Science Council's Discussion Paper praised rotational

schemes such as that of Panarctic Oils Limited, which allow this sort of flexibility and balance to occur.[6] These are examples of existing pressures and activities which implicitly support the mixed strategy which is proposed.

Consequences of a Strategy of Mixed Development

Mixed development will not automatically resolve tensions and disagreements. It will, however, contribute to the general aim of increasing the self-sufficiency of northern peoples and the choices available to them. Some other anticipated consequences of pursuing this strategy include:

1. There will be a measurable improvement of the northern "balance of payments" problem. (Inasmuch as the North is a hinterland to the rest of Canada, there is a natural tendency for imports to flow northward and exports to flow southward.)
2. Knowledge about the environment and resources of the North will increase. New orientations in research on the development of technologies which are smaller scale, less capital intensive, better adapted to northern conditions and geared to long term renewable resources will emerge.
3. Large projects will be carefully assessed and the participation of all interested parties in such assessments will increase.
4. Government participation in large projects will become even more common.
5. Although a few settlements may remain relatively self-sufficient and isolated, there may be a trend toward regional aggregations which are socially and economically interdependent. Where inadequate resource bases exist, governments may continue supportive measures. The enormous diversity within the North will be recognized and reflected in a diversity of approaches.
6. Increased social, political and environmental accountability on the part of industry, government and, in the event of a land claim settlement, native peoples themselves will be evident.

The most significant aspects of this strategy are a willingness to entertain local projects and to extract the mineral resources of the North more slowly than some major participants may desire. While the Science Council does not advocate a general moratorium on major northern projects, it realizes that the goals for northern development, which the government has adopted, require consideration of many more factors than the simple attractions of the economics of exporting a non-renewable resource. The pace of northern development must depend upon sufficient scientific and technical information for assessment of the feasibility and desirability of a project.

Emphasis on *local* projects requires that large scale projects be controlled so that they will not threaten long-term social, environmental and economic goals. Proponents of large-scale projects should have to satisfy the authorities in open court that they can satisfy criteria which would develop from this approach.

Meeting such criteria will require attention to social impacts. This will involve considerations such as the separation of large-scale activities from local activities and the provision of suitable job opportunities for native peoples. It will also involve the development of technologies required to avoid ecological damage. In this sense, the development of large-scale projects presents a challenge to Canadian scientists to solve particularly Canadian social, environmental and physical problems.

In the case of the Mackenzie Valley Pipeline, for instance, it appears that currently (May 1977) available information[7] does not justify proceeding with a pipeline for gas from the Mackenzie Delta now. How long the project needs to be delayed depends on the speed with which new information can be developed and the perceived issues resolved. The situation should be the subject of continuing review, not only in relation to evolving circumstances in the North, but also in relation to the evolution of alternative energy supplies, technologies and demand patterns.

Perceptual Shifts Required

The strategy of mixed development will require *greater sensitivity to traditional patterns of land use* and a recognition of the low biological productivity of the North, which means that the land and water are used extensively, over relatively wide areas, rather than intensively, as in mining or agriculture. "The land" has special significance for many native northerners; it needs to be valued not only in terms of its measurable economic value, but also in terms of its capability to meet a variety of needs which are not measurable in monetary terms.

There must also be greater *recognition of the value of public participation*. The right of people directly affected by a project to have something to say about it is becoming more widely accepted; disagreements now focus around who should participate, when and how. In the North, in fact, complaints about inadequate *consultation* have been so frequent that the question of *participation* itself is only now being raised. To pursue successfully the strategy of mixed development, there must be more than informing, educating, and consulting northern peoples about the needs of the rest of Canada for a certain project. A land claim settlement offers a possibility of a legislative basis for this participation by providing its framework, rationale, and legal forms.

IV. Principles of a Science Policy for Northern Development

Four principles should guide the pursuit of science policies for northern development. In more specific form, these principles will become performance standards against which to measure the success of demonstration programs, regulations, large projects and other initiatives. The principles are:

1. *Technological sovereignty*–the ability of Canadians to control, direct and benefit from technological enterprises deemed essential to the country.[1] (A national concern, primarily).

2. *Life Style Flexibility*–the need to allow opportunities for choices of life style. (A local concern, primarily).

3. *Maintenance of the regenerative capacity of the land.* (Standards of environmental acceptability).

4. *Comprehensive and balanced assessment and monitoring of large and small projects.* (Standards of political acceptability).

There is a need for science policy to reflect national and regional goals for northern development. To achieve this, the Science Council recommends that the above principles should govern the choice of all new research and development initiatives in the North.

Technological Sovereignty

An obvious element of technological sovereignty is the capacity to support certain key R & D tasks in Canada. In the North, as elsewhere in Canada, Canadians and Canadian science and industry tend to place undue emphasis on foreign expertise and foreign consultants.[2] This is because of the relatively low level of industrial R & D performed in Canada and because of the structure of Canadian industry which is largely foreign-owned. Foreign-owned firms tend to perform the research which has greatest potential for long-term pay-offs in their home country.[3] In offshore Labrador, for example, where several companies are searching for oil and developing the expertise necessary for that environment, Canadian firms have participated in the data collection phase, but they have had very little to do with planning and design of production and transportation facilities. The nature of research activity in Canadian resource-related industries, then, tends to resemble the resource extraction industries themselves. That is, with few exceptions, Canadians provide the raw materials, but the control of the operation, the processing and, hence, long-term benefits tend to flow out of the country.

A similar situation exists with respect to construction management for large projects. Canadian Bechtel, a subsidiary of Bechtel in the United States, with its experience in Churchill Falls, James Bay, and Syncrude, now has far more experience on large projects than any Canadian-owned firm. Canadian Bechtel's contacts with financial interests in the United States are at least as important to project backers as is construction experience.

This problem persists even with smaller components of large projects, or with projects that are on a scale consistent with the capabilities of Canadian industrial and technological competence. The design of offshore Labrador production facilities and the development of ice-cutting drill ships need not have been undertaken abroad except for the fact that it was not in the commercial interest of the companies involved to do this work in Canada. Even if the work were done here, the principles of proprietary knowledge would prohibit it from being generally available to Canadians.[4]

Offshore petroleum exploration has given rise to continuing concern in Canada. In 1973, the government announced that "Canada must develop and control within its own borders the essential elements needed to exploit off-shore resources" by:

- stimulating development and effective participation of Canadian industry in the plan to see that Canada controls the essential industrial and technological ingredients to exploit off-shore resources.
- emphasizing a wide range of marine science and technology programs relating to management of marine environment, renewable and non-renewable resources, development and maintenance of ocean engineering at universities and in government laboratories, and better forecasting of weather, current, ice and similar atmospheric and oceanic factors.
- achieving, within 5 years, world-recognized excellence in operating on and below ice-covered waters.
- being equal or superior to foreign governments or large multinational corporations in developing and maintaining a current information base about its renewable and non-renewable offshore resources.[5]

In this enunciation of an oceans policy, the Canadian government expressed its political sensitivity to the need for "technological sovereignty". However, the enormous amount of foreign investment needed to finance large projects can create pressures which may continue to make it difficult for Canadians to assert control over technologies which are vital to national economic health, or to the health of the industrial and scientific community. "Will one of the trade-offs for adequate levels of foreign investment in Canada's energy future be a continuation of the 300-year pattern of colonial development in Canada?[6]"

We therefore advocate the promotion of technological sovereignty as a cornerstone of science policy for northern development. There must be an effort to support and promote research and development which will improve Canada's capacity to control and to benefit from the technologies needed to extract, process and transport its resources. This is important not only for economic reasons, and because it will aid the health of the technical and scientific community, but also because it will be easier for Canada to control the pacing of projects so that the maximum benefits from large northern projects may accrue to Canadians.

Ownership and control are two means of attaining technological sovereignty. We will also need to create an appropriate political environment, organizational structures, and managerial skills to effectively control relevant technologies. Norway and Japan have shown that with the proper political environment, it is possible to control important technologies through appropriate licencing arrangements and/or appropriate regulatory mechanisms, provided, of course, that the nation develops and retains an indigenous capacity for innovation.[7]

Technological sovereignty is a national concern with important regional implications. For instance, Alberta, Saskatchewan and Quebec have consciously pursued policies whose primary goal is the attainment of provincial control of key technologies affecting their future.

Some provinces, as well as northern regions within provincial and/or federal jurisdictions, will view any thrust toward "technological sovereignty" as benefitting other areas more than their own. A major component of technological sovereignty should be a concern for regional and northern benefits, as well as overall national benefits.

Flexible Life Style Options

The Science Council supports the first stated objective of the federal policy for the North[8] which gives the highest priority to the welfare of the northern peoples, especially indigenous peoples. Concern for the disappearance of a traditional way of life is not romantic. Hunting and fishing economies have provided a source of income, food, and satisfaction to those who pursue these activities, as well as a source of pride for Canadians who value the distinctiveness of the North. Ensuring that northerners have the option of continuing these pursuits will produce social as well as long-term economic benefits. Already there are exemplary industrial programs which, to some extent, attribute their success to work arrangements that take into account the traditional life style of native peoples. The Panarctic Oil system of 20 days on and 10 days off is an often cited example.[9]

Research and development can help to preserve life style options in the North by promoting appropriate "intermediate technologies". This orientation has implications for education and communications, and could alter the role of technology transfer to and from northern Canada. While technologies will continue to be adapted for use in northern environments, some may actually be developed in the North. This will require local participation in research *and* in the choice of research projects in the North.[10]

Regenerative Capacity of the Land

The flora and fauna of northern lands and waters are not "fragile". They can regenerate if the regenerative capacity of the land is understood and respected. However, the low biological productivity of northern ecosystems means that renewable resource harvesting cannot be successfully pursued in the same manner as in southern Canada. The spruce of New Brunswick are not only larger than those in the Northwest Territories, but will mature in 50 years rather than in the 100–200 estimated for the NWT. Sport fishing in the high arctic has already depleted some lakes of large char, which take 40 years to reach maturity. Large fish in more southern lakes are rarely this old, because they grow to maturity more quickly. Ecological balance is more easily disturbed and less easily restored in the North.

Concern for the regenerative capacity of the land implies that non-renewable projects must take the low biological productivity of the land into account when considering possible environmental impacts. Projects already undertaken will require more time to monitor effects on the environment than in southern Canada.

The Science Council believes that geographical areas should be established where no damage would be permitted. Standards of maximum damage should be set in other areas to ensure that no long run degradation of the regenerative capacity of northern lands and waters will occur.

Adequate Assessment and Monitoring

The Science Council Study began with a concern for improving the role of science in decision making about northern development. Is the process for assessing projects and their proposed technologies adequate?[11] The answer to this question involves asking who the participants were in different projects, what their interests were and what capacity they had for assessing a project

and ensuring that it worked to their advantage. The matrix constituted by these "actors" and their interactions has been described as the "technology assessment system."[12]

The Council's review of six projects in the North has shown that:[13]

1. There has been a tendency for the interests of the major actors (i.e., government and industry) to override the interests of the other actors.

2. Northern residents have tended to be excluded from the assessment system.

3. Environmental issues have tended to be addressed only after the project was agreed upon.

4. Social issues have been narrowly defined, often in terms of job opportunities in a wage economy.

5. Economic issues have been paramount, but the traditional price system and relatively short time-frame of these issues have sometimes conflicted with long term national benefits. This reflects the fact that economic considerations, notably the cost of money, often impel major actors to take actions before an adequate data base can be developed. Timing the assessment process so that the pacing of the constituent elements of northern development is orderly is therefore critically important.

The Council believes that the assessment process for northern projects is an important component of northern policy. Science and technology should play an important role in these assessments. Some general principles apply for such assessments:

1. All affected parties must have the opportunity to *participate* fully in the assessment, that is, the process must be *balanced*.

2. Assessments must be timed so that they take place *before* the decision to proceed is taken. (There is still the very important task of implementation and monitoring. The same criterion of balanced participation also applies here).

3. Assessments must be conducted in the context of other related projects. A single proposal, for instance, may have a relatively minor effect. However, if it is just one of many, the cumulative effect may be much greater.

4. Assessments must have broad terms of reference. It is not enough, for instance, merely to consider whether there will be environmental effects. Each affected party must be able to determine in what ways the project may affect its interests and how, if modified, the project might have less harmful or more beneficial impact.

5. Government is responsible for ensuring that affected parties have adequate opportunity to make their needs known, that no projects are undertaken which do not meet basic economic and environmental standards and that, from a long term point of view, the most desirable rate of non-renewable resource depletion is determined. This requires a *capacity for independent data gathering and the independent assessment and evaluation of data belonging to others.*

6. There must, as a general principle, be open access to information. While there are occasionally good reasons for keeping some data or plans confidential, too often this is done routinely.

7. There must be independent bodies to identify areas in need of technology assessment, as well as independent bodies to conduct the assessments.

8. Where unrefereed scientific work supports a project proposal there must be opportunities for a credible validating procedure. The adversary approach is useful in this context, as was demonstrated at the hearings of the National Energy Board and Mackenzie Valley Pipeline Inquiry on the Mackenzie Valley Pipeline. The competing applications of Foothills and Canadian Arctic Gas incidentally produced a much more thorough examination of the pipeline proposal than if there had been only one application.

The process employed by the Mackenzie Valley Pipeline Inquiry (Berger Commission) has been a valuable national experience; it has made a unique contribution toward the evolution of a balanced technology assessment system in Canada.[14]

The Science Council urges that attention be paid to these principles in the course of implementing science policies for northern development. Demonstration projects, research activities, regulations, and technological innovations which flow from the policy should be carefully measured against these principles. If they are shown to be wanting with respect to fostering technological sovereignty, for instance, they should be amended accordingly. This will require means of defining appropriate indicators against which to measure the success of northern policy proposals and programs. Such work could be undertaken, in consultation with native groups and others with northern interests, by agencies such as the Institute for Research on Public Policy, the Economic Council, Statistics Canada, the C.D. Howe Institute, university groups, or the Department of Indian Affairs and Northern Development.[15]

V. Initiatives to Support a Strategy of Mixed Development

A science policy for northern development should aim at acquiring adequate knowledge and experience so that informed decisions can be made. Decisions should be taken by those charged with formal decision making *and* by those living in affected areas. Decisions should be taken with a view toward both long term benefits and total costs.

For the most part, existing institutions will be able to deal with emerging problems, although some need a change in orientation. The following recommendations are intended to suggest possible new orientations. Like technologies, they will have to be adapted to the distinctive conditions of different northern areas.

The Science Council suggests several initiatives which will support a consistent science policy for northern development. Recommended initiatives are intended to support a strategy of mixed development.

University Research and Education

The Role of Universities with Northern Competence

Universities should play a greater role in the solution of northern problems. The relative role of Canadian universities in northern research and development has declined. Despite the efforts of the Universities of Alberta, Saskatchewan, McGill, Chicoutimi, Laval, Memorial and others, most northern research is now performed by industry and government. Much university research in the North is done on contract, sometimes with restrictions on its general availability and usually without peer group reviews of the researchers or the quality of their work. Moreover, contractual arrangements have proved to be a poor way to ensure continuity in university programs. The capacities of universities for independent work in the North, which were never high, have not increased.

Canada needs to have a cadre of university researchers in the North who are not dependent on receiving contracts from interested parties for their research money. *The Science Council urges that funds available for Canadian researchers in northern research be reallocated* so that grants are emphasized over contracts. The granting councils should encourage northern research by providing funds for logistic support over and above other costs. This means giving good applicants what they need to do research, then adding what they need to do it in the North. In addition, contracting out policies of the federal government should be modified to ensure continuity of support for university research workers.

Independence of university research should be coupled with coordination of the efforts of various university researchers. Even within a university, coordination between researchers can be difficult; it depends more on stimulating initiatives than on legislating cooperation. Among universities there are even greater problems of coordination, even though the benefits of cooperation are considerable. Happily, twenty-five universities in Canada with interests in northern research have recently organized an Association of Canadian Universities for Northern Studies to ensure a greater joint university effort and to provide a more effective interface between government and the university sector.

Most Canadian universities could be expected to place greater emphasis on northern research that they can do in their own backyards. Except for Nova Scotia, New Brunswick and Prince Edward Island, all of the provinces

have a hinterland which is a logical place for research activities. The costs of research north of 60° are very high so that if university research in the far North is to flourish, the federal government will need to provide adequate support. The provinces will have to make analogous efforts.

Northern oriented university research does not, of course, constitute the only area for university response to the needs of the North in higher education, nor, for that matter, to the needs of southern Canadians for improved understanding of the northern features of their country. In 1971–73, in Canada as a whole, only 0.8 per cent of biology and wildlife courses, no health science courses, and 1.1 per cent of engineering and agriculture courses were "northern" oriented.[1] And, in the North, native people have consistently perceived a mismatch between the research and education which is available to them and that which they desire. The most obvious lacuna is courses in the North on biology and renewable resource management, which are commonly cited by northerners as areas they wish to learn more about.

For southern Canadians, the whole educational system could do with some northern perspectives; for northern Canadians there is need for a well-organized delivery system for specialized higher education.

A University of the North

A University of the North should be established. The most immediate value of a University of the North would be to provide a focus for the development of northern research activities explicitly designed to solve northern problems. This would mean an emphasis not only on encouraging research and developing and evaluating small demonstration projects, but, perhaps more importantly, an equal emphasis on extension activities – the dissemination of knowledge and research findings to those needing them. The university could play a key role in the implementation of a balanced science policy for northern development.

The university should concentrate on areas such as resource management and systematizing resource inventories. It should vigorously promote the innovation of northern technologies by sponsoring demonstration projects and by helping to assess the projects of others. It should be seen to be doing excellent and relevant research. Native peoples should play a central role in the choice of research topics and in undertaking research. Native northerners should be given every opportunity to gain experience by working with pre-eminent scholars.

The University of the North should act as a centre for information about the North and for the North. A good library and information centre should perhaps be the first step in building a university. Resource inventories and other data banks should be filed and maintained in the centre. There should be easy access to other repositories of northern information. A computer linkage to other parts of Canada would be essential.

With this base of gathered knowledge, the university should launch a vigorous information service and couple this with an extension program that responds to the requests of northerners for more knowledge. The university should also provide on-the-spot seminars, workshops and extension courses, using its own faculty and perhaps faculties from southern universities.

A University of the North would have a student body including (1) some graduate students, largely from the south to begin with, but perhaps, with time, a growing cadre of northern students who had gone south for

undergraduate training, and (2) all the people of the North who wanted specialized and reliable information of northern relevance. The first group of students would receive graduate degrees. The second group of students would in the first instance get the information they wanted, but in time diploma programs could be developed. Eventually, the university might stimulate the creation of a northern polytechnic college.

The choice of faculty members for the university would be critical, for they must combine research ability with a willingness to live year round in the North and to devote their time as much to disseminating their findings as to accumulating new knowledge. With the right kind of faculty members, the University of the North could ensure that northern science had continuity and was not another boom and bust phenomenon.

The university should have a Board of Governors, mainly northerners; it should have a main campus that is a conspicuous physical presence; and the existing school facilities and scientific establishments in other places should be used as subsidiary campuses.

Funding should be primarily from the federal government. With a small administrative staff, a faculty of perhaps 50 professors, and a library and communications group of perhaps 50, the university could be launched for a small amount of money in comparison with other government expenditures in the North.

The idea of a University of the North is not new,[2] and there have been other visions of what form such an institution might take. But the Science Council believes that the institution described herein is most responsive to the future needs of the North. While a university with a graduate emphasis and an extension service without an undergraduate role may sound unorthodox to traditionalists, the northern need now is for good research and good local extension work. Canada has many good undergraduate programs in its southern universities. To duplicate them in the North would be expensive and would take a long, long time.

What is needed now is a relevant institution, with all the prestige that attaches to the word "university", and which provides a vehicle for formal communication with the intellectual resources of the rest of Canada. Few things could better serve northern aspirations than a University of the North. The whole of Canada would benefit.

Knowledge and Research Base for the Strategy of Mixed Development

An Adequate Data Base

To aid choices among development options, comprehensive knowledge of northern conditions and resources must be developed. Special attention should be given to the assessment of the potential of renewable resources.

For information to be useful, it must be accessible and relevant to its intended purposes. Critical information has often not been available when needed in the North, so that "crash" programs have had to be mounted.[3] The question of pacing is also paramount. Deliberate and steady accumulation of knowledge is preferable to crash programs, especially in view of the variability of northern conditions, particularly climate, soil, and population dynamics. Because of the shortage of scientific resources and facilities, research has tended to concentrate in areas in which major large projects have been under-

taken or are about to be undertaken. Research in other areas is spotty. There are *too many areas where too little research is done.*

One of the major tasks of the proposed University of the North could be to help overcome the episodic and spotty nature of much northern research. A university located in the North could be better suited to initiate and conduct major research programs on a continuing basis and with representative geographical coverage than universities in Southern Canada which are not *focussed* on northern research problems. The communication network we foresee for the North will be the tool by which the new university can monitor and aid research being conducted anywhere in this vast region.

Two kinds of data bases, which in practice overlap, are necessary. The first is *data at a general level* which facilitate policy decisions. The second is the kind of *detailed information* which is necessary for a project to be implemented.

Lack of information can be expensive and disruptive. For instance, without having carefully studied the possible environmental impact of tailings disposal into Strathcona Sound, Mineral Resources International Ltd. set up its concentrator and townsite at locations which assumed that disposal into the Sound would be acceptable. Similar situations have developed with respect to James Bay and the Syncrude project. If important environmental information had been known and designed for earlier in the process, significant savings could have been made later. A process of decision making which had admitted environmental factors into the process at an earlier stage would probably have obviated these errors.

It is important, therefore, to distinguish between research which provides the information needed to make a choice between policies, and research which supports a policy already chosen. All too often, research which supports a policy already chosen is presented as research which will aid in the decision of whether or not a specific project which supports that policy should proceed.

To pursue the mixed strategy successfully, *knowledge of both renewable and non-renewable resource potentials is important.* Inadequate knowledge can lead to ill-informed decisions. The Council recognizes that it will not always be possible, given the size of the North, to have a completely satisfactory data base. Decisions to proceed or not will inevitably rest on incomplete facts, but this is no excuse for not trying to improve our knowledge base.

The Existing Data Base for Non-Renewable Resources and Hydroelectric Projects

There is now more detailed knowledge of non-renewable resource potentials than there is of renewable resource potentials. As far as minerals are concerned, large areas of the North have already had systematic geological, geophysical, and geochemical surveys. Although such survey techniques can and ought to continue to improve, the data base for mining is reasonably good. There are a number of undeveloped deposits, particularly of uranium and lead-zinc, which await only a favorable political and financial climate.

Techniques for the discovery and exploitation of hydrocarbon resources are relatively well developed. Although principles of proprietary knowledge restrict detailed public knowledge of the extent of recent discoveries, it is known that the most likely areas of future frontier development lie in the Arctic Islands, in the Beaufort Sea and, possibly, in offshore Labrador. More

exploratory work will have to be done before it can be decided whether these areas have potential for commercial production.

Information is sparser with respect to hydroelectric projects. While there is sufficient data to indicate how much hydro potential exists in the North, much less is known about the engineering practicability, availability of storage sites, or economic viability of the sites. Of the total theoretical potential (16 400 MW (at 0.6 capacity) in the Yukon and NWT), 0.4 per cent has been studied to a pre-feasibility level.[4] Given the limited population of the North, this may be sufficient for many years to come, except in areas where mineral extraction is contemplated.

While there are some problems with respect to data on potentials for non-renewable resource extraction and for hydroelectric projects, research in these areas could more profitably concentrate on aspects of extraction, production, transportation and the attendant social and environmental impacts.

Data for Smaller Projects

There are serious deficiencies in the available data on renewable small scale resource potentials, despite a few efforts presently underway to improve the knowledge base. Major renewable resources are fish, game, agricultural products and forestry products.

Some numerical estimates of past levels of resource harvesting can be derived from records of the Hudson's Bay Company and provincial and territorial government departments. However, this knowledge is rarely systematic. Because of wide fluctuations in populations and habitats, surveys taken in one year are not always useful the next. In the Northwest Territories, the Arctic Land Use Research Program and the Inuit Tapirisat of Canada have made good progress in mapping the general locations of game and fish populations. However, the data for accurately determining sustainable yields are lacking in many instances, such as for the salmon fishery off the Labrador coast as well as the fish in the Mackenzie River. Nevertheless, estimates have been made which show that while the land is being well used (in fact, in some areas there would be overharvesting without regulatory controls), there are many significantly underutilized species including arctic fox, caribou, musk-oxen, reindeer, ring seal, white whale, char, whitefish, beaver, various bird species, lynx, wolverine, and edible plants and berries.[5] As with all resources of the North, access to the resource is often a major impediment, but it is not the only one.

Canada needs more extensive inventories of many northern animal and plant species, improved knowledge of food chains and ecological relationships, and research and demonstration projects on new systems of marketing and price supports. While a few projects have been initiated and have enjoyed some limited success, "these schemes have usually been undertaken without adequate funding and always without a clear acknowledgement that the native people should run these ventures themselves."[6]

Agriculture

There are about 4.8 million acres of potentially arable land in the NWT and Yukon.[7] Although the potential land area is vast, almost all of it is of marginal utility compared with the productive potential of more southerly agricultural lands. At one time, when transportation was more difficult and

transportation costs were higher, gardening and animal husbandry were commonly pursued by missionaries and other northern residents of European descent. Despite increased populations, agricultural pursuits are now much less common in the North, as relative transportation costs have declined. Among northern people, store-bought foods have become a major part of their diet, especially in the larger settlements with large non-native populations. However, except for market gardening, the Department of Indian Affairs and Northern Development no longer issues land use permits for agriculture, in order to allow the completion of a soil survey which is designed to permit sharper delineation of the most suitable agricultural areas of the NWT.[8]

Forestry

It is known that the wood resources of the North are large. However, many stands are comparatively inaccessible to commercial markets, might take a century or more, if ever, to regenerate, and are of marginal quality for lumber uses. Nevertheless, while perhaps not suitable for large-scale commercial exploitation, they can serve the needs of local populations.

Renewable Resource Inventories Need Special Attention

The data base for resource *potentials* is imperfect, but is adequate for assessing large projects. It ought to become adequate for assessing the potential of smaller projects as well. Project implementation or evaluation of interactions between competing land uses are often unsatisfactory because of insufficient information. Once the potential of a resource has been established, it can quickly become evident that the knowledge necessary to develop the resource successfully does not yet exist. It is equally obvious that, without adequate data bases, it is impossible to make reliable financial, engineering, environmental, or social predictions with respect to northern activities.

Because of the size of the North and its relative inaccessibility, data have proved to be a particular problem in northern science. A report on fisheries and wildlife research in Canada expressed concern that ecological and environmental research might not receive adequate attention in the push to develop Arctic resources. The Council urged, therefore, that the *first priority in environmental research be given to renewable resource inventories, that ecosystem studies be extended, and that research on industrial impacts upon Arctic renewable resources be instigated.*[9]

These recommendations still need to be acted on. Canada still needs an inventory of most renewable resources, even those with little obvious commercial attraction.[10] Inventories cannot be taken only in one year and in one place, because many northern species fluctuate widely in numbers, and there are also wide variations in soil and vegetative conditions.

Inventories should include the establishment of potential sustainable yields of several resources from a region. Thus, they cannot be conducted or interpreted in isolation from each other. For example, in considering inventories of potentially arable land, alternative renewable resource uses, such as trapping or logging, and the long-term effects of one pattern of resource use on another need to be addressed. The potential of forestry in the NWT is theoretical, because no one knows what would happen if large areas of the

North were completely logged over. There has been speculation that this would extend the tundra, and negatively affect wildlife populations, for instance. Therefore inventories of renewable northern resources should take into account alternative patterns of renewable resource development and their possible impacts on each other. Modelling and simulation studies will be useful methodologies.

Data for Decisions

Without an adequate data base it is virtually impossible to assess the impacts of large scale resource exploitation *before* making decisions to proceed.

> "During the past two or three years we have become aware that our knowledge of the North is inadequate – inadequate, that is, to formulate an integrated development plan for that vast region of Canada. Crash programs to collect badly needed information, often after development decisions have been made, will neither relieve the knowledge deficiency nor provide strong foundations for a sound development policy (which, interestingly, would still be unimpeded by the jurisdictional problems that beset the rest of Canada). *A sustained, organized research effort is badly needed.*"[11]

Governments responsible for administering and regulating northern development are concerned with a bewildering variety of legislation and regulations. While these regulations can and, in some cases, should be criticised, the data base and available labour are often inadequate to the task. For example, there are woefully inadequate data to refer to in administering the Arctic Water Pollution Prevention Act. The data base for the administration of environmental protection legislation, such as the Northern Inland Waters Act or the Territorial Land Use Regulations, is often lacking as well. The situation is compounded by insufficient and often inadequately trained labour for the day-to-day administration of such measures.

* * *

The Science Council recognizes that it is not feasible to have a "complete" data base ready at all times for all purposes. What is needed, as much as improvements in the data base itself, are:

1. The *capacity* to obtain a data base when needed.
2. Sufficient *time* to obtain the data base to ensure an adequate understanding of the environment.
3. Ready *access* to the data base by relevant, interested parties.

There will often be pressing reasons why time is not allowed to compile enough base-line information. In such cases, extreme conservatism is needed in setting regulations such as allowable catches, and length of drilling season. A further reason for conservatism is that the prospect of increasingly variable, and possibly colder, climate will have negative impacts on both biological productivity and Arctic navigation. This contingency needs to be allowed for in setting standards and permissible limits.

Development of Appropriate Expertise and Technologies

Appropriate northern technological capabilities and the indigenous expertise necessary to utilize this capability must be developed and nurtured.

Inventories, resource data bases and other basic information are not ends in themselves, but essential ingredients in advancing northern develop-

ment. Developing the ability to process and use data is as important as the original collection. Not only are there important gaps in this process, but some of the participants in northern development, notably native peoples and northern residents, do not have the same level and quality of research resources as industry and government. Canada must develop a capacity for addressing northern problems with an appropriate level of knowledge and processes that ensure optimal use of available information.

The Science Council has for many years been calling for improved efforts related to earth sciences, forestry, fisheries and wildlife, energy, and oceans science in the North. Others have expressed similar concerns. According to scientists, industrialists, and northern residents, many areas need further attention.[12]

A great deal of expertise, particularly that related to inventories and environmental matters, resides with industry, both inside and outside Canada. In his report, Mr. Justice Berger proposed that government "must have an independent body of knowledge" in order to intelligently assess industry proposals for facilities such as laying pipelines in permafrost, drilling in the Beaufort Sea, under-sea transportation systems or arctic tankers. He proposed a "continuing and comprehensive program of northern science and research."[13] The Science Council agrees with the theory but not with the practicality of Mr. Justice Berger's recommendation. We agree that government must have the ability to assess industry claims independently. However, Canada is a thinly populated nation. It is inconceivable, though it would be desirable, for the government of Canada to replicate all of industry's research. Instead, the Science Council urges that government develop a capacity to selectively replicate key data needed for evaluating project proposals intelligently. This will allow for spot checks as needed without unnecessary duplication. It should have been possible, for instance, for the Berger Inquiry to let out or cause to be let out contracts to fill key research gaps to NRC or another independent organization.

This position of selective independence is reasonable only to the extent that project proponents and their parent companies are willing to bear the full costs and to take the full risks of their actions. To the extent that government is expected to provide financial guarantees, pay for social and environmental costs, or take equity in a project, it will be correspondingly important that the guardian of public interest take fuller responsibility for verifying the claims of those who have only limited liability if the research is deficient.

Science policy suggestions often reflect differing perspectives. The participants at the NATO Arctic Systems conference held in St. John's, Nfld., in August 1975 were chiefly concerned, for instance, with the communications, navigations, and transportation technologies needed to support resource exploration and production in the Arctic. There are many tasks to be performed in this area, starting with techniques for assessing resource potentials and engineering requirements such as remote sensing and improved geophysical and geochemical exploration techniques. For example, areas which need to be addressed, and expertise which is required, for industry to design and government to choose between pipeline and marine modes of transportation for gas from the Arctic Islands, include the following:

- meteorology, climatology
- properties of upper atmosphere and magnetosphere

- studies of the marine circulation of the channels of the Arctic Archipelago, coupled with studies of fresh water inflow, heat inflow, and thermal pollution
- oceanographic studies, especially offshore Labrador and Baffin Island
- submarine and sub-ice hydrocarbon production techniques
- iceberg and sea-ice reconnaissance and forecasting
- communications and navigation systems
- physics of ice and icebergs
- properties of permafrost
- process of terrain degradation and recovery
- terrain evaluation in areas where construction is planned
- hydrographic surveys
- materials engineering
- oil spill prevention, clean-up and contingency plans
- icebreaker design
- large mammal inventories, especially habitat requirements, harvest rates and behavioral adaptation to human intrusion.

There are other research areas which are critically important if the strategy of mixed development is to be successful. These include:

- studies of improved techniques and programs for renewable resource management (especially those commissioned or performed by northern peoples)
- existing land use patterns of native people
- epidemiology of specific northern health problems
- research on the social effect of communications
- occupational health hazards
- training of health and educational employees from the south in the language and culture of northern peoples and investigation of alternative means of health care delivery with higher participation by northern peoples
- studies of native language, culture, and social achievements
- comparative studies of circumpolar economic development strategies
- comparative studies of the applicability of "third world" strategies for economic development, including the use of "appropriate technology".[14]
- waste disposal techniques
- housing design and construction
- demonstration projects using "appropriate technology"
- assessments of the impact on communities of an influx of transients and non-northerners to the North
- ecosystem studies on both an extensive and intensive basis, using systems analysis and other modelling techniques with a view toward understanding interrelationships between forestry management and wildlife harvesting, for example, or between mining and ambient air or water pollution. Particular emphasis should be paid to phenomena with wide variability, such as flood regime, population dynamics and other climatically dependent phenomena whose characteristics cannot be determined from short term studies.
- hydro-meteorological research to develop information on water balances, permafrost hydrology, river-ice flow, and flooding. This is especially important in areas where hydroelectric projects are being considered.

- methods of producing, storing, and transmitting energy for community uses, as well as for projects
- air pollution and water pollution characteristics and impacts.

It is within Canada's competence to significantly improve our expertise in these and related areas of northern science. In some areas knowledge exists but is not applied. Housing and waste disposal are often cited, but there are other problems. For instance, there is a lot of useful information about geotechnical terrain evaluation, yet each year the same mistakes are repeated, with resultant losses in time, money, and equipment, as well as damage to the terrain.[15] These mistakes are not made because information is inaccessible or unavailable, but because of ignorance and/or haste. Technology assessments (see Chapter VI) are one way of ensuring that such knowledge is actually applied.

Communications, Cooperation, and Coordination

To *utilize the fruits of scientific knowledge, the appropriate communications technologies and facilities must be made available to northern peoples and institutions.*

Communications technologies and facilities include not only conventional telephone, radio and television services, but also information retrieval systems and satellites, which have particular relevance to the needs of people living and working in the North.

Existing facilities are inadequate. Northerners often complain that their telephone service is inferior to that in the South and that television programs originate exclusively in the South. Radio service receives fewer complaints, but is criticized for not providing enough programming in native languages, for not originating from outside the major centres, and for being biased against rapid development which some northern residents feel is crucial to economic growth.

An effective *network* between various parts of the North is needed. This network should not be limited to radio and telephone nor only to the Yukon and Northwest Territories. Its goal should be to meet the informational, educational, and entertainment needs of all northern peoples. The introduction of the Anik satellite system has indicated that communications technologies have powerful transformative possibilities.[16] They should *not* be introduced without having to undergo the same rigorous technology assessment process advocated in Chapter VI of this Report. The Science Council believes that experiments involving the Communications Technology Satellite have a great deal to tell us in this respect. Assessments of the CTS projects will be more credible if they are performed by people other than those who suggested and carried out the project and who have a natural interest in seeing the project declared a success.

Of all the major service technologies applied in the North (medical, housing, waste disposal, and communications), the choice of communications technologies is the most critical. Too little is known of the ideal changes in design that would best adapt communications technologies to northern environmental and social conditions. Studies should be undertaken *now*, before decisions are made which will commit northerners to communications technologies which are either inappropriate or inadequate to met the needs of a strategy of mixed development for the North. For instance, plans for the

Anik B satellite call for two to four 12/14 GHz channels with the capacity for interactive video and audio communications in addition to the 12 regular channels on the 4/6 GHz band. Should not at least one of these channels be assigned to the North in such a way that access to adequate communications facilities will be broadly available to *all* northern residents? This is just one possibility.

Communications and Cooperation Technologies

Techniques of cooperation and information exchange must be developed among representatives of special interest groups (including native groups and environmentalists), government, industry and universities – a process that has national and international ramifications for Canada.

Computer-accessed data gathering and storage systems are an essential component of modern scientific enterprises. In this respect, there is a particular need for a *Canadian* northern bibliographic service. A first step toward the establishment of a Canadian-based northern data system would be the identification of northern elements in existing Canadian scientific and technological data systems. There is also need for more international cooperation on information exchange. This might enhance the possibility of using the most appropriate research, whatever its origin.

Exchange and coordination at the working scientist level are also needed. There are frequent opportunities for cooperation and contact with scientists from the United States, often aided by the Arctic Institute of North America, reflecting that the characteristics of western Alaska have a great deal in common with the Yukon and the Mackenzie Valley. Contacts with scientists from other circumpolar countries should be increased. There is also a need for a publication which surveys the Arctic literature of other nations and makes translations available. Such a publication should deal not only with the natural sciences, but also with economic development, and native communities. The Arctic Institute of North America produced a bibliography which accomplished this to a considerable extent, but it is no longer published.

National Coordination of Northern Research

The Science Council recommends that *information about the results of scientific and technological activities be assembled and coordinated so that they are accessible and useful to northern peoples and others involved in northern development.*

At the national level, several inter-university, inter-governmental, and inter-industrial committees and consortia have been established. Some of these have been effective, such as the Arctic Petroleum Operators Association. On the other hand, the Advisory Committee on Northern Development, chaired by DIAND, has been by-passed by DIAND on many occasions and, on others, has been used for departmental purposes, so that its effectiveness in a coordinating role was considerably diminished. The fact that some of its activities are not public knowledge has made it difficult for parliamentarians and others with an interest in the North to inform themselves about activities related to northern development as fully as they ought.

A major need is for coordination and exchange among those who fund northern research. It is not necessary that all coordination be done by government which, like any institution, has special interests to project.

The recently constituted "Association of Canadian Universities for

Northern Studies" is an important development that could provide a vehicle for coordinating university involvement in government-sponsored research activities. With its several subcommittees (Research, Education Policy, Relations with Northern People, International Relations, Northern Field Research) the Association has major potential as an institutional device for achieving the coordination of research.

Intra-Northern Cooperation

Northern parts of the provinces have many similar problems. A "council" of provincial and federal assemblies, composed of members from the Mid-North and Far North, who meet to discuss areas of common concern would improve cooperation. Such a council should have the capacity to commission research; it should have a continuing secretariat, perhaps provided by the Canadian Council on Rural Development.

Bilateral exchanges should also be encouraged. While the physical characteristics of, for instance, northern Saskatchewan and the Labrador Coast are quite different, the political and economic problems have similarities. Opportunities for exchange between the Northern Municipal Council in Saskatchewan and the Labrador Resources Advisory Council would be beneficial for both groups. This program should also encompass the needs of native groups and civil servants.

Federal-Provincial Coordination of Northern Resource Projects

On past occasions the Science Council has recommended a variety of coordinating mechanisms.[17] Specific recommendations have included the strengthening of the Canadian Council of Resource Ministers and its secretariat (unfortunately the opposite has occurred: the CCRM has virtually ceased to function); regional resource management authorities; and an intergovernmental secretariat to serve the development of a national energy policy through federal-provincial Ministerial Meetings.

Fragmented ownership and jurisdictions within Canada have helped to foster significant barriers to effective resource management.[18] Some problems are constitutional, while others reflect the administrative framework which has evolved in response to political requirements and pressures. As a result, jurisdictional patterns often make no sense in terms of rational resource use planning. Political boundaries simply do not always reflect geographically important conditions such as terrain, river flows, fish, bird, and mammal migration patterns, to mention a few. In this context all levels of government should have research capabilities or access to them for dealing with technical issues.

Access to Information

The Science Council has identified several problem areas with respect to the acquisition of information. Improved communication and a coordinated data base accessible to northern residents and institutions will do much to solve the problem of secrecy.[19] It may well be that principles of proprietary information and the Official Secrets Act may be used more than strictly necessary. In particular, members of parliamentary committees and provincial legislative assemblies need to have better access to information (and not on a restricted or confidential basis). It is intolerable that Members of Parliament should regularly report difficulties in gaining access to technical and scientific

information relevant to political decision making. If the government required the earliest possible disclosure of industrial engineering and environmental research related to specific or likely project proposals, then unnecessary barriers to the flow of government sponsored technical information relevant for northern development would be removed.

Research Capacities of Legislative Bodies

The Science Council recommends that the research capacities of legislative bodies and individual legislators be systematically improved.

Inadequate research support to legislatures goes far beyond the question of northern development. Among the innovations which should be considered are:

1. Providing adequate research support to federal and provincial legislative committees.

2. Providing provincial legislators with facilities at least as adequate as those provided by the Parliamentary Library of the House of Commons. Contrary to procedures in the Library of Parliament, this research should be publicly available.

Some provinces, as well as the NWT,[20] by establishing science policy advisory bodies, have explicitly recognized the role which knowledge plays in policy making. They should also consider the processes and institutions which can aid the acquisition, dissemination and assessment of technical information.

VI. Direction and Control of Development

The major challenge for the strategy of mixed development is determining the optimal choice and pacing of projects. Whether or not there is a conscious strategy for northern development, the choice of which projects are undertaken, and in what order, amounts to a *de facto* policy which largely determines the type of change which will take place.

The Science Council has four major recommendations in this context:

1. *The goal of technological sovereignty should guide northern development.*

2. *There is a special need for Northern research, development and demonstration projects to be determined by local needs.*

3. *In general, the Science Council endorses the Guidelines for Federal Scientific Activity in Canada's North.*[1] It is now necessary to seek appropriate means of implementation, and to apply them to scientific activities more generally.

4. *Large projects, as well as small ones, need to be assessed in terms of their feasibility, acceptability, and impact,* both individually and in terms of their cross-impacts.

Technological Sovereignty

The goal of technological sovereignty should guide northern development. There are several kinds of policy measures which can and are being used in pursuing technological sovereignty. Some are aimed at influencing the flow of information, others at influencing the rate of reinvestment, still others at influencing the corporate decision-making process. The means to this end include:

1. regulation, taxation, royalties, tariffs, quotas
2. public ownership and equity participation by governments
3. patent, licensing, and freedom of information policy
4. subsidies and/or incentives for research, development, exploration and investment
5. informal and formal advisory and persuasive bodies

Some of the initiatives currently exist and deal, piecemeal, with this issue. The Science Council believes that these initiatives are frequently implemented late in the innovation process and often do not have as their long-term goal Canadian *control* of technologies relevant to resource development. There is too often a willingness to settle for "a piece of the action," positions and policies are designed and adopted to optimize short-term returns rather than the realization of long-term goals.

Policies must be deliberately coordinated to promote technological sovereignty by protecting new opportunities for Canadian enterprises and by supporting the evolutionary development of Canadian expertise in areas of importance now controlled by others. A clear statement of intent and goals by government is needed – to be followed by careful organization and promulgation of a consistent framework of regulation, procurement policies, taxes and incentives. The aim is to stimulate private Canadian enterprise.

Crown corporations should have as part of their mandate the promotion of technological sovereignty and should be assessed and held accountable for their performance with respect to this goal.

The Role of Regulations

Regulatory procedures to promote the development of indigenous industries of special interest and importance are used extensively by many countries. Only through the internal development and associated domestic control of the means of production can one shape and utilize technologies in support of broad national goals. When control of technologies lies elsewhere, allegiance to the economic, social, industrial, and national interests and policies of another country or countries is inevitably seen to be detrimental to the host nation.

In contrast to many other nations with comparable technological competence, Canada has been singularly flexible and compliant. Too often, policies are *ad hoc* or depend to too great an extent on goodwill and persuasion.

The Advisory Committee on Industrial Benefits from Natural Resource Development, a subcommittee of the Advisory Committee on Northern Development, illustrates Canada's approach. Composed of civil servants in the Department of Industry, Trade and Commerce, the objective of the Committee is to increase Canadian participation in large northern projects which have an element of federal control and/or regulation. While the Committee has no direct powers to enforce Canadian content rules where they exist, it does attempt to increase Canadian content of resource projects by meeting with the appropriate company and finding out what the company is willing to do to maximize Canadian participation. The implied power of the government to withhold export permits or other necessary regulatory approvals gives the Committee some indirect influence.

Since the opportunities before Canadians must involve far more than a "piece of the action", the preferable course is to strive for long-term technological control. This may mean considering projects on a different scale or at a different pace than those most advantageous to non-Canadians. It will certainly mean balancing short-term returns with the more important long-term goals. All the opportunities for regulation through the granting of permits, licenses, grants, etc., and the control of information flow, should be consistently used as instruments in support of the broad national objectives of technological sovereignty.

In the May 1976 announcement of a Proposed Petroleum and Natural Gas Act and New Canada Oil and Gas Land Regulations by the Ministers of Energy, Mines and Resources, and of Indian Affairs and Northern Development, the government explained that its position was designed to increase the pace of exploration activity, and to better control the *pace* of development and production.

> "This new legislation is designed to promote the early assessment of Canada's frontier oil and gas resources through incentives to explore, and disincentives to allow land to remain idle, and by granting the necessary authority to require a certain pace in exploration activity as a condition of holding exploration permits. This is in accordance with the goal of self-reliance and the elements of the National Energy Strategy announced in late April."[2]

Could the proposed regulations not also reflect a measure of commitment to the goals of technological sovereignty and, in their application a realization of the importance of early participation by Canadian expertise and industry and its development where lacking? Control of the technologies vital to our sovereignty will continue to elude us if Canadians fails to take such action.

The Role of Public Corporations

In the North, risks are already high and projects have far-reaching national implications. The federal government role is critical. In the Arctic Islands, Pan Arctic Oils Limited is the major operator and is 45 per cent government-owned; official government policy has now given PetroCanada a significant northern role. The Act establishing PetroCanada gives it exceptionally broad objectives and the appropriate powers to achieve them.[3] PetroCanada is at present participating in a number of frontier projects where there are significant opportunities to develop indigeneous Canadian technologies and where industry is important in both the near and long-term future. PetroCanada is a participant in Syncrude, Polar Gas, and a proposed project to produce, gather, liquify, and ship to market, gas from the high Arctic Islands.

In these projects, PetroCanada is acting effectively as an instrument of government policy rather than as a competitor in the oil industry. Within its broad mandate, PetroCanada should strengthen its efforts to develop similar means by which it can play a central role in effecting the direction and rate of northern development and in enhancing Canadian technological sovereignty, particularly as it pertains to the North.

The Role of Research, Development and Demonstration

Research, development and demonstration (RD & D) programs are set in place to remove uncertainties from potentially beneficial ventures so that the level of confidence pertaining to project decisions is increased. These programs are also vehicles through which industrial innovation can be stimulated in Canada.[4] RD & D programs can stimulate industrial innovation in a number of ways. In addition to tax incentives, and a supportive regulatory framework, there is contracting-out of research and the use of the purchasing powers of departments and agencies to encourage industry.

Governments can also set up special agencies to do the job. The Alberta Oils Sands Technology and Research Authority (AOSTRA), which is a particularly good example, has $100 million to spend on contracts for industrial research and pilot projects to establish the most advantageous methods of *in situ* extraction and production from the oil sands.

The goals of the Authority resemble the goals of the federal oil and gas regulations, as well as the goals of the government of Saskatchewan with respect to potash. In both these cases, the governments felt that the industrial pacing of development was too slow to meet the needs of the province (or nation). By taking direct action, government could increase the pace of development.

The activities of AOSTRA should make a valuable contribution to developing technologies which may make *in situ* extraction from the oil sands more feasible. This, in turn, will give the people of Alberta an opportunity to choose and to own those technologies most appropriate to their needs. To date, five major projects have been launched to test advanced oil recovery concepts; they are being financed on a 50/50 basis by industry and the Alberta Government. All technical know-how and patent rights will be owned by the Authority, and the licensing income will be shared with the industrial partner. By investing now in the research and development, there will be a better opportunity to control the pace of development later. The potential size of the tar sands oil reserves justifies reinvesting Alberta's royalties in this way. Research subsidies have a valuable role to play in supporting selected

activities and companies which can improve northern development. The same principle applies to enterprises smaller in scale than the oil sands.

Research and Development for Local Needs

In addition to activities in support of the broad objectives of technological sovereignty, Canada needs more northern research, development, and demonstration projects, as determined by local needs. The first need is for research which attempts to define and gather data on the impact of southern governments and industrial society on northern peoples and the northern environment. Secondly, there is a need for research and demonstration projects which promote the economic and social development of northern peoples, particularly projects on a scale amenable to community control. It is important to stress that these research activities will only be effective if they are related to local needs.

Research addressed to the first need would be designed to obtain more information on physical and mental health, and the environment. Nutritional research is an example. The introduction of western-style foods has been bad for the dental health of most native people, and may be a contributory cause of other, more common ailments, such as obesity.[5] The economic value of "country foods," on the other hand, has often been underestimated or ignored by researchers.

If country food were more accurately valued in terms of its relationship to store bought substitutes, and if its dietary use led to reduced health and social costs, its value would be high indeed. These considerations provide an example of the kind of activity needed to achieve the strategy of mixed development. In this case, pilot projects, or full-scale projects where appropriate, could test various means of reestablishing native people's dependence on country foods. These projects should be evaluated in terms of the impacts on health and social costs.

The social science research necessary for the successful realization of such projects would have a different orientation from most present social science research, especially research with an "activist" cast. The necessary research is related to flexible life style options, and its primary orientation should be toward identification of desires and needs, and the means of achieving these. This distinction is subtle, but important.

The second area of research activities is concerned with locally controlled community development. Here, designs and appropriate technologies often exist and need only be applied or implemented, e.g., technologies for northern housing, waste disposal, and health care delivery. Techniques of log house building, for instance, are well known, but northern native initiatives to build log houses have stalled, in part because of a Central Mortgage and Housing Corporation requirement for logs which are larger in diameter than those normally found in the North.

Notwithstanding available technologies, work remains to be done. A few basic principles should guide the design and application of technologies which have, as a primary aim, the goal of enabling northern communities to become economically more self-sufficient, thereby giving many northern residents the opportunity to become self-supporting without leaving their community or abandoning their preferred life style. The principles are:

1. Development opportunities which involve wage employment should

exist in the community and should relate to development opportunities which involve subsistence living and the harvesting and trading of renewable resources.

2. Local materials, products, labour, and capital are preferable to imports.

3. Production methods must not make unrealistic demands, particularly with regard to organization, skills required, financing, and so on. In order to use more simple technology, developmental work will be required in many cases which takes account of the objectives of the activity, the scale of the resources available, and the skills of the users.

Although the possibilities are enormously varied, they have not often been seriously investigated. The following areas hold promise for the coastal residents of Labrador:[6]

- improving gear and shore facilities in support of the inshore fisheries
- the utilization of species not now harvested, such as brook trout, mackerel, scallops, and herring spawning under ice
- development of snowmobiles and associated equipment that would permit harvesting of local timber resources with less damage to machines and forest
- development of techniques of fresh water winter fishing combined with husbanding caribou, hunting and trapping
- local garden plots
- the berry industry.

Similar lists could be developed for other northern areas. They would constitute evidence that it is possible, given the appropriate conditions and technologies, for the residents of many northern areas to establish, reestablish, or continue the development of a capacity for self-reliance based on the wise use of local resources in community industries built around appropriate technologies. If Canada's North is truly to develop, such developments must be encouraged.

The maintenance of flexible life style options will not come about through technological fixes. Knowledge and research are a necessary condition for helping to create opportunities for life style choices. They are, however, only a means, not an end.

Science in the North

In general, *the Science Council endorses the "Guidelines for Federal Scientific Activity in Canada's North."*[7] *It is now necessary to seek appropriate means of implementation* and to apply them to scientific activities more generally.

The recently promulgated guidelines of the Department of Indian Affairs and Northern Development are designed to increase the role of native peoples in scientific work, to increase their role in decisions on reseach affecting them, and to ensure that the research is well planned, relevant, and adequately communicated to those who need it. As well, the guidelines advocate that research should progress at a steady pace "rather than on a crash basis in response to crisis demands." The guidelines also urge, sensibly, that observational networks aim for broad coverage, rather than depending, for the sake of convenience, on existing settlements and communications. Finally, the guidelines point out the important role Canada plays as host to international

scientific projects and our rights to receive the data from such projects.

The Science Council's concerns are:

1. The guidelines have a federal orientation and do not take sufficient account of the possibility that northern objectives may sometimes require different research to be undertaken than is necessary from a strictly national viewpoint. How about *northern* goals for the North, and northern objectives?
2. The guidelines recommend that the Advisory Committee on Northern Development (ACND) review federal scientific activities in the North to ensure that these activities are within their original purposes. The Science Council believes that in the natural science area this is properly a function of the Ministry of State for Science and Technology (MOSST). The ACND is not in a position to evaluate programs objectively because of the departmental allegiances of its members.

Other statements have addressed the activities of individual scientists in the North. A subcommittee of the Canada/Man and Biosphere (MAB) group has issued guidelines for the conduct of scientists undertaking work in the North. As well, native groups[8] and the Government of the Northwest Territories[9] have taken initiatives to enhance both the participation of northerners in research and the relevance of the reseach to northerners.

These moves are desirable and we hope they will also be extended to areas of provincial responsibility. Their thrust is to encourage collaboration and participation of northern peoples in scientific work.

Local participation in science policy decisions must also occur more frequently. No one expects the average northern citizen to have a useful opinion about research on the aurora, or the physical circulation of the Beaufort Sea, or the likely climate on Ellesmere Island in the Jurassic period. In the absence of discernible impacts on northern communities, decisions about these kinds of research can be left to specialists. But most of the research that is needed by northern peoples is highly relevant to their lives. Where do the whitefish come from that spawn near the mouth of the Mackenzie? What are the seaward migrations of Arctic char from Pond Inlet? What determines where the caribou will go? What is a safe harvest of narwhals? Where are the best stands of timber? What kinds of soil are found near Fort Smith? How can you best relocate musk oxen in the North? For these kinds of questions local knowledge is important not only to help with the answers, but also to help formulate new and better questions. It would make good sense to provide special research funds to a northern committee, composed equally of local citizens and experts to finance research projects of local merit.

Technology Assessment and Decision Making

Projects with potentially large impacts require an appropriate commitment to assess their feasibility, acceptability, and impact.

For informed northern development decisions to be made, there must be some means of assessing and identifying possible conflicts, such as those between presently competing land uses, or between present and possible future land uses. These conflicts may reflect the relative advantages of extracting non-renewable resources. They also reflect conflict between the perceived needs of southern Canadians for energy or minerals and the perceived requirements of native northerners for developing social, political, and economic

self-sufficiency. These conflicts are important, but the Science Council believes that the application of appropriate technologies and scientific research can provide information with which to resolve them and mitigate some of the polarization which has occurred. In the North, as elsewhere, there is a discomforting tendency among opposing forces to ignore or distort scientific results which do not conform to pre-established expectations. Such attitudes exacerbate conflicts rather than helping to resolve them.

Technology assessments help to identify and resolve the scientific issues about which major actors disagree.[10] An example of such an issue is the question of whether the pipeline construction plan of Canadian Arctic Gas adequately explored the effects of a phenomenon such as frost heave, which might weaken or even fracture the pipe. This was a subject of intense dispute at the Berger Hearing. As a result of unsuccessful attempts at the National Research Council to duplicate their test results, Arctic Gas put forth a new method of dealing with frost heave to the National Energy Board, because the original design based on these results had been shown, by their own admissions to be inadequate.[11] It is in the areas where technological issues may arise where government must concentrate its scientific efforts in support of technology assessments.

It is the task of the political system as a whole to decide the more contentious question–risk acceptability. This includes, for instance, a decision on whether to take the risk of a blow-out in the Beaufort Sea, considering the relatively low probability of a blow-out in any one well, versus the major problem of how to clean up a large spill quickly enough to prevent extensive environmental damage if a blow-out did occur.

The most critical aspects of an assessment are its timing and its comprehensiveness. It is important to begin assessments of a project or series of projects early in the decision-making process. Comprehensiveness will vary with circumstances. The size of the potential impact, rather than the size of the project, is critical. The costs of assessing smaller projects will often be less than larger projects. In fact, it may be argued that the same time-consuming standards of comprehensive assessment need not apply because in some instances there would not be enormously disruptive social or environmental impacts. For this reason, the Science Council urges that there be *more* pilot projects and small scale demonstration projects in the North, and that the monitoring of these projects be considerably improved. Too often the lessons of failure are hidden or the successes exaggerated.

The value of a technology assessment process was clearly demonstrated in the Mackenzie Valley Pipeline Inquiry. The evidence and the procedures employed, combined with the fact that there were two (and later three) competing applications to transport gas from Alaska and the Mackenzie Delta, enhanced the quality and quantity of information about the proposal. The Inquiry had the unintended consequence of providing the National Energy Board with better prepared intervenors than it would have had if the Berger hearing had not taken place. Moreover, as a consequence of the hearings and the time they consumed, Canadian citizens and their elected representatives had a much better opportunity to appreciate the issues.

For example, there is now a wide public awareness that the choice of route for a pipeline has implications for the distribution of benefits between Canada and the United States, and that much depends on which country has how much gas for potential distribution to which markets. With a modest

perception of such fundamental economic and political issues, the average citizen could at least begin to participate to the extent of judging who was likely to exaggerate this and minimize that. The actors and issues were no longer the same shade of grey.

There were, of course, many other dimensions to heighten public awareness. Placed in the context of wide concern about energy resources, the Berger Inquiry was a local issue in discussions of world energy shortages and their impact on the national economy. Alternative sources of gas, alternative methods of transporting gas, alternative sources of energy, and alternative life styles were all mentioned in the debates, and while much of this discussion would have taken place in any event, the Inquiry was nevertheless a fairly conspicuous catalyst.

Perhaps the most significant impact of the Inquiry was its emphasis on the social issues. Again, the Inquiry took place at a time when many other events were shaping public concern for native peoples, but the thoroughness and patience with which the hearings were conducted established a high standard of investigation which was widely recognized and praised. Indeed, the Inquiry enabled an articulation of the views of some groups of northerners who otherwise may not have been heard.

The intent of the Berger Commission procedures, which was to combine the social context with hard scientific evidence, is consistent with the argument of this Report. Whether the Inquiry will achieve the desired balance remains to be seen. But one lesson has already emerged and is irrefutable – the future uses of science and technology in the North will be much more related to the aspirations and needs of northern people.

The lessons of the Berger Commission should be a subject for detailed assessment in the not too distant future. In particular, the use of the adversary procedure for the evaluation of technical evidence, while successful in pointing out knowledge gaps, had the disadvantage that the evidence was often presented in a selective manner. Assessors should be able to go beyond the courtroom and in a sense, contract for scientific work. The normally reactive stance of regulatory bodies in Canada has not always permitted this. However, those bodies which have an independent research capacity, or the ability to contract for it, are better able to discharge their regulatory and technology assessment functions. This should be encouraged.

All government bodies contemplating a major project should carefully consider the degree to which technology assessment procedures and broad interpretation of terms of reference are applicable.

Another not yet completed technology assessment system concerns a reach of the Churchill River where the Saskatchewan Power Corporation (SPC), a provincial Crown corporation, has proposed a hydro power development. After SPC had developed this engineering proposal in detail, an agreement between the federal government and the provinces of Saskatchewan and Manitoba led to an environmental and social-economic impact assessment known as the Churchill River Study (CRS). Even before CRS commenced its work, the province of Saskatchewan stated its intention to follow-up the study with the Churchill River Inquiry. At present, CRS has completed its task and a Board of Inquiry of four members has been appointed. Its initial meetings will obtain information to guide the preparation of more formal Hearings. The Board's report is expected in 1978. It is to contain a recommendation to the Saskatchewan government on whether or not to proceed on the SPC proposal, or to proceed with certain safeguards.

The Mackenzie Valley Pipeline Inquiry and the Churchill River Inquiry differ in terms of the scale of the proposed developments and their technical and scientific studies. In addition, there are some notable differences in the timing and separation of study and inquiry, and the involvement of intervenors in various phases of the assessments. One component of the CRS was a public participation program which it is now conceded was only partly successful.[12] Further contributions are being invited from the public during the inquiry phase of the total assessment of Churchill River development plans. It is hoped that such further involvement, after intervenors have been provided with financial aid to prepare critiques of the study, will lead to a balance in the expression of local interests and those of the Saskatchewan public as a whole. It is also to be hoped that the participants in the Berger Commission will recommend how these processes can continue to be improved.

Areas Requiring Further Assessment

In order best to direct and control development, assessments should become an integral part of the decision-making process. They should not be allowed to become a validation for decisions already taken.

At least five areas related to the North require assessment:

1. An examination of alternative transportation and production methods for gas from the Arctic Islands. In a Science Council seminar held in February 1977,[13] the option of transporting gas from the Arctic by Arctic Class LNG tankers received support. The Science Council believes that LNG tankers *may* afford advantages in terms of pacing and the potential for addressing regional imbalances. It may be also an ideal vehicle for Canadian export markets, reserving Alberta supplies for the domestic market. While this approach appears to be technically feasible, its safety and its economics remain to be assessed. Although the cost of the gas would be so high as to probably preclude large royalty or tax payments, an adequate tradeoff might be achieved in terms of promoting a Canadian capability in LNG and shipping technologies. This option should be seriously examined.

2. An assessment of commuting from urban centres to northern mines by air. There is now enough experience to begin drawing some conclusions.

3. An assessment of the effect of telecommunications and television upon the North.

4. An assessment of alternative means of community development which emphasize renewable resources. This would inevitably include considerations of the assumptions, training, and techniques involved in transferring technology and knowledge to and from less developed countries and regions with analogous development goals.

5. A comprehensive review of the specific technologies relevant to the North which should be supported by an analysis of the rates of development most advantageous to achieving Canadian technological sovereignty.

These are technology assessments relating specifically to the North. However, similar efforts will be needed in the south, particularly with respect to changing energy production technologies and with respect to information, computer, and communications technologies. These southern assessments, however, should take explicit cognizance of the North and should not assume that it is merely an extension of the South. With this kind of anticipation, Canada should be able to make good use of existing and developing areas of scientific knowledge and technological expertise for the benefit of northern peoples and all Canadians.

Appendix

Guidelines for Federal Scientific Activities in Canada's North

"1. In conducting scientific activities in the North, the native people must be encouraged to participate to the greatest extent possible. In scientific activities related to the people, this involvement is essential in nearly every case if the research is to be meaningful and of maximum benefit to the northern people. Every effort should be made to provide opportunities for the native people to become involved in research programs and in the uses of science and technology.

"2. In research affecting the native people, there should be prior consultation leading to informed agreement, participation in the conduct of the research itself, and feed-back of results to northern communities concerned. It is the inhabitant's perception of his environment that influences his decisions. His perception of the environment, therefore, as well as its physical properties, is an important element of research programs.

"3. Scientific activities sponsored or supported by Federal or Territorial governments should be treated as tools or services to help in the attainment of the national goals for the North. They are not ends in themselves and can only be justified if they support one or more national objectives.

"4. It is essential that in northern science programs of a multidisciplinary nature, all relevant sources of expertise are involved in the planning and implementation phases and in the analysis of results.

"5. In accordance with the government policy, scientists from the academic community and industry should be involved to the maximum extent practicable in government-sponsored or supported scientific activities. Wherever appropriate, the scientific programs should be carried out "by contract" with universities, non-government scientific institutions, industry, or individuals.

"6. Every effort should be made to ensure that the scientific concerns are taken fully into account in the design and phasing of northern programs. Where overriding considerations force the introduction of such programs before adequate scientific assessment is possible, the promoters should be made aware of any known deficiencies in scientific knowledge, and the implications thereof.

"7. In the design and implementation of programs, provision should be made for scientific evaluation of progress in relation to objectives, and to assess impacts and effects of program activities in order to undertake any necessary adjustments.

"8. To ensure that the lessons of experience and the results of research already completed are recorded and available for use, and to guard against repetition of research, all useful scientific and technical information acquired from programs should be adequately reported and fed into the appropriate scientific information services.

"9. All scientific programs sponsored or supported by the Federal or Territorial governments should be reviewed at regular intervals by the Advisory Committee on Northern Development through the Committee on Science and Technology to ensure that activities remain in keeping with the original purposes of the studies and their objectives. The scientific activities undertaken to meet defined needs must remain the responsibility of the accountable department or agency.

"10. The amount of effort which the Federal Government devotes to increasing and broadening its information base in northern science should take into account estimated future demands of northern development. As far as possible, government research in the North should progress at a steady pace rather than on a crash basis in response to crisis demands.

"11. The design of Canada's northern observational networks should be the object of careful study, in order that they yield the most useful and general data, especially in relation to variations of site and habitat. Present networks often emphasize cheap operation because of existing settlements and communications, rather than good sampling principles.

"12. With Canadian sovereignty extending over such a large northern region which contains many features of special scientific interest, it is important that Canada should play a significant role in international arctic research. From the government's point of view, the emphasis should be on programs aimed at the achievement of Canadian objectives; however, there will be occasions when the international scientific community wishes to pursue research projects in Canada which do not rate as priority items for the Federal and Territorial governments. In such cases, Canada not only has some obligation to assist them but may also stand to gain from the contribution made to the pool of international knowledge and the leverage which such co-operative action provides in obtaining reciprocal information of direct value to Canada from other countries.

"13. Where the Federal Government initiates international co-operative scientific activities in the Canadian North, the following principles should apply:

a) the Canadian contribution should be defined in terms of Canadian objectives;

b) the leadership in co-ordinating such activities in Canada and their effective control should be provided by Canada;

c) Canada should receive all data and all analytical results.

"14. Where the initiative for co-operative international programs comes from other countries and the objectives are not priority items for Canada, the following principles should apply:

a) government logistic support of international scientific programs should not be considered a substitute for scientific involvement;

b) the need for the program and the reason for conducting it in Canada should be stated to the satisfaction of Canadian authorities;

c) there should be Canadian scientific participation in any significant scientific investigation in the Canadian North;

d) non-government sources, primarily universities and scientific institutions, should be invited to participate;

e) Canada should receive all data and all analytical results."

Source: Department of Indian Affairs and Northern Development, *Guidelines for Federal Scientific Activities in Canada's North,* Ottawa, 1977.

Notes

I. The North

1. Hamelin's ten criteria are latitude, degree-days of warmth, degree-days of cold, ice types, total precipitation, natural vegetation, accessibility, air service, total and wintering populations, and economic activity. Louis-Edmond Hamelin, *Nordicité Canadienne,* Edition Hurtubise, Montreal, 1975, pp. 84–88.

2. c.f. The Arctic Institute of North America and the Department of Indian Affairs and Northern Development, *Northern Population Workshops, Summary Report* (Paula Weston, ed.), 10–12 May 1976, North Hatley, Quebec.

3. Canada Council on Urban and Rural Developments, "A Development Strategy for the Mid-North of Canada," Ottawa, 1976.

4. L. Auerbach and A. Gerber, *Perceptions 2, Implications of the Changing Age Structure of the Canadian Population,* Science Council of Canada, July 1976, p. 11.

5. *National Atlas of Canada,* Ottawa, 1974, pp. 119–120.

II. Development or Exploitation

1. K. J. Rea, *The Political Economy of Northern Development,* Science Council of Canada Background Study No. 36, April 1976, p. 30.

2. The era of naval exploration following the end of the Napoleonic wars was characterized by the pursuit of scientific knowledge, and the Royal Society customarily nominated a scientist to take part in naval expeditions.

3. Meteorological stations were established in Eureka and Resolute Bay in 1947, in Isachsen and Mould Bay in 1948, and in Alert in 1950.

4. Graham Rowley, "Northern Science", unpublished paper.

5. See Appendix.

6. Rea, *op. cit.,* p. 160.

7. *Ibid.,* p. 164.

8. *Ibid.,* p. 172.

9. Hedlin Menzies and Associates Ltd., *The Role of Canadian Control of Technology in Northern Development,* An Essay for the Committee on Northern Development, Science Council of Canada, October 1976, pp. 68–70.

10. *Ibid.,* p. 78.

11. Rea, *op. cit.,* p. 222.

12. Financial Post Corporation Service.

13. Private communication, J. H. Salter, Chairman and Chief Executive Officer, Pine Point Mines Limited, Vancouver, British Columbia.

14. R. Gibson, *Arctic Mining: A Case Study of Decision Making – The Strathcona Sound Mine – Baffin Island,* Science Council of Canada, forthcoming.

15. John Palmer, *Measurement of the Value of Economic Activity in the North,* DIAND, April 1974.

16. W. O. Kupsch, *Synthesis,* prepared by Churchill River Study (Missinipe Probe), Saskatoon, 1976, p. 21.

17. For more detailed statistics on the Northwest Territories and Yukon, the interested reader should consult: Palmer, *op. cit.*; DIAND, *Statistical Abstract of the Northwest Territories,* Annual; *Canada Yearbook 1975.* There is no single statistical publication which deals satisfactorily with both the federal and provincial North. This is partly a reflection of inadequate data and partly the result of inadequate federal and inter-provincial coordination of existing demographic and economic statistics.

18. *Circumpolar Health, Proceedings of the Third International Symposium, Yellowknife, NWT,* edited by Roy J. Shepherd and S. Itoh, University of Toronto Press, 1976.

19. P. Larkin, "Science for the North," *Science Forum,* vol. 9, no. 6, December 1976.

20. P. J. Usher, "The Significance of the Land to Native Northerners." *Canadian Association in Support of the Native Peoples Bulletin,* vol. 17, no. 1, March 1976, p. 6.

21. Council of the NWT, "Priorities for the North," Tabled 16 May 1977.

III. Strategy of Mixed Development

1. See p. 6 for a list of titles and authors.

2. J. Chretien, Statement to Standing Committee on Indian Affairs and Northern Development, 28 March 1972, pp. 39–40.

3. Department of Indian Affairs and Northern Development, *Guidelines for Federal Scientific Activities in Canada's North,* Ottawa, 1977, and *A Development Strategy for the Mid-North of Canada,* Canadian Council on Rural Development, 1976.

4. Science Council of Canada, *Issues 3, Northern Development, A Paper for Discussion,* June 1976, pp. 19–20. Obviously, there are instances where a permanent settlement is desirable, such as in the Labrador City-Wabush area which has an iron ore body with an expected lifetime of more than 100 years, and which requires several thousand miners and support personnel.

5. Mackenzie Valley Pipeline Inquiry, Commission Counsel Submissions, October 1976.

6. *Issues 3, op. cit.*

7. We say this for two reasons: The first is that proven (and more accessible) gas reserves in Alberta are 10 times greater than those in the Mackenzie Delta. At a 90 per cent probability, likely reserves are still about 2.3 times greater in Alberta than the Mackenzie Delta. (Energy, Mines and Resources Canada, *Oil and Natural Gas Resources of Canada,* 1976). Since we recommend in Chapter VI that the LNG option for the Arctic Islands should be given an adequate assessment, we wish to see this option for the development of frontier petroleum resources remain open since it is likely that non-frontier gas resources can meet *Canadian* needs for at least the next decade. This would also allow adequate time for orderly, not episodic, development. Secondly, important information about financing, pricing, feasibility of winter construction plans, and resolution of native land claims, was not available at the end of the hearing. For example, Mackenzie Valley Pipeline Inquiry: Vol. 86, pp. 13013–13036, 13055–13058; Vol. 69, pp. 10339–10353; Vol. 201, pp. 31824, 31732–33; Vol. 202, pp. 32058, 31891. Also National Energy Board: pp. 3319, 31992, 29484, 6187, 1763, 32284–5, 14873, 35916, 15992, 15941, 17534–5, 33738, 14535–6, 17611–12, 24318–9, 15993, 34781. These gaps are in addition to the environmental and social consequences predicted by Mr. Justice Berger.

IV. Principles of a Science Policy for Northern Development

1. Technological sovereignty has also been defined as developing and controlling the technological capability to support national sovereignty. Josef Kates, Chairman, Science Council of Canada, *Annual Report 1976–77,* Ottawa, 1977.

2. A clear example of this problem in connection with petroleum exploration off the Labrador coast has recently been described: A. A. Bruneau, "A Federal Sellout of Canadian Interests," *Science Forum*, Editorial, vol. 9, no. 6, December 1976, p. 2 (See note 4, below.)

3. Arthur J. Cordell, *The Multinational Firm, Foreign Direct Investment and Canadian Science Policy,* Science Council of Canada Background Study No. 22, December 1971.

4. "The most active operator [offshore Labrador] has, with the approval of the Department of Energy, Mines and Resources, during the past few years, spent most of the money committed to the preliminary engineering of production systems in France. And the millions of dollars so spent have been the gift of Canadian taxpayers, for these expenditures have been allowed as charges against the permit deposits made – the only contribution given in exchange for the exclusive right to conduct exploratory drilling for our resources. This has been allowed even though the demonstrated competence and the necessary capabilities to undertake this work exist in this country.

Furthermore, the work has gone on without public disclosure. In the few instances where R&D has been undertaken by Canadian contractors, they are expressly forbidden even to indicate the nature of the work, let alone any results – results as innocuous as environmental information observed while at sea!

In virtually every other developed nation, indigenous experts, industry, and engineers are given the first chance to be involved in resource development, and only when this expertise is demonstrated to be incapable of taking up the challenge are others given an opportunity to participate – Norway being a most striking example. We have allowed virtually the reverse." A. A. Bruneau, "A Federal Sellout of Canadian Interests," *Science Forum,* vol. 9, no. 6, December 1976, p. 2.

5. "New Oceans Policy", *News Release,* Office of the Minister of State for Science and Technology, 12 July 1973, pp. 1–2.

6. Science Council of Canada, *Issues 3, Northern Development, A Paper for Discussion,* June 1976.

7. Hedlin Menzies and Associates Ltd., "The Role of Canadian Control of Technology in Northern Development," An Essay for the Committee on Northern Development, Science Council of Canada, October 1976.

8. J. Chretien, Statement to Standing Committee on Indian Affairs and Northern Development, 28 March 1972, pp. 39–40.

9. Charles Hetherington, Paper at Science Council Seminar on Northern Development, 14 January 1976, Calgary.

10. "There are two reasons why science must be developed in the north for northerners, and to the maximum possible extent by northerners. First, it is essential that northerners know about their own regions, not only as they do now, but more systematically, in the scientific mode. Second, it is essential that northerners have their own scientists to enrich the cultural base of northern communities and to blunt the impact of the transients, partly by replacing them, partly by educating them, and partly by dominating them." Peter Larkin, "Science and the North: an essay on aspirations," *Science Forum,* vol. 9, no. 6, December 1976, p. 21.

11. *Issues 3, op. cit.*

12. M. Gibbons and R. Voyer, *A Technology Assessment System: A Case Study of Offshore Petroleum Explorations,* Science Council of Canada Background Study No. 30, Information Canada, March 1974.

13. *Issues 3, op. cit.*

14. J. J. Shepherd, "Technology Assessment in the Canadian Environment," *Jurimetrics Journal,* vol. 16, no. 3, 1976, pp. 167–172.

15. The Department of Indian Affairs and Northern Development (DIAND) is also known less formally as the Department of Indian and Northern Affairs (DINA).

V. Initiatives to Support a Strategy of Mixed Development

1. Del. M. Koenig, "Northern People and Higher Education: Realities and Possibilities", AUCC, Ottawa, p. 5. (This was Phase 2 of a project on The University and the Canadian North. The data referred to originally appeared in Phase 1, by W. O. Kupsch and Maryse Caillol.)

2. See, for example, Concepts Conference (University of Canada North), Inuvik, 19–22 November 1971; J. Lotz, *Northern Realities,* Toronto New Press, 1970, pp. 238–248; Arctic Institute of North America, *Education in the Canadian North – Three Reports 1971–1972,* Montreal, 1973.

3. The Science Council of Canada case studies have pointed to great problems in this area. See, for example, in the case studies listed on p. 6 of this Report: Canadian Resourcecon Limited, pp. 145–148; Gourdeau, p. 59 and the Appendix by P. Dansereau; M. Gibson, Chapter II; Keith, Fischer *et al.,* p. 117.

4. W. J. Smith, "Hydro," Presentation to the 7th National Northern Development Conference, Edmonton, 3 November 1976.

5. J. G. Nelson, Summary and Recommendations, Renewable Resource Project, Vol. II, Inuit Tapirisat of Canada, July 1975.

6. T. Berger, *Northern Frontier, Northern Homeland,* Vol. I, Ottawa, 1977, p. 186.

7. W. Pringle, "North of the 60th," *Agrologist,* Nov.–Dec. 1974, p. 4.

8. Department of Indian Affairs and Northern Development, "Temporary Suspension of Disposition of Federal Crown Lands for Agricultural Uses in Yukon and Northwest Territories", *Communique 1–7460,* Yellowknife, 10 January 1975.

9. Science Council of Canada Report No. 9, *This Land is Their Land – A Report on Fisheries and Wildlife Research in Canada,* October 1970.

10. Since the publication of Report No. 9, International Biological Program has completed a study, (headed by Dr. L. Bliss of the University of Alberta), of biological productivity of a tundra ecosystem on Devon Island.

11. Science Council of Canada Report No. 19, *Natural Resource Policy Issues in Canada,* January 1973, pp. 38–39.

12. These have been comprehensively described at the Mont Gabriel conference, the St. John's conference, and at the Mackenzie Valley Pipeline Inquiry. There are many other documents which also make relevant northern science policy recommendations which the interested reader may wish to consult: K. Greenaway (ed.), *Science and the North,* Ottawa, 1973; NATO Arctic Systems Conference, St. John's, 1975; T. Berger, *Northern Frontier, Northern Homeland,* Ottawa, 1977 (and the evidence); D. Pimlott, K. Vincent, C. McKnight (ed.), *Arctic Alternatives,* Canadian Arctic Resources Committee, 1973; J. G. Nelson, (Director), *Renewable Resources Project,* Inuit Tapirisat of Canada, July 1975; Canadian Council on Rural Development, *A Development Strategy forthe Mid-North of Canada,* Ottawa, 1976; H. A. Regier, "Science for the Scattered Fisheries of the Canadian Interior", *Journal of the Fisheries Research Board of Canada,* 1976, 33(5); T. R. Parsons, "Biological Oceanography in Canada: A Perspective and Review", *Journal of the Fisheries Research Board of Canada,* 1975, 32(11); Dick Hill, "Science for Northerners, Opportunities for the NWT Science Advisory Board", Paper presented to the "Seminar on Northern Development" sponsored by the Science Council of Canada, Inuvik, NWT, 25–27 June 1976; Hedlin Menzies and Associates Ltd., *The Role of Canadian Control of Technology in Northern Development,* An Essay for the Committee on Northern Development, Science Council of Canada, October 1976.

13. T. Berger, *op. cit.,* p. xviii.

14. E. Schumacher, *Small is Beautiful,* Sphere Books Ltd., ABACUS edition, London, 1974.

15. Two well-known northern examples are the problems encountered in the Schooldraw area of Yellowknife and by the Dempster Highway just south of Inuvik. The houses are sinking into permafrost and the highway was not usable.

16. "Transformative technologies" give to fundamental change in human thought and action. Science Council of Canada Report No. 21, *Strategies of Development for the Canadian Computer Industry,* September 1973, p. 13.

17. Science Council of Canada Report No. 19, *Natural Resource Policy Issues in Canada,* January 1973, p. 30; Science Council of Canada Report No. 23, *Canada's Energy Opportunities,* March 1975, p. 42.

18. A. R. Thompson and H. R. Eddy, "Jurisdictional Problems in Natural Resource Management in Canada," *Essays on Aspects of Resource Policy,* Science Council of Canada Background Study No. 27, May 1973.

19. Science Council of Canada, *Issues 3, Northern Development, A Discussion Paper,* June 1976.

20. Northwest Territories, An Ordinance for the Establishment of a Science Advisory Board in the NWT, Yellowknife, 1975.

VI. Direction and Control of Development

1. See Appendix.

2. Statement of Policy: Proposed Petroleum and Natural Gas Act and New Canada Oil and Gas Land Regulations, May, 1976, Energy Mines and Resources Canada, Ottawa.

3. Bill C–8, PetroCanada Act, Statutes of Canada, Ch. 61, Vol. II, Received Royal Assent on 30 July 1975.

4. The problems of Canadian industry have been addressed in previous Science Council reports. See, Science Council of Canada Report No. 24, *Technology Transfer: Government Laboratories to Manufacturing Industry,* Ottawa, 1975; Science Council of Canada Report No. 15, *Innovation in a Cold Climate,* Ottawa 1971; A. J. Cordell and J. M. Gilmour, *The Role and Function of Government Laboratories and the Transfer of Technology to the Manufacturing Sector,* Science Council of Canada Background Study No. 35, Ottawa, 1976.

5. J. T. Mayhall, "Inuit culture change and oral health: a four-year study"; K. C. Titley, J. T. Mayhall, "The dental disease status of Indians resident in the Sioux Lookout zone of northern Ontario" and H. H. Draper, "A review of recent nutritional research in the arctic", *Circumpolar Health, Proceedings of the Third International Symposium, Yellowknife, N.W.T.,* Roy J. Shephard and S. Itoh, ed. Published for Health and Welfare Canada, University of Toronto Press, 1976.

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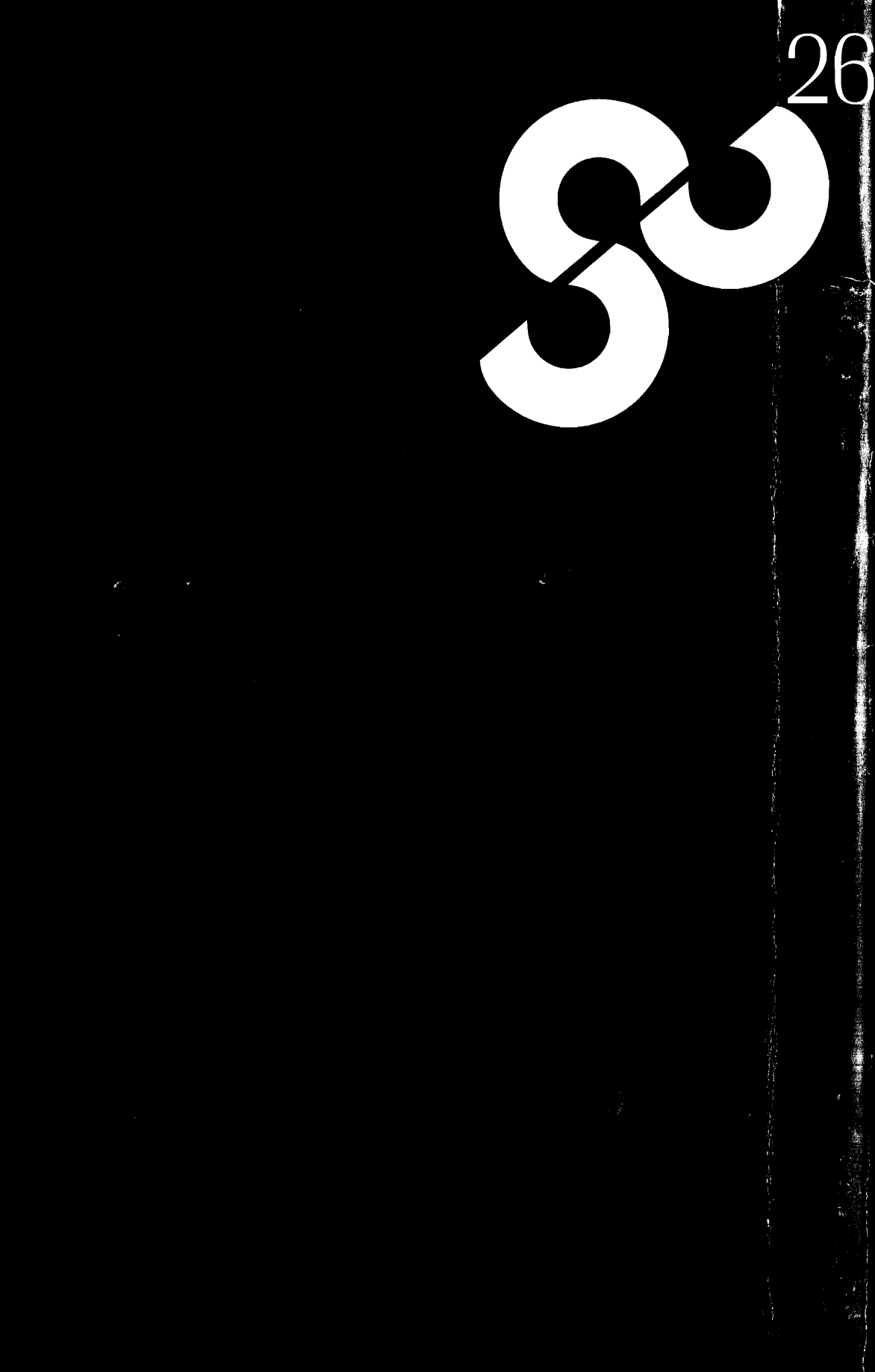
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Science Council
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NORTHWARD LOOKING
A Strategy and a Science Policy for Northern Development

SUMMARY


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Canada is a northern country. The many parts of the North are distinctively different from southern Canada, not only in terms of climate, vegetation, and soil characteristics, but in terms of the kinds of people who live there and the kinds of activities that are pursued to survive. The predominance of native peoples and languages in many settled parts of the North is the most visible manifestation of these differences.

The northern hinterland economy has always been based on the exploitation of natural resources. However, there are major differences between an economy that employs traditional resource harvesting activities, such as fishing, hunting and trapping, and the activities associated with large-scale, mineral and hydrocarbon extraction and large hydroelectric projects. There are also similarities; the nature of large-scale industrial activities, as well as fur trading, are mainly determined by influences external to the North, but can involve social and environmental costs which nevertheless must be borne by Northerners.

The North has often been viewed as a

storehouse of resources, a cornucopia waiting only to be tapped. Recently, the cornucopia vision has been tempered by a growing concern for the "finiteness" of natural resources and a better appreciation of the total economic costs of overcoming the relative inaccessibility of the North. Two development trends in the North, one toward large-scale industrial activities and the other toward small scale, renewable resource harvesting, have conflicted in the past, sometimes producing social tensions and environmental degradation. Although the first trend predominates, both are important to the future of the North. What Canada needs, in the short term, is a transition to a more balanced strategy for northern development. This transition will inevitably require a greater emphasis on renewable resource management.

The Science Council advocates a strategy of mixed development. Firstly, more economic and technological self-sufficiency is required. This means that more activities should be locally defined and controlled in order to counteract those that tend to increase political and economic dependence, welfare, and other undesirable social conditions. There should be

an emphasis on relatively low-capital, decentralized, and small-scale development.

Secondly, economically viable (including social and environmental costs) large scale projects can and should take place in the North, because Canada will continue to depend on energy and mineral resources. Although there are already activities which implicitly support the mixed strategy, there is a need for a more explicit science policy to support the strategy. This science policy will require sensitivity to traditional patterns of land use, recognition of the low biological productivity of the North and of the role of public participation.

Four basic principles should guide the pursuit of a science policy for northern development.

1. Technological sovereignty - the ability of Canadians to control, direct and benefit from technological enterprises which affect the future of the nation. (This is a national concern.)
2. Life style flexibility - the need to allow opportunities for choice of life style. (A local concern primarily.)
3. Maintenance of the regenerative capacity of

the land. (Standards of environmental acceptability.)

4. Comprehensive and balanced assessment in monitoring of large and small projects. (Standards of political acceptability.)

These principles should govern the choice of all new research and development initiatives in the North.

Several specific initiatives are also needed. A "University of the North" should be established. This facility would provide a focus for the development of northern research activities explicitly designed to solve northern problems and to serve northern peoples. Universities should play a greater role in solving northern problems. Funds available for Canadian researchers in northern research should be reallocated so that grants are emphasized over contracts. This would improve both the quality and the independence of Canadian university research in northern matters.

Comprehensive knowledge of northern conditions and resources is essential to aid choices among development options. Special attention should be given to the assessment of

the potential of renewable resources in the North. As this resource potential becomes understood, appropriate indigenous capabilities and the expertise necessary to develop the resources must be developed and nurtured.

To utilize the fruits of scientific knowledge, appropriate communications technologies and facilities must be made available to northern peoples and northern institutions. As well, barriers to the flow of government-sponsored technical information should be removed. The capacities of legislative bodies and individual legislators to assemble and evaluate technical information should be systematically improved.

Knowledge alone is insufficient to exert control over the direction and character of development. Technological sovereignty can be most successfully pursued in a firm regulatory environment designed to protect new opportunities for Canadian enterprises. Crown corporations, such as PetroCanada, have a potentially important role to play in enabling Canada to better control the pace and choice of technologies relevant to northern development. Important, as well, is the

practice of contracting out research to relevant organizations. The activities and goals of the Alberta Oil Sands Technology and Research Authority are illustrative.

To complement technological sovereignty, Canada needs northern research development and demonstration projects that are determined by local needs. Some of this research must deal with the identification and solution of existing problems in the health area, for instance. Other research must be oriented toward community development projects that have as their ultimate goal the economic and social self-sufficiency of northern peoples. This means an emphasis on local materials, products, labour, and capital. The Science Council endorses the "Guidelines for Federal Scientific Activity in Canada's North", especially insofar as they encourage local participation in science policy decisions and scientific activities.

Finally, the Science Council stresses that large projects, as well as small ones, require an appropriate commitment to assessment of their feasibility, acceptability and impact. It is the size of the potential impact rather than the size

of the project that is critical. The process employed by the Mackenzie Valley Pipeline Inquiry is a unique contribution to the development of a balanced assessment system. As a result of this and other assessments, it is now clear that there are a number of problems - economically, environmentally, and socially - with constructing a gas pipeline for gas from Alaska through the Mackenzie Valley and that there are insufficient reserves to justify a pipeline for Mackenzie Delta gas only, at this time. While important data are still lacking, in August 1977, these assessments provided more information upon which to choose a route through Canada to carry Alaskan gas than was available in 1974 when the Mackenzie Valley Pipeline was first proposed.

The Council recommends assessments in five other areas which it believes will contribute to the process of northern development:

1. An examination of alternative transportation and production methods for gas from the Arctic Islands.
2. An assessment of commuting from urban centres to northern mines by air.
3. An assessment of the effect of telecommunications and television upon the North.

4. An assessment of alternative means of community development which emphasize renewable resources. This would inevitably include considerations of the assumptions, training, and techniques involved in transferring technology and knowledge to and from less developed countries and regions with analogous development goals.

5. A comprehensive review of the specific technologies relevant to the North which should be supported by an analysis of the rates of development most advantageous to achieving Canadian technological sovereignty.

These are technology assessments relating specifically to the North. However, similar efforts will be needed in the South, particularly with respect to changing energy production technologies and with respect to information, computer, and communications technologies. These southern assessments, however, should take explicit cognizance of the North and should not assume that it is merely an extension of the South. With this kind of anticipation, Canada should be able to make good use of existing and developing areas of scientific knowledge and technological expertise for the benefit of northern peoples and all Canadians.