Law of the Sea Workshop, June 1971
Canadian - U. S. Maritime Problems

Edited by Lewis M. Alexander
and Gordon R.S. Hawkins

Law of the Sea Institute
University of Rhode Island

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Introduction: Part One

Lewis M. Alexander, *Director, Law of the Sea Institute*

Canada and the United States are in a unique geographic relationship with one another. Together they occupy the bulk of the North American continent, and face each other across a land boundary measuring more than 4,000 miles in length. They share access to three oceans, and their adjacent continental shelves rank second and third, respectively, in extent among those of the world's coastal nations. The fisheries resources off western and eastern North America are among the most productive to be found anywhere in the ocean.

Both countries are developed, with strong industrial, agricultural and commercial economies; both depend on the sea as an avenue for commerce and for defense. Yet despite these similarities there have been in the past few years a series of difference arising between the two nations with respect to ocean policies. Most of these have involved free or restricted use of the seas, particularly for shipping and fishing. There have also been differences—some of them long-standing—over the delimitation of offshore boundaries between Canada and the United States.

These growing differences over marine policies have taken place against a background of increasing uncertainty over future trends in the international law of the sea. In 1958 the First Law of the Sea Conference, at which 82 countries were represented, was held in Geneva. A result was the adoption of four Conventions on the Law of the Sea; all four Conventions were subsequently ratified by a sufficient number of states to be in effect for the countries adhering to them. The 1958 Conference failed, however, to reach agreement on a uniform breadth of the territorial sea or on an extra-territorial exclusive fisheries zone. Two years later, a Second Law of the Sea Conference was convened in Geneva with 88 countries in attendance. The hope of the Conference leaders was to resolve the territorial sea/exclusive fisheries zone question. In the closing days of the Conference, a joint Canadian-U.S. proposal was submitted, calling for a universal six-mile territorial sea, plus a six-mile contiguous exclusive fisheries zone in which foreign fishermen would enjoy historic rights. The proposal was defeated by one vote, and the Conference then adjourned. Both questions have been subject to international debate ever since.

Since 1960 interest in the sea and its resources had grown considerably among the world's nations. The number of independent states of the world has increased from 99 to 149 and the membership in the United Nations, from 100 to 132. During the same period the annual fisheries catch from the world ocean doubled in volume while offshore oil production increased five times. Greater development of ocean resources brought with it greater concern for the utility of the four Geneva Conventions, because of both the problems they had left unresolved, and the inadequacies of some of their provisions in the light of new technological, economic, and political conditions. In December, 1969, the United Nations General Assembly issued a call for a Third Law of the Sea Conference, scheduled to be convened in 1973. All problems relating to the sea and its uses are liable to be considered at this new Conference, and a great deal of preparatory work has already been carried out by the Seabeds Committee of the United Nations. In contrast with the 82 delegations represented at the First Law of the Sea Conference, it is possible that between 130 and 140, or even more, may be in attendance at the Third, each with its own concept of its country's national interests in the sea.

In anticipation of the new Conference, it might be supposed that governments would be restrained from carrying out major changes in existing policies of offshore control. New ocean regimes might quickly render obsolete any recent rules and regulations which have been enacted. On the other hand, unilateral actions taken in advance of the Third Conference would have the effect of presenting the Conference delegates with *faits accomplis,* which must be taken into account in their deliberations. The utility of this tactic is well known to anyone who has been involved in international negotiations. Moreover, much time may elapse before any new ocean regimes are adopted at a Conference and subsequently ratified or acceded to by a sufficient number of states to come into effect, even for the participating countries. In the interim, much damage may have been done to the interests of littoral states through non-enact-

ment of what they consider to be essential restrictions.

The time frame for the orderly development of the law of the sea through consensus of a majority of the world's nations must be weighed against the immediacy of what are perceived to be legitimate needs by individual states. Here then is the crux of most of the differences between the United States and Canada. The United States would prefer to minimize increased national claims to offshore control pending the establishment of a new world-wide ocean regime; Canada—perhaps as a reaction to the failures of existing international agencies—is inclined to seize the initiative now in new approaches in law of the sea matters, particularly those—i.e. fishing and environmental protection—which are seen as seriously affecting Canadian interests.

The difference in approaches is evidenced in the fact that the United States has ratified all four of the Geneva Conventions, while Canada has ratified only one—the Convention on the Continental Shelf. It is also reflected in Canada's claim to Hudson Bay as an historic water body, while the United States has no such claims to any of its own bays and inlets which are greater than 24 miles in width at their mouth; likewise, Canada has proclaimed a series of straight baselines along portions of its coast, while the United States has refrained from adopting any special straight baseline regime. But the greatest evidence of policy differences occurred in June 1970 when the Canadian government extended Canada's territorial waters to a breadth of twelve miles and authorized the establishment of extra-territorial exclusive fishing zones off the east and west coasts. Canada also proclaimed national regulation over extra-territorial activities (commercial shipping, mineral exploitation, etc.) which could lead to pollution, within zones/areas up to 100 miles seaward of the Arctic coast. Among other things the legislation empowers the Canadian Government to establish regulations applicable to all ships in the safety control zones to be designated in the Arctic, and to prohibit vessels not complying with the regulations from navigating in these designated zones—a clear restriction on the doctrinal unlimited freedom of navigation, which the United States has long espoused.

Differences over offshore boundary locations have in the past been muted. But in recent years interest has grown in the possibilities of oil on the continental shelf underlying the Gulf of Maine, and exploration leases have been granted both by the United States and Canadian Governments. Because of the dispute over the boundary location in this area, several of the leases granted by both governments have been overlapping.

Officials of the United States and Canadian Governments have on numerous occasions met to discuss one or more of the above-mentioned differences, generally without resolution of their disagreement. Meetings have traditionally been in closed session with little opportunity for persons outside the respective governments to become acquainted with the issues at stake and to get an idea of possible alternatives for solution. It was in the interests of airing these differences, and perhaps contributing somewhat to the awareness of new perspectives, that the Law of the Sea Institute conceived the idea of convening a workshop in Canada which could address the entire gamut of marine policy problems outstanding between the two countries. The Institute found ready acceptance of its concept by the Canadian Institute of International Affairs and the University of Toronto Faculty of Law, and the three institutions jointly sponsored the workshop in Toronto in June, 1971. Basic support for the project came from a grant made to the Law of the Sea Institute by the Ford Foundation. The papers presented at the workshop, and the Rapporteur's Report of the gist of the discussions and debate, are contained in this volume.

Introduction: Part Two

Gordon R. S. Hawkins, *Workshop Chairman*

A tidal wave of arguments, crises and agreements is sweeping over the whole saltwater and seabed scene. It is inevitable, therefore, that papers on maritime problems printed in the year after they were written will be marked by this movement. The increasing complexity of the situation in the U.N. Seabed committee, the indisputable achievements of the last ICNAF meeting in Washington, the impressive if more arguable gains of the U.N. Conference on the Human Environment, the seemingly decisive moves on the Trans Alaska pipeline project are all examples of the changes that have taken place within that year.

While some of the opinions—and facts— in this volume may thus seem to have acquired some historical overtones, the important point about their publication at this time is that, when taken with Dr. Brown's summary report of the discussions, they illumine quite sharply the differences in approach of the two North American neighbors. They exemplify also something of the atmosphere in which these differences are discussed. At the technical level, they show the degree to which an inevitably continuing argument is governed by the constraining facts of science and nature.

The papers in this volume thus fall into distinct groups. There are those which bear upon the technical considerations that must inform any Canada-U.S. discussion on the general topic. Dr. Hoult's paper on the effects of hydrocarbons in sea water, Dr. Britton's paper on the full range of problems of the Arctic environment, and the discussion of the economics of oil transportation in the Arctic by Professors Quirin and Wolff all fall into this category. So also, in its particular way, does the paper on Atlantic fisheries by Dr. MacKenzie.

Schematically, Professor Herrington's paper on the same subject and Dr. Alexander's study of the problems of offshore boundaries lead us into the topic with which the remaining papers are concerned. This is a consideration of specific Canada-U.S. interests and differences and, still more specifically, the statement and substantiation of Canadian initiatives in this field. These are represented by the papers of Professors Pharand, Johnston and Clingan, respectively, on the implications of the Canadian legislation for international law, its significance in historical perspective and its implications in terms of third-party imitation. The prescient summary of Dr. Brown completes this section.

The current conventional wisdom on Canada-U.S. relations, using the fashionable measure of rhetoric, tells us that the "special relationship," the "partnership," the effective consultation" of the era preceding the Merchant-Heeney Report of 1965 have given way to "sovereign independence," "economic nationalism," "national interest" and "diversification." This shorthand analysis undoubtedly gives some clue to the reality of the changes that have taken place in that relationship and to its present state.

It is necessary to note, however, that it is in the context of alliance relationships and economic dependence that this analysis is set. When the relationship is observed on the maritime scene it seems much less relevant. Indeed, it is possible to argue, for reasons good and bad, that this relationship is quite different, almost *sui generis*. Of course, this aspect of the relationship does have its own rhetoric also. "Special circumstances," "creeping jurisdiction," "freedom of the seas modified by self defense," "trusteeship," "the total marine environment" are all used both as signposts and shibboleths.

The important thing, it is argued here however, is that Canada-U.S. maritime relationships should be seen neither in the context of an unequal partnership nor in homely neighborhood terms. Even that enduring construct of continental amity, the undefended border, is useless here. While it remains intact when faced with the crossing of draft dodgers and the rhetoric of politicians, it is unreliable under water. It is a highly contentious notion at any depth in the Gulf of Maine.

The maritime relations of these two states operate largely within the state system. Their context is not continental but international. It is not stretching words, moreover, to say that it is more a relationship of equals than it can ever be in military and industrial terms. Indeed, because of its location and disposition, Canada is more equal in that sense in which Iceland, in fisheries terms, is more equal than Britain.

When Canada decided that in 1964 it would create a 12-mile exclusive fisheries zone and implement the straight baseline method for the measurement of its territorial sea, the Leader of the Opposition in the Canadian House of Commons warned that such unilateral acts would probably lead to reprisals by its powerful neighbor. When the controversial legislation of 1970 was introduced into the Canadian Parliament, support for it was unanimous. Canada had learned the lesson that, for all the unilateralism and notwithstanding the inevitable protest and passing acrimony, the differences would not lead to hard bilateral confrontation because they have to be resolved in an international context. Put another way, it could be said that, for all the fishing incidents and boundary disputes, the basis from which each country argues and the direction each is taking, divergent as they are, share the assumption that what is important is not so much neighborliness as a commitment to consider their difference in an international context and to find solutions in international negotiation.

This, at any rate, is the thesis the junior, Canadian and less oceanographically-oriented editor finds it possible to float on the basis of both the content and the spirit of the joint enterprise recorded in these pages.

Special Problems of the Arctic Environment

M. E. Britton, *The Arctic Institute of North America*

The Arctic is much in the news these days and it is gratifying to observe the development of public awareness, appreciation and conscience for this long-neglected, forbidding, romanticized, circumpolar region. The romance has been fading for many years as easier access has opened the Arctic to increasing numbers of people. Surface and airborne exploration are over but much can yet reward any adventurer with the wit or good luck to command the services of an under-ice vehicle.

To record a "first" in an attempt on the North Pole one must be innovative indeed, as the most obvious means—dog team, on foot, on skis, by motor toboggan, drifting on the ice—have had their moment in the sun. Sooner or later some hardy soul is likely to make the effort by unicycle. The Navy research station on drifting Ice Island T-3, now about 250 km off Ellesmere Island, is becoming a way-station for adventurers. Just a few weeks ago a lady with babe in arms arrived by air; and a party led by an Italian gentleman, complete with Greenlander drivers and 196 dogs, spent a few days there enroute to the Pole.

Anyone can be deep within the North American Arctic within one day traveling by regularly scheduled commercial aircraft. All parts of the Arctic land are accessible at most times of the year to those who have the resources to acquire special flight services and are blessed with patience and willingness to take advice and assistance from experienced people. International flights over the ice pack are accomplished daily and routinely by major airlines on established routes, and excursions by charter flights take place essentially anywhere. Landings on the ice of the Arctic Ocean, at preferred times of the year, are more or less routine within a hundred miles or so from shore, as in the case of bush pilots providing services and guarantees of success to hunters of polar bears. Deeper penetration of the Arctic is hazardous, but possible, and is accomplished without fanfare by experienced people for special purposes. In other words the Arctic is reasonably open, and the principal deterrent to waves of people going there, even in the most favorable seasons, is the cost. Tourist services to the North Pole have been announced for March-April 1972. Mr. Weldy Phipps, famous Canadian arctic pilot, will operate out of Resolute and land passengers at a campsite which will be moved as necessary over the drifting ice to remain fixed at the Pole.

Distance from the population centers, coupled with difficulties of existence once there, have hampered all development in the far North. These are problems. Getting there is expensive and staying there for any appreciable length of time is both expensive and too often tinged with hardship. Although exceptions are numerous, long-term occupancy in the Arctic and the accomplishment of anything of a productive nature has generally been reserved to organizations with large money resources. This means big government and big business. Governments led the way, at first modestly, by simply attempting to locate, describe, inventory and determine what they actually owned up North. Later military considerations, during and immediately following World War II, gave impetus to increased invasion of the northern fringes of the continent. The beginning of construction of the Distant Early Warning Line in 1955 opened the North and brought into public focus the nature of northern problems as no other single enterprise before or since—that is, until quite recently.

Without regard to the true historical facts of exploration, the Arctic seems only to have been discovered within the past three years. Radar warning systems, under-ice nuclear submarine exploits, icebreaker penetration of the ice pack, isolated weather stations at the outposts of the continent, and the like, enjoyed their brief times of glamour; but substantial public awareness is ignited and kept aflame by the promise of economic gain. The missing ingredient essential to exploitation, and perhaps development, of the Arctic has been found. Prospective wealth of breathtaking proportions has focused more attention on arctic North America in just three years than all other stimuli in all time. Major discoveries of oil and gas reserves on the North Slope of Alaska and in the Canadian Arctic Archipelago, with the promise of more to come, have given a nudge to the real opening of the door to the Arctic, but there are problems and the door is yielding grudgingly.

Applied forces from opposite sides of that

door, at least in Alaska, have highlighted areas of concern and conflict—they have illuminated problems on scales ranging from local to national, international and global. There are many issues to be resolved; and industry, with phenomenal speed, advertently or inadvertently, has forced large sectors of the public and government to evaluate their own stakes in the Arctic and to assume their responsibilities.

It has been both amazing and heartening to observe the acceleration in interest and responsibility within government agencies with respect to arctic affairs. Responsibilities existing, but dimly perceived, have been clarified and implemented, new responsibilities have been assumed or delegated, and probably some individuals or agencies are looking for "a piece of the action" where they have no apparent responsibility at all. The occupants of a host of superior positions in government, sitting over one or another of many arctic programs, have had their indoctrination trip to the Arctic only since Prudhoe Bay appeared in the headlines. There has been a flood of people north—Senators, Secretaries, Under Secretaries, Department Heads, Congressional Committees, Task Forces, Admirals, Generals and other high level officials as well as their uncounted subordinates. These visitations, and the events that brought them on, mark new dynamism in the North, the recognition of problems and the development of a sense of urgency to do something about them. There is a new alignment of priorities; and with respect to environment it is regrettable that it came so late if, indeed, not too late in important instances.

Feverish activity on the part of either industry or government does not necessarily spell progress, and can easily mean the opposite. It is tempting to suggest that governments were "caught with their pants down" by the sudden discovery of arctic oil—a situation not conducive to running while looking over the shoulder to check the gains of the pursuer. With energy-hungry nations demanding and high profits beckoning, industry, backed by ready funding, can and does move with admirable if somewhat frightening speed. Consider the rapidity with which the multimillion dollar ice trials of the *Manhattan* got underway, and the purchase in Japan and delivery in Alaska of 800 miles of 48-inch pipe in the absence of any assurance of how, when or whether a hot-oil pipeline across Alaska could or should be constructed.

Private, public and government arguments have at least temporarily enforced a slow-down. In the process many problems have surfaced, and both industry and governments within the United States and Canada are making large expenditures and utilizing the best talent they can marshal to find solutions to these problems. Whether solutions can be found in the short term for what are intrinsically long-range problems constitutes a problem in itself. Resource development with a profit-making goal and enormous investment requires speed of action to assure profits at the earliest. There is a rate factor involved, and the immediacy of demand for return on investment engenders rates inimical to circumspection and the protection of the public interest in other resources and values.

Governments, the protectors of balance in the totality of the public interest, cannot always be prepared to render decisions suddenly or at the same rate as can large industries which, either by design or fortuitous circumstances, have seized an economic initiative. Governments can and do respond with speed and intensity once problems and responsibilities are recognized. The rate of decision making can match that of industry when knowledge is adequate as a basis for decision and the presumed facts are not substantially contested. If increased knowledge, based on new research, becomes a factor in complex decisions, the rate of its acquisition can be accelerated, but only with inevitable retardation of the rate of development. How much we know about arctic environments, how much we must know before taking a given course of action, and what can acceptably be done concurrently with development all constitute problems. One of the most critical problems to be faced is the definition of research which can be conducted hand in hand with resource exploitation and development. The interplay of forces imposed by different sectors of society, with differing goals and aspirations, at a national level can only become more complex at international levels. This Workshop addresses U.S.-Canadian maritime problems. My assigned task is to provide an appraisal of special environmental problems and, in so doing, to assume that the participants know little about the Arctic. This is dangerous business since many or all may be well informed about the Arctic and certainly a few among the participants are well known for demonstrated, outstanding qualifications to treat the subject.

In planning this paper my thinking has revolved 180 degrees from the view that there is really nothing very special among arctic environmental problems to that of holding everything special. From somewhere along the gradient of these polarized views a few environmental, or environmentally related attributes of the Arctic, which appear to have some claim to

being special, are selected for examination. First of all, what is the Arctic?

The Arctic Region

The Arctic can be variously defined, depending upon the biases and purposes of the definer. Everyone presumably has at least a vague concept of an area lying somewhere around and about the North Pole. The axis of the pole in this case happens to extend through a jumbled, drifting ice pack and more than 4 km of water before intersecting bottom sediments and solid earth.

From the pole position a 360° turn (Fig. 1) readily reveals who and where the neighbors are and the magnitude of their holdings on the ocean front. The most striking feature of the polar view of the earth is that its northern reaches consist of an ocean sufficiently landlocked to be considered a mediterranean sea. The narrow Bering Strait connects it to the Bering Sea and the Pacific Ocean, and directly across the Arctic Ocean Basin there is a much wider connection through the Greenland and Norwegian Seas to the Atlantic Ocean.

The major political and economic powers "gaze" at, or in one way or another sense each other across this mediterranean sea, and altogether five countries share the periphery of its central basin. In terms of kilometers of coastline, the Soviet Union leads with about 6,440,

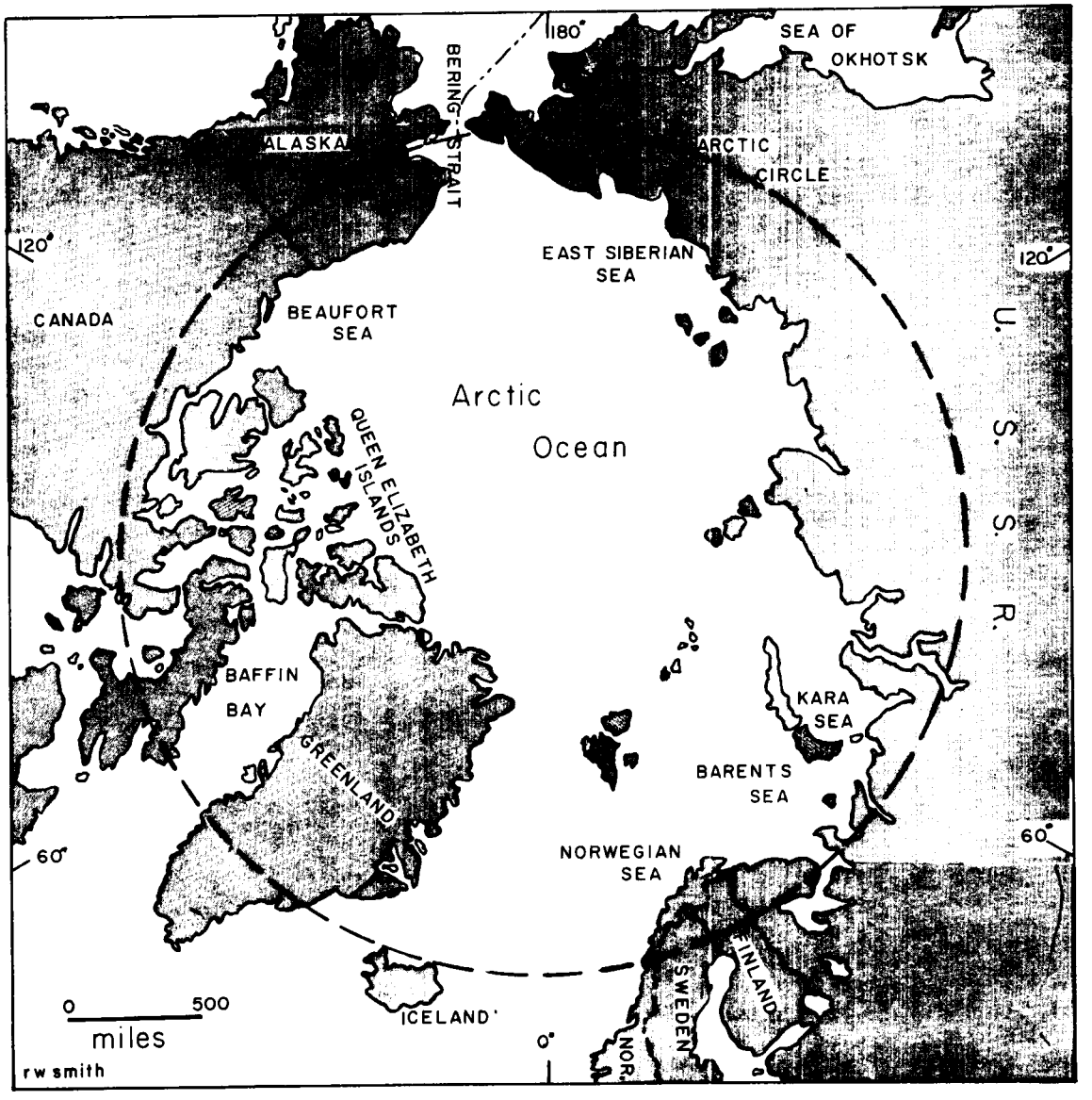

Figure 1. The Arctic Region.

Canada has about 2,416, the United States 1,450, Denmark (Greenland) about 805 and Norway (Svalbard) about 160.[1] Distances between neighbors sharing this frontage are modest enough to encourage good neighborhood plans and policies. Jet planes and under-ice submarines could provide varying degrees of rapid transit over the 3,220 km or so of distance from point to point on any of the coasts. We shall see later that people, flotsam, jetsam and waste products of whatever origin can be exchanged at a much slower rate controlled only by the natural forces resulting in surface drift.

The boundaries of the Arctic Ocean (Fig. 2) delimit what oceanographers consider truly arctic waters from sub-arctic waters which differ in temperature, salinity and other properties. The limits of the Arctic on land are difficult to set, and many different criteria have been used with limited success. Climatic characteristics would appear to furnish appropriate criteria, but the question arises as to where along a climatic gradient a line can be drawn separating significant breaks in those characteristics.

Significant boundaries are determined by seeking visible, mappable, natural features of the earth which are believed to be under the control of climate and in reasonable equilibrium with it. The distribution of vegetation has furnished one of the most useful guides to the boundaries of different climates. In the North the northward limit of trees, the tree line (Fig. 2), has been so used and provides a visible and useful approximation of the southern limit of the true Arctic. Northward of the tree line toward the Arctic Ocean lies the treeless, circumpolar, geographic Tundra.

Deciphering and expressing the features of climate that exert control on tree distribution in the North have not been very successful. The attempts have emphasized one expression or another of temperature. One such attempt, expressing an empirical relationship between the mean temperatures of the warmest and coldest months, produces the Nordenskjöld Line (Fig. 2) which in a very general way exhibits the same pattern as the tree line.

The difficulty with a boundary of this type is that there is no known physiological means of relating it to the behavior of protoplasm in trees or any organism. A recent report by Hare relates annual net radiation to the tree line and tundra climate. Along the tree line, he states, ". . . about 55 kilocalories per square centimeter (kilolangleys) per annum . . ." of solar radiation are absorbed at the surface. Deducting for heat loss from surface to the atmosphere, net radiation values of 15-20 kly "seem to apply" at the tree line. In thermal terms Hare defines tundra climate as having annual net radiation values of 0-15 kly and a midsummer mean daily air temperature of 3-10°C—trees lie southward where both radiation and air temperature values are higher.[2]

The southward limit of continuous perennially frozen ground, or permafrost, is also taken as a significant, climatically controlled boundary for the southward limit of the Arctic. Its distribution (Fig. 2) is fairly consistent with the tree line and the Nordenskjöld Line—perhaps better than should be expected—in North America, but shows disturbing departures in the Soviet Union. The difficulties in setting such boundaries are numerous and they need not be belabored here.[3] This Workshop is concerned with arctic maritime matters and essentially everything discussed here will apply to unquestioned arctic areas characterized by treelessness, continuous permafrost and an ice-covered ocean.

An Overview of Arctic Environments

It is impossible to characterize the Arctic as a single environment, for there are many. Ocean alone occupies 14,000,000 square kilometers of its area and its marginal lands are diverse in relief, exposure and properties of surface, both physical and biological, which modify the impact and expression of climate at ground levels. Plains and plateaus are dominant features around the ocean both in North America and Asia and complex folded mountains occur in Greenland, the northern islands of the Canadian Arctic Archipelago, the Yukon, Alaska and northeast Siberia. The Ural Mountains also extend to the ocean and into the islands of Novaya Zemlya.

The plains and plateaus have elevations from just a few meters above sea level, as along the north coast of Alaska, to heights of about 915 m in the Taymyr Peninsula.[4] Mountains forming the drainage basin of the Arctic Ocean are generally below 3,050 m, those of the Canadian Arctic Archipelago and Greenland reaching maximum elevations of about 2,100-2,700 m. Maximum elevation in the eastern part of the Brooks Range of Alaska is 2,817 m.

Crossing the circumpolar Arctic Drainage Basin and discharging into the Arctic Ocean Basin are innumerable streams and rivers which transport both heat and mass northward and greatly modify environments both along their courses and within the ocean. The largest of these are the Mackenzie River in Canada and the Lena, Ob and Yenesei Rivers of Siberia—Alaska having none to compete.

The Arctic is in many ways a disadvantaged region. It is short on energy (ignoring fossil

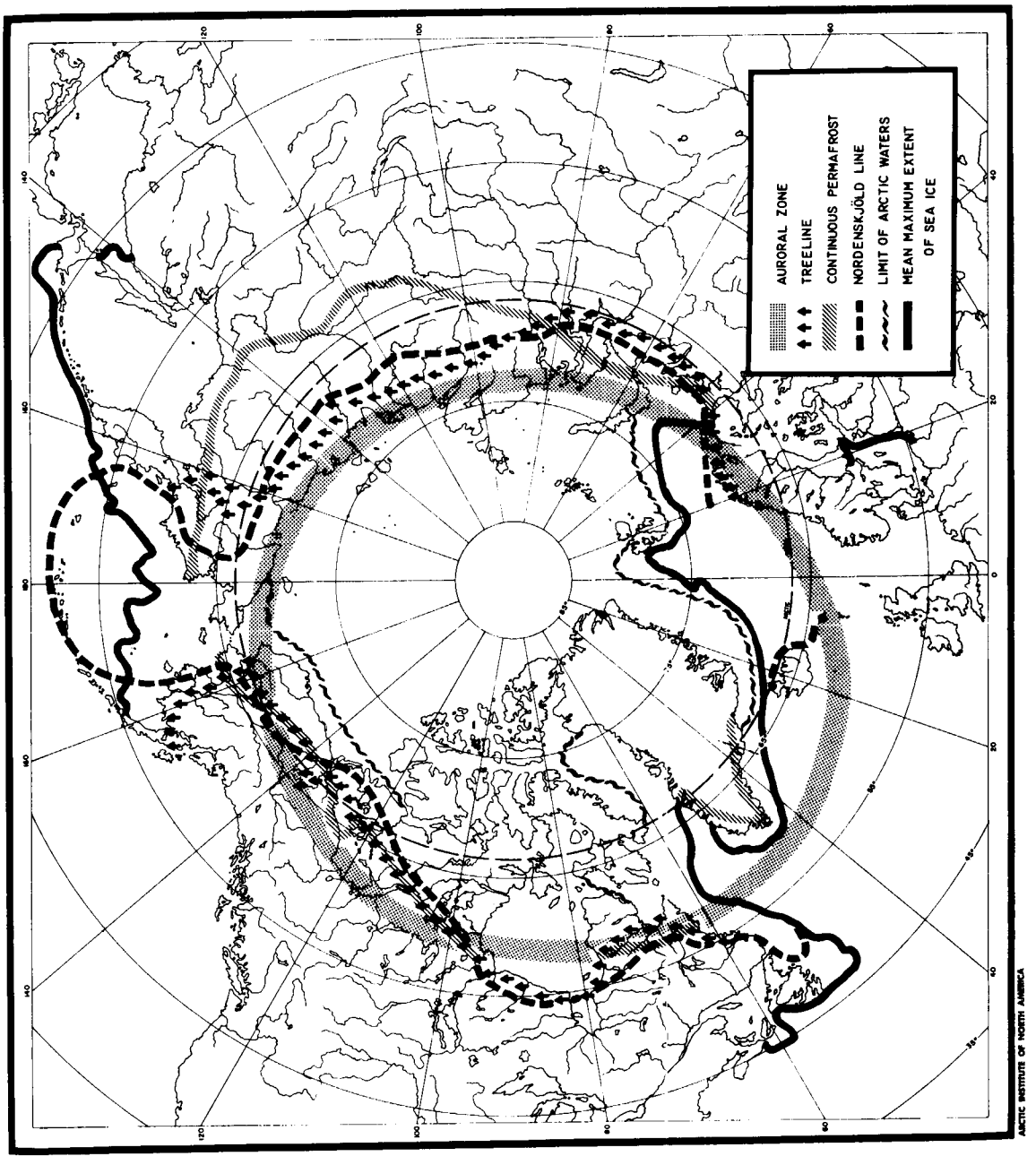

Figure 2. Some significant boundaries in the Arctic Region (Sater, 1969).

fuels for the moment), also short on water, daylight for periods that are too long, people, comforts, amenities and a host of other attributes. It is over-endowed with ice, long months of snow cover and frozen ground. Man from gentler climes can be understood for his adverse reactions to the North and the frequent judgement that it is a harsh, hostile and inhospitable land. Cold, dark days of long winter and cool, light days, including 24-hour sun, of short summer are among the more evident environmental characteristics dramatized by all who have experienced them. Even these, however, have unequal distribution within the Arctic, and what you experience depends upon where you are. The radiation environment is very different depending upon latitude. The amount of solar radiation, received principally as visible light, during the summer is critical to the economy and survival of all biological populations. The annual radiation balance problem and the total budget of heat flux are very important with regard to permafrost and sea ice, and will be given further attention later.

Potential availability of sunlight is only part of the problem. Sun angle is low in the Arctic, and the amount of radiation received on a unit area in unit time is much less than at lower latitudes. Additionally, at any latitude in the Arctic the coming of the warm and light season is accompanied by increased cloudiness and fog and resulting reduction in light intensity. Especially at sea and over maritime lands, clouds and fog are common. The thaw of lakes, rivers, tundra surface and sea ice, the freeing of coasts of winter shore-fast ice and the increased formation of open leads in the ice pack all combine to provide water sources. High evaporation rates and strong turbulent convection transfer large quantities of moisture to the atmosphere and contribute to the production of fog. Along coasts the onset of advection fog is sudden, frequent and intense. Clear, sunny days are the exception during maritime summers.

Winter is the season for any activity such as flying operations which benefit by clear skies. The incidence of fog declines with the progress of freeze-up in the autumn. This process is well under way in September and by November freshwater lakes and streams are frozen over as are tundra surfaces. The ocean may remain open several weeks longer depending upon when the pack drifts in, becomes grounded along the coast and the freezing process completes the closure of water surfaces. Large leads may remain open offshore until January or later and there is a large amount of open water in the drifting ice pack at all times of year.

Mr. Weldy Phipps has set his schedule for tours to the Pole in March and April for very good reason. From late February to mid-May, clear skies are probable and with the sun returned, flying conditions and landings of opportunity on the ice are at their best. Cold weather still, but now the skies are usually clear, the snow and ice clean, and every operation at this time of year benefits by the improved psychology of people happy for the return of the sun after a long season of darkness and perhaps cabin fever.

The extreme low temperature records of the North are set in the continental climate of the sub-Arctic. Although it is perhaps cold enough for anyone's taste in the Arctic, temperatures are much ameliorated by the ocean in the maritime areas. The winters are warmer but unfortunately the summers are also cooler. At Barrow, Alaska, the mean annual temperature is -12.2°C, on the central ice cap of Greenland it is -33°C, and it is estimated to be about -23°C at the North Pole.[5] Illustrative of extremes are -50°C on exposed tundra and -66°C on the Greenland ice cap.[6] At Barrow temperatures are below freezing most of the year, only the period June through August having mean temperatures above 0°C. On the average, maximum temperatures there exceed 0°C on about 111 days of the year and minimums are below 0°C on 323 days.[7] In the northern islands of the Canadian Arctic Archipelago, 90% of the days from January through March have temperatures as low as -30°C and reach -40°C on one-third to two-thirds of those days.[8]

February is usually the coldest month with a mean of -28°C and July the warmest at 4°C at Barrow.[9] Around the periphery of the ocean the July mean temperature generally runs from 4-10°C. Freezing temperatures may occur at vegetation levels on the tundra when clear night skies permit intense radiation losses to the atmosphere. On clear days in July when insolation is most intense, temperatures at vegetation levels may rise to 38°C when air temperature at standard levels are 18-20°C lower.

Winds are almost a constant feature for most of the year, and in combination with low temperature cause great discomfort and hamper outdoor activities. At a wind speed of 9 mps (about 20 miles/hour) a temperature of -15°C has a chill effect on man equivalent to a temperature of -40°C at a wind speed of less than 1 mps.[10] Extreme conditions of this type in the Canadian Arctic are winds of 45 mps and temperature of -30°C observed at Winter Harbour and 27 mps and temperature of -37°C at York Factory.[11] Calms often prevail, however, during periods of extreme cold. Storms may occur in all seasons and often attain velocities that are destructive. Coastal areas are seriously eroded during summer storms and when high winds coincide with offshore ice-free water, storm surges of water are destructive to engineering structures within reach. Such a storm did extensive damage and endangered lives at Barrow in October, 1963.

Precipitation is low throughout the Arctic and is received about one-half in the form of warm season rain and half in winter snow. Some coastal areas of Siberia and Canada receive total annual precipitation of only 10 cm, most of the Arctic has under 25 cm and some areas receive as much as 40 cm.[12] Along the Arctic Circle annual precipitation in Canada is about 20 cm and in Siberia 40 cm.[13]

Snow provides the dominant scene throughout most of the year, but conveys an impression of greater abundance than is actually present. Snowfall is light and is subject to much redistribution and drifting in the strong winds. Exposed topographic features, even in areas of very low relief, have thin snow cover and in midwinter large areas may be swept essentially free

of snow. Accumulation is usually less than 25 cm along the arctic coast and the average maximum is less than 75 cm for the Arctic as a whole.[14] The average depth of late winter accumulation north of 70° is about 40 cm compared to 40-80 cm in the continental interiors.[15]

Low annual precipitation and low atmospheric humidity during most of the year are prevalent conditions which in their more extreme expression in the higher altitude Arctic, as in the Canadian Archipelago and northern Greenland, contribute to the development of arctic deserts. Low coastal plains, as at Barrow, are so poorly drained that ponds, lakes and extensive swampy, boggy areas dominate the terrain. Here summer humidity is higher, evaporation rates lower and most sites are amply provided with water despite low precipitation. There is great variability in this regard from year to year, and in some summers drought effects are conspicuous in the vegetation of the better drained sites.

No sketchy commentary like the foregoing can do more than hint of the general severity of this environment. By any standard it is severe for southern man; but whether or not terms like "hostile" are appropriate really depends upon the individual. It is unlikely that most people would share the views and philosophy that produced "The Friendly Arctic,"[16] but many do. There is basically little man cannot do in the Arctic to realize its resource potential if he will utilize past experience, respect and work with an environment that is unforgiving of mistakes, consider consequences of each operation in advance, and spend large amounts of money. Hundreds of species, both on land and in the sea, often in large populations, have been extremely successful in meeting the environmental challenge. The success of native man as an integral part of a complex environmental system, as well as the successes of all organisms, offer lessons to be learned if they endure long enough for the rest of us to achieve understanding.

What Are Special Arctic Environmental Problems?

It must be assumed that man will make increasing use of the Arctic and that our major concern here might be to assess the impact of the environment upon him and his enterprises and, reciprocally, the effects of these on the environment. The former, insofar as living, building, transporting, communicating or similar activities on land are concerned, have solutions in the Arctic as elsewhere—that is, there are known techniques and practices which work if only the existing knowledge and broad experience are put to work. This does not imply that everything is known, or that better and safer or more economical ways cannot be found to improve present methods and technologies.

The point to be made is that none of the environmental data previously cited, or none of the volumes of such that could be cited, necessarily forecast failure in living or working on arctic lands. Therefore, it does not appear necessary to be concerned here with problems of the impact of environment on such matters, interesting though they might be. It is contended that the Trans-Alaska Pipeline might have been long since approved, perhaps even under construction, had available knowledge of permafrost been applied at the outset and the line designed accordingly—namely, by hanging it in the air over most of the route. This is suggested only from an environmental engineering point of view and without regard to any or all of the other arguments which have been advanced for or against the pipeline.

Offshore, across-the-shore and at-sea operations, implicit in the plans of oil and gas interests, lack the benefit of necessary knowledge and experience; and the potential impact of environment on these areas is deserving of some attention. However, the major problems of the over-all Arctic are considered to be those deleterious changes to environment brought about by man. One might well argue that without "outside" man there would be no problems in the Arctic.

Since governments, as well as individuals and corporations, have arctic interests, as this Workshop is illustrative, some attention must be given to what appear to be problems worthy of their mutual concern although no flags will be raised to lend emphasis.

We will examine three major dynamic systems. Two of these, the arctic atmosphere and ocean, are fluids in motion which change rapidly and interact continuously with the global atmosphere and ocean, as well as with each other. The third system, the Tundra, dynamic but slow to change in the absence of man's disruptions, is relatively insignificant in a global sense. The Tundra has its global importance, however, as the arctic tern migrates all the way from Antarctica to breed there and hosts of other avian species from thousands of kilometers to the south also breed there each summer.

Problems of the Atmosphere

The ice cap of Greenland, glaciers of Ellesmere and other Canadian islands, perennial sea ice of the Arctic Ocean and perennially frozen ground are conspicuous consequences of arctic

heat deficiency. This deficiency is the result of low values of incoming solar radiation, principally due to low sun angle, and to the high reflectivity (albedo) of snow, ice and tundra surfaces. Since there is little absorption of light the amount of heat is small on an annual basis and it is dissipated by radiation to the atmosphere, convection and other thermal transfer processes, and the seasonal melting of snow, ice and surface layers of the frozen ground. Cold air blankets the Arctic, and the entire region constitutes a heat sink and an essential component of the heat engine—which Fletcher[17] calls the "Global Climate Machine"—which drives the world atmospheric circulation. The circulation of warm equatorial air northward and cold polar air southward is a heat and mass transporting system which, together with the same system in the Southern Hemisphere, leaves its climatic stamp on all parts of the world. This is truly a problem in global meteorology. Hare stated, "Meteorology is the most global of all sciences in outlook, and it can be argued that there is no longer any such thing as *arctic* meteorology, at least in the free atmosphere."[18]

The circulation problem requires international cooperation in data-gathering, analysis and interpretation, and this is being accomplished. Since the Arctic is a very important part of the problem, and data have been slow and difficult to accumulate there, it is perhaps necessary that arctic countries increase their level of research activity.

The objective of this paper, in this connection, is to examine briefly the special role the Arctic has in global circulation, to consider the implications of variations in arctic climate and to note some of the real potential changes which may produce these variations.

Climatic Variations

Year-to-year or decade-to-decade fluctuations in climate, as well as long-term variations over thousands of years, are well known. Significant changes in climate must always result in changes in those physical and biological complexes at the earth's surface which are under climate control. The ice pack, for example, thins and its boundary retreats under a warming trend and thickens and advances with increasing cold. Animals migrate, vegetation boundaries shift and all the complex of ecological interrelationships at the earth's surface undergo accelerated change as the environment changes.

From about 1890-1940 a warming trend was accompanied by a northward retreat of sea ice and variations in its mean area of about 10-15% and of mean thickness of about one-third. According to Fletcher, " . . . recent decades have exhibited opposite trends. . . . . southward shifts of ice boundaries and cyclone paths and sharp cooling and different rainfall patterns over continents."[19] McKay has indicated the socio-economic importance of climatic change, citing the Iceland experience of 1870-1918 which entailed the emigration of thousands of people as a consequence of cold, increasing ice, reduction in crop yields and migration of herring from Icelandic waters.[20] Similar economic threats face Iceland today as ice has become an increasing problem in recent years and the fishing industry is suffering.

Climatic changes which brought on the great continental ice sheets of the Pleistocene, and those which resulted in their wastage, are not completely understood, but they are dramatic evidence of long-term variations of climate and there is ample documentation of their effects in terms of vegetation change, fluctuating sea levels, species extinction, and the like. The last stage of the Pleistocene ended at the latitude of Milwaukee, Wisconsin only about 11,000 years ago and the Arctic is still in the grip of Ice Age climate. Fletcher mentions the effect of post-glacial warming on colonization of Greenland and Newfoundland where the Vikings were able to move in following the warming which continued to about 1000 A.D. These colonies ended with the advancing ice boundaries and cooling climate of the period 1300-1840.[21]

The areal extent and surface properties of sea ice have a very important bearing not only on the arctic climate, but the entire global circulation. Ice cover impedes heat exchange between ocean and atmosphere. If the ice were to disappear from the Arctic Ocean, heat flow from water to atmosphere would increase five to six times during winter.[22] In summer, due to the high albedo of ice, solar heat to the ocean is reduced by a factor of about four. The net effect is atmospheric cooling. Any change of surface decreasing albedo increases light absorption and heating. Meltwater puddles on the ice have such an effect, and when they are at a maximum in July, light absorption reaches a maximum also despite the fact that the solar energy maximum comes in June. A two-percent decrease in albedo causes an increase in absorption equivalent to the heat melting 20 cm of ice.[23] An increase over the present heat input by 25 kcal/cm^2 in a year would melt the arctic sea ice.[24]

If the ice cover disappeared the reduced albedo would result in heat storage during the summer sufficient to prevent formation of "more than a thin skim of winter ice."[25] The question has often been raised as to whether sea

ice is unstable and would form again if removed. This simply means that under present climatic and oceanographic conditions the ice is able to maintain itself, at its equilibrium thickness of about three meters, by reason of its high albedo. The argument for instability cannot be proven, but it suggests caution in such matters as weather modification, careless practices which conceivably could reduce albedo, or tampering with Arctic Ocean circulation, as has been suggested from time to time. A warming trend could have desirable effects, such as improved shipping in an open ocean, but disastrous ones as well. Heat sufficient to result in sea ice melting would also probably melt the Greenland Ice Cap and other arctic glaciers. Meltwater from the land would increase sea level and drown Prudhoe Bay, much of the circumpolar tundra and many a harbor and city at lower latitudes. Who wants which ox gored?

The history of climatic change, as determined from analyses of inorganic and organic sediments and their fossil record in the Arctic Ocean, indicates a very long interval of ice cover. Clark finds evidence " . . . that the Arctic has not been warmer than at present for at least the last one and one-half million years."[26] More paleo-ecological and paleoclimatic studies are needed to further elucidate the long-term climatic trends. For the time being there is no apparrent justification to redesign navies or to plan on marine shipment of oil in the Arctic Ocean except by plowing through or going under the ice.

Pollution of Atmosphere and Ice

The foregoing comments suggest there are perils in introducing albedo-changing substances to the ice, either directly or via the atmosphere. There are other perils as well since gases and particulate matter, radioactive or not, introduced in one country enter a global system that presents other countries with the benefits or hazards, as the case may be. This would appear to be an area for international concern, agreement, controls and regulation.

Particulates airborne to sea ice in amounts such as to lower albedo drastically appears rather remote, although dust in the atmosphere is reported to be increasing. Contaminants to the ice are more likely to come by way of oceanographic avenues, but the potential of the atmospheric pathway should be borne in mind.

Stratospheric dust from volcanic sources has been increasing and has the effect of reflecting light and reducing heat. Increases in the dust load by man's activities is taking place exponentially with a doubling time on the order of 10-20 years.[27] Dust also absorbs solar radiation and suppresses radiation of heat from the earth's surface.[28]

Hare stresses the fact that arctic surface airstreams are very stable and have small capacity to remove atmospheric contaminants through turbulent diffusions, hence are vulnerable to pollution by smoke.[29] Intense temperature inversions persisting for several days while surface temperatures are below -30°C result in heavy ice fog when there is heavy injection of water vapor and freezing nuclei to the atmosphere from car and aircraft exhausts, power plants and other users of fossil fuels. Such pollution and ice fog are serious problems in such sub-arctic cities as Fairbanks, Alaska, where air traffic is often seriously impeded. Ice fog occurs in the Arctic, but the source of hydrocarbon pollutants is limited. Future burning of oil and flaring of gas wells could become a problem and should be avoided.

Carbon dioxide pollution has become a matter of world-wide concern as it reduces the radiation of energy to space and results in increased temperature. Carbon dioxide has increased 11% in the past century, and Fletcher states, " . . . this increase was enough to account for about half of the 0.6°C warming that occurred before 1940."[30] He also expects that increased rates of fossil fuel consumption over the next three decades will increase the CO_2 level by about 50% and result in global warming of 1°C. Should this occur large effects on the extent of sea ice are to be expected.

Problems of the Arctic Ocean

Little use has been made of the Arctic Ocean to date excepting the seasonal Soviet Union shipping operations along the Northern Sea Route. Rich fisheries which have been exploited lie in water peripheral to the Arctic Ocean but are influenced by it in many ways. The ocean has been more an object of study than a resource to be exploited or a route to be taken to anywhere. Exploration and the continuing research which has followed have been attended by much difficulty and slow rate of accomplishment. The level of knowledge is growing annually, but little is known of this ocean in terms of how it operates as an integrated system including interrelationships of all of its physical, chemical and biological components. One of the special problems here is that of acquiring new data and knowledge, not just in an inventory and survey sense, but through experiments designed to provide answers to specific questions.

Whaling ships, icebreakers and many types of smaller vessels, as well as the huge *Manhattan,* have made limited penetrations of the main ice pack and the ice infested waters of the Canadian Archipelago. Several U.S. nuclear submarines have made long transits under the ice of the ocean basin and at least one has taken the Northwest Passage. What the Soviet Union experience has been with under-ice operation is unknown, but it must be assumed to have been extensive. The U.S.S.R. has obvious interest in this body of water and many techniques have been successfully used, especially drifting research stations and air operations, to learn about the entire basin. The British have now announced a visit to the North Pole, in March 1971, of the H.M.S. *Dreadnought.*

The varied interests of several governments and now that of industry exploring the possibilities of surface shipping and talking at least of the possibility of submarine transport of oil to Europe add pressure for knowledge and planning. Within the next few decades, it may be assumed, both surface and submarine shipping along some preferred routes will become feasible and a reality. Problems can be foreseen for any of these or related enterprises. Accidents will occur with resulting contamination of the marine and coastal environments. A problem existing now is that essentially nothing is known of how to cope with an oil spill in cold, ice-covered waters or what the consequences would be to arctic ecosystems.

Sea-air rescue will be a problem, especially with regard to any submersible in trouble below the ice. Under-ice navigation and communications by hydroacoustic techniques constitute major problems as does through-the-ice communication of any type. All of these, and many others that could be cited, are related to special environmental problems. The most special of all is the solid cover of ice—its properties, extent, variations, and drift. No single aspect of arctic environment, except the climate, is more important to the character of the marine environment in all of its physical and biological complexity. It is a factor to be reckoned with in every human endeavor at sea and along-shore.

Basic Features of the Ocean Basin[31]

Disposition of national frontiers about the Basin (Fig. 1) has been mentioned previously, and now it is necessary to examine the nature of the contacts of different land masses and countries from the point of view of below-surface features. With an area of 14,000,000 km^2 this is the world's fourth largest ocean, and about one-fourth of its area is over deep water (Fig. 3). Maximum depths are in excess of 4,000 m and the mean depth is about 1,200 m. Bottom topography is highly diverse (Fig. 3,4) and includes broad continental shelves, plateaus and impressive mountain systems.

The Eurasia Basin and Amerasia Basin are separated by the Lomonosov Ridge, which stretches over a distance of 1,400 km from its continental shelf contact northwest of Greenland to the shelf off the New Siberian Islands. The Ridge is 40-200 km wide, has relief of about 3,000 m above adjacent plains, and the depth of its crest varies from 850 m to 1,200 m. The Amerasia Basin is divided by the Alpha Cordillera, which rises within 1,200 m of the surface in places and separates the Canada and Makarov Basins. Similarly, the Eurasia Basin is divided by the Nansen Cordillera.

Water exchange between the Arctic Ocean and the Atlantic takes place through the broad Norwegian and Greenland Seas, several hundred kilometers in width, and a sill depth of 2,500 m, and through the Canadian Archipelago and Baffin Bay. Connection to the Pacific is through Bering Strait which is only 64 km wide and 45 m deep. About twice as much water flows into the Arctic Basin through the Norwegian Sea as through Bering Strait, and about two-thirds of the total outflow is to the Atlantic by way of the Greenland Sea.

Warm, saline water from the Atlantic flows into the Basin along the eastern side of the passage between Svalbard and Greenland where it sinks below the surface and forms a characteristic layer, at depths from 150-250 m down to 900 m, with a temperature of about 0-3° C.

Mixing of Atlantic water and fresh water from precipitation and river sources and intense cooling produces dilute water with temperatures near the freezing point. This Arctic Surface Layer, which covers the entire Arctic Basin, is the only layer of purely arctic origin and provides the outflow of water to the Atlantic. Beneath the Atlantic water lies a layer of "bottom water" which originates in the Norwegian Sea. This layer has temperatures which reach the range -0.7 to 0.8° C in the Eurasia Basin and -0.3° to -0.4° C in the Amerasia Basin. An additional layer known as Pacific water occurs only in the Amerasia Basin. This layer of relatively warmer and fresher water flows northward through Bering Strait, overrides the Atlantic layer and forms a thin layer between it and the Arctic surface water.

Much remains to be done to evaluate properly the magnitude of the volumes and the rates of water, heat, salt, and ice exchange. Only a major international program of monitoring all of the passages simultaneously can provide the answers. It is obvious, however, that the Arctic

Figure 3. Bathymetry of the Arctic Ocean and its seas. Depths are in fathoms; 1 fathom = 1.85 m (Sater, 1969).

Ocean is dynamically related to the global ocean and that the heat and mass exchanges are of major importance. Any increase in heat of Atlantic water entering the Arctic Basin, in conjunction with any increased warming of the atmosphere as previously mentioned, could have large impact on the boundaries, extent and thickness of sea ice.

The Continental Shelves

The shelves are likely to become increasingly important in terms of resources, and the "inner shelf" in the United States and Canada will probably see oil extraction in the not too distant future. About two-thirds of the Arctic Ocean bottom is continental shelf (Fig. 3,4). North of Eurasia the shelf is the widest in the world, reaching widths of 850 km. North of Alaska the shelf narrows to 25-40 km.

The shelves are notched by numerous submarine canyon systems which should be known in greater detail. Two of these, the Svataya and Voronin Troughs, extend deep into the Kara Sea at depths of 500 m. Three submarine canyons are known north of Alaska on the Chukchi Shelf. One of these, the Barrow Canyon, has been used by at least one submarine as a deep water access across the shallow, ice-covered Chukchi Sea to the Canada Basin. Transit of Bering Strait and the Chukchi Sea is hampered by shallow water and heavy, deep ice cover which leaves little space at places for a submarine to operate safely. For this reason the Bering may never become a route for submarine transport of oil; but the submarine canyons offer some prospects and the characteristics of all canyons, especially those lying off mouths of navigable rivers, should be known.

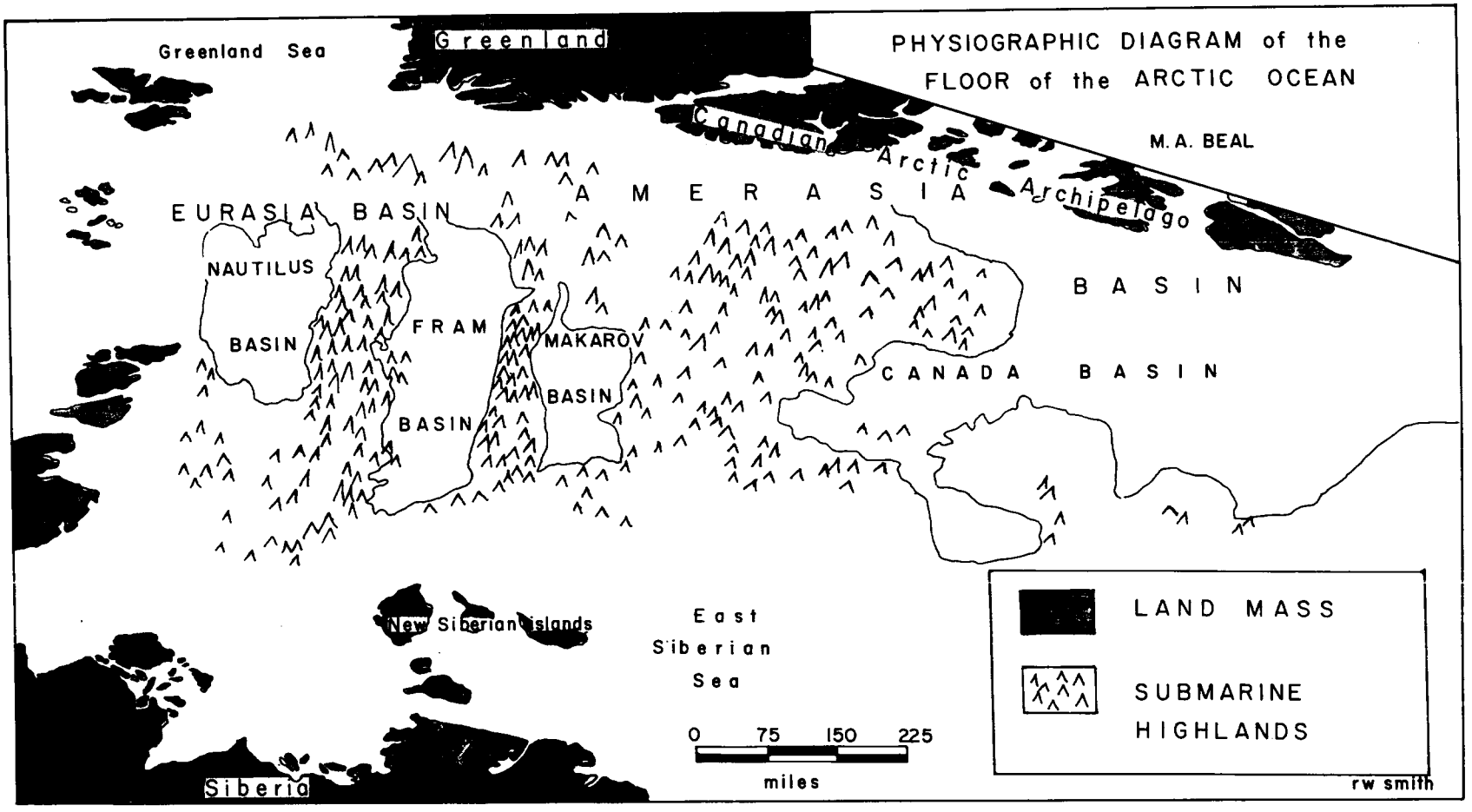

Figure 4. Beal's physiographic diagram of the Arctic Ocean floor (Committee on Polar Research, 1970).

The Nature of Sea Ice

One of the most unique features of the Arctic Ocean is its ice cover. It is an impediment to shipping except around its margins for short summer periods which may last for only a few weeks and in some years scarcely occur at all. Predominantly the ice is frozen seawater and makes up the so-called ice pack, but occasionally within the Arctic Basin proper, and especially in waters adjacent to Greenland, huge masses of freshwater or slightly saline ice are found adrift.

The ice pack goes through a seasonal cycle of surface melt amounting to about one meter and bottom replenishment by a like amount. There are large annual variations in the ice boundary which on a year-to-year basis amounts to several hundred kilometers, but the central Arctic Basin is within the zone of perennial ice cover, excepting only the relatively narrow coastal areas (Fig. 5).

The pack is highly mobile, in fact always in motion, excepting for a coastal area of variable width of grounded, shore-fast ice. Its movements are primarily wind-driven and the combination of all forces operating on it, both atmospheric and oceanographic, result not only in movement but cracking, fracturing, hummocking, pressure-ridging and other deformations. The balance between warm season wastage and winter growth is such that the equilibrium thickness is about three meters, although many actual measurements variously have indicated thickness to be 2.0-4.0 m.

The ice surface exhibits extreme roughness, and this feature applies to both top and bottom surfaces. Pressure ridges reach their greatest expression along shorelines where ice trapped by land and under pressure from the seaward direction is forced up into massive ridges 10-15 m in height. In the open pack the ridges at the upper surface are usually smaller, but very abundant and subject to rapid change. Ridges at the bottom side are equally numerous and may commonly extend to depths of more than 30 m, constituting a hazard to submarines. Since the ice is continuously "working," areas of open water of any size up to many kilometers in extent are always present, more in the summer than winter, but even in winter some estimates indicate as much as 10% open water. The large open areas formed by cracking and movement of the ice are commonly known as leads. Refrozen leads form extensive areas of young, smooth ice which sooner or later will be deformed.

The pack is a complex of ice of varying ages, roughness and differing physical properties. Large variations in physical and chemical make-up of sea ice make it a nightmare-material to work with in determination of engineering strength, electromagnetic and acoustic signal transmission properties, light transmission, and the like. The lower ice surface creates many problems in propagation of acoustic energy, and therefore hampers navigation, communication and detection systems employing this mode.

Surface Circulation and Ice Drift

Knowledge of surface drift patterns and velocities has largely been gained through observations of manned research stations, either on pack ice floes or ice islands. The latter are glacier ice complicated by ice of marine origin. This results from movement of glaciers from land to ocean and long residence as part of an ice shelf. Most such islands seem to have originated on the north coast of Ellesmere Island. Masses several kilometers in width and length, with thickness on the order of 30-40 m, become detached from the shelf, join the ocean circulation, and endure for many years. Notable cases are Fletcher's Ice Island, T-3, still in use as a U.S. Navy research station, and ARLIS-II which was occupied for four years by Navy-sponsored scientists.

The major circulations (Fig. 6) consist of the Pacific Gyral over the Canada Basin,[32] the Transpolar Drift Stream, which lies largely on the Eurasian side of the Lomonosov Ridge, and the East Greenland Drift stream. The Pacific Gyral is a clockwise drift circling past Alaska, toward the North Pole and back along the Canadian Archipelago. Ice within this circulation may circle around for many years, as T-3; diverge into one of many channels in the Archipelago; diverge into the East Greenland Current, as ARLIS-II did in 1965; or divert into the Transpolar Drift.

The Transpolar Drift carries ice from the region of the East Siberian Sea and Bering Strait across the area of the Pole and into the East Greenland Drift. In this drift there are many complications of anticlockwise circulations in the various peripheral seas which also are the source of most of the ice in this circulation. Speed of drift is highly variable and, in the central Basin, generally amounts to about 2.2 km to 7.4 km per day and in one case reached 10.7 km per day. Mean annual drift rates vary from 0.37 km to 4.8 km per day. T-3 required about ten years to make one full turn of the Pacific Gyral. Currently T-3 is located north of Ellesmere near 85° N. Lat. 88° W. Long. and is long delayed in its expected drift southwestward along the Archipelago. The island has been gyrating back and forth over an area roughly 150 km in diameter for about 18 months.

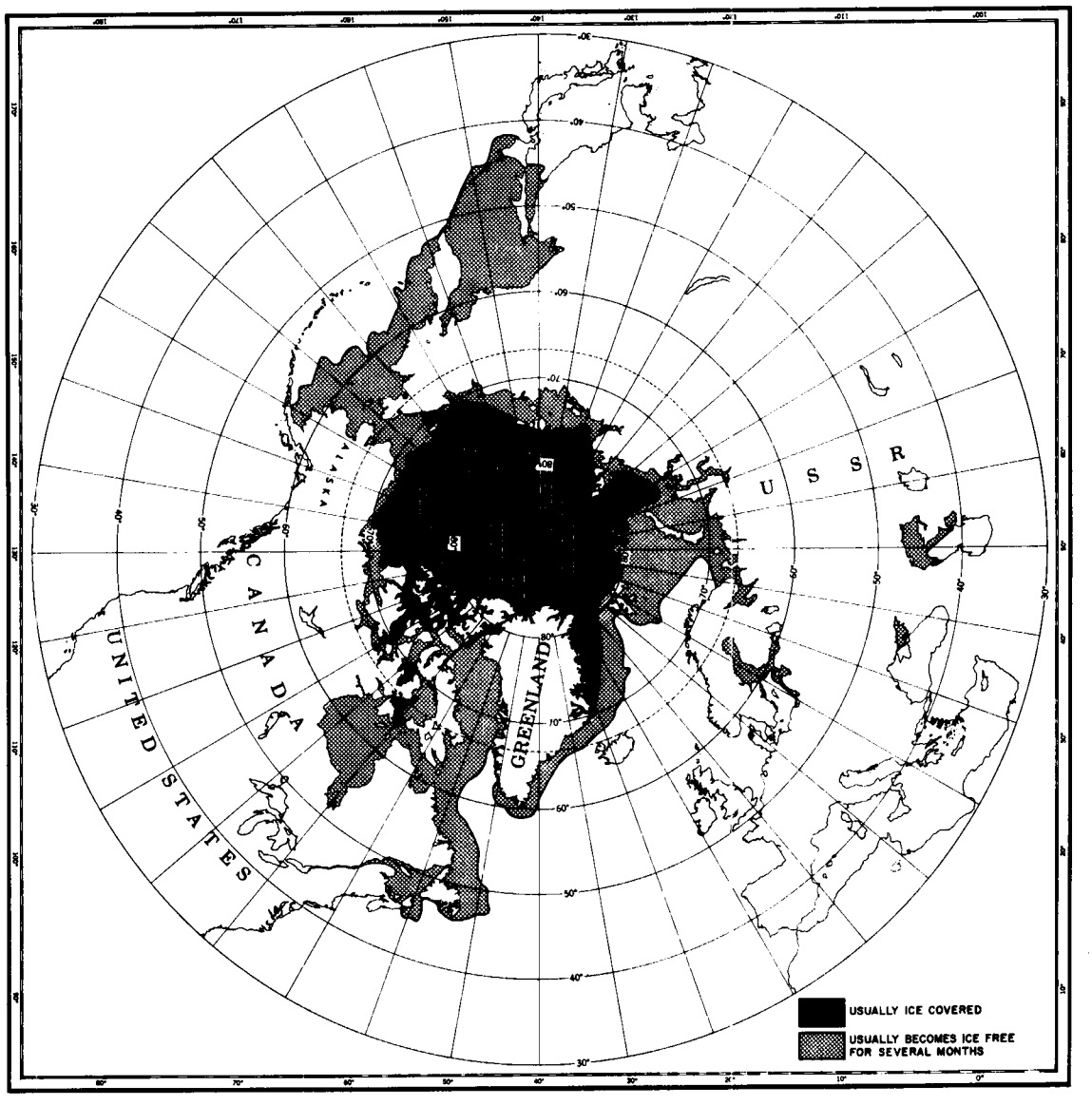

Figure 5. The maximum and minimum extent of sea ice in the northern hemisphere (Sater, 1969).

Drift Station ARLIS-II exhibited similar behavior for several months, at a somewhat higher latitude, in the winter of 1964-1965 before exiting the Basin via the Greenland Sea. The station was deactivated and people removed in May 1965 northwest of Iceland in Denmark Strait. It continued its southern drift, broke up once in open water, and parts of it with buildings intact circled the south end of Greenland and ended the drift at Frederikshab.

It is instructive to cite something of the history of five ice islands created by a massive break of the ice shelf off Ellesmere in 1962. These islands, all several kilometers in width and length, were named Ward Hunt 1-5 respectively and their drift paths followed by Canadian scientists. One drifted east and then southward through Robeson Channel, between Ellesmere and Greenland, and being of larger dimensions than the channel, became hung up and blocked the surface transport of ice from the Lincoln Sea into Baffin Bay. The other islands drifted down the Archipelago to various fates. This writer visited one as it neared Point Barrow several years later and found a cache, complete with canoe—a reminder of a summer scientific party operating on the ice shelf prior to 1962. Another of the Ward Hunt islands passed Point Barrow and was later occupied by the Soviet Union as a research station.

The surface circulation holds the certain promise of exchange of pollutants, wrecked

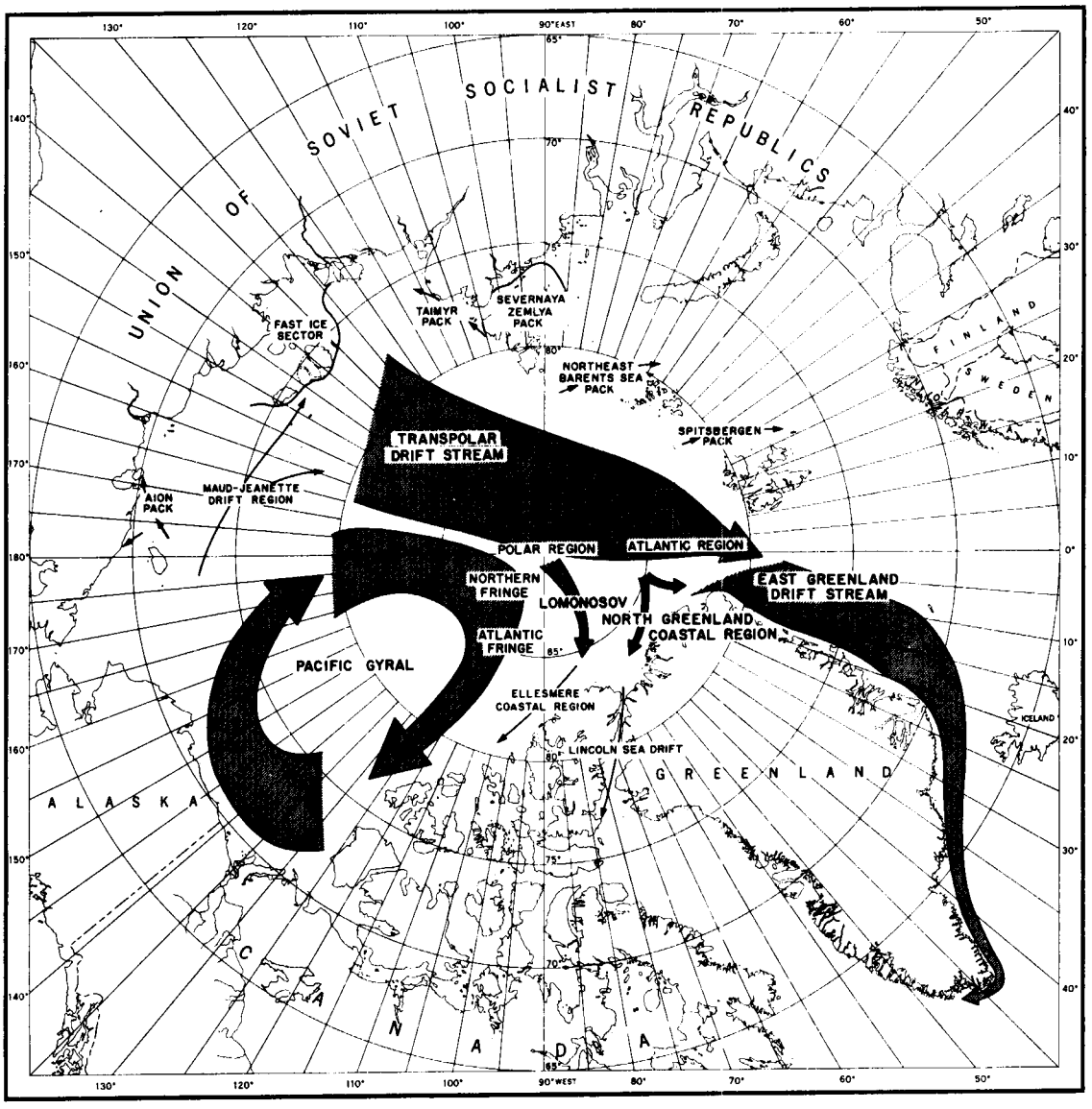

Figure 6. Major drifts of polar ice (Dunbar and Wittman, 1963).

ships, or whatever, among all countries peripheral to the Arctic Ocean. These items are also obviously subject to export to the Pacific and the Atlantic, and especially to the latter. The future of the Arctic Ocean is a matter of serious concern for all governments. The location of boundaries of national interest is important, as is definition of jurisdiction over the solid but mobile ocean surface.

The Marine Ecosystem

The Arctic Ocean is populated by a large diversity of organisms throughout its extent, both horizontally and vertically, and including the bottom in the deepest waters. Along the water column from surface to bottom there is a great deal of qualitative and quantitative variation in populations, and there appear to be some species of animals which may be unique to each of the water layers previously mentioned. At the bottom of the drifting ice, as well as deeper within the limit of light penetration, there are populations of microscopic plants (phytoplankton) and of small animals, microscopic or larger (zooplankton) which feed on the plants. Their concentration is usually greater at the bottom of the ice.

In the spring season there is a sudden and dramatic increase in numbers of phytoplankton, sufficient to produce highly turbid water. These provide an increased food supply to zooplankton and their numbers also increase

markedly. As a simple illustration, small zooplankton then may be eaten by larger species of zooplankton and the latter, or both, in turn become a food supply for fish or baleen whales. Fish may be consumed by seals which, being mammals, must go to the surface for breathing purposes and there face the possible fate of furnishing a meal for a polar bear. What the polar bear leaves uneaten may become food for an arctic fox which has been following the bear with this possibility in mind. This illustrates a food chain, the dependency of organisms on others, the transfer of energy and material from one food level to another; in this case, the polar bear is shown at the top of the chain and much dependent upon all the preceding events in the chain. Eskimos in their primitive hunting culture were at the top of the chain since they lived largely upon sea mammals—seals, walrus, whales and polar bear. Among the total of arctic marine populations these interrelationships are much more complicated, but the trends and the end results are the same in the upper levels of water.

The concept of an ecosystem takes into account all of these relationships between organisms and between them and their total physical and biological environment, and offers explanation of how the entire environmental system works. We are far from knowing how the marine ecosystem works, but progress is being made.

Chlorophyll-bearing algae make up the phytoplankton which lie at the base of the food chain. With visible light of solar radiation, and when supplied with raw materials of water and carbon dioxide at suitable temperatures, these organisms synthesize carbohydrates. This process, photosynthesis, is an energy-storing reaction; that is, light energy is converted to chemically bound energy. With a sugar supply the plant can synthesize fat and also, with the addition of salts of nitrogen, sulfur, and phosphorus, can synthesize proteins. These organisms, because of their energy-storing capabilities, are called primary producers. As a not completely correct generalization, animals which obtain carbohydrate and amino acids, from which proteins are made, from plants can also synthesize proteins and fats. Many additional mineral salts are essential to other biological processes.

Carbon dioxide and water, the raw materials of photosynthesis, are in abundant supply in the ocean, but light and suitable temperature, and possibly minerals, are problems.

As related in an earlier connection, snow and ice reflect a very large percentage of solar radiation received at the surface, but absorption increases with snow melt and formation of puddles of water. Not much is known of the transmission of light through ice, but it does get through and penetrates to some depth of water. Maximum absorption occurs in open, ice-free water, but how much of the effective light on an annual basis can be accounted for by this pathway rather than through the ice is not known. The light-zone at best cannot extend to very great depth, and within this shallow layer, subject to all of the interferences with light penetration from above which reduce intensity, all of the primary production must occur.

This production must sustain all populations living in the upper waters and those that migrate upward into this zone; and, through living or dead organisms, organic particulates, dissolved organic material, and the like settling downward, it must provide a food supply for all populations at greater depths. Further, during the season of any effectively available light, energy must be accumulated to maintain all populations throughout the dark periods.

The Arctic Ocean is not very productive as compared even with adjacent sub-arctic seas. Dunbar[33] believes neither light nor temperature account for the low productivity, but rather thinks limited availability of minerals in the light-zone is the problem. He finds the Arctic water column very stable and lacking in a mixing mechanism to transporting minerals from depth back to the illuminated zone. Thus, minerals released by bacterial digestion and oxidation of organic matter at depth cannot recirculate upward. In sub-arctic seas where vertical mixing is greater, production is greater and provides the basis of important fisheries. Dunbar cites research indicating that light absorption at certain wave-lengths in some phytoplankton is six times more efficient than in the normal plankton. Little is known about such biochemical adaptations, but in time we may learn that many arctic organisms exhibit adaptations rendering them metabolically more efficient in the arctic environment.

The Arctic Ocean is poor in numbers of species, but individuals of each species are relatively more abundant as compared with other oceans. This reflects a well-known fact, which is equally true of the land biota, that species numbers decrease from the equator toward the poles. Nevertheless, there are hundreds of species succeeding in meeting at least their minimal requirements. The ecological balance may prove to be quite tenuous, and until we know, every effort must be made to protect against chemical pollution which could be devastating

to critical parts of the system. Polar bears, walrus, the great migrating whales, and the entire ecosystem are worthy of protection. Such protection requires sound national and international policies, cooperation and regulation. First, time is needed to achieve understanding of the ecosystem and this is a big problem.

Problems of the Tundra

Two special problems will be emphasized: first, the nature of the tundra ecosystem and its vulnerability to change, and second, a consideration of the importance of permafrost. Many have referred to the Tundra as being fragile, and called attention to the need for its protection against environmental degradation threatened by current and future resource exploitation.[34] The importance of permafrost has been highlighted by plans to construct hot-oil pipelines, both in Alaska and Canada; and it is important otherwise in all engineering practices and to the tundra ecosystem itself.

The Tundra Ecosystem

The elementary comments made with respect to the marine ecosystem apply equally here. Tundra biological populations are made up of few species, and most of these are relatively abundant. This equator-to-pole decrease in kinds of organisms carries across the entire tundra, there being many more species at the southern than the northern limits. There is considerable diversity in vegetation in different circumpolar areas varying from meadow-like grassland of low coastal areas to the often sparsely distributed vegetation of mosses, lichens, herbs, grasses and low shrubs in areas of more diverse topography including mountains. Moisture availability is an important environmental factor, and many areas in the Canadian Archipelago are so low in water supply and so lacking in soils on rocky substrates that they are classified as polar deserts. Snowfall amount and its distribution on the ground are often critical, both in terms of a meltwater supply for plants in the more arid areas and also as protection of animals against temperature extremes and the desiccation of winter. The warm season growing period is only two to three months in duration, and biological activity is intense during this time. Destructive frost may occur at any time during the growing season.

Plants are the primary producers and the beginning point of the energy and material transfers to consumers. The cycling of energy and mineral nutrients through the food chain proceeds from plants to herbivores, of which caribou and small rodents, especially lemmings, are of greatest importance, and then to carnivores. Tundra productivity is low as compared with other parts of the world but Bliss finds daily productivity and photosynthetic efficiency, at least in some vegetation, to be comparable to similar vegetation in temperate regions.[35] Lemmings undergo population oscillations, characterized by maximum build-up of numbers followed by rapid decline, on an approximate three to five year cycle.[36] Predation on lemmings by several carnivorous birds (owls, gulls and jaegers), as well as depletion of their plant food supply, contribute to depletion of the lemming population. Mineral nutrients are deficient, and lemmings are important cyclers of these back to the environment through their fecal droppings. Soils have large populations of a variety of arthropod species which in part are herbivores and otherwise are mainly decomposers of organic materials which, together with bacterial activity, further contribute to the return of minerals to the soil.

In North America, tundra animals expected to be normally resident include such birds as ravens, willow ptarmigan, rock ptarmigan, and snowy owls.[37] Mammals include shrews, colored fox, white fox, wolf, barren-ground grizzly bear, weasel, wolverine, two species of lemmings and two other small rodents, ground squirrel, muskox and, in some mountains, the hoary marmot. Caribou are migrators between their tundra summer range and their winter range, near or south of the tree line, but small numbers are to be found on the tundra all winter.

A variety of migratory birds breed on the tundra each summer. These include large numbers of waterfowl, carnivorous and insectivorous species and cliff-nesting birds which feed at sea.

The small number of species of both plants and animals, slow growth rates of plants, low productivity, short growing season, short food chain, general severity of climate, low temperature of soils overlying permafrost, and large fluctuations in numbers of some animal species make the tundra ecosystem extremely vulnerable to change, and lend credence to the argument that it is fragile. Damages to the system, such as destruction of vegetation, are very slow to be repaired and may require time on the order of several decades. The organisms present in the undisturbed state of the ecosystem are notably successful in exploiting all but the most unstable surfaces and niches, but the balances are delicate and easily upset.

The total area of tundra in Alaska alone is immense, and to the casual visitor may appear to

be wasteland and an area of desolation which might be put to better use. Careful development practices on the part of industry can no doubt permit a great deal of invasion of this ecosystem without jeopardizing the whole. It is essential, however, that large areas be completely protected, and that the scale of the areas be carefully determined by the requirements of species such as the barren-ground grizzly and wolf which are few in number and spread over a wide territory. By international study, sharing of research results, planning of wildlife refuges and research and recreational reserves, and setting these aside for such long-range functions, the economic development of the Arctic will be possible.

Permafrost

Although the term perennially frozen ground is often used to mean permafrost, the term, by definition, implies freezing only for pure water. Any surficial material of the earth can be classed as permafrost if, over a period of two or more years, it maintains a temperature of 0° C or lower. Even when water is present many conditions, such as high brine concentration, prevent freezing. Permafrost is a consequence of a negative heat balance; under continuing outward heat flow, temperatures continue to gradually decrease at depth, and when reaching 0° C qualify as permafrost. Over long periods of time this negative heat balance results in permafrost depths on the order of 600 m, and much greater depths have been reported. The materials may include bedrock, sand, gravel, peat, ice or other.

Properties of surface are important to both the absorption of solar radiation, which heats the ground in summer, and to radiation, convection and conduction of thermal energy back to the atmosphere. Exposure to the sun, roughness, vegetation cover, snow cover, moisture content, material components, and others have major effects on heat transfer. This energy exchange is complex at the ground surface and not throughly understood. Elevation of temperature above 0° C at the surface and to some depth into the ground occurs on essentially all sites each summer. If the materials have in fact been frozen, they thaw. The depth of thaw is slight but variable, and reflects the effects of different surface properties as mentioned above. Thaw may amount to only a decimeter or two in wet organic substrates, or 2-3 m in gravels of low moisture content. On the North Slope of Alaska most sites thaw to depths not exceeding 0.5 m.

The thawed zone is referred to as the active layer, and the top of the permafrost beneath it as the permafrost table. Within the active layer all sub-surface biological activity takes place, and the underlying permafrost is an effective barrier to root growth, which excludes deeply rooting species. The relation to burrowing animals is obvious. Lemmings, for example, make shallow burrows during the warm season, but abandon these for grass nests under the snow during winter. Ground squirrels hibernate in burrows, normally in sandy areas.

Water from melted ice in the active layer drains away if there is a gradient and accumulates as puddles or ponds. In low coastal areas, permafrost is an impediment to downward movement of water; and since drainage gradients are very low, bodies of water of sizes up to several miles in length are characteristic.

Permafrost is usually absent under larger lakes which have sufficient depth that they do not freeze to bottom. It is also usually absent from larger streams, and probably extends only short distances under the ocean.[38] The numerous lakes of northern Alaska are in large part shallower than the approximate 2 m depth of freezing, hence freeze to bottom. Although water appears abundant in summer, it provides an uncertain supply for human consumption on an annual basis.

Permafrost poses many challenging engineering problems of which the one to be stressed here is that of construction on ice-rich substrates. Extensive areas of permafrost have a high ice content which may include anything from small ice veins to large masses of clear ice. A notable example is the occurrence of ice wedges which are formed in contraction cracks in frozen ground. These cracks become filled with water and hoar frost and form vertical ice veins. Through successive cracking—perhaps annually, during the extremely cold winters—and growth of ice, the total mass continues to widen and deepen until reaching a few meters in width and several meters in depth. Since the ground cracks in polygonal patterns the ice wedges have the same arrangement. These produce characteristic features on the ground surface known as polygonal ground.

Ice-rich materials are usually fine-grained and have little strength when the cementing ice is melted. Such materials tend to flow upon thawing and large soil movements occur on steeper gradients. Thaw of massive ice without subsequent drainage results in collapse and slumping of the ground, and creation of pools and small lakes which tend to grow in size. The best protection against such thaw is the normal peat and vegetation of tundra surface. Human activity, whether vehicle traffic, scraping, or disturbance of any kind, which removes the insu-

lating materials, or compacts them to the point that they lose their insulative properties, results in ice melting and degradation of the substrate. The success of such engineering ventures as road building depends upon the measures taken to prevent thaw. A road bed of five feet of gravel on top of the tundra surface usually preserves permafrost on the North Slope of Alaska.

Construction of buildings must be such that there is no heat transfer to the ground. A common method of meeting this situation is to build on wood piling, set deeply into the frozen ground, which conducts only negligible heat. Piling height of one meter or less above ground is sufficient to provide ventilation that dissipates heat from the building without effect on ground temperature.

The controversial proposed construction of hot-oil pipelines by burial in frozen ground represents a critical problem with respect to environment. No matter how well insulated, over a period of years sufficient heat would be transferred to the ground to melt ice and for the pipe to lose the mechanical support initially provided by frozen materials. The degree of such degradation would be proportional to the volume of ice in the ground, and the erosion resulting would be greatly increased if the event occurred on a grade sufficient to provide drainage. Other engineering solutions are essential for such a pipeline to cross extensive areas of ice-rich terrain. It is essential that these areas be known in detail before construction begins or designs are made. The tundra surface will not tolerate massive or chronic oil spills, and government regulation of engineering methods is mandatory.

Problems of Shores

Environmental problems so far discussed have primarily involved dynamic processes at surfaces where different systems meet and interact. Shores where land and ocean meet represent an additional complex which should at least be mentioned. Little is known of permafrost distribution under the shore, or of the depth and intensity of scouring of the bottom by grounded sea ice. Tides and their effects on ice movement also require evaluation.

The extensive arctic shorelines present enormous problems of access to the continental shelves, to pipeline crossings and construction. History of geomorphic change, present processes and their rates, and predictions of future erosion and deposition have a bearing not only upon engineering problems but on setting of boundaries as well.

Notes

1. Moira Dunbar, "The Arctic Setting." *The Arctic Frontier,* R. St. J. MacDonald, ed. (Toronto: University of Toronto Press, 1966), p. 3-25.
2. F. K. Hare, "The Tundra Climate." *The Tundra Environment,* Transactions of the Royal Society of Canada, 4th Series, vol. VII (1970), p. 32-38.
3. M. E. Britton, "Vegetation of the Arctic Tundra." 18th Annual Biological Colloquium, Oregon State College (1957), p. 26-61.
4. M. Dunbar, *op. cit.*
5. John E. Sater, coordinator, *The Arctic Basin* (Washington: The Arctic Institute of North America, 1969).
6. G. A. McKay, B. F. Findlay and H. A. Thompson, "A Climatic Perspective of Tundra Areas." *Productivity and Conservation in Northern Circumpolar Lands,* W. A. Fuller and P. G. Kevan, eds. International Union for Conservation of Nature and Natural Resources, Publications New Series, No. 16 (1970), p. 10-33.
7. Britton, *Op. cit.*
8. Sater, *Op. cit.*
9. J. Brown, "Structure and Function of the Tundra Ecosystem at Barrow, Alaska—Environmental Setting." *Productivity and Conservation in Northern Circumpolar Lands,* W. A. Fuller and P. G. Kevan, eds. International Union for Conservation of Nature and Natural Resources, Publications New Series, No. 16 (1970), p. 50-71.
10. Sater, *Op. cit.*
11. McKay et al , *Op. cit.*
12. Sater, *Op. cit.*
13. McKay et al , *Op. cit.*
14. Sater, *Op. cit.*
15. McKay et al , *Op. cit.*
16. V. Steffanson, *The Friendly Arctic* (New York: MacMillan & Company, 1927).
17. J. O. Fletcher, "Polar Ice and the Global Climate Machine." *Bulletin of the Atomic Scientists* (December 1970), p. 40-47.
18. F. K. Hare, "The Atmospheric Circulation and Arctic Meteorology." *Arctic,* 22 (3), (1969), p. 85-194.
19. Fletcher, *Op. cit.*
20. G. A. McKay, "Climate: A Critical Factor." *The Tundra Environment,* Transactions of the Royal Society of Canada, 4th series, vol. VII (1970), p. 40-47.
21. Fletcher, *Op. cit.*
22. *Ibid.*
23. N. Untersteiner, "Sea Ice and Heat Budget." *Arctic,* 22 (3), (1969), p. 195-199.
24. Glaciology Panel, Committee on Polar Research, "Glaciology in the Arctic." *Transactions of the American Geophysical Union,* 48 (2), (1967), p. 759-767.
25. Untersteiner, *Op. cit.*
26. D. L. Clark, "Paleoecology and Sedimentation in Part of the Arctic Basin." *Arctic,* 22 (3), (1969), p. 233-243.
27. Fletcher, *Op. cit.*
28. McKay, *Op. cit.*
29. Hare, *Op. cit.*
30. Fletcher, *Op. cit.*
31. Based on summaries by Sater (note 5) and Committee on Polar Research (note 24).
32. Moira Dunbar and W. Wittman, "Some Features of Ice Movement in the Arctic Basin." *Proceedings of the Arctic Basin Symposium,* Arctic Institute of North America (1963), p. 90-108.
33. Dunbar, *Op. cit.* (note 1).
34. L. C. Bliss, "Oil and the Ecology of the Arctic." *The Tundra Environment,* Transactions of the Royal Society of Canada, 4th Series, vol. VII (1970), p. 1-12.

J. D. Ives, "Arctic Tundra: How Fragile? A Geomorphologist's Point of View." *Ibid.*, p. 39-42.

35. L. C. Bliss, "Primary Production Within Arctic Tundra Ecosystems." *Productivity and Conservation in Northern Circumpolar Lands*, Ed. by W. A. Fuller and P. G. Kevan, International Union for Conservation of Nature and Natural Resources, Publications New Series, No. 16 (1970), p. 77-85.
36. J. Brown, F. A. Pitelka and H. Coulombe, "Structure and Function of the Tundra Ecosystem at Barrow, Alaska—A Word Model of the Barrow Ecosystem." *Ibid.*, p. 41-43.
37. W. O. Pruitt, "Tundra Animals: What is Their Future?" *The Tundra Environment*. Transactions of the Royal Society of Canada, 4th Series, vol. VII (1970), p. 13-25.
38. Since this was written, research evidence has indicated permafrost under the ocean to be more extensive than was formerly believed.

Marine Pollution, Concentrating on the Effects of Hydrocarbons in Seawater

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Introduction

Oil pollution, a topic of growing interest to those concerned with the environment, is also a recent topic of discussion. Let us begin one discussion with an understanding of how this rather old problem (as oil tankers have been spilling oil since the 1920s) has rapidly become so serious. There are three causes for this change.

The first is the increased per-capita demand for energy in developed countries. The second is that a growing portion of all oil pumped out of the earth comes from offshore wells, and is transported by tanker. (Oil companies are currently investing three billion dollars per year in offshore production. They expect to be investing 30 billion dollars per year in offshore production by the end of the decade.) Third, the demand for energy increases because of growth in population. All this adds up to an enormous increase in the last half decade in the amount of oil produced offshore or shipped overseas. It is this changing scale of the oil production and transportation offshore which is the cause of the growing concern about oil pollution.

About one-tenth of one percent of all oil transported or produced offshore is spilled on the sea. Crude oil is a bad thing to spill in the ocean. First of all, it is toxic to most marine organisms and hence does damage to the marine environment. Second, crude oil contains carcinogens; hence, there is the fear that carcinogenic material may be concentrated by the ladder of life in the sea in such a way as to poison the commercially valuable fishes for human consumption. Third, oil spills destroy scenic values such as beaches, and kill large populations of birds. There is an economic loss of tourism due to oil pollution.

One of the main features of oil pollution is that it is relatively long lasting. Oil is degraded by being combusted by bacteria and other microorganisms in seawater. This degradation process takes about one year in the tropics, two or more years in Woods Hole, Massachusetts, and perhaps longer than ten years in the Arctic. That is, one moderate spill every two years in Buzzards Bay (near Woods Hole) if uncontrolled, is probably enough to permanently change the ecology of the area.

There are a number of proposed methods of dealing with oil pollution. First, let us consider additives—i.e. detergents, absorbents, burning agents and sinking agents. There are some general considerations which mitigate against using these agents on a large scale. First, consider logistics: it takes 20 to 200 pounds of additive to treat 1 ton of crude oil. With 10^5 tons of oil spilled from a super tanker, prompt application of such massive amounts of material is exceedingly difficult. Note also that the light materials (20 lbs./ton) are quite bulky (they are generally low density materials, such as straw) so that one has problems with either mass or volume. Second, most additives are toxic. Detergents in particular seem to be more toxic than the crude oil itself. Third, most additives are expensive either to buy or to apply. Crude oil is worth about \$20/ton, and the cost of additives generally exceeds the value of the oil.

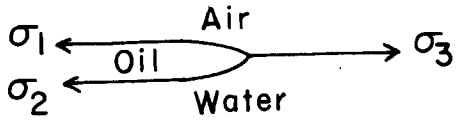
Special mention should be made of burning agents. Burning agents do not work well in temperate climates because the crude oil tends to spread into a film too thin to support combustion. However, this tendency is absent in the Arctic. Burning currently seems to be the most promising (but completely unproven) method of dealing with oil spilled on ice.

Spread of Oil

Oil spreads, in temperate waters, because of a combination of four forces: gravity, surface tension, viscous drag and inertia. A rather intricate theory has been developed which predicts fairly well how large an oil slick will be after a given length of time. Space and time do not permit a full discussion of these results.

Instead, we will consider how the oil gets drawn into a thin film by surface tension. The

sketch shows the definition of the net spreading coefficient



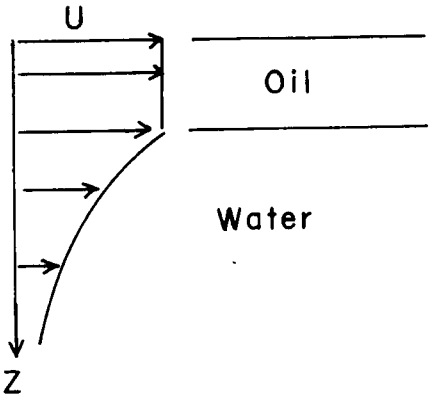
σ = net spreading coefficient = $\sigma_3 - \sigma_1 - \sigma_2$

A typical value of σ is 20 dynes/cm.

Consider a pool of oil of radius $l(t)$. The surface tension force which tends to draw out the oil is

$$2\pi\sigma l \qquad (1)$$

The retarding force which balances (1) may be shown to be viscous drag in the water. It arises in the following way: as the oil is much more viscous than the water, the velocity profile in the oil has a very small gradient (because the viscous stress at the oil-water interface is continuous). Thus the velocity profile looks like this:



Now the boundary layer in the water exerts a drag on the oil, which is

$$\text{viscous drag} \cong \mu\left(\frac{l}{t}\right)\frac{1}{\sqrt{\frac{\mu t}{\rho}}}\pi l^2 \qquad (2)$$

where μ is the viscosity of the water and ρ the density of the water.

Combining (1) and (2) yields

$$l = (2\sigma)^{1/2}\mu^{-1/4}\rho^{-1/4}t^{3/4} \qquad (3)$$

This equation, which has been verified both in the laboratory and at sea, leads to two interesting conclusions.

First, the rate at which oil spreads to a thin film is independent of the volume of release. Thus one cannot determine the amount of oil spilled by simply measuring the area of the spill, and how it grows with time. This implies that to obtain convictions for tankers offshore who discharge more oil than allowed by international rules, one must measure both the area of the slick (fairly easy using an aircraft) and the oil slick thickness (which is difficult, and requires direct measurement).

Second, in the Arctic, σ is very small, so that crude oil does not spread to a thin film. When the oil remains thicker than about 1/10 cm, it can be burned with or without using a burning agent. This seems to be the case in the Arctic in the summer time, at least.

Let us turn now to the spread of oil on ice. First note that North Slope crude oil is generally heavier than ice, and lighter than water. Thus, the oil will tend to spread *under the ice,* at the oil water interface, and collect in pockets at the interface. If the mean roughness height of the ice is z, and a volume V of oil is spilled, the radius of the pool is

$$l \cong \left(\frac{V}{\pi z}\right)^{1/2} \qquad (4)$$

A super tanker breaking up in an ice field would create a pool of oil about a mile in radius with a mean thickness of 1 foot. Thus, in contrast to the problem in temperate climates, the oil spill on ice does not form thin films.

The Technology for Control of Oil Spills

In temperate waters, the proposed method of control of oil spills is first to contain the oil with a barrier, and second to collect the oil from the sea. Both tasks require mechanical hardware carefully designed for the task, as it is known that the backyard inventors have not produced workable results. The procurement program for this hardware is well under way with the U.S. Coast Guard at the present time. It is known that, if successful, this plan of attack will have the following advantages over additives in dealing with large spills. First, the projected costs will be lower than with additives because the hardware is reuseable. Second, the damage to the environment is minimized because the oil is removed from the marine environment before it gets to the beach.

I will now describe some basic physical phenomena which control the use of barriers (which stop the oil from spreading) and skimmers (which collect the oil).

Consider a barrier of draft d in a current of velocity U. At the bottom edge of the barrier, the pressure is about

$$\frac{1}{2}\rho U^2 \qquad (5)$$

lower than it would be if the barrier were absent. Now if the oil has a buoyancy

$$g\triangle = g\left(\frac{\rho_o - \rho_w}{\rho_w}\right) \qquad (6)$$

where g is the acceleration of gravity, ρ_o the density of the oil and ρ_w the density of the water, then the amount of suction required to draw the oil under the barrier is

$$\rho g \triangle d \qquad (7)$$

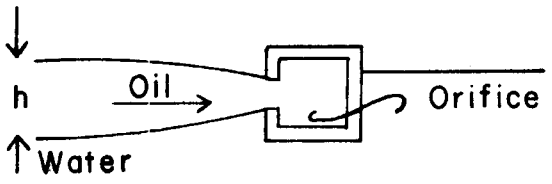
Hence, if the current is too large,

$$U \geq \sqrt{2g\triangle d}, \qquad (8)$$

the oil will flow under the barrier.

All barriers are subject to this restriction. As $\Delta \approx 1/10$, barriers of 3-foot draft are required for currents of two knots. It does not seem feasible to build small, lightweight barriers for currents in excess of two knots.

Skimmers also have a basic limitation. Consider an oil slick of depth h, and an orifice placed in the oil to suck out the oil. It can be shown that if the velocity at the orifice is too large, either water or air will be entrained.



The maximum velocity with which the oil can be withdrawn is

$$\sqrt{g\triangle h} \qquad (9)$$

If the orifice has a length L, then the maximum flow rate at which oil can be removed is

$$Q_{max} = \sqrt{g\triangle h}\, hL \qquad (10)$$

Equation 10 limits the rate at which oil can be removed by any skimmer. It shows that one must contain a deep pool of oil ($h \sim 1$ ft.) if high collection rates are to be obtained.

The Economics of Oil Transportation in the Arctic

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Basic Issues

We approach this topic with some hesitation. As a topic for scientific discussion, it leaves a good deal to be desired; since no oil has yet been transported from the north it has so far proven impossible to confront one's hypotheses with the facts of the real world. However, our speculations may be confounded soon enough. Another reason for our hesitation is that we have approached the problem in previous studies we have done as a question of "how," not as one of "whether"; and have proceeded on the assumption that if reserves were found in sufficient quantities, they would be moved to market in one way or another. This was the only "if" we have considered.

Yet it appears that there is a substantial body of opinion, both in Canada and the United States, which appears to hold the view that oil from the north should not be moved by any known form of conveyance at any time in the foreseeable future. Because of the existence of this point of view, we feel we should move back a step or two and consider the question of whether development, and ultimately transportation, of the resource should be allowed to proceed. We are not concerned with the identity of the developers—at least some of the opposition appears to object to development at the hands of international oil companies, if not to their continued existence, and has seized on this issue as a means of beating the latter over the head for a variety of reasons of its own which are largely irrelevant to the issue at hand. While such issues may be red herrings, the ecological issues raised by the opponents are not, and would remain no matter who might develop the resource. A question has also been raised over balance of payments consequences, which could pose problems in a variety of circumstances, at least in part independent of sponsorship.

In considering whether development should proceed, we have sought to avoid falling into the opposite trap of assuming that development is inevitable and that failure to develop is unthinkable. It is quite "thinkable"; North America could meet its energy requirements either by using domestic alternatives to oil and gas, or by importing these energy sources from a multiplicity of overseas sources. Nor is petroleum industry development in the Canadian north essential to the economic development of the latter, at least if we are willing to accept a sufficiently modest goal in that respect. Our calculations suggest that full employment of the existing native labor force in the Canadian north could be attained as the consequence of reasonable expansion in the mining industry alone, if this were deemed desirable.

While non-development is quite "thinkable," its advocates have a responsibility to examine the alternatives. It appears to us that the proponents of development have done a much better job of this to date than have those opposed to development. The point of the matter is that the alternatives have costs, both in ecological and "merely economic" terms, that there is no solution which is without cost, of both types, and that a rational choice must consider these costs, and must at some point face up to the problem of defining a trade-off between costs of potential or actual environmental damage, and the costs of other resources which will be consumed if these are averted.

We do not wish to underestimate the difficulty of arriving at a consensus with respect to what the trade-off should be. The oil companies may have underestimated the weight which the community wishes to be given to environmental factors, though there is no evidence that they have done so deliberately or to any greater extent than representative examples of public-sector decision makers such as the provincially-owned electric utility which so generously pollutes the air we breathe here in Toronto, or the municipal sewage plant in Montreal which dumps millions of gallons of raw sewage into the St. Lawrence every day. Any operator on an oil transport system has a strong financial interest in keeping it operating and avoiding those incidents which result in pollution; hundreds of millions will have been invested in the system itself as well as the fields and refineries it serves, and down-time is expensive. Yet some of the pronouncements on proposed pipeline systems in the North seem to be based on the belief that operators are willing to spend billions of

dollars with the secret, sinister, singular objective of flooding the tundra with oil.

It should be recognized that serious pollution incident to the operation of oil transport systems is likely to result only from circumstances which impose significant costs on their operators, in the form of the destruction of part of the system, loss of a valuable commodity, and the disruption of operations in plants costing hundreds of millions.

Our examination of alternatives to moving oil out of the north might well begin by reminding ourselves that oil is but one of the raw materials from which we derive energy, and that North Americans use more energy per capita than anyone else in the world. Is all this consumption really necessary? We use energy to heat and light our homes, to run a variety of electrical appliances in our homes, to run transportation systems of various kinds and to run industries. We use more energy than others because our homes are bigger, better heated, better lighted, and more abundantly equipped with labor-saving but energy-using devices than the average home in other countries; because we use more transportation than other people; and because we have higher industrial output. In short, our energy consumption is but a mirror image of our standard of living. Somewhat less energy may be consumed by using energy more efficiently, but any reduction is likely to be marginal. Household energy consumption for heat, light, and various conveniences will continue to grow as housing standards improve. Paradoxically, we have less hope for efficiency improvement here than a country like England, where central heating has recently been independently reinvented.

Similarly, industry is a major user, and one which we can hardly expect to reduce its requirements unless industrial output is to be cut. Industry has made substantial gains in efficiency of energy use, and will make more, but this improvement is already built into the forecast. Perhaps the most promising avenue for reduced consumption is in transportation; but unless we are prepared to give up the automobile and the truck, we cannot look for any magic improvement. Some improvement in gas mileage is resulting from the shift to smaller cars, but it is not spectacular. A shift to electric cars might ease pollution problems associated with the automobiles, but would do so at the expense of consuming more, not less, energy. Again, a significant degree of improvement is built into the forecast.

Looking at overall energy consumption, we would seriously doubt whether a reduction of 5 percent in the forecast figure could be attained even with radical innovations in transportation technologies, without a significant reduction in living standards. It should perhaps also be noted that published forecasts of energy use have rather consistently erred on the low side. But let us assume that somehow we do cut energy consumption by 5-10 percent below our forecast figure.

This still leaves a demand for energy which is awesomely large by today's standards. 1990 consumption of oil in North America is projected at 29 million barrels daily (Canada 3.0, U.S. 26.0 million) if current trends persist. A radical restructuring of the transportation sector could cut this by 3.5 million barrels per day. Since the reduction would all take place in the transportation end-use sector, it would reduce oil requirements by an equivalent amount, but we still need a lot of energy.

The next level at which we should consider alternatives is to look at alternative sources of energy. It is reasonable to view the existing pattern of energy consumption, and that which we have projected, as reflecting the results of decisions taken by individual consumers in the market place to obtain lowest energy costs. To the extent that environmental costs associated with the use of particular fuels are not reflected in their prices, it is not a least-social-cost mix. But it is a least cost solution in a restricted sense, and we must recognize that substituting other forms of energy for oil would increase costs as currently measured, and would impose other environmental costs in place of the environmental costs associated with using oil. Even if these were less than the environmental costs of using oil, the net gain might well be offset by the higher traditionally-measured costs of using other fuels. There is, after all, no such thing as a free lunch.

Let us examine alternative energy sources, to see what may be said briefly about their costs, both in a market sense and in a total environmental sense.

Hydroelectric energy is cheap at the generating site, but the generating sites near population centers have long since been used up, though improvements in transmission technology and the rising cost of other clean fuels have pushed the extensive margin of "cultivation" into some of the more remote parts of the continent, including Labrador, the Peace River and the rivers flowing into James Bay. There is untapped hydroelectric potential further away, but it will cost more and there is not enough of it to meet the demand for energy in those applications for which we are accustomed to using electricity. While it is clean to use, generation and transmission of hydroelectricity have en-

vironmental consequences: the creation of tree-filled lakes, destruction of downstream wildlife habitat and the decimation of populations of anadromous fish are too well known to require specific documentation. Some of these problems can be avoided, at further increases in cost, but some ecological damage is inevitable. Then too we have the scenic pollution created by mile upon mile of transmission towers marching across otherwise unspoiled landscape.

Thermal generation of electricity is generally more expensive but avoids transmission costs. This market has largely been shared by coal and oil, because the Federal Power Commission (F.P.C.) decided in the 1940s that natural gas was too valuable a fuel to be used for generating electricity.

Coal's capabilities as a pollutant are well known to residents of Toronto; and while some strip-mine sites bear a superficial resemblance to the Grand Canyon, none has yet been hailed as a scenic wonder.

In most parts of North America oil is a cheaper fuel than coal, and results in somewhat less pollution at the point of use. There are pollution hazards associated with its production and transportation, with which we deal later.

In many respects, natural gas is an ideal energy source for thermal generation. Though it is more expensive than oil or coal it is virtually pollution-free. In retrospect, the F.P.C.'s restriction on such use seems a tragic mistake, and one that we have been fortunate to avoid repeating. The air pollution problems resulting from thermal generation are largely the consequence of burning large volumes of fuel in a given location which results in undesirable concentrations of undesirable combustion products. Replacement of dirty fuels by natural gas would avoid these concentrations, and overall pollution could be reduced even if some present residential consumers were forced to switch to fuel oil for space heating.

The apparent need for such two-way substitution is a result of the relative scarcity of natural gas in the United States. The latter in turn is in large measure the result of the imposition of field price controls by the F.P.C. as a consequence of the Supreme Court's ruling in the *Phillips* case in 1954.[1] The current gas scarcity was predicted by observers, including the senior author, a decade ago.[2] We raise this issue, not to cry "I told you so," but to underline the need to base regulatory legislation on an understanding of the fundamental economic factors involved rather than dealing with surface phenomena. However, the resource base is limited; substantial liberalization of natural gas markets will be needed to enable gas to retain its projected (decreased) share of the energy market; significant further substitution of gas for other energy forms seems to be out of the question.

A further substitution possibility is provided by nuclear energy. Some is being used now and a significant increase is predicted over the next two decades. Previous projections as to the share of energy markets to be supplied by nuclear energy and as to its costs have nearly all been excessively sanguine, and we would be very hesitant to count on further expansion of the nuclear sector as a means of reducing our dependence on oil. Air pollution from generating stations is minimal, and the concern for safety of the nuclear power industry has been relatively commendable; but there is a radioactivity hazard which is not under perfect control, there is a "thermal pollution" problem, and there are a number of radioactive lakes in the Algoma area to attest to some of the other environmental hazards associated with the use of nuclear power.

In short, there is no substitute which can magically supply our energy requirements without creating environmental damage in some degree, and little likelihood of our being able to reduce significantly our need for oil over the next two decades or for that matter, the next five or six.

So we are really left with a question of how we will meet society's oil requirements, which will most likely mount to some 29 million barrels per day (b/d) by 1990, though they might be reduced to as little as 25.5 million by fairly drastic measures. Sources within established producing areas, for which established transportation systems exist, will be able to supply little more than half of these requirements—some 11.0 million b/d from the lower 48 states and perhaps 4.0 million from western Canada. The rest, some 14 million b/d, will have to come from somewhere else. Possible sources include:

1. Alaska, where perhaps 25 billion barrels of reserves have been found, which could contribute up to 6 million b/d.
2. The northern Canadian mainland, where undetermined reserves have been found.
3. The Artic archipelago, where gas, but not oil, has been found.
4. Offshore sites in Hudson's Bay or off the east coast, where geology is favorable but no reserves have been found.
5. Overseas, where ample supplies exist.

Overseas Supplies

We could just forget about northern oil, and bring in our requirements from overseas. There is no obvious cost penalty in so doing. Supplies

are ample; competition between suppliers has been fierce and is likely to remain so despite the influence of O.P.E.C. Cartels of raw material producers have always broken down in the past because of the rewards available to new suppliers who stay out, and there is no reason to believe this one will be any more effective. Tanker rates have been high since the Six-Day War, but are on their way down. Tanker freight rates have a 60-year history of secular decline, associated with increasing hull sizes, punctuated by occasional periods of sharply higher rates when international developments disrupt shipping patterns and create temporary supply shortages. While northern oil can, hopefully, be delivered at prices competitive with overseas sources, it cannot be brought in more cheaply.

However, bringing in 14 million barrels per day from overseas (or any other source involving tanker movements) will require daily arrival of 2 million dwt of tankers in North American ports. That is some 10-20 tankers per day in the 100,000-200,000 dwt range, or 40 of 50,000 tons, arriving in a relatively limited number of ports, with equal numbers leaving. This traffic would be confined to probably three West Coast ports and perhaps four on the East Coast. In concrete terms this means an average of six movements per day, with peak movements of perhaps twice that figure, and perhaps 20-30 movements per day in high-traffic ports. When account is taken of other traffic, and of the fact that large vessels cannot stop on a dime, or even within a couple of miles, the congestion problem becomes evident. It will be less serious than that in the English Channel, where crowding is already acute, but it will be serious enough and will have an unhealthy influence on the rate of collisions and the frequency of oil spills. The abandonment of potential northern oil sources does not mean the elimination of environmental damage; it means rather its transference from somewhere up north to populated areas along our coasts. Pollution up north is not *per se* desirable either, of course, but its social costs might just be lower than those in some conceivable southern spill sites. It is our view that the major case for some of the northern development options rests on their potential ability to reduce the total incidence of pollution below those schemes involving ocean movement, with no increase in cost. Unfortunately this does not apply to TAPS, which in our view presents magnified marine pollution dangers in comparison with overseas movements, because the tankers would move in coastal waters all the way, and terrestrial pollution dangers as well because of the pipeline component of the system and its location.

Before moving on to the alternative systems for transporting northern oil, we would like to examine the overseas movement problem in a little more detail, because it serves to illustrate some critical features of the problem. First of all, no system is foolproof. Ships can collide, run aground, or break up and sink in adverse weather. Secondly, we must distinguish the *frequency* of pollution occurrences from their *severity*, the amount of damage caused. In evaluating polution costs, we use the notion of expected pollution cost, defined merely as weighted average of pollution costs (using probabilities of occurrence as weights), resulting from the operation of a given system.

The frequency of pollution damage is simply the product of the probability that a single vessel will be involved in a wreck and a spill on a given moment, times the number of ship movements involved in the system in a given period of time. Because of the congestion factor, this probability is not a constant but increases with the number of ship movements; the volume of tanker traffic alone, however, is small in relation to total ship movements and accordingly has a negligible impact on overall congestion or on accident frequency, and can be ignored for the time being.

Unfortunately, we do not have very good figures on frequency of losses. Shipping statistics are aggregated and include substantial numbers which may be idle a significant fraction of the time. The population of giant-sized tankers is simply too small to produce a credible estimate of loss frequency. However, it appears unlikely to be any greater than .05 on an annual basis.[3] Assuming the ship is at sea 85 percent of the time, the probability of sinking on a given day is .00015; that of sinking within two days sailing distance, which is a generous estimate of the effective polluting radius about a port, is .0003 on a given voyage. It should be stressed that this is a deliberately high estimate.

In evaluating severity, we have very little data to go on. There is some data on the costs of cleaning up recent spills, such as those involved in the loss of the *Arrow*, and that of the *Torrey Canyon*, but these do not cover all costs, nor do they provide an estimate of intangible losses, such as to wildlife. Nevertheless, some facts are better than none, and their use can at least give us a feel for the dimensions of the problem.

The *Arrow* cleanup cost some $3 million; the *Arrow* was a small tanker, and the volume of oil involved was small—around 17,000 barrels. The *Torrey Canyon* was a much larger vessel, 200,000 dwt, and the cleanup cost more, though less oil ultimately reached shore than it

did in the *Arrow* case. Costs appear to be related to the volume spilled, and to the proximity of the coast, as primary variables. We assume that, given the location, the increase in costs is more than proportional to the size of the spill. Spilling a cup of oil, or even a barrel of it, into Lake Ontario would be essentially harmless, but a large spill would be disproportionally catastrophic. The *Torrey Canyon* disaster involved 200,000 tons of oil; cleanup, etc. cost $15 million.

A plausible mathematical formulation of the cost structure (holding location constant) is exponential,

$$C = ax^b$$

where x is the tonnage and a, b are constants. We do not have enough data to determine appropriate coefficients for this relationship, so have assumed an exponent of 2 (i.e. costs increasing as the square of the volume involved). Doubling the *Torrey Canyon* costs to take account of wildlife damage, and using the result as a base, we get

$$C = .00075x^2$$

where C is cost in dollars. This implies that pollution costs can be minimized by using small tankers (Table 2). The annual costs are substantial.

This does not mean that we should restrict tankers to smaller sizes; there are other costs to be considered. Movement in large tankers is cheaper than movement in small ones, and no particular gain to society results if an extra dollar is spent on transportation costs to save a nickel in pollution costs. Table 3 shows the relation of transportation costs to tanker size. We can add a second column showing pollution costs, and a third showing the sum of transport costs and pollution costs, which we have defined as the social cost of delivery. What is evident in Table 3 is that pollution costs, even generously interpreted, are an order of magnitude smaller than transport costs, and that the additional burden of transport costs which would be imposed by regulating tanker size in order to cut down pollution costs would simply not be justifiable.

This does not mean that we should not seek to influence the level of pollution costs, and to ensure that they are kept as low as possible in the circumstances. We must ensure that operators take full account of potential pollution costs in their calculations, and seek to minimize these where it is economic to do so. At present there are reasons why they do not.

Fortunately, we do not believe the problem needs to be approached by direct regulation. The essence of the problem is that excessive exposure to pollution risks results because the costs of pollution are not fully reflected in the transportation bill. In our opinion much of it would disappear if this oversight of the market (which is really a deficiency in the legal structure) were remedied. We examine a system for doing this in more detail below.

Northern Oil—Transport Costs

Bringing oil down from the Arctic offers at least some transportation alternatives which pose lower pollution hazards than bringing in oil from overseas by tankers. A number of modes and routes have been suggested. Restricting ourselves to mainland sources, these include

1. The TAPS scheme—pipeline across Alaska, tankers down the coast to Puget Sound and California plus a pipeline overland to the Midwest.
2. The Mackenzie Valley Pipeline scheme—a pipeline all the way to Midwestern and possibly West Coast markets.
3. The Northwest Passage scheme—by tanker all the way to Eastern markets.
4. A variant of the latter in which nuclear submarine tankers are used.
5. Air Transport along the northern part of the route to a pipeline or tanker terminus somewhere to the south.
6. Rail transportation to a pipeline terminus somewhere in the south or all the way to markets.

Inclusion of the rail and air alternatives in the list seems strange at first glance, given historical ton-mile cost relationships for the different modes. However, the proposed carriers of both types are highly sophisticated specially-designed integrated systems and bear little resemblance to their traditional counterparts. By ruthless application of systems engineering, idle time of the expensive components has been cut virtually to an irreducible minimum so that costs, also, bear little resemblance to traditional levels. For example, the aircraft proposal we have seen involves the use of special purpose tanker aircraft substantially larger but much simpler than the 747, carrying 1,000-ton payloads in detachable external tanks, with a highly automated ground handling system that permits turnaround times of six minutes between flights. Even so, as we shall see, its pure transportation cost component is none too favorable. Some of these apparently offbeat proposals, however, offer favorable pollution cost

characteristics. The crash of an airplane with 7,000 barrels of oil, which would likely burn on impact, would be a localized nuisance in comparison with the spilling of 2 million barrels out of a supertanker. Unit trains would offer a similar advantage. Spills might be inevitable but they would be of small and relatively manageable proportions.

In order to look at the comparative costs of these technologies, we have examined a single movement, that of 2 million b/d from Prudhoe Bay to the Chicago area with five different systems:

1. TAPS as proposed.
2. A Mackenzie Valley pipeline.
3. An air-pipeline system using aircraft for the first 1,000 miles south of Prudhoe Bay, a pipeline along the Mackenzie Valley route for the rest of the movement.
4. An air-tanker system in which air movement substituted for the pipeline component of TAPS.
5. A rail-pipeline system, using rail to Montana with a pipeline system the rest of the way.

First we examine transportation costs, conventionally defined. A point which should be stressed is that there are significant differences between these systems in the initial capital cost-annual operating cost mix, so that the apparatus costs are quite sensitive to assumptions about the carrying cost of the capital which would be required. Almost any monstrosity can be made to appear economic if a sufficiently low interest rate is chosen. Capital does have a cost, reflecting what it could earn elsewhere in the economy, even if it is provided from public sector sources at a price not fully reflecting this cost. It is our view that the full cost should be reflected in selecting a system, regardless of what subsidies it might be decided to provide or in what form they might be provided. We have assumed that an appropriate cost, on an after-tax basis, is 10 percent. The before-tax earnings needed to produce such a return are dependent on the method of financing chosen and the extent to which tax-deductible interest and taxable profits figure in the total. Here we have assumed that since all systems serve an identical market from an identical source, their commercial risks can be regarded as identical despite the dissimilarity of the physical asset structures involved, and that the use of leverage in the capital structure can be identical. To be more specific, we have assumed that 70 percent of the required funds would be provided by selling bonds or debentures bearing an 8 percent coupon.

To produce a weighted average return of 10 percent, we require 14.67 percent on the equity:

After Tax

	Weight	Cost	Product
Debt	.7	.08	.056
Equity	.3	.1467	.044
	1.0	.10	.100

With a tax rate assumed at 50 percent on the equity, its before tax yield must be 29.33 percent, so that the appropriate capitalization rate before tax is 14.4 percent (which we have rounded to 14 percent).

Before Tax

	Weight	Cost	Product
Debt	.7	.08	.056
Equity	.3	.2933	.088
	1.0		.144

We have neglected differences in tax treatment of depreciation; the equivalent annual cost formula we use implicitly incorporates depreciation on a sinking fund basis which does not correspond precisely to the rates used for tax purposes. Lives used in making the calculations are shown on the tables. Unfortunately, we do not have estimates of capital and operating costs for the rail alternative, but have been quoted a figure of $1.35 which is based on a lower return on investment figure than we have been using (6-7 percent vs. 14 percent).

Total system investment ranges from about $2.5 billion via a Mackenzie Valley-Prince Albert-Chicago route to well over $5 billion for the more expensive air version. Our figure of $2.8 billion for the system incorporating TAPS is based on an estimated cost of about $1.4 billion for the Alyeska Line alone, which is low in comparison with recent published estimates. How much of the latter is accounted for by interest during construction, and non construction, we do not know. (Tables 4-7).

Delivered costs are summarized in Table 8. We have omitted discussing the cost of tanker movement to East Coast ports, since a comparable destination is not involved. The cost of this movement is relatively low (Table 9) but the oil it displaces from the supply system is less valuable than that at a Chicago destination.

These are just the conventional economic costs of moving oil from the north. Delivered costs, of course, will include the F.O.B. field price in addition; we have not added this because it is probable that the field price will be set at a level which makes delivered prices competive with alternative sources of supply. This should be borne in mind when looking at the

Northwest Passage alternative, for the cost of competing crudes is lower on the East Coast than in the Midwest and the resulting field price would accordingly be lower. The difference between costs of producing northern crude and wellhead prices will, in large measure, emerge as royalty or lease bonus payments to leasing agencies of the respective governments; any economic gain from using continental sources of supply rather than imports will emerge in this form rather than in direct savings to consumers.

The transport cost estimates of Table 8 are for movement of a fixed volume, and do not reflect the sensitivity of costs to scale economies and similar factors. Most of the systems utilize facilities at or near existing technological limits; this is particularly true of the air and rail alternatives which are somewhat beyond the operational frontier of existing technology. Some unexploited economies of scale exist in the pipeline options, and to a lesser extent in the tanker systems.

Northern Oil—Pollution Costs

However these are only part of the story; we have also attempted to examine ecological consequences. Here we have much less to go on. First of all, let us look at the costs of a spill. The cost figure we developed earlier was based on costs of marine spills in reasonably accessible areas. Will costs of terrestrial spills of comparable size be greater, less, or equal? We have assumed equality, in the absence of much in the way of firm evidence. However, it has been alleged that northern spills will be more expensive owing to logistic factors; against this is the consideration that the property values affected will likely be lower. It is our view that any doubt should be resolved in a way which cuts the risk of damage to fragile northern environments. We have accordingly multiplied our earlier spillage cost figures by a further factor of two for terrestrial spills in the north and marine spills in the north and marine spills in the Arctic ocean, making these four times the cost of the *Torrey Canyon* prototype. Our original figure of double these levels is used for Pacific Coast spills.

Magnitude of the spills is given by vessel or vehicle size in the case of ships, trains and aircraft. In the pipeline case it is not. On the level ground it is theoretically possible that the entire line contents could be spilled if no preventive action were taken. In fact, however, a serious rupture would be almost immediately detected and steps taken to contain it, before much was lost. Variations in terrain, and the use of check valves in the system, would reduce losses even in the unattended case. However, a 48-inch pipeline contains some 11,000 barrels per mile, and a pipeline spill would likely be larger than one resulting from a plane crash or train wreck.

The size we have assumed is based on the experience of a major Canadian crude oil system. In a period of over 15 years, it experienced several hundred leaks or spills, mostly attributable to pipe defects. Only two spills involved over 10,000 barrels, only one over 50,000. Allowing for the difference in line size, and ignoring the 100-200 barrel spills, we estimate the average serious break on a 48-inch northern line would involve perhaps 350,000 barrels of oil.

Our resulting estimates of mean costs per major spill are as follows:

Tanker (Arctic)	$60 million
(Pacific)	$30 million
Pipeline	$ 2 million
Aircraft	$.1 million
Railroad	$.25 million

The other item in the equation determining expected costs is, of course, frequency. Again, our measures of this are not very good.

The TAPS system, operating at 2 million b/d would, we estimate, require fifteen 200,000 dwt tankers which would be moving, loaded, for 118 days per year. All of this time would be spent in waters near the coast between Valdez and Puget Sound, giving the equivalent of 1,770 loaded operating ship-days per year. Using our admittedly crude estimate of probable ship losses at .00015 per day the probable annual losses are .266 loaded vessels, i.e. one sinking every four years. With a per sinking cost of $30 million, expected annual cost is just under $8 million.

The other hazard associated with TAPS is the threat of a pipeline break resulting from an earthquake. The southern terminus of the line, at Valdez, is within 50 miles of the epicentre of the 1964 Alaska earthquake. During the last 40 years, there have been five earthquakes with a Richter magnitude of seven or more within 100 miles of the route; the incidence seems to have been similar in the preceeding 40 years. The region is one of intense earthquake activity. Let us suppose that earthquakes of this magnitude would result in leaks, and that lesser earthquakes would not. The frequency of earthquake-induced breaks we estimate therefore at .125, i.e. one every eight years. To this must be added possible leaks not due to earthquakes, estimated at .025. Expected annual costs on the pipeline portion of the route are $300,000 ob-

tained by multiplying the per spill cost of $2 million by the frequency factor of .15.

Total pollution costs of this alternative are, therefore,

	Per Year
Maritime	7.95 million
Terrestrial	.30 million
Total	8.25 million

The Mackenzie Valley route eliminates marine pollution. The northern portion of the line, from Prudhoe Bay to the Mackenzie Valley, passes through an area which has experienced some earthquakes, which were less frequent and less intense than those on the Pacific Rim. On this portion of the line we have assigned an estimated frequency of .025, i.e. a break every 40 years. Once the line swings south, it is near the edge of the shield and in a zone where the probability of an earthquake severe enough to break the line is sufficiently low to be disregarded for computational purposes. Probability of leaks from defective pipe etc. we estimate at .025. Total expected pollution cost on this route is .05 x $2,000,000, or $100,000 per year.

The airlift system bypasses the portion of the MVPL system on which a significant earthquake risk exists, substituting for the risk of a pipeline rupture that of a plane crash. At 7,000 barrels per flight, there would be 286 flights per day; 286,000 loaded aircraft miles flown. At a crash rate of one per 100-million aircraft miles, there would be about one crash per year. With per crash pollution cost of $100,000, and $50,000 on the pipeline portion, expected annual pollution cost is only $150,000.

The rail system would likewise eliminate the hazard of a pipeline rupture, substituting therefore the hazard of a train wreck. We have estimated the average spill from a wreck at 25,000 barrels, which may be rather an impressive wreck. With 80,000 train-miles daily, and a wreck probability of one train every five years, expected annual cost of pollution is in the order of $50,000.

Use of tankers through the Northwest passage involves a pipeline movement to a suitable deep-water terminal, since coastal waters off Alaska are too shallow for large tankers. It would therefore involve risks of terrestrial pollution comparable to northern portions of the Mackenzie Valley pipeline; in addition there would be a risk of marine pollution. In a 2 million b/d movement, there would be 20 loaded ships between Herschel Island and New York on the average. All of this would be in waters within distance sufficiently close to shore to create a pollution hazard. Probability of loss would, in our view, be significantly greater in the Arctic ice than in the Pacific. We do not know how much greater, so have left the figures as they are. Allowing for the higher per-incident costs mentioned above, expected annual pollution costs of this alternative are:

	Per Year
Terrestrial	$ 100,000
Marine	$65,500,000
Total	$65,600,000

Table 10 summarizes the expected pollution costs of these alternatives, and adds them to transport costs.

For the sake of comparison, recall that supplying a North American market with offshore crude on the indicated scale, using 200,000 dwt tankers, involves annual pollution costs of $4.68 million. These are lower because the tankers arriving from overseas pose a serious pollution threat to North American waters only during the last day or two of their inbound voyage. We have ignored pollution farther to sea; it undoubtedly has costs but their magnitude and incidence are poorly defined. It is clear that in terms of potential environmental damage alone, TAPS and the Northwest Passage alternative are dominated by the use of overland routes via the Mackenzie Valley. Of these, combined social cost by pipeline is much the lowest, and compares favorably with those of TAPS or the Northwest Passage route. If it is desired to reduce environmental costs still further, alternative modes such as rail should be seriously considered. Note, however, that it picks up modest improvements in pollution cost at the expense of major increases in transport costs, and that pollution costs are a relatively insignificant part of the total costs of the pipeline system.

We have concentrated on the environmental consequences of oil spills; other environmental impacts have been neglected. Thus we have not explicitly considered the problem of pipeline construction in permafrost and its effects on the latter, on the premise that the problem can be solved by insulation or other means within the cost parameters specified. Nor have we examined barriers to caribou migration, possible interference with the Alaska Wildlife Refuge or the muskrat grounds around Old Crow, except as the major hazard to the latter two is included in the oil spill cost. Most of these problems can be handled in selection of appropriate construction techniques. These subsidiary problems are not confined to pipelines; railroads pose an obvious threat to wildlife which has to cross the tracks; aircraft pose an air pollution problem.

This analysis has concentrated on a single movement of given size from one location. It has shown that at least a part of the growing North American crude oil deficit can be supplied from continental sources, and environmental pollution costs reduced in the process. It has not shown that the entire deficit should be met from such sources (if the amounts available are large enough), nor that it should not. Answers to this question require a more detailed analysis of the entire supply system, which could not be performed with the time and resources available.

Such an analysis would have to examine systems for the transportation of oil from other sources, including the offshore areas near the Maritime Provinces and the islands of the Arctic. The order of desirability of various transport modes will not necessarily remain invariant when alternative sources are considered. In the case of the Arctic islands, the rail alternative disappears, and use of TAPS becomes even more absurd, but the other alternatives remain. Pipeline costs increase, partly because of the greater distance, but chiefly because of the ocean crossings involved. The latter, under ice, and at great depth, appear to involve significantly increased pollution hazard. Tanker costs drop, because the length of haul is reduced; significant pollution cost remain to be met. In this instance the air movement offers a possibility of minimizing pollution costs by a shipment to the mainland, with a pipeline across the Shield where earthquake risk is minimal.

Some Subsidiary Matters

Because it has received wide publicity, note should be taken of the claim that MVPL will create balance of payments problems, push the Canadian dollar to $1.50 U.S., and in general lead to economic disaster in Canada. While the charge has been levied against MVPL it has equal merit with respect to any system in which Canada is a participant. All of the systems use large amounts of capital; if all of the funds were raised externally, all of the resources used purchased in Canada, and construction completed within one or two years, there is no doubt that the conversion of the imported capital to Canadian dollars with no offsetting imports could create a problem in this direction. However, substantial portions of the MVPL system would be in American territory, at both the northern and southern ends of the system. Only the fraction of the funds that would be spent in Canada would have to be in Canadian dollar form. Presumably there would be some Canadian equity in the system, which would already be in Canadian dollars and exert no pressure on the exchange markets.

Not all of the expenditures made in the Canadian parts of the line would be spent on Canadian goods and services. Canadian capacity for rolling wide steel plates is sufficient for something like 20 percent of the pipe requirements. While our rolling capacity would undoubtedly be expanded, the bulk of the pipe would have to be imported, along with much of the hardware for valves, pumping stations and the like. These imports would create an offsetting demand for foreign currencies, and it is a matter of fairly simple arithmetic to show that if the funds raised in Canada were equivalent to expenditures on Canadian goods and services, and if expenditures on foreign goods and services were met from funds raised abroad, and the timing of funds conversions handled with care, construction would have no net effects whatever on the Canadian balance of payments nor on the Canadian-dollar exchange rate. Annual revenue from the export of transportation services would, however, strengthen our balance of payments position. There would be an increase in the demand for Canadian labor, which can hardly be described as a scarce commodity.

Within the broader context there might be a problem. Assuming the Canadian balance of payments effects were neutralized, but that funds were raised in the United States and all pipe imports came from Japan, for example, the project would contribute to the existing imbalance on the U.S. dollar-yen market. If the yen is not revalued, it would seem perfectly legitimate to impose country of origin controls on the material content of any system that is constructed. It would be clearly preferable if the irrationalities of the international monetary situation could be ironed out independently, and the need for offsetting irrationalities in construction of transportation systems eliminated.

Another issue which we find hard to evaluate is security. Much of the U.S. passion for security looks, from this side of the fence, like an (unintentionally) transparent cloak thrown over measures that are purely protectionist, to avoid open defiance of GATT. We recognize that there may be some legitimate concern. The paramount fact is that the United States is at a point where it can no longer count on meeting almost all of its oil requirements from the lower 48 states, and is going to have to go farther afield, using supplies from sources where the threat of interdiction is greater. Tankers provide splendid targets for submarines, though the entire fleet must be destroyed if supplies are to be entirely cut off. Pipelines on territory under friendly control are, we suspect, more se-

cure. Even if supply can be completely cut off by acts of sabotage, repairs can be effected quickly unless an enemy controls the territory. Similar continuity applies to rail systems, while air delivery probably offers greater security since there are fewer points open to sabotage, and if these are held, loss of a few aircraft should not seriously impair deliveries.

In the security context again, we find MVPL superior to TAPS. There is no tanker portion to be sunk, and the pipeline portion can be protected as easily as that of TAPS. The only objection which has been raised is that it is on foreign soil, and that the Canadian government might cut off supplies. Such action, in our view, would only be taken in the event of United Nations sanctions against the United States; or, unilaterally, if relations in our two countries had reached a point just short of a shooting war. A desire on the part of the United States to preserve its security of supply under either of these eventualities can only lead to the gravest doubts about U.S. intentions. In view of the demonstrated capacity of Ontario Hydro to turn off lights over the entire northeast, the attempt to preserve oil supplies would seem to be largely beside the point in any event.

Legal Issues

In looking at legal issues raised by these alternatives, we find there are a number of gaps, or at least areas where it appears to us that some improvement in the machinery is desirable.

One of these areas relates to jurisdiction over the carrier system with respect to control over entry, nature of service, and tariffs. Irrespective of the technological means chosen, any transportation system for northern oil will have to be just that—an integrated system. While competing units may be used in parts of it (e.g. tankers), control over key sectors (e.g. loading facilities) will give the system operator a degree of monopoly power that could result in excessive transportation charges, borne either by consumers or producers; exclusion of independent producers; or some of the other problems that have contributed to the development of pipeline jurisprudence in both countries. At the national level, there is adequate legal machinery for dealing with these problems. To date, international systems have come under dual regulation, subject to Canadian jurisdiction on the Canadian portions of the systems and U.S. jurisdiction on U.S. portions, with a dual system of export-import licenses further controlling the flow of oil and gas across the border.

In some respects this is less than adequate. Powers to control location and size of systems, and rates, remove potential monopoly power of private operators, but do not prevent their exercise by regulatory authorities on behalf of real or believed local interests. This is not a theoretical possibility. Such powers were in effect used by the F.P.C. in the regulatory skirmishes prior to the construction of the west coast gas system to deny Canadian gas its most obvious and economic market and force it to be exported to the United States at a price based on markets further south, which was lower than that charged distributors in contiguous points in Canada, and lower than that contemplated in the original proposals. That occurred when the United States had a degree of monopsony power with respect to natural gas. The shoe seems to have changed feet since then, and we would regard Canadian regulatory authorities as remiss if they did not recover our pound of flesh, with interest, or perhaps even triple damages which may be deemed an appropriate penalty for the willful misuse of monopoly power.

However, we're not prepared to advocate "sock it to 'em," emotionally satisfying as it might be for a while, as an appropriate basis for policy in this area.

Even if we ignore the possibility of retaliation in another field, which we should not, we must recognize that the extent of monopoly power we can exercise with respect to an oil transport system is strictly limited by the availability of alternatives which are beyond Canadian reach. These include reliance on overseas sources, and TAPS, which is beyond Canadian legislative reach at present. From the U. S. point of view, TAPS is the one system for moving Alaska oil from which the possible misuse of Canadian monopoly power is absent. It doesn't cost too much more from the U. S. point of view than the other alternatives, particularly if it is remembered that much of the pollution cost would be borne by Canadians. Rather than using our monopoly position with respect to the other alternatives to increase their cost to the same level as TAPS, which is the best we could hope for, and which would likely ensure its construction, it would be useful to negotiate international control over rates etc. of an alternative system under a treaty which would set up an international regulatory body which would perform the usual regulatory functions and would in addition:

1. guarantee equal access to the line and equal access to U.S. markets for Canadian oil whether carried in the system or not.
2. eliminate discriminatory treatment of other Canadian commodities (base metal quotas come to mind), and
3. recognize Canadian or create international

jurisdiction over pollution in international waters where damage to Canadian interests results.

This approach is apt to be dismissed by the more ardent among Canadian nationalists as creeping, or even galloping, "continentalism." Perhaps it is. However, environmental damage knows no international boundaries. TAPS does pose a threat to the Canadian environment, but in the present state of the law, it appears to be a purely internal U.S. matter over which we have no control whatever. Canada can, of course, proclaim pollution regulations governing a wide belt off the West Coast; whether it can enforce these regulations in an effective manner or whether they would be mere window dressing is another matter. If we wish to extend our sovereignty in this direction, we believe we must be prepared to accept its limitations in others.

This brings us to the other area of legal concern, the extension of legal controls over pollution. The nature and intent of such controls are still under discussion, as well as the design of control mechanisms. One widely held point of view is that pollution is analogous to crime, and that the appropriate goal of pollution control should be to prevent any pollution from taking place. The alternative is to view it as an undesirable byproduct of a great many otherwise desirable activities, to be kept within tolerable limits. While we have sympathy with the first of these positions, and with other simple-minded dedications to abstract virtue, its unmitigated pursuit can only lead to social wastes which are equally irresponsible.

Society has other needs besides pollution control, and a solution that results in $10.00 being spent to prevent pollution having a social cost of $.10 when there are a multitude of other uses from which the social benefit may be $10.00 or more, simply will not do. There is a point beyond which attempts to prevent pollution are simply wasteful, although we do not suggest that we are at, or even near, that point. We believe, however, that this consideration is of some importance in formulating approaches to the problem of bringing pollution under control.

One approach is to attempt to regulate the construction and operation of facilities in such a way that pollution is prevented or minimized. In related fields, this approach is exemplified by those provisions in building codes which attempt to enforce construction standards to prevent loss of life in fires, and in the International Convention for the Safety of Life at Sea, which uses similar regulations for similar purposes. These are the legislative embodiment of the "stamp out all pollution" philosophy criticized earlier. In application, this approach does both too much and too little. It does too much in that it tends to freeze technology at the point where the regulations are drafted, that it imposes control over minute details which may make no contribution to the safety or otherwise of the system of which they form a part. Such controls are expensive to administer, and costs of compliance with specific details may be quite disproportionate to the benefits derived. They may also lull the public into a false sense of security, because in fact they do too little. They do not prevent loss of life through fire or marine hazards, and serve to relieve owners or operators of any responsibility beyond that of mechanical compliance with the regulations, insofar as these affect criteria applied in determining negligence. Doubtless there has been some reduction in the frequency of such losses since the regulations were adopted; this does not mean that they are the only means of controlling them, nor even the most effective.

At the heart of the problem is the fact that the operators of transport systems have to bear the full cost of transportation, including that of any parts of the system included to reduce pollution hazards, but are not required to bear the costs of pollution. As a consequence, in their pursuit of efficiency, their choices of technology are those which economize on construction and operating costs at the expense of the environment.

Similar problems are inherent in most pollution situations. The general water pollution case has been studied by Professor Dales.[4] He has dealt, however, with the case where pollution involves small volumes, is continuous and substantially deliberate. Neither his analysis nor his proposed solution is directly applicable to the typical oil transportation case, where pollution is unintentional, sporadic, and may involve large volumes of pollutants. Our discussion and proposals have, however, been significantly influenced by his work.

There are at least three major reasons why the private-social cost discrepancy exists in the oil transportation case:

1. Pollution may result from incidents where the carrier is not liable—the proximate cause may be a negligent third party, for example.

2. Where it is liabile at law, the carrier may avoid practical liability for damages in excess of its available assets by use of the corporate form. This is particularly relevant in situations where damages may be of disaster proportions and where parts of the system may be separately incorporated, e.g. ships.

3. Even if the carrier is liable at law and finan-

cially responsible, the rules by which damages are assessed may fail to impose liability for the full cost, because the harm done is merely probable or because of a lack of property rights in the things damaged or destroyed. Who is the injured owner of wild seabirds, or uncaught fish?

While some degree of direct control over operations may be desirable, such controls will not force carriers or shippers to give appropriate weight to environmental considerations. Design of a system in which they are given appropriate weight requires, in our view,

1. that damage to aesthetic values and to wildlife be recoverable, including an allowance for probable damage to future populations. New legislation is probably required to require the inclusion of such items in damages.

2. an appropriate body will have to be charged with the responsibility of claiming such damages. It might well also claim for cleanup costs incurred by various public bodies. In order that losses suffered by individuals, each of which may be too small to justify the legal costs incident to recovery but which may be significant in the aggregate, are not omitted, the agency should also be empowered to act as agent for those individuals who wish to use its services in this respect.

3. liability of carriers for damage caused by their cargoes should be made strict in those cases where it is not already so. They should retain a right of action against negligent third parties for such losses as they are required to pay, but must assume primary responsibility for the payment of damages.

4. carriers operating in a country or within portions of the adjoining seas where pollution hazards exist must be required to demonstrate financial responsibility. This is a primary requirement with respect to the tanker operator whose only asset within reach is a rusty hulk lying at the bottom of the sea after its cargo has been spilled. Ensuring that he is "judgement proof" with respect to such claims, by keeping individual vessels under separate corporate ownership, and under competitive pressures, his freight charges are unlikely to include any allowance for expected pollution costs. While tankers pose the most serious problem, there are rail and air carriers on this continent whose ability to meet catastrophic claims is at least questionable, so we would impose a financial responsibility requirement on all carriers.

The basic means of ensuring financial responsibility would be a requirement that carriers have insurance coverage for their liability in respect of pollution damage, written by responsible underwriters. Self-insurance of a reasonable deductible amount would be permitted for domestic corporations having adequate working capital or foreign corporations posting a bond, but insurance would be required for losses in excess of, say $5 million.

Objections

The big objection which will be raised to such a scheme is that it amounts to locking the door after the horse is gone, that the emphasis must be on preventing spills rather than on compensating society for losses after they occur. To the extent that this is a manifestation of the "no spills at any price" philosophy, it must be rejected. The scheme *will* reduce the numbers and sizes of spills by incorporating the expected costs of pollution into shipping costs, and thereby encouraging shippers to use less pollution-prone techniques to the extent that the relative levels of other items of transport costs permit.

Our estimates of pollution costs are indeed highly arbitrary, little more than guesses intended to provide a starting place. Society may feel that the "true" costs of pollution are in fact higher than we have suggested. If so, it should raise the price, by increasing the penalty attached to pollution. Under the scheme we have proposed, this will raise the relative cost of the more pollution-prone modes and discourage their use.

The scheme, insofar as it relates to requiring proof of financial responsibility from tankers, represents a rather drastic modification of the traditional freedom of the seas and the related right of innocent passage through territorial waters.

This is scarcely a reason for its rejection. The only alternatives that we can see, other than interpreting these rights as unlimited freedom to pollute, involve equal and perhaps greater interference with the essential underlying principle. These freedoms have been restricted in a number of important ways, and the costs of failure to impose some kind of constraint have risen to the point, largely owing to the increase in the volume of traffic and the size of ships, where they are no longer acceptable. The constraint we have suggested offers, we believe, the minimal interference with these traditional freedoms which is consistent with controlling the social problems involved.

Conclusions

Several conclusions, we think, emerge from our analysis. The first of these concerns the nature of the choice faced by policy-makers concerned with northern oil transportation prob-

lems. This choice is not between polluting the environment and keeping it in its present pristine state. It is rather a question of how much will have to be accepted as the inevitable price of meeting our growing energy requirements, and where it is going to occur. We can prevent pollution of the north, at least from this source, by preventing development and exploitation of the resources. Doing so will result in pollution costs, at least as great and likely greater, being incurred elsewhere on the continent, probably nearer to major population centers.

Our examination of probable pollution costs suggests that it is possible to move northern oil to continental consumption centers at overall pollution costs which are significantly lower than those which would be incurred in using alternative sources of supply, and that there is no reason to reject the northern alternative on pollution grounds. Unfortunately, the TAPS proposal does not appear to be among those which accomplish this objective.

The analysis also suggests that pollution costs are a small fraction of the total cost of any alternative, and that the use of conventional pipelines is so much cheaper than that of more exotic alternatives that any saving in pollution cost realized by adopting the latter would be at the cost of a substantial increase in other transport costs. It is our view that the resources thus absorbed could be better used, e.g. in reducing environmental pollution from existing sources of continuing pollution.

We have also examined a framework which would remedy an apparent "market failure" whereby pollution costs do not always enter the economic calculations of carriers and shippers, which should serve to reduce the incidence of pollution resulting from oil transportation.

Notes

1. *Phillips Petroleum Co.* v. *Wisconsin,* 347 U.S. 567 (1954).
2. G. D. Quirin, "The Regulation of Field Prices for Natural Gas Under the Natural Gas Act," (Ph.D. Dissertation, Princeton University, 1961).
3. Actual losses from the entire tanker fleet have been nearer 0.3 percent of total tonnage; the 5 percent figure reflects experience on 75,000 dwt and over vessels in 1969. The difference between these loss rates suggests that extraordinary risks are associated with supertanker operation, but may not be statistically significant. In the present context it appears preferable to use the higher rate rather than assume a decline to experience on the entire fleet.
4. J. H. Dales, *Pollution, Property and Prices.* (Toronto: University of Toronto Press, 1968.)

Table 1. *North American energy consumption 1990 (millions of metric tons oil equivalent).*

By End Use	Canada	U.S.	Total
Industrial	88	882	970
Transport	68	672	740
Residential, "Commercial"	72	818	890
Transformation, etc., Loss	141	1350	1491
Total Primary Energy	369	3722	4091

By Sources	Canada	%	U.S.	%	Total	%
Oil	132	36	1378	37	1510	37
Natural Gas	74	20	900	24	974	24
Coal	40	11	650	17	690	17
Hydro and Geothermal	70	19	75	2	145	4
Nuclear	53	14	719	19	772	19
	369	100	3722	100	4091	100

Source: Canada—N.E.B.; U.S.—our estimates. (Percentages may not equal 100 because of rounding.)

Table 2. *Expected pollution costs on 2 million b/d movement to a single port.*

	Size of Vessel—000 dwt				
	25	50	100	200	400
Number of Inbound Movements per Year	4160	2080	1040	520	260
Spills per 100 Movement	.03	.03	.03	.03	.03
Expected Number of Spills per Year	1.248	.624	.312	.156	.078
Cost per Spill* ($ million)	.47	1.88	7.5	30	120
Expected Cost/Year	580,000	1,170,000	2,340,000	4,680,000	9,360,000

* $C = .00075\ x^2$

Note: higher costs in the *Arrow* sinking are attributable to (a) propinquity to shore and (b) cargo residual fuel oil rather than crude.

Table 3. *Combined transportation and pollution cost vs. tanker size (3,000-mile haul).*

Vessel Size (dwt)	Per Barrel		
	Transport Cost	Pollution Cost	Total
25,000	.51	.0008	.5108
50,000	.42	.0016	.4216
100,000	.35	.0032	.3532
200,000	.29	.0064	.2964
400,000	.25	.0128	.2628

Table 4. *Cost of moving Alaskan oil—Prudhoe Bay to Chicago—via TAPS.*

Capital Costs	Capital Cost ($ million)	Life-Years	Annualized Cost @14% ($ million)
Pipelines*	2,370	33	336
Tankers	375	20	57
Port Facilities, etc.	75	40	11
Total Capital	2,820		404
Annual Operating Expense			
Pipeline			299
Tankers			130
			429
Total Annual Cost			883
Per Barrel Cost (730 million b/yr.)			$1.14

* Including Puget Sound-Chicago Line, $974 million.

Table 5. *Cost of moving Alaskan oil—Prudhoe Bay to Chicago—via MVPL.*

	Capital Cost ($ million)	Life-Years	Annualized Cost @14% ($ million)
Capital Costs			
Pipelines	2453	33	348
Annual Operating Expense			304
Total Annual Cost			652
Per Barrel Cost			$.90

Table 6. *Cost of moving Alaskan oil—Prudhoe Bay to Chicago—via air, eastern route.*

Capital Costs	Capital Cost ($ million)	Life-Years	Annualized Cost @14% ($ million)
Aircraft	3,700	10	710
Pipeline	1,136	33	161
Terminal Facilities	430	40	61
	5,266		932
Annual Operating Expense			
Pipeline			190
Aircraft			630
			820
Total Annual Cost			1,752
Per Barrel Cost			$2.40

Table 7. *Cost of moving Alaskan oil—Prudhoe Bay to Chicago—via air, western route.*

Capital Costs	Capital Cost ($ million)	Life-Years	Annualized Cost @14% ($ million)
Aircraft	1,950	10	374
Terminals	430	40	61
Ports	75	40	11
Tankers	375	20	57
Pipeline	974	33	133
	3,804		636
Annual Operating Expense			
Aircraft			395
Pipeline			157
Tankers			130
			682
Total Annual Cost			1,318
Per Barrel Cost			$1.81

Table 8. *Summary of transportation cost per barrel—Prudhoe Bay to Chicago.*

System	Per Barrel ($)
TAPS	1.14
MVPL	.90
Air Eastern	2.40
Air Western	1.81
Rail	1.35

Table 9. *Cost of "Northwest Passage" tanker movement—Prudhoe Bay-U.S.N.H.* (2 million b/d movement).

	Capital Cost ($ million)	Life-Years	Annualized Cost @14% ($ million)
Capital Costs			
Tankers and Icebreakers	2,790	20	412
Port and Pipeline	311	33	44
Total Capital Cost	3,101		456
Annual Operating Expense			
Tankers			427
Icebreakers			11
Pipeline			16
			454
Total Annual Cost			910
Per Barrel Cost			$1.25

Table 10. *Pollution costs and transport cost* (2 million b/d movement).

System	Expected Pollution Cost		Transport Cost	Total Social Cost
	Per Year	Per Bbl.	Per Bbl.	Per Bbl.
TAPS	8,250,000	.013	1.14	1.15
MVPL	100,000	*	.90	.90
Air Eastern	150,000	*	2.40	2.40
Air Western	8,050,000	.011	1.81	1.82
Rail	50,000	*	1.35	1.35
NW Passage	65,600,000	.090	1.25	1.34

* Less than 1 million.

Canadian-U.S. Fishery Problems

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For nearly all of my entire professional life, from the early days of the International North Pacific Halibut Commission to the present, I have rarely found myself concerned with maritime problems which were outside the range of Canadian fishery interests and Canadian fishery experts. During all these years, in matters involving exploitation and conservation of fishery resources, the differences between the national interests and government positions of the two countries have often been less than differences within the U.S. fishing industry. In the case of multi-national fishery problems and negotiations involving both countries, our national interests generally have been so close that our representatives could operate in close coordination. This is not to say that we did not have differences in interests and views, but these were more like family differences and generally did not prevent achievement of mutually acceptable compromises. Where substantial differences occurred and persisted, more often than not they stemmed from non-fishery interest, particularly matters concerned with national security.

This ability to get along together on fishery matters stems from the similarity in our economic views, in our fishing methods and markets, in the academic and field background of many of our early fishery leaders, and in our readiness to accept scientific findings based on empirical as well as theoretical analysis as the basis for developing equitable agreements and pragmatic management measures.

My recent survey of current U.S.-Canadian fishery problems, particularly those on our Atlantic coast, leads me to the conclusion that the pattern I have described has not changed materially during the last few years. Currently there are a number of fishery issues which from time to time raise the hackles of one or another of our fishery oriented citizens, but even a cursory examination of the "true facts" shows that, with respect to outside problems, we have much more in common than differences between us.

For many years there have been issues connected with the Northwest Atlantic herring (Maine sardine) industry that have been irritating, if not critical. These were related to poaching on one side or another of the international boundary line, the extent of importation of Canadian herring by U.S. canners, and the impact of fishing by one country on herring stocks available to the other. These irritations now have faded into the background in the face of the very recent threat to the continued yield of the fishery, generated by the massive increase in fishing along the North Atlantic coast by the great fleets of overseas foreign countries. The most prominent U.S.-Canadian differences have been resolved by the recent herring agreement, and a common front has been developed in efforts to secure a drastic reduction in the impact of overseas fishermen on the herring stocks. However, the results of these efforts at the recent ICNAF (International North American Fisheries Commission) meetings were in the classic pattern of our current international management system—postponement of action pending more time and more study.

The serious decline in the yield of the scallop fishery on Georges Bank poses a problem of substantial importance to New England and Nova Scotian fishermen. This fishery was developed, and until recently, dominated, by New Bedford fishermen. In recent years Canadians have accounted for an increasing share of the catch. During these years total production has declined substantially as the result of the reduced abundance of scallops. No action has been taken to adopt national or international conservation measures, but this failure apparently stems primarily from the inability of the fishery managers and research men to come up with practical measures which would appear to be effective in increasing the sustainable yield of the resource. This is more of a mutual problem than a problem between countries.

The Georges Bank haddock appears to be the first major victim, in the Northwest Atlantic, of modern massed fishing techniques. Beginning in the late 1920s this species provided the backbone of the New England fishing industry centered in Boston. Canadian trawlers did not fish on Georges Bank. After peaking in the late 1920s the catch leveled off at something over 100 million pounds annually and maintained this average until recent developments. Re-

search during the 1930's demonstrated that use of large mesh in the otter trawls would permit most of the less than market size haddock to escape and thus make possible a substantially larger sustainable yield in later years. However, save for an abortive voluntary "savings gear" program among the Boston fleet, no legislative action was taken because of opposition from some segments of the U.S. industry. Substantially later, when ICNAF became functional, a savings gear program was adopted. However, no other action was taken by ICNAF and in 1965 the inevitable occurred. Some of the Europeans, notably the USSR, under pressure to increase their catches and due to the increasing scarcity of certain previously under utilized species which had first attracted their interest, turned their attention to haddock. Prior to this the Georges Bank stock had been in precarious balance with fishing effort. Although this situation should have been evident from the statistics of the fishery, no action was taken by ICNAF, and the addition of short term but massive fishing effort from the overseas fishing fleet resulted in a drastic decline in numbers of mature fish. For this, and/or other reasons not presently understood by the scientists, the successive haddock spawnings since that season have produced few young fish, and the stock has continued a catastrophic decline in spite of drastic reductions in the allowable catch. It seems more than a coincidence that the series of year class failures should have originated just after the imposition of greatly increased fishing pressure on the Georges Bank stock, and continued since then.

Haddock production from the Northwest Atlantic has come principally from Georges Bank and the Nova Scotian banks. The United States and Canada in recent years have had an informal understanding that their respective fishing fleets would concentrate their haddock fishing efforts principally on the banks off their own coasts. No substantial bilateral problems apparently have darkened the horizons of the North American haddock fisheries. The present haddock crisis then has come, not from problems between the two countries, but from the common problem, impact of overseas fishermen.

A U.S.-Canadian maritime problem that has generated increased attention in recent years is that of a seabed boundary down through the Gulf of Maine and out to the edge of the continental shelf. This appears, however, to have little fisheries involvement for there are no commercially important seabed species on this area of sea bottom (lobsters and scallops do not qualify as resources of the seabed under the 1958 Continental Shelf Convention). The United States and Canada have no serious unresolved frictions regarding the non-shelf species.

The U.S.-Canadian fishery problems of the Northwest Atlantic seem typified by an incident which took place in the 1950s, when the late Stewart Bates was Deputy Minister of Fisheries for Canada and I was concerned with international fishery problems in the U.S. Department of State. At that time Canada had (and I understand still has) a regulation that prohibits her large trawlers from fishing inside of 12 miles along the Nova Scotia coast. This regulation was based on political rather than conservation considerations, to advantage the operations of the smaller boat draggerfleet in relation to the big Canadian trawlers. At that time Canada had a three-mile territorial sea and international fishery limit. This 12-mile regulation therefore did not apply to the big Boston trawlers, although the Halifax and other Canadian trawlers, not surprisingly, argued vigorously that it should.

It was during this time that one morning I received a telephone call from Ottawa. It was Stu Bates. Rather plaintively he stated, "Bill, I'm having a difficult enough time enforcing this 12-mile regulation on Canadian trawlers without having your Boston trawlers fish inside the 12-mile zone and then call our enforcement officers and report that Canadian vessels are violating Canadian regulations by fishing alongside them. What are they trying to do, goad us into repealing the regulations so that they will have more competition?"

On the Pacific coast as on the Atlantic, bilateral fishery problems qualify more as irritants than major differences. The recent 1970 agreement on reciprocal fishing privileges took care of problems that might have stemmed from Canada's claims to jurisdiction over certain areas within "closing lines," notably Hecate Strait and the Gulf of St. Lawrence. Another bilateral issue involves catching salmon in the jurisdictional waters of one country which originate in waters of the other. These problems are limited in scope by our long standing Convention covering the restoration and management of Fraser river sockeye and pink salmon and our agreement to ban high seas netting for salmon. Both countries accept the general philosophy that each is entitled to harvest the salmon produced in its waters. These agreements and philosophy, plus consideration of historic use, provide a framework which has made it possible to develop understandings which have prevented major differences on these issues.

Problems arising from the definition of inter-

national boundary lines and the impact of the Canadian liberal closing lines on the rights of navigation, etc. involve much more than fishery issues. Furthermore, the manner in which Canada has qualified these claims with respect to U.S. fishermen has made the closing lines more advantageous than otherwise for many U.S. fishery interests. These qualifications, permiting continued U.S. fishing in the enclosed areas, undoubtedly were influenced by old agreements, the 1713 Treaty of Utrecht and 1818 Treaty of London. However, I suspect that equal or greater influence was exerted by more current considerations related to overlapping interests in fishing grounds off each other's coasts, markets, and operations of overseas fishing fleets in North American coastal waters. It will be considerations such as these that will play the major role in shaping our fishery relations in the future.

It should be clear from what I have said that in my observation of any experience with international and U.S.-Canadian fishery problems, I have been favorably impressed with the procedures that have been successful in maintaining our friendly relations and cooperation on fishery matters. I have no proposals or suggestions to make for alteration of these procedures. However, I would urge that continued attention be directed to means of assuring, as far as possible, that other interests related to the sea, such as navigation, pollution, and national security, do not unnecessarily complicate our fishery interests and cooperation in this field.

This brief examination of U.S.-Canadian fishery problems illustrates how relatively few, and somewhat less than crucial, are the conflicts in fishery interests of the United States and Canada. Even more, it highlights the similarity of our major problems, the present and threatened future impact of the massive-mobile fishing fleets of overseas countries, and the urgent need to improve the yields and economic returns of our domestic fishing industries, through modification of the old common property concept that has dominated thinking about resources of the seas.

Canada and the United States have major and similar interests in bringing to a halt the piecemeal decimation of the fishery resources along both coasts of North America, which has been brought about by the concentration of massive fishing power successively on different stocks of fish. Haddock, yellowtail flounder, herring, and a number of less widespread species already have been seriously affected. Others are threatened. As the great fishing fleets reduce one stock to uneconomic levels, attention is focused on another. This sequence advances so rapidly that the scientific evidence of overfishing necessary to secure international agreement on effective conservation measures is not available until the damage has been done. This not only is destroying the basis of the old North American fishing industry, such as the Boston haddock fleet and New Bedford yellowtail flounder industry, but is depleting previously unutilized or underutilized stocks of fish which once provided alternatives for North American fishermen.

Informed persons in the United States and Canada increasingly are coming to similar conclusions. The only development that will forestall the rapid depletion in abundance of the coastal resources and reduction in their sustainable yields, with continued deterioration of our coastal fishing industries, would be recognition that each coastal state has the responsibility and authority to regulate all fishing for stocks of fish found predominantly in its coastal waters. Such regulation would be for the purpose of conservation and to implement the preferential interest of the coastal state in harvesting such stocks as long as full use was being made of the permissible yield (sustainable yield). To the extent that the coastal state was not making full use of the resource, other states should be permitted to participate in the harvesting. High seas fish such as tuna, which are not found primarily in coastal waters, would not qualify as coastal stocks.

Differences in the Canadian and U.S. positions regarding "law of the sea" stem mostly from certain responsibilities and interests which the United States, as a major power, judges that it must take into account. These "other" interests sometimes conflict with U.S. fishery interests, conflicts which we seek to resolve. Our Canadian neighbors, with many similar interests in North American fisheries and the security of the North American continent, appear to be less troubled by such conflicts. The discussions among this group could perform a very useful service if they should lead to a better understanding of the respective problems and responsibilities of our two countries, greater reconcilation of our respective positions, and closer cooperation in the intricate maneuvers that will characterize the preparatory work for, and activities during, the coming Law of the Sea Conference.

Problems of the Fisheries in the Atlantic Provinces

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Development of Commercial Fisheries

The commercial fisheries of the Atlantic provinces are our oldest industry, antedating even the fur trade. The fishery resources of the northwest Atlantic have been exploited by expeditions from Europe since the beginning of the 16th century and perhaps earlier. Exploitation from bases ashore began under the French regime, and expansion dates from the spread of settlement in the last half of the 18th century.

Throughout the 19th century, and much later in certain areas, the staple products of the industry were cured (salted and dried) codfish, pickled herring, and latterly canned lobster. Apart from the catch of cod taken by dory schooners ("salt bankers") and their predecessor craft on the offshore grounds, these products were derived from landings by small-boat fishermen operating in waters close to shore. Since the curing process required a large amount of space ashore, and the inshore runs of cod and herring occurred at many points along the coast, fishing communities gradually sprang up throughout the region from the Bay of Fundy to Hamilton Inlet. There were more than 1,000 such communities in Newfoundland-Labrador alone.

Change began in the early years of the present century with the introduction of power in fishing craft. The market for the traditional products of the industry started to contract, a trend that is still in progress; and, beginning in the 1920's (first in southern and western Nova Scotia), a modern processing (filleting and freezing) industry slowly developed—based principally on the stocks of groundfish (cod and related species, flounders and redfish) and dependent more and more on resources offshore, i.e. in international waters.

Modernization and expansion have progressed rapidly since the second World War. The index of production in physical terms indicates a growth of about 60 percent between 1950 (following Newfoundland's entry into Confederation) and 1970. Small-boat fisheries (excepting the lobster fishery) have declined everywhere and have been or are being replaced by operations with larger vessels. The use of power, of electronic fish-finding and catching equipment and the mechanization of operations generally have increased steadily.

The movement of change has been from southwest to northeast, lagging behind similar trends in New England by a decade or more. The remoter areas remain largely untouched by it even yet. It has brought about the rise of certain fishing ports and the decline or disappearance of others, the far-reaching social adjustment that results from technical and economic evolution and the political stresses and strains that accompany such adjustment.

Economic Aspects of Commercial Fisheries

The Resource Base

More than 60 species of fish, shellfish (crustaceans and molluscs) and marine mammals are available in commercially exploitable quantity in the waters adjacent to the Atlantic provinces. Some of these occur in very large quantity: the "standing stock" of cod has been estimated in excess of 3.0 million metric tons, for example, and that of herring at about 1.5 million metric tons. At least 15 species are not exploited at all by the Canadian fleets; fisheries are developing on about 20 species, and the fisheries for another 10 are in a more or less advanced stage of maturity. Some 15 species support fisheries that have become stabilized under regulation or otherwise, and one species is known to have been seriously over-exploited.

Investment and Employment

Investment in the primary industry, i.e. the sector engaged in the catching and landing of fish, approximates $200 million. About 90 percent of this is in fishing craft. There are 30,000 craft in the region, most of which are under 25 tons gross; there are 600 vessels in an intermediate group of 25 to 100 tons and some 350 in a group of large vessels up to 600 tons of thereabouts. The ratio of larger to smaller craft increases continuously.

Information on investment in the secondary and tertiary sectors of the industry (fish processing and distribution) is extremely meagre. Including plant and working capital, it may be as much as $150 million. There are approximately

185 establishments, most of which are relatively small in size: the average number of employees is 50.

Employment in primary fishing operations totals about 40,000. Not more than 6,000 of these are engaged in fishing on a full-time basis, i.e. for ten months or more each year. The rest are evenly divided between part-time (at least five months) and occasional fishermen. The majority of those classified as full-time fishermen are found among the men, numbering 7,000, employed in the fleets operating offshore, i.e. on vessels of 25 gross tons and over.

Employment in fish handling and processing numbers somewhat in excess of 15,000. Among the latter the ratio of female to male workers is approximately 2:3. Excepting southern and western Nova Scotia and the south coast of Newfoundland, this employment is subject to wide seasonal fluctuation.

Market Factors

The great bulk of the products of the commercial fisheries of the Atlantic provinces are exported outside Canada. For the major segments the proportions, in terms of product value, are as follows:

Product Group	% Exported
Cured codfish	90
Chilled and frozen groundfish	85
Lobster and lobster meat	75
Scallop meat	75
Canned herring (including "sardines")	50
Herring meal and oil	45

With the exception of the cured and canned products, 75 to 100 percent of these exports represent sales in the United States.

The lobster and scallop products are luxury commodities and, barring submergence of the affluent society on this continent, the rise in prices that has characterized the trade in these products may be expected to continue indefinitely. The same outlook is visualized for other shellfish fisheries, e.g. crab, shrimp and oyster.

The U.S. market for chilled and frozen groundfish (dressed, filleted, in blocks, etc.) has been subject to periodic crises (occurring roughly every six years) over the past two decades, most recently in 1967-68. To a significant extent, the crises are attributable to the structural deficiencies of the domestic trade described below. With better management of supply on the part of the leading exporters in Canada and Scandinavia, these crises (collapses in price) may be eliminated in the future.

Along with the imminent tightening in groundfish availability throughout the world, the result should be a stable upward trend in prices for some time to come. Not enough is known at present about the relevant demand elasticities to permit a projection of the inclination and duration of such a trend.

Much the same considerations apply in the case of the trade in cured codfish and similar products, which finds its principal outlets in Caribbean and Mediterranean countries. The decline in the world market appears to have halted and this, in association with the supply shortage now anticipated, would suggest a continuous rise in prices—in the immediate future at all events.

As indicated, the products of the herring fishery enjoy a substantial market in Canada. The market for reduction products (meal and oil), however, both domestic and export, is rather precarious because of the presence of competing vegetable products which are subject to considerable variation in availability and price. The domestic demand for "gourmet" products is expanding slowly, and supply shortages in Europe may provide greater opportunity for sales of herring food products to that market.

Structural Factors

Until a few months ago, the herring fishery of the Atlantic coast could be described as a developing fishery. The catches that followed the introduction of improved technology, beginning in 1965, were such as to indicate that virtually virgin stocks were being exploited. Returns to the capital and labor employed were unusually high, and a rapid expansion of supply was achieved with no change in the port-market price level. A falling catch rate is now reported, however, and it appears that the herring fishery, notwithstanding the extent of the natural resource, may have reached maturity in the short space of five years.

The leading commercial fishery of the region, the group of fisheries known as the groundfishery, probably has reached an advanced stage of maturity. Until about 1960, the growth in the demand for groundfish products on this continent had been met by diverting the raw fish supply from curing to filleting-and-freezing. Since then the total supply has been increased year by year. This was accomplished by greater utilization of species other than cod, the Canadian catch of which has remained fairly stable; the intensified exploitation of the cod stocks of the Northwest Atlantic is due to the expansion of fishing operations by European countries.

Mature fisheries tend to be burdened with the results of over-expansion during the earlier

stage of development, e.g. excessively high processing costs due to small operational scale and unsuitable location; and this one is no exception. Although the fishery is prosecuted to an ever-increasing extent by distant-water fleets integrated vertically with firms in the secondary industry, a large proportion of the raw material (especially codfish) is still derived from the widely scattered small-boat fishery.

Horizontal integration is conspicuous by its absence. A few firms (perhaps half a dozen) command adequate resources, but there is a large number of very small operators that depend heavily on the export trade (dominated by powerful importers in the United States) and that lack both financial strength and managerial competence. Many of these provide the sole economic base of certain coastal communities in the region. In contrast with New England, for example, or the Pacific coast of Canada, there are approximately 40 ports in the Atlantic provinces that serve as bases for the offshore groundfishery—not to mention the hundreds of small-boat harbors.

The other major commercial fishery of the Atlantic provinces, the lobster fishery, is a stabilized fishery. Output, i.e. the catch or harvest, has been controlled for many years, with the result that the symptoms of over-crowding and economic waste (rent dissipation) have long been visible in acute degree. The stocks are found mainly in littoral waters and are relatively sedentary. Control has taken the form of regulations to reserve access to fishermen located in the vicinity of specific grounds and to prevent the use of efficient means of capture. There are some deep-water stocks that have not been utilized hitherto and a more remote possibility that, with the continuous rise in price projected for lobster, augmentation of the supply by aquacultural methods may become practicable.

Status in the Regional Economy

The annual output of fishery products in the Atlantic provinces is valued currently at about $275,000,000, distributed as follows (rounded to the nearest five per cent):

Product Group	%
Chilled and frozen groundfish	35
Lobster and lobster meat	15
Scallop meat	10
Cured codfish	5
Canned herring (including "sardines")	5
Herring meal and oil	5
All other	25

The "value added" in the catching and processing of fish is nearly 15 percent of the total for all commodity-producing industries in Nova Scotia and 10 percent in Newfoundland. Almost 20 percent of the labor force is employed in the fishing industry in Newfoundland and 10 percent in the Atlantic provinces generally, excluding Quebec.

Social Aspects of Commercial Fisheries

Management Policy

Although the application of improved technology has been given increasing attention in recent years, resource management in the narrow sense of conservation has tended to be foremost in the minds of fishery administrators in this country.

The principal social objective, if rarely so stated, has been to accommodate as many commercial fishermen as possible, thereby adding to the public cost of protecting the resource. Low mobility, together with a dearth of alternative employment, has contributed to the congestion, as have erratic closures and measures designed to prevent the use of labor-saving devices. As a result the commercial fishing industry tends to be fragmented, lacking in financial, organizational and innovative capacity and dependent on government support for its survival.

In response to pressures for such support, in addition to what might be termed the normal requirements of fishery administration, i.e. research, patrol, inspection and the like, the annual cost of government services for the fisheries has reached a point where it equals 25 percent of the gross value of commercial fishery production in the Atlantic provinces. For Newfoundland separately the figure is close to 35 percent. By far the greater part of this support is provided from federal sources, and most of it is directed toward the primary sector.

The Traditional Industry

The failure of the commercial fisheries in the Atlantic region generally to develop in line with the logic of modern industry, i.e. consolidation to effect locational and scale economies, is attributable in part to certain inhibiting influences, e.g. the wide dispersal of settlement, which is a heritage from the region's past, and the retardation of economic growth which has tended to immobilize the population of the more remote districts especially. In such areas the small-boat fisheries have served to absorb under-employed and surplus labor for generations.

To these forces have been added government programs that tend to work in the same direction, such as financial and other inducements to extend fish-processing operations to outlying

communities, grants and loans for the construction of comparatively small fishing craft and price subsidies in various forms. Despite such props, productivity and morale remain low. The problem is greatest in the far northern areas of Quebec and Newfoundland-Labrador. Altogether perhaps 10,000 fishermen and 25,000 dependents are involved. Annual cash income per household on the average approximates $2,500, more than half of which is obtained in the form of "transfer payments" of one kind or another.

The Modern Industry

This term is not synonymous with the division of the commercial fisheries based on the offshore or deep-sea resources, demersal (groundfishes, crab, shrimp, scallop, etc.) and pelagic (herring, tuna, etc.), but it coincides with it tolerably well. Apart from problems arising from over-expansion and fragmentation, already referred to, the most serious difficulty encountered in this division of the industry at present concerns the manning of the fleets. It is attributable to dissatisfaction with working conditions and, in the groundfishery particularly, unsatisfactory levels of remuneration: a deckhand's earnings average less than $5,000 a year in an extremely arduous occupation. Deterioration in the fishermen's "self image" is also a factor; evidently from being one of the more "glamorous" occupations fishing has dropped to the bottom of the prestige scale. For many years fleet owners were able to recruit from a pool of manpower inured by inheritance to the rigors of deep-sea fishing, but that source has dwindled and the application of modern technology in the fisheries is creating a requirement for different types of skill.

Prospects for Commercial Fisheries

International Resource Management

Excepting lobster, all the important fishery resources of the Atlantic coast are found in the high seas where they are subject to exploitation by the fleets of other countries. The management of these resources has been assigned to an international agency, the International Commission for the Northwest Atlantic Fisheries, established by a convention among most of the nations participating in the fisheries of the area. The attitudes of the parties to the convention (the membership includes 15 nations), reflecting domestic economic and social policies, are not always convergent and agreement on management measures is often difficult to achieve—and, if achieved, to enforce. Essentially the problem arises from the disparate interests of coastal states and of states with distant-water fishing fleets.

Canada has maintained its position in the northwest Atlantic fisheries quite well, despite claims to the contrary. Although the total catch in the Convention Area (in physical terms, i.e. tonnages) has increased by nearly 120 percent over the past 20 years, our share of this total has been constant at about 35 percent. The next largest producer, the USSR, takes approximately 25 percent. Where operations are concentrated on grounds in close proximity to the coast, the proportion taken by the Canadian fleets is much larger: 80 percent in ICNAF Sub-Area 4, which is the Gulf of St. Lawrence and the banks to the east and south of Nova Scotia.

Aside from cod, only 15-20 percent of the total annual catch of which is now taken by our fleets, Canada's position is also comparatively strong with respect to the species in greatest demand in the markets served by the industry in this country. The proportion of the total catch of these species in the Convention Area that is taken by the Canadian fleets is as follows:

Species	%
Plaice	95
Scallop	85
Pollock	80
Salmon	70
Turbot	65
Herring	55-60
Lobster	50-55
Haddock	50
Redfish	50

Moreover, since the above species include lobster, scallop, salmon and haddock, from which higher-priced products are derived, Canada's position is a good deal better than a calculation based on physical data alone would suggest. If quantities were weighted by prices, the landings of species like certain of the hakes and others, which are of considerable importance for the European fleets, would be almost valueless in Canadian port markets.

There is valid cause for concern, however. When management under the International Commission was instituted, in the early 1950s, the catch of groundfish per gross-ton-year in the offshore (otter-trawl) fleet averaged 15,000 lbs. This has declined to a current level of slightly less than 10,000 lbs. Such a trend is characteristic of a maturing fishery, of course. Concomitant with it is a trend toward the capture of younger (smaller) fish, and there is plenty of evidence of this. These trends signal a rise in

both harvesting and processing costs. They may also indicate that production from the stocks hitherto exploited is approaching a limit.*

In that event, the possibility of future expansion would lie in three directions: (1) aquaculture or fish-farming, practicable for some anadromous species such as salmon, much more difficult for estuarine and littoral species like lobster and doubtlessly out of the question for demersal and pelagic species of which cod and herring, respectively, are the most important examples in the present instance; (2) utilization of stocks of substitutable species such as hake for cod and mackerel for herring, a limited possibility; and (3) the capture of a larger share of the catch from certain stocks that are exploited internationally, conceivable in the case of codfish for example. To what extent the price and cost trends of the future would justify development in any of these directions is indeterminate, unfortunately.

International fishery management seems to be approaching a choice between (a) establishment of national catch quotas by a supranational authority and (b) regulation of the fisheries by the coastal states in a position to exercise this prerogative. There are more precedents for the first than for the second alternative, perhaps, but there is evidence also that the special need of coastal states (which is the outstanding example of "historic rights" because the economy of whole regions and not merely of certain ports is involved) is obtaining recognition in the international community. Such recognition probably would be preferable to enforcement of regulations unilaterally by coastal states, which might be effective for fisheries like the groundfishery, but, since assertion of national jurisdiction beyond the continental shelf is hardly conceivable, would not protect Atlantic salmon for example. A system of international management based on one principle for demersal stocks and on another (or others) for anadromous and pelagic stocks might be feasible or it might not. Moreover, one has to consider the interest of the Canadian industry in the fishery resources of continental shelves adjacent to the coasts of other countries: examples are certain stocks of scallop, tunas and, until lately, swordfish.

National Fishery Regulation

Reference has been made to the tendency toward over-investment and employment in mature and stabilized fisheries, attributable to the common-property nature of fishery resources. Maturity and stabilization is the condition ultimately reached in all fisheries. Thus, whether quotas are imposed in the Atlantic groundfishery by international agreement or by the government of Canada acting unilaterally, the end result would be a fixed supply of raw material for the industry and trade.

In the absence of entry control, a scramble for the quota or quotas inevitably would follow—induced by the rise in prices that occurs when a secular growth in demand is associated with an inflexible supply. The regulatory objective in such cases should be to restrict fishing power or capacity to what is actually needed, with given technology, to obtain the available supply at least cost to the industry and to society. Ideally this should be done through the impositon of user charges that in the aggregate would approximate the potential rent of the resources involved.

Regardless of the manner in which a program of this kind may be implemented, the pace of implementation is crucial if unacceptable hardship, caused by the displacement of equipment and manpower, is to be avoided. In the Atlantic provinces, where the "surplus" manpower in the lobster and other small-boat fisheries may be 25,000 or more, the high unemployment rates prevailing generally in the region present a formidable barrier to the pursuit of a national fishery-management policy.

It is obvious that the only permanent solution of the social problem represented by the large group of especially disadvantaged people described earlier is massive re-employment of the majority and an upgrading of the technology available to the remainder. Programs of resettlement and retraining and of financial assistance (loans and subsidies for re-equipment) are ready for these purposes, but as yet the capacity of the regional economy for expansion sufficient to provide employment opportunities on the scale and with the speed necessary is wanting.

A policy of rationalization should be applicable to the secondary and tertiary sectors as well as to the primary sector of the fishing industry. Assuming that exploitation of the groundfish and herring stocks is brought under quota, the future viability of the industry based on the use of these resources depends on its success in controlling production costs, e.g. through mechanization and concentration of fleet and plant operations to maximize economies of location and scale.

A movement in this direction has far-reaching implications. It implies, for example,

*Incidentally, if the estimates of standing stocks of cod and herring mentioned earlier are correct, a current rate of exploitation in excess of 50 percent per annum is indicated for these species. Total production in the Convention Area reached a peak in 1968 and has declined in both subsequent years.

centralization of the offshore fisheries at major fishing ports—perhaps a half dozen at the most—where the necessary ancillary services (required by a relatively sophisticated technology) and an urban labor force may be found. It implies too, probably, a merging of the business enterprises concerned—a development from which problems of monopsony power and consumer protection might emerge.

The question has been settled, for the time being anyway, as regards the cured-fish trade, by the intervention of the Canadian Saltfish Corporation. It is probable that a solution to the problem as it affects other segments of the industry may be found through less drastic institutional innovations.

The situation in general might be ameliorated substantially if the philosophy expressed in the *Coastal Fisheries Protection Act,* which prohibits the landing of foreign-caught fish at Canadian ports except in conditions of distress, were abandoned. Fish handling and processing is much more labor-intensive than the catching of fish in modern fishing operations: the ratio of jobs ashore to jobs at sea is something like 3:1 and this is likely to increase with further fleet mechanization, including a degree at least of automation.

Encouragement for the delivery of raw fish by non-Canadian nationals at ports in the Atlantic provinces, therefore, for processing in bond or on a custom basis, would accomplish three things: (a) it would reduce the need for the Canadian fleets to resort to operations in more distant waters and/or on less accessible stocks, thus incurring the higher costs associated with such operations; (b) it would permit the industry to expand its physical volume of production even when forced to operate under a regime of national quotas; and (c) it would enable the fisheries to provide additional employment opportunities in a region where this has a high priority.

One might even contemplate acquisition of supply for its own market outlets by the industry in Canada if, as a result of subsidization or because of lower opportunity labor costs, landings from foreign fleets were available at comparatively low prices. It would be necessary to ensure continuation of operations by the Canadian fleet, no doubt, as well as the negotiation of contracts on a long-term basis for supplies of foreign origin. Arrangements to avoid infringement of established market shares might be involved. None of these, however, represent insuperable obstacles.

The Recreational Fisheries—Problems and Prospects

The recreational fisheries of the Atlantic provinces are in the main those that have been in existence for a long time. Although tourism is expanding in the region, there has not yet occurred the remarkable growth in sports fishing such as that experienced, for example, on the Pacific coast and in parts of the central regions of Canada. By far the most important resource is Atlantic salmon, which is also exploited commercially. The stocks of trouts and chars, striped bass, pollock and tuna are also utilized for sports purposes.

The salmon stocks have long been threatened by the spread of settlement and industrialization, and more recently by the appearance of a commercial fishery on the high seas. Although these encroachments may be halted, or at least controlled, high public and private costs are involved, and high returns from the use of the resource are required to justify them. Judging from experience in Quebec and New Brunswick, where fishing rights on certain rivers are sold at auction periodically (among the rare instances of such rights being marketed), the long-run returns to society from recreational use of the salmon stocks would far exceed those from their commercial use. To the extent that this is the case they should be allocated for the former use exclusively, as in the case of most of the trouts and chars, and as has been done with salmon in parts of Europe.

Some success is being achieved in salmon farming in the region, and this may provide a means of augmenting supply in the future for both commercial and recreational use. Aquaculture is inapplicable for species such as swordfish, tuna and pollock, and probably even for striped bass.

The list of species, however, and it is by no means exhaustive, suggests the potential of the Atlantic provinces for sports fishery development. Charter-boat services are beginning to make an appearance, with provincial government encouragement, and expansion of such services would provide outlets for small-boat enterprises now crowding the lobster, inshore-cod and other commercial fisheries. Realization of the potential depends on rational management and the extension of supporting infrastructure, such as harbors for pleasure craft, and so on.

The Nature of Offshore Boundaries

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The problem of offshore boundaries is a complex one, involving major policy decisions on the allocation of marine areas, and specific delimitation procedures for laying down baselines along the shore and determining the outer limits of national control. Although the 1958 Geneva Conventions contain specific provisions relating to these problems, there are sufficient gaps in the Convention articles, or differences in interpretation of wording, to permit a variety of national practices even among states signatory to the relevant Conventions. Moreover, in recent years there have been supplementary court decisions, international agreements, and duplicate claims by states which further complicate boundary determination in the sea. Finally, there have been unilateral national assertions of offshore control—made under the general heading of "special circumstances"—which may or may not, with the passage of time, become part of the customary international law of the sea.

This paper deals with the offshore boundary problems affecting the two nations of Anglo-America in the context of what has gone before in the law of the sea, and what the future might hold. I should point out at the start that I do not speak in any way for the United States Government, nor for the Law of the Sea Institute.

There are at least four aspects of the offshore boundary problems of Canada and the United States which, in one way or another, might be said to be controversial. A first involves the territorial sea—both its breadth, and the baselines from which its outer limits are measured. Second are the exclusive fisheries zones beyond territorial limits. Third are what I would call for simplicity's sake "pollution control zones" particularly in the Canadian Arctic. Finally there are the maritime boundaries between Canada and the United States. For the first three categories, controversies arise primarily over Canadian claims; there are, to my knowledge, no important claims by the United States to territorial waters, exclusive fisheries limits, or pollution control zones, to which Canada has strong objections. It should also be noted that one of the principal bases for U.S. objections to the recent extensions of Canada's offshore control may be directed not so much at specific geographic areas or activities which are affected as they are at the precedents which may be set with respect to other parts of the world.

The basic Canadian legislation affecting recent offshore claims is the July 1964 Territorial Sea and Fishing Zones Act, sections 5 and 5a of which permit the subsequent delimitation of straight baselines and outer limits of exclusive fisheries zones along the Canadian coasts. In November 1967 and June 1969 straight baselines were delimited from Cape Chidley, Labrador, to the U.S.-Canadian border, and from Cape Muzon, Alaska, to the Strait of Juan de Fuca. In June of 1970 Canada amended the 1964 Act to extend its territorial breadth from three to twelve miles; at the same time it enacted legislation "to prevent pollution of areas of Arctic waters adjacent to the mainland and islands of the Canadian Arctic." Eight months later the Canadians delimited fisheries closing lines across five water areas—two on the east coast and three on the west.

Let us start with the question of the territorial sea, and specifically with the baselines from which Canada measures these waters. The Geneva Convention on the Territorial Sea and the Contiguous Zone lays down specific rules for delimiting the baseline if the low water line is followed. But the Convention also provides for special situations where a straight baseline regime may be employed "when the coastline is deeply indented or cut into, or if there is a fringe of islands along the coast in its immediate vicinity." The United States, some years ago, made a policy decision not to utilize straight baseline regimes along its own coasts, although in parts of Maine and Alaska such a regime would certainly be justified from the standpoint of coastline configuration. But what the United States has not done subsequently is work out a set of minimum standards for what it deems acceptable for straight baseline regimes off other countries' coasts. Within the United States there are those who would advocate, first, that the Government decide on its own minimum standards of acceptability (it's been twenty years since the Norwegian regime was approved by the International Court); and sec-

ond, that some consideration be given to a form of straight baseline regime off parts of the U.S. coast.

In 1963 a brief was submitted to the Canadian Government by the Fisheries Council of Canada which contained maps showing possible locations of Canadian straight baselines along the east and west coasts. The United States objected strenuously to the suggested lines, particularly in parts of Nova Scotia, Newfoundland, Labrador, and Vancouver Island. Modifications in the lines were made by the Canadians, prior to the enactment of legislation in 1967 and 1969 adopting the straight baseline regime. Some of the specific baselines still might be open to question, as for example in Newfoundland across the entrances to Notre Dame, Placentia, White, and Bonavista Bays.

By extending the breadth of its territorial sea from three to twelve miles last year, Canada joined a growing bloc of countries. According to a recent estimate, of 105 coastal states which have a fixed territorial breadth, 29 claim three miles, 48 claim twelve, 18 have claims between three and twelve, and 10 have claims greater than twelve. But the combination of straight baselines *and* a twelve-mile breadth serves to increase considerably the extent of waters under Canadian jurisdiction. In the Arctic, Canadian territorial waters now close off Barrow Strait connecting Baffin Bay with Viscount Melville Sound; Prince of Wales Strait between Banks and Victoria Islands was already closed off by the three-mile territorial belt.

The delimitation by Canada of straight lines marking the outer limits of exclusive fisheries zones does not directly affect the interests of American (or French) fishermen who have historic fishing rights in Canadian national waters as established by the 1713 Treaty of Utrecht and the 1818 Treaty of London. These lines exist in the Gulf of St. Lawrence, Bay of Fundy, Queen Charlotte Sound, Hecate Strait, and Dixon Entrance. But two points are involved here. First (and hopefully of less importance) is the possibility that in time Canada may seek to phase out or at least modify U.S. historic fishing rights, particularly in those areas beyond Canada's territorial limits but within the exclusive fisheries zones. Such changes could reflect Canadian interpretations of the 18th and 19th century Treaties noted above. Also Canada's action in closing off certain areas to foreign fishermen, even though parts of these are not claimed as historic or territorial waters, may be setting a dangerous precedent for other countries to follow. What are the bases for Canada's actions—geographic configuration, special dependence of coastal communities, or unique dependence of the nation as a whole on fisheries, as Iceland once argued as grounds for special treatment? What is there to prevent other nations from emulating Canada, merely on the grounds of "national interest"?

A third category of offshore extension was the Arctic Waters Pollution Prevention Act of 1970 which established a zone "adjacent to the mainland and islands of the Canadian Arctic within the area enclosed by the sixtieth parallel of north latitude, the one hundred and forty-first meridian of longitude, and a line measured seaward from the nearest Canadian land a distance of one hundred nautical miles . . ."* Within this general area the Governor in Council may prescribe a "shipping safety control zone" within which special regulations pertaining to ships may be applied.

The United States has objected to Canada's "unilateral extensions of jurisdiction on the high seas" and has announced that it "does not recognize any exercise of coastal State jurisdiction over our vessels in the high seas . . . in any area beyond 12 miles." The right of a country to unilaterally establish 100-mile contiguous zones to control pollution through application of its own shipping regulations could again establish a dangerous precedent for other nations to follow. The United States would have preferred "cooperative international action" on the problem, but apparently such a solution was unacceptable to the Canadians who cite the special circumstances of their Arctic environment as grounds for their legislation.

But there are at least four other themes underlying Canadian claims in the Arctic. A first is that Canada may look upon all inter-island waters off its northern coast as internal on the basis of the so-called "archipelago principle." This question was laid aside during the 1958 Geneva deliberations on the grounds that there was insufficient information available to formulate a general proposal, but it subsequently served as the basis for the offshore claims of Indonesia and the Philippines. While such a principle is anathema to the United States with its world-wide maritime and naval interests, it should be noted that in the years since Geneva, very little factual data has been compiled in the United States and elsewhere on the geographic, historical, and legal background of island

*". . . except that in the area between the islands of the Canadian Arctic and Greenland, where the line of equidistance between the islands of the Canadian Arctic and Greenland is less than one hundred nautical miles from the nearest Canadian land, there shall be substituted for the line measured seaward one hundred nautical miles from the nearest Canadian land such line of equidistance."

groups and archipelagoes, and their interests in and claims over inter-island waters.

A related theme is the status of inter-island waters of the Canadian Arctic as "straits which are used for international navigation" and thus subject to the right of innocent passage by foreign ships. This brings up a third (and also related) theme: Does the transport of oil by tankers fall within the category of "innocent passage" or could it be considered as "prejudicial to the peace, good order or security of the coastal state"? Finally a delimitation question: does Canada consider ice islands to constitute part of the mainland from which 100-mile pollution control zones are measured?

In the situations cited above, a basic question is whether the nations of the world should adhere to carefully defined rules designed to preserve as much freedom of the seas as possible, or whether, given the present Geneva Conventions as operative, nations should be permitted additional controls in the sea on the basis of "special circumstances." When, for example, can bays and other coastal waters be closed off as "historic"; when can exclusive fisheries or pollution control zones be established; when can straight baseline regimes be instituted and what are the conditions for individual baseline delimitation? Under what conditions can the inter-island waters of island groups and archipelagoes more than 12 miles from shore be closed off as internal? Perhaps it is already too late in the day for any world-wide agreements to be reached on such matters; an alternative then are regional international agreements—which some say may be the way of the future for most questions on the law of the sea.

A fourth category of U.S.-Canadian maritime boundary problems involves those areas where our coastlines adjoin one another. There are four such areas: on the east coast between Maine and New Brunswick; on the west coast in the Strait of Juan de Fuca between Washington and British Columbia, and to the north between British Columbia and Alaska; and on the north slope between Alaska and Yukon.

There appears at present to be no active controversy on the north slope, and in the Strait of Juan de Fuca there is agreement in principle on the use of an equidistance boundary between the two nations. At Dixon Entrance the Canadians claim that the straight line laid down by the 1903 arbitration between Pearse Channel on the east and Cape Mouzon on the West is the international boundary; whereas the Americans contend that the line was intended merely to separate land areas to the north and south as belonging to the United States and to Canada. Accordingly, the international boundary to the west of Portland inlet should, in the U.S. view, follow a lateral line between Alaskan and Canadian territory.

A more serious controversy exists in the Gulf of Maine and affects offshore concessions and possible oil and gas production on the continental shelf. The Canadian view here is that the boundary between the two countries should follow an equidistance line, while the Americans contend that the shelf is adjacent to the United States mainland and that the interactional boundary should pass through the deepest parts of Jordan, Cromwell, and Georges Basins and the midpoint of Northeast Channel. A related problem is whether the uninhabited Maine Seal Island, south of Grand Manan Island, belongs to the United States or Canada. Here again the principle of "special circumstances" comes in—a principle enunciated, but by no means clearly defined, two years ago in the North Sea Continental Shelf Cases.

Finally, let me cite two possible developments which might take place with respect to Canadian offshore claims. A first is that Canada may extend its pollution control legislation to affect areas along its eastern and western coasts—a move which could be prompted by the construction of an oil pipeline across Alaska to Valdez, and the transport by American supertankers past the coastline of British Columbia down to terminals on the U.S. west coast. (Alternatively, the development of a shipping route across the Northwest Passage and down to terminals in New England could also prompt such action by the Canadian Government.) A second development—one which also could take place in the United States—would be the assertion by Canada of its "preferential rights" to fisheries in its coastal waters beyond national limits. This again might involve the historic rights of American fishermen—or at least some sort of bilateral agreement to protect American interests.

Three sets of interests must be accommodated: national, regional, and world community. There is (or should be) an overall framework of international rules and regulations within which variations in regional and national approaches to offshore control can be set. Recourse to arguments of "special circumstance" is not an ideal solution; rather a global regime should be so constituted as to be able to provide for situations where legitimate special circumstances can be accounted for.

Regional accommodations are also necessary, but care must be taken to utilize viable concepts of regions. Canada, for ex-

ample, is a member of several regions: Anglo America, and the Arctic, North Atlantic and North Pacific Basins. The regional concept in the oceans should be a functional one with different groups making decisions on different activities.

The delegates at Geneva in 1958 tried to establish universal norms for the activities of all countries of the world despite their differences in geography, history, ideology, and levels of economic development. In the years since then, the pressures for ocean development seem to have widened rather than reduced the impact of these differences in the make-up of states. The problems of ocean control which we face here in North America are in a sense a microcosm of the world-wide ocean problems which will soon be confronting the delegates at a new Law of the Sea Conference.

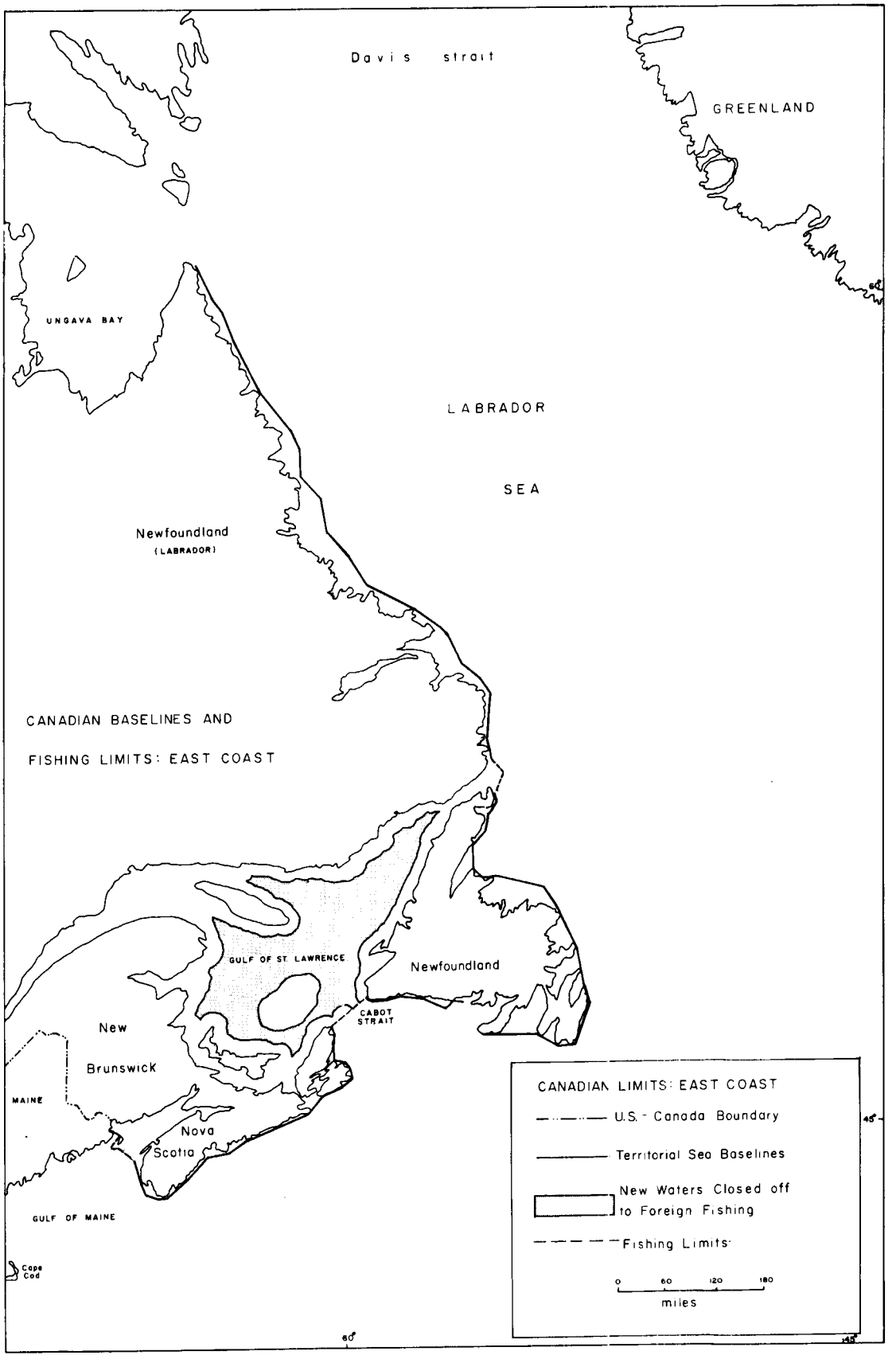

Figure 1. Canadian baselines and limits: east coast.

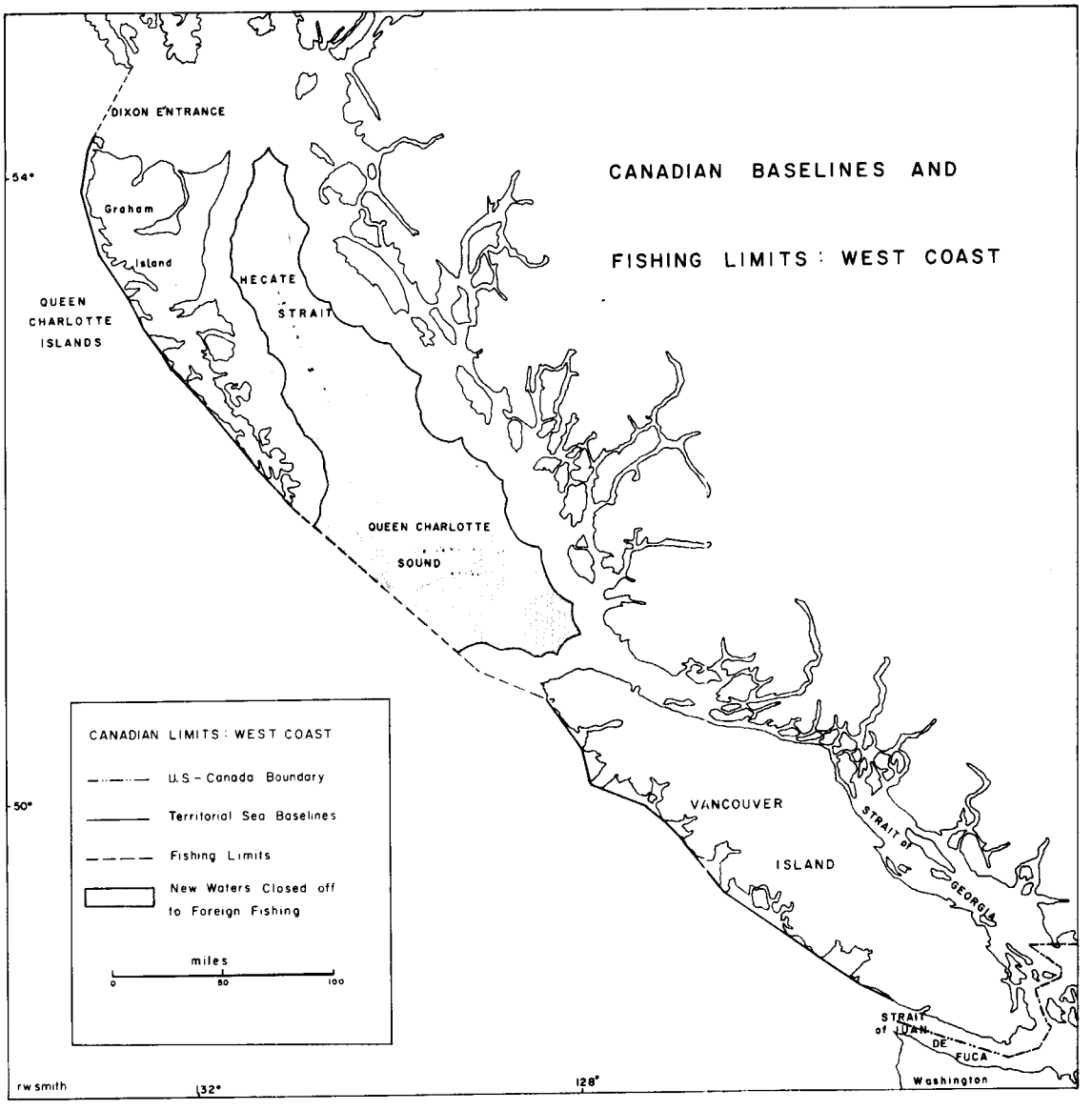

Figure 2. Canadian baselines and limits: west coast.

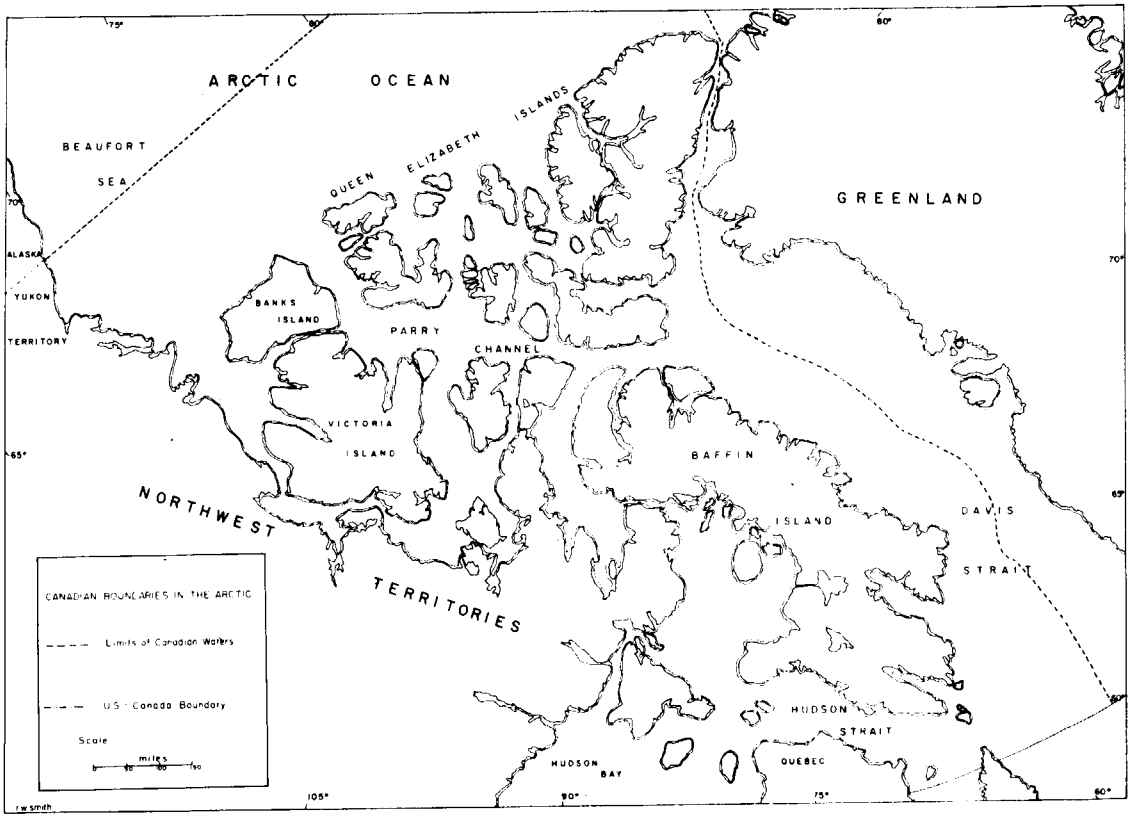

Figure 3. Canadian boundaries in the Arctic.

Recent Canadian Marine Legislation: An Historical Perspective

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The Sea as Space, Resource and Environment

Most international lawyers are classicists, or neoclassicists, at heart. They are vulnerable to the attractions of simplicity, symmetry, clear-cut distinctions, harmony, order and repose. The classical proclivities of the international lawyer shaped the first-order principles of the law of the sea. Even today the crucial concept of balance between inclusive and exclusive authority can be seen as neo-classical, derived directly from the classic contest between Grotius and Selden.

Yet the international society we know today is complex, lopsided, confused, dissonant, disorderly and hectic. In brief, we live in a fitful and intemperate age of political romanticism. The contemporary law of the sea is, therefore, generally conceived as performing a defensive role, restraining dangerous excesses that threaten to disturb the existing balance between shared and unshared authority at sea.

For some the classical tradition goes beyond asserting this kind of balancing role for the law of the sea to maintaining the Grotian or neo-Grotian position that the balance should be kept in favor of shared authority over the largest possible extent of the world's oceans. The freedom of the high seas should be defended against all encroachments. Concessions should be made only in the face of strong evidence of universal consent.

The classical tradition lasted up to World War Two. Until then the international law of the sea was developed within a rather simple framework of concepts. Norms were few and general. Reciprocity and uniformity were the cardinal principles governing the allocation of state authority. The sea itself was a *spatial* concept, global in comprehension. The primary legal issue was the legal *status* of the area in question. For users of the sea—men and vessels—the criterion of nationality provided the link between status and function.

It was natural and easy for states in the classical period to accept one another's claims to possession of exclusive, all-purpose authority in coastal waters. Claims to a uniform seaward extension of territorial integrity were supported by the common need of maritime states to shore up their social, political, military and psychological defenses. National economic interests were also served by the grant of monopoly to the coastal state over the resources within its territorial waters, but for most maritime states economic interest was served much more significantly by the assurance of unimpeded opportunities in the great expanse of the high seas.

After the Second World War cynicism and despair gave way to a measure of confidence and a renewed faith in the prospect of human development. Highly organized and universal devotion to developmental objectives provided a moral climate conducive to acquisitive national philosophies. Partly because acquisitive wars could no longer be tolerated in the international society, the sea became a new frontier, as one after another the maritime states began to stake out their claims to the wealth of the sea. The sea had become a *resource*. A more functional, resource-related approach to the law of the sea fell logically into place. The role of marine resource law was seen, in neoclassical perspective, as that of a restraint on the most excessive acquisitive claims by states to the universal patrimony of marine resources.

Short-sightedly, the neo-Grotians conceded that a national regime over the wealth of the continental shelf was a safe compromise with the proponents of closure; the legitimacy of national development objectives in the sea was accepted uncritically; mineral exploitation of the shelf seemed free of the conservation issues that complicated disputes over renewable resources; the fact of unequal benefit could not be blamed on human choice; and it was a relief, after all, to be able to respond to a claim made by all coastal states on the basis of reciprocity.

By 1958 it was clear that fishery disputes were the most difficult of all marine resource issues to resolve. The new marine technology widened disparities in fishing capability and thereby aggravated the problem of finding a classically simple formula that could accommodate conflicting fishery needs and interests. Since then it has been argued more frequently by fishing states that their fishing needs and interests are unique or special. This alleged loss in comparability

has resulted in a de-emphasis on uniformity and reciprocity and is reflected in a trend away from universal formula to special regime, from special regime to regional organization, from regional organization to bilateral negotiation, and from bilateral negotiation to unilateral assertion. For political, economic, and even scientific reasons, many maritime states are adopting an increasingly particularistic, less widely cooperative approach to their marine needs and interests, an approach that has disturbing diplomatic, legal, and even moral implications.

The latest phase in the history of the law of the sea is of very recent date. The *environmental* crisis is composed of elements that seem to present an opportunity for the neo-Grotians to regroup in defense against expansionist, acquisitive claims by states. Developmental logic is now fashionably suspect. Coordination of resource management policies is a new imperative. Cooperation and the merger of managerial units have already resulted from the acceptance of the need for a new emphasis in comparative studies and an integrative approach to resource policy planning. Whatever the outcome of the forthcoming Stockholm and Geneva Conferences, it is difficult to believe that concern for the state of the biosphere will not have an intellectual impact on the latest attempt to modernize the law of the sea.

The new environmental approach to the law of the sea involves biological or ecological concepts that will replace eventually the purely spatial concepts of the pre-scientific classicists and will modify the economic concepts of the developmentalists. It should not be thought, however, that the environmental approach is hostile to the classical or neo-classical tradition. Balance is the critical concept in ecology. But for environmentalists, balance relates to the preservation of mutually interdependent biological processes, not to the juxtaposition of complementary legal concepts or the moderation of political claims. Legal asymmetry and political immoderation are environmentally dangerous only if they tend to produce an imbalance in biological relationships.

Nor is the environmental approach to the law of the sea opposed to the general need for resource development. But now, at the beginning of the third stage of the law of the sea, we can observe that the sea is dying. The overriding threat now is not so much that of resource depletion through overuse as that of environmental decay through misuse.

Focus on National Marine Policy

If new developments in the law of the sea are to be appraised by environmental criteria, as well as by existing legal and political criteria, then so too must new national claims to maritime jurisdiction. The *Canadian Arctic Waters Pollution Prevention Act* enacted by Parliament in 1970, is a new kind of unilateral national initiative in the law of the sea. Unlike the unilateral national initiatives of the second stage, this Canadian statute is non-acquisitive in purpose: that is, it is not designed to facilitate the acquisition of marine resources by the coastal state in areas beyond the normally accepted limits of the territorial sea. Moreover, it is distinguishable from conservation legislation, for the protective authority claimed extends beyond a single resource, or a single set of resources, to the entire environment. There are, of course, economic reasons for environmental protection in the Arctic, for all users of the region, but these reasons are less immediate and less basic than the biological or ecological.

The unilateral form of the initiative has, unfortunately, distracted attention from the fact that the purpose and the substance of the legislation owe no more to the closed sea philosophy of Selden than to the open sea philosophy of Grotius. It can be argued that Selden's central argument was self-defense, but it is equally true that Grotius' transcendental concern was for the perpetuation of nature in the service of mankind. The issue can no more be resolved in purely spatial terms, than simply by reference to the right of access to scarce resources.

As a claim to environmental authority, the Canadian initiative can be fairly judged only by inquiry into the larger context of emerging Canadian *national marine policy* and by comparison of that policy with the marine policy emerging in other countries. This may sound like a bold and unusual approach in the context of the law of the sea, but it is likely to be regarded as a realistic and conservative approach in the context of international environmental problems. In the environmental stage of the law of the sea it must be questioned whether Geneva logic can afford to be much more restrictive than the logic of Stockholm. In other words, the modernization of the law of the sea in the environmental era should, ideally, be undertaken by national governments in the wake of a massive effort to organize knowledge about the marine environment, it uses and abuses; and a rational, modern international marine policy based on that knowledge is most likely to emerge after a systematic comparison of national marine policies. The usefulness of comparative studies of national marine policies is more evident, however, as an approach to the study of marine disputes, which is a surprisingly

ill-developed study, considering the number of such disputes and their relevance to the development of the law of the sea.

The scope of a study of national marine policy cannot be defined in an arbitrary way. It should in any event vary with the nature and extent of the maritime interests of the state in question. In some cases, however, it may be desirable to inquire into non-policy as well as policy. At the moment, for example, Canada has a merchant marine non-policy that certainly needs to be examined in the context of Canadian national marine policy.

However its scope is to be defined in any one study, "national marine policy" can be regarded as having "soft" and "firm" components. Expressions of policy may range from positions adopted consistently for purposes of diplomatic negotiation though various kinds of government decisions to permanent constitutional requirements. The outside observer's difficulty in discovering the "softer" components of national marine policy may lead him into excessive dependence on the "hard" data provided by national legislation. It should, therefore, be borne in mind that the rest of this paper, focusing on Canadian marine legislation, is likely to be distortive, over-emphasizing the "firmer" components of Canadian marine policy.

The Legislative Component of Canadian Marine Policy

Canadian sea-consciousness is extremely spotty. Beyond the Pacific and Atlantic coastal provinces and outside the marine-related industries, Canadians rarely give thought to the nation's maritime interests. The Canadian naval service is felt to be the offspring of the British naval tradition. With its vast, largely unrealized hinterland, Canada internalizes its expansionist aspirations to a high degree. The Canadian marine economy has never been systematically planned though a single national marine investment policy. On the other hand, the sea has never seemed to threaten the Canadian way of life, even in time of war. As for Canada's Arctic, few citizens considered its maritime aspect before the *Manhattan* voyages. In the environmental period the traditionally casual attitude toward Canadian marine interests is now changing and taking on a protective character, in line with Canadian public attitudes towards the Far North and the Great Lakes Basin. Faced with this change in public sea-consciousness, it is certain that Canadian governments will be encouraged to adopt further protective legislation with respect to the Canadian marine environment.

The nature and extent of Canadian claims to protective environmental authority beyond territorial limits at sea will depend very largely, of course, on the speed and adequacy of international action. It will depend, on the one hand, on the outcome of bilateral diplomacy concerning specific pollution problems, such as Canadian-U.S. negotiations for the establishment of a regulatory regime governing oil tanker traffic in the Northeast Pacific, and possibly in other regions. It will depend also on the outcome of Stockholm, Geneva, and the 1973 IMCO Conference on Marine Pollution. There is already clear evidence that the Canadian government intends to press hard for a comprehensive, scientifically meaningful, international approach to the problems of protecting the total marine environment. To be scientifically meaningful, environmental law has to focus on preventive rather than remedial measures. This approach does, however, involve enormous difficulties, and requires some faith in the scope of political inventiveness and legal imagination. It is likely to fail in the absence of significant international action after Stockholm in dealing with *non-marine* environments.

The Arctic Waters Pollution Prevention Act, the Canada Water Act, recent amendments to the Canada Shipping Act and the Fisheries Act, and (arguably) the Clean Air Act, are all conspicuous examples of new Canadian marine legislation which is environmental in orientation. It would be wholly misleading, however, to suggest that all recent Canadian marine legislation fits this description. The 1970 amendments to the Territorial Sea and Fishing Zones Act and the Fisheries Act were designed to extend Canada's territorial sea from three to twelve miles and to authorize the establishment of exclusive Canadian fishing zones on the high seas in areas adjacent to the new 12-mile territorial sea. The first purpose was to bring Canada into line with most other states though the extension of a *spatial* concept which is becoming less meaningful, in rational terms, under the stress of specific developmental objectives that are now commonly entrusted to separate national or international regimes of a functional nature. The second purpose, of course, was to extend the Canadian national fishery regime under the rubric of national *resource development* policy.

The 1970 extension of Canada's territorial sea did not produce a strong reaction abroad. As an expansionist territorial claim, the amendment to the Territorial Sea and Fishing Zones Act has been less provocative to neo-Grotians than the original statute, enacted in 1964, which took the more controversial step of adopting

straight baselines for the measurement of territorial and fishing limits to close extensive areas off the coasts of British Columbia, Nova Scotia, Newfoundland and Labrador under the regime of internal waters. In 1951 the principle of straight baselines was accepted by the International Court of Justice and applied to the Norwegian coastline. The principle was endorsed in the 1958 Convention on the Territorial Sea and Contiguous Zones and applied to all areas where coasts are heavily indented or where there is a fringe of islands. At the time of writing, straight baselines have been promulgated and applied to only a few sectors in the areas designated in the 1964 Canadian statute. However gradually applied, the Canadian straight baseline policy is in sharp contrast with the present United States practice of keeping the areas of internal waters at a minimum by following the low-water line wherever possible.

Under the 1970 amendment to the 1964 Act, Canada proclaimed "fisheries closing lines" in the Dixon Entrance-Hecate Strait, Queen Charlotte Sound, the Bay of Fundy, and the Gulf of St. Lawrence. The concept of fishery closing lines, pioneered by Canada, originated by analogy with the concept of straight baselines. The Canadian fisheries closing lines, by contrast with straight baselines, do not affect the legal status of the areas enclosed; they relate only to the extent of Canadian fisheries jurisdiction. Closing lines for the designated areas came into existence in February 1971, but it should be noted that the Dixon Entrance line has been regarded in recent U.S. charts (8152 and 8102) that delineate the U.S. territorial sea and contiguous zone.

This resource-oriented, non-territorial claim (to fisheries closing lines) has been described as a measure "to assert Canadian jurisdiction over fisheries conservation and management in an additional 80,000 square miles of coastal waters and to extend those waters the effective range of Canada's anti-pollution programmes." But it is clear that this legislation is primarily an expression of economic interest, rather than of environmental concern. This was implicitly conceded by the Secretary of State for External Affairs and the Minister of Fisheries and Forestry when they announced the government's intention to negotiate the phasing out of fishing activities by countries which have traditionally fished in the areas enclosed within the promulgated fisheries closing lines; namely, Britain, Norway, Denmark, Portugal, Spain, Italy, and France. France, which has treaty rights in specific areas off Canada's east coast, presents a special case. The United States also has treaty rights in the Canadian Atlantic region, but a separate Canadian agreement confirmed that American fishing activities would not be affected by the Canadian fisheries closing lines during the period of the agreement, which is due to expire in 1972.

Canadian Marine Legislation and International Marine Policy

As noted above, legislation represents a relatively "firm" mode of expressing national marine policy. When it purports to have extra-territorial effect, it constitutes a direct affront to Grotian and neo-Grotian predispositions in favor of shared authority over the high seas. When it goes further and purports to extend territorial limits, and thereby the range of national sovereignty, it raises basic questions about the making of international marine policy.

In the early 1970s the Canadian adoption of a 12-mile territorial sea can scarcely be regarded as unusually provocative. The principle objection to this kind of territorial claim is that it is becoming logically unnecessary as the rationale for more extensive claims to national maritime jurisdiction for specific purposes. The extension of a state's territorial sea conceals its real maritime needs and interests and renders its national priorities obscure. It will often tend to result in self-deception as well as concealment and obfuscation. But there is still a substantial symbolic investment in the concept of a territorial sea by states throughout the world and it may still be premature to anticipate its absorption into a system of functional and environmental regimes.

The Canadian adoption of straight baselines is a more controversial piece of legislation. The principle is well established in international law, but the application of the principle to designated areas of the Canadian cost-line and the manner of drawing the baselines are matters that should not be withheld from the jurisdiction of the International Court of Justice. In the absence of effective international controls for the prevention of marine pollution, there is *prima facie* a stronger environmental argument in favor of bringing semi-enclosed coastal waters under the regime of internal waters. It would be interesting to see if the I.C.J. would take notice of such lacunae and go beyond its 1951 *resource* criterion of socio-economic dependence to espousal of the *environmental* principle that the nearest adjacent state has a special responsibility for (as well as a special interest in) the preservation of the marine environment. Once again, however, it should be emphasized that the concept of territory (internal waters) is unnecessary

to justify the exercise of national environmental authority over coastal waters.

The Canadian resort to fisheries closing lines to extend fisheries jurisdiction beyond territorial limits is an interesting device that should be, and is, regarded as preliminary to negotiations with the foreign fishing states that would be affected. How these states respond to this evidence of Canada's policy emphasis on its coastal interests will no doubt be determined by considerations that transcend the limits of "legal policy." The principle of phasing out foreign fishermen over a period of years in favor of the coastal state is a familiar one in the recent histroy of fishery diplomacy. As long as the fisheries closing lines legislation remains anticipatory in character—pending the successful outcome of Canadian phasing out diplomacy—it should be regarded as a less inflexible component of Canadian marine policy than it appears to be in legislative form.

The Canadian marine pollution legislation made applicable beyond territorial limits has to be viewed as part and parcel of a tough, coherent national environmental policy that is now emerging in the newly-created federal Department of Environment. It is believed that the new marine environmental legislation, still in an early stage of evolution, should be regarded as representing a firm and important component of Canadian national marine policy. It is also apparently an area in which Canadian diplomacy is prepared to offer initiatives in promoting international action without prejudice to Canada's own environmental interests.

In conclusion, it seems necessary to comment on the charge that Canada has abandoned its internationalist tradition in maritime affairs. Canada has never been an important flag state. Only in recent years, with growing attention to the policy implications of the nation's maritime needs and interests, has a Canadian government identified closely with the class of coastal states to which it belongs. As a coastal state, Canada can hardly be expected to defend the neo-Grotian tradition at the expense of its coastal interests. The concern should be that a coastal state does not adopt an unreasonable nationalistic marine policy that involves unilateral action and unnecessary encroachments upon the freedom of the high seas. The reasonableness of Canadian national marine policy should be tested by reference to a balance between relatively firm legislative components and relatively flexible diplomatic components. It is still rather early to judge the firmness of the former or the flexibility of the latter, but it should be noted that recent marine legislation at home has not deterred the Canadian Department of External Affairs from adopting an all-inclusive approach to the composition of the agenda for the Third United Nations Conference on the Law of the Sea. In December 1970 the Canadian Representative in the First Committee supported the adoption of an agenda that would include "all the issues to which various states or groups of states attach importance, namely: (a) the breadth of the territorial seas; (b) transit through international straits; (c) the nature and extent of jurisdiction of the coastal state over coastal fisheries; (d) the rights and duties of states with regard to the conservation and management of the living resources of the sea, including in particular the special interests of the coastal states; (e) marine pollution; (f) scientific investigations; (g) the precise definition of the outer limit of the continental shelf; and (h) the international regime, including machinery, for the seabed beyond national jurisdiction."

Whatever positions may be taken on these issues, this all-inclusive approach to the Geneva agenda is hardly that of a maritime state that has lost the faith in international processes of law making.

Third-Party Imitations of Canadian Legislation and the Implications for International Law Development

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The analysis of the implications of third-party imitations leads to very basic and substantial inquiries, none of which are really very original. Certainly one consideration is the probability of such imitations, and another is the merits of the legislation. Beyond that one is almost inescapably drawn to the question of whether the claim[1] is arguably within the scope of recognized international norms. Then there is the vexing worry over whether the more technical approach remains relevant considering today's factual and conceptual realities. Because these questions are extremely troublesome, they cannot here be accorded the full treatment they deserve, and I shall have to satisfy myself with presenting a nucleus for discussion purposes.

The first question is in many ways the most difficult because it is so highly speculative. It is almost impossible to predict the frequency or character of third-party imitations of the Canadian claim. To complicate the matter, it seems proper to consider a broader range of responses than the title would suggest. Thus, we might consider briefly not only imitations by third parties, but extensions, reactions, and apathy as other reasonable consequences. Apathy, I believe, can be dismissed with little discussion. It is highly unlikely in this day that pollution will not muster a sufficient number of opinions to be a major problem. This is not to say, of course, that all will be in favor of pollution control. If apathy were the likely consequence, I doubt very much if we would be meeting today.

Imitation, as the concept is used herein, refers to the duplication of the Canadian claim to increased jurisdiction for the purpose of pollution control by other coastal states. If the imitation is to be a reasonable facsimile, then it will most likely occur because another state can be identified within which the motivating factors are essentially the same. These factors are geographical, historical, economical, political, and ecological. Geography is perhaps the most tangible element, for it has played an important role in the total history of Canada's policy toward her Arctic areas. In the recent legislation, the geographical area delimited for controls is those waters:

> . . . adjacent to the mainland and islands of the Canadian arctic within the area enclosed by the sixtieth parallel of north latitude, and the one hundred and forty-first meridian of longitude and a line measured seaward from the nearest Canadian land a distance of one hundred nautical miles; . . .[2]

The 141st meridian is precisely the limit of Canadian jurisdiction as depicted on a large number of maps; thus the choice should not be considered arbitrary.

The delimitation of a zone for pollution control calls for a review of the general Canadian policy toward broader claims to sovereignty over a sector of the Arctic archipelago. The guidelines for such a sector were described by Ivan Head in 1963:

> An Arctic sector is deceptively simple, and is compounded of only two ingredients: a base line or arc described along the Arctic Circle through territory unquestionably within the jurisdiction of a temporate zone state, and sides defined by meridians of longitude extending from the North Pole south to the most easterly and westerly points on the Arctic Circle pierced by the state.[3]

It is apparent that the key to such a claim is contiguity of the claimant state with the Arctic Circle. If this is true, then exact imitations might come from Norway, Sweden, Russia, the United States, or Denmark. Of these, only the USSR has already advanced an Arctic sector claim.[4] Clearly the United States does not intend to do so; and as for the remaining states, Mr. Head is of the opinion that their geography would not support it. He has written that the archipelago of Canada is:

> well-defined geographically; it is orderly in the sense that its outer limits are unbroken by vagrant islands lying far-distant from the regular and symmetrical shape of the whole. The archipelago forms a natural extension of the continent and shares with it a common continental shelf.[5]

To the extent, then, that the pollution control zone rests upon geographical factors, the possibility of exact determination is highly limited.

Turning very briefly to the other factors, the author must admit that his knowledge of the history, economy, ecology and politics of other Arctic nations make it impossible for him to make a comparative study. Suffice it to say that Canada is ecologically sensitive,[6] highly concerned over the preservation of the Arctic and its inhabitants; not especially concerned with the economic development of the area in question, as would be, for example, the more shipping or oil oriented interests in the United States;[7] and, in developing this legislation, its administration was under considerable political stress.[8] Most, if not all, of these factors would have to be duplicated before a precise imitation could logically be expected.

Extension of the claim into other areas of international law has been of greater concern: some believe it could go far as to lead to open conflict. I will have more to say of this form of acceleration subsequently. However, Leigh Ratiner, a candid spokesman for the U.S. Defense Department, has capsulized this fear in the following manner:

> Unilateral claims tend to exaggerate a coastal State's interest in the sea. In formulating them, nations are not restrained by any concern to accommodate the genuine needs of other nations. Rather, the tendency is to claim all a nation can, short of the point where it will risk serious conflict with more powerful nations. Inherent in the approach is the risk of miscalculation. Ultimately, coastal State unilateral claims may be pushed so far that maritime nations will have to react strongly to protect their most vital interest.[9]

The fear is not simply the extension, but the accelerated extension of coastal state claims. If one is to depart from the rules for ecological reasons, the question goes, what are the limits or what needs are sufficient to justify other departures by other states?

In addition to these worries, the Canadian claim raises considerations with respect to the reaction of non-Arctic states. The United States has been rather unsuccessfully struggling with this sort of question in its attempt to arrive at a proper reaction to the seizure of American tuna boats by certain Latin American nations. Responses in terms of reaction can differ according to whether the reacting nation is deeply involved or underdeveloped, whether it has strong or weak naval interests, or whether it wishes to advance its political or nationalistic aspirations in the world community. Correspondingly, the reactions can range in theory all the way from acquiescence to armed intervention, with the full scale of political, economic, and diplomatic sanctions in between. Fortunately, the reactions to the Canadian legislation thus far have been confined to diplomatic channels and show no prospect for accelerating into other areas pending a better understanding of the problem.

It seems fair to conclude that there is little likelihood of immediate imitation of the Canadian claim, that the reactions will continue to be controlled and intelligent, and that the only avenue of concern is probably a bit of nervousness with respect to the potential for advanced claims to coastal state authority utilizing the Canadian claim as justification.

Moving to the next set of questions, I must establish a frame of reference so that you may all know my prejudices. In considering my attitudes toward the problem, I found myself drawn once again to a passage from Smith's *Jurisprudence*[10] dealing with the proper use of case law in the common law system, which Canada and the United States both share. It seems appropriate to the occasion:

> The rules and principles of case law have never been treated as final truths, but as working hypotheses, continually retested in those great laboratories of the law, the courts of justice. Every new case is an experiment; and if the accepted rule which seems applicable yields a result which is felt to be unjust, the rule is reconsidered.

This portion of the quote reflects quite well my understanding of the Canadian argument in support of Arctic rights. The next sentence is the corollary and appears to summarize the American response, which we all realize was less than enthusiastic:

> It may not be modified at once, for the attempt to do absolute justice in every single case would make the development and maintenance of general rules impossible; . . .

and the closing phrase of this quote may well represent the attitudes of many in this room:

> But if a rule continues to work injustice, it will *eventually* be reformulated. (Emphasis added.)

Today we are in a laboratory similar to that to which the quote refers. We are here to test the validity of the Arctic claim by present standards of international law, the merits of the goals the legislation seeks to achieve, and the

wisdom of the processes selected to advance those merits.

The essence of the Canadian justification has been propounded as follows:

> Canada reserves to itself the same rights as the United States has asserted to determine for itself how best to protect its vital interests, including in particular its national security. Thus the proposed Canadian Arctic Waters Pollution Prevention Legislation constitutes a lawful extension of a limited form of jurisdiction to meet particular dangers, and is of a different order from unilateral interferences with the freedom of the high seas such as, for example, the atomic tests...[11]

and

> The proposed anti-pollution legislation is based on the overriding right of self-defense of coastal states to protect themselves against grave threats to their environment.[12]

Secondarily, the claim is rested upon the implication that Canada has a duty to the world community at large to protect the marine environment of the Canadian Arctic. In the words of the Prime Minister:

> We do not doubt for a moment that the rest of the world will find us at fault, and hold us liable, should we fail to ensure adequate protection of that environment from pollution or artificial deterioration. Canada will not permit this to happen either in the name of freedom of the seas, or in the interests of economic development.[13]

At the heart of this argument lies the notion of international trusteeship, which has been called a new concept in international law reflecting "what most citizens expect of their governments."[14] However this may come to pass in the future, I cannot at this point in our history accept the conclusion that such a trust can be formulated lacking traditionally recognized elements of trusts. Something more at law or in equity is required to create such an arrangement than the mere acceptance of the trust *res* by the prospective trustee, notwithstanding his good motives. In brief, trusts cannot be created by the unilateral act of one party, and I find little evidence of facts that would constitute an international implied trust for the benefit of the rest of the world's population in this instance.

However, the self-defense argument is of a much more substantial nature and should be considered carefully. Many of the arguments in support of the anti-pollution legislation proceed on the basis of the validity of the self-defense claim, yet almost as many have assiduously avoided dealing with the precise nature and elements of that principle in international law. Mr. Legault, speaking before the Law of the Sea Institute at Rhode Island last year, expanded on the basic argument as set forth on April 16:

> In the view of the Canadian Government, a grave danger to the environment of a State constitutes a threat to its security and indeed perhaps to its continued existence. Whether that threat is accidental or deliberate is, after all, a relatively meaningless question once the potential danger has materialized. Thus the Arctic Waters Pollution Legislation constitutes an exercise of the fundamental right of self-defense which lies at the heart of international order.[15]

This exposition reflects a call for the broadening of the traditional doctrine into ecological areas. Assuming one were to desire to take this approach, it seems to me quite clear that he is going to have to come to grips with the difficult problem of how to identify within the Arctic claim the traditional elements that are prerequisites to a recognizable self-defense assertion. Otherwise, should different elements be identified in the process, it can no longer be argued that one is relying on the same principle, however it may be broadened.

The United States, quite like Canada, would be in no position to reject a claim to self-defense out of hand, for as early as 1928 the U.S. went on record as saying that "the right to self-defense is inherent in every sovereign state and implicit in every treaty."[16] But the United States has also been steadfast in adhering to the basic requirement as enunciated in *The Caroline* in 1842.[17] In that case Webster reconfirmed that the utilization of the self-defense justification is restricted to those cases in which the "necessity of that self-defence is instant, overwhelming, and leaving no choice of means, and no moment for deliberation." This qualification has been broadly accepted as the primary prerequisite, and it was applied, for example, during the Nurnberg Trials in answer to Germany's contention that it was compelled to attack Norway to forestall an allied invasion.[18]

To break with that standard now would require much persuasive argument, for nations, following the suggestive language of Smith, ought not to be encouraged toward unilateral solutions in contravention of settled rules. The *Caroline* requirement serves as a preventive against arbitrariness, and its de-emphasis, even in this pressing instance, would reopen most troublesome questions with respect to the more

critical uses of self-defense arguments such as in anticipatory force cases. Henkin, commenting upon the use of anticipatory force, pointed out that:

> The logic of the deterrent and the balance of terror does not suggest that nations should be encouraged to preventive or even preemptive attack . . . to permit anticipation may virtually destroy the rule against using force, leaving it to every nation to claim anticipation and unleash the fury. . . . If a nation is satisfied that another is about to obliterate it, it will not wait. But it has to make that decision on its own awesome responsibility."[19]

The responsibility for anticipatory regulation of pollution is less "awesome" than in Henkin's situation, but it is none the less present. In balance, assuming the self-protection doctrine to embrace ecological threats, the cry of "ecological threat" must be considered of a much less compelling order than armed attack; thus the danger must be shown to be imminent and unavoidable to justify the exercise of unilateral judgment. Current documentation of the threat to the Arctic, though intellectually appealing, does not in my estimation support the need for such a response. It is easy to comprehend how by Canadian standards that conclusion could be reached, but the decision will be judged through other eyes.

Self-defense as described by *The Caroline* is but one exception to the general rule embodied in the *freedom of the seas* doctrine. There are others on a lower level of urgency which the Canadian claim appears to embrace. The April note made reference to United States claims to extended jurisdiction with respect to atomic testing, fisheries, customs enforcement as far seaward as 62 miles, and the Truman Proclamation of 1945. Certainly the international community has given sanction to certain of these lower orders of claims to authority from time to time. Such claims are normally supported on the grounds that they were: (a) necessary, though not perhaps leaving "no moment for deliberation"; (b) limited in time and space; and (c) in most instances restricted with regard to the scope of the regulating authority claimed. As an example of this type of claim, one might examine the U.S. establishment of nuclear test sites during the last three decades.[20] This claim rests one rung below self-defense, and has been described by McDougal as a "claim to prepare for self-defense."[21] The zones were limited in size considering the magnitude of the test, claiming no more than was essential for protection; they were of temporary duration, and were designated as warning areas as opposed to areas of exclusive control.[22] By comparison, the Arctic claim is neither temporary nor limited to warnings, but, considering the rights to exclude[23] or seize[24] upon certain occasions, depicts a much higher order of authoritative claim. On the other hand, it is based on the same order of necessity and there is no claim to sovereign rights. In spite of that, however, it is not easy to overlook the permanency of the claim nor the comprehensive powers granted to the coastal state within the Arctic area.

The Truman Proclamation, the U.S. fisheries claim, and the U.S. customs enforcement legislation fall on a still lower level of consideration, and provide a much more cogent base for comparative argument. Each, however, bears certain distinctive differences from the Canadian legislation. The customs zones have never been a serious point of international conflict because they have not been enforced except against vessels from nations with which the U.S. has had independent understandings.[25] Thus in many ways they are in the same status as the Canadian claim prior to enforcement. It must be readily admitted that such claims to coastal state competence became widespread during the nineteenth century.[26] It must also be said that these claims were based upon the right of the coastal state to protect its exclusive interests. But the key to the comparison, it seems to me, lies in two observations. First, the customs claim of the U.S. reached only vessels having illegal intent. The comparison, therefore, is not apt if we compare oil tankers with vessels smuggling liquor into the United States, which conduct was prohibited, but rather oil tankers with vessels carrying liquor outside of or through U.S. waters. The second observation is linked with the first. The potential for interference with free navigation was much lower, and is now even less, in the case of customs enforcement than with the anti-pollution provisions. Finally, we could rationally conclude even at this late date that such an extensive claim to exclusive authority would be unacceptable as applied to non-consenting nations, and if one were to take that view, such examples should not be asserted as precedent.

The Truman Proclamation and the fisheries claim[27] raise the same order of issues. However, fisheries should be quite readily eliminated from consideration because the concept was not adopted by the U.S. Congress until that body was assured that the exercise of such rights were so widespread in practice as to constitute the acceptance of nations. The Truman Proclamation

can also be distinguished because of its express reservation of rights on the surface:

> The character as high seas of the waters above the continental shelf and the right to their free and unimpeded navigation are in no way thus affected.[28]

Given the *freedom of the seas* as the applicable standard, and I will have more to say of this in a moment, examination shows that the one claim by its terms involves interference with passage of vessels on the high seas while the other expressly excludes that possibility. Of course, there are those in the United States today who believe that the Truman proclamation was unfortunate, excessive, and productive of undesirable consequences.[29] From that point alone it should not be a prime candidate as a precedent.

All of these considerations have led me to conclude that an attempt to justify the anti-pollution legislation either on self-defense grounds, or on the lower level of claims to protect exclusive interests, must fail. Existing principles must take priority because the "attempt to do absolute justice" may only be taken, as Henkin points out, on a nation's "own awesome responsibility."

The matter, of course, is not thereby resolved. Having concluded that existing rules provide no precedent for the Canadian claim, I am compelled to proceed to consider how long we can afford to ignore its merits, and how they might properly be attained. Clearly, principles, such as law, that govern conduct are no more than an articulation of sanctioned responses to operative facts. When one confronts legally similar facts, he is likely to make the same response, and he may expect the same sanctions. If, however, the facts are *not* legally the same as when the sanctions were formulated, he will probably make a different response, and then it remains to decide whether that response will be forever rejected because non-sanctioned, or whether the new response calls for new principles. Thus because we are faced with this type of problem, it seems that we must now consider the Arctic legislation with emphasis on the flux of the law rather than its statics.

We must begin by recognizing with open frankness that the oceans today are not the oceans that Grotius once perceived. The question then becomes whether they have changed sufficiently for us to say that they call for the application of new principles, including those that take into account the exploration and exploitation of deep sea mineral deposits, non-mineral uses, and the environment, factors not even conceivable in Grotius' day when the *freedom of the seas* doctrine was conceived.

Alan Beesley, at a recent meeting of the American Bar Association's Committee on Natural Resources in Houston, called the *freedom of the seas* doctrine to account on this ground. Others have likewise been of the opinion that we have been blind too long to changed circumstances and have done ourselves a disservice by strict adherence to a static principle. Ambassador Pardo, writing for an American law journal, made this observation:

> The first of the [se] fundamental problems concerns the nature of the basic concept that should govern the exploration, use, and exploitation of the seabed beyond national jurisdiction. Will it be the traditional concept of freedom of the high seas, or the new concept of common heritage?[30]

By placing "freedom of the seas" in contraposition with the "common heritage," he makes clear that adherence to the "freedom" doctrine in his estimation is not tenable and might lead to the polarization of future negotiations.[31] In the same vein, Christy has pointed out that the time has come to think of the oceans on more than one level, perhaps separating freedom of access from considerations of distribution of wealth.[32]

Problems related to ocean use have moved beyond considerations of navigation and fisheries alone, which were the uses upon which Grotius based his theory.[33] We cannot now avoid the conclusion that the doctrine must be given new meaning, or, as is often the case with law that remains rigid while circumstances change, it will atrophy and eventually fall useless. In facing this problem of adjustment we need not fear, as some suggest, that there will be substantial detriment to traditional usages such as transportation; for marine transport is a commodity required by all nations, land-locked or coastal, for their continued economic health. No one can seriously suggest, therefore, that Canada or any other nations has as its objective the inculcation of a system that constitutes a disruption of ocean trade routes to the point of crisis.

In this light, it is possible to comprehend that the "law" has already changed—in the sense that the operative facts are different. But it yet remains to find an appropriate mechanism to identify, quantify, and sanction these changes, and that is what is lacking in the present Canadian claim.

In addition to the argument that the claim is acceptable in international law, Canada must have considered the possibility that should the argument not be accepted, the claim would still assist in establishing a pattern for customary

law. However, before there can be a reasonable expectation of uniformity among duplicative claims, we would have to anticipate that the elements motivating Canadian action would be repeated, and the lack of encompassing guidelines relative to the needs of other nations renders the prospect remote.

The alternatives to unilateral action are well recognized, and if we could turn back the clock, they would be worthy of consideration. Widespread international agreement would be preferred, but the Canadian discouragement in I.M.C.O. is at least indicative of the lack of interest in this approach, although that attitude is not surprising considering I.M.C.O.'s historical shipping orientation. I am not, of course, privy to information needed to draw firm conclusions, but one in my position must wonder why, in the face of opposition by the so-called "shipping bloc," Canada did not seek the support of those with similar concerns to hers. Would not a regional position lend more credence than unilateral action, even though it might be subject to the objection that the interests of those nations desiring to utilize Arctic areas for transportation were not considered? Finally, it seems to this observer that if unilateral action was the only route, due to lack of interest or agreement among other nations similarly affected, that action might have been made more palatable by making the rules more proportionate to probable threats, temporary pending more satisfactory arrangements, or less severe in potential impact.

In conclusion, it is unfortunate that Canada and the United States have compounded the problem by taking such intemperate public positions.[34] Negotiation is much more difficult because of them. The future solution to the problem will depend upon the next course of action. One course, naturally, is to do nothing proceeding down the same road. For reasons previously set forth, I find this choice unacceptable. Another is to hope for widespread agreement on the vital issues in 1972 or 1973. Because of the divergence of national views, this solution may well be unacceptable to Canada.

Once again, I am not privy to the negotiations and talks that have been taking place, but I would hope that they would explore alternatives that would ameliorate the present standoff. I would be so bold as to suggest just one. The nations most immediately affected by the enactment of the anti-pollution legislation are obviously Canada and the United States; thus it would seem to be up to them to reach an agreement which will allow the legislation to stand, satisfy U.S. objections to the exercise of Canadian authority, and reduce the possibility of the adverse implications on international law. It seems to me that this could well be done by the establishment of a Joint Canadian-U.S. Commission on Arctic Pollution and Transportation which will have as its goal the establishment of regulations and procedures applicable to vessels of both nations and fair to each. Such a Commission would be patterned after the international Joint Commission established by the Boundary Waters Treaty of 1909, but with greatly expanded powers and responsibilities. The Commission would be, by the terms of the agreement, temporary in nature pending more appropriate arrangements for the Arctic, and it would have the power and resources to conduct the research necessary for the development of cogent regulations pertaining to the transport of oil and other materials in Arctic seas. It should have the power to instigate investigations and refer violations to the appropriate governmental authority; and, of course, supporting legislation should be enacted in the United States to assure prompt and effective action, including appropriate penalties where called for. The enacting legislation should make clear that the guidelines and rules established by the Commission are binding, and arbitration or conciliation may be provided for if advisable. Provision should be made in such agreement for the addition of other parties should that become necessary. In return for the establishment of such Commission, Canada should agree not to implement her own regulations within the area agreed upon by the Commission as to the signatories' vessels.

This is but one of many alternatives to be explored. It seems to me, however, that it should satisfy the immediate objectives of both nations, reserving broader considerations until more data becomes available. Whatever the ultimate choice, one thing is certain. If the U.S.-Canadian tradition cannot provide the atmosphere to resolve such problems, the implications for international law are grave indeed.

Notes

1. For an early analysis of the claim, see Bilder, "The Canadian Pollution Prevention Act: New Stresses on the Law of the Sea," 69 *Mich. L. Rev.* 1 (1970). See also Wilkes, "Control of Pollution in the Canadian Arctic and International Due Process," paper for the Master of Marine Affairs Program, University of Rhode Island (1971); papers by Legault, McCracken, Ratiner and Johnston in *The United Nations and Ocean Management*, Proceedings of the Fifth Annual Conference of the Law of the Sea Institute, June 15-19, 1970 (Univ. of Rhode Island, 1971.)
2. Arctic Waters Pollution Prevention Act, Article 3(1).
3. Ivan Head, "Canadian Claims to Territorial Sover-

eignty in the Arctic Waters," 9 *McGill L. J.* (1963), p. 202-203.

4. Decree of the Presidium of the Central Executive Committee of the Union of Soviet Socialist Republics, April 15, 1926, *Soviet Statutes and Decisions,* Vol. III, No. 4 (Summer 1967), p. 9. See also the discussion in Pharand, "Innocent Passage in the Arctic," 6 *Can. Yrbk. of Int. Law* (1968), p. 28-29.
5. Head, *Op. cit.,* p. 9. See also Pharand, *Op. cit.,* p. 48.
6. See, generally, Wilkes, *Op. cit.* (note 1), and the remarks of Prime Minister Trudeau to the press following the introduction of the legislation on April 8, 1970, 9 *Int'l. Legal Materials* (1970), p. 600.
7. *Ibid.* See also Bilder, *Op. cit.* (note 1).
8. In response to a question, the Prime Minister, on April 8, 1970, responded:

   > I think I've renounced the hope of satisfying those who are critical of this Government from the statements in the House today by the N.D.P. and the Conservatives. It's obvious we're not going to satisfy them. They have been extremely critical in the past because we haven't gone ahead and sort of grabbed the whole Arctic and made a tremendous big grab of all this and saying it's ours.

9. Ratiner, *Op. cit.,* note 1.
10. Smith, *Jurisprudence* 21 (1909); cf. Pound, "Courts and Legislation," 7 *Am. Pol. Sci. Rev.* 361 (1913); Pollock, *Essays in Jurisprudence and Ethics,* (1882), p. 246.
11. Summary of Canadian Note of April 16 Tabled by the Secretary of State for External Affairs in the House April 17, 9 *Int'l. Legal Materials* (1970), p. 608.
12. *Ibid.,* p. 610.
13. House of Commons, October 24, 1969, quoted in Legault, *Op. cit.* note 1, p. 296.
14. Wilkes, *Op. cit.* note 1, p. 22.
15. Legault, *Op. cit.* note 1, p. 297-298.
16. Note of June 23, 1928, *U.S. Foreign Relations,* 1928, 1, p. 91.
17. *The Caroline Case, Moore's Digest of International Law,* Vol. 11, p. 412. The Case involved the destruction of an American vessel in an American port by an armed group acting under orders of a British officer during the Canadian insurrection of 1837. The British Government defended the act on the theory of self-defense.
18. William Bishop, *International Law,* 3rd ed. (Cornell University, 1971), p. 918.
19. Louis Henkin, "Force Intervention and Neutrality in Contemporary International Law," 1963 *A.J.I.L. Proc.,* p. 147.
20. See, generally, Marjorie Whiteman, *Digest of International Law* Washington: Government Printing Office, 1963), p. 546.
21. Myres McDougal, "The Hydrogen Bomb Tests and the International Law of the Sea," 49 A.J.I.L. (1955), p. 356.
22. Whiteman, *Op. cit.*
23. Arctic Waters Pollution Prevention Act, Art. 15(3)(b):

   > A pollution prevention officer may . . . order any ship that is in or near a shipping safety zone to proceed outside such zone in such a manner as he may direct, to remain outside such zone or to anchor in a place selected by him, . . .

24. *Ibid.,* Art. 23(1):

   > . . . a pollution prevention officer . . . may, with the consent of the Governor in Council, seize the ship and its cargo anywhere in the arctic waters or elsewhere in the territorial sea or inland waters of Canada.

25. e.g., Great Britain; see generally, Whiteman, Vol. 4, at 480.
26. See McDougal & Burke, *The Public Order of the Oceans* (New Haven: Yale Univ. Press, 1962) p. 587-589.
27. The original, non-delimited claim was issued in 1945. Proclamation No. 2668, 10 *Fed. Reg.* 12, 304. The most recent policy was enacted in 1965. See 16 U.S.C. §§1091-94, claiming for the U.S. fisheries jurisdiction similar to that enjoyed within the territorial waters to a distance of nine miles beyond those limits.
28. Proclamation No. 2667, Sept. 28, 1945, 10 *Fed. Reg.* 12, p. 303.
29. Ratiner, *Op cit.* note 1, p. 308:

   > Perhaps if the United States had not itself uncorked the bottle and let loose the genie with its 1945 Truman Proclamation, the maritime powers would have held off the rebellion a little bit longer —but when the United States, defender of the 3-mile limit and champion of freedom of the seas, chose to act unilaterally it gave a license—not in the legal sense but in a power-politics sense—to every other nation to make claims of its own if it could make them stick. We tried to have it both ways and we failed.

30. Arvid Pardo, "Development of Ocean Space—An International Dilemma," 31 *L.S.U.L. Rev.* 45 (1970), p. 70.
31. For a more thorough development of this thought, see Clingan, Paper for the Marine Technology Society Law Committee, delivered in Washington, February 1971.
32. F. T. Christy, "Marine Resources and the Freedom of the Seas," 8 *Nat. Res. J.* (1968), p. 424.
33. Hugo Grotius, *Mare Liberum,* 1604:

   > . . . all property is grounded upon occupation which requires that moveables shall be seized and immovable things shall be enclosed; whatever therefore cannot be so seized or enclosed is incapable of being made a subject of property. The vagrant waters of the ocean are thus necessarily free. The right of occupation, again, rests upon the fact that most things become exhausted by promiscuous use and the appropriation consequently is the condition of their utility to human beings. But this is not the case with the sea; it can be exhausted neither by navigation nor by fishing, that is to say, in neither of the two ways which it can be used.

34. See e.g. the U.S. Department of State Press Release No. 121 of April 15, 1970.

The Implications of Canadian Marine and Arctic Legislation for the Development of International Law

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Introduction

The topic which was assigned to me by the organizers of the Seminar is not an easy one and it could be developed at considerable length. However, I shall confine my remarks to three Bills recently adopted by the Canadian Parliament: (1) Amendment to Territorial Sea and Fishing Zones Act (C-203), (2) The Arctic Waters Pollution Prevention Act (C-202) and (3) Amendment to the Canada Shipping Act (C-2).

Before proceeding to comment on these three Bills, it might be helpful to remind ourselves of the role played by international law in the delimitation of sea areas, since all of the three Bills in question pertain to the exercise of jurisdiction by Canada over certain areas of the sea adjacent to its coasts. As was pointed out in the *Anglo-Norwegian Fisheries Case* in 1951 by the International Court of Justice, the act of delimitation of sea areas by the coastal state has always an international aspect of it. Of course, the coastal state is the only one competent to undertake such a delimitation by the adoption of national legislation, but the validity of such delimitation with regard to the other states of the international community depends upon international law.[1] It should not be concluded from this, however, that it is necessary to find some principle of international law which specifically permits such delimitation, but it is sufficient that the delimitation of the sea area in question does not contravene a generally accepted principle of international law. Indeed, the only decision made by the International Court of Justice in the *Anglo-Norwegian Fisheries Case* was that the Norwegian legislation was "not contrary to international law."[2] We must keep this in mind when we proceed to examine the international law implications of the three Canadian Bills to which I have referred and which we will now study very briefly.

Amendment to Territorial Sea and Fishing Zones Act

Main Provisions. The amendment to this Act contains two main provisions: (1) extending Canada's territorial waters from three to 12 miles (section 3) and (2) the creation of new fishing zones by Order-in-Council (section 4). Until then Canada had confined the breadth of its territorial sea to the traditional three miles and had established an exclusive fishing zone of nine miles beyond its territorial sea in 1964. The effect of this new legislation, which came into force on June 26, 1970, is to eliminate the nine-mile fishing zone which now falls within the territorial waters and to create certain special fishing zones in such areas of the sea adjacent to the coasts of Canada as are to be prescribed by Order-in-Council. The four areas specifically mentioned by the Secretary of State for External Affairs, the Honorable Mitchell Sharp, when he moved the second reading of the Bill on April 17, 1970, were the Gulf of St. Lawrence and the Bay of Fundy on the east coast, and Dixon Entrance—Hecate Strait and Queen Charlotte Sound on the west coast.[3] In fact, the promulgation of what are now called "Fisheries Closing Lines," which was announced in the Canada Gazette of December 26, 1970, mentions only the bodies of water specified by the Secretary of State.[4] These fisheries closing lines have become effective upon expiration of the mandatory 60-day waiting period, namely on March 1, 1971.

International Law Implications. Insofar as the extension of Canada's *territorial waters* to 12 miles, there was no opposition on the part of other states that this writer is aware of, except from the United States. Their objection was a somewhat mild one, since it limited itself to saying that they had already indicated their willingness to accept a 12-mile limit, as part of an international treaty which would

provide for the freedom of passage through and over international straits.[5] They were undoubtedly thinking of the effect which the extension of territorial waters would have on the Northwest Passage, which possibly they might have been considering as an international strait. It is a fact that, with the coming into force of this new legislation, there is no longer any strip of high seas throughout the Northwest Passage. Indeed, the distance between Young and Lowther Islands in Barrow Strait being only 15 miles, there is now an overlapping of territorial waters, thus forming a "gateway"[6] at that juncture of the Passage. As for the validity of the 12-mile territorial sea in international law, it is certainly not contrary to any generally accepted principle, since no uniform breadth was ever agreed upon at the 1960 Law of the Sea Conference nor since then. On the contrary, the trend appears to be toward the adoption eventually of the 12-mile limit as the uniform rule. The fact is that some 60 states have already adopted a territorial sea of 12 miles or more, so that there is probably some basis in customary international law for the adoption of such a limit. Furthermore, there seems to be an implied recognition of the validity of a 12-mile territorial sea in article 7 of the *Convention on the Territorial Sea and the Contiguous Zone* of 1958 which provides for a maximum closing line of 24 miles for bays, anything within that line being internal waters. This is all the more significant since the International Law Commission, in its draft convention, had suggested only 15 miles as a closing line, and it was on the proposal of the USSR at the 1958 Conference that the 24-mile closing line was adopted.

As for the new *fisheries closing lines* adopted by Canada for the Gulf of St. Lawrence, the Bay of Fundy, the Dixon Entrance—Hecate Strait and Queen Charlotte Sound, the international law implications would appear more evident. The legal basis for such exclusive fishing areas cannot be the customary international law concept, which has developed since 1960 and which undoubtedly permits states to adopt exclusive fishing zones up to 12 miles from their coast. It is therefore necessary to examine each of the specific areas involved and try to determine what the legal basis or bases could be. Again the United States objected to these fisheries closing lines and stated that the areas affected were "traditionally regarded as the high seas" and considered "this unilateral act as totally without foundation in international law."[7] Before examining the validity of these closing lines, however, it is important to note that Canada had taken two precautionary measures. First, it had concluded on April 24, 1970, a Reciprocal Fishing Privileges Agreement with the United States valid for a period of two years and which, by the way, was renewed for a further period of two years in 1972. Secondly, the announcement of the promulgation of the new fisheries closing lines specified that the government intended to conclude negotiations for the phasing out of the fishing activities of certain countries which had traditionally fished in the areas concerned; namely the United Kingdom, Denmark, France, Italy, Norway, Portugal and Spain. Canada has now concluded such phasing out agreements with all of those countries except Italy, which ceased fishing in those waters in 1964, making it unnecessary to conclude a special phasing out agreement. The agreement with Spain is not quite finalized, but an *ad referendum* basis for agreement has already been reached.

Now let us proceed with an examination of each one of those sea areas. The status of the *Gulf of St. Lawrence* has been the subject of a number of commentaries in the past, particularly since the entry of Newfoundland into confederation in 1949.[8] At that time, Prime Minister St. Laurent stated in the House of Commons that "the waters west of Newfoundland constituting the Gulf of St. Lawrence shall become an inland sea";[9] and, indeed, it has been regarded as such by Canada ever since. The same position was adopted by the Diefenbaker government in 1957,[10] and the External Affairs Department has been giving the same answer to the various inquiries which it has received over the years. Furthermore, it should be stated that the lines drawn across the Cabot and Belle Isle Straits follow the general direction of the coast, as much as it is possible, having regard to the particular geographical configuration of the surrounding territory. It is a fact that, when one looks at a small scale map, the Gulf being surrounded by Canadian territory looks nearly as much as an inland sea as Hudson Bay which has been traditionally so regarded. In addition, one should not forget the really important economic factor involved in the Canadian decision, as well as the general principles of conservation and rational management of living marine resources which apply to all of the areas in question. Having said all this, however, it should be emphasized that Canada did not choose to formally close the Gulf as internal waters but merely to claim the area as an exclusive fishing one.

As for the *Bay of Fundy*, its status in in-

ternational law was fully examined in 1963 by an eminent Canadian jurist who pointed out that as early as 1621, when King James granted to Sir William Alexander the colony which became the provinces of Nova Scotia and New Brunswick, it was so described as to include the Bay of Fundy, and it has been considered as forming part of the internal waters of Canada ever since.[11] This was made quite clear to the Soviet Union by Prime Minister Diefenbaker in November 1962, when a Soviet fishing fleet was advised to leave the Bay.[12] However, Canada did not choose to draw a baseline across the Bay of Fundy but merely a fisheries closing line.

Insofar as the west coast is concerned, the *Dixon Entrance and Hecate Strait* have been claimed by Canada as internal waters since the Award of the Alaska Boundary Tribunal of 1903. The United States, however, disputes the effect of the A-B line across Dixon Entrance as representing a territorial delimitation of Canada under this Award. In other words, it is a question of interpretation of the 1903 Award which is really involved here. More precisely, Canada's claims are on the basis of both history and an arbitral decision. The geographical element is not absent either, since the closing line in question does follow the general direction of the coast, if the Queen Charlotte Islands are considered as mere appendages to the coast proper. In any event, in this third instance again, Canada has chosen to limit itself to claiming Hecate Strait as constituting an exclusive fishing area.

Finally with respect to *Queen Charlotte Sound,* the international law implications are somewhat more pronounced, since those waters have traditionally been regarded as forming part of the high seas and have never been claimed by Canada as historic waters. If Canada were to eventually claim these as internal waters, the only possible basis so far would seem to be the straight baseline system for coastal islands approved by the International Court in the *Anglo-Norwegian Fisheries Case* and incorporated in article 4 of the 1958 Territorial Sea Convention. One would have to determine if the two main geographical criteria would be met in this particular case. The first criterion is that the straight baseline must not depart to an appreciable extent from the general direction of the coast. This would not seem to present any problem. As for the second criterion that the sea area being enclosed is sufficiently closely linked to the land domain to fall under the régime of internal waters, this might present some difficulty since the average distance from the coastline would seem to be some 60 miles. Invoking the *Anglo-Norwegian Case* as a precedent, the baseline across the Lopphavet Basin was only 19 miles from the nearest point on land. As for the length of the closing line which in this case is 97 miles, there is no maximum set by the Territorial Sea Convention of 1958. Using the Lopphavet Basin again as a precedent, the straight baseline in that case was in effect 62 miles when one considers that two of the points were isolated submerging rocks.[13] Whether the International Court would accept the validity of such a straight line for the purpose of enclosing internal waters remains a question. However, here again the only step taken so far by Canada was to declare this sea area as an exclusive fishing zone. The only existing basis in positive international law which may be invoked is the concept of the "special interest" of the coastal state in the maintenance of the productivity of the living resources in areas of the high seas adjacent to its coasts, incorporated in the *Convention on Fishing and Conservation of the Living Resources of the High Seas* of 1958. Of course, this is a considerable extension of that concept and it is one which Canada has been pressing for in the United Nations Seabed Committee, this Committee serving as the preparatory committee for the Third Law of the Sea Conference scheduled to be held in 1973. In this regard, the Head of the Canadian delegation at the Seabed Committee made the following statement on March 15, 1972:

> The coastal state has a special interest in and responsibility for the conservation of the living resources of the sea adjacent to its coast and should have the authority required to manage those resources in a manner consistent with its special interest and responsibility, as well as preferential rights in the harvest of such resources.[14]

In other words, exclusive jurisdiction over fishing resources in order to insure conservation and rational management does not preclude the possibility of sharing fisheries exploitation with other countries. Indeed, the Secretary of State for External Affairs made the following statement in the House of Commons with respect to this question of exclusive fisheries jurisdiction in the areas under consideration:

> That jurisdiction, however, does not rule out the possibility of sharing fisheries exploitation with other countries; it does, however, allow us to set rules for that exploitation, to impose licensing requirements necessary and thus to share the fi-

nancial burden of conservation as well as the financial rewards of exploitation.[15]

It is worthy of notice that the concepts of "special interest" and "preferential rights" of coastal states are gaining considerable recognition in the Seabed Committee, in the light of the growing necessity to take adequate conservation measures to prevent the depletion of certain fish stocks, in particular the anadromous species.

To sum up on the international law implications with respect to Canada's adoption of a 12-mile territorial sea and new fisheries closing lines for certain bodies of water, it may be stated that on the whole this new legislation does not depart appreciably from well-established international law concepts, except perhaps for those relating to the special interest and preferential rights of coastal states relating to fishing.

Arctic Waters Pollution Prevention Act

In spite of considerable objection on the part of the United States, the Canadian Arctic Waters Pollution Prevention legislation was adopted unanimously by the House of Commons and was given royal assent on June 26, 1970. The Act will come into force on a day to be fixed by proclamation, but this date has not yet been fixed. Presumably, the regulations which will accompany the legislation will be promulgated at about the same time.

Main Provisions. In this short presentation, we shall limit ourselves to mentioning the area of application, the type of pollution covered, the nature of the liability envisaged, the safety zones to be established and the powers given to the coastal state.

The *area of application* is the "arctic waters," which are those enclosed in a triangular area having as its southern boundary the 60th parallel, the northeastern boundary starting at the 141st meridian of longitude and running along the coastline of the Canadian Arctic Archipelago, extending 100 miles from the mainland and islands until it reaches the 60th meridian. The eastern boundary is the median line between Greenland and Ellesmere Island and then widening to 100 miles in Baffin Bay until it reaches the 60th parallel. The pollution prevention zone in question, therefore, does not extend to the North Pole as some commentators have interpreted it. The *type of pollution* covered by the legislation is quite comprehensive in nature since "waste" is defined as meaning any substance that, if added to any waters, would degrade their quality to an extent that is detrimental to their use by man, or by animal, fish or plant that is useful to man.

The *nature of the liability* is an absolute one, in the sense that it does not depend upon proof of fault or negligence, and the burden of liability is shared jointly by the ship and cargo owners. The Act envisages the establishment of "shipping safety control zones" by way of regulations. Navigation within those zones will be prohibited by any ship which does not meet certain prescribed standards concerning hull and fuel tank construction, navigational aids, handling of the ship, pilotage, ice-breaker assistance and other standards of a similar nature. The anti-pollution standards which will be spelled out in the regulations will vary from one zone to another, depending on the dangers created by the presence of ice and other dangerous factors in those zones.

The *powers* accorded to Canada as the coast state are quite extensive, since they permit a pollution prevention officer to order a non-complying ship out of any shipping safety control zone and to seize, if necessary, any such ship and its cargo anywhere in the Arctic waters as defined. The coastal state may go so far as to actually destroy a ship if it has reasonable grounds to believe that such a ship within the Arctic waters is in distress, stranded, wrecked, sunk or abandoned, and is actually or likely to pollute the waters in question.

International Law Implications. This legislation brings into play a number of international law principles and concepts such as the freedom of the high seas, the flag state jurisdiction, the right of innocent passage, the right of self-defense and self-protection, and the spatial limitation of contiguous zones, as well as the new concept of environmental integrity.

The *freedom of the high seas* principle is involved if one considers that the Arctic Ocean, as well as the Beaufort Sea of which it is a part, and Baffin Bay constitute high seas. In this writer's opinion the principle of the freedom of the high seas is applicable, but this does not mean that certain limitations ought not to be imposed in its exercise. Surely, the right of any state to use this common and shared resource must be limited by a duty owing to the other members of the international community to make use of it with reasonable regard to the interests and rights of others. In other words the right to freely navigate the oceans does not include the right to pollute them, particularly in an ecologically sensitive area such as the Arctic waters.

As for the principle of the *flag state jurisdiction,* it is true that so far only two major exceptions are provided for in positive interna-

tional law: one relating to slave trade and the other to piracy. All states have a duty to co-operate in the repression of piracy on the high seas, and consequently there is a universal jurisdiction in their favor to seize a pirate ship on the high seas and to deal with it in accordance with their own internal legislation and the generally recognized principles of international law on the matter. It seems to me that there is a certain similarity between piracy and pollution on the high seas, in the sense that both represent a misuse of a common resource which should be used with reasonable care so as to preserve it for the benefit of the international community as a whole. The analogy is of course of partial application only, but it is suggested that the scope of the existing exceptions to the exclusiveness of the flag state jurisdiction should be enlarged and that the universal or protective jurisdiction principle should be extended to include pollution prevention.

The *right of innocent passage* is relevant here since, as was pointed out in discussing the amendment to the *Territorial Sea and Fishing Zones Act,* there now exists a gateway of territorial waters in Barrow Strait halfway through the Northwest Passage, and all of those waters come within the ambit of the Act. Under existing international law, the passage of a foreign ship is innocent so long as it is not prejudicial to the peace, good order or the security of the coastal state. Canada's position is that the present definition of innocent passage is inadequate to cope with the new threat posed by oil tankers. In other words, it is suggested that a restrictive interpretation be given to this principle by restricting the meaning of "innocent" and enlarging the notion of "prejudicial."

The concepts of *self-defense and self-protection* are both involved in the sense that either one or both could be invoked as a basis or bases for the powers accorded to the coastal state in the legislation in question. Canada has chosen to invoke the principle of self-defense in order to justify its anti-pollution legislation in international law. Personally, I believe that this well-established principle in both national and international law presupposes an actual threat or a wrong amounting to a breach of duty to the state alleging self-defense as a basis for its action. I agree with our American colleague, Professor Thomas A. Clingan Jr., that the self-defense argument is rather weak, since it would be difficult, if not impossible, in certain circumstances to identify the traditional elements that are prerequisities to a recognizable self-defense assertion. As an alternative, I believe that the concept of *self-protection,* which is a much wider and flexible one, could serve as an adequate basis for this legislation. This concept, which is often referred to as the "protective principle" is one of the four generally recognized bases for the exercise of state jurisdiction in international law. The right of self-protection is indeed at the basis of most of the instances where coastal states have extended their jurisdiction unilaterally over ships on the high seas within zones contiguous to their coasts. Fairly recent examples of such instances are the *Anti-Smuggling Act* of the United States adopted in 1935, the *Truman Proclamation* of 1945 invoking jurisdiction over the natural resources of the continental shelf, and the *Air Defense Identification Zones* of both the United States and Canada. These are all cases where coastal states have exercised jurisdiction on, under, or over areas of the high seas within zones ranging from 62 to 300 miles from their coasts.

The *spatial limitation* of the anti-pollution zone envisaged by the Canadian legislation also has implications in international law. The contiguous zone envisaged by article 24 of the 1958 Territorial Sea and Contiguous Zone Convention does not envisage pollution prevention measures and extends only to 12 miles beyond the baseline from which the breadth of the territorial waters is measured. However, as was once pointed out by Professor Jessup, later judge of the International Court of Justice, "the rights of self-defense and the protection of the national security are not included" in article 24 of the convention.[16] Those rights exist independently of the convention and may of course extend beyond that limit. Personally, I believe that the limit should depend on the nature and the importance of the interest to be protected. The question arises here as to whether the distance of 100 miles is too great or too narrow. In the opinion of Professor Daniel Wilkes "the 100-mile zone, far from over-reaching itself, is too narrow if the aim is to safeguard the unique ecology of the Arctic."[17] Personally, I believe that it would have been preferable not to mention any specific spatial limitation but to depend on the sound principles of reasonableness and proportionality expounded by Chief Justice Marshall in the old case of *Church and Hubbart*[18] in which he stated that if the means adopted by coastal states "are reasonable and necessary to secure their laws from violation, they will be submitted to."[19] As for the principle of territorial integrity, which is well established in international law, the question arises as to whether it should not include *environmental integrity* as

well. Surely, it is the same concept which is involved but its scope is being enlarged in the light of the growing awareness of the importance of a health environment generally and of a marine environment in particular.

To summarize our comments on the international law implications involved in the Canadian Arctic Waters Pollution Prevention legislation, it can be stated that a good deal of rethinking of traditional international law principles must be done in order to cope with new situations. In essence, we are faced with the problem of striking an equitable balance between the individual right of coastal states to take certain measures to protect their territory and marine environment as against the collective right of the international community to exercise the basic freedoms of the high seas, in particular that of navigation. This is what Professor Myres McDougal calls the "balancing of inclusive and exclusive interests of states in the enjoyment of a great sharable resource."[20] The comment which the learned author goes on to make with respect to the validity of the Canadian Arctic legislation is as follows:

> The Canadian claim to assert competence with respect to ultra-hazardous pollution in a specified zone might . . . be found by appropriate contextual analyses and distinction of different interests to be in accord with the policies which underlie historic assertions of contiguous zones and other extraterritorial competences. Relation to common interest depends upon the degree of danger and the proportionality of the competence asserted.[21]

It is submitted that the Canadian legislation in question is in accord with well established assertions of contiguous zones for similar purposes and that the extent of the competence asserted by the coastal state is proportioned to the degree of the danger involved. Consequently, the common interest of the international community, as a well perceived and long term objective, is properly respected.

Amendment to Canada Shipping Act

The main purpose of this Act is to protect Canadian waters and Canadian fishing zones from pollution by oil from ships. The Act came into force on July 1, 1971, and some regulations have already been promulgated while others are in process of preparation.

Main Provisions. Our remarks will be confined to the geographical area of application of the legislation, the nature of the pollution covered, the type of liability envisaged and the powers of the coastal state.

The *geographical area* application is obviously intended to be complementary to the one covered by the Arctic Waters Pollution Prevention Act. It covers three types of water areas: (1) the Canadian waters south of the 60th parallel, (2) the Canadian waters north of the 60th parallel but not within a shipping safety control zone specified in the regulations made under the Arctic Waters Pollution Prevention Act, and (3) the new fishing zones prescribed in the amendment to the Territorial Sea and Fishing Zones Act, discussed in the first part above. The *type of pollution* envisaged is similar to the one contained in the Arctic legislation. Indeed, the definition of "pollutant" is essentially the same as that of "waste" in the other legislation.

The nature of the liability is an absolute one, in that it does not depend upon proof of fault or negligences. The liability attaches to the owner of the ship carrying a pollutant in bulk and to the owner of the pollutant; they are both jointly and severally liable.

The *powers* of the coastal state are extensive ones and permit a pollution control officer to board a ship and order it out of the waters in question if it does not meet the requirements specified by the regulations. He might also order the ship carrying a pollutant to proceed by prescribed route and order such ship to take part in the cleanup operation if pollution should occur. The coastal state may go so far as to remove or destroy the ship if it has reasonable cause to believe that such a ship is in distress, stranded, wrecked, sunk or abandoned, and is either discharging or likely to discharge a pollutant into the waters covered by the Act.

International Law Implications. The principles of international law do not come into play in the application of this legislation, except insofar as the fishing zones are concerned. As indicated in the first part of this study, Canada has not gone so far as to claim the new fishing zones in question as internal waters or, for that matter, as territorial waters. Consequently, foreign states might well consider some of those areas as high seas, particularly those on the west coast. There is no doubt that this is the position adopted by the United States. Consequently, all of the international law implications discussed above, with the possible exception of the right of innocent passage, are applicable here when discussing the new fishing zones.

Conclusion

It follows from this short study of the marine and Arctic legislation recently adopted by

Canada that there are definite implications for the development of international law. It is submitted, however, that none of those represent a radical departure from established principles and concepts. They constitute rather an extension of those concepts which it would appear reasonable to accept and implement, in the light of a growing need to protect the marine environment and the new threats which the use of modern technology has developed. Insofar as the Arctic legislation is concerned, it is hoped that either the Stockholm conference to be held in June 1972 or the Third Law of the Sea Conference scheduled for 1973, or both of them, will recognize the necessity to embody in treaty form more adequate measures of protection for the coastal state against pollution of its marine environment. It should be pointed out in this regard that the *Report of Inter-Governmental Group on Marine Pollution* at its second session, held in Ottawa in November 1971, contains 23 principles which go a long way to afford a legal basis for the Canadian Arctic legislation. It recognizes in particular that every state has a duty to protect and preserve the marine environment and that states should assume joint responsibility for the preservation of the marine environment beyond the limit of national jurisdiction. In addition, it grants the coastal state the right to take appropriate measures where there is an imminent danger of pollution of its coastline and related interests.

Notes

1. *Anglo-Norwegian Fisheries Case* [1951] I.C.J. 116, at 132.
2. *Ibid.*, at 143.
3. 6 *Can. H.C. Debates* at 6015 (1970).
4. *Ibid.*, Appendix entitled "Promulgation of Fisheries Closing Lines," at 2244-2245; reproduced in 10 *Int'l Legal Materials* 437-438 (1971).
5. See "U.S. Press Release on Canada's Claim to Jurisdiction over Arctic Pollution and Territorial Sea Limits," reproduced as Appendix "A" in 6 *Can. H.C. Debates*, 5923-5924.
6. This was the term used by J.A. Beesley, legal adviser to the Canadian Government, in his testimony before the Standing Committee on External Affairs and National Defence; see *Minutes of Proceedings and Evidence*, No. 25, at 18 (1970).
7. See "United States Statement Concerning Canadian Fishing Zones", 10 *Int'l Legal Materials* 441 (1971).
8. See in particular the following articles by Jacques-Ivan Morin: "Les eaux territoriales du Canada au regard du Droit international," 1 *C.Y.I.L.* 82, at 108-114, (1963); "La zone de pêche exclusive canadienne du Canada," 2 *C.Y.I.L.* 77, at 92-93 (1964); "Le progrès technique, la pollution et l'évolution récente du droit de la mer au Canada, particulierement à l'égard de l'Arctique," 8 *C.Y.I.L.* 158, at 173-183 (1970).
9. 1 *Can. H.C. Debates*, at 368 (1949).
10. G.V. LaForest, "Canadian Inland Waters of the Atlantic Provinces and the Bay of Fundy Incident," 1 *C.Y.I.L.* 149 (1963).
11. *Ibid.*, 149 at 156-157.
12. *Ibid.*, 149-150.
13. See Waldock, "The Anglo-Norwegian Fisheries Case," 28 *B.Y.I.L.* 114 at 146 (1951).
14. See *Statement by Mr. J.A. Beesley, Representative of Canada to the United Nations Seabed Committee, Sub-Committee II, New York, March 15, 1972*, at p. 4 of the mimeographed document distributed to the members of the Committee.
15. 6 *Can. H.C. Debates* at 6016 (1970).
16. Jessup, "The United Nations Conference on the Law of the Sea," 59 *Col. L.R.* 234 at 245.
17. D. Wilkes, "International Administrative Due Process and Control of Pollution—The Canadian Arctic Waters Example," 2 *Journal of Maritime Law and Commerce* 499 at 509-510 (1971).
18. 6 U.S. (2 Cranch) 187 (1804), quoted in L. Hydeman and W. Berman, *International Control of Nuclear Maritime Activities* 227 (1960).
19. *Ibid.*, at 235.
20. McDougall, "The Teaching of International Law," 2 *Georgia J. Int'l & Comp. L.* 111 at 112-113 (1972).
21. *Ibid.*, at 113. For further readings on Canada's anti-pollution legislation, see the following: Bilder, "The Canadian Arctic Waters Pollution Prevention Act: New Stresses on the Law of the Sea," 69 *Mich.L.Rev.* 1 (1960); Pharand, "Oil Pollution Control in the Canadian Arctic," 7 *Texas Int'l L.J.* 46 (1971); Cohen, "The Arctic and the National Interest," 26 *Int'l J.* 52 (1970-71); Carnahan, "The Canadian Arctic Waters Pollution Prevention Act: an Analysis," 31 *Louisiana L. Rev.* 632 (1971); and Green, "International Law and Canada's Anti-Pollution Legislation," 50 *Oregon L. Rev.* (1971).

Rapporteur's Report

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The ground rules for the Workshop specified that no verbatim record of the proceedings would be made and that the function of the rapporteur would be to prepare a report on the "sense of the meeting" on a non-attributable basis.

Inevitably in a short meeting of this kind and given the diversity of disciplines represented in the Workshop, discussion tended to concentrate on the few significant problems which have threatened to cause major political difficulties between the two countires. If, therefore, the balance of this report seems impaired in relation to the more comprehensive coverage of the Workshop agenda, this is but a reflection of the proceedings. The balance is restored by the publication in this volume of the more technical papers prepared for the Workshop.

Workshop Perspectives

It was intended that the Workshop should examine its subjects in two perspectives. First, it should seek to identify the maritime issues of mutual concern to Canada and the United States and, in a process of reciprocal re-education, add to the factual understandings that underlie these issues and which will help to mold the future policies of the two countries. Second, it was intended that the Workshop should assess the likely impact of these policies on the future development of international law.

In endeavoring to distill the "sense of the meeting," the rapporteur has concentrated on reporting the contribution which the Workshop has made in these two directions.

No "Serious Problems"

In the course of the Workshop discussions, one of the participants defined "serious problems" as being, in this context, those which are not capable of resolution by negotiation between the two parties. Perhaps the most striking feature for a neutral observer was the apparent conviction that there are probably no serious problems in this sense between the two countries in the field of the law of the sea; or, that if there are, they will not be acknowledged as such until every possible effort has been made to achieve a meeting of minds. Even in relation to Canadian legislation on fishery closing lines and pollution control in the Arctic, it was clear that, while differences remain, United States objections are concerned far more with the manner of Canada's actions than with their immediate, direct effect on United States interests.

Despite this underlying attitude of good neighborliness and a wide measure of agreement on desirable ends, the discussions did bring out very clearly the factual differences which distinguish the two countries and help to mold national policies and national attitudes and prejudices.

American and Canadian Interests Distinguished

Adjacently situated along a land frontier of continental dimensions and closely linked as allies and trading partners, the two nations are nevertheless separated by significant differences in geographical location, wealth and political power, differences which have resulted in different approaches to maritime questions.

The United States is a major world power operating a very large fleet of vessels, merchant and military, the latter including a nuclear submarine fleet. Canada is not. The United States is a major exporter of investment in offshore development around the world. Canada is not. Such disparities have produced differences in approach and emphasis in such matters as the negotiation of the recently concluded Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction in the Sea-Bed (1971); on the desirable limits of national jurisdiction over submarine resources and on the prevention and control of oil pollution. On the other hand, the two highly developed allies possess very long coastlines and enjoy extensive continental shelves; they are both concerned with protection of their coastal fisheries; they both recognize in principle at least that multilateralism is to be preferred to unilateralism.

One further factor seemed to the rapporteur to permeate the whole of the Workshop's dis-

cussion of Arctic pollution: the contrast between the youthful, impatient originality in Canadian thinking and the conservative, cautious "responsibility" exhibited especially by the more official representation on the American side. The Canadians were clearly very much aware of their increasingly impressive reputation as leaders of constructive thought on marine and environmental questions; of being international legal frontiersmen ready to stretch the law somewhat for the common good as they perceive it; of being prepared to challenge the community of states to re-examine traditional doctrines in the light of contemporary technology, civil and military; of representing the interests of the coastal states against the shipping states.

The American response was to affect incredulity that a power like Canada, widely respected for its internationalism and attachment to the rule of law in international relations, should have departed from the paths of righteousness by espousing unilateralism as a means of changing international law. The point was constantly reiterated, as it has been in other fora, that such a means, however desirable the end, could only encourage other states, perhaps less responsible than Canada, to adopt similar tactics whenever the short-term national interest seemed to demand it.

Philosophical Basis of Canadian Policy

Had the debate on this point proceeded no further, it would have amounted to little more than a restatement of known attitudes. More interesting was the emphasis from Canadian officials and academics alike that Canadian legislative and policy statements are not always what they might seem to be on the surface.

One speaker sought to distinguish between the relatively firm legislative components of Canadian maritime policy and its relatively flexible diplomatic components. Thus, Canadian legislation on fishery closing lines should be judged in the light of the outcome of Canadian phasing-out diplomacy. Similarly, the nature, extent, and speed of implementation of Canadian pollution-control legislation would depend on the speed and adequacy of international action, including, apart from advances on the wider multilateral front, the successful conclusion of Canadian-U.S. negotiations for the establishment of a regulatory regime governing oil tanker traffic in the Northeast Pacific.

Baldly summarized in this way, it might be thought that the Canadian approach involves an element of international bribery and assumes a monopoly of international rectitude.

Perhaps aware that the Canadian approach is open to such charges, both officialdom and academia, well represented in the Workshop, have not been slow to provide a philosophical basis for Canadian claims and proposals. There was much talk in the opening meeting of the Workshop about "unfrocking Grotius"; about the freedom of the high seas and flag state jurisdiction being little more than a license to pollute, to over-fish, to indulge in a marine arms race. Given the lopsided and apparently sacrosanct nature of the current regime of the high seas, there was no alternative, it was argued, but for the coastal state to act unilaterally.

In subsequent meetings, complementary arguments were deployed to show that what was dictated by necessity was also amply justified by consideration for the good of mankind. As the scientists in the Workshop had shown, the Arctic Ocean is a mediterranean sea of global significance, dynamically related to the global ocean and involved in heat and mass exchanges of major importance. Still, the scientific study of the Arctic is in its infancy, the need for more knowledge is urgent and, given the present degree of ignorance, the case for an excess of caution is surely clear. If the international community is unable or unwilling to recognize the dangers, the argument continued, an obligation akin to a trust lies upon the nearest coastal state to protect the general interest. Naturally, it was conceded, limits upon the discretion of the coastal state must be recognized but these might readily be found in the standard of civilization. One contributor went so far as to wonder whether the International Court might not espouse the environmental principle that the nearest adjacent state has a special responsibility for, as well as a special interest in, the preservation of the marine environment. Lying behind this conjecture was the interesting theory that just as the old classical (spatial) approach to the law of the sea was gradually replaced by the post-1945 developmental, resource-oriented approach, so the latter is being overtaken by the environmental approach. If, therefore, the International Court could make reference to the resource criterion of socio-economic dependence in its judgment in the *Fisheries Case* in 1951,[1] could it not similarly refer to environmental criteria today? That the Canadian Government is unwilling to depend on such a development of judicial thinking is clear from its recent declaration under the Optional Clause of the International Court's Statute, whereby the compulsory jurisdiction of the Court is not recognized in relation to disputes concerning the prevention or control of

pollution in marine areas adjacent to the coast of Canada.[2]

"Special Circumstances"

A number of speakers (not all Canadians), defending the Canadian position on protection of the Arctic environment, sought to justify the Canadian approach and the legislation to which it had led, by underlining the special circumstances which existed in the Arctic. They were able to rely on and reemphasize the data presented by some of the scientists among the Workshop participants. In addition to the balanced account on the special problems of the Arctic environment presented in Dr. Britton's paper, they were able to point to the special nature of oil pollution in Arctic waters. For example, the degradation process in the Arctic was reported to take ten years or more as compared with about one year in the tropics and two or more years in Massachusetts. Again, it was shown that heavy North Slope crude oil would tend to spread under the ice. As a result, a mammoth tanker breaking up in the Arctic might produce not a relatively thin oil film, as it would in more temperate climes, but perhaps a pool of oil at the oil-water interface about a mile in radius and about one foot thick.

These reiterated references to special circumstances provoked a varied response. One speaker suggested that it was always possible to argue on the basis of functionalism; that it was difficult to think of any jurisdictional claim which could not be alleged to be justified in terms of "the environment," "functionalism," or "special circumstances." What was important in this speaker's view was to consider the future; to consider what international environmental law was acceptable to Canada; and to consider what in the meantime was to stop others from making similar functional claims.

The Canadian response was to emphasize again their attachment to the ideal of multilateralism in international affairs whenever possible; to stress their refusal to allow irreparable damage to be done to the national heritage and to vital Canadian interests by patient acceptance of international law which was either unsatisfactory or even non-existent; to explain that unilateralism was regarded as a necessary spur to the international community but was not considered to be at odds with their continuing preference for a multilateral approach; to indicate that they were prepared to negotiate with anyone in order to arrive at acceptable multilateral solutions—solutions which might well enable them to abandon their present "go-it-alone" policy.

Complacency Criticized

A refreshingly iconoclastic note was struck by one speaker concerned with the protection of fishery interests. He seriously questioned two propositions, the truth of which many of the Workshop participants had seemed to accept. First, he asked whether it was indeed true that North American energy requirements are as great as is officially claimed. He suggested that the pressing need was to ensure that efficient use was being made of existing supplies. Secondly, and with some force, he sought to demolish the myth as he saw it that United States tankers are operated by competent, concerned people. In his experience and that of his colleagues, they were in fact run by incompetent and under-concerned people.

Other contributors sought to set against the special-environmental-circumstances argument the need-for-fuel argument, stressing the relatively greater security offered by Arctic supplies as compared with overseas imports.

Another speaker pointed out that one must be careful not to cure Arctic problems by exporting pollution from the Arctic to the heavily populated coastal states. As Professors Quirin and Wolff had pointed out in their paper, abandonment of northern supplies would merely mean an increase in ship-borne supplies from overseas with an inevitable pollution product, no matter what precautions might be taken or laws passed.

In this context, another speaker drew attention to the school which Standard Oil has established in France to train tanker personnel, and commented that Liberian flag tankers had the world pollution record per million tons of shipping.

Underlying these and similar comments was the evident feeling that there is too much complacency about the control of oil pollution and a determination not to be fobbed off with international conventions which still deny the coastal state adequate jurisdictional powers of prevention and control, or with lip service to high standards of care by a still careless industry.

Given that many on the Canadian side tended to view the pollution question in this perspective, it was perhaps not surprising that they were less impressed by what some of their American counterparts described as the remarkable progress made by the international community since the Torrey Canyon affair in 1967.

Thus, on the one hand, it could be pointed out that, within the IMCO framework, the London Convention for the Prevention of Pollution of the Sea by Oil, 1954, had been amended in 1969 in recognition of the major contribution which general adoption of the Load-on-Top system would make to the prevention of oil pollution; that in November 1969 the Brussels Conference had succeeded in agreeing on two further Conventions regulating the right of the coastal state to intervene on the high seas in cases of oil pollution casualties and liability for oil pollution damage; and that gradual progress was being made on such related questions as routing of tankers, subdivision of tankers and training of tanker personnel.

On the other hand, it could be stressed that it would not reflect a lack of appreciation of such advances if it were to be pointed out that none of the above mentioned conventional provisions has yet come into force and the new Brussels Conventions were not considered adequate.

Similarly, whereas the one side might point to work being done on marine pollution in preparation for the Human Environment Conference in 1972 and the IMCO Pollution Conference and Law of the Sea Conference in 1973, the other side would acknowledge the opportunities presented by this work but insist nonetheless that the problem is an urgent one and that the coastal state and the marine environment need protection now.

Fishery Problems

The discussion of Canadian-United States fishery problems suggested that the only serious problems which exist are really problems common to the two countries rather than problems between them. It was said, for example, that in the Northwest Atlantic herring fishery, minor Canadian-U.S. irritations soon disappeared in the face of the greater threat from large foreign fleets. Similarly, the crisis in the Georges Bank haddock fishery was caused by the impact of foreign fleets and not by difficulties between Canadian and American fishermen. Again, the problem in the Georges Bank scallop fishery was a mutual overfishing problem.

Developing a theme from his prepared paper, Mr. Herrington argued that the only serious problem was the common one of the decimation of fishery resources along both coasts of North America by the massive fishing power of foreign fleets. His suggested solution was that the coastal state should be given jurisdiction to regulate all fishing for stocks found predominantly in its coastal waters. Such jurisdiction would facilitate the conservation of those stocks, while at the same time recognizing the preferential interest of the coastal state in those stocks so long as full use was being made of the sustainable yield of the fishery.

The discussion made it clear that parallel studies by Canadian Government experts had led them to share the view that "the good of mankind" requires first that stocks must be preserved and that acceptance of the common property concept makes adequate management impossible. There seemed to be some doubt, however, on the American side as to whether the United States Government would feel so ready as the Canadian Government to act on the basis of these conclusions unless it were clear that the promotion of a rational fishery policy in this way was also consistent with wider security interests.

In expressing their sympathy with Mr. Herrington's thinking, Canadian participants drew attention again to the notion of trusteeship which underlies their approach not only to the question of offshore fisheries but also to the control of marine pollution and the exploitation of seabed resources.

Maritime Boundaries

The discussion stimulated by Professor Alexander's paper on "The Nature of Offshore Boundaries" brought to light a number of interesting facts, some of which were clearly new to most of the Workshop participants, irrespective of their national origin.

It was revealed, for example, that a policy decision had been made in the U.S. State Department in the 1950s not to use the straight baseline system for the delimitation of territorial waters. On the other hand, no guidelines had been laid down by reference to which the adoption of straight baseline by other states might be challenged. The problem had not been overlooked. An attempt had been made during the past five years to develop objective guidelines, but so far no satisfactory answer had been found. Every coastline was unique and it had not been possible to find parameters which did not involve subjective judgments. For this reason, it was made clear that the U.S. State Department was not impressed by mathematical models showing the boundary as a function of specified factors. Such a model might produce theoretical certainty and consistency and permit adoption of a policy not to protest bound-

aries set in accordance with the model. In practice, however, subjective judgments always intruded and it was the better policy to eschew generalizations and evaluate each case as it arose.

It was revealed that Canada had received protests from all the NATO Allies against the recently adopted straight baselines. The United States had protested probably more than half of them.

Clear differences of opinion were evident over a number of boundary lines. United States speakers questioned whether the bays of Newfoundland were in fact historic bays and whether the Canadian closing lines were lines closing bays. Responding to a question from a Canadian speaker, a State Department representative declined to take a general position on the acceptability of an 80-mile bay-closing line.

There was also a clear-cut conflict over the delimitation of the Continental Shelf in the Gulf of Maine. The current United States position was stated to be that the Gulf of Maine involves special circumstances. Like the Danish-Dutch-German coast at issue in the *North Sea Continental Shelf Cases*,[3] division of the Gulf on the basis of the equidistance formula would result in inequity. As a result of the concave nature of the coast, an equidistance line would give only about one-half of the Gulf to the United States, despite the fact that the United States coast abutting on the Gulf is eight to nine times longer than that of Canada.

Apparently, this was the first that the Canadian side had heard of this particular version of the "special circumstances" argument relating to the Gulf, and the immediate reaction was to deny the relevance of the North Sea analogy to the Maine coast. Rather revealingly, it was also pointed out that the Canadian Government had been issuing permits in the Gulf area since 1964 and had notified them to the United States Government. The United States response in 1965 had been to express the hope that, in issuing these permits, the Canadian Government was observing the equidistance line. Unfortunately, the United States Government had lost sight of this fact until it was rediscovered in 1970 following a Canadian reminder. The Canadian Government was thus unaware that a dispute existed for about five years after receiving the United States note in 1965.

Doubts were expressed from the Canadian side about the seriousness of the American position on the Maine frontier but it was stressed that the Canadian Government was ready to have the question settled by litigation. The idea of sharing revenues from Gulf exploitation was not found attractive since it would in essence mean merely that the same dispute would have to be determined in a somewhat different context.

Responding to a question about the justification for the fishery limits recently adopted by Canada, a Canadian speaker candidly confessed that while some were based on historic claims, they were also functional claims based on economic interest, and involved an attempt to make new law.

As regards the Canadian Arctic boundary, the hope was expressed on the American side that a map would be produced specifying precisely the boundaries of the Canadian pollution zone established by the 1970 Arctic Waters Pollution Prevention Act.

It was pointed out that sovereignty had not been claimed over the waters of the Arctic archipelago, but this fact failed to impress some American participants who feared that a dangerous "creeping jurisdiction" would result from claims to functional jurisdictions in the archipelago. The Canadian officials remained unrepentant, pointing to the special regime established by the Soviet Union for navigation through the waters to the north of the Soviet Union, a regime also necessitated by the special character of navigation in the Arctic. The idea of a trust for the international community and of obligations upon Canada in respect of international navigation were again stressed.

Finally, a Canadian spokesman asked whether an American protest had been made against the new United Kingdom statute (the Oil in Navigable Waters Act 1971) under which the United Kingdom assumed certain powers of interference with foreign shipping on the high seas in advance of the entry into force of the International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (1969). In the Canadian view, this Act was merely declaratory of rights enjoyed under international customary law. An American official indicated that no protest has been entered against the United Kingdom statute but that the possibility of so doing might still be considered.

Impact on Development of International Law

In informing the Canadian House of Commons of the terms of the new Declaration which the Canadian Government had made under the Optional Clause of the Statute of the International Court of Justice, the Prime Minister described the crucial new reservation inserted in

that Declaration as being intended "to guard against any possible litigation of certain features" of the legislation, then about to be initiated, on the protection of Canada's marine environment and the living resources of the sea. Canada was not prepared, he said, "to engage in litigation with other states concerning vital issues where the law is either inadequate or nonexistent and thus does not provide a firm basis for judicial decision." The new reservation was described as "relating to those areas of the law of the sea which are undeveloped or inadequate."[4]

Elsewhere, the new Canadian legislation has been justified in terms of "the protection of vital interests," "the overriding right of self-defense," and the concept of an international trusteeship. The weakness of these latter arguments was very competently demonstrated in Professor Clingan's Workshop paper and, listening to the contributions of various Canadian participants, it was certainly the Rapporteur's impression that they are not taken very seriously by the Canadian Government. Even in public utterances it is made clear that the views expressed in the above-quoted statement of the Prime Minister more accurately reflect the Canadian Government's greater concern with *lex ferenda* than with *lex lata.*

The unbiased observer might also be forgiven for wondering just how inflexible the Canadian position is on fishery zones and Arctic pollution. The distinction noted above between the firm legislative component and flexible diplomatic component of Canadian marine policy was clearly reflected in several comments made by Canadian speakers in the Workshop, and the impression given was that the Canadian Government finds it more congenial to negotiate from a strong position created by *fait-accompli* type municipal legislation than to work through the available multilateral forms for changing the law.

One must also bear in mind that in the Canadian view, attempts had been made at the Brussels Conference in November 1969 to secure adequate rights for the protection of the coastal state and that the negative response of the "shipping states" had clearly indicated the futility of depending upon established multilateral channels to effect the acceptable minimum changes demanded to protect Canadian vital interests. Given the fact that Canada has earned a reputation for creative internationalist thinking in international organizations and the present state of flux pending the Human Environment Conference (1972) and the IMCO Pollution Conference and United Nations Law of the Sea Conference in 1973, the Canadian position might well have been intentionally exaggerated for public relations purposes in an endeavor to win support from environmentalist world opinion and coastal states.

In the meantime it may well be that individual states will find that a reasonable accommodation of their interests can be achieved by bilateral negotiation or that the adoption of regional policies will be accelerated by the Canadian initiatives. Even if this be so, serious doubts—frequently expressed in the Workshop—will continue to exist over the wisdom of Canadian tactics. These doubts relate to the long-term effect on the processes of peaceful change both in the law of the sea and in international law more generally.

As regards the law of the sea, the Canadian attitude is regarded by some as tantamount to raising the concept of "special circumstances" from the status of an exception to that of a general basis of policy; and, perhaps more seriously, of denying the international community the opportunity to test the validity of unilateral determinations of the existence of such special circumstances by reference to international law.

As regards international law more generally, it is of course well known that advances in international customary law may be achieved or international conventional change inspired by unilateral claims which are gradually emulated and/or acquiesced in by the generality of states. Whether in this case there exists, or shortly will exist, a consensus of state opinion on the desirability of remolding parts of the law of the sea on the basis of the concept of international trusteeship is a matter on which judgment may differ; in its absence, customary norms will not mature and Canada will need a different foundation for its functionally-oriented claims.

In reporting the sense of the meeting in the Workshop on this question, it can only be said that no American voice was heard to offer any evidence for the existence, embryonic or mature, of the notion of trusteeship in relation to Arctic jurisdiction. The same could not be said of fishery jurisdiction, however. Whether reflecting official thinking or not, many American speakers expressed a clear preference for wider fishery zones designed to facilitate rational management (performed perhaps in trust) but not necessarily involving the exclusion of foreign interests in the exploitation of the fishery. It should also be stressed that the Canadian thinking on trusteeship is quite consistent with at least one interpretation of the notion of "the common heritage of mankind," a concept

which may well be destined to work radical changes in the traditional law of the sea.

The Sense of the Meeting

It may be appropriate to conclude with a few general remarks which sum up the sense of the meeting.

The most lasting impression for a "neutral" observer was the remarkable demonstration of the principle of goodneighborliness in action. Speakers on both sides clearly found little difficulty in indulging in a role-reversal exercise and thereby understanding fully, while still not accepting, the thinking of the other side. There was a manifest reluctance to consider any of the conflicts dividing the two countries as "serious" or non-negotiable and an obvious desire to assist in the search for alternative policies which might accommodate the "vital interests" of one side or the other.

A second impression was that all participants found the Workshop to be an invaluable experiment in creating an environment founded on faith in the value of academic/official cross-fertilization and permitting "a full and frank exchange of views" between officials of the two governments to be observed and contributed to by academics and representatives of various interest groups.

The extent to which this exchange of views may have influenced the policies of the two countries is difficult to assess, since one is of course uninformed on the details of the negotiations which are more or less constantly proceeding on the official level. The fact, however, that Canadian officials were clearly unaware of the current American thinking on the application of the "special circumstances" argument to the boundary problem in the Gulf of Maine suggests that such meetings are valuable even on the purely factual-information level. The mood pervading the exchanges in the Workshop suggests that such meetings are even more useful as a contribution to the process of solving disputes by negotiation and making a reality of the principle of goodneighborliness. Many of the participants in the Workshop would not normally be directly involved in intergovernmental negotiations or would be so on particular issues only; some of them, most of them perhaps, would, however, make a contribution at the formative stage of national policies. The opportunity to view the marine policies of the two countries in a wider perspective and to exchange views with their counterparts in the public or private sectors could surely only contribute to their understanding of the other side's viewpoint, and thus better qualify them to advise in the future.

On the other hand, it was clear that the main lines of Canadian policy are firmly set, and unlikely to be substantially modified in the short term. The Canadian Government has a firm commitment to a creative leadership role, based on the need for a functional, pluralistic approach to the law of the sea as opposed to the more traditional gradualist multilateral approach. There was a feeling among some of the Workshop participants that, like all pioneers, the Canadian Government had become somewhat obsessed with particular issues and approaches to their solution, and in the process did less than justice to the continuing efforts of others to solve these problems by different means.

Finally, departing, with consent, from the rule on non-attribution in accordance with which this report has been prepared, it may be fitting to conclude with a few lines which Professor R.R. Baxter was moved to pen during the Workshop—not only lest they might otherwise bloom unseen but because they reflect the closeness of the relations between the two countries of Anglo-America and the good humor with which the Workshop was conducted:

> Canada had a little environment
> It used to be white as snow
> And everywhere that Canada went
> The environment's sure to go!

Notes

1. *Fisheries Case, I.C.J. Reports* 1951, p. 116.
2. International Court of Justice, *Yearbook 1969-1970*, p. 55-56.
3. *North Sea Continental Shelf*, Judgment, *I.C.J. Reports*, 1969, p. 3.
4. House of Commons Debate (Canada), April 8, 1970, p. 5623-5624.