Environment Canada Review

of the

Hibernia Development Project Environmental Impact Statement

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ENVIRONMENT CANADA REVIEW OF THE HIBERNIA DEVELOPMENT PROJECT AS PRESENTED TO THE HIBERNIA ENVIRONMENTAL ASSESSMENT PANEL

July 1985

Scientific and Technical
Comments

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1. Introduction

Environment Canada has reviewed the scientific and technical merits of the Hibernia Development Project Environmental Impact Statement. This document summarizes our findings. The Department is prepared to explain or enlarge upon any of the commentary we have provided.

Environment Canada acknowledges the considerable contribution which Mobil Oil Canada Ltd. has made in consolidating the existing knowledge of the Northeast Grand Banks and by sponsoring additional studies in an effort to fill existing data gaps. Continued research and monitoring in this area will add to the data and understanding of the ecological interactions which are occurring and will facilitate management decisions on hydrocarbon exploration and production activities in the Grand Banks region.

There are, however, some significant weaknesses in the impact assessment contained in the Mobil Impact Statement. The following commentary is intended to assist the Panel in identifying these areas and the proponent in addressing them.

A Departmental position on the proposed Hibernia Oil Field Development project will be provided to the Panel subsequent to our evaluation of the information to be provided by Mobil Oil Canada Ltd. in mid-August.

2. Summary

2.1 Overview

Environment Canada recognizes the fact that the Hibernia Development Project Environmental Impact Statement as prepared by Mobil Oil Canada Ltd. is based upon development concepts which have yet to be precisely defined. The proponent has yet to declare its preferred development approach - floating or fixed production systems - and as such, the present Impact Statement remains a planning tool by which the principles and constraints of design may be identified. Environment Canada fully supports consideration of environmental factors at the earliest stages of development planning; it is equally important, however, that environmental criteria are incorporated in the development, construction and ultimate operation of Hibernia. The proponent does not provide a commitment to the principles of best practical technology to protect the environment. Just as there are guiding principles by which an engineering project is designed, so there are environmental principles to which a commitment should be made, even at the earliest stages of project design.

This Department considers that the proponent is overly optimistic in the evaluation of environmental risks inherent to this development. In presenting qualitative narratives of the ecosystems and incomplete evaluations of, for example, the environmental risk from oil spills and potential seabird mortalities, the proponent has not provided the Panel or the public with an accurate understanding of the risks and benefits of the Hibernia Development Project.

Although the department does not have the expertise to dispute the proponent's claim that a structure can be built to operate on the Grand Banks in an environmentally safe manner, the proponent has not adequately supported its claim by providing evidence of a thorough engineering risk analysis or its equivalent. The environmental conditions on the Grand Banks are extreme and a number of the engineering aspects of this project, for example, the potential for iceberg collision and bottom scouring, are unprecedented. Neither the analysis of the data base nor the means by which impacts are evaluated are adequate to provide a comprehensive understanding of the risk posed by the environment to this development.

The boundaries utilized in the Impact Statement are artificial and inconsistently addressed. For example, the potential for shoreline or coastal impacts should be considered and significant ecological features such as Flemish Cap and the Southeast Shoals are noted but not included when impacts are evaluated. As well, the cumulative effects from developments ancilliary to Hibernia or from other concurrent uses of the Grand Banks are not addressed.

Regardless of its limitations as a predictive or planning tool, the Impact Statement and the background documents used to produce it represent a significant compilation of information on the Grand Banks ecosystem. As a descriptive work, the Impact Statement will be widely utilized as a reference and, therefore, should be factually accurate. We have identified a number of corrections in our commentary and we urge the Panel to require the proponent to issue a corrigendum.

2.2 Marine Birds

The Grand Banks can be considered the ornithological crossroads of the Northwest Atlantic, and human induced changes in the marine environment place entire populations of birds at risk. It is Environment Canada's judgement that oil losses from this development will lead to significant mortalities in certain seabird species and could result in irreversible impacts on some populations. This could affect birds which breed in Newfoundland, as well as immigrant species which range from the high Arctic to the South Atlantic Ocean. The proponent has not fully evaluated the potential impact on seabird populations, even though it is stated that the risk to individual animals is high. Since seabird mortality following an oil spill bears no predictable relationship to the amount of oil spilled, Environment Canada is as concerned with the incidence of small chronic oil releases as with the occurrence of a large accidental oil spill. The proponent should be required to more fully evaluate the risk to seabird populations and propose mitigative measures to reduce or eliminate the loss of even small quantities of oil.

2.3 Meteorological and Oceanographic Criteria

The Department considers that the proponent's ability to mitigate iceberg collision through early detection and avoidance has been overstated. Remote detection of icebergs is still very much in the developmental stage. Although the Impact Statement presents relatively comprehensive and up-to-date meteorological and oceanographic data, the data are not always interpreted appropriately. If not corrected in the early stages of project design, this may lead to invalid design criteria with respect to wave height or ice accretion, for example.

2.4 Oil Spills

Environment Canada considers the treatment of oil spill prevention, fate and mitigation to be incomplete even though the slick trajectory models employed are state-of-the-art. In addition to the evaluation of the impact of a major oil spill at the well site, the proponent should determine the impacts of spills from a tanker carrying Hibernia crude along existing traffic lanes. Furthermore, the properties of Hibernia crude and its tendency to form dense persistent emulsions with cold seawater should be factored into the predictions of slick fate and effects to more accurately reflect likely conditions. Effective oil spill clean-up technology has not been demonstrated under open ocean conditions. The potential for and feasibility of such oil spill clean-up, as well as alternative approaches to mitigation should be investigated. The proponent should provide more analysis of movement of oil in pack ice and below the water surface. In addition, the potential for a blowout, a large accidental oil spill and smaller spills during oil transfer has not been inadequately addressed.

2.5 Environmental Effects of Oil

The Impact Statement has not dealt adequately with the possible effects on the marine ecosystem of either major oil spills or chronic releases of oil. Environment Canada considers that the Impact Statement presents an overly optimistic picture of the environmental effects resulting from a major oil spill. In addition, long term impacts, such as a build-up of contamination around production wells and ancilliary offshore fields, have not been addressed by the proponent. The question of cumulative impacts of all present and potential uses of the coastal environment is not adequately addressed. Additional justification is therefore required to support the statements that oil spill impacts will be "negligible" or have "no impact". The argument that the Grand Banks is a homogeneous mass which will quickly replace any biological component destroyed or damaged by oil pollution is disputed by Environment Canada.

2.6 Risk Analysis

No risk analysis has been presented by the proponent. Although the proponent has made a commitment to perform an engineering risk analysis on some part of the project at an unspecified future date, there has been no commitment to conduct an environmental risk analysis. Both types would form a rational basis for comparison of the development production alternatives and it is the opinion of this Department that this or some other form of quantitative comparison should be provided as a basis for the proponent's decision on the production method of choice.

2.7 Operational Discharges and Controls

Environment Canada does not agree with the proponent's plan for managing oily water discharge. Reasonable estimates of the frequency of upset conditions which could significantly increase the total quantity of oil discharged have not been presented. The proponent should therefore be required to provide these estimates and should investigate the feasibility of more appropriate methods of controlling discharges under routine and upset conditions.

2.8 Monitoring

The lack of a detailed monitoring plan of predicted impacts and a strategy for detecting other impacts is a major deficiency of the Impact Statement. To effectively mitigate unpredicted impacts, a comprehensive monitoring program is essential. A commitment by the proponent to evaluate various monitoring mechanisms and implement a suitable approach at project start-up is needed at this stage of the proponent's planning process.

2.9 Socio-economic Analysis

The proponent has underestimated the full spectrum of socio-economic impacts and consequently the environmental impacts such as the land and resource use from the Hibernia project. As a result, discussion on the management of impacts has not fully considered the range of mitigative measures that may be required.

3. Subject Reviews

3.1 Marine Birds

Environment Canada considers that the sections of the Impact Statement dealing with seabirds do not fully evaluate the potential impact on seabird populations. Chronic oil spills have not been evaluated nor has the proponent integrated seabird distributions with spill trajectories.

3.1.1 The Grand Banks seabird community

The Grand Banks may be thought of as an ornithological crossroads in the north-west Atlantic, and human-induced changes in its marine environment may affect populations of seabirds which breed far away from Newfoundland. Canada has international obligations to protect these species under the Migratory Birds Convention.

The Impact Statement correctly notes that many of the seabird species visiting the Grand Banks migrate from distant breeding places. However, the significance of this warrants particular emphasis in a general summary, instead of being discussed piecemeal in the individual species accounts. For example, the world population of Greater Shearwaters from the South Atlantic winters on the Grand Banks, as does the Dovekie population of north-west Greenland, the principal breeding area for that species. Banding and taxonomic studies demonstrate that significant numbers of Northern Fulmars fly from western Europe and the European Arctic. Most of the juvenile Atlantic Puffins from south-west Iceland (the world population centre for the species), Thick-billed Murres from west Greenland and the eastern Canadian Arctic, Black-legged Kittiwakes from there and from Britain and the European arctic, Cory's Shearwaters from the Azores, Sooty Shearwaters from the Falklands and Wilson's Storm-petrels from Antarctica **all make their way to the Grand Banks.** These aspects should be addressed in the Impact Statement.

3.1.2 The risk of inshore oil spills

Statements such as ". . . the movement of oil towards the coast of Newfoundland is very unlikely because of the prevailing westerly winds . . " (I: 46) take no account of possible spillages away from the Hibernia field. Tuck (1961) has shown as long ago as the 1950's that dead birds, apparently oiled by chronic minor leaks from passing ships, were common along the south east coast of Newfoundland. Presumably the shuttle tankers (Section 3.2.4) will pass through this area en route to refineries in eastern Canada and the U. S. The Impact Statement merely states that tankers "would use existing shipping lanes when transporting the oil from the Hibernia field to the shore" (II: 23); this is too vague a description for planning or environmental assessment. Accidental spillages, tank and bilge washing, etc. associated with the construction phase of the project at Come-by-Chance or Argentia, are also a possible source of chronic spills. The species most at risk here, to judge from the distribution maps, and the investigations which followed the "Irving Whale" spill in 1970 would be the very large flocks of shearwaters which feed inshore in early summer, the seabirds breeding at Cape St. Mary's, and wintering eiders, oldsquaw and black guillemots. **An estimate of risk to these species should be developed and the proponent's proposed mitigation should be detailed prior to project approval.**

Diving birds such as the common Atlantic puffin, Razorbill and Northern Gannet are the most vulnerable species to oil pollution, as are birds in the waters adjacent to major breeding colonies and offshore in feeding areas when the birds are locally concentrated. Major seabird colonies at risk are Baccalieu Island, the Witless Bay Seabird Sanctuary comprised of Gull, Green and Great Islands and Cape St. Mary's Sanctuary. Other than direct oiling of adult and non-breeding birds, serious reproduction losses are possible even though spills may be 40 to 60 miles from the colonies. These losses can occur by transfer of oil to eggs by incubating birds, ingestion of contaminated prey species by chicks or reduced provision of food to chicks from oil-impaired adults. **Contingency plans in the case of an oil spill affecting these areas should be outlined in detail; estimates of risk, implications of losses and mitigation should be detailed.**

3.1.3 The 'zonation' of seabird distributions off eastern Newfoundland

It would have been more relevant for planning purposes, and highly pertinent to this Impact Statement, if the authors had abandoned these zonations altogether and used operational criteria instead. Table 3.2-23 could have shown, for each seabird species, the probability of its occurence - in spring, summer, fall and winter - a) at the outer edge of the Grand Banks, adjacent to Hibernia, in the area of predicted slick-drift (Figures 4.7-7/-8/-9); and b) in Placentia Bay and its outer approaches, adjacent to whatever activities are planned for Come-by-Chance and/or Argentia. The Sensitivity Indices from IIIa, Appendix B: Table B-4, properly defined (see below), could have been added for good measure, and would have provided a practical "planning tool". **Seabird distribution should be integrated with spill trajectories to more thoroughly evaluate the impact on seabird populations.**

The oversimplified system of "zones" is unacceptable in this section because the proponent has missed the opportunity to add a predictive dimension to its summary of facts. Ivory gulls, for example, are not so much "offshore" as ice-associated birds; they are actually coastal in northern Newfoundland, where the pack-ice comes close to land. The distribution of winter pack-ice, shown by satellite imagery, should allow a fairly good prediction of the distribution of ivory gulls. A comparable prediction of shearwater distributions in the spring could be made from fisheries data on the distribution of capelin, an important prey. Prediction of the distributions of dovekies and auks, notoriously vulnerable to oil spills, is even more to the point. They depend on local concentrations of zooplankton, close to the surface, for economical foraging (c f. Brown, 1980). Figure 3.2-28 and earlier sections of Vol. IIIa show that dovekies and zooplankton are sometimes locally abundant at the eastern edge of the Grand Banks; also that oceanographic frontal systems, such as are known to concentrate zooplankton, occur there as well. Satellite imagery can show the position and intensity of fronts, and could be used to predict dovekie distributions - verifiable through aerial surveys - in the event of an oil spill from the Hibernia field. This, too, would be a valuable "planning tool". **We, therefore, recommend that a revised evaluation be developed in collaboration with Environment Canada which will include a predictive dimension.**

The value of Section 3.2.7 (Vol. IIIa) is greatly diminished by the fact that the distribution maps (Figs. 3.2-33/-37, Vol. IIIa) use a single symbol to cover the range of densities from "0 - 5 birds/km". It is an elementary requirement of any distribution map that the **absence of a species must be clearly distinguished from its presence, even at very low densities.** A casual reader might well assume that the blank areas on the maps indicate an absence of birds, whereas they probably (the point is not clear) only indicate an absence of census coverage.

Table 3.2-23, and the text summaries in Section 3.2.7, are very hard to assess because, there is no definition of the "coastal", "nearshore" or "offshore" zonation, the basic background against which the species' distributions are discussed. For example, Table 3.2-23 states that the northern fulmar is "offshore, coastal", but in fact it is unusual to see the species close to land in the survey area, as Figure 3.2-33 confirms. The same applied to dovekies, unless the "coastal" boundary is extended unrealistically far out to the inner edge of the Grand Banks. Common and arctic terns occur "offshore" only during spring and fall migration; they are otherwise highly "coastal". Iceland, herring, glaucous and great black-backed gulls are "nearshore" rather than "offshore" in the survey area: they are normally scarce on the outer edge of the Grand Bank (Brown et al., 1975).

3.1.4 Use of Existing Information on Newfounfland Seabirds

The literature cited as the basis for the species accounts (IIIa: section 3.2.7) **has some significant omissions:** the two waterfowl volumes of "The Handbook of Northern American Birds", for example, the three published volumes of "The Handbook of Birds of Europe and the Western Palaearctic", and even Peters and Burleigh's "The Birds of Newfoundland". This has led to oversimplifications such as "razorbills are rare in the study area in winter" (IIIa: 202), an unsupportable statement which seems to imply that they may therefore be ignored. Reference to Lloyd's (1976) review of the world population of the species would have shown that it is the rarest colonial auk in the Atlantic and should be protected - a relevant point in the present context. It is true that most of the North American population breeds in Labrador, but a search through the papers on winter oil-kills reviewed by Brown (1982) would have shown that it winters off New England. It is a fair deduction, supported by banding data, that at least part of this population migrates twice a year through the area covered by the Impact Statement. The fact that razorbills are seldom recorded, reflects nothing more than the difficulty of distinguishing them from the much more numerous murres.

The Impact Statement also omits pertinent information from some of the references which it cites. For example, it is clear from Tuck's (1961) analyses of winter oil kills in south-east Newfoundland, and from CWS Progress Notes on the Newfoundland "turr" hunt (Wendt and Cooch, 1981; Gaston et al., 1983), that the waters off the east coast of Newfoundland are a major wintering area only for thick-billed, not common murres (IIIa: 200); Gaston's (1980) quantitative distribution of these birds into High Arctic, Low Arctic and west Greenland components is at least as relevant for impact assessment as his overall estimate of the size of the population. The Impact Statement cites Tuck's (1961) hypothesis of a northerly post-breeding dispersal of Newfoundland common murres, safely away from the Hibernia area, without noting its principal flaw: there is virtually no chance that a banded bird could be recovered to the east, away from the coastline. It also omits the point, clearly stated by Tuck (1961), that this is a **swimming** migration, and that a year-class of chicks and half their parents might be put at risk by an oil spill at this season. **It is recommended that the Impact Statement address these matters.**

3.1.5 Effects of oil on seabirds

The effects of oil on seabirds are discussed only in a general way, and the summary on page 83 of Vol. IIIb is confused. **The principal effect is in fact external**; the ingestion of oil causes long-term, sublethal effects, but is less important in the context of the adult. It would be more accurate to say that "the increased weight of the wetted plumage hinders swimming, flying and diving and, as an added consequence, increases energy requirements." "Drowning" is an unlikely cause of death - if, indeed, it has ever been recorded: oiled birds eventually sink to the bottom, but probably only after they are dead. "Hypothermia" and "exhaustion" are not alternatives, but part of the same syndrome: the birds lose heat, mobilize their energy reserves to replace it, and die when these are exhausted.

This section should have described the actual cases-histories of seabird and waterfowl mortalities caused by oil spills off Newfoundland and elsewhere in Atlantic Canada. The omission is unexplainable because the Impact Statement cites several references (e. g. Tuck, 1961; Brown, 1982) from which this information may be obtained. Citation of these historical data would have provided the Impact Statement with a useful "planning tool", illustrating among much else, based on the results of the "Arrow" and "Irving Whale" oil spill incidents, **the bird mortality following an oil spill bears no predictable relationship to the amount of oil spilled.** This undermines the basic assumption, implicit throughout the Impact Statement (e. g. IIIb: 69), that any consequence of oil spills which may occur in the course of the proposed operations will at worst be minor, and therefore of little consequence in terms of seabird and waterfowl mortality.

3.1.6 Cumulative Mortality

It would also have been useful if the Impact Statement had considered seabird mortalities due to oil in the context of all the other, human-induced mortalities to which the birds are subjected, that is, the cumulative effects. Salomonsen (1967) describes the disastrous effects of overhunting on the west Greenland population of thick-billed murres. The estimated annual kill of 250,000-500,000 birds in the Newfoundland "turr" hunt (IV: 123) is of the same order of magnitude. The drownings of large numbers of murres and other auks in gill-nets, both in Newfoundland and Greenland, is also well-documented. These are serious losses for species whose reproductive strategies are geared to low annual mortalities due to "natural" causes. It is relevant to ask whether the populations can absorb additional mortality due to oil. A statement such as "a few organisms will undoubtedly be disrupted or killed . . . but this disruption does not appear to be at the population level" (IIIb: 104), if intended to apply to seabirds, is simplistic and **not** an acceptable answer. The Impact Statement provides generalized summaries such as the paragraph "Seabirds are the group most sensitive to oil spills . . . dependent on time of year, type of spill, and direction of movement of oil" (IIIb: 83), which is too vague to be of practical use. The vulnerabilities of the various species should be spelled out, if only in such simple terms as: "analyses of previous oil kills show that diving birds (auks, loons, grebes and diving ducks) are the most vulnerable groups; gulls and dabbling ducks are relatively unaffected. The behavior of shearwaters and phalaropes at sea would put them at risk, though no actual instances have been reported." **It is true that the species are ranked according to a Sensitivity Index in IIIa, Appendix B: Table B-4, but it is not acceptable to find no explanation or justification for this index.**

3.1.7 Disturbance from Helicopter and Light Aircraft

The operation of helicopters and light aircraft is likely to cause serious disturbance to seabirds at the landward end of their routes, not in the Hibernia area. This point should have been made in, for example, IIIb: 95. **Flight paths must avoid the exclusion zones around seabird colonies,** as described by Nettleship (1980). There must be compliance monitoring and strict enforcement to prevent joy-ride visits by industry helicopters and light aircraft to the colonies at Cape St. Mary's, Witless Bay and elsewhere. Such overflights have already caused significant disturbance at Witless Bay, as well as at Arctic colonies.

3.2 Meteorological and Oceanographic Criteria

3.2.1 Data Base Interpretation

Meteorological and oceanographic factors have a significant effect on the safety, design, construction, and operation of project facilities. Although the EIS presents a relatively complete data set, the analysis and interpretation of these data are deficient. **A more thorough analysis is required to ensure adequate design criteria with respect to wave height or ice accretion.**

Data from St. John's Airport, Marine Statistics System (MAST), and drilling platforms are used to represent the climatology of the project area. There is no discussion of the apparent discrepancies which exist between different data sources, or resulting from the amalgamation of statistics based on significantly different periods of records, or the adaptation of land-based data for the offshore.

Other examples where the interpretation is weak or misleading are in V llla: 26, 3.1.1, P2 and V llla: 28, 3.1.1, Table 3.1-4. Both the Evans-Hamilton Inc (1981) and the Ocean Weather Inc (1982) values are derived from sample wind speeds occuring in the maximum wave-producing storms, not the overall maximum wind speeds. Other data sets use the overall maximum winds. Comparisons are made but there is no discussion of the differences between the samples.

3.2.2 Ice and Icebergs

Environment Canada disputes the proponent's claims regarding the use of remote sensors for iceberg detection. Under conditions of poor visibility and high sea states, bergy-bits, growlers and/or ice floes are not detectable with high confidence using present-day remote sensing techniques.

Furthermore, the proponent's method of determining the "maximum" kinetic energy for icebergs is unclear. No maximum velocity is given for icebergs except to say they can exceed 1.4 m/s in general (V 11:28, P4, L22), or 0.6 m/s for the Hibernia area, in particular. **This is extremely important in relation to the development of design criteria for a Gravity-based Structure (GBS).**

It is stated by the proponent that the edge of sea ice on the Grand Banks can advance westward at a rate of more than 50 km per day under certain conditions (Vol 3A p69). This implies a potential for sea ice from the Hibernia area to approach the Avalon Peninsula Coast somewhat faster (approximately 6 days) than mentioned earlier in the report (10 to 20 days). It is agreed, however, that ideal sustained conditions for this period of time would be unusual.

The statement, "As pack ice drifts southward from the Strait of Belle Isle along Labrador and onto the northern Grand Banks...," (Vol. 3A p71) does not describe the typical sequence of events. It is more unusual to observe pack ice drifting southward along the Labrador Coast toward the Strait of Belle Isle and the northern Grand Banks areas.

It is stated that sea ice of this region is highly deformed and that ice ridge heights have been estimated up to 4.5m. However, the report dismisses the likelihood of an associated ice keel having a draft of 14 metres on the basis of melting due to drifting over warm water. Assuming uniform melting of the underside of the ice floe, the ridge structure would survive and the thinnest ice would disappear first. Also, if floating ice is to obey hydrostatic equilibrium and the 1:3 ridge height to keel depth ratio is applied, a keel depth of 14 metres is not unreasonable. Furthermore, it is quite feasible that the "old surface feature" described (Vol. 3A, p. 71) was in fact the feature of an old (multiyear) ice floe originating from further north.

The likely severity of sea ice and iceberg impacts on the development should be carefully re-evaluated by the proponent.

3.2.3 Wind

The proponent's method of analyzing the wind data is a major concern. The values quoted for design winds (V II: 27, Table 3.3.1) are lower than Environment Canada would judge to be true based on observations from the general area. One reason for this discrepancy appears briefly in the footnote to this table -- "the winds which were used as a sample for the extremes were selected from those which occur simultaneously with maximum wave height." **The only true estimate of design wind in table 3.3-4 is that provided by Swail and Saulesleja (1981) who estimate the 100 year wind to be 116 knots. Extremes of wind speed, independent of wave heights, should be provided in the Impact Statement either instead of or in addition to the values given.**

The maximum wind speeds from the MAST data are apt to have a fair weather bias resulting in the highest value predicted in 100 years being lower than that which could actually occur. The Evans-Hamilton Inc (1981) data are certainly too low, since the wind speed sample used came from the sample of the largest wave-producing storms. According to the East Coast Storm Catalogue, storms occurred on February 14, 1982, with winds of 91 knots and on December 25, 1983, with speeds in excess of 100 knots; both as measured from ships. Although these winds were recorded outside the Hibernia area, such storms are similar to those that traverse the Hibernia area.

3.2.4 Sea Spray and Atmospheric Icing

The Impact Statement acknowledges the need for further investigation of icing design criteria (V II: 27, footnote 2; and V II: 29, 3.3.2.2, P1) **and Environment Canada agrees that the ice accretion potential for design purposes should be investigated more thoroughly.** The Impact Statement gives an extreme ice accretion rate of 12.5 mm/hr for the project structures (Vol. II: 27, Table 3.3-1). However, based on recorded observations from the project area and using widely accepted relationships of meteorological parameters to accretion rates (e.g. Merton, Sawada, KGS), it is the opinion of this Department that extreme accretion rates caused by sea spray would be significantly greater than 12.5 mm/hr. Accretion rates could be increased further by freezing precipitation at or near the time of significant accretion from sea spray. **This ice buildup may affect the stability of floating facilities and vessels associated with the project. The Sedneath incident on the Scotian Shelf on February 25, 1970 is a case in point.** It is our understanding that ice accretion rates were very high causing problems with draft and stability of the rig. Environmental conditions at the time were 50 mph winds, 15 foot seas, 10 to 12 foot swells, freezing rain and freezing spray.

In addition, the proponent's assessment of aircraft icing is not adequate. There is no discussion of aircraft icing problems that may be encountered after the aircraft is enroute.

3.2.5 Environmental Information and Forecasting Services

The document provides no details on the provision of real-time weather and environmental information and forecasting services, except to indicate that observational data transmission and forecast functions may be carried out in the same way as during the exploration phase and would involve an amalgamation of Departmental and private sector activities. **The Impact Statement should provide specific information on how the proponent envisages that these will be provided** (e.g. elements observed/forecast, observation and forecast issue times, frequency and period of forecasts, criteria for issuing revisions, amendments and warnings, responsibility centre for each function, etc.).

3.3 Oil Spills

Environment Canada considers the treatment of oil spills prevention, fate and mitigation to be incomplete. The value and acceptability of an impact analysis can be judged as much by what is omitted as by what is included. Many important findings identified in the background documentation prepared for the proponent have not been presented in this Impact Statement or have been downplayed.

The impact statement attempts to reduce impact ratings to "minor" or "negligible" based on available containment and clean-up measures and yet such measures are largely ineffective. **Spill prevention will, therefore, be of paramount importance. Regulatory agencies must be given adequate opportunity to review and influence the final development and contingency plans.**

3.3.1 Spill Trajectories and Slick Fate

The slick trajectory models employed are state-of-the-art and the procedures employed are considered acceptable, however, **a number of significant concerns remain relative to the assumptions that are made, the input data, and the conclusions that are drawn from the analyses.**

The proponent has chosen to limit modelling of major spills to the immediate Hibernia area; this is considered inappropriate since **the potential impact of the project on the wildlife and fish resource cannot be adequately evaluated unless the risk of spills from shuttle tankers are also taken into account.** Recognizing that tanker destinations are uncertain at this time, the proponent should, as a minimum, develop spill trajectories for the points where the shuttle tankers merge with major shipping lanes approximately 46°30'N, 52°20'W and 45°N, 50°15'W). It should also be noted that Figure 4.5-1 in Volume III(b) simplifies the original map as referenced in Canadian Coast Guard (1981) and in the process excludes a heavily travelled shipping lane which crosses one of the two proposed tanker routes at about 45°30'N, 50°W. **A tanker spill scenario emanating from this area should also be provided by the proponent.** In order to illustrate our concern, Environment Canada commissioned an analysis of a worst case batch spill from 46°30'N, 52°20'W, employing the same model and input data as used by the proponent to assess spills at Hibernia. The results of this simulation are attached (see Appendix). These worst case scenarios suggest that oil may come ashore in any of the four months selected (i.e. January, April, July and September). Up to 31% of the oil spilled could impact Newfoundland shorelines within thirty hours.

The modelling (Ross 1984) that has been provided in the Impact Statement is based on an assumption that no emulsification occurs; nowhere is this fact clearly stated in the Impact Statement. This is of particular concern since Hibernia crude readily forms stable emulsions, which significantly increase the volume of the slick, and the time required for it to dissipate. In the Impact Statement, impact predictions are based on a "typical" crude at sea.

The emulsification process leads to a five to ten times increase in the original oil volume and a slick thicknesses at least five times those predicted (Ross, 1984). Emulsified oil spreads, disperses and evaporates at very different rates than crude oil that is not emulsified.

An addendum to the Ross (1984) background document indicates the blended Hibernia crude is waxier than originally thought. It does not appear that this has been reflected in the slick trajectories which appear in the Impact Statement as Figures 4.7-8 and 4.7-9 in Volume III(b). **The proponent should clarify the properties of the crude and identify those used in the modelling exercise. In order for the modelling and slick trajectories to realistically simulate the probable oil movement in the case of a spill, emulsification phenomena must be factored into the simulations.**

Some attempt should have been made by the proponents to model and predict the movement, distribution and impact of oil which may travel below the water surface.

It is informative to consider the predicted area of coverage after five days for the various spill scenarios (Ross, 1984) since this gives a better perspective on the problem facing sea birds and other wildlife than is available in Table 4.7-1 and Figures 4.7-1, 4.7-2 and 4.7-3 of Volume III(b). After only five days, the worst case subsea blowout is anticipated to cover a 2,400 km^2 area, the worst case platform blowout an area of 1,650 km^2 and the worst case batch spill roughly 500 km^2. These are the areas actually covered by the oil slick, according to Ross (1984), and not the broader area contaminated by rogue oil slicks which will have broken away from the main slick. **This type of information should be included in the Impact Statement along with environmental implications and remedial measures planned.**

While it is not indicated in the text, Figure 4.7-6 shows that 60% of the oil remains after forty days from a large batch spill in summer, a time when sea birds are most vulnerable in the study area (c f. Marine Birds, Section 3.1). Although the spill trajectories show a high probability of impacts to areas such as Southeast Shoals and Flemish Cap, there is no discussion of specific resources at risk in these biologically rich areas. Furthermore, comparison of spill trajectories with salmon over-wintering distributions east of Grand Banks, and spring migration routes S. E. of Hibernia, suggest more of a coincidence than the text implies; this is especially true for worst case surface blowouts and a worst case batch spill in summer. Spring trajectories (a time when salmon are concentrated in the area) should be provided to show whether this area is more or less susceptible at that time of year.

The proponent has attempted to discuss dispersion and evaporation phenomena separately. **An attempt should be made to provide an overall oil budget and more consideration should be given to the fate of oil residues**

such as tar balls and viscous mats. It is not adequate to state that the oil either evaporates or is eaten by bacteria.

Potential for oil-ice interactions and the effect that this may have on the oil movement predictions is dismissed without adequate discussion as are the oil-ice-biota interactions. The importance of ice intrusions into the Hibernia area is downplayed and its implications not adequately considered.

It is assumed by the proponent that because oil is not likely to reach shore, there are no significant environmental impacts anticipated (see Volume II, Sec. 11.6.4 for an example of this assumption). The large volume of water overlying the Grand Banks is also used as a reason for not developing appropriate mitigative measures for handling many forms of liquid and solid wastes and for spills (see Section 3.4, 3.5, 3.6, 3.7). **Environment Canada does not accept this argument or the principle of dilution upon which it is based.**

3.3.2 Oil Properties

The apparent differences between the properties of the oils from the Hibernia and Avalon reservoirs and the effect these have on the fate and behavior of a spill are not mentioned in the Impact Statement. It is also not clear from the Impact Statement at what point the two oils are co-mingled to produce the blend oil called Hibernia crude. It is, therefore, not possible to determine whether there is a significant potential for spillage of pure Hibernia or Avalon oil. According to Ross (1984), both oils display unusually slow weathering characteristics related to their high pour points; evaporative losses are very small compared to other crudes, especially at ambient temperatures on the Grand Banks. **Ross (1984) concludes that both oils would tend to remain fresh for unusually long periods of time when spilled at sea.** It has also been demonstrated that the blended Hibernia crude also retains many of these properties. Fresh, unweathered oil from the Hibernia field is relatively waxy and has a high pour point. When spilled, it tends to become viscous under most ambient conditions, especially after some weathering, and rapidly forms oil-in-water emulsions which are also highly viscous (they are in fact more viscous than bunker C at cold temperatures according to Ross (1984)). These emulsions will not spread on water and are very resistent to natural dispersion when thick. The summary and elsewhere throughout the Impact Statement (for example, Volume III(b), Sec. 4.1.3.1) assumes that the Hibernia oil behaves like other crudes and will disperse rapidly. In many cases, the impact predictions are heavily predicated on this assumption, however, it is evident from the preceeding discussion that this is unlikely to be the case. **Impact predictions should be reworked to incorporate the specific behaviour and characteristics of the Hibernia oils.**

The fate and effects of subsurface/near surface oil should be evaluated by the proponents. Volume III(b), Sec. 4.7.1.5 indicates that emulsification will lead to bulk densities as high as 1,010 kg/m^3 which approaches that of seawater (i. e., 1,025 kg/m^3) and yet no mention is made of the possibility of oil sinking and moving below the surface. Ross (1984) states that due to the very low buoyancy of emulsions of Hibernia oil, it may exist as mats floating below the surface, rather than as a coherent surface slick. This phenomenon is particularly prevalent where surface waters have a low salinity due to melting ice.

The fact that Hibernia oil readily emulsifies in rough seas is used to imply that it will not have much effect on marine resources such as sea birds (vol. III(b), Sec. 5.3). Evidence to support this claim should be provided.

3.3.3 Frequency of Oil Spills

The proponent has not presented an adequate assessment of oil spill risks from ship and iceberg collisions, blowouts, transfer operations and pipeline leaks. They should state how many of each type of potential accident or spill are likely to occur and estimate impacts over the life of the project supported by historical, published and company data. **This analysis should be presented for review.**

The probability of spills in the North Sea is given as 1 m^3 per million m^3 of crude produced. However, in reviewing the source document (Ross, 1984), the basis of this figure is unclear. The information is derived from a review of 1964-1980 data yet production did not commence in the North Sea until 1975. The average given for the remaining four years of the study period is 13.5 m^3 per million m^3 produced. The much lower value employed in the Impact Statement is derived by deleting the 1977 spill rate (i. e., 44 m^3 million m^3 produced) since it was considered anomalous. The value given in the Impact Statement, which is, we consider, still an underestimate, is therefore based on only three years of data.

Historical records from the North Sea and Gulf of Mexico show an increasing accident/spill trend for a number of years after an area moves into the production phase; this phenomenon is likely to also be observed at Hibernia and should be addressed in terms of its significance on the Grand Banks.

Canadian east coast statistics could and should be used for comparison purpose wherever possible. For example, in Vol. III(b), Sec. 4.7.12 reference should be made to the sinking of the "OCEAN RANGER", two serious well control problems, and two helicopter ditchings during the drilling of roughly 200 exploratory wells. As well, there have been two incidents of ships in danger of colliding with drill rigs and numerous incidents of rigs moving from the path of icebergs and sea ice. The Canada Oil and Gas Lands Administration or the Canadian Coast Guard should be consulted for details of these relevant incidents. East coast accident statistics should also be included in Sec. 11.1 of Vol. 11. Environmental, geological, regulatory and other factors lead to differences in the frequency and severity of accidents between the Gulf of Mexico, North Sea and Canadian east coast; where available, this basis for comparison should be used in the process of developing appropriate prevention and contingency plans.

Worst case blowout spill scenarios are based on maximum completion time for a relief well of ninety days (refer to Vol. II, Sec. 4.4 and Vol. III(b), Sec. 4.7.1.1). In fact, the 90-day figure is the **normal** expected completion time for a relief well of this depth; it is not a maximum. The IXTOC well took 295 days to control after several failed relief wells and more recently, and closer to home, the West Venture well off Sable Island required two relief well attempts and nine months to control. Completion of a relief well in this case was not required. **The potential effect that storms and sea ice/iceberg intrusions into the Hibernia area may have on the time required to drill a relief well should be discussed in the Impact Statement.**

3.3.4 Operational Spills

Mobil plans to install several kilometers of infield pipeline to move crude from satellite wells to the production platform. The Impact Statement suggests that these lines will be laid along the ocean floor and will not be buried or trenched to protect from iceberg scour. The rationale for this is that remote controlled valves and pressure sensitive valves may be installed to automatically shut down a flowline in the event of a major leak.

These infield pipelines probably pose a greater risk of a large spill in the Hibernia area than any other source. An iceberg moving through the area and barely scouring the surface could rupture several of these lines, not just a single line. Pipeline trenching could substantially reduce the risk of iceberg rupture. **The proponent should provide an evaluation of the value of pipeline burial.**

There is a general lack of attention to spills during product transfer which account for 80% of North Sea oil spills by volume; we also believe pipeline spills should also be addressed more specifically in Vol. III(b), Sec. 4.7.1.2. The maximum oil spill volume from subsea pipelines is given as 300 m^3 (Vol. II, Sec. 4.4) and yet the average flow rate given for the export line is stated as 9,000m^3/hr in Table 3.2-1 of the same Impact Statement. Do the proponents assume that shut-off valves immediately close when a break in the line occurs? **What is the risk of a valve activating incompletely or not at all?**

More reference should be made to Mobil's own experiences at its production facilities in the North Sea with respect to chronic leaks and loading leaks especially in Vol. III(b), Sec. 4.3.

Fuel handling and storage facilities and practices for land-based operations as described, for example, in Sec. 4.8 of Vol. III(b) should be designed to minimize risk of accidental spills and to control and contain any spills that do occur.

3.3.5 Oil Transport

The guidelines, both Federal and Provincial, issued to the proponent for the Hibernia project required transportation systems to be considered. The study area defined by the proponent, however, excludes transportation routes (Vol. III(a), Sec. 1.2 and Vol. III(b), Sec. 4.1.3.1) and associated spills or prevention measures. The Impact Statement does not, for example, provide estimates on the frequency of supply and other vessel movements related to the project (some data on existing supply vessel movements are presented, but little on future movements). There is no quantitative information on existing merchant traffic or incidences of intersecting traffic and fishing vessel traffic. Documentation of navigational hazards, such as the Virgin Rocks which lie directly between Hibernia and the junction of shuttle tanker traffic and shipping lanes south of the Avalon Peninsula, should be provided as should the impact on Hibernia vessel traffic. **The basis used for initial route selection and alternatives should also be provided since it is unclear what criteria were used.**

As noted above, information on vessel traffic is scattered throughout the Impact Statement (Vol. III(b), Sec. 4.5 and 4.8.4, Vol. IV, Sec. 4.6.4.1, 4.8 and 4.8.3.8). **There should be one consolidated section highlighting vessel movements.**

There is no attempt to quantify vessel accident risks; this is required if the risks to renewable resources are to be adequately addressed. The frequency of shuttle tanker round trips and the destinations have a bearing on ship collision risks and on areas that would have to be considered as potentially suffering impacts from a shuttle tanker accident.

There is repeated reference to the fact that shuttle tankers and other Hibernia project vessels will have state-of-the-art navigational aids to prevent collisions with the storage vessel, 'ALPS' and/or the 'GBS'. However, the potential for a collision from another less well equipped Canadian or foreign flag vessel is not considered. Several near misses involving rigs have been recorded off the east coast in the last few years. **The risk of collision between vessels and with the platform should be determined.**

In designing shuttle tankers and other vessels for servicing the Hibernia field, efforts should be made to provide oily water separators on board to clean bilge water and thus reduce routine oil discharges to the Grand Banks. Alternately bilge should be treated by bilge cleaning facilities at point of departure or arrival. **Any increase in oil in water on the Grand Banks is undesirable.** Even a four to six per cent increase in volume may prove significant to marine birds already under stress from existing levels.

3.3.6 Contingency Planning and Oil Spill Countermeasures

Reference is made in a number of sections, for example, 3.8 and 6.3 of Vol. II, to the fact that manuals, training and other features of the project will prevent accidents and spills; it is important to note that these have been in place throughout the exploration phase and have not prevented serious accidents from occurring.

The Impact Statement makes repeated reference to the use of oil spill clean-up countermeasures as a real option that will have a substantial beneficial effect in reducing residual impacts to minor or negligible levels and yet the countermeasures section (4.7.1.6 in Vol. III(b) clearly states that the harsh offshore environment and unfavourable characteristics of the oil makes these ineffective. The proponent places emphasis on the hope that wind and wave action will quickly disperse slicks and yet the oil properties suggest this may not occur. **Monitoring slick movement appears to be the only significant action that the proponent proposes to carry out following a spill of any size and duration. Information on potentially useful containment and clean-up techniques is included in the background studies. The proponent should provide a more detailed discussion of these in the EIS.**

No specific assurances are given that research into techniques for cleaning up waxy oils will be undertaken. Rather, the proponent proposes "to follow the development of new systems for better sea-keeping characteristics and improved capability to handle viscous crudes". The proponent should encourage support through the Environmental Studies Revolving Fund and/or fund research themselves. Environment Canada notes that in the July 9, 1985 (update) of ESRF, a study funded for $41,548 is being conducted on "Countermeasures for Dealing with Viscous Waxy Crude Oils" by S.L. Ross Environmental Research Ltd., Ottawa, Ontario.

Ross (1984) concludes that in-situ burning in conjunction with fireproof booms could remove up to 90% of the oil released from a 30,000 m^3 batch spill, 40% from a 9,000 m^3 batch spill and 25% from a 48,000 m^3/day surface blowout. The consultant (Ross 1984) goes on to suggest that oil well ignition is a viable countermeasure for preventing surface oiling from above-surface blowouts and "obviously, should be the first oil removal measure considered". The use of fire-proof booms, particularly under rough sea conditions, is still in the developmental stage. The percentage of oil which could be removed appears to be overly optimistic, nevertheless, the **proponent having raised the possibility of the applicability of this technology, should at least have discussed the use and consequences of this countermeasure in their impact statement.**

The proponent indicates that over two years were spent developing procedures for emergency preparedness; **a more comprehensive discussion of such procedures should have been included in the impact statement.** The information included is too general to provide assurance that an adequate environmental response plan is forthcoming. It is not clear what the purpose of the response plan is, given that the only stated countermeasure capability is to track the progress of the slick. **A supplementary discussion of viable countermeasures response is, therefore, recommended.**

The shoreline characteristics are adquately described in Vol. III(a) and yet no attempt has been made here or elsewhere to conclude whether the shoreline would have to be cleaned up if oiled and if it was, to identify the techniques/equipment suitable for the task (see also Section 3.4).

3.4 Ecological Impacts of Oil

"Present evidence supports the concept that petroleum in the marine environment does not reflect the "doomsday" potential claimed by some a few years ago. However, exposure of some species and development stages to petroleum and its derivatives under certain environmental conditions clearly can result in substantial damage to marine life . . . Whether or not petroleum entering the marine environment will have substantial or minimal impact depends on interactions among complex variables that are only now beginning to be understood" (Malins and Hodgins, 1982).

The Impact Statement has not dealt adequately with the possible effects on the marine ecosystem of either chronic oil discharges or major oil spills. In Volume IIIa, the Impact Statement gives an extensive review of the marine ecology of the Grand Banks based on both historical information and research sponsored by the project proponents. However, in Volume IIIb, the Impact Statement concludes that except for marine birds, impacts on the marine ecosystem range from "no impact" through to "negligible" to "minor" impacts (VIIIb, Table 4.7-4, 83). Unfortunately, the details of how these impact ratings were determined are not presented, so it is difficult to assess the accuracy of the conclusions. **Generally, Environment Canada considers that the Impact Statement presents an overly optimistic picture of the environmental effects (or lack of them) resulting from a major oil spill** into the marine ecosystem of the Grand Banks and the coastal zone of Southeast Newfoundland, without demonstrated or demonstrable foundation for such optimism.

Increased hydrocarbon concentrations in the marine waters of the Grand Banks, and probably in coastal waters along tanker routes near the south coast of Newfoundland are believed to be inevitable if this project proceeds. Quantities are not easily predicted since these would be influenced by operational practices (normal drilling and production discharges, and chronic minor spills) and by major accidents (blowouts, tanker accidents, etc.). However, any increases in hydrocarbon levels will have some adverse effect on the marine ecosystem.

3.4.1 Effects of Petroleum on Marine Organisms

The toxic effects of various types of petroleum products ranging from crude oil through to highly refined fuel products have been the subject of extensive scientific research over the past two decades (NAS 1985). Since no reference was made in the Impact Statement to any of these studies, a brief summary of published toxic effects of crude oil on marine plankton, benthos and fish is provided for the information of the Panel. (The Panel is referred to the United States National Academy of Science Report (1985) on the subject for a more detailed evaluation than is possible here.)

The toxic effects of pollutants should be considered not only in terms of acute lethality **but also in terms of acute sub-lethal effects and chronic toxicity.**

Crude oil or at least some of the constituents of crude oil are known to cause all three types of toxicity (lethal, sub-lethal and chronic) to marine organisms. Generally, the aromatic hydrocarbons are considered to be the more toxic components of crude oils. These aromatic hydrocarbons include such compounds as benzene, toluene, napthalene and xylenes. These aromatic hydrocarbons also have a much greater water solubility than the other crude oil components. Therefore, since the more toxic components are the ones that are more likely to dissolve in the water, the risk of exposure of marine organisms to these compounds is increased. Due to surface water circulation during, for example, storm events, hydrocarbon levels in the water column can be especially high immediately after a spill, or blowout.

Physical effects of oil spilled in the offshore include coating of organisms and habitat alteration. Coating of marine organisms usually involves weathered oil which has lost most of its more toxic soluble aromatic hydrocarbons through evaporation into the atmosphere or dissolution into the water column. Plankton are particularly susceptible to coating by oil. Oil released from a sub-sea blowout has the potential to contaminate sediments in the immediate vicinity, rendering them uninhabitable by the normal community. Oil residues, such as tar balls and viscous mats, may also sink to the bottom with similar results.

Laboratory studies have determined that adult marine organisms may exhibit acute lethal effects from exposures to concentrations of soluble aromatic hydrocarbons ranging from 1-100 ppm. Larval stages are more sensitive and may be killed by concentrations of soluble aromatic hydrocarbons as low as 0.1 ppm (Moore and Dwyer, 1974). In a study conducted specifically on Hibernia crude oil using native Newfoundland coastal fish and invertebrates, the acute lethal concentrations ranged from 16 ppm to 205 ppm, which indicates that Hibernia crude oil displays similar acute lethality to other crude oils (Atlantic Biological Services, 1980).

A summary of sub-lethal toxicity effects and concentrations of hydrocarbons causing these effects is given in the Impact Statement (VIIIb, Table 4.3-7, 48) without an explanation of the significance or meaning of the effects noted. The table indicates that levels of hydrocarbon as low as 1 ppb may impair an organism's chemoreception abilities which could cause difficulties for the organism to find food or avoid predators. Levels of 10 ppb may cause tainting (impart an oily flavour) to the flesh of fish and shellfish.

Petroleum hydrocarbons have been shown to have toxic effects on most trophic levels of marine organisms ranging through phytoplankton, marine plants, benthic animals and fish. Since Hibernia crude oil has been demonstrated to have similar toxic properties to other more thoroughly studied crude oils, it is reasonable to conclude that Hibernia crude oil discharged to the ocean either through regular operations or through accidental releases will have similar effects on marine organisms on the

Grand Banks. The toxic effect depends on the concentration of hydrocarbon in the water and the duration of the exposure. Detecting such an effect may be beyond our capabilities, at this time, however, **the proponent should clearly indicate predicted concentrations of hydrocarbons from routine or accidental losses likely to occur and, where relevant, indicate the necessary research and monitoring it is prepared to undertake to ensure impacts are fully understood, minimized and, if necessary, mitigated.**

3.4.2 Offshore Ecosystem Effects

Environment Canada considers that the proponent has under-estimated the possible impacts on the marine ecosystem of both chronic discharges of oil and accidental oil spills. The marine environment of the Grand Banks is a very complex ecosystem with interactions between many organisms at many trophic levels (Impact Statement Volume IIIb, Table 3.2-1, 105 and Figure 3.2-41, 217). These relationships between organisms and factors which affect the production rates of individual organisms and populations of organisms are not well understood.

The method used in this Impact Statement to describe impacts is not rigorous (see also Section 3.7.1). Impacts are assessed only in terms of each individual discharge and activity, isolated from other concurrent discharges that may exert additive or even multiplicative effects. Only impact at the population level is considered in the impact definition. **Long term impacts, such as a build-up of contamination around the well-sites and in traffic lanes or from other oil and gas and ancilliary developments and other uses, have not been addressed in the Impact Assessment.**

Although the Impact Statement indicates the population level of impact is being considered when evaluating environmental effects, the evaluation is actually far more restrictive. Only standing crop or simple numbers of individuals are considered. Turnover rate or standard demographic descriptors, such as intrinsic rate and age structure, are not utilized but should have been. Ecological effects can occur on every level of biological organization from sub-cellular to ecosystem. By concentrating on the population level, the proponent also makes several unstated assumptions which then influence the results of "no" or "negligible impact". In particular, the proponent argues that natural variability is so large that most population estimates cannot be determined with certainty or that no detectable effects can be found between natural and perturbed levels, however, no estimate of natural variability is given for any of the populations. After a review of the Grand Banks Oceanographic Data set (McLaren Plansearch 1984), it becomes apparent that some of the sampling and laboratory analyses are not sufficiently detailed to determine what type of variability estimates could be calculated. For some parameters, however, it is possible to make these calculations and they should be done from the raw data. There are many oceanographic parameters that are not highly variable. The field program did not measure variability effectively. **Subsequent monitoring efforts should correct this.** Natural variability can be handled effectively in a well planned program. High variability in a particular component is a function of the position of that component in the overall ecosystem, knowing the variability level can help identify its ecological function in a causal sense if the appropriate techniques are used.

Although most of the impacts on organisms of the Grand Banks are anticipated to be sub-lethal, there is the potential for unexpected and significant effects on populations or communities of organisms. Individuals may not be killed outright but their ability to feed or reproduce may be impaired and the more sensitive young may not survive. With the relatively high rate of population growth of most zooplankton such effects could result in rapid collapse of certain components of the food chain, affecting productivity or survival of other organisms in the complex offshore ecosystem (Gulland, 1973; Levinton, 1982; Nybakken, 1982). Impacts which are rated "minor" or "negligible" by the proponent might under some circumstances more realistically be considered more significant; for example, minor impacts on a small discrete population may still be unacceptable.

Despite extensive literature that reports severe, potentially significant sub-lethal effects on many marine organisms at low levels of hydrocarbons (i e., less than 0.1 ppm), the proponent makes the assumption that dilution of the pollutant and quick replacement of affected individual organisms will reduce impacts to localized or negligible levels. **This assumption may be incorrect (NAS, 1985). Serious ecosystem impacts may occur which have not been anticipated in the Impact Statement. Without an appropriate monitoring program, such changes may not be identified early enough to be effectively mitigated.**

Throughout the Impact Statement, it is implied that major circular current patterns (gyres) in the Grand Banks contribute to retention and subsequent high concentrations of detritus, nutrients, and ichthyoplankton. It is reasonable to assume that these same conditions which create a highly productive and biologically rich environment may also result in increased retention and persistence of spilled oil and other contaminants (both from chronic discharge, small spills and major accidents and blow-outs) within the Grand Banks area. Hydrocarbon levels, as noted in the Impact Statement, are already elevated above background levels, probably due to the present level of chronic discharges from ship traffic in the area. **The potential for long term cumulative impacts, such as reduced productivity, from all discharges and spills, is an important unanswered question.**

3.4.3 Coastal Impacts

The authors of the Environmental Impact Statement for the Hibernia Development Project have not provided a thorough assessment of impacts in the coastal zone. Although shoreline is included in their "study area", it is limited in extent and impacts are not seriously considered due to the assumption that oil spilled in the Hibernia field will rarely, if ever, reach the coast of Newfoundland. We do not consider this argument valid (see Section 3.3) and, therefore, a more thorough evaluation of coastal impacts is required. For example, considerable study has been conducted on the effects of the "Arrow" and "Kurdistan" tanker accidents in the Atlantic provinces on various types of shoreline and associated flora and fauna (Keizer et al., 1978; Stewart and Marks, 1978; Gordon et al., 1978; Gillfillan and Vandermeullen, 1978; Thomas, 1978). **Little of this work is referenced in the Impact Statement despite its relevance to coastal situations in Newfoundland.** Although the physical behaviour of oil on shorelines is described briefly along with some biological impacts, specific detail is needed to assess environmental effects and to quantify risk. The biophysical description of the southern and southeastern coast of Newfoundland is lacking in adequate detail. **Sensitivity mapping of the coastline is available and should be discussed in the context of coastal risk, protection and clean-up potential.**

Coastal areas with shallow water, high nutrient levels, and dynamic water circulation are the most productive component of the marine ecosystem (Mann, 1982). Rapid and prolific growth of macroalgae contribute a massive carbon input utilized by intertidal and nearshore organisms. Studies have demonstrated significant impacts from oil spills on fish species and coastal crustacea (especially juveniles) and on other benthic and intertidal invertebrates. Effects range from reduced growth, reproductive depression, death of juvenile forms, removal of certain species, tainting, and subcellular metabolic effects (NAS 1978). The available literature must be better referenced to support conclusions drawn relative to impacts of oil in the coastal environment.

Shoreline

Sand beaches occur rarely on the south and southeast coast of Newfoundland but cobble beaches and pocket beaches (mostly cobble) are frequent. Oil reaching such areas would have an impact on recreation and their aesthetic value ranging from minor to major depending on its chronic occurrence or catastrophic inundation. As pointed out in the Impact Statement IIIb (84, 4.7.1.7), cobble beaches will retain deeply buried oil for long periods (longer than sand or gravel beaches) and release it over time under warmer conditions or more active storms, so that the impacts could be recurring or chronic. Impacts on certain species have been documented to continue as long as 6-8 years after an oil spill invaded coastal bays (Gilfillan and Vandermeulen, 1978). **Effects on capelin spawning beaches could be severe (as stated) and such beaches should be clearly identified with protection or contingency measures in place. The probable value of available counter measures should also be discussed.**

Impacts of oil on coastal bird sanctuaries is a serious threat but is not adequately addressed. Again the focus is offshore and not coastal, ignoring the threat of coastal oil on young and immature seabirds which remain close to breeding areas during their early development. Even oil spilled offshore may move inshore unpredictably if it sinks below the surface and is not subjected to movement by wind. Trajectories for subsurface oil movement are needed (see also Sect. 3.1, 3.3).

In the coastline of the limited "study area" 47 marshes are identified (IIIa, 97, Figure 3.1-57) some of which are presumably barachois marshes. They are considered to be vulnerable to oil released from the Hibernia field, but these and many more along the south coast would be affected even more by oil released during transportation. The Impact Statement states that oil reaching barachois marshes is "likely to persist for long periods", but impacts on the biota are not fully addressed. The potential effects of marsh contamination on birds using the marshes, or on mammals that live in or around marshes should be presented.

Salt marshes are a rare habitat in Newfoundland and are particularly vulnerable to oil. Their exact location and susceptibility to oil spilled at or in transit from Hibernia is needed in order to fully assess the impact of this project. For salt marshes, as with other vulnerable shore types, the ecological consequences of oil contamination must be evaluated.

It is true that much of the south and east coast of Newfoundland is rocky with high wave energy and is probably minimally effected by spilled oil. Nevertheless, several large deep bays; St. Mary's, Placentia, and Fortune and numerous deep fjords are sheltered from the high energy zone and offer varying degrees of protection from wave action. The potential for persistence of oil on the shoreline in these areas is much greater. What this means in terms of impact is not described, but often the exposure of marine organisms and birds as well as mammals feeding intertidally will be greatly prolonged, with the chance for physiological effects increased. Incidents of shore mammals such as otters dying from ingesting oil through food or grooming have been recorded (Baker 1981). **The introduction of oil into a fjord deserves special consideration due to the unique water circulation characterizing fjords.**

Warm summer temperatures in sheltered inlets or bays are likely to cause an influx of hydrocarbons at a time of high biological activity, an event which may occur over a number of years until stranded oil has completely weathered. **The proponent has not adequately addressed impacts on aquaculture, shellfish harvesting and other inshore fisheries.** The long term exposure of birds using sheltered contaminated inlets or estuaries to hydrocarbons should also be discussed. The recreation potential of sheltered coastal bays could be affected by persistent oil for a period up to 4 or 5 years. **There is no indication of the recreational potential of vulnerable coastline.**

Onshore Impacts

While land-based projects will be reviewed in another forum, **the proponent remains responsible for evaluating and presenting the potential cumulative effects of the project's onshore components in their impact statement.** In the context of impacts on land and resource use, the Impact Statement states that "no analysis was done on land uses from speculative activity or from spinoff uses related to Hibernia because no data was available" (Vol. IV, page 315). As a result, there is insufficient information in the Impact Statement for a suitable assessment of cumulative onshore impacts from land-based facilities and other ancillary developments likely to result from the Hibernia development. The lack of information in the Impact Statement concerning the onshore impacts of the Hibernia development is unacceptable, particularly since the proponent considers the impact statement as a planning tool.

Spin-off developments must be adequately evaluated from an environmental perspective in order to facilitate orderly planning and avoid incremental environmental degradation of terrestrial and aquatic ecosystems. **We recommend that all land-based facilities and ancillary developments associated with Hibernia be subject to full impact assessment.** The ancillary developments could include: powerlines, roads, railways, waste disposal areas, quarries, work camps, recreational lands, etc. Without adequate environmental planning, any of these Hibernia-related ancillary developments have the potential to degrade the quality of the environment. These projects must be evaluated to adequately assess the cumulative effects of Hibernia development.

During formal environmental assessment of onshore developments subject to provincial environmental assessment procedures, Environment Canada normally participates in the reviews and provides data or advice in areas for which it is responsible or has expertise.

The North Sea experience (Robertson 1984) clearly indicated that impacts from land-based facilities are of equal or greater concern than offshore impacts and that a regional planning approach that directs development to environmentally acceptable locations minimizes impacts. Through its facilities siting program, the Newfoundland government has shown leadership in this integrated approach. **Serious consideration should be given to implementing a more broadly based environmental strategic plan (similar to that used in Scotland) for both offshore and onshore areas potentially affected by Hibernia, its "spin off" developments and subsequent offshore development.** This approach would allow orderly planning to develop and would avoid problems created by planning on a narrow-focussed, project-by-project basis.

Although no detailed biophysical data were provided on "generic" construction and operational support sites (i e., Argentia and Come-by-Chance) in the biophysical assessment volume of the Impact Statement (Vol. IIIa), impact predictions were provided in Volume IIIb of the report. **Impact predictions were therefore made without the provision of baseline information or any other form of quantitative information. This is an unacceptable approach to impact prediction.**

Other ancillary facilities need more documentation in the Impact Statement. The impacts of rail, road and powerline construction and other necessary infrastructure on terrestrial and aquatic ecosystems should be discussed. More detail on how cement will be transported to the site from Corner Brook and the associated environmental and safety concerns is required. The Impact Statement contains no detail on borrow areas which could be a major consideration should a GBS be built.

3.5 Risk Analysis

3.5.1 The Need for Environmental Risk Assessment

The acceptability of the risks induced by the proposed development must at all times be weighed against the anticipated benefits. For the purposes of this review, risk is defined as the probability that something undesirable will happen.

The probability of an event occurring is dependent upon the inherent uncertainties in the complex systems we wish to understand; especially when we want to predict future behavior of such systems. "Uncertainty" is a commonplace idea when discussing the weather or economic forecasts. Likewise, it has been used extensively in health to estimate mortality, disease incidence, birth defects, mutations, etc. The nuclear regulatory and other industries have used risk analysis for a variety of safety determinations among other uses. **Risk measures are increasingly becoming part of legislative and management decision making processes related to these fields (NAS 1983).**

To be valid, evaluation of the environmental risk, that is, risk to organisms or ecosystems must first be based upon an evaluation of the engineering risks. Engineering risk includes the likelihood of a mechanical failure, human error, damage to the platform and loss of hydrocarbons or other toxic substances to the environment. Secondly, environmental risk must be based upon an understanding of the life histories of the ecosystem component organisms and an understanding of their variability in relation to physical and chemical parameters and relations to each other in the food web. The inherent variability of environments is re-enforced by human interventions which are often cumulative, multiplicative, indirect and counterintuitive. This argues for the need to develop objective risk analysis tools for ecological systems so that uncertainty can be quantified and evaluated rigorously. If this is not done, risk-benefit decisions involving the environment will continue to be made with an insufficient scientific basis. The risk-benefit trade-off has to be made explicit and this can only be done with a firm quantitative basis.

3.5.2 Engineering Risk

In the Impact Statement, "risk" is most often associated with the engineering components of the document but **no evaluation of acceptability of risks can be made since risk assessment has yet to be carried out for the development. A thorough engineering risk study is required which will allow relative risks for the two development alternatives to be evaluated.** The diversity of opinion among knowledgeable engineers on the subject of risks in developing offshore oil fields and prediction uncertainty is high. One view expressed was that the GBS would never withstand a major iceberg impact or indeed repeated bergybit collisions. Is this likely? What are the relative risks from storms and icebergs for the two development plans? **The proponent should present this risk analysis as part of their justification for their choice of the production system.**

3.5.3 Environmental Risk

Compared to an industrial risk analysis that often emphasizes human safety, for an environmental risk analysis of a system like Hibernia, there are large numbers of non-human organisms which will become involuntary risk takers and which clearly do not stand to benefit from an oil-enhanced economy. The challenge is to clarify the environmental risk portion of the risk-benefit ratios so that evaluation of environmental risks can be made objectively and subsequently defended in public forums. The Hibernia Development is an excellent example of the potential for conflicting perceptions of risk by different interest groups. The best way to resolve these conflicts is to have relative levels of risk quantified as rigorously as possible. To identify an implied threat or hazard is not sufficient to demonstrate risk, it must also be shown that at least a potential causal pathway between the hazard and target exists. The Impact Statement has not successfully done this.

The proponent should quantify uncertainty with regard to environmental risk for: (1) catastrophic events such as a major oil spill as well as (2) chronic environmental deterioration from routine operations of the development. This needs to be done for both development scenarios if a well-reasoned conclusion is to be reached on which development plan would cause the least environmental risk. The quantification of risk is different for the catastrophic and chronic cases. In the case of chronic environmental deterioration, there is usually no adequate, historical data base for the probability of rare events but the identification of cause and effect is usually quite clear and easy to document. In addition, the public is often most concerned over the catastrophic event such as major oil spill or the sinking of a platform, however, the common risk from small recurring events might be much greater than for a single catastrophic event.

There is almost no mention of risk in the environmental portions of the Impact Statement and no attempt to consider risk. The Impact Statement methodology is therefore not adequate. The proponent avoids the risk question by stating repeatedly that there are no impacts or only small, negligible ones. If one writes statements of complete certainty assuming the Grand Banks is a "determined" ecosystem that is completely understood, then there is no place for uncertainty and consequently no need to calculate risk. **This overall approach is not acceptable. Environment Canada is prepared to work with the proponent to gain a mutual appreciation of the environmental risks related to possible catastrophies and each of the development alternatives.**

3.6 Operational Discharges and Control

From an environmental perspective, the discharges of major concern include produced water containing dissolved and dispersed petroleum hydrocarbons and often high concentrations of heavy metals, contaminated drilling muds and oily water discharges from separators and deck drainage.

The zone of influence of a project is the area within which the project will have an impact from either operational discharges or physical disruption. **Environment Canada is concerned that actual extent of the impact area will be considerably larger than that depicted in the Impact Statement.** The zone of influence for the Hibernia project is depicted in Vol. IIIb as covering an area of approximately 8 km in diameter centered on a production platform. This will probably be more than sufficient to encompass the impact of routine discharges but is not sufficient for the chronic oil spills that occur from production facilities. **A considerably larger area than 8 km. should be considered and such events as chronic oil spills should be included within the zone of influence of the project.**

There are a number of large volume discharges from a production facility for which Mobil has developed dispersion plans and suggested treatment and discharge depths. Environment Canada considers that some of these discharges can be significantly reduced or eliminated by consideration of alternate methods of handling, such as reinjection of produced water into the formation.

3.6.1 Produced Water

The volume of produced water to be discharged at full production, with either production scenario, is estimated to be a maximum of 14,300 m^3/day. The maximum oil content of the produced water will be controlled by regulation or guidelines at 35-40 mg/l. This amounts to approximately 0.32 m^3/day (2 barrels/day) but could increase to more than 3.2 m^3d (20 barrels/day) during upset conditions. The efficiency of oil/water separators is dependent to some extent on the stability of the platform which they occupy and therefore gravity separation would be less efficient on a floating platform than on a GBS. It is suggested that the produced water would be treated in a system that might include air floatation and inclined plate separators. This type is at the level of best practical technology (BPT) and by using it the concentration of oil in produced water would be expected to meet regulatory requirements.

Several references are made in the Impact Statement to discharged or spilled materials reaching a thermocline and dispersing at that depth. If this is the case, the thermocline will reduce the dilution and in fact, act to concentrate contaminants at a depth which could be critical to planktonic and pelagic species. The maximum rate of phytoplankton production, in fact, coincides with this depth. The thermocline acts as a natural barrier to vertically migrating zooplankton and ichthyoplankton and large numbers of these species are often concentrated at or just above the thermocline. Such species could be exposed to unusually high levels of contaminants at considerable distance from the source, especially if movement along the thermocline is accelerated by currents. **This possibility should be addressed by the proponent and estimates of potential hydrocarbon concentrations at the thermocline should be made.**

Discharge below the thermocline appears to increase dilution as stated in the Impact Statement but also bring the discharge into deeper and less productive waters. Discharge below the thermocline is a minimum mitigation recommendation for the discharge.

There is a possibility that the produced water discharge can be eliminated entirely. Mobil has not considered in its mitigation of impact of produced water the option of including it with injection water for re-injection into the formations. Since it was originally part of the formation water this should present no difficulties. This is especially important when the possibility of breakthrough to the producing area of injection water, and associated biocides, is considered. The acute lethal toxicity of the treated injection water could have a detrimental effect not adequately described in the Impact Statement, but if produced water is re-injected, not only is one oily water discharge eliminated, but the potential effect of breakthrough water is also eliminated.

3.6.2 Cooling Water

Once through cooling water will be treated with chlorine and possibly biocides to reduce the settlement of fouling organisms in cooling water pipes. This is a common practice for most salt water used for cooling. A large portion of this water will, it appears, be used as injection water since it is estimated that 180,000 m^3/day will be used and only 120,000 m^3/day will be discharged. While we agree that the free chlorine content of the cooling water will not likely have any detrimental effects on the marine environment, the biocides used may. Mitigation of this potential impact has not been fully considered. **Since disposal below the thermocline could reduce the impact on the biologically productive zone and ensure more stable temperature regimes near the production facility, it is recommended that this option should be explored by the proponent and revised plume models prepared.**

3.6.3 Drilling Muds and Cuttings

Two types of muds are proposed for use; water base and oil base. Water base muds have traditionally been used offshore and, other than the potential problems of heavy metal contamination, present no significant problems. **Mud components should, however, be screened for bioavailable metal contamination before they are approved for use.** A potential pollution problem does arise when diesel oil is added to drilling mud to free stuck drilling pipe. The diesel becomes emulsified in the mud and common practice is to eventually discharge it overboard.

Oil based drilling muds have been used offshore in a number of locations. Concern over the environmental effects of diesel oil has prompted the industry to develop a base oil substitute referred to as mineral oil or alternate base oil. The acute toxicity of these oils is considerably less than diesel and the effects recorded to date indicate that the mud formulated with alternate base oils is less acutely toxic than some of the water base muds. **It is recommended that the proponent note in the Impact Statement that the new mineral oils will be the base oils used, notwithstanding that present guidelines do severely restrict the use of diesel oil. Considering the volume of oil to be discharged with cuttings during development, the designation of 15 g/100 g as an achievable discharge limit would seem reasonable (UKOOA et al. 1983).**

3.6.4 Tanker Ballast and Storage Displacement Water

Ballast water from shuttle tankers and the floating storage vessel present no problems for Environment Canada as long as the proponent holds to its commitment that all tankers and the Floating Storage Vessel have segregated ballast. Ballast water discharges from crude oil tankers without segregated ballast systems have resulted in environmental problems throughout the world (Levy, 1984, NAS, 1985).

Storage Displacement Water discharges do pose potential problems for the environment. The long time that water and oil are in contact in the storage cells of the GBS may allow for a part of the soluble portion of the crude oil to dissolve in the water. Discharge limits have not been established for the oil content of this water and the proponent presently proposes direct discharge to the ocean without treatment. The Impact Statement has estimated that the concentrations of oil will be between 10 and 35 mg/l and dilution by 1000 times within 1 km. Based on the North Sea experience 10 mg/l appears to be an average oil concentration for the majority of the storage displacement water, however, the proponent does not address the concentration of oil in the oil/water interface in the storage vessels.

At the oil/water interface oil/water emulsions are likely to be formed (see Section 3.3) which may have concentrations of oil in the 10-50% range. The proponent has not addressed the requirements for treatment of this layer of emulsion during discharge of the storage displacement water. It would be expected that if such emulsions were discharged it would present problems in the water column and surface layers.

The proponent should consider the possibility of utilizing an oil/oil displacement system for the storage vessels in the GBS to eliminate the need to handle oily displacement water.

3.6.5 Minor Discharges

Deck Drainage

The proponent has separated deck drainage into two distinct sources: 1) Discharges from the drilling floor and machine servicing, and 2) other sources, e. g., rainfall, deck wash down. In both cases the drainage will flow to oil water separators for treatment by gravity separation and the oil collected for disposal. The efficiency of the oil/water separators is in question since not only will they receive the oily water but also rig wash, a detergent, which will emulsify the oil, reduce the efficiency of the separators and increase the oil in solution. **It is recommended that the proponents incorporate a system for breaking down emulsions or develop some alternate method of disposal of deck drainage.**

Well Workover Fluids

This minor discharge occurs sporadically based on need to increase production from wells. The proponent plans to discharge these very acidic solutions of hydrocloric and hydrofloric acid within the produced water. Although dilution will significantly affect the pH and bring it close to that of sea water, pretreatment to raise pH levels prior to incorporating it into the produced water will significantly reduce the potential for heavy metal leaching from both the workover fluid and the produced water. **The proponent may be required to incorporate a pre-treatment system for well workover fluids into the platform design.**

Produced Sand

Produced sand may need to be collected and treated to reduce oil content before disposal. **The Impact Statement may provide indication of the quantity of oil that might remain on produced sand.**

Hydrostatic Test Fluids

Hydrostatic fluids used to test in-field pipelines will utilize an oxygen scavenger and possibly a biocide. Mobil has not identified the biocide to be used, the treatment necessary to neutralize the biocide prior to discharge or the volumes of hydrostatic fluids to be used. **The biocide should be identified specifically and an estimate of the acute toxicity of the test fluid and quantity to be used should be provided.**

3.6.6 Compliance & Audit

Regulations and guidelines are being established for some of the discharges but not all. **The proponent should be required to monitor all discharges for oil content on a regular basis.** At start of production, monitoring should be frequent for each discharge; after discharge levels have been confirmed to be within regulatory limits, the sampling can be carried out less frequently. This data should be supplied to the Canada/ Newfoundland Petroleum Board and made available to other agencies such as Environment Canada.

Regular audits of the proponent's monitoring will be conducted by regulatory agencies. Audits should be conducted once or twice per month during start up and quarterly after operations have stabilized.

3.6.7 Abandonment

Upon abandonment of the Hibernia field, the proponent should expect to be required to remove all seafloor obstructions that may interfere with fishing activity including infield pipelines and the GBS platform itself. An abandoned platform could pose a significant threat to shipping unless it is properly maintained as an aid to navigation.

3.7 Effects Monitoring

This evaluation focuses on effects monitoring as opposed to compliance monitoring. The latter, which has been discussed in Section 3.6, applies to the routine monitoring of regulated discharges to ensure that they comply with pre-set limits on the amounts and concentrations of certain contaminants in the effluent. Effects monitoring alternatively is carried out in order to evaluate the effect of the project on the biological resources and processes potentially impacted by the development. The results of these studies can then be used to verify the accuracy of predictions about impacts outlined in the EIS and to provide feedback to project managers and regulators should unexpected and undesirable impacts be detected.

In the case of the Hibernia development, there is a need to clearly state the objectives and limitations of proposed monitoring programs. Major monitoring of valued ecosystem components (VEC's) may have to be undertaken if ecological effects are to be detected. The interpretation of field data such as bird mortalities in terms of environmental impact will require careful analysis.

While it is accepted that effects monitoring programs should be explicitly related to the major impact predictions outlined in the Impact Statement, **the proponent's method of identifying the subsequent impacts from the Hibernia development cannot be verified due to their qualitative nature (see also Section 3.5).** Qualitative first-order matrices are used whereby impacts are assessedin terms of individual discharges and activities, and in isolation from other concurrent discharges that may exert additive or even multiplicative effects. **Long-term impacts** (such as build-up of contamination around the well sites and in traffic lanes) or from other oil and gas and ancilliary developments, have not been addressed by the proponent. Because the proponent has not evaluated impacts comprehensively or quantitatively, **there is insufficient basis in the Impact Statement to develop an acceptable monitoring program for the Hibernia development and additional analysis is needed.**

3.7.1 Monitoring Sub-lethal Effects

Although the proponent's impact rating definition states that it includes sublethal effects on reproduction, growth, feeding and metabolism, it is clear in the sections on assessment of project components, that acute mortality is, for the most part, the only criterion considered. This narrow definition of impact is the major reason impacts rated by the proponet appear mostly as "minor" or "negligible". Sublethal effects can be of equal or greater significance to the population or ecosystem. For example, recent studies (cf., Moriarity 1983, McIntyre and Pierce 1980) have demonstrated a range of potentially significant effects on marine organisms, including chromosomal aberrations, cytological deterioration of eggs, malformed embryos, reduced or abnormal gonad development, reduced hatching success (both teleost and avian eggs), lesions and tumors, fin erosion, reduced growth and enhanced mixed functional oxidase (MFO) induction, all of which may result in reduction of populations over time. Many of these effects were observed at low concentrations or under actual spill conditions (NAS 1985). **It should be recognized therefore that sublethal effects are important in determining the nature and extent of impacts, and should be included in any monitoring strategy.**

3.7.2 Limits of Detection

Often, the limiting factor in understanding the significance of pollution impacts is the difficulty of studying the effects under field conditions where other major factors may obscure them. The oceanographic regimes, hunting, fishing, predation, concentrations of food organisms, weather and other external influences can, for example, greatly affect the number of organisms that are observed in a monitoring program. When, as the proponent has done, simple numerical abundance is the only criterion used to identify impacts, it is difficult in a subsequent effects monitoring program to verify these impact predictions. Any reduction in seabird populations and/or fish stocks must be very large before it can be detected in such a monitoring program. However substantial, and possibly irreversible, ecological (and economic) impacts can occur with very little prior indication. The inability to detect an impact should not be interpreted as "no impact". Accordingly, **the Hibernia Development Monitoring Program should carefully examine methods and techniques for monitoring low level impacts in order to facilitate the introduction of mitigative measures as required before any such impacts become critical.** (See MacIntyre and Pierce 1980, Gray 1980).

3.7.3 Monitoring at the Production Site

Impacts from the production site, as noted previously, are evaluated in the Impact Statement in terms of isolated effects mostly on the benthos, presumably because most (if not all) of the effects monitoring around well sites has consisted of sampling sessile macro-benthos abundance and diversity. However, the macro-benthos are often less sensitive to the presence of pollution than pelagic forms, and because of large variation and heterogeneity, only major reductions (i.e., 50% losses) may be statistically significant (Hargrave and Thiel 1983). Results of such programs may be of limited value for the evaluation of impacts from Hibernia or for addressing the major concerns of this development. Furthermore, the North Sea monitoring studies (UkOOA et al 1983) referenced by the proponent were not intended as effects monitoring programs for other than oil-based mud discharges. Being specifically designed to study the effects of a single contaminant, they are not a valid model for many of the other sources of concern. The proponent has predicted that there will be only minor or negligible lethal and sub-lethal impacts on marine organisms (including juvenile and adult fish, zooplankton and benthos not normally included in monitoring programs) in the vicinity of well. **It is the view of this Department that the proponent's suggested monitoring program will not test these predictions and is therefore unlikely to assist decision-making or serve as an early warning of more severe long-term impacts to the Grand Banks.**

3.7.4 Monitoring Onshore Impacts

Onshore impacts are rated mostly "minor" or "negligible" because the area is either already developed (St. John's), already disturbed (Argentia) or generalized to be local and therefore minor. This approach to evaluating impacts from shore-based facilities is inadequate, particularly because experience elsewhere has demonstrated that impacts from shore-based developments are of equal concern to offshore impacts (Robertson 1984). Monitoring of potential impacts from shore-based facilities was likewise not addressed by the proponent but, in the opinion of this Department, should be included as part of the impact assessment of this project.

3.7.5 Monitoring Coastal Impacts

Impacts from spills on coastal habitats are underestimated by the proponent. There is a large body of literature which suggests that long term severe impacts to productive estuaries should be expected if impacted by an oil spill (NAS 1985). Clean-up attempts have been largely unsuccessful and have often inadvertently caused additional damage. The adequacy of baseline information for monitoring the coastal impacts from a spill or increased chronic oiling has not been addressed by the proponent. The proponent appears to want to limit monitoring to the seafloor and benthos around the well sites. Monitoring related to shore habitats, seabirds and other marine life in relation to major spills, minor spills and chronic long-term discharges does not appear to be included in their plan and should, therefore, be added. Furthermore, the requirements for Environment Canada and other agency involvement should be addressed by the proponent, particularly with regard to the need for increased baseline monitoring and accelerated surveillance of seabird populations. The proponent has not committed itself to a comprehensive program aimed at evaluating even the impacts predicted to be "major" in the Impact Statement.

3.7.6 The Elements of a Monitoring Program

It must be emphasized that this Department believes that the effects monitoring program should focus on ecosystem components which could act as a barometer of overall environmental degradation. Monitoring such components should provide an early detection of impacts which can be used to implement remedial action to preserve the integrity of other species (e.g. commercially significant fish) located in the Grand Banks. We also believe that this type of monitoring program will serve our needs in the most efficient and cost effective manner.

As noted earlier, the Impact Statement does not clearly state the objectives and limitations of any monitoring programs recommended for the Hibernia development. Accordingly **it is Environment Canada's view that the proponent should be required to prepare, in consultation with those agencies involved, a comprehensive monitoring program.**

In general, this Department believes that the following elements should be addressed in the development of a comprehensive effects monitoring program:

i) It must be recognized that effects monitoring should be related to anticipated impacts. It is recommended that the proponent, in consultation with concerned agencies, develop impact hypothesis for significant ecosystem components and sensitive areas that will form the basis for developing the required monitoring program;

ii) Sublethal effects should be incorporated as a barometer of the overall health of the ecosystem. To measure such effects, an assessment of the methods and techniques for monitoring low level impacts in relation to the Grand Banks ecosystem would be essential;

iii) The monitoring program should address both short-term acute effects (e.g. the immediate vicinity of the well sites, shore-based facilities and any ancilliary developments), and long-term chronic and cumulative impacts on the Grand Banks ecosystem;

iv) The monitoring program should be related to validation of the adequacy of discharge limits;

v) Any such efforts should be jointly funded by government and industry and explicitly directed to the long-term evaluation of impacts and management of biological resources in the Grand Banks.

3.8 Socio-economic Assessment

The Environment Canada Review of Socio-economic Impact Assessment is limited to its environmental aspects. Reliability of environmental impact projections stemming from socio-economic impacts depends to a large degree on the validity of the assumptions and methodology that are used in the socio-economic analysis and it is in this context that the following comments pertaining to The Socio-economic Volume are made.

There is a general lack of rigorous analysis of the information provided. Measures of impact significance such as duration, reversibility, cumulative effects, probability of occurrence, relative importance and risks associated with the impacts are dealt with superficially, if at all. Many of the individual impacts on land and resource use are described as small, insignificant, or negligible; **Environment Canada, however, is concerned that the cumulative effects of these individual impacts could lead to significant environmental disruption.**

The uncertainties associated with such statements as: "these estimates should not be interpreted as a prediction of what will happen. Rather, they provide a reasonable indication of what could happen", and ". . estimates are based on conceptual designs only and may change substantially once detailed engineering is completed" make it difficult to gain a proper appreciation of the environmental impacts presented.

The absence of social cost-benefit analysis limits the scope and depth of the proponent's assessment, providing no insight into the fundamental considerations for selecting a particular production alternative.

By assuming that approximately 78-79% of direct project employment and 100% of indirect and induced employment will be filled by present residents of Newfoundland, and starting with the projection of low in-migration based on this assumption, **the full spectrum of socio-economic impacts and consequently the environmental impacts such as the land and resource use from the Hibernia project may have been underestimated.** Speculative in-migration is not discussed in a satisfactory manner and analyses of land and resource use resulting from speculative activity or from spinoff use are not considered. It is important to recognize that such activities result from the general perception that "things are happening" as much as it does from the manpower requirements of a particular project such as Hibernia. The cumulative effect of Hibernia and other developments, eg., Lower Churchill, will provide a general inducement which is difficult to capture on a project-by-project basis.

In reviewing the background document entitled Hibernia Socio-Economic Impact Statement - Land and Resource Use Study, May 1985, by CBCL Limited and D. W. Knight Associates, Environment Canada notes that a number of key points of concern raised by the authors have been overlooked in Volume IV of the Impact Statement.

For example, as cited below:

i) "The current situation is such that significant fishing pressure increases could severely deplete the size of a salmon run on key rivers, to a point where the only management strategy would be to close the rivers to all angling until salmon stocks had recovered" (Water and Fish Resource, p. 6.3).

ii) "As an area is industrialized an improved transportation network, electrical distribution system and water and sewer systems may have to be established. Such developments could conceivably have an adverse impact on fish populations in watersheds" (Water and Fish Resources, p. 6.4.).

iii) "Resources . . . such as caribou, seabirds, ducks and ecological reserve areas are under threat from two major sources: (1) an increasing and more affluent population; and (2) pollution from related onshore industrial development or a major oil spill" (Wilderness and Wildlife Resources, p. 6.5.).

iv) "There are two major species of seabird that could be devastated by such an occurrence (oil spill). The first of these is the puffin colony on the Witless Bay Seabird Sanctuary where 80% of the Northwest Atlantic puffins breed. The second is the murre population which is totally pelagic at birth and remains unable to fly for quite a long time afterwards. An oil spill at that stage in the life cycle could kill any affected birds" (Wilderness and Wildlife Resources, p. 6.5.).

v) "Indirect impacts will be the greatest on the Avalon and Burin Peninsulas due to increased pressure on natural resources in localized areas resulting from the presence of a larger population with increased means of access" (Introduction, p.7.1.).

vi) "The use of the Placentia Bay area for construction, aggregate extraction and mating of the GBS base and deck may have impacts on wilderness and wildlife resources in the area. Any resource extraction or other development on or next to the Placentia Bay Islands may threaten the local eider duck population . . . The use of these Islands for heavy aggregate, or for local hunting, should be carefully monitored to minimize negative impacts" (Wilderness and Wildlife Resource, p. 7.4.).

As a result of the inadequacies outlined above, discussions on the management of impacts have not fully considered the range of mitigative measures that may be required. Since there is no evidence of planning for mitigation in the event the predictions of impact are incorrect, **a commitment from the proponent to respond to unanticipated consequences would be appropriate.**

4. Conclusion

The Hibernia Development Project Environmental Impact Statement is an optimistic evaluation of the probable and possible environmental impacts associated with the production of oil on the Grand Banks. The Impact Statement is extensive and the supporting documentation is voluminous, however, significant errors and omissions have been identified. The limited attention paid to environmental risk in this Impact Statement is a particularly serious omission.

Environment Canada considers that the proponent has under-estimated the possible impacts on marine ecosystems from both chronic and catastrophic discharges. The Impact Statement fails to address coastal impacts and the risk of tanker accidents. These limitations are considered significant deficiencies for a region so dependent on its marine environmental quality for sustained economic and social benefit.

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APPENDIX

Simulated Batch Oil Spill of 30,000 m^3 at 46°30'N, 52°20'W for January, April, July and September

Prepared for
Environment Canada
by
SeaConsult Ltd.
July, 1985

OIL SPILL MODELLING RESULTS
BATCH TANKER SPILL AT 46°30'N; 52°20'W

In preparing the Environmental Impact Statement, the proponent has chosen not to consider the potential for spills away from the Hibernia development site. Environment Canada believes that the environmental consequences of spills originating from shuttle tankers should be evaluated.

In order to assist the Panel in this regard, Environment Canada commissioned a study by Seaconsult Ltd. simulating a 30,000 m^3 batch spill at location 46°30'N; 52°20'W - one of the sites where shuttle tankers will merge with an existing shipping lane. The same input parameters and deterministic trajectory model employed by the proponent to assess the movement of oil spilled at the Hibernia development site has been used here.

Wind input is from the Atmospheric Environment Service (AES) Geostrophic Wind Climatology (GWC). Vectors have been backed 15° and reduced by 12% in magnitude to best represent Grand Banks conditions. Water current input is from the International Ice Patrol residual current field while oil chemistry data pertinent to Hibernia crude have been employed. A six-hour time step has been used in the model.

Batch spill simulations have been executed for every day in the interval 1946-1975 for the months of January, April, July and September. Each simulation evolves until:

- the trajectory reaches a coastline;
- the trajectory reaches an external grid boundary;
- or the remaining volume falls below 5% of the initial volume.

Oil distribution probability plots have been prepared for each of the four months. Probable directions of slick motion and probable spill destinations are defined by these oil distribution probability plots. The basic probability plots are developed from simulations of every possible "day-lot" spill over the duration of the available wind record. Each grid element through which at least one trajectory passed is labelled with a number between zero and ten indicating the percentage of all trajectories which passed through that element, according to the following code:

Code	Percentage of Trajectories (P)
0	$1 \leq P \leq 10$
1	$10 \leq P \leq 20$
2	$20 \leq P \leq 30$
3	$30 \leq P \leq 40$
4	$40 \leq P \leq 50$
5	$50 \leq P \leq 60$
6	$60 \leq P \leq 70$
7	$70 \leq P \leq 80$
8	$80 \leq P \leq 90$
10	$90 \leq P \leq 100$
	$P = 100$

Grid elements through which at least one but less than 1% of the trajectories passed are designated with a dot. The quoted percentages can be interpreted as presenting the probability that oil would reach the indicated site, given a spill originating on any day of the particular calendar month. Grid elements showing no designation are considered, on the basis of these model results, to have negligibly small probabilities of oil impact.

Each oil distribution probability map is accompanied by a summary table of shore impact statistics. This table identifies, by geographical region, those grid elements impacted, and quotes earliest mean and latest times to shore, plus minimum, mean and maximum percentage spill volumes remaining at time of impact, for each impacted grid element.

The results of at least 900 (30 years times 30 days per month) simulations for each month were surveyed to identify that one case in which the earliest shore impact was predicted. This is (subjectively) considered to represent the worst case event for the given month. Trajectory plots and shore impact listings are provided for each monthly worst case scenario. Essential results are summarized as follows:

Summary of Worst Case Simulations

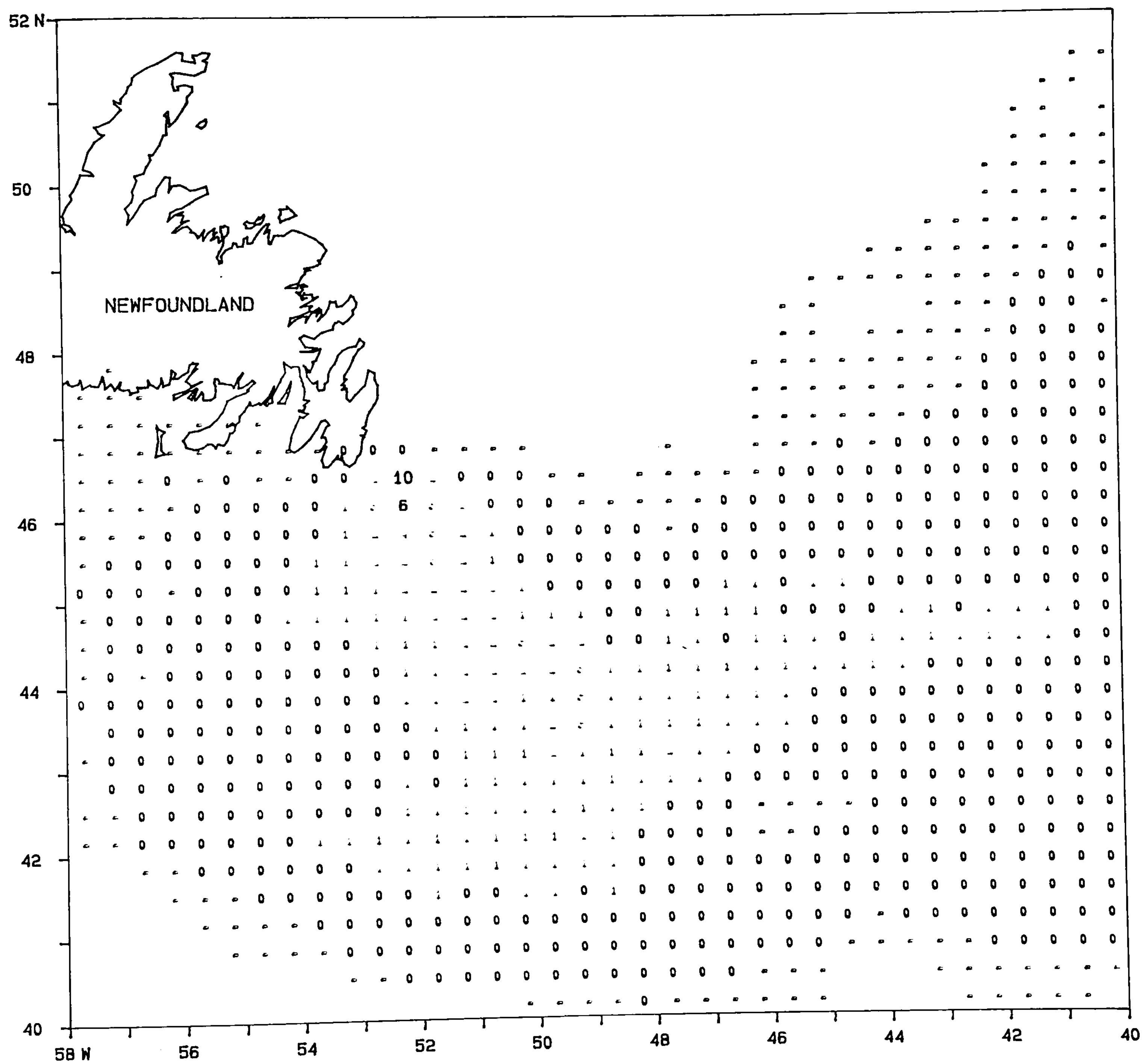
Date	Location of Shore Impact	Time to Shore	% Volume Ashore
January 15, 1956	SE Avalon	30 hours	31.4%
April 21, 1971	SE Avalon	30 hours	31.5%
July 2, 1966	SE Avalon	72 hours	25.0%
September 2, 1975	SE Avalon	66 hours	24.3%

Finally, one composite map is provided to indicate the maximum excursion of the batch spill in any of the four months while greater than 10% of fractions lighter than C_{14} remain in the surface slick.

Monthly Oil Distribution Probability Maps

and Shore Impact Summaries

OIL DISTRIBUTION PROBABILITIES FOR THE MONTH OF JAN



▪ REPRESENTS PROBABILITY LESS THAN ONE PERCENT

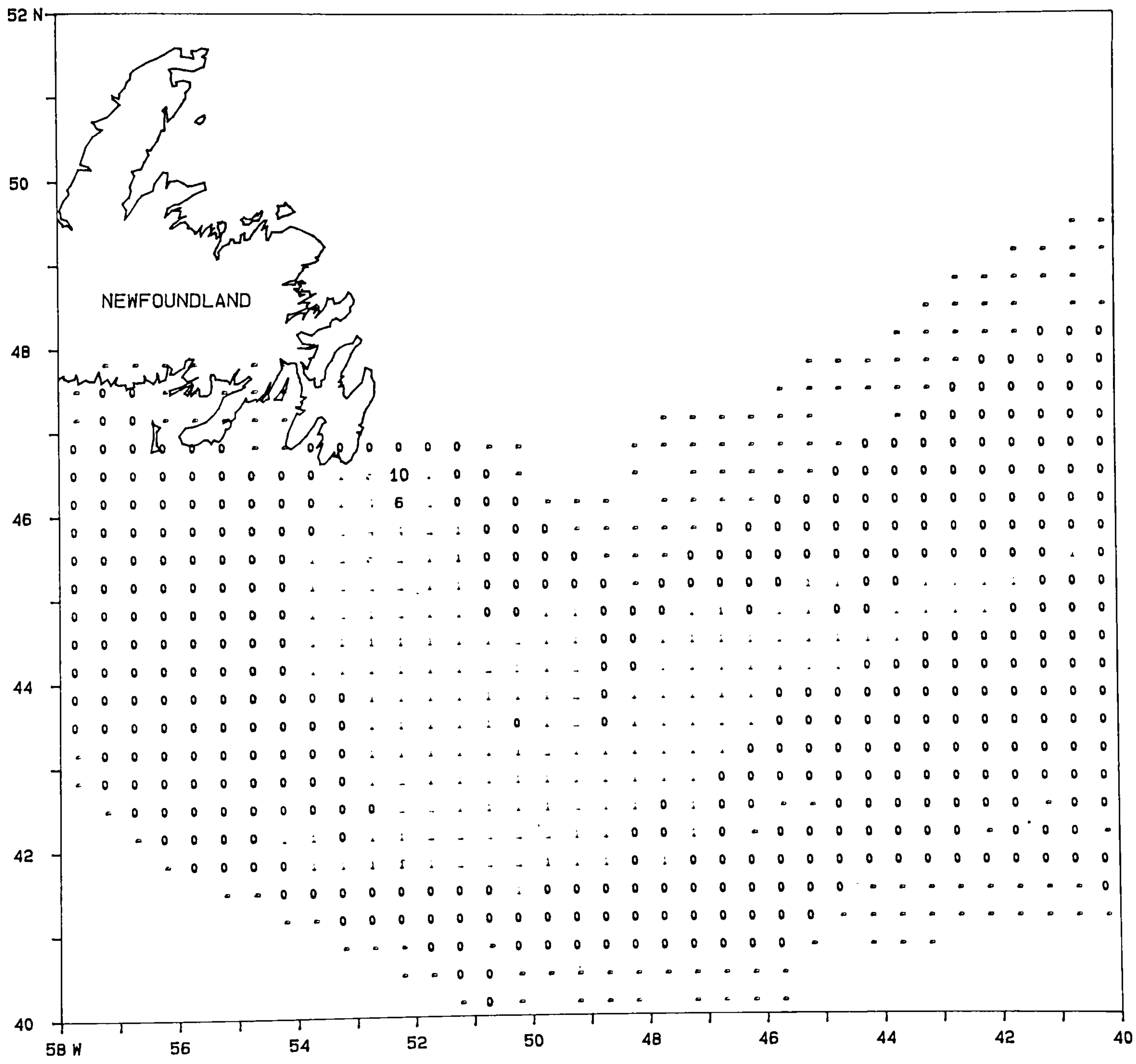
EPS TANKER SPILL

SHORE IMPACT STATISTICS FOR NEWFOUNDLAND FOR THE MONTH OF JANUARY

POSITION ROW	COL	PERCENT IMPACTS	MIN VOL. PER CENT	MAX VOL. PER CENT	MEAN VOL. PERCENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
13	5	.11	16.	16.	16.	504.	504.	504.
15	10	.11	15.	15.	15.	162.	162.	162.
15	15	.11	15.	15.	15.	138.	138.	138.
15	16	.11	15.	15.	15.	162.	162.	162.
16	27	.11	26.	26.	26.	48.	48.	48.
16	28	.43	19.	25.	22.	60.	420.	161.
16	29	.54	17.	29.	22.	36.	390.	167.
16	30	2.04	16.	32.	24.	30.	306.	100.

TOTAL: 3.55 PERCENT OF 930. TRAJECTORIES ASHORE ON NEWFOUNDLAND

OIL DISTRIBUTION PROBABILITIES FOR THE MONTH OF APR



• REPRESENTS PROBABILITY LESS THAN ONE PERCENT

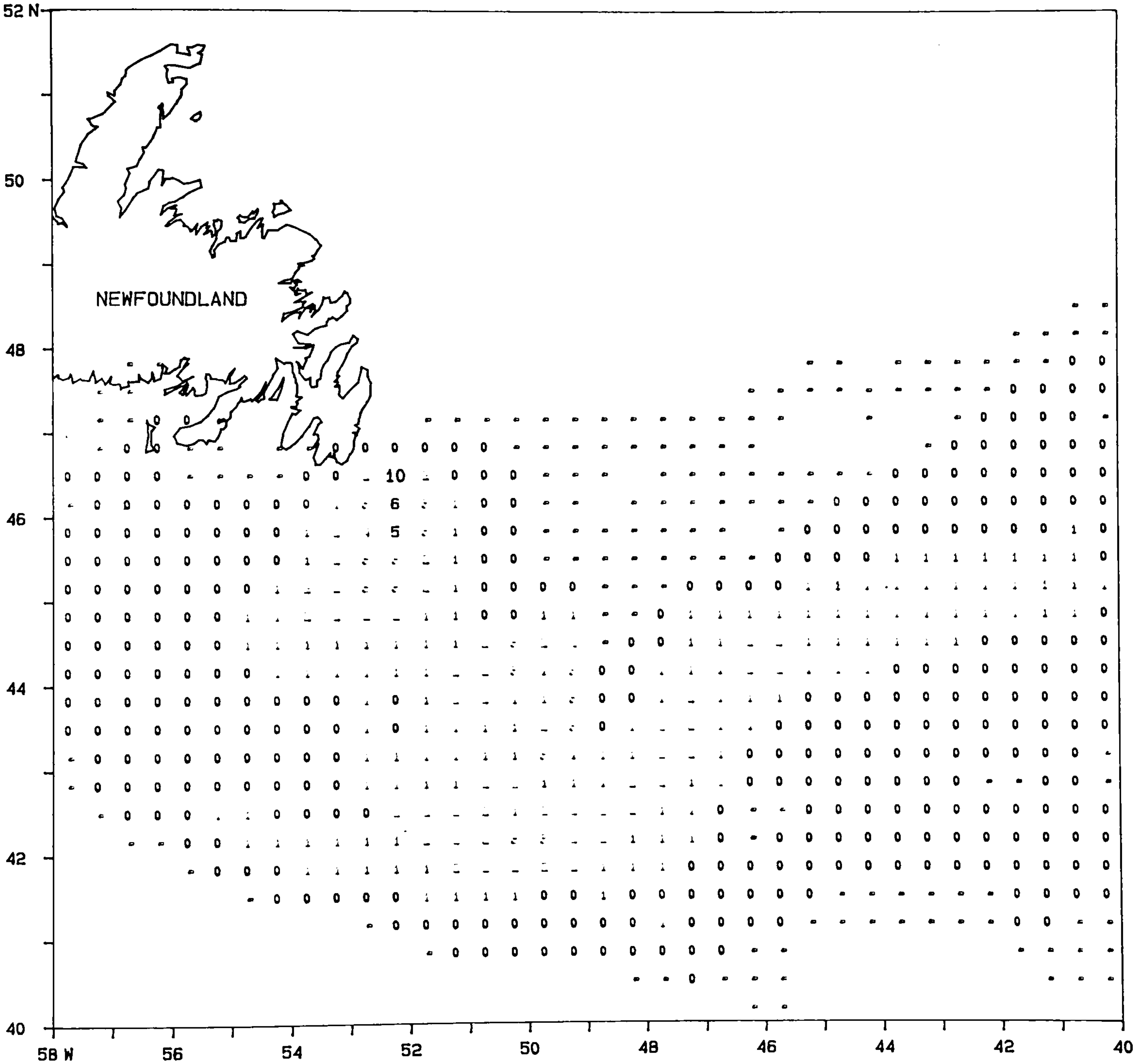
EPS TANKER SPILL

SHORE IMPACT STATISTICS FOR NEWFOUNDLAND FOR THE MONTH OF APRIL

POSITION ROW	COL	PERCENT IMPACTS	MIN VOL. PER CENT	MAX VOL. PER CENT	MEAN VOL. PERCENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
13	4	.22	15.	16.	16.	462.	726.	594.
13	6	.11	17.	17.	17.	468.	468.	468.
13	7	.33	15.	18.	17.	414.	624.	516.
13	8	.33	15.	17.	16.	540.	588.	558.
13	9	.11	18.	18.	18.	492.	492.	492.
13	11	.11	13.	13.	13.	726.	726.	726.
13	12	.11	12.	12.	12.	648.	648.	648.
13	13	.11	19.	19.	19.	516.	516.	516.
13	19	.11	16.	16.	16.	336.	336.	336.
13	23	.11	11.	11.	11.	426.	426.	426.
14	15	.11	12.	12.	12.	570.	570.	570.
14	16	.11	14.	14.	14.	660.	660.	660.
14	23	.33	10.	18.	13.	492.	534.	516.
15	10	.44	7.	18.	13.	306.	1350.	674.
15	14	.11	13.	13.	13.	594.	594.	594.
15	15	.22	12.	18.	15.	240.	474.	357.
15	16	.11	21.	21.	21.	420.	420.	420.
15	23	.33	16.	19.	18.	204.	570.	384.
16	24	.33	18.	22.	20.	108.	186.	150.
16	27	1.22	14.	26.	22.	54.	276.	119.
16	28	.56	18.	28.	23.	48.	312.	128.
16	29	1.11	16.	28.	23.	48.	276.	148.
16	30	2.78	16.	32.	23.	30.	324.	118.

TOTAL: 9.44 PERCENT OF 900. TRAJECTORIES ASHORE ON NEWFOUNDLAND

OIL DISTRIBUTION PROBABILITIES FOR THE MONTH OF JULY



• REPRESENTS PROBABILITY LESS THAN ONE PERCENT

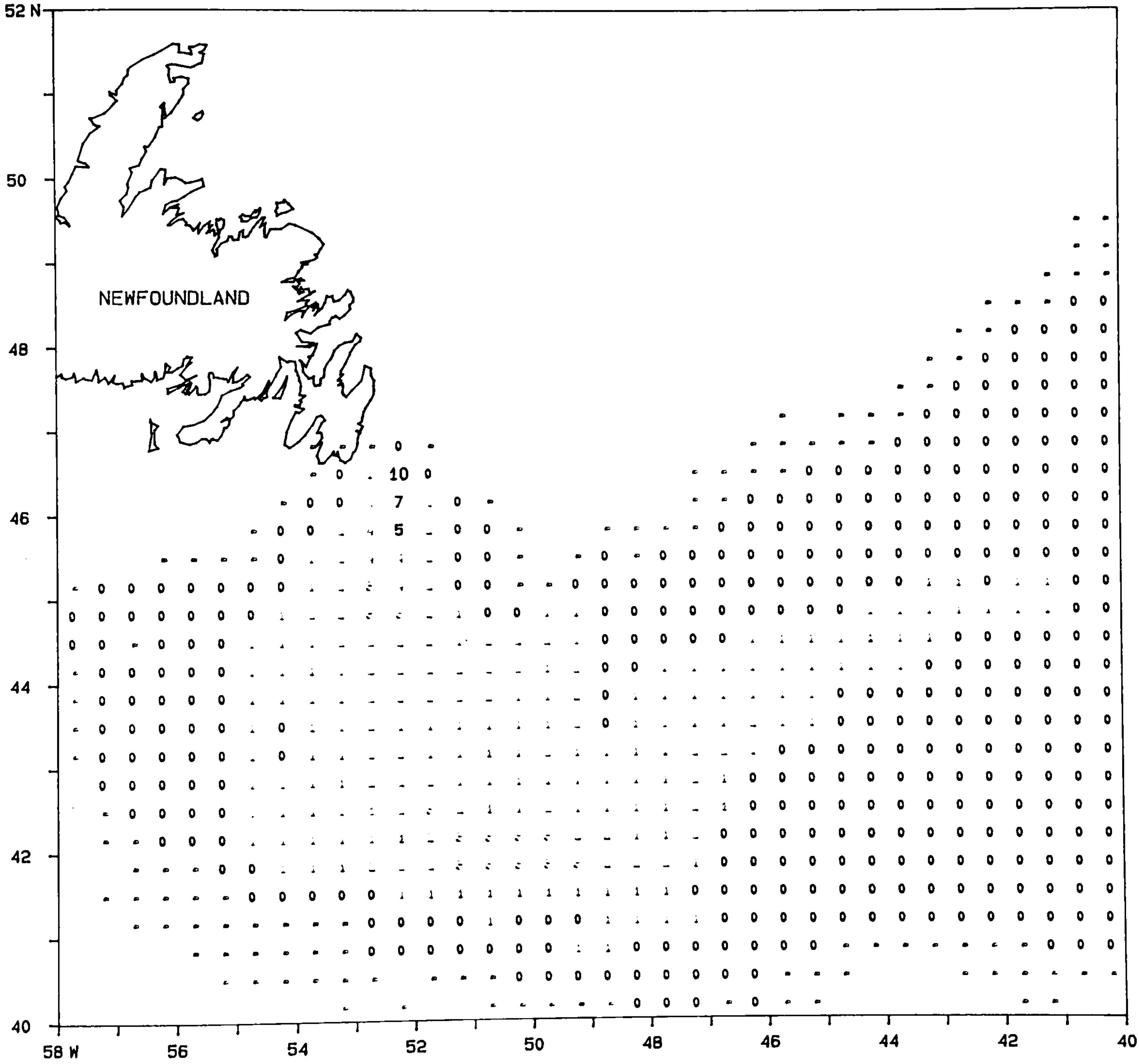
EPS TANKER SPILL

SHORE IMPACT STATISTICS FOR NEWFOUNDLAND FOR THE MONTH OF JULY

POSITION ROW	COL	PERCENT IMPACTS	MIN VOL. PER CENT	MAX VOL. PER CENT	MEAN VOL. PERCENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
13	9	.22	15.	16.	16.	612.	636.	624.
13	10	.11	11.	11.	11.	1470.	1470.	1470.
15	10	.86	10.	20.	15.	666.	1104.	882.
15	13	.97	11.	22.	16.	654.	1260.	917.
15	14	.11	22.	22.	22.	504.	504.	504.
15	16	.11	21.	21.	21.	480.	480.	480.
16	24	.32	21.	23.	22.	162.	234.	202.
16	27	.22	21.	26.	23.	180.	186.	183.
16	28	.11	19.	19.	19.	240.	240.	240.
16	29	.22	23.	24.	23.	84.	162.	123.
16	30	.86	16.	27.	21.	72.	372.	155.

TOTAL: 4.09 PERCENT OF 930. TRAJECTORIES ASHORE ON NEWFOUNDLAND

OIL DISTRIBUTION PROBABILITIES FOR THE MONTH OF SEPT



- REPRESENTS PROBABILITY LESS THAN ONE PERCENT

EPS TANKER SPILL

SHORE IMPACT STATISTICS FOR NEWFOUNDLAND FOR THE MONTH OF SEPTEMBER

POSITION ROW	COL	PERCENT IMPACTS	MIN VOL. PER CENT	MAX VOL. PER CENT	MEAN VOL. PERCENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
16	27	.11	21.	21.	21.	90.	90.	90.
16	30	.11	24.	24.	24.	66.	66.	66.

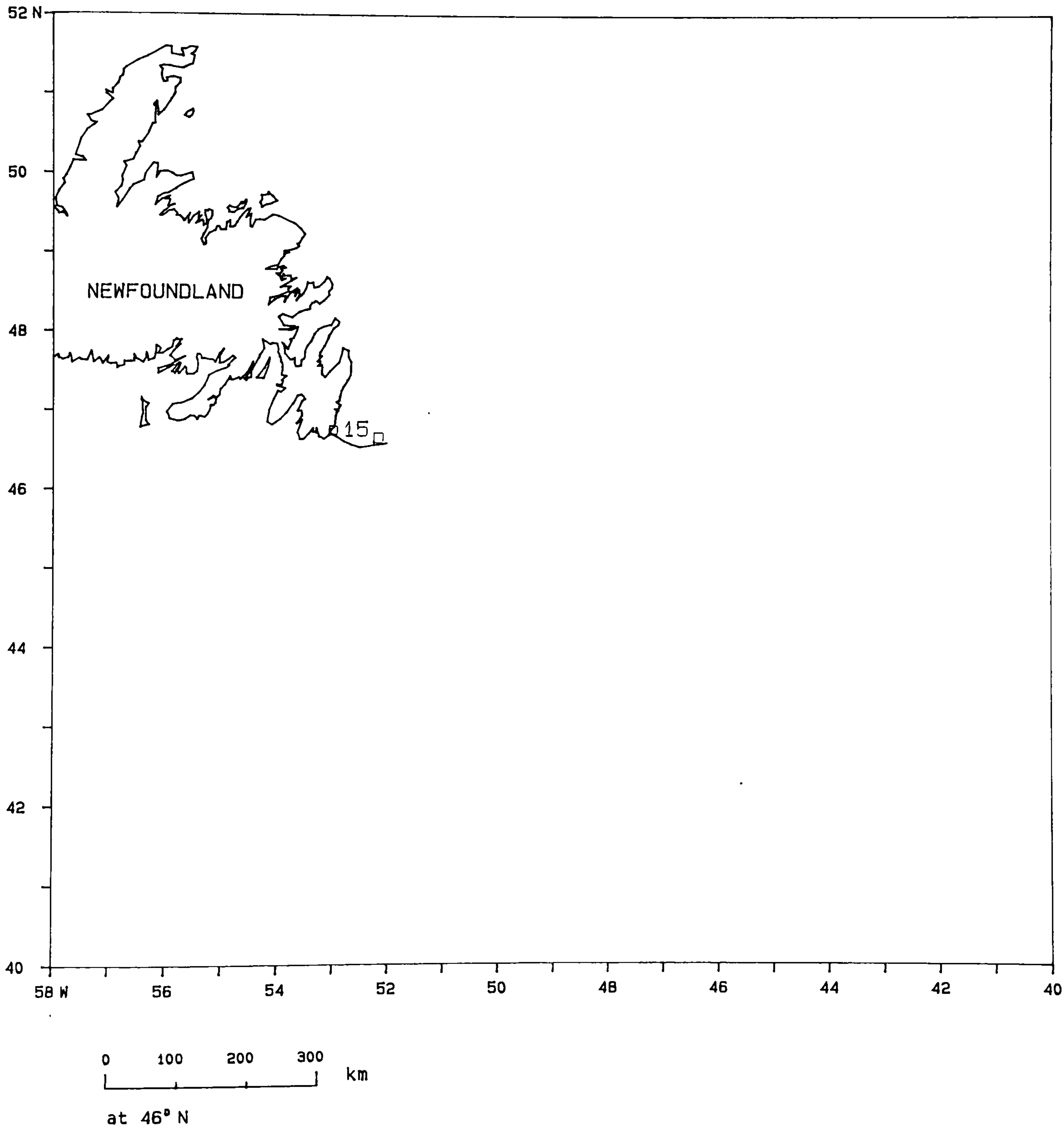
TOTAL: .22 PERCENT OF 900. TRAJECTORIES ASHORE ON NEWFOUNDLAND

Monthly Worst Case Trajectories Plots

and Shore Impact Summaries

TANKER SPILL
WIND SOURCE:
CURRENT SOURCE:

JANUARY 15
1956
STANDARD DIRECTION
STANDARD SPEED



EPS TANKER SPILL SPILL BEGINS AT 0000 HRS, 15 JANUARY

WIND SOURCE: 1956. CURRENT SOURCE: STANDARD DIRECTION WITH STANDARD SPEED

DAY	ROW	COL	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	TIME C-14 HOURS	% AT ENDPT
15	16	30	60.	293.	46.7120	53.0590	YES	30.	60.7	48.55	18.	31.4

PERCENTAGE BAD WIND DIRECTION/WIND SPEED POINTS 0.00 0.00

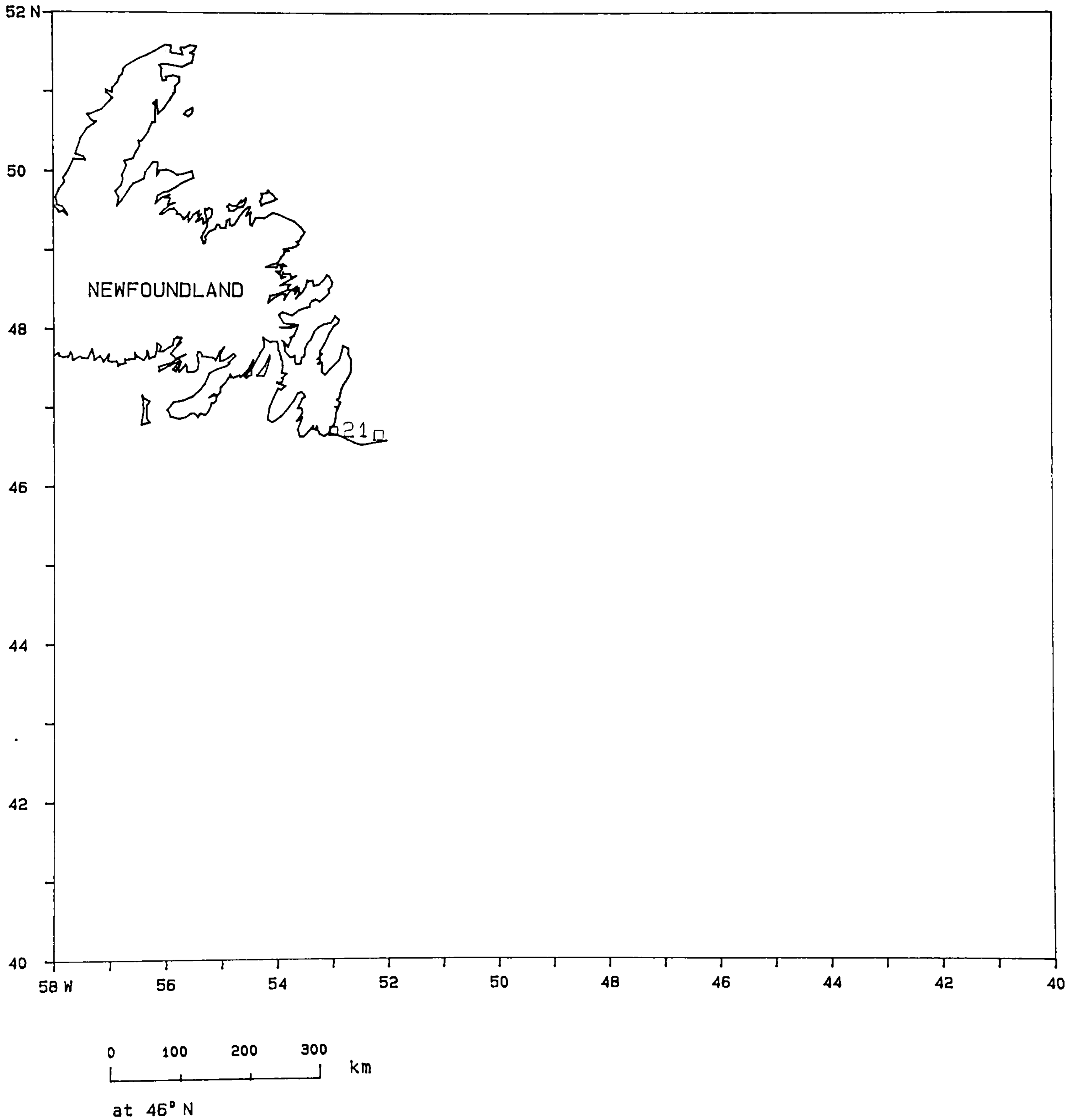
SHORE IMPACT STATISTICS FOR: NEWFOUNDLAND

POSITION ROW	COL	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
16	30	1	31.	31.	31.	30.	0.	30.

TANKER SPILL — APRIL 21

WIND SOURCE: 1971

CURRENT SOURCE: STANDARD DIRECTION, STANDARD SPEED



EPS TANKER SPILL SPILL BEGINS AT 0000 HRS, 21 APRIL

WIND SOURCE: 1971. CURRENT SOURCE: STANDARD DIRECTION WITH STANDARD SPEED

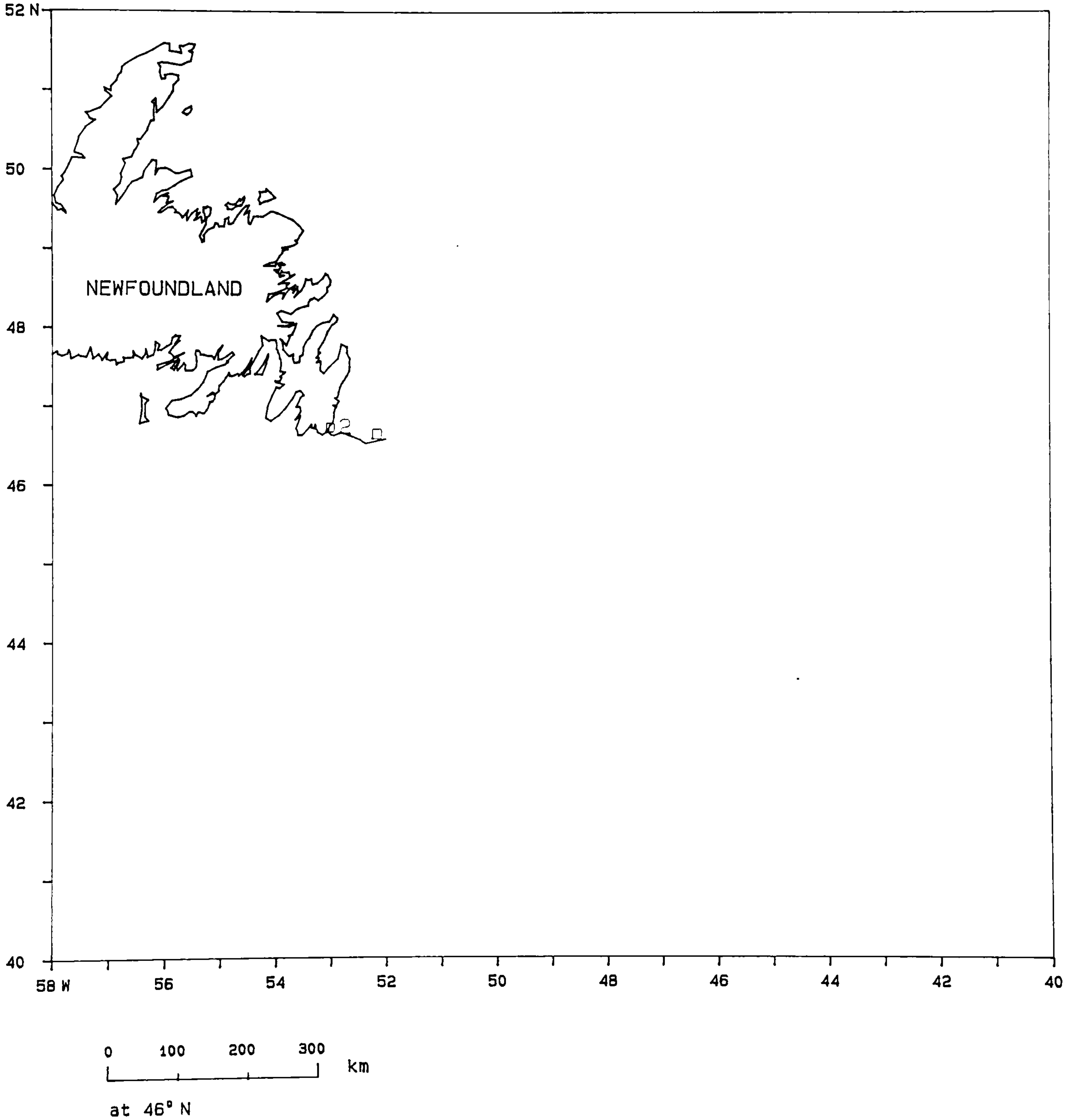
DAY	ROW	COL	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	TIME C-14 HOURS	% AT ENDPT
21	16	30	59.	289.	46.6753	53.0556	YES	30.	58.9	47.11	18.	31.5

PERCENTAGE BAD WIND DIRECTION/WIND SPEED POINTS 0.00 0.00

SHORE IMPACT STATISTICS FOR: NEWFOUNDLAND

POSITION ROW	COL	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
16	30	1	31.	31.	31.	30.	0.	30.

TANKER SPILL — JULY 2
WIND SOURCE: 1966
CURRENT SOURCE: STANDARD DIRECTION
STANDARD SPEED



EPS TANKER SPILL SPILL BEGINS AT 0000 HRS, 2 JULY

WIND SOURCE: 1966. CURRENT SOURCE: STANDARD DIRECTION WITH STANDARD SPEED

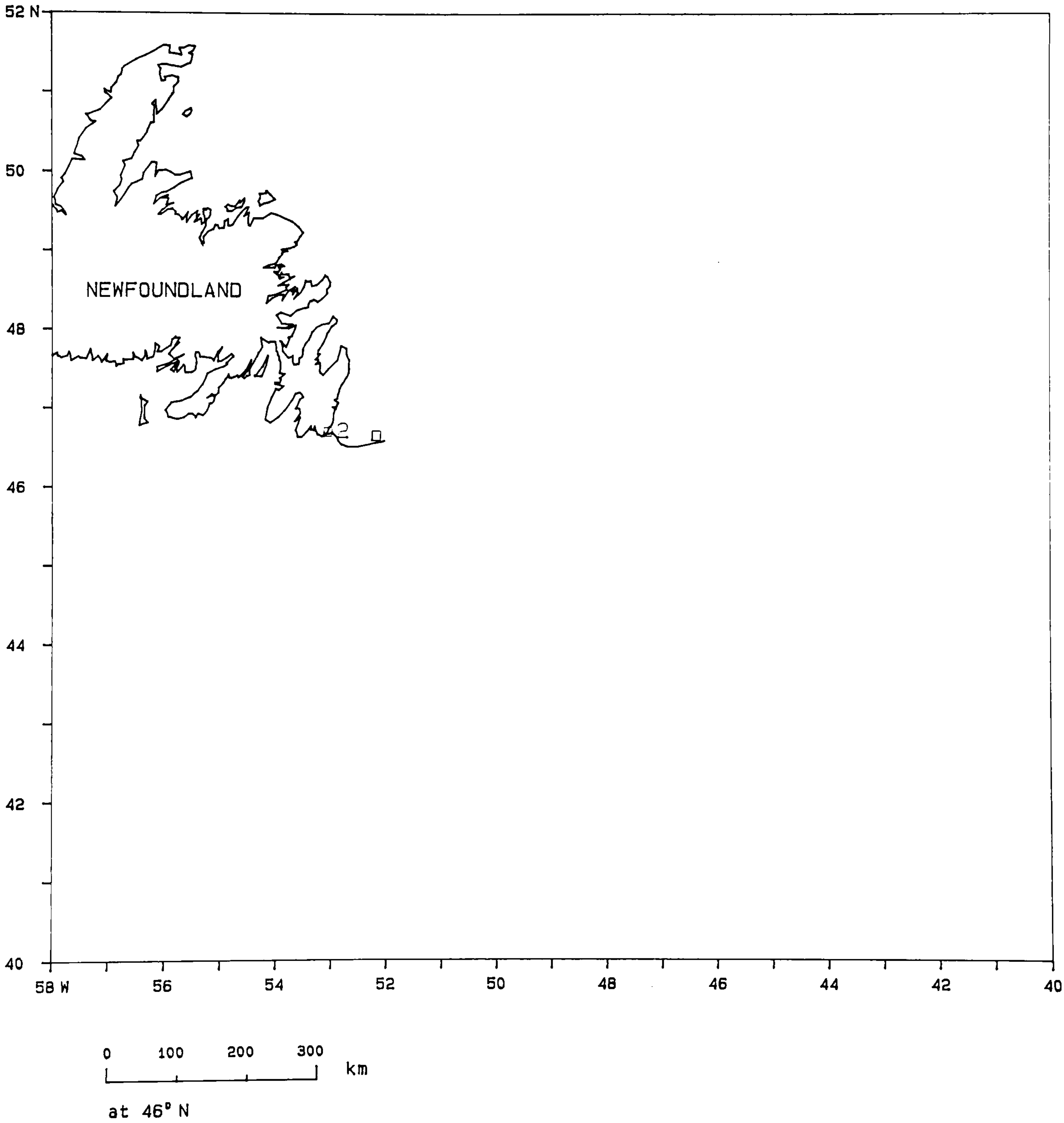
DAY	ROW	COL	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	TIME C-14 HOURS	% AT ENDPT
2	16	30	61.	291.	46.6983	53.0849	YES	72.	66.7	22.25	18.	25.0

PERCENTAGE BAD WIND DIRECTION/WIND SPEED POINTS 0.00 0.00

SHORE IMPACT STATISTICS FOR: NEWFOUNDLAND

POSITION ROW	COL	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
16	30	1	24.	24.	24.	72.	0.	72.

TANKER SPILL — SEPTEMBER 2
WIND SOURCE: 1975
CURRENT SOURCE: STANDARD DIRECTION
STANDARD SPEED



EPS TANKER SPILL SPILL BEGINS AT 0000 HRS, 2 SEPTEMBER

WIND SOURCE: 1975. CURRENT SOURCE: STANDARD DIRECTION WITH STANDARD SPEED

DAY	ROW	COL	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	TIME C-14 HOURS	% AT ENDPT
2	16	30	62.	287.	46.6682	53.1173	YES	66.	69.7	25.34	6.	24.3

PERCENTAGE BAD WIND DIRECTION/WIND SPEED POINTS 0.00 0.00

SHORE IMPACT STATISTICS FOR: NEWFOUNDLAND

POSITION ROW	COL	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
16	30	1	24.	24.	24.	66.	0.	66.

Extreme Envelope of Fractions Lighter Than C_{14}

TANKER SPILL C-14 ENVELOPE