THE WEST COAST OIL THREAT IN PERSPECTIVE

An Assessment of the Natural Resource, Social and Economic Impacts of Marine Oil Transport In Southwest B.C. Coastal Waters

Volume I

Summary, Conclusions and Recommendations

prepared for

ENVIRONMENT CANADA

by

HOWARD PAISH & ASSOCIATES LTD.
Environmental and Resource Management Consultants

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PREFACE

This first volume of the study report "The West Coast Oil Threat in Perspective" is intended to serve as a summary document, with all the limitations that any summary entails.

It contains the foreword, introduction, conclusions and recommendations of the final report in their entirety. The detailed technical content of the chapters of the full report have been condensed to provide some background to the conclusions we have reached. In this summary we have of necessity compromised between omitting details and watering them down to the point that they are misleading. We trust that the reader will bear this constraint in mind and, if more details from either maps or technical data from specific chapters are required, we recommend the reader consult the full report.

FOREWORD

As the final sections of this report are being written - in mid-March, 1972 - a Panamanian freighter bound for Vancouver with a load of Japanese automobiles is aground on the rocky shoreline of Austin Island adjacent to the newly established Pacific Rim National Park (Refer to Study Area Base Map). The vessel ran aground in typical weather for this time of year late on the evening of March 14. It was badly holed and approximately 450 tons of bunker fuel and unknown quantities of diesel and lubricating oil were released. Some of this oil has already ended up on the rocky shorelines of Austin and adjacent islands. Attempts are being made to contain and remove the oil slicks that are still on the water as a result of that wreck.

This 450 ton spill, which has already prompted widespread attention on the west coast and has proved to be the first real testing ground for oil spill contingency planning on this coast, represents less than a two hundred and fiftieth part of the total cargo of one of the supertankers that will start to operate on the Cherry Point tanker route at a rate of one per month in 1972. Regardless of Alaska crude, which would not be shipped to Cherry Point before 1975, one and a half million tons of crude oil will come to the Cherry Point in foreign flag tankers in 1972, 1973 and 1974. From then on, shipments of Alaska crude would lead to an average one 120,000 ton capacity American flag tanker coming to Cherry Point every five days.

Four hundred and fifty tons of oil represent a fraction of the spill that can be anticipated through a tanker grounding or through a collision between a tanker and one of the 7,500 major ocean-going vessels that enter the Puget Sound-Strait of Georgia area via the Strait of Juan de Fuca every year.

The grounding of the Vanlene is the fourth incident that we have had a chance to observe within our West Coast - Juan de Fuca-Strait of Georgia study area during the short time that this study has been underway.

On December 14, 1971, a self- admitted human error during the course of pumping operations from a half million gallon capacity barge to shore-side tanks at Lang Bay near Powell River resulted in the accidental spillage of nearly 9,000 gallons of gasoline.

On March 10, 1972, 1,000 gallons - less than 5 tons - of bunker oil was spilled from a Canadian forces vessel at Nanoose Bay on Vancouver Island. A lucky combination of tidal conditions and the presence of a readily available clean-up force of 300 servicemen made a quick clean-up possible. However, even that comparatively tiny spill took two days to clean up and has resulted in the closure of commercial oyster harvesting.

Only a few days later, on March 18, an unkown amount of oil going through refinery operations spilled from the Standard Oil refinery on Burrard Inlet. The spokesman for the oil company was quoted as saying: "We know the cause; it's one of these things you can't do anything about - it was a mechanical failure, not a case of carelessness."

Four incidents within four months, and each a question of human error or mechanical failure.

Each of these spills represents but a minute fraction of the amount of oil that will actually be spilled in a tanker collision or grounding along the super-tanker route from the open Pacific to Cherry Point.

This comment on four incidents that have occurred while we have been undertaking a predictive study on an oil transportation system that is yet to go into operation, provides the very real day-by-day backdrop to the report that follows.

CHAPTER I - INTRODUCTION

A. THE CONTEXT OF THE PROBLEM

Man has been transporting crude oil and petroleum products by sea for over fifty years, yet only in the past five has he really become conscious of the actual and potential impact of oil spills on the marine environment.

Obviously, one of the key factors in this awareness of the environmental dangers of oil spills is the growing world-wide concern for the impact of man's activity on his environment. Coincidental with this growing concern, and part of its cause, is the technological change that is taking place in oil transportation. For years we have been transporting oil cargoes in relatively small tankers with capacities in the 10,000 to 20,000 ton range. However, during the past ten years, we have seen the emergence of the supertankers - vessels with capacities measured in hundred thousands of tons - and a consequent drastic increase in the potential damage from spillage, yet with relatively few technological advances in operational capability to offset the potential dangers that spillage of these immense cargoes poses.

1. Torrey Canyon

Against this general background of increased environmental awareness and advances in the economically expedient facets of tanker technology, the Torrey Canyon went aground on the southwest shore of the British Isles in 1967. This one incident, more than anything else, focussed world attention on the dangers inherent in large-scale ocean transportation of oil and petroleum products.

Although spills had occurred prior to the Torrey Canyon, this one, the largest in history, happened on the shorelines of a major maritime nation and affected both British and French coastlines. Perhaps most significant, it occurred on the shores of an advanced modern country with an alert news media able to focus attention on the problem, a well-established scientific community able to document the immediate and long-term impacts of the spill, and a technological strength capable of responding to the urgency of the problem.

2. Chedabucto

This broad world-wide concern was brought home to Canada in February, 1970, when the Arrow, a relatively small tanker of 18,000 tons, grounded and broke in two off Chedabucto Bay in Nova Scotia, spilling some 10,000 tons of heavy bunker oil on adjacent shorelines. After a slow start, a major, well-documented clean-up operation was initiated by the Canadian Ministry of Transport in close cooperation with other Canadian government departments, resulting in a report entitled, "Operation Oil". We have found it of invaluable guidance for our study and have appended its summary of recommendations in Appendix E of this report.

The Arrow incident coincided closely with the voyage of the Manhattan through arctic waters to evaluate the feasibility of transporting oil through arctic waters and had a significant impact on regulations to protect Canada's shorelines, particularly in the arctic, from the dangers of oil spillage.

3. Alaska Oil

Late in 1970, government officials and conservation groups in British

Columbia rather suddenly became aware of the potential threat to marine and shoreline resources on the west coast from plans to ship Alaska oil by tanker from Valdez to a refinery at Cherry Point, near Bellingham. It became apparent later that regardless of Alaska oil, crude would be coming to Cherry Point, by supertanker. The route for this trans-shipment would run adjacent to Canadian territorial waters in an area where arbitrary straight-line maritime boundaries are academic anyway. Canadians realized that a large oil spill anywhere along the tanker route from S. W. Vancouver Island to Cherry Point, regardless of its position in relation to the international boundary, had major implications for Canadian marine resources and shorelines, as tidal currents and winds have no regard for international boundaries.

Probably because of the major concentration of interest by American officials on the pipeline route across Alaska and the fact that a route across Canada was also being suggested as a possible oil pipeline location, Canadians had at first concentrated most of their interest on the overland implications of oil transportation. However, some of this concern soon shifted to the tanker route as the public became more conscious of the hazards of marine oil transportation.

B. THE LIMITS OF THE STUDY

It is within this context, then, that this study began.

In its very simplest terms, the study sets out "to assess and evaluate the socio-economic implications on the marine environment of oil transportation and possible oil spills in the S. W. Vancouver Island - Juan de Fuca - Strait of Georgia region."

The term, "socio-economic" is a jargon way of asking, "What would be the effects on people?" So much of the work on oil studies to date has concentrated solely on the physical effects of oil spills on marine resources and on the clean-up measures that could be undertaken. In almost all of the literature on oil spills apart from the Chedabucto report, the implications for people from both an economic and life-style standpoint, have been dealt with almost incidentally. Of course, any valid assessment of the impact of oil spills on people must be predicated on sound basic knowledge of the physical and biological implications of those spills.

Because of the relatively recent interest in the hazards of marine oil transportation, virtually no studies have set out to determine beforehand what the site specific implications of oil transportation might be in a given area (apart from work undertaken concurrently with this study on Puget Sound, and released too late to be of significant help to us).

The main thrust of this study has been to examine the information that has been obtained on oil spills and oil transportation elsewhere in the world and to relate it to the Strait of Juan de Fuca and the Strait of Georgia.

To do this properly, it has been necessary to examine the actual oil transportation plans, vessel limitations, traffic patterns in the area, water conditions, weather and known navigational hazards. This physical information in turn has had to be related to an understanding of what would likely happen to oil should a spill occur, the influence of tidal and wind movements on an oil slick, and finally and most significantly, the impact that all of this would have on the marine and shoreline resources of the region. Although obviously a complex undertaking, it is a very necessary one if Canada is either to make a strong case against the planned tanker route or if she is to be in a good state of preparedness should any oil spill occur within the region.

Right from the outset of the study we were aware that oil products had been moving through Juan de Fuca and the entire Strait of Georgia for many years. Marine transportation has played a key role in the development of the region and the transport of petroleum products by sea has been a part of this development. Spills that have occurred within the study region have, of course, all been part of this existing transportation pattern and regardless of plans for shipment of crude oil to Cherry Point, the concern for the dangers inherent in marine oil transportation demands a better understanding of oil transportation and its implications within the study region.

Current and potential oil spill hazards within the study area fall into three main categories:

i) Harbour Problems

These include the numerous relatively minor spills that have always been occurring in harbours, at storage facilities and at any points where oil is being transferred either from vessel to vessel or from vessel to shore installation.

The oil spills that frequently take place in Vancouver harbour and other harbours throughout the study region fall into this category. Spills of this type can be prevented in large measure by far more stringent control over the actual manner in which oil is moved from vessel to vessel or to shore. Coastguard monitoring of such operations in Puget Sound, for example, has resulted in a dramatic decrease in the number of unidentified slicks in the area. Furthermore, spills of this type are usually small and can be far more readily cleaned up. Most of the contingency planning for controlling oil spills to date on the west coast has concentrated on this type of spill.

Within the terms of reference of this study, relatively little attention has been given to the smaller type of spill within harbours and at shoreline installations, though naturally the baseline information on marine resources, their susceptibility to oil spill damage and methods of clean-up are directly applicable to any spill.

ii) A Legacy Problem

A second level of oil spill threat is that posed by the existing transportation of petroleum products in the study area. While the bulk of crude oil used in B.C.'s coastal region is brought to refineries by pipeline, the refined products are distributed to all the coastal distribution points, including many remote logging camps and marinas, by barge or small tanker. In addition, all of the vessels coming into the study region carry their own fuel cargo -

some of the larger vessels coming into the Port of Vancouver and Roberts Bank have a fuel capacity, for their own purposes, in excess of the total capacity of smaller tankers and barges operating within the region.

For the most part, it is within Canada's power to control spill dangers from this local transportation. However, although such dangers are important, we have been moving oil within the region for a considerable period of time without a serious accident and also this area of concern lacks the time urgency and magnitude posed by the transportation of Alaska crude to Cherry Point. Nevertheless, the general information on marine resources and their susceptibility to damage and clean-up methods is directly applicable to this internal movement of oil within the study region.

iii) The New Threat

A third and major area of concern is, of course, the transportation of crude oil to Cherry Point - a new threat that is governed by factors over which Canada may have no control, and one with a serious sense of time urgency. This facet of the study has obviously received the heaviest emphasis.

C. LIMITS OF THE STUDY REGION

In order to obtain information on both the likely impact of existing oil transportation and the Cherry Point tanker route, the study region has included the Strait of Georgia from Johnstone Strait to the international boundary, the Strait of Juan de Fuca and territorial waters of southwestern Vancouver Island to a point opposite Tofino.

Within this much broader study region, the highest hazard zones in relation to the shipment of Alaska crude have been identified and the heaviest emphasis has been placed on the likely impact of a spill within those hazard zones.

D. STUDY CONSTRAINTS

All of the published material that we have dealt with on oil spills has been "after the case" information. To apply this to the study area on a predictive basis demands as thorough a knowledge as possible of the region and its resources in relation to the likely impact of an oil spill. Limited general background data on the Strait of Georgia has been brought together only recently in connection with marine park studies, and we have taken this and similar information and examined it in the light of potential oil spills, recognizing that the information is still far from complete. If a meaningful assessment of the social and economic impacts of a spill on these resources is then to be made, obviously that assessment must be made on the best possible understanding of what the actual physical impact is likely to be.

It would be very misleading, for example, to simply deal with the economic values associated with the marine resources of the study region as a whole on the assumption that all these resources would be affected by a spill. It is true that the total resource complex of the region is at risk, but it is a serious over-simplification to assume that total risks would be involved in even the most serious spill that could occur within the region. There are just too many variables operating, as this study will indicate. Even assuming that we are dealing with a spill of crude oil of a given size, the time of year at which the spill occurs and the meteorological and oceanographic conditions at the time of the spill are three major variables that automatically introduce a very wide range of potential impacts, and equally important, a wide range of effective clean-up actions that could be undertaken.

Superimposed on this complexity of interactions that revealed themselves in more detail as the study progressed, is the fact that the study deals in future possibilities which are in many instances based on dynamic living resources, about which scientific knowledge is still seriously lacking, and on the new and still nebulous area of assessing recreational values.

E. OUR APPROACH

In the light of the foregoing constraints, the approach that has been taken falls into three main categories, each of which represents an increasing level of reliability within which interpretations could be made.

1. First we have dealt with the resources and oil transportation patterns of the study region at a macro-level. Obviously one oil spill is not going to affect the entire area, but since one main thrust of the study is to provide information to assist in the clean-up of a spill should one occur, information on the total regional resource complex is important. At a region-wide level, however, resource abundance, economics and other values must be interpreted with extreme caution. They simply give an indication of the total values within the study region, not the total values that would be affected by an oil spill.

2. Within this broad regional context, the study area has been broken into a grid pattern, and an assessment has been made of the full range of resource values - commercial, recreational and aesthetic-intangible value judgements - lying within each square of the grid. The system used in the assessment is explained in more detail in the report. It has enabled us to identify shoreline and marine areas where the impact of oil spills would be greatest in terms of resource values affected. In addition, of course, it gives an idication of resource values throughout the study region to help assess priorities for clean-up operations should a spill occur. These higher potential resource damage zones can then be combined with higher spill probability zones based on transportation patterns and navigation considerations to identify hazard zones. It is within the hazard zones that quantitative and qualitative information takes on even more meaning.

3. The third stage of the study has involved the simulation of oil spills of different types at different seasons of the year within selected hazard zones. At this level, it is possible to be more precise in dealing with the impacts on a known set of resources within a known region under given meteorological and oceanographic conditions. Within the context of these scenarios, potential resource damage information becomes more realistic yet.

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Again, two major constraints must be borne in mind. First, detailed knowledge of the abundance, distribution and consequently, the economic or other values of some of the resources that would be affected by an oil spill within the study region, is far from complete. This is particularly true of recreational resources.

The second constraint is that in the light of the relative newness of research on the impact of oil spills on living resources, our knowledge of the long-range and sublethal impacts of oil on marine resources is by no means complete.

The major significance of these constraints is to point out, as is the case with almost every environmental argument, that a major cause for concern should be those facets of the problem in which our knowledge is far from complete, and that this lack of knowledge in itself forces us to be extremely cautious in any decisions that we make. On the one hand, predictions on the demand for petroleum products and on the economics of transporting those products can be based on plenty of prior experience, and more important, they are subject to man-made decisions and manipulation. On the other hand, in dealing with the impact of those same petroleum product demands on the environment, be it through extraction or transportation, we have no background pool of knowledge to fall back on.

Equally significant, the problems associated with those demands are not simply technological and economic, but may involve ecological imperatives to which man will have to adapt his demands, not vice versa. Until we know precisely whether or not we are dealing with solvable problems that technology can overcome, or with imperatives to which we must adapt our demands, then we should move with extreme caution. To date our track record in exercising caution and restraint has been poor.

This study does not try to deal with the international implications of the problem other than to point out the obvious artificiality of international boundaries in dealing with marine pollution problems. We do, however, touch briefly on international implications by determining which kind of action Canada can take on her own, what kind of action she could take in cooperation with the U.S., and in understanding what the problem demands on a broader level of international cooperation.

Another consideration that must be borne in mind is the fact that this study has been undertaken in a relatively new area of work. Some major facets of the oil spill problem that could not be anticipated at the outset emerged during the course of the study. This of necessity has made time constraints difficult, because it was also essential to recognize the time urgency of the study. As the work progressed, new information from other sources published during the course of the study came to hand, some of it unfortunately too late for incorporation in this report. In addition, policy moves relating directly to the study were taking place and, as we have indicated in the foreword, oil spill incidents also were occurring while the study was underway. Of necessity, for the study to be really meaningful and not simply an academic excercise, the objectives in themselves became something of a moving target, since there was little point in our preparing a report in a dynamic field to reach a completely static goal. We looked upon these difficulties as challenges rather than insurmountable obstacles. They do, however, point out how much more very basic information we have yet to obtain if we are to manage even our own territorial waters wisely.

Finally, we are well aware that this particular study is only one component of a total analysis of the problem of transporting oil from the arctic to U.S. markets. Much that has been written and said recently about west coast oil transportation has involved a comparison of coastal and overland transportation routes. We hope that this report will contribute to that comparative analysis. However, we must caution against an over-simplified "either - or" approach to the problem of oil transportation and the Pacific Coast.

Cherry Point refinery is built and operating, and will be served by tanker supplies of crude oil, starting this year, quite independently of crude supplies from Alaska.

CHAPTER II - REGIONAL PHYSICAL CHARACTERISTICS

The study region (see Map 1) extends from Johnstone Strait south through the Strait of Georgia to the international boundary, through the Strait of Juan de Fuca into the waters off southwestern Vancouver Island.

The region is characterised by a high number of shoreline miles relative to its water area. Extreme variations in topography complicate oceanographic and meteorologic features of the area.

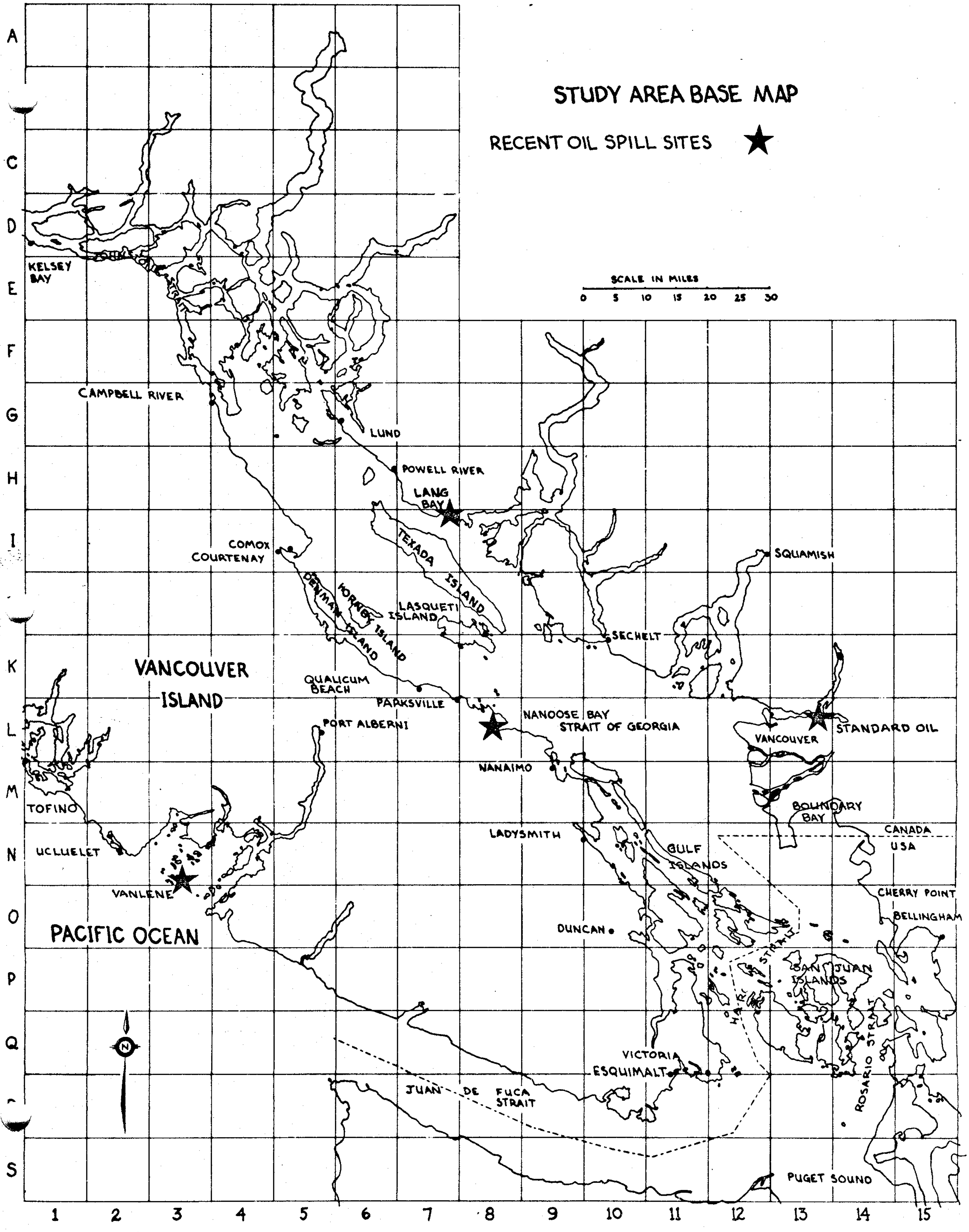
A. OCEANOGRAPHIC CONDITIONS

Although the region includes many sheltered sites which are relatively calm for much of the year, even within inlets wave heights can reach 5 feet in strong gales, and higher in waters exposed to the open Pacific. The overall size of the area is sufficient to create water conditions that prohibit viable boom or slick-licker oil clean-up operations for much of the year.

Water temperatures range from a winter average of 45 degrees to summer averages in the mid-60's.

Tidal ranges in excess of 15 feet are common. This is particularly significant on gently sloped coastlines where tidal action can spread oil over large portions of the intertidal zone.

Tidal current speeds vary from several knots in narrow passages to a


STUDY AREA BASE MAP
RECENT OIL SPILL SITES
SCALE IN MILES
0 5 10 15 20 25 30
KELSEY BAY
CAMPBELL RIVER
LUND
POWELL RIVER
LANG BAY
COMOX
COURTENAY
TEXADA ISLAND
DENMAN ISLAND
HORNBY ISLAND
LASQUETI ISLAND
SQUAMISH
SECHELT
VANCOUVER ISLAND
QUALICUM BEACH
PARKSVILLE
PORT ALBERNI
NANOOSE BAY
STRAIT OF GEORGIA
VANCOUVER
STANDARD OIL
NANAIMO
TOFINO
BOUNDARY BAY
LADYSMITH
CANADA
USA
UCLUELET
GULF ISLANDS
VANLENE
CHERRY POINT
BELLINGHAM
PACIFIC OCEAN
DUNCAN
SAN JUAN ISLANDS
HARO STRAIT
ROSARIO STRAIT
VICTORIA
ESQUIMALT
JUAN DE FUCA STRAIT
PUGET SOUND
A
C
D
E
F
G
H
I
K
L
M
N
O
P
Q
S
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

fraction of a knot in the central Strait of Georgia. In Juan de Fuca Strait, they range from 1 to 3 knots on both ebb and flood tides, while in Rosario Strait and Boundary Pass they can be as high as 5 knots, and in narrow passages such as Active Pass may even reach 8 knots. These current conditions in many of the passes of the Strait of Georgia can create problems for marine transportation, and pose serious problems for oil spill clean-up.

The influence of the Fraser River on a significant portion of the study region further complicates the oceanography and related predictability of the movement of any oil slick.

B. METEOROLOGIC CONDITIONS

Fog can pose a serious navigational hazard within the study region, with an August maximum of 20 days per month at the entrance to Juan de Fuca and 15 days per month around Victoria in October when visibility of 1000 feet or less is normal.

With recent studies indicating wind will move a surface oil spill with a velocity about 3 % of wind speed in the direction of the wind, the intensity of winds within southern portions of the study region suggest that winds can be the major determining factor in oil spill movement in that area.

The overall impact of oceanographic and meteorologic conditions on an oil spill indicates that a spill in the Strait of Juan de Fuca or the southern Strait of Georgia would undoubtedly contaminate large sections of Canadian and/or U.S. shorelines.

CHAPTER III - MARINE RESOURCES

A. BIOLOGICAL RESOURCES

The study region has an excellent diversity and abundance of marine life. It supports some 1100 higher life forms including 300 recorded species of invertebrates, over 200 species of fish, 134 species of marine-associated birds and 16 species of marine mammals.

Similar to terrestrial environments higher life forms of the sea are dependent on the energy of the sun. Phytoplankton in association with basic nutrients harness the sun's energy. In turn the minute animals of the sea, the zooplankton, feed on the small plant life. Plankton supports many smaller fish and filter-feeding shellfish, while grazing animals are dependent on higher plant forms for their environment as well as their feed. Thus, in a total perspective, the predatory salmon, seals, killer whales and many marine birds owe their existence to phytoplankton.

The most important zone in the study region that would be affected by an oil spill is the intertidal. The distribution of plants and animals in this zone is dependent on such factors as temperature, salinity, degree of exposure to wave action and type of substrate. Throughout the study region there is a wide variation in these factors and hence an extreme variation in the distribution and abundance of intertidal life. Some sandy beaches may support only a few species while rocky shores, particularly on the west coast of Vancouver Island, may be literally covered with marine organisms. The intertidal and littoral zones support the immature stages of many animals before they migrate to deeper waters. Although most intertidal life is not of economic importance, it is an integral part of the food chain and total ecology of the region and provides aesthetic and recreational enjoyment for both resident and tourist.

Wintering bird populations in the study area are outstanding. Some areas such as Boundary Bay and the Fraser delta support thousands of birds during late fall, winter and early spring. The migratory waterfowl, salmon populations and some marine mammals are of international importance and the Strait of Georgia is particularly noted for its killer whales.

In this section in Volume II we attempted, where meaningful, to map, document and cost biological values within the Straits of Georgia and Juan de Fuca and along the west coast of Vancouver Island to Tofino. We placed a greater emphasis on those species, particularly birds, that would be most adversely affected by oil pollution. The study does not attempt to provide a pure biological inventory or other detailed scientific information, as collecting data on population sizes and distribution of many species of plants and animals in the study region would be a time-consuming and complex undertaking beyond the scope of this study. As well, there still exists only a very limited knowledge of the distribution and abundance of many species.

B. PHYSICAL AND MAN-MADE RESOURCES

For man, the shorelines within the study region, are perhaps the most important part of the total marine environment. It is the shoreline, particularly in the intertidal zone, where he first comes to grips with the sea, where he first finds marine resources most accessible, and where his activities usually have the first and most significant effect on the marine environment.

The most extensive beaches within the study region are around the perimeter of the Fraser delta, the eastern shore of Vancouver Island in the vicinity of Qualicum and Parksville and along the new Pacific Rim National Park on the west coast of Vancouver Island. Numerous smaller sites are scattered along the shorelines of the entire study region. Although the beaches have never been fully inventoried in terms of acreage, we estimate that of 3,270 miles of shoreline within the study region, 1,350 are beaches.

Recent reliable quantitative information on the use of beaches is also difficult to get. Through updating information from the Lower Mainland Regional Planning Board's 1966 study "Land for Leisure", we have estimated that the region supports an annual total of over 10 million swimming and beach activity outings. Other foreshore recreational activities including diving, beachcombing, nature study, picnicking, sightseeing, account for another 5 million outings annually.

In addition to these numerical values, there is the obvious though not always well expressed relationship between the aesthetic and scenic aspects of shorelines, and incidental activities such as driving for pleasure or ferry travel.

The study region offers an outstanding opportunity for all types of recreational boating because of the proximity of sheltered waters, ease of access to them and the diversity of opportunity afforded, ranging from short day-use to season-long cruising opportunities. An extension of information from a 1966 report on recreational boating indicates a total of 14.3 million boating recreation days per year by people owning boats within the study region.

With forestry as B.C.'s largest industry, the study region contains a large number of log booming and foreshore leases, containing stocks of approximately 770 million board feet with a total value of $54.5 million.

C. LAND STATUS

In addition to the actual biological and physical resources, special land status reflects some of man's priorities. Provincial parks and park reserves are constantly being established throughout the area and there is also the new Pacific Rim National Park near Tofino on the west coast of Vancouver Island. The quality of recreational experience offered within these parks is extremely high.

The region includes nine ecological reserves established under the B.C. Ecological Reserves Act, adjacent to the shorelines, and a substantial number of Indian reservations which cover historical settlements on attractive and biologically productive basin estuaries throughout the study region.

Real estate values are difficult to discuss on a region-wide basis. The wholesale value of foreshore property bought in large parcels averages $30 per front foot, although attractive beach areas on the Gulf Islands and southern Vancouver Island retail for as high as $250 per waterfront foot.

CHAPTER IV - TRANSPORTATION

A. MOVEMENT OF OIL AND OIL PRODUCTS

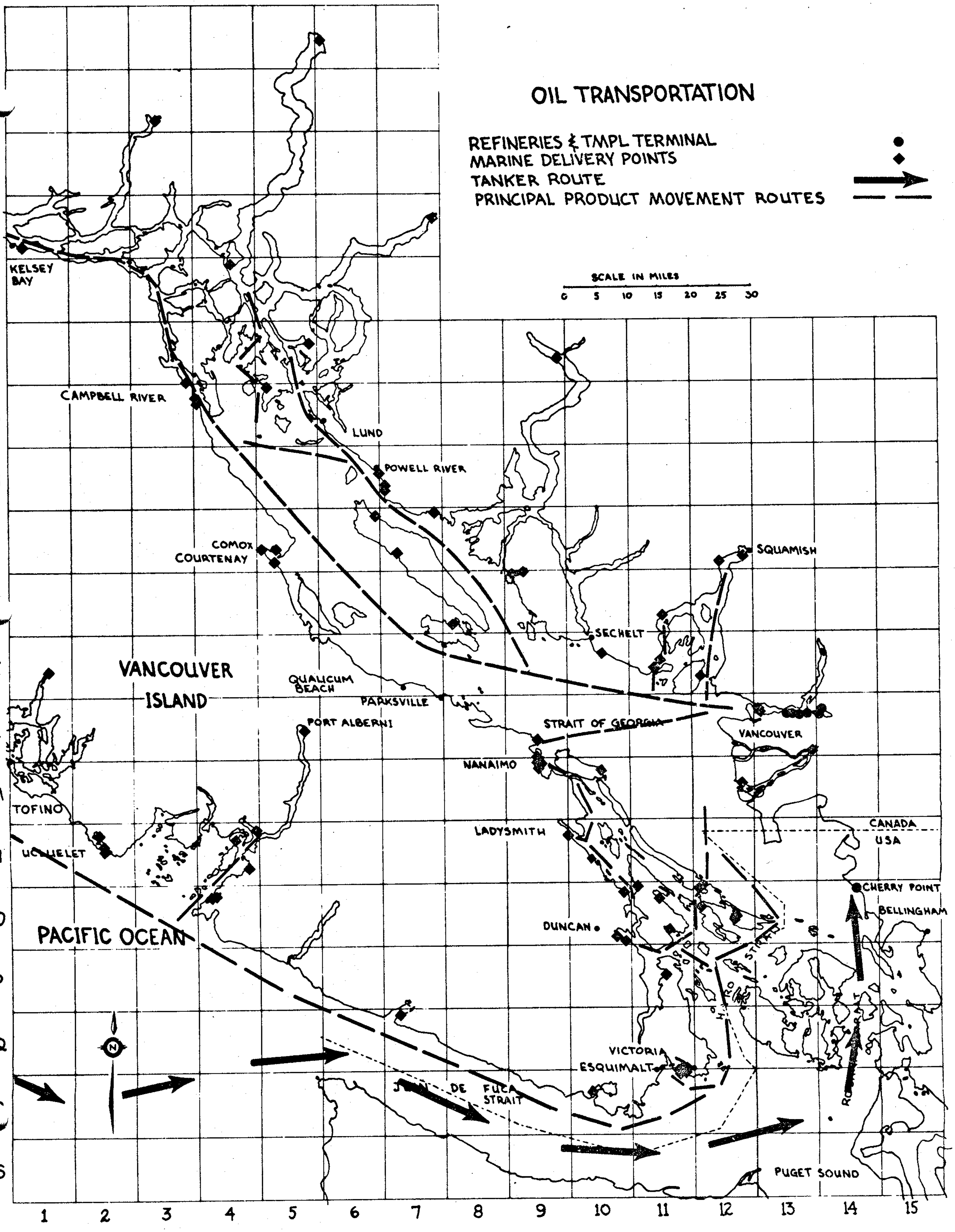
Southwestern British Columbia and the states of Washington and Oregon have no local sources of crude oil. It is clear, therefore, that unless a major trans-shipment centre is located in the region, the volume of imported crude oil will be limited to the amount necessary to satisfy the regional demand for oil products. At present, the entire demand for crude oil in the region is met by the Trans-Mountain Pipeline which has a capacity of about 380,000 barrels per day (bpd) of Albertan oil. This pipeline has permission to expand capacity to 600,000 bpd and can therefore supply the region, including the Cherry Point refinery, for at least another fifteen years on its own.

A number of factors conspire to frustrate estimations of the volume of tanker traffic which would arrive at Cherry Point as a result of the development of Alaskan oil: the initial flow of oil through the Trans-Alaskan Pipeline (TAPS) is not accurately known, it is uncertain where the oil will be marketed, and it is not known whether or not a pipeline would eventually be constructed from the Puget Sound area to serve the U.S. midwest. It appears, however, that should TAPS begin operation, at least five or six 120,000 ton (854,000 barrel) tankers would be arriving at Cherry Point each month and would represent about 1% of the total sea-going traffic in the region. This number of arrivals will increase in the future, especially if a trans-U.S. pipeline is built, but the amount of the increase is uncertain. Irrespective of the fate of Alaskan oil, the Atlantic Richfield Oil Company will be bringing in at least one such tanker of oil per month to Cherry Point, starting this year, 1972.

The movement of oil products in the study region follows a complex pattern. Generally speaking, both British Columbia and the U.S. northwest supply their own needs, and there is very little transfer of products across the border. The Canadian refineries are located in the Vancouver area, and products are moved by barge and small tanker up the B.C. coast and over to Vancouver Island at the rate of about 13 million barrels per year. This rate will likely increase to about 24 million barrels by 1980 and to 34 million barrels by 1990 at the present rate of increase in the demand for oil products. The tanker route and the general pattern of oil products movement are shown on the map - Oil Transportation.

B. CHARACTERISTICS OF OIL AND OIL PRODUCTS

When spilled on water, oil floats and spreads quite rapidly, the spreading rate being determined primarily by the volume and density of the oil. The oil slick is subject to the effects of three major processes - evaporation, emulsification, and mechanical transport. Evaporation leads to an increase in the density and viscosity of the oil and thus acts to retard the spreading rate of the slick. Spreading and evaporation are the two major processes affecting spills of the lighter oil products. Water-in-oil emulsions are formed naturally and reasonably rapidly in sea water and are very stable. The lighter



OIL TRANSPORTATION
REFINERIES & TMPL TERMINAL
MARINE DELIVERY POINTS
TANKER ROUTE
PRINCIPAL PRODUCT MOVEMENT ROUTES
SCALE IN MILES
0 5 10 15 20 25 30
KELSEY BAY
CAMPBELL RIVER
LUND
POWELL RIVER
COMOX
COURTENAY
SQUAMISH
SECHELT
VANCOUVER ISLAND
QUALICUM BEACH
PARKSVILLE
PORT ALBERNI
STRAIT OF GEORGIA
VANCOUVER
NANAIMO
TOFINO
LADYSMITH
CANADA
USA
CHERRY POINT
BELLINGHAM
DUNCAN
PACIFIC OCEAN
VICTORIA
ESQUIMALT
DE FUCA STRAIT
PUGET SOUND
A
C
D
E
F
G
H
I
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oil products such as diesel oil and gasoline do not emulsify. Emulsification also increases the viscosity of the oil and thus inhibits spreading. The spreading characteristics of oil are probably less important than its mechanical transport by wind, tide and current from the point of view of the hazards to a coastline. Under the influence of wind, slicks have been observed to travel at about 3% of wind speed.

Very little information is available on Prudhoe Bay crude oil, but it is known that it has an above average specific gravity and pour point, an average sulphur content, and a low proportion of gasoline. Given the fairly low content of lighter components in this oil and the relatively cool water temperatures of the study region, evaporation will likely not alter the characteristics of a spill significantly. Thus emulsification and mechanical transport will be the dominant processes.

C. NAVIGATION CONSIDERATIONS

Considerable disagreement exists in the literature concerning the operating characteristics of supertankers. On the one hand are the opinions that these ships are monstrous cumbersome machines with little capability to stop quickly or manoeuver, and on the other there are the equally respected opinions that the ships do have the manoeuverability and stopping ability to safely navigate the waterways in which they are expected to sail. Since the use of these ships has become a fairly "hot issue", there no doubt exists some bias on both sides of the argument, but the extent of the disagreement indicates that these ships must be used with caution, especially since they carry a cargo which is potentially dangerous to the world's environment. Until much more experience is accumulated in the handling of supertankers, they should be given special consideration when they enter confined coastal waters.

The Strait of Juan de Fuca - Strait of Georgia waterway does not present any significant navigation problems in clear weather. However, conditions of poor visibility are often encountered since fog is a common phenomenon, and smoke from forest fires and the burning of slash is frequent in the late summer and fall. Moreover, the weather off the entrance to the Strait of Juan de Fuca as a rule is exceptionally severe.

While collisions and groundings can occur anywhere in the study region, it is possible to identify areas where a greater danger of these accidents occurring exists. Because of the generally poor weather at the entrance to the Strait of Juan de Fuca, this area can be considered to offer an increased danger of both collisions and groundings. In the eastern end of this strait, there exists a complex pattern of traffic as well as two banks and an island, and the danger of collisions and groundings is consequently higher than along the length of the strait. Both Rosario and Haro Straits contain a number of rocks and shoals, and experience a fairly concentrated traffic flow. They must therefore also be considered areas of higher potential collision and grounding frequency.

D. SPILL PROBABILITIES

Any attempt at predicting the number of major oil spills which will occur in the study region must necessarily first of all attempt to predict the number of collisions and groundings which will occur. Such predictions are tenuous at the very best as they must be based on accident data which are historical, from another part of the world, and/or not necessarily relevant to supertankers. However, based on our analysis of accident probability derived by Honeywell Inc. and our understanding of the operating characteristics of the tankers and the navigational problems of the study region, it is concluded that there is a 50% chance of an oil spill involving a supertanker occurring at least once every twenty years. This conclusion is derived from a statistical analysis, and the fact still remains that such a spill might never happen or, alternatively, might happen this year.

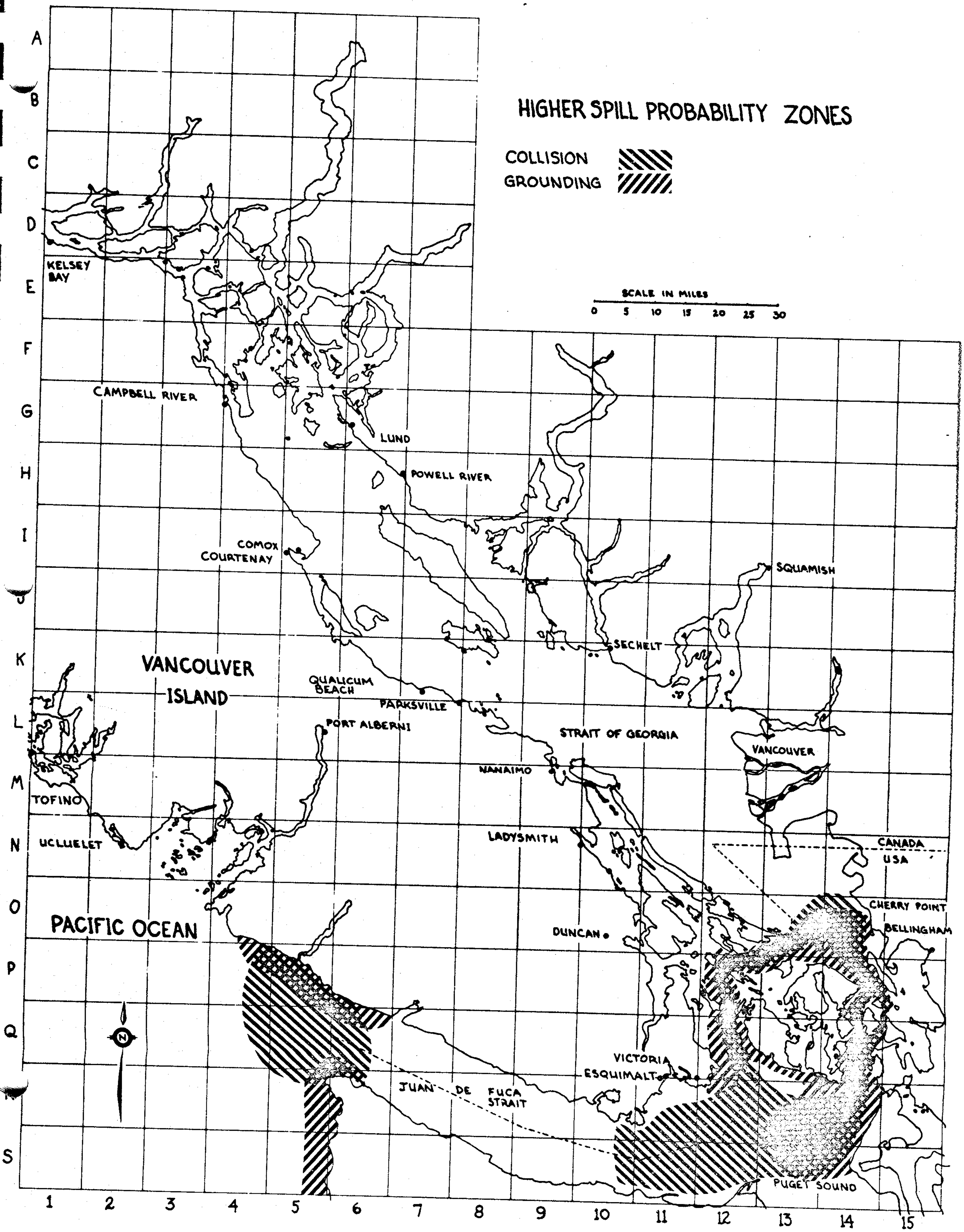
Three zones in the study region have been identified where there exists a large possibility of a major oil spill relative to the general level of danger in the whole region. (Refer to the map - Higher Spill Probability Zones.) These zones are:

(i) The entrance to the Strait of Juan de Fuca;

(ii) The eastern end of the Strait of Juan de Fuca;

(iii) Rosario Strait, including its southern approaches.

If Haro Strait is used as an alternate tanker route, it should also be considered a higher spill probability zone.



HIGHER SPILL PROBABILITY ZONES
COLLISION
GROUNDING
SCALE IN MILES
0 5 10 15 20 25 30
KELSEY BAY
CAMPBELL RIVER
LUND
POWELL RIVER
COMOX
COURTENAY
SQUAMISH
SECHELT
VANCOUVER ISLAND
QUALICUM BEACH
PARKSVILLE
PORT ALBERNI
STRAIT OF GEORGIA
VANCOUVER
NANAIMO
TOFINO
UCLUELET
LADYSMITH
CANADA
USA
CHERRY POINT
BELLINGHAM
PACIFIC OCEAN
DUNCAN
VICTORIA
ESQUIMALT
JUAN DE FUCA STRAIT
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Based on our understanding of the meteorology and oceanography of the study region and the record of tanker accidents in the rest of the world, it is concluded that the grounding of a 120,000 ton tanker could result in a volume of oil in excess of 40,000 tons (approximately 284,000 barrels) escaping on to the sea. Should a grounding occur on the west coast of Vancouver Island, a considerably larger amount of the cargo could escape. A collision would likely cause a smaller oil spill than would a grounding.

E. OIL SPILL INSURANCE

The Strait of Juan de Fuca / Strait of Georgia / Puget Sound inland sea represents a contiguous environment - the fact that man has arbitrarily divided it into two jurisdictions means little to the fish and birds which inhabit the region, or to the winds, tides and currents that are active within it. It is a whole, and a major oil spill anywhere in the whole will spread and disperse in total ignorance and total disregard of the international boundary. Therefore, measures to prevent potential oil spills and clean up ones that have occurred must logically be based upon international cooperation between Canada and the U.S.A.

It is proposed that an international fund be created, from which are paid the costs of maintaining oil spill clean-up contingency forces and the costs of cleaning up individual spills. This fund would be financed by a tariff on all oil and oil products being transported by barge or tanker in the inland sea. It is estimated that the required tariff would be in the order of 17 cents per ton of oil.

CHAPTER V - THE IMPACT OF OIL SPILLS

A. BIOLOGICAL AND PHYSICAL CONSIDERATIONS

1. Biological Effects

Crude oil or its by-products floating on the surface of the water can cause widespread damage to marine life. Very small quantities of oil, either ingested or on plumage, can kill birds. It smothers intertidal animals and plants, interferes with the normal feeding and respiratory mechanisms of shellfish in particular, introduces toxic components into the water column, increases the level of hydrocarbons in the marine food chain, and alters communities to a point of extreme ecological instability. Direct economic losses occur when the flesh of fish or shellfish becomes oil-tainted or when it is no longer possible to utilize fishing gear in oil-polluted waters.

Laboratory and field studies carried out to date have indicated the extent, increasing seriousness, and harmful effects of oil pollution. However, there are practically no long-term studies to indicate "safe" levels of oil products in the marine environment under continuous or long-term exposures, and we know little of the sublethal effects of oil and its breakdown products on marine life.

The adverse effects of oil on marine bird populations alone is sufficient cause for alarm. If no other consequences could be demonstrated, the welfare of bird populations alone would justify extreme caution. If more funds were spent on the prevention of oil spills, there might be less concern with studying their effects.

Once a large oil spill does occur, it is often difficult to determine its effects. Very little is known about natural mortality rates of animals in the sea and hence it is difficult to separate natural mortality from oil-induced mortality. It has been a problem to separate the effects of oil pollution from natural long-term and seasonal fluctuations in animal numbers and the lack of baseline information prior to a spill taking place makes it virtually impossible to compare conditions after the spill.

It is not easy to predict the biological effects of a spill from laboratory toxicity tests or from information gained from previous spills elsewhere. The types of oil spilled, the environmental conditions at the time of the spill, and the degree and duration of confinement of the oil are some of the variables that make it difficult to generalize on the harm that might be done.

However, examination of experiences gained at major recent spills was the main option left open to us and on this basis we attempted to assess probable effects in the study region. Our survey of available literature indicated that:

(i) Oil and oil products should be regarded as poisons that damage the marine ecology;

(ii) Marine resources can be endangered by a direct kill or by the long-term accumulation of petroleum hydrocarbons in the marine food web. The steady accumulation of oil in the marine environment may be far more serious than single large spills;

(iii) Oil spills may present a public health hazard by increasing the level of carcinogenic hydrocarbons in sea water and bottom sediments, thereby increasing their concentration in sources of human food from the ocean;

(iv) Dispersants introduce oil with its water soluble components into the water column. Toxicological studies have indicated that chemically emulsified petroleum oils are several fold more toxic than the same oils spilled on the water surface and naturally mixed by waves, winds and tides. Tarzwell (1970, in "Water Pollution by Oil", ed. P. Hepple) after carrying out fairly extensive tests on the toxicity of oils and oil dispersant mixtures, concluded that it was undesirable to use dispersants unless absolutely essential for final clean-up or to protect waterfowl or damage to shore installations and beaches;

(v) Acute toxicity of oil is largely due to the lighter volatile fractions that are evaporated or dispersed quickly in open water areas. Toxicity could cause widespread damage in the study region if oil arrived on intertidal areas, estuaries or shallow littoral zones shortly after spillage;

(vi) The physical effects of oil (such as interference with normal feeding or respiratory mechanisms, or alteration of the substrate on which animals live) could cause widespread damage to intertidal organisms, birds and juvenile fish;

(vii) Marine-associated birds would be severely affected by a major oil spill;

(viii) Where oil was allowed to reach the shore, intertidal organisms would be severely affected. Although many of these organisms would recover, the effect of chronic pollution could lead to a reduction in the diversity of species and a greatly increased tendency to ecological instability. For example, a reduction in grazing mollusc populations can bring about an overabundance of marine algae;

(ix) The eggs and juvenile stages of fisheries resources are extremely vulnerable to oil pollution. Herring spawn and larvae and juvenile salmon could be adversely affected.

2. Effects on Physical and Man-Made Resources

Heavy oils tend to concentrate at the high water mark of a shoreline, cover the surface of rocks in the intertidal zone, and stabilize normal movement of beach materials. Oil also forms nodules that become covered with a surface layer of sand which in turn can be broken up by tide and wave action.

Oil on any type of shoreline seriously inhibits recreational use of that shoreline until such time as the oil is removed - the reduction in recreational use being inversely related to the speed at which oil is removed. Assuming a fairly rapid clean-up (within two to three weeks of a spill), then the recreational impact of an oil spill on shorelines is not usually of a lasting duration other than for biological resource-based recreational activities such as clam-digging or oyster gathering.

The presence of oil in an area used for recreational boating would seriously inhibit normal recreational use for a limited period of time and, as well, docks and pleasure craft fouled by oil would require cleaning.

The forest industry is not unanimous regarding the degree to which oil damages log stocks. However, oil contamination could result in wood penetration, handling problems, staining, re-routing of log rafts to avoid spill areas and the secondary biological effect of transferring oil from one site to another through the movement of contaminated booms.

Areas of specific land status such as parks and park reserves, ecological reserves and Indian reserves would all be detrimentally affected by an oil spill because of their unique status. Parks and ecological reserves are established because of the unique natural values that they possess, and any change in the natural environments would of course partially negate the reasons for their existence. Damage to Indian reserves would further complicate an already complex land status and political issue.

Since a polluted shoreline would immediately be reduced in usefulness, the value of the real estate property adjacent to it would be lowered for a period in close relationship to the time that the properties were contaminated.

B. ECONOMIC ASSESSMENTS

The economic costs of an oil spill are not measured simply by totalling the dollars spent on clean-up and restoration. As well, the costs must be measured in terms of opportunities which are foreclosed and in decreases in utility resulting from damages. These are an important part of the real cost and damage of an oil spill - they include production loss when resources are transferred to clean-up use, lost leisure time, lost recreation values, reduced utilization in enjoyment of marine resources and other uses of the marine environment which would be precluded for a period of time.

A study of this type will always encounter quantification problems with non-priced goods. Furthermore, economic assessments can never be better than available data, which in the case of oil spill studies may never become fully available. However, within these considerations, main economic factors include the following.

1. Clean-Up and Property Restoration

Clean-up costs include all payments for labour, materials and capital or rental costs for equipment - a more detailed analysis of these are found in Appendix D of the main report. The tabulations of clean-up and restoration costs can be concluded at one of three points: One is when all clean-up and restoration is completed, another when it is determined that all possible clean-up is completed, and the third when the only unrestored resources are not worth the cost of restoring. The conclusion in the first case is obvious. In the second case, the damage to resources left unrestored would be assessed as the difference in use or utility after contamination as compared to their original state. In the third case, if the value of resources is less than the cost of restoring them, the loss should also be assessed on the basis of the reduced utility or value.

2. Commercial Fishery

Damage to commercial fisheries depends greatly on the season in which a spill occurs. However, if one happened during the fishing season, it is unlikely that either fishermen or those involved in fish processing could switch their efforts to alternate fishing sites or production. Through the whole spectrum, then, of commercial fisheries, including processing, it is proper to sum the loss that occurs at each level, counting only the extra value at each level which would be lost because of an oil spill.

3. Tourist Industry

In assessing social costs for the tourist industry, it is important to distinguish between actual losses and mere transfers to other parts of the province. To assess the social cost, the increased income in the alternate locations should be deducted from the lost income in the oil spill area. It is also proper to include the reduced utility to Canadian tourists who are forced to take a less preferred vacation area, but these are beyond the scope of this study to assess economically.

4. Property Values

There seem to be two ways in which property values can be affected. On the one hand, the value of all shoreline property might be depressed as a result of the risk of an oil spill. On the other hand, the value of any shoreline actually contaminated by a particular spill would be depressed. To isolate the effect of oil spill risk on property values does not appear practical at present as many other dynamic factors determining property values are involved. However, in the second case of actual contamination, one can assume the measure of cost to property owners could be estimated by imputing a return, similar to the rate of return on capital, to the reduction in rental value of property during the time the shoreline is contaminated. This rate of return represents a monetary expression of the utility derived each year from ownership and use of the property.

5. Recreational Values

Most of the recreation affected would be centred on the use of public recreation areas, where boating, fishing, beach use and swimming would be most important, with walking, beachcombing and perhaps hunting of somewhat less value. Both alternative activities and alternative locations must be considered in computing recreational losses and the difference in these from the original activities and locations would indicate the proper measure of social cost. For practical application, the constraints of available data may enable one to only roughly approximate average values for recreation and days of use.

6. Option Demand

Option value relates to possible future use of a good or service and is the premium which a person who is an uncertain demander would pay to ensure the availability of that service. The uses to which option demand apply are those which are outside of the normal courses of market transaction, such as outdoor recreation of various types and opportunities for education and research. Within the broad spectrum of those who could in future use the study region for such purposes, it seems reasonable to assert that there will be many who are uncertain demanders and would pay an option price to ensure continued supply of the service. To the extent that option values relate to ensuring the supply and availability of a service in the long run, it is difficult to argue that they are significantly reduced by oil spills of a short-term nature causing a temporary reduction in the quantity of that service being provided. If, on the other hand, an oil spill had the effect of permanently reducing or limiting the supply of a service, option value would be a relevant policy consideration. However, to the date of this report, no practical means of estimating option value have been proven.

C. SOCIAL IMPLICATIONS

This study was triggered because people on the west coast were concerned about the impact that the transportation of Alaska crude along their coastline would have on their lives. It is within this context that the physical, biological and economic impacts of oil spills on the west coast takes on real meaning, especially when we realize that as far as Alaska crude is concerned, we stand the risk of spill damage but have no dependence on that oil as a source of energy.

From the little work that has been done elsewhere on the social implications of oil spills, it appears that they fall under two main headings: First, the publicly expressed response to the oil spill threat and subsequent public relations and political implications. Second, the actual effects that oil spills would have on the more difficult to define aspects of the life-style of people living in the region affected by a spill, on the psychological effect of knowing that a spill is taking place in the area, and the concern that people feel for unique and irreplaceable resource values.

1. Public Concern and Oil Spills

Public concern is closely related to the media which has kept the whole question of oil transportation very much in the public eye for almost two years. Politicians and other prominent citizens have made repeated comments on the oil spill threat, all of which have found outlet through the news media.

Over 100 editorials have appeared in the four major west coast daily newspapers during the past eighteen months and a monitoring of the Vancouver Sun for six weeks during February and March showed that a news story directly related to the points covered in this study appeared in every issue. Other media, particularly television, have maintained a steady coverage of the oil spill problem. Citizens groups, boards of trade, municipal governments and the B.C. government have all expressed concern.

This concern is significant, particularly for public officials, because oil spills are a relatively new threat and unless people are honestly informed of the impact that a major spill might have, mistrust of public officials would inevitably result.

People on the west coast generally expect the Canadian government to register the strongest possible objection that it can to oil transportation by tanker down the west coast, but there seems to be a latent feeling of frustration that no matter what Canada does in this regard, the tanker route will go ahead anyway.

2. The Effect of Oil Spills on People

There is a generally expressed anxiety and concern at living under the threat of possible disaster. This in itself is disruptive.

Loss of jobs and the economic results of unemployment, are one way of viewing the loss. The type of job opportunities that would be lost as a result of an oil spill are extremely seasonal, and are critical for people who have chosen activities such as fishing and catering to recreationists as a means of making a livelihood, simply because they are prepared to trade off the security of a steady job against the freedom and pleasure they get from the kind of occupation that they choose.

Social losses can be assessed in terms of loss of recreational opportunities, education and research values and unique and irreplaceable resources.

It is recognized that the study region is constantly being modified by industrial, commercial and recreational activities and any one decision, including the decision to move oil by tanker, would not in itself result in the total disruption of the environment. At the same time, many small decisions taken independently could reduce the quality of the environment to a level unacceptable to those having a strong preference for its preservation.

D. ASSESSMENT OF OIL SPILL IMPACT

An index has been developed to identify those portions of the study region which exhibit a relatively higher vulnerability to oil damage, based upon the likely impact on a selected set of resources that would be seriously affected by oil spills.

The study region is divided into a system of grid squares each representing an area of approximately 100 square miles. Within these squares, the quantity of each resource is identified relative to its general level of abundance in the entire region. In order to provide for quantitative comparability between resources, each resource is assigned a numerical value for each square in the grid on a 0-5 scale (where 5 is high).

The next stage of the index is the actual impact assessment. Commercial, recreational and aesthetic-intangible facets of oil spills are assessed for each resource under the following assumptions:

(i) That there is an equal probability of a severe oil spill in all parts of the study area;

(ii) That the actual assessment of impact presupposes the conditions of a severe spill;

(iii) That the type of oil spilled is Prudhoe Bay crude oil;

(iv) That the oil spill has occurred when each resource is most abundant, if it shows cyclic variations;

(v) That the spill occurs where human use of the resource is at peak intensity.

The following step involves determining the relative importance of one resource to another in terms of both commercial and recreational values on a scale of 0-5. As the aesthetic-intangible category is not based on particular resources, it is not subject to any relative importance considerations.

All these factors together lead to the establishment of three indices of oil spill impact for each grid square for each of the impact categories - commercial, recreational, and aesthetic-intangible. These indices are not summed, but simply considered together in assessing the total impact of oil spills.

In this way, a comparative analysis of the effect of oil on resource values throughout the study region is possible and high potential resource damage zones can be identified. The map - High Potential Resource Damage Zones - indicates where these occur, the major ones being:

(i) Long Beach / Barkley Sound;

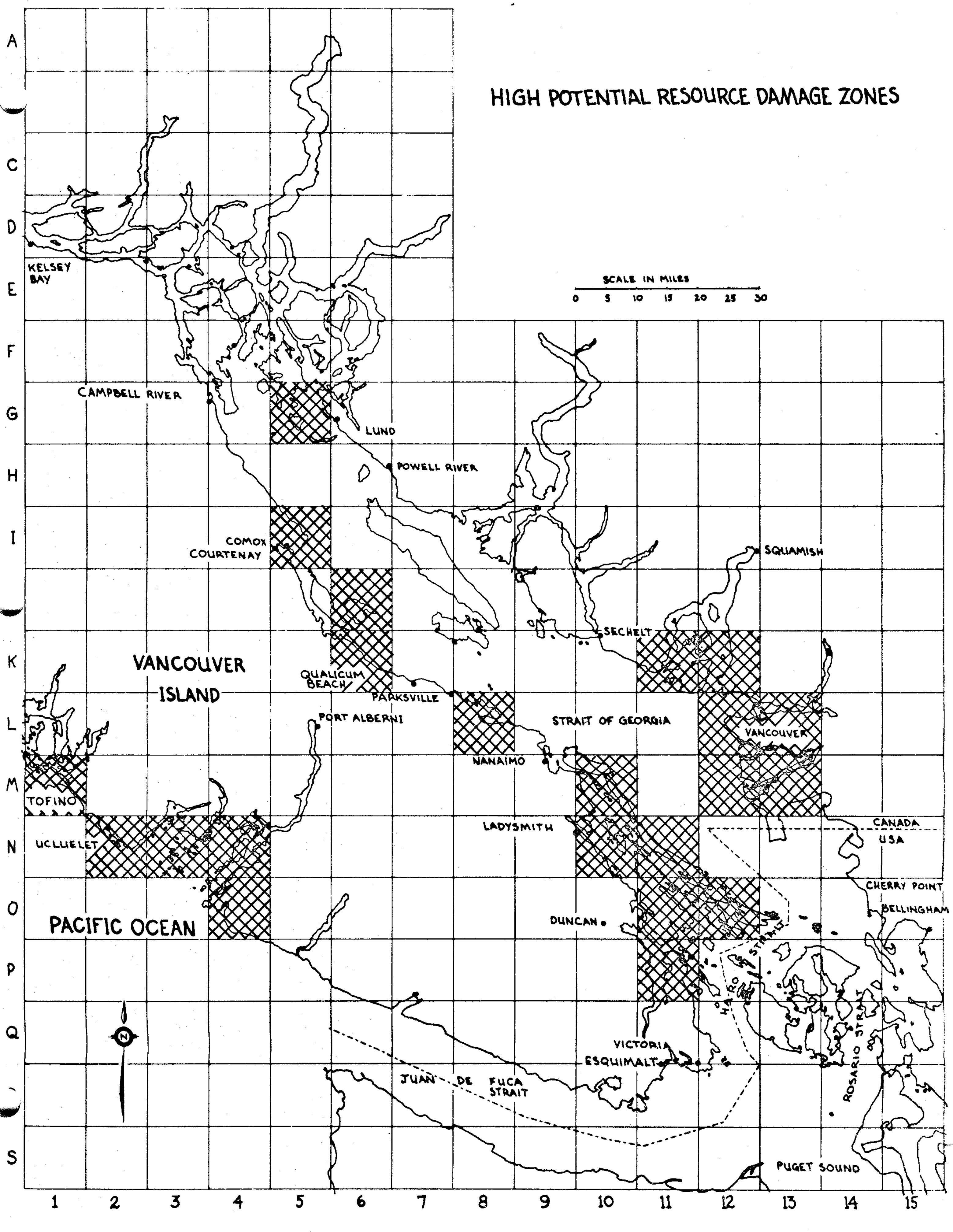
(ii) The Gulf Islands;

(iii) Lower Howe Sound / Vancouver / Fraser Delta.

A high spill impact is also indicated for smaller areas on the east coast of Vancouver Island between Comox and Nanaimo and around Cortez and Hernando Islands in the northern parts of the Strait of Georgia.

After an analysis of higher spill probability zones and high potential

HIGH POTENTIAL RESOURCE DAMAGE ZONES



resource damage zones, we were able to identify the major hazard zones within which the scenarios could be selected. The two principal hazard zones derived on this basis turned out to be (i) the Semiahoo Bay / Boundary Bay / Point Roberts / Fraser Delta area, and (ii) the Victoria / Saanich Peninsula / Southern Gulf Islands area. Within these units, we later identified two scenarios, one of which is summarized in the following chapter summary. We also added a third scenario of an actual spill which occurred outside of the two principal hazard zones, near Powell River.

CHAPTER VI - SCENARIOS

Three scenarios are detailed in the full report of this study. For brevity, we have included as an example only one in this volume. The development of this scenario was based on:

(i) Usual oceanographic and meteorologic conditions for the seasons and locations involved;

(ii) Determination of spill size with mathematical formulae from the oil spill literature;

(iii) The premise that oil would stay together within major slicks rather than divide into smaller patches;

(iv) The assumption that the clean-up operation would describe possible practical procedures within known technology rather than present capability to carry out a clean-up operation.

This scenario represents a composite of what could easily occur and is not meant to be precisely predictive.

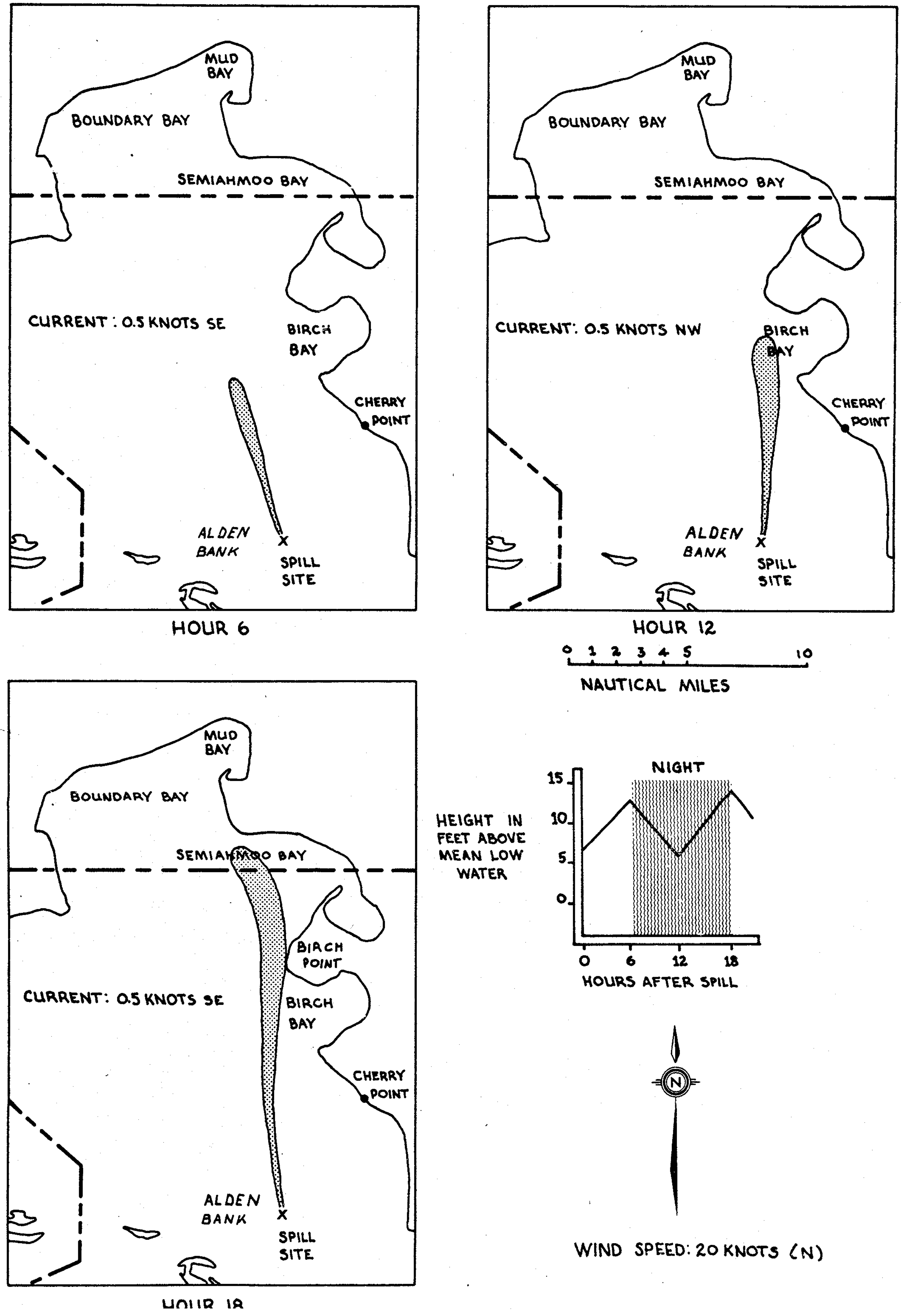
A. SCENARIO #1

During the last week in March on its approach to Cherry Point, a 120,000 ton tanker loses its steerage as it slows down and is pushed on to Alden Bank by 20 knot winds from the south. The hull is damaged and 40,000 tons of crude oil are spilled over a 24-hour period. Wind speeds prevent barges or other tankers from being brought alongside to off-load oil in damaged tanks.

1. 0-18 Hours (Refer to Map - 0-18 Hours)

The grounding occurs at the beginning of a flood tide. At the end of that

SCENARIO NO. 1



tide, a one square mile slick moves northward from the ship. After the first tidal cycle, the three square mile slick is off Birch Bay - 2 1/2 miles north of the spill site. At the end of the next flood at 18 hours, the slick is covering 7 square miles and has crossed the international boundary almost blocking the opening of Semiahoo Bay.

Various crab and bird populations in Boundary Bay are threatened. Peat moss bombing commences and tugs, slick-lickers, and barges arrive at the spill site just before nightfall. Shorelines are reconnoitered to establish the priority areas to be protected. Booms are placed across the Serpentine and Nicomekl Rivers and around jetties and wharves. Road building to the vital areas begins and a command post for the oil spill clean-up program is established.

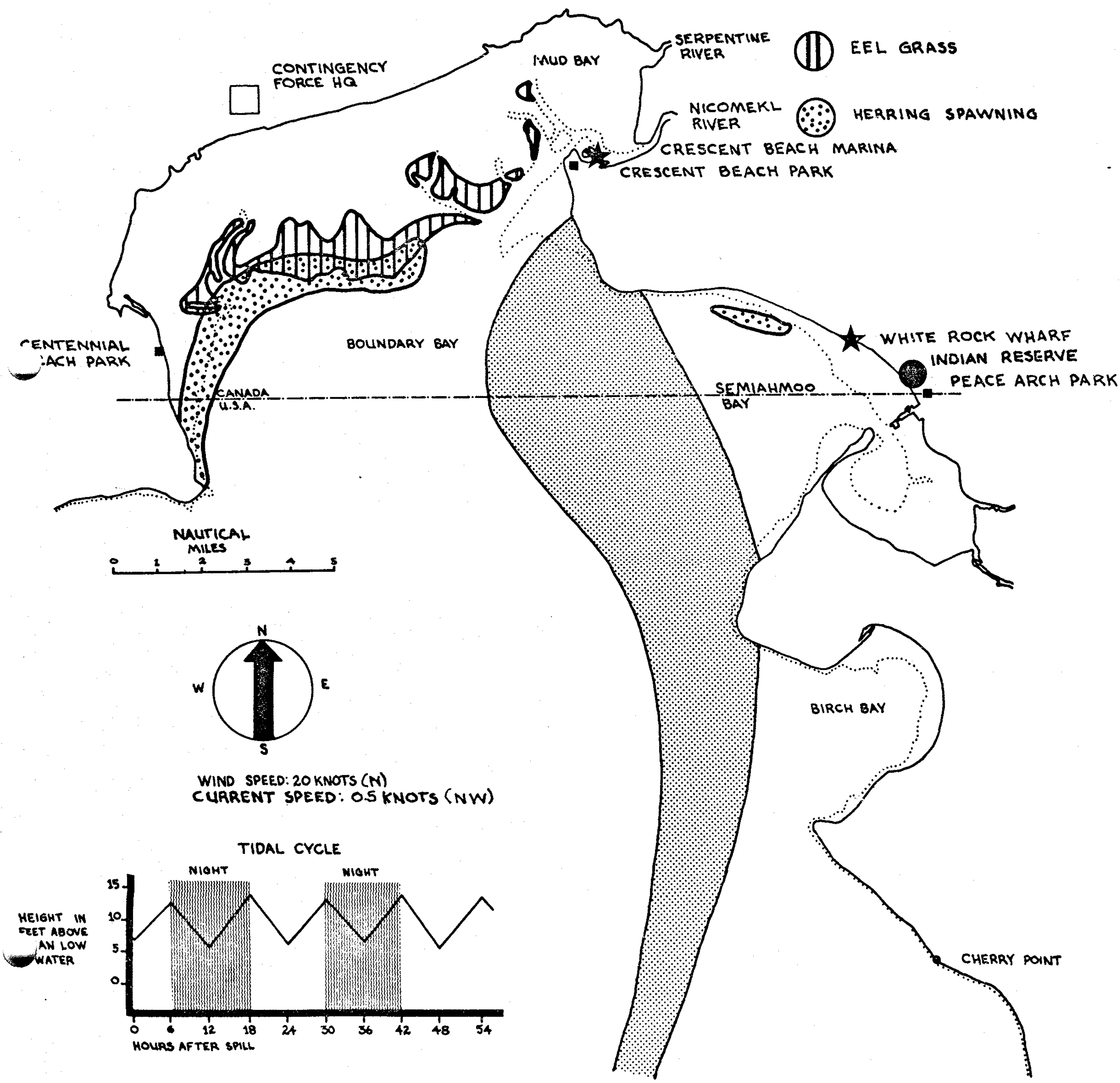
2. <u>18-24 Hours</u> (Refer to Map - Hour 24)

The next ebb tide carries the head of the slick to the Canadian coast south of Crescent Beach and into Semiahoo Bay. The slick has travelled 17 miles northward, covers 14 square miles, has contaminated approximately two miles of beach, and is beginning to emulsify. The leaking from the vessel has stopped.

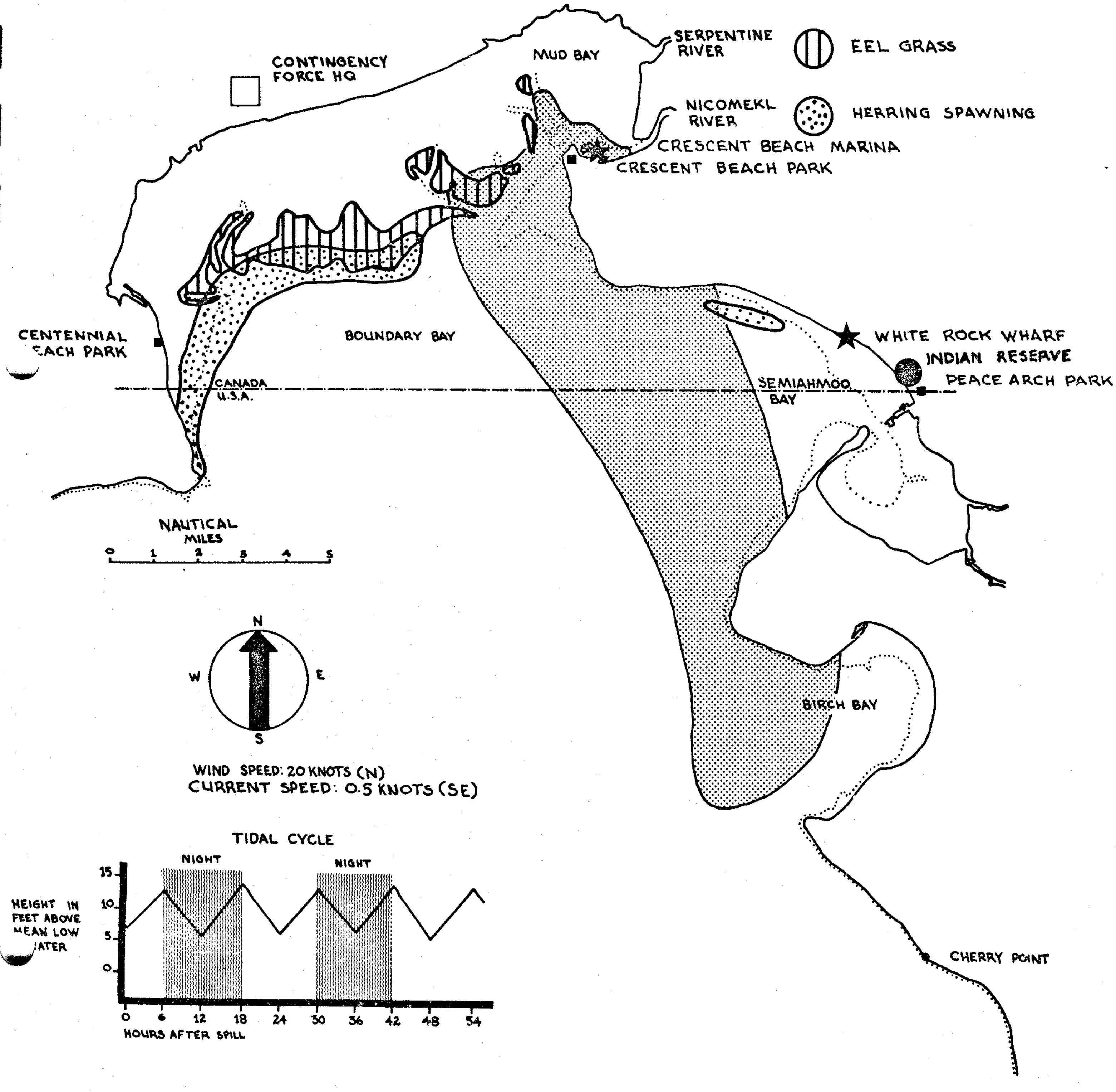
3. <u>24-30 Hours</u> (Refer to Map - Hour 30)

Tidal cycles carry the slick into Boundary, Mud and Semiahoo Bays contaminating intertidal areas.

SCENARIO NO. 1 (HOUR 24)



SCENARIO NO. 1 (HOUR 30)



A thousand birds, including seagulls and dabbling ducks, have been affected by the oil. The western edge of the slick is approaching the main herring spawning and brant feeding grounds in Boundary Bay. The shorelines of Crescent Beach have been coated with oil. Short booms are being towed parallel to the Crescent Beach shore to intercept some of the oil-soaked peat and oil escaping under these booms is bombed with more peat. A flotilla of boats and landing craft is being used to spread fresh peat moss and collect soiled material.

4. 30-36 Hours (Refer to Map - Hour 36)

The ebbtide countered by 20 knot southerly winds tend to push the slick northeast into a more circular configuration.

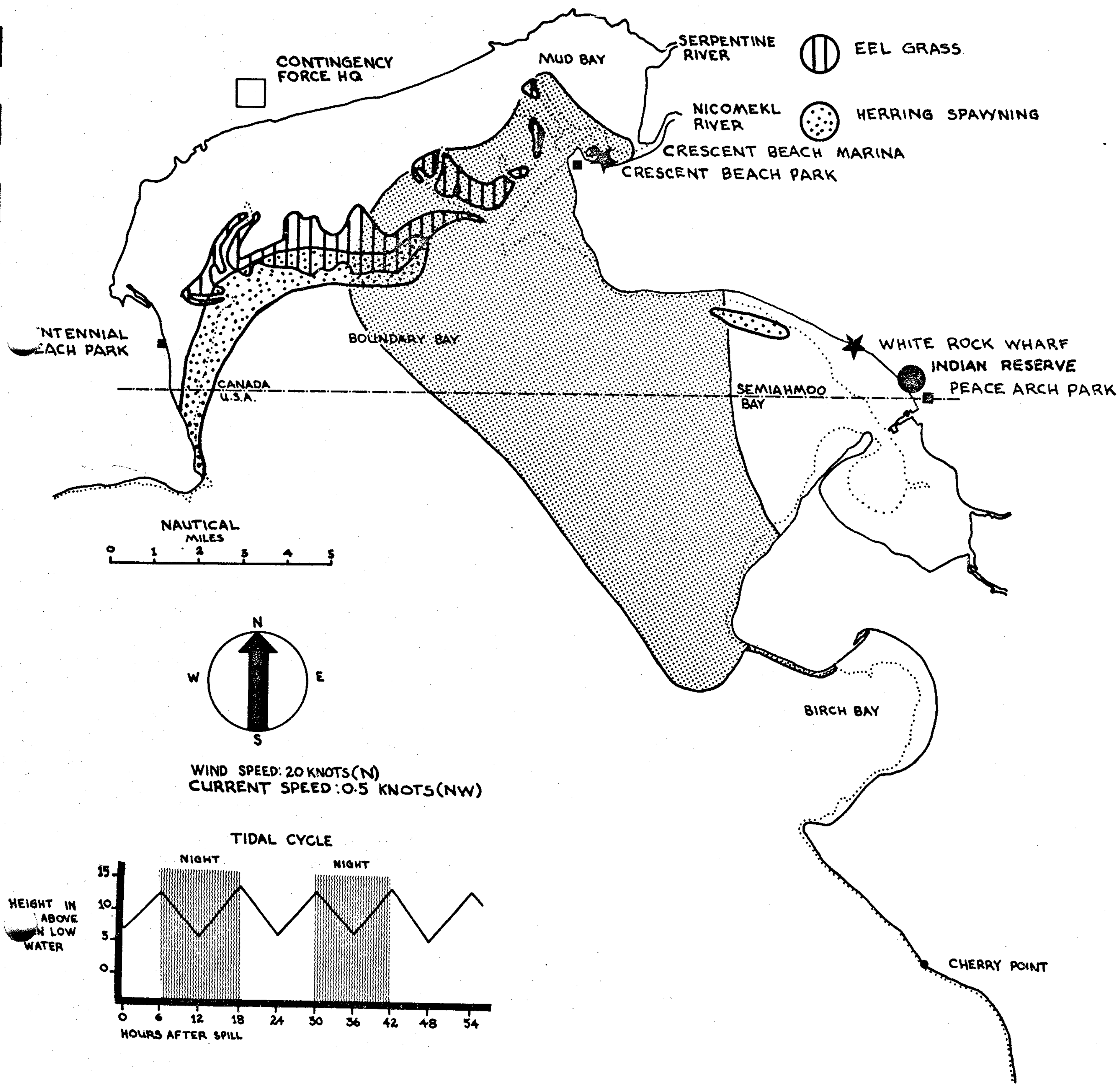
Eel grass and shell fish beds are becoming fouled with oil. Birds feeding during the night along the tide line on the eel grass beds are affected.

5. 36-48 Hours (Refer to Maps - Hour 42 and Hour 48)

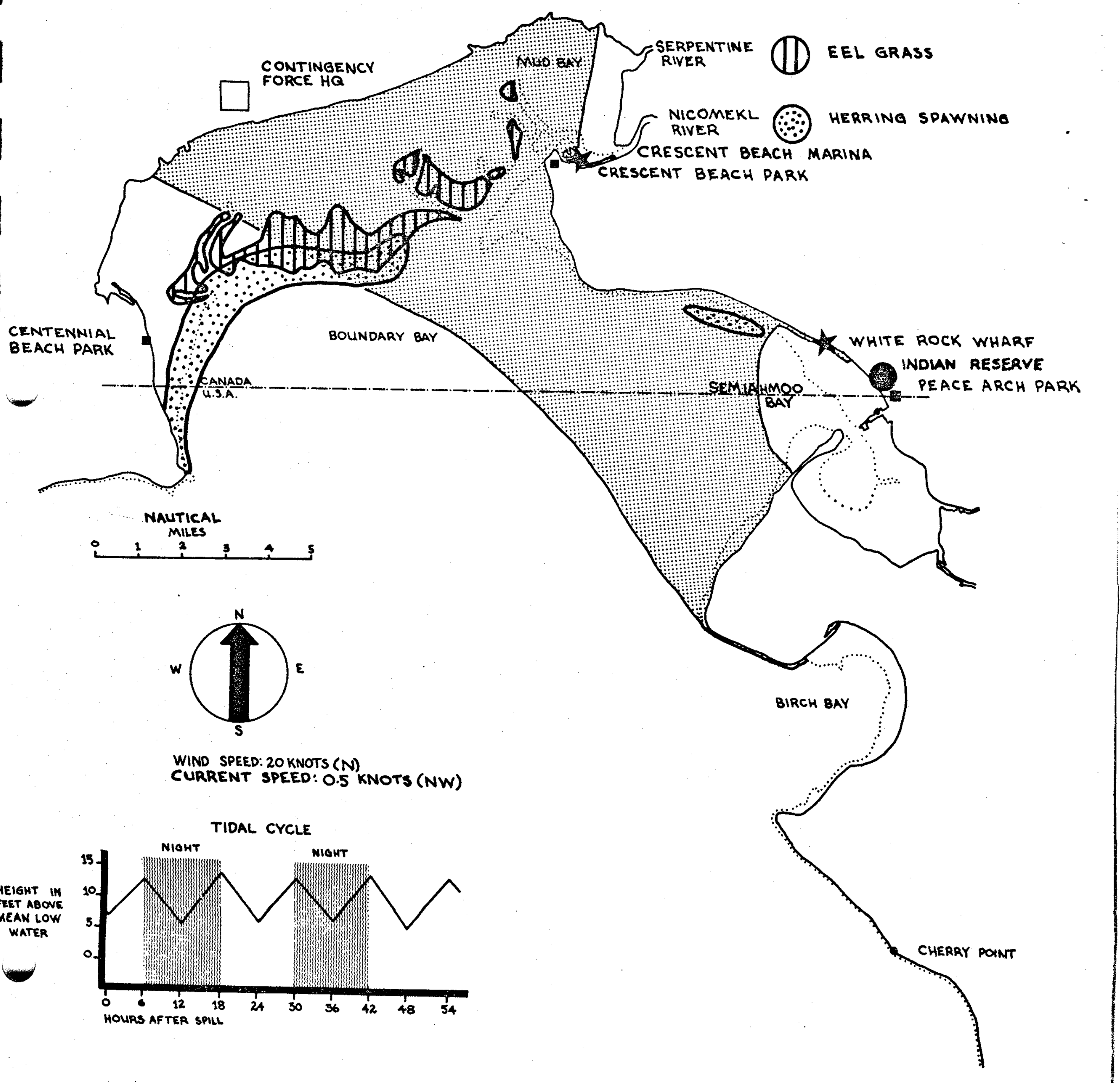
This flood tide causes the slick to cover thousands of acres of the intertidal zone in Boundary, Mud and Semiahoo Bays.

By daybreak, ten miles of Boundary Bay shoreline are coated with oil. Virtually all of the bird species inhabiting the bay have been oiled with estimates running up to 10,000 birds that have been affected - the actual number perhaps running five times that. Herring production has probably

SCENARIO NO. 1 (HOUR 36)



SCENARIO NO. 1 (HOUR 48)



been lost for the year and the impact on shellfish is severe.

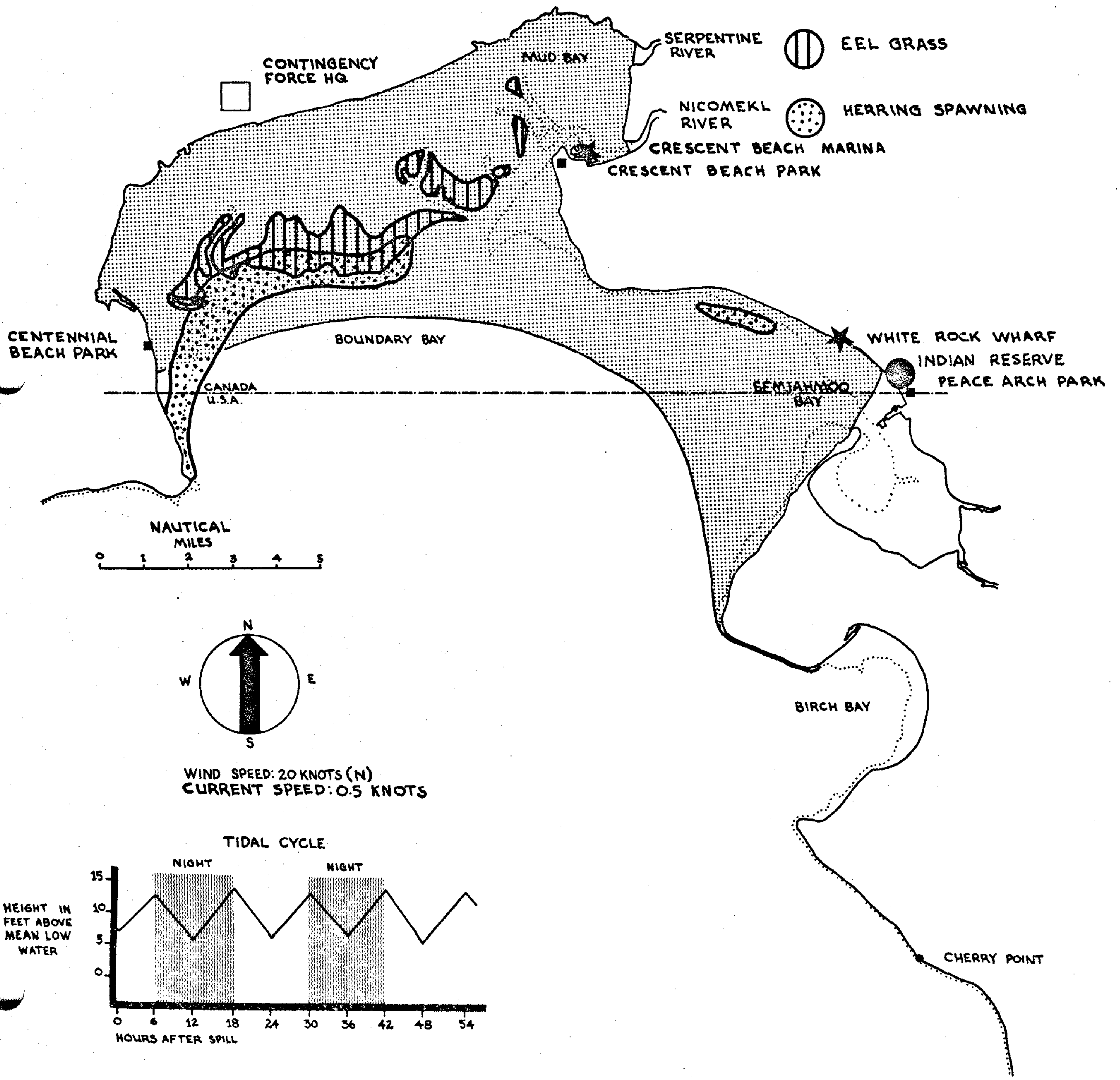
6. Beyond 48 Hours (Refer to Map - Hour 54)

After two days, the slick has reached its maximum area of some 35 square miles. Upwards of 3,000 people are now involved in the clean-up operation using boats, dune buggies, tracked vehicles, scrapers, and graders. The flood tide has now covered the complete shoreline of Boundary Bay. With migrant birds entering the bay each day, it is estimated that over one hundred thousand birds could be killed, including as much as .5% of the total Pacific black brant population. Efforts to rehabilitate the birds have been unsuccessful. Intertidal areas are recontaminated each flood tide and long-term biological effects may never be known. Recreation activity in the bay will be severely affected. Bathing and beachcombing will virtually cease because of continuous occurrences of oiling from the contaminated intertidal flats. Clean-up will continue for at least a month with a longer period of standby operation to deal with any re-oilings.

B. ECONOMICS OF LOST RESOURCE VALUES

The total reduced rental value of waterfront property is estimated at $700,000 with Crescent Beach and Boundary Bay being more seriously affected than White Rock and Ocean Park. Loss of property value of properties close to the water approaches $3 million, while an estimate of total recreation beach losses is a little over $1 million. With the addition of economic losses from the loss of waterfowl hunting, the total economic loss for the Boundary Bay area is nearly $4,700,000.

SCENARIO NO. 1 (HOUR 54)



C. SOCIAL CONSEQUENCES

Boundary Bay is one of the largest natural tidal flats on the entire Pacific coast, and its importance to migratory waterfowl has given it international significance. Recreationists and conservationists in the Lower Mainland have acquired a strong proprietary interest in the bay, and studies to develop a range of alternative plans for its development for recreational purposes and for the maintenance of its natural values are underway. Although there are no major educational or scientific programmes relating to the bay at present, the potential for these is immense.

D. COST OF SPILL RESPONSE AND CLEAN-UP

The Boundary Bay spill takes a month to clean up because of the difficulty encountered in clearing the extensive tidal flats. The clean-up costs involve land and water-based equipment, booms, slick-lickers and skimmers, barge tugs, barges, absorbents, aircraft, high flotation tired vehicles, 800 skilled personnel and 2,000 labourers. The approximate cost for this clean-up is estimated at $24,363,000.

CHAPTER VII - CONCLUSIONS

1. Starting this year, 1972, oil tankers of the 120,000 ton (854,000 barrel) class - the size of the Torrey Canyon - will be travelling from the open Pacific through Juan de Fuca and Rosario Straits to Cherry Point at the rate of about one per month. This rate will increase to one every five or six days if Alaskan oil becomes available for use at the Cherry Point refinery. On the basis of existing accident probability information, it is concluded that there is a 50% chance that this tanker traffic could result in an oil spill occurring at least once every twenty years, which would dump upwards of 20,000 tons of crude oil on to the sea in a manner that would seriously affect the Canadian coastal environment.

2. Extreme caution must be exercised in dealing in regional terms with the highly site specific impact of even an extensive oil spill, particularly in an area with the shoreline diversity and oceanographic complexity of the Strait of Georgia / Strait of Juan de Fuca. There is a natural tendency to consider the impact of a spill in the light of overall values of the total resource complex of the region, but this can be extremely misleading. The actual spread of oil from a spill is dependent on the rate at which the oil is being spilled, characteristics of the oil and, particularly, on existing oceanographic and meteorologic conditions. Furthermore, it is extremely unlikely that a collision or grounding of a tanker would result in the total loss of its cargo. These statements are not intended to down-play in any manner whatsoever the very serious implications of the sort of spill that could well take place within the study region, but are intended to

forestall the kind of criticism that can be levelled at statements which say that the contents of a supertanker could form an oil slick around the entire shore of Vancouver Island, and from that point automatically assume that the total resource complex of the shoreline is going to be affected. While dramatic positions such as this catch public attention, they do not constitute a realistic approach to dealing with the serious site specific reality of oil spills.

3. Crude oil or its by-products must be regarded as poisons that damage the marine ecology and as such will ultimately have to be treated with the same concern now shown for DDT and other chemical pesticides. While we have attempted to show on a general and site specific basis the environmental impact of a major oil spill in the study region, we are left with the overriding concern that since the scientific community still knows very little about the impacts that would result from the spillage of large volumes of oil at this latitude, oil spills may be doing far more harm that we can appreciate. However, the damage that would be done, plus the unknown long-term and sublethal effects of oil indicate that we cannot afford major oil spills even at twenty year intervals. If we are serious about protecting ecological and environmental values in the Straits of Georgia and Juan de Fuca, then we should conscientiously examine alternative means of transport for Alaska crude oil within both a national and international context.

4. The major social impact of oil transportation is probably the part that it plays in contributing to the general anxiety that society is expressing for environmental protection. While it is possible to assess economic and recreational losses and,

to a lesser extent, the disruption of life-style and the impact that an oil spill could have on human interest in unique and irreplaceable resources, it is extremely difficult to come to grips with the stress created by the awareness that once major crude oil shipments begin moving to Cherry Point, the vulnerability of the Canadian coastline leaves us holding yet another environmental time bomb. Coupled with this is the sense of frustration that people seem to feel about the fact that there is so little Canada can do unilaterally to protect herself, particularly with the knowledge that there are absolutely no economic or social advantages for Canadians in the tanker route.

5. Since no two oil spills are alike, it is necessary to simulate a real spill in order to identify its impacts and implications. A scenario of the kind of spill which could occur indicates that about $5 million worth of identifiable resource values could be lost, as well as significant biological and social values, and the complete clean-up costs to restore shorelines to as nearly as possible their original condition could be in excess of $24 million. To put these figures into perspective, and advanced traffic management system designed to control the speed and route of all major ships in the study region for the purpose of minimizing accident probability would cost about $3 million to install and $400,000 annually to operate. To establish a contingency force capable of reacting effectively to major oil spills would cost not less than $2.5 million to $4 million to create and about $200,000 annually to administer. In addition, the cost of replacing clean-up materials after each spill would be in the order of $500,000 to $1 million, though this cost would be much less if peat moss were

not stockpiled strictly for oil spill clean-up.

6. As human error is a key factor in over 90% of all oil spill incidents, the use of advanced navigation and shore-based traffic control equipment can only reduce the frequency of spills to a socially acceptable level; it cannot eliminate them. Measures for the prevention of oil spills are therefore concerned with minimizing the likelihood of oil spills occurring as a result of accidents during the transportation, transfer to and from vessels, and storage of oil. At present, these measures are largely lacking, though transfer operations in the American part of the study region are becoming increasingly more regulated. Only the barest beginnings are being made to regulate ship movements in the study region, and a concerted international effort to establish a comprehensive traffic management system in the Strait of Juan de Fuca / Strait of Georgia / Puget Sound area would be a major step toward reducing the frequency of oil spills occurring in it. The necessity of implementing such a system cannot be over emphasized as similar systems in other parts of the world have shown that they significantly reduce the frequency of shipping accidents.

7. Areas of concentration of high marine resource values and areas of high oil spill probability have been identified for the study region. Through a literature review, through discussions with people who have been involved in oil spill clean-up operations, and through first-hand observations of major and minor spill clean-up operations, we conclude that every effort should be made to refine our knowledge of the resource complex within the high hazard zones both as a means of determin-

ing the priorities for clean-up operations and as a way of assessing resource losses arising from a spill. Regardless of increasingly sophisticated clean-up technology and the use of the best transportation and communication aids, successful oil spill clean-up still depends on the degree to which clean-up efforts are sensitive to the environmental values that the clean-up is protecting.

8. Oil spills occur at three main levels and can perhaps be treated analagously to one, two and three alarm fires.

The first level - the one alarm spill - is the result of human error and mechanical failure in ship-to-shore and ship-to-ship transfer operations, and from deliberate or accidental discharges within harbours. These spills are usually small in size, techniques to clean them up are already developed, and most contingency planning efforts by the oil industry have been directed towards them. Spills of this type should be handled by oil industry, transportation companies, and local harbour authorities.

The second level - the two alarm spills - are those resulting from accidents to vessels distributing refined oil products and from the loss of bunker fuel arising from accidents to vessels operating within the region. The lack of firm data on marine transportation within the study region makes prediction of this type of spill virtually impossible. Such a spill calls for a higher level of contingency planning than that required for local harbour spills, although equipment stockpiled for harbour spills and for the major type of oil spill can both be used in dealing with this second hazard level.

The number of one and two alarm spills is much greater than the number of major tanker spills. Technology to control them is increasing, and they are the level at which Canada can, and should, be expecting to undertake contingency planning on a unilateral basis in the study region.

The third level - the three alarm spill - is the major spill resulting from an accident involving a tanker transporting large quantities of crude oil or oil products. Just as no single fire station is equipped to handle a three alarm fire, neither Canada nor the USA could be individually prepared to clean-up a major spill and every consideration should be given to joint Canada - USA preparations to handle these spills, especially those which could involve a supertanker on the approaches from the Pacific to Cherry Point, since the shorelines of both countries are equally vulnerable.

Notwithstanding these specific possible areas of responsibility, the lack of knowledge on the long-term effects of a continual build-up of oil in the marine ecosystem means that far more stringent international regulations must be imposed on the transport of oil by sea. Since oil is becoming a ubiquitous substance on the seas of the entire planet, it is obvious that no maritime nation can hope to protect its seashores on its own, and that international action to control oil pollution of the seas is long overdue.

9. It is concluded that attempts to deal with the environmental impacts which could result from a major oil spill, and impinge upon both Canada and the USA, could easily be frustrated by international debates over who is responsible for cleaning up and paying the costs of cleaning up such spills. One method of avoiding such delays would be to create an international fund to pay for the clean-up costs of all spills occurring in the Strait of Juan de Fuca / Strait of Georgia / Puget Sound inland sea as well as the costs of maintaining contingency forces. This fund could be financed by a tariff in the order of 17 cents per ton on all oil and oil products being transported in the region. Compensation for loss of resource values not adequately covered by other means could be paid out of an expanded fund. The costs of spills caused by vessels not carrying oil or oil products as cargo could be paid directly by the owner of the vessel and/or cargo. The fund would have to be administered in close conjunction with any international oil spill clean-up contingency arrangements between Canada and the USA.

10. The point has frequently arisen in the literature and in our own field experience that no matter what the method of oil spill clean-up, fast notification and mobilization of contingency teams are critical. Early action not only can protect shorelines from contamination, but also minimizes it should it occur. Considering crude oil properties, shoreline features and the special "inland sea" characteristics of the study region, it is concluded that mechanical means of clean-up - notably the use of booms, slick-lickers and the application of peat moss - are generally less harmful than chemical ones, although not always as effective.

11. We strongly endorse the summary of recommendations incorporated in Part 2 of Volume I of the "Report of the Task Force - Operation Oil (Clean-up of the Arrow Oil Spill in Chedabucto Bay)" as it appears in Appendix E of this report. We particularly endorse the scientific preparedness priorities suggested. Through our own literature research, we have identified precisely the same shortcoming as the Operation Oil team recognized in their establishment of scientific preparedness priorities.

12. While this particular study has dealt with oil transportation on the west coast in isolation, we recognize fully, and stress, that this is only one component of what should ideally be a major international accord between Canada and the USA on the manner in which oil is moved from Alaska to U.S. markets.

Ecological imperatives repeatedly point out the artificiality of our international boundary from the standpoint of environmental damage, and this study is an excellent case in point. We have dealt with the impact of a potential oil spill on Canadian shorelines, but the impact on adjacent U.S. coastlines would, of course be equally devastating. Sooner or later we have to face up to the harsh reality, that ecological and environmental imperatives, not man-made imperatives such as national security or arbitrary boundaries, are really going to determine whether or not men and nations are to live in harmony with their environment. It is the environmental imperatives and not the man-made which must act as the real constraint on international oil shipment.

CHAPTER VIII - RECOMMENDATIONS

It is not our intention in these recommendations to list the numerous specific items which should be undertaken - these are embodied in the report and have been discussed at various times with people in the responsible agencies on the west coast. As well, the terms of reference did not call for an agency specific study. The recommendations presented here are derived from the broader level of conclusions that we have reached.

1. We recommend that the Canadian government pursue with the utmost vigour every possible avenue to bring about international recognition of the environmental imperatives that must act as the real constraints on international oil shipments.

2. We recommend that Canada proceed unilaterally to establish and maintain an effective contingency plan that is genuinely responsive to local conditions and takes care of the type of oil spills that arise in harbours and shoreline installations as a result of ship-to-ship and ship-to-shore transfer of oil products.

3. We recommend that Canada unilaterally establish on the west coast a contingency force capable of dealing with the type of oil spill that is likely to arise from the spillage of refined products being transported within west coast territorial waters, and of bunker oil that would be spilled as a result of accident to a vessel operating within the area.

4. We recommend that a third level of contingency planning be initiated in cooperation with the USA for the control of major spills arising from an accident involving a tanker transporting large quantities of crude oil or oil products. Particular emphasis should be placed on preparing for spills on the route to and from Cherry Point.

5. We recommend that any oil spill contingency plan incorporate as its major features: a) the ability to react quickly and effectively to contain and clean up spills; b) the stockpiling of critical and difficult to obtain clean-up materials and equipment for quick mobilization; and c) the documenting of access to other required materials and equipment.

6. We recommend that, in addition to international oil spill contingency planning between Canada and the USA, a fund be created to pay the costs of all contingency forces and clean-up operations in the region. The fund should be financed on a "user pays" basis, most preferably by a tariff on each ton of crude oil or oil products being transported. A value in the order of 17 cents per ton appears to be a reasonable first approximation of the tariff required, and could be used as a basis for more detailed economic and political considerations to arrive at the final levy. Consideration should also be given to paying compensation out of the fund for loss of resource values not adequately covered by other means.

7. We recommend that Canada and the USA jointly establish and operate a

comprehensive marine traffic management system for all major vessels travelling in the Strait of Juan de Fuca / Strait of Georgia / Puget Sound inland sea. This system should monitor all communications and vessel locations, and issue either advice or direct orders concerning the routing and speed of all vessels it manages.

8. We recommend that the regulation, surveillance and enforcement of transfer operations be undertaken by one federal agency to prevent chronic long-term pollution of coastal waters and shorelines.

9. Since time constraints and the urgency of dealing with the crude oil movement to Cherry Point prevented the fullest possible examination of internal traffic movement within the study region, we recommend that a more intensive examination of internal barge and tanker movements, and other major vessel movement in the study region, be undertaken in order that a realistic assessment of spill probability of refined products can be made.

10. Since the major purpose in an oil spill clean-up operation is to protect the environment, we recommend that the baseline information on the high hazard zones identified in this study report be further refined and used to dictate the actual level of contingency planning eventually arrived at for the west coast. The information should be developed to the extent that it can be used to determine clean-up priorities and the degree of resource loss in the event of a spill.

11. We recommend that in any oil spill contingency plan a major provision be made for an effective programme of community relations to ensure that individuals who would be affected by the spill are adequately informed of the likely impacts and, equally important, to ensure that uninformed public opinion does not result in politically expedient clean-up measures that simply remove the oil from sight to the long-term detriment of the environment.

12. We recommend that the recommendations of the Operation Oil Task Force which was responsible for the clean-up of the Arrow oil spill in Chedabucto Bay form a significant role in developing Canada's preparedness for oil spills. A summary of those recommendations appears in Appendix E of this volume.

13. Our first twelve recommendations have dealt with the reality of oil transportation as it exists in 1972. However, the threat of oil pollution from supertankers has its origin in problems beyond economics or national security, and we recommend that Canada and the U.S. join in an examination of not only alternatives to the tanker route, but also the fundamental and real question of our exploding energy use.

APPENDIX A - ECONOMIC VALUES

This appendix develops dollar figures for the major economically identifiable resources within the study region. It does not attempt to be completely comprehensive as many resources have values beyond monetary terms. Extreme caution must be exercised in using this broad spectrum of economic information as the figures represent simply an asset statement in monetary terms of resources within the study region rather than potential losses from one oil spill.

1. Fisheries

For all fish except salmon, there was a landed value in excess of $2 million in 1970 and a wholesale value of about $3.5 million that year.

The current study region landed catch value of salmon is in excess of $14 million with a corresponding wholesale value of just under $30 million. This represents a very conservative estimate of the sustainable catch level in this area which through potential productivity of the Fraser system and hatcheries programme could rise to an average annual landed value of $25 million and an average annual wholesale value of $54 million.

2. Waterfowl Hunting

License revenues to the provincial and federal governments from hunting within the study region are estimated at $98,000, payments to land-owners at $30,000, hunters' expenditures at between $756,000 and $900,000, and the value of the hunting experience to the hunters themselves at $420,000 to $500,000.

3. <u>Pleasure Boating and Moorage</u>

On the basis of analysis of the economics of pleasure boating in recent reports, it is estimated that the total value of boats in the study region is approximately $250 million, and the total replacement value for boat berthing is $49 million.

4. <u>Commercial Fishing Vessels</u>

The total value of commercial fishing vessels is about $78.6 million.

5. <u>Log Booms and Storage</u>

Total log boom inventories of some 750,000 Mbm are estimated at $54 million.

6. <u>Recreation</u>

The estimated outdoor recreation values based on hunting, boating, recreation days, saltwater sports fishing, swimming, beach activities, strolling, picnicking, sightseeing, and nature study represent a total of $122 million, based on the best methods of assessing recreational values which are available.

. . .

Concluding this summary of economic information, it must be stressed that this broad background information simply gives a guide to the total identifiable marine resource values within the study region exclusive of real estate values which were impossible to assess fairly within the time constraints of the study. These figures do not represent the resources that would be affected within the realistic terms of actual oil spill conditions.

APPENDIX B - PREVENTATIVE MEASURES

It is unrealistic to expect to prevent all oil spills from occurring. While the use of sophisticated technology can reduce the number of oil spills, it will not reduce the percentage caused by human error. As human error is involved in over 90% of all oil spill incidents, we can therefore reduce the problem only to a level which is socially acceptable; we cannot eliminate it.

In attempting to specify oil spill preventative measures, it is how they perform rather than how they are designed which should be considered. In this way the desired level of safety can be required of a preventative system without restricting the development of its design. It should be a regulation philosophy that any preventative measure - human, mechanical or electrical - be backed up by at least a second measure performing the same function which becomes operational should the first measure fail.

Items relating to the performance of tankers which are highly relevant to the avoidance of accidents and oil spills are: (i) stopping distance; (ii) manoeuverability; (iii) the resistance to hull damage due to grounding, collision, explosion or fire; (iv) the capability of on-board navigational instrumentation; (v) on-board facilities to prevent the discharge of oily waste into the sea and to contain and collect accidental spills; (vi) on-board facilities for the removal of oil should the vessel be sunk. Navigation aids and regulations should define definite and compulsory rules of the road for all vessels to reduce the incidence of grounding. Their operation must not be impaired by poor weather, and should enhance the reliability and usefulness of navigation equipment on board the vessels using the waterway. Preventative measures pertaining to the transfer of oil from vessel to vessel or from vessel to shore tank must ensure that any system malfunction (i) is detected immediately by the operators; (ii) will not cause a rupture to occur; and (iii) will automatically result in a safe shutdown of operations.

Without the cooperation of the U.S.A., Canada can do nothing to regulate the operation of tankers bringing crude oil from Alaska to Cherry Point since at no time need these ships enter Canadian waters and thus become subject to Canadian regulations. There is much more that can be done by Canada to ensure the safe transport of oil and oil products in her own waters. The 1971 amendments to the Canada Shipping Act empower the Canadian government to make regulations concerning a wide range of items associated with the pollution hazards of shipping. The extent to which the implementation of this act will in fact militate against pollution damage from oil spills is debatable since so much of the problem derives from the operating characteristics of the ships themselves. World-wide international agreement is required to realistically attempt to solve any matters concerning ship design and the capability of navigation instrumentation. No country can attempt to regulate these items on its own without accepting a serious reduction in the number of ships coming and going from its ports.

With the cooperation of the U.S., considerably more can be done to protect the coastal environment from oil spill damage. While the two countries together still cannot realistically attempt to regulate ship design and operating procedures, they can establish a comprehensive traffic management system for the Strait of Juan de Fuca / Strait of Georgia / Puget Sound waterway. From one management centre, such a system would continuously monitor all ship-to-ship and ship-to-shore communications as well as all vessel locations as determined by shore-based equipment, and would issue either advice or direct orders to vessels in the management area with respect to their route and speed. Participation in the management system would have to be made compulsory for all vessels in the management area. A number of similar systems are presently in operation around the world, and have resulted in a significant reduction in shipping accidents.

Both Canada and the U.S.A. are in the preliminary stages of developing systems of traffic routing and surveillance in the inland sea; however, they are doing it independently of each other even though a jointly operated traffic management system would undoubtedly be more effective than two separate systems. It would cost at least $3 million to establish and approximately $400,000 annually to operate. In comparison, the total cost of clean-up in Chedabucto Bay after the grounding of the Arrow was about $3,100,000, and even after this expenditure, much of the oil remained on the shores of the bay.

APPENDIX C - CONTINGENCY PLANNING

The terms of reference for this study did not call for a detailed specific assessment of contingency planning but rather for a more general statement of a possible and practical contingency plan required for the region. A detailed review of contingency planning and clean-up operations in other parts of the world has been undertaken and we have also observed several oil spills that have occurred in this area during the study period.

Rapid systematic deployment of equipment and personnel is of the utmost importance in preparing and implementing a contingency plan. On the west coast, the B. C. Forest Service approach to forest fires (hit hard and fast) is a good parallel for oil spill contingency planning. Fires are initially treated as major problems and the cost of over-reaction is regarded as inexpensive insurance when compared to the damage expense which could have occurred had a fire become large. Any oil spill involving a supertanker could be directly comparable to this forest fire fighting situation.

The approach to contingency planning and clean-up falls into four areas: alert, initial response, major response, and post clean-up operations. The following table schematically outlines one preferable contingency force mobilization plan.

The capital expenditures required to set up a contingency plan are

CONTINGENCY FORCE MOBILIZATION TABLE

ACTION	SECTIONS MOBILIZED: OPERATIONS	SECTIONS MOBILIZED: SERVICES
Alert	(a) Detection	
Initial Response	(a) Reconnaissance and Classification (b) Suppression Force	
Major Response (Large Oil Spill)	(a) Containment (b) Floating Oil Clearance (c) Debunkering Salvage (d) Beach Clearance (e) Disposal	(a) Communications (b) Scientific Sector (i) Environmental (Physical - Oceanography & Meteorology) (ii) Environmental (Biological & Assessment of Damages) (iii) Oil Characteristics (iv) Clean-up Technology (c) Administration (i) Contracts, Legalities, Finances (ii) Manpower, Acommodation, and Catering Services (iii) Purchasing (iv) Damage Assessment - Human Values (d) Logistics and Transportation (e) Documentation and Public Relations (f) Library and Outside Advisors

ACTION	SECTIONS MOBILIZED	
	OPERATIONS	SERVICES
Post-Clean-Up	(a) Demobilization (b) Post-Clean-Up Surveillance (c) Rehabilitation	

estimated at $2. 5 to $4 million. This spread is in part attributable to the fact that much of the equipment required is already in the hands of different government departments for other purposes. It is estimated that the annual administration for a contingency plan would be approximately $200, 000, while replacement costs for materials used in clean-up of a spill of the type and magnitude outlined in the scenarios would range from $500,000 to $1,000,000.

APPENDIX D - CLEAN-UP METHODS

1. The Behaviour of Oil

Different types of liquid petroleum products behave in very different manners depending on volume, density, viscosity, volatility, and chemical composition when spilled on water. There are, however, some general characteristics:

(i) Oil usually floats on water but in some cases may sink in lens or droplet form;

(ii) The layer of spilled oil will be thickest at the source of the spill and thinnest at the perimeter;

(iii) Oil spills spread gradually over a wider surface area unless contained by artificial or natural barriers;

(iv) Crude and bunker oils emulsify rapidly forming stable water-in-oil emulsions;

(v) Oil degrades: lighter fractions evaporate; all fractions slowly oxidize.

When heavy oils are washed onto shorelines, they tend:

(i) Concentrate at the high water mark of the shoreline;

(ii) Coat the surface of rocks in the intertidal zone and penetrate cracks and fissures;.

(iii) Stabilize the movement of beach material on cobble beaches;

(iv) Divide and become covered with a surface layer of sand. If left for a period of time, tidal action can create an impervious layer of oil and sand over which water may percolate causing erosion of the upper beach layer.

2. Clean-Up Methods on Water

a) Mechanical Methods

The most effective method of cleaning water-borne oil spills is to pump oil directly from the source of pollution and transport it to shore, weather conditions permitting. A variety of mechanical devices such as skimmers and slick-lickers are being developed to remove oil from the surface of water, but their effectiveness depends entirely on moderate surface water conditions. Booms have also been developed to contain oil spills but they generally cannot contain oil in currents that exceed two knots.

b) Chemical Methods

Chemicals can be used to treat water-borne oil spills by promoting emulsification, sinking, or burning. One of the major problems associated with the use of chemicals is the fact that the chemicals themselves can be more toxic than the oil. At the present moment, the burning of oil slicks is extremely difficult because of the heat loss across the oil-water interface.

3. Clean-Up Methods on Shore

Restoration of polluted shorelines is difficult at best and in some cases impossible. As well, existing technology is both labour and capital intensive.

a) Physical Removal

This usually involves application of absorbent materials to the polluted area to concentrate oil which is then removed by equipment or by hand.

b) Chemical Removal

Dispersants can be used to clean sandy beaches and rocky shorelines. Most of these chemicals are toxic to tidal life and can only be used with extreme caution and when absolutely necessary.

c) Processing

The removal of beach material and treatment by thermal or other processes is in the experimental stage and has not been used under the actual conditions of a spill. Expense may limit its practical application.

APPENDIX E - REPORT OF THE TASK FORCE - OPERATION OIL

(PART 2 - SUMMARY OF RECOMMENDATIONS)

INTERNATIONAL ACTION

We recommend that

consistent with the initiatives taken by the Government with respect to Arctic pollution and at the IMCO special conference on pollution in 1969, Canada take a parallel initiative to convene a conference of all those concerned to write a new international convention for the operation and control of shipping throughout the world and that this convention be patterned on the principles of the Convention on International Civil Aviation.

the convention should ban all deliberate pumping of oil, oily waste or tank cleanings, or bilge cleanings into the oceans or any other body of navigable waters

Canada should take the initiative with the appropriate international bodies to seek agreement on a series of definitions and descriptions that will permit the reporting of spills in an orderly and understandable manner.

NATIONAL ACTION

We recommend that

extensive pollution control zones be established to cover the rest of the coast of Canada consistent with the position taken by the Government in the Arctic the law should make it clear that those who pollute pay the complete cost of clean-up, including the cost of any Canadian federal or provincial personnel used in the clean-up, that the ship concerned be impounded until this has been accomplished or assured and that the legal penalties be in addition to this liability for the complete cost of cleaning up the pollution.

We recommend that

1) with respect to tanker operations, in order to enter Canadian waters, they provide evidence that they are fitted with adequate and serviceable navigation equipment

2) Canadian pilots be required on all vessels entering Canadian waters unless the ship and its captain have been given special clearance by the federal authority

3) standards of competence of crews of ships entering Canadian waters should conform with our national standards

4) the same principles as in 2) and 3) above should apply to Canadian ships in Canadian waters

5) there should be a compulsory filing of samples of all petroleum products loaded on ships and a requirement that any spillage of petroleum products, regardless of whether they originate from a shore tank or a ship, be immediately reported and sampled

6) the federal government establish one or more central laboratories capable of "finger-printing" petroleum products in a manner acceptable to the courts

7) until a better scheme is developed, the tankers and barges used in the petroleum trade be fitted with the Madsen valves.

We recommend that

1) all bulk storage tanks holding petroleum products or other hazardous substances be protected by dykes capable of containing the entire contents of the tank

2) pipelines running along water courses be similarly dyked.

ORGANIZATION AND PREPAREDNESS

1. Governments

We recommend that

1) the federal government should have the operational responsibility and authority for all major spills at sea and should reach agreement urgently with the provincial governments concerning the responsibility for all other major spills

2) with respect to moderate spills within provincial jurisdiction, agreements be reached with each province

3) with regard to minor spills agreements be reached between the provincial government and municipalities, with the provincial government having someone on site to take over in case the municipality is unable to cope.

We recommend that

the Minister of Transport have the responsibility for dealing with pollution arising from oil spilled in water when the extent and nature of the spill makes it a federal responsibility.

2. Ministry of Transport

We recommend that

this responsibility of the Minister of Transport be focused in a small team at the headquarters level and comprising a minimum of one physical scientist, one biological scientist and one operations expert, with the physical scientist being the leader

very careful attention be given to the community relations aspects of contingency and operation plans and that those information officers who are capable of effectively operating in a community relations setting be identified, involved with the headquarters team in the planning, and be immediately available when operations are mounted to deal with a pollution incident

stockpiles of material be located at strategic ports. These would include peat moss or other absorbents, booms and boom components, and a variety of equipment not readily available, which will vary with each location

at least one slick-licker be placed at each major port on the Canadian coast and that at least two others be held in a central contingency packet

the Canadian Coast Guard have primary responsibility for the recovery of oil floating on the water, which will include slick-lickers, containment booming and all other ramifications

the Canadian Coast Guard be responsible for steam cleaning operations.

3. Department of National Defence

We recommend that

HMCS Cape Scott and Cape Breton be maintained operationally ready to fulfil primary roles in the national contingency plan

the Department of National Defence take on the responsibility of developing an operational communications plan so that in an emergency all segments of the federal government in the field can communicate with one another.

4. Industry

We recommend that

the oil industry reach agreement among themselves to provide on immediate call from a Federal Government Task Force suitable oil recovery vessels

industry be heavily involved in research, development and production of equipment and material needed for the contingency packages on the one hand and the actual clean-up operations on the other, as well as devices to assist in the prevention of pollution incidents.

5. Department of Public Works

We recommend that

the Department of Public Works provide engineers to supervise the beach cleaning operation

6. Department of Energy, Mines and Resources
Department of Indian Affairs and Northern Development
Department of Fisheries and Forestry
Department of National Health and Welfare
National Research Council
And Support of Research

We recommend that

the scientific advice required by the headquarters team in the Ministry of Transport be provided by a group actively concerned with a portion of the research themselves. This advice will include assessment of research done in other countries, assessment of proposals for research to be carried out in Canada, and advice on grants to universities and industry to involve them in research, development and innovation in this area of pollution and its prevention. We feel that at the present time the best group to perform this function is the group that came together in Halifax on an ad hoc basis for Operation Oil headed by Dr. W. L. Ford, Director of the Atlantic Oceanographic Laboratory.

money for the support of relevant research at universities and in industry should be made available to the Ministry of Transport and disbursed on the recommendation of the headquarters team with the assistance of their

PROJECT TEAM MEMBERS

Principal Consultant: Howard Paish & Associates Ltd.

John Boyle

Ken Fujino

Lorna McCreath

Dougald MacDonald

Howard Paish

Ted Richardson

Lorne Russell

Bob Sherwood

Sub-Consultant: Pearse Bowden Economic Consultants Ltd.

Gary Bowden

Gerard Mos

COVER PHOTO: Oil Spill from Freighter Vanlene/Austin Island/ March, 1972

PHOTO CREDIT: Dave Looy

scientific advisers

the initial funds to support the Canadian research effort on oil pollution problems in universities and industrial laboratories be $250,000 per annum

the National Science Library be the central repository for literature dealing with oil pollution and that there should be no proliferation of library holdings in the various federal government departments.