OIL POLLUTION AND THE NEWFOUNDLAND & LABRADOR FISHERY: CURRENT AND POTENTIAL THREATS FOR THE CONSERVATION OF COMMERCIAL FISHERIES RESOURCES IN PLACENTIA BAY

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Oil Pollution and the Newfoundland & Labrador Fishery: Current and Potential Threats for the Conservation of Commercial Fisheries Resources in Placentia Bay

by

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ABSTRACT

Marine oil pollution and the continuing encroachment on marine habitats from the oil and marine transport industries pose a serious threat for the marine natural resources of Newfoundland and Labrador. The effects of oil pollution on highly visible marine wildlife such as seabirds, which are often dramatically affected by such events, have more recently been the subject of intense study. However, studies of the impacts of marine oil pollution on the commercial fisheries resources of Newfoundland and Labrador have not been as rigorously pursued. This study examines the marine oil pollution problem in Newfoundland and Labrador from both the marine transport industry and the oil industry operations currently underway within the province and their impacts on commercial fishery resources. The focus of the study is Placentia Bay, Newfoundland, where prominent oil handling operations, heavy marine traffic associated with the oil industry, and one of the richest fishery resources within the North Atlantic coexist. Chronic oil pollution is identified as a current and very real threat to fisheries conservation in southeastern Newfoundland and the Placentia Bay area. The threat of an oil tanker accident is also examined, with particular attention given to volume of tanker traffic, volume of oil transported through Placentia Bay, and oil spill response capacity for the Newfoundland and Labrador region. Also examined are the existing initiatives in place to address the issue of current and potential oil pollution threats to the fishery resources of Placentia Bay. Further, the shortcomings of these initiatives are identified and alternative preventative measures are suggested. Based on the number of reported oil pollution incidents and high seabird mortality within the region, the marine oil pollution problem of southeastern Newfoundland and Labrador is one of the worst in the world. However, the challenge of combating oil pollution is not unique to the region. Hence, the information provided for the current report draws upon other global regions and their experiences.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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1.0 Introduction & Background

Conservation and sustainable use of its marine fisheries resources is one of Newfoundland and Labrador's most formidable challenges. Several issues contribute to the difficulty associated with achieving these objectives, including stock conservation, allocation disputes, international boundary conflicts, excessive harvesting (Department of Fisheries and Oceans-DFO, 1999a), and numerous environmental considerations. A significant environmental problem for Newfoundland and Labrador, and indeed the rest of Canada and other coastal states, is the increasing prevalence of marine pollution, particularly in the form of oil. Competing demands for diverse ocean resources such as fisheries and oil exploration have been difficult to balance (DFO, 1999a), and this concern has been prevalent in Newfoundland during recent years.

The marine sector in Canada has experienced unprecedented growth over the past 25 years, and has the capacity to exceed the growth of any other economic sector of the Canadian economy (DFO, 1999a). Along with this future growth is the potential for environmental degradation and further threats to the conservation of ocean resources. Already, without considering future growth potential, southeastern Newfoundland and eastern Canada are experiencing significant oil pollution events, which have not been dealt with adequately (Prevention of Oiled Wildlife-POW Report - Phase I, 1998). Oil exploration, development, and shipping activity are growing at an unprecedented rate in the waters surrounding the island of Newfoundland. The economic growth that has occurred as a consequence of oil related industries has been paralleled by an increasing trend in oil pollution (POW Report - Phase I, 1998) with inadequate planning to deal with potential impacts on marine wildlife and fisheries resources.

This report is an investigation into the continuing and potential impacts of oil pollution on the important commercial fisheries resources of Newfoundland and Labrador. Also considered are the implications of increases in shipping and oil exploration and development industries in Newfoundland and Labrador in terms of the province's fisheries resources. Particular consideration is given to Placentia Bay, Newfoundland, an area with important fisheries resources that is potentially at risk from a major oil pollution incident as a result of increased vessel traffic associated with the oil industry. This report also examines the existing issue of chronic oil pollution around Placentia Bay and southeast Newfoundland. In this context, both direct and indirect impacts upon fisheries resources are examined. The legislative and preventative measures that are currently in place are considered in the context of whether these measures are adequate to protect the resources of Placentia Bay and elsewhere from persistent oil discharge events from shipping and from a potential oil tanker accident. Specific linkages are also drawn with major oil development initiatives east of Placentia Bay on the Grand Banks, where the Hibernia and Terra Nova oil fields are already well into development. There is currently great interest in the potential for additional oil field development in the Grand Banks region.

Oil exploration and development and the associated environmental risks are not unique to Newfoundland and Labrador. Hence, this report draws upon experience and information from other global regions that have faced similar challenges and experienced the effects of oil spills in major coastal fishing regions.

The sources of the oil and oily wastes that are currently entering the marine environment are varied, but for the most part, can be attributed to the shipping industry (i.e., vessel source oil pollution). Oil pollution events characteristically manifest themselves in the form of small-scale, persistent oil spill events or "mystery spills", where the source is unidentified. Mystery spills are usually identified by aerial surveillance flights as a sheen on the ocean or by residents of coastal communities as oil washes up on local beaches. More often, however, the first or only indication of oil release at sea is the presence of oil-covered seabirds on beaches, most of them with no chance of survival. Ironically, the thousands of oiled seabirds appearing on the shores of Newfoundland and Labrador (POW Report - Phase I, 1998) have become the most reliable indicator that an offshore oil spill or illegal oil discharge event has occurred. Research is currently being conducted through Memorial University, Environment Canada, and the Canadian Wildlife Service to assess the impact of persistent oil pollution on seabirds in coastal Newfoundland. However, investigations into the impact on other marine resources, including fisheries resources and the industries and communities relying on them, have been limited. Thus, the incentive was provided to investigate this issue and develop the current report.

For the purpose of this report, chronic oil pollution is considered separately from the issues and risks associated with oil development or the transport of oil in tanker vessels. In addressing the impact of oil pollution on fisheries resources, all sources of oil pollution must be examined. However, this report does not set out to link chronic vessel source oil pollution to the local oil exploration and development operations currently underway in waters surrounding Newfoundland and Labrador, or to the oil industry itself. Rather, culpability for much of the chronic oil pollution rests with the global shipping industry. Nevertheless, chronic oil pollution both from shipping discharges, and the potential for acute releases directly linked to the oil industry (i.e., tanker accidents), pose an increasing threat to Newfoundland and Labrador's fisheries resources.

1.1 Scope of Study and Limitations

Where possible, sources of oil pollution are identified throughout this report. However, oil from unidentified sources or mystery spills are also discussed. The report reflects the contention of several authorities (i.e., the Canadian Coast Guard, Canadian Wildlife Service, Transport Canada) that the source of most oil spills from "unidentified sources" likely originates from seagoing vessels that pollute undetected. To that end, the scope of the report is limited to more obvious sources of marine pollution (oil tankers, supply vessels, cargo vessels, fishing vessels, offshore exploration and development) and does not consider the impact of oil pollution from oil and oil related operations within terrestrial environments.

This report primarily examines the impact of oil pollution on commercially important species within the Placentia Bay area. The report is not a comprehensive examination of the potential effects of oil on all aspects of the marine ecosystem (i.e., marine vegetation, marine mammals, and various non-commercial species) or those inhabiting coastal beaches. Nevertheless, this report is intended to provide insight into the severity of the problem by presenting information from a wide range of local, national, and international sources. In summary, the overall goal of the report is to examine the problem of oil pollution on the fisheries resources of Newfoundland and Labrador, and in particular Placentia Bay, and to place the problem in the larger context of oil pollution as a global threat to marine conservation.

1.2 Methodology

The resources used for this report include literature on the subject of marine oil pollution and fisheries resources, scientific and non-scientific journals, publications from several government agencies, non-governmental organizations, and the fishing and oil industries. Personal correspondence (i.e., via telephone, e-mail, standard mail) with individuals from the aforementioned organizations was widely used and provided valuable insight into the issue of marine oil pollution and its current or potential effects upon commercial fishery resources.

2.0 The Shipping Industry versus the Oil Industry as Sources of Marine Oil Pollution in Newfoundland and Labrador

There are over 100,000 sea trips through Canadian waters every year, transporting more than 360 million tonnes of goods with an import/export value of about $85 billion (DFO, 1999a). Marine transportation through Newfoundland waters alone accounts for thousands of vessel movements annually, including vessels of international registry. The Department of Fisheries and Oceans maintains that "the safe, reliable routing of ships is vital to Canada's economic viability. Canada must optimize sea transport while ensuring that safety standards, accessibility, and environmental protection are maintained" (DFO, 1999a). Despite this statement from the DFO, the shipping industry alone was responsible for a large portion of the over 114 tonnes of oily waste discharged into Newfoundland waters during 1998 (POW Report - Phase II, 1999). These oil pollution incidents reflect only those that are detected and reported. Further exacerbating the problem of monitoring vessel source pollution are cuts in the DFO's surveillance activities designed to identify and prosecute polluting vessels (personal correspondence with DFO Surveillance Flight Coordinator, May 2000).

In 1999, total fines for eleven counts of illegal oil discharge from vessels in Newfoundland waters were $122, 000 (Transport Canada, 1999). In Canada, the maximum fine for an intentional discharge of oily waste at sea is $1 million (Transport Canada, 1999) but fine imposition for such events have not exceeded 1/3 of the maximum (personal correspondence with Canadian Coast Guard-POW Project Manager, April 1999). Overall, it appears that the message being sent to the potential violators by the governmental lead agencies with the responsibility for protecting the marine environment is one of weakness and complacency.

Although the shipping industry appears largely to blame for the persistent oil pollution problem in Newfoundland's marine environment, the oil exploration and development industries are also culpable. It is important, however, to maintain a distinction between these two sectors, although they may not be mutually exclusive in terms of their contribution to oil pollution and the threats posed to fisheries resources.

Oil discharges directly related to marine exploration and development of offshore oil resources off the coast of Newfoundland and Labrador also pose a threat. The Canada-Newfoundland Offshore Petroleum Board (CNOPB) reported that from 1997 to 1999 inclusive, the Hibernia production platform reported 60 oil spill incidents, in which a total of 58 barrels was discharged into the ocean (Burley, 2000). The mean spill size was reported to be 153 litres with a total volume of 9.2 cubic metres (Burley, 2000). The Terra Nova development project reported 3 spill incidents in 1999 which discharged 29 barrels of oil into the marine environment with a total volume of 4.5 cubic metres (Burley, 2000). Oil exploration is also a contributor to marine oil pollution. The CNOPB reports that during this phase of development, 30 spill incidents occurred and discharged 33 barrels of oil into the ocean, covering a total area of 5.2 cubic metres (Burley, 2000). Future offshore oil exploration and development projects, such as the White Rose development project, will undoubtedly contribute to the trend of marine pollution during these initial stages of oil production. The incidents of oil discharge into the marine environment by oil exploration and development activities have so far been a relatively minor contributor to Newfoundland and Labrador's chronic oil pollution problem. However, the risks posed by the oil industry, from the development and transport of oil, specifically in high-risk areas such as Placentia Bay, are important considerations.

3.0 Overview of Placentia Bay

Placentia Bay, located on the southern coast of the island of Newfoundland, runs approximately northeast to southwest with the mouth of the Bay opening to the Atlantic Ocean (Figure 1). The average width of the Bay is approximately 80 km and narrows to less than 22km at the head of the Bay (Hart, 1999), while the southern mouth of the Bay widens to about 100km (Bradbury *et al.*, 2000). The average depth of Placentia Bay is 125m, reaching a depth of approximately 200 m near the mouth (Hart, 1999). The sides of the Bay are steep, and many areas are several hundreds metres deep (Bradbury *et al.*, 2000). The overall bathymetry of Placentia Bay is complex, with trenches and other areas exceeding 500m in depth (CHART, 1999a). The Bay has traditionally provided critical fisheries resources for the region and more recently has become a prime area for aquaculture development (Personal communication with personnel of the Ocean Sciences Centre, Memorial University of Newfoundland, April 2000). Moreover, Placentia Bay has supported one of the few stocks of Atlantic cod (*Gadus morhua*) in eastern Canada that is presently able to support a commercial fishery.

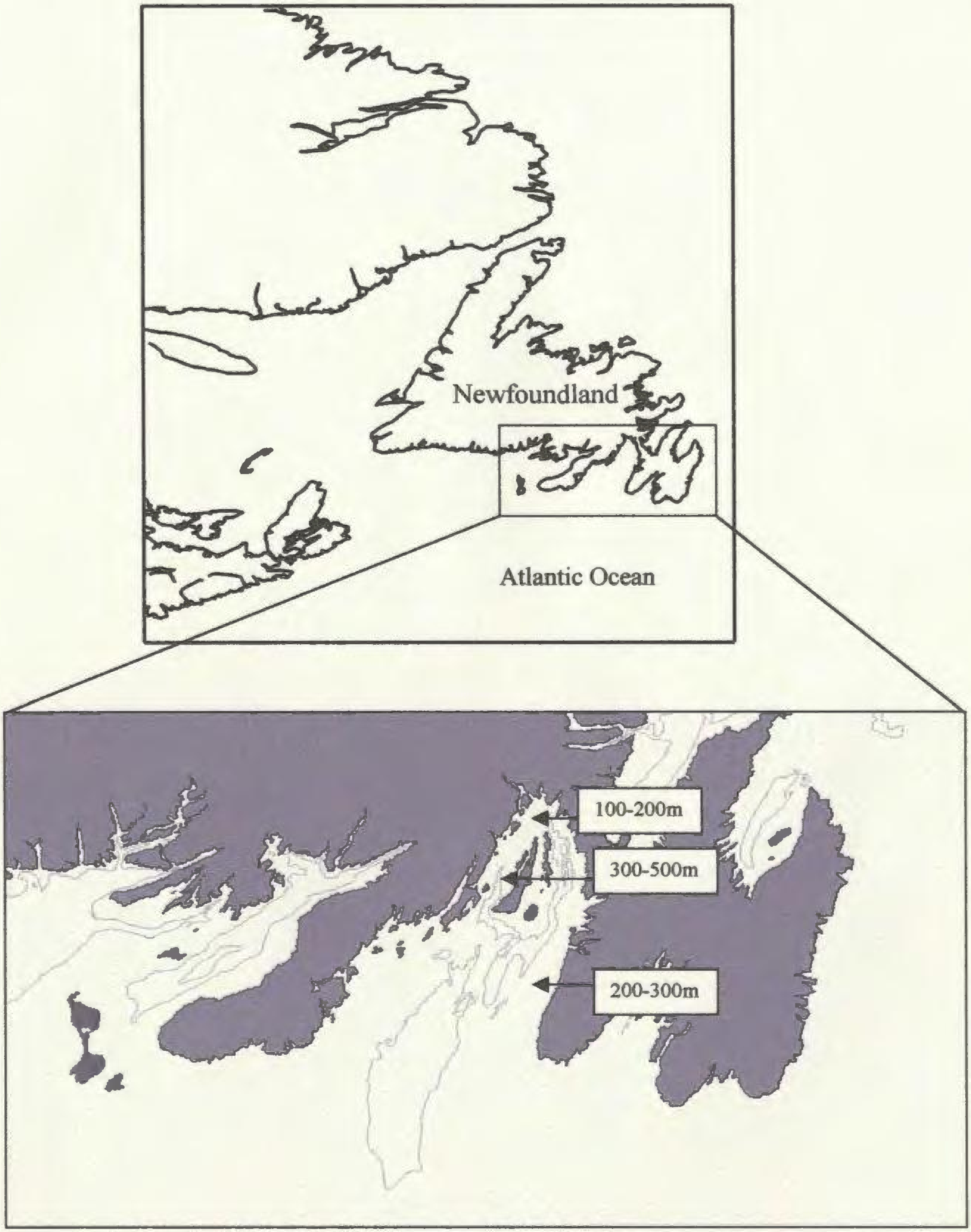


Figure 1: Placentia Bay, Newfoundland, illustrating general bathymetric information.

The vast shoreline of Placentia Bay is environmentally sensitive with a range of beach types (DFO, 1999b). The marine resources and productivity contained within Placentia Bay has contributed to the economic reliance within the region on its rich natural resources.

Despite some recovery of cod populations following a fishing moratorium and implementation of various conservation measures, Placentia Bay remains in an environmentally precarious position. Chronic oil pollution, likely originating from the shipping industry, has been reported along several sections of the Bay's vast coastline. In addition to the threat to fisheries resources, several large-scale oil industry initiatives are underway within the Bay itself, and have the potential to put the natural resources of the area at even greater risk.

3.1 Physical Characteristics of Placentia Bay

Many islands and shoals are found within Placentia Bay (Figure 1). The Eastern Channel, which runs along the eastern side from the mouth almost to the head of the Bay, is typically deeper than 200 m (DFO, 1999b) although a shallow bank at 20m depth is also present. Most shipping activity and large vessel movement is restricted to the Eastern Channel (Figure 2).

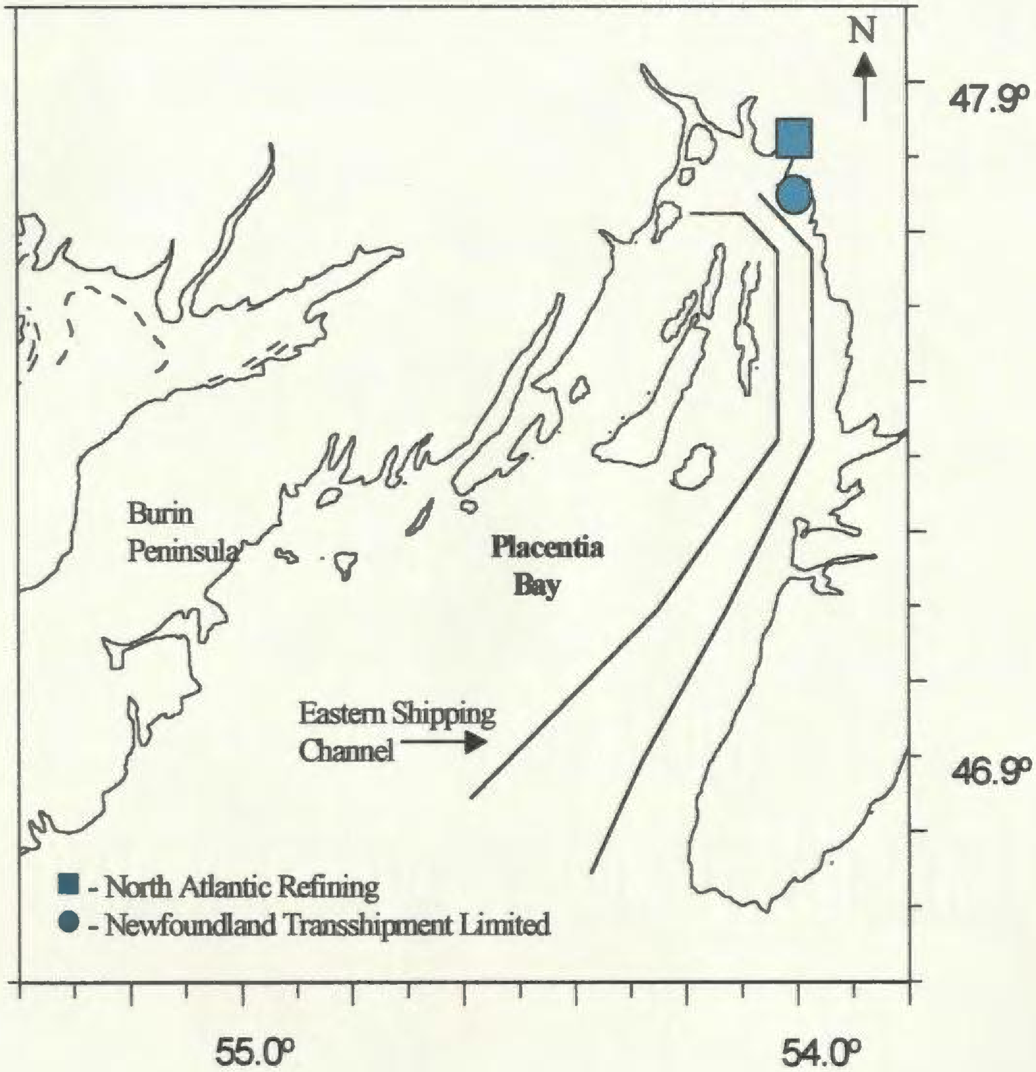


Figure 2: Placentia Bay, illustrating the location of the Eastern Shipping Channel and shore-based oil handling operations.

Several gravel beaches characterized by onshore-offshore sediment transport comprise a large portion of the shoreline in the eastern region of the Bay, particularly in the northeast. The western portion is composed of many shoals, reefs, and banks, none of which intersects the shipping channel (DFO, 1999b). At the northern head of the Bay at Whiffen Head there is a deep water traffic route via a 0.5 nm wide by 160 m deep channel that deepens toward the sea (DFO, 1999b).

The climate in the region is noteworthy for two key reasons. Firstly, there is a predominant southwesterly wind in the summer months (Banfield, 1981). Secondly, the incidence of fog in the region is extremely high, averaging 154 days with fog in a given year (Geological Survey of Canada (Atlantic), 1998). Fog and a very low ceiling commonly occur in Placentia Bay, most often between April and September. Visibility can be reduced to <0.5 nm for 40% of the time, and is <0.1 nm on average one day of every month. In July, as many as 16 days of the month may have severely reduced visibility within Placentia Bay (DFO, 1999b).

Surface currents in Placentia Bay typically flow inward on the eastern portion, and outward on the western portion of the Bay (Canadian Hydrographic Service, 1986). Data obtained using s4 current meters and Acoustic Doppler Current Profilers (ADCPs) confirm the existence of a general counter-clockwise flow within Placentia Bay (Schillinger *et al.* 2000; Bradbury *et al.*, 1999).

Air temperatures within Placentia Bay vary greatly during the year from –29° C to +29° C, but the temperature is typically between -10° C and +15° C. Average temperatures are approximately -5° C in the winter and +15° C in summer (DFO, 1999b). In some years, Placentia Bay can have a considerable amount of ice, particularly during February (Canadian Hydrographic Service, 1986). However, heavy ice is rare and dependent on seasonal wind patterns (Geological Survey of Canada (Atlantic), 1998).

The physical and oceanographic characteristics of Placentia Bay have important ramifications in the event of an oil spill incident, and have the potential to affect oil transport, persistence, and the extent of expected environmental damage.

3.2 Overview of the Placentia Bay Ecosystem

The biological environment of Placentia Bay is spatially diverse and productive and contains a variety of marine habitats. Several species of marine mammals, river otters, seabirds, and raptors reside within the Bay. Placentia Bay also supports a variety of marine fish and fish habitats, several commercial shellfish species, as well as diverse benthic communities (DFO, 1999b). Specific fisheries resources of the Bay are presented in greater detail in section 3.4 of this report.

The head of the Bay contains areas of shoreline that are considered particularly sensitive because of their high species diversity. The mouth of the Come by Chance River provides marsh vegetation and estuarine habitat for several species of waterfowl. The lower eastern side of the Placentia Bay shoreline also contains various sensitive habitats, including small estuaries found along the coastlines of Cuslet Cove, Patrick's Cove, Gooseberry Cove and Ship Cove (Figure 3). Sections of these shoreline areas support a variety of plant species known to be rare or threatened (DFO, 1999b).

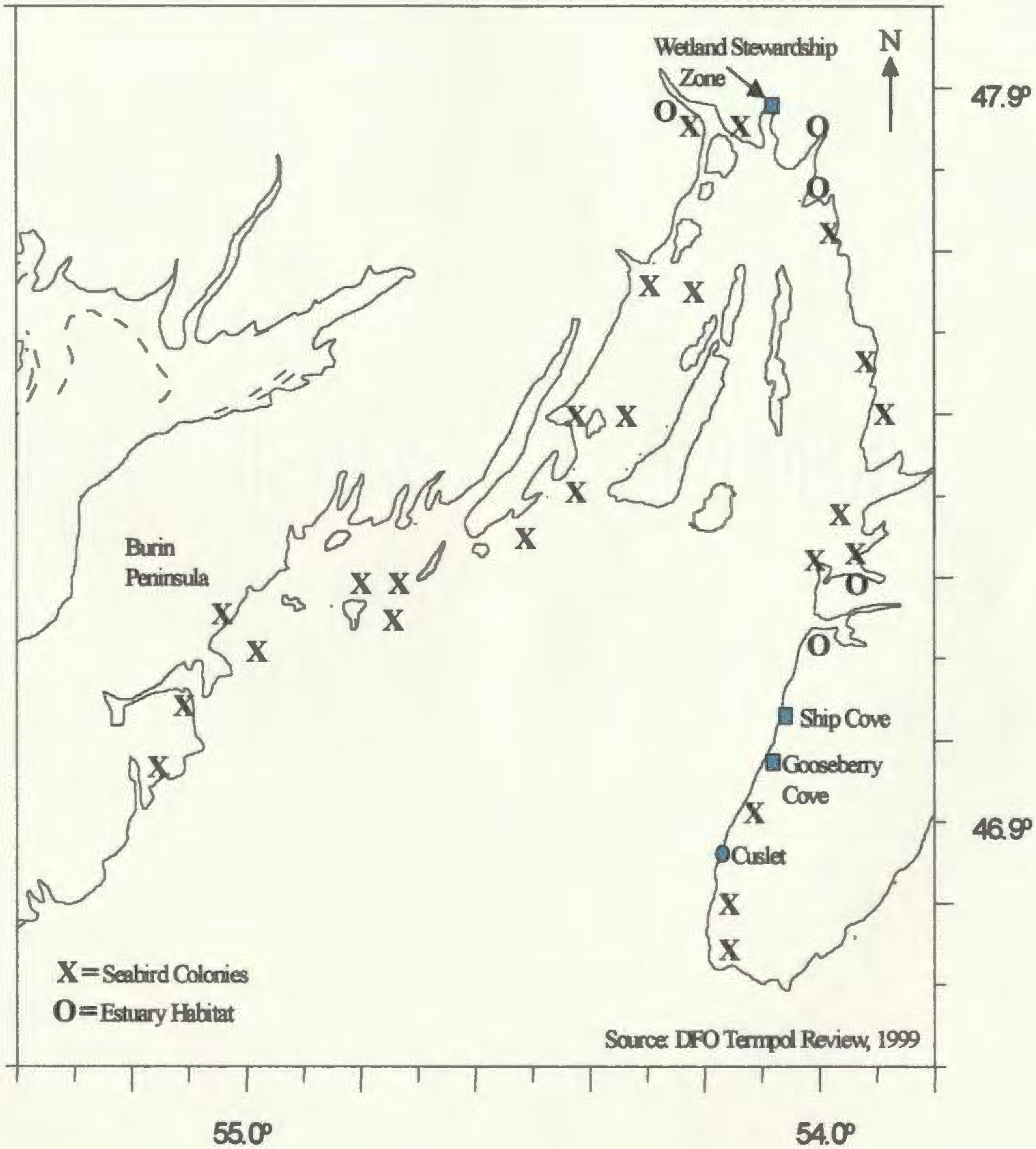


Figure 3: Sensitive shoreline areas and habitats of Placentia Bay

In response to concerns about the sensitive habitats within the Bay, several ecological reserves and parks have been established in the region (Figure 4).

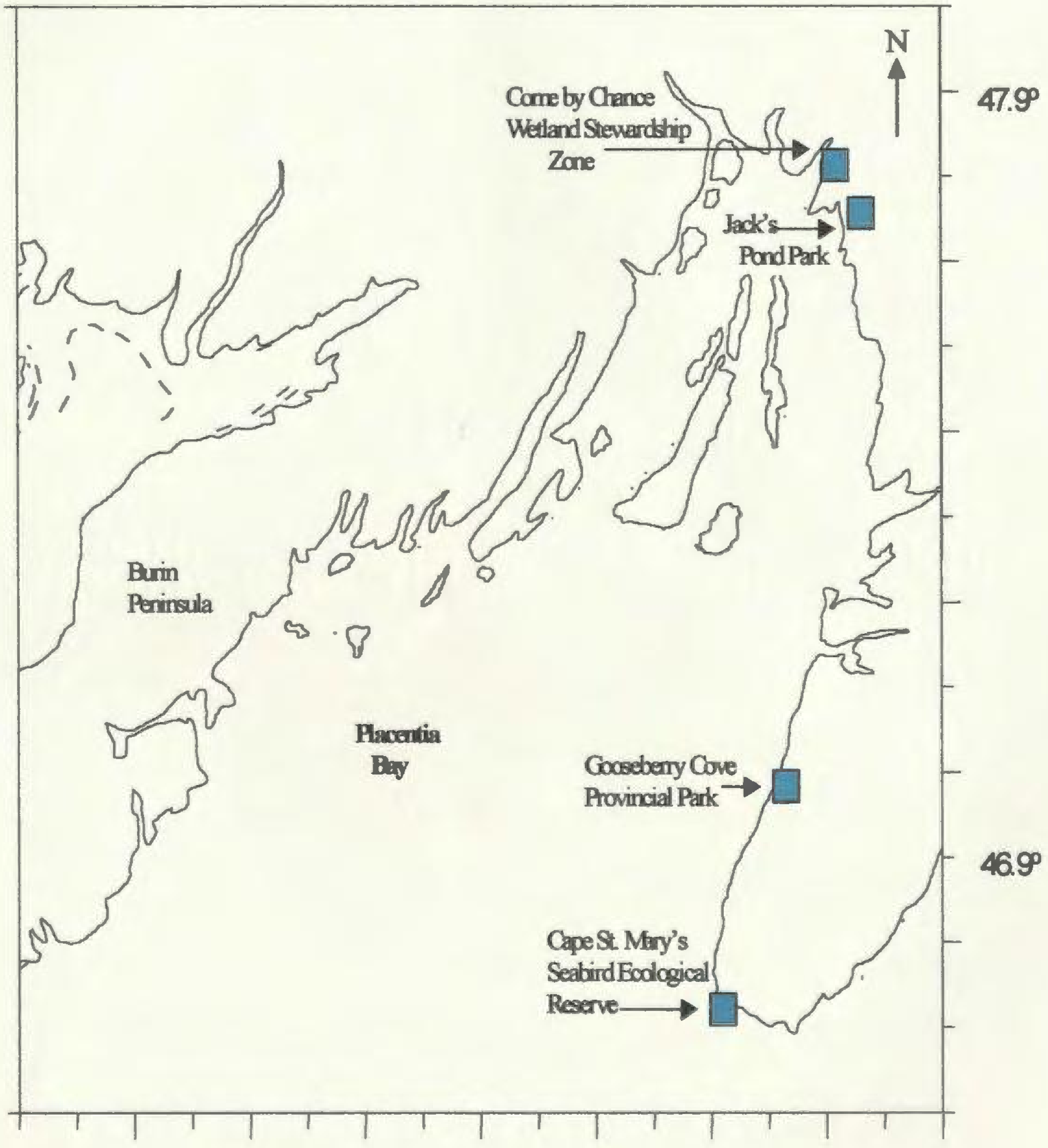


Figure 4: Ecological Reserves and Parks that fall within the potential zone of influence of an oil spill along the Placentia Bay shipping route.

Particularly noteworthy is the Cape St. Mary's Ecological Reserve, where thousands of nesting pairs of seabirds including cormorants (*Phalacrocorax carbo*), gulls (*Larus, sp.*), razor-billed auks (*Alca torda*), northern gannets (*Morus bassanus*), guillemots (*Cepphus, sp.)*, kittiwakes (*Rissa tridactyla*), thick billed murres (*Uria lomvia*), and common murres (*Uria aalge*) reside (Canadian Parks [on-line], 2000).

Cape St. Mary's Ecological Reserve is one of the world's largest seabird sanctuaries and is home to many populations of seabirds whose numbers have been reduced by habitat disturbance, hunting, fisheries development, and oil pollution (Canadian Parks [on-line], 2000). Other reserves within the Bay include the Come by Chance Wetland Stewardship Zone, Gooseberry Cove Provincial Park, Jack's Pond Park. Other nearby reserves include Point la Haye Park (St. Mary's Bay), and Mistaken Point Ecological Reserve (Cape Race).

These reserves and parks were established because they encompass areas that have ecological, biological, and / or historical significance. All of these areas fall within the potential zone of influence for an oil spill event along the shipping route from the Grand Banks to Placentia Bay and between the mouth and head of the Bay (DFO, 1999b). Yet the existing reserves, while important, do not encompass the full range of ecologically important habitats, especially beach and subtidal areas. Furthermore, is it uncertain how the reserves themselves are protected from current trends in oil pollution or the threat of a major oil spill.

3.3 Historical Significance of Placentia Bay

The early settlement and history of Placentia Bay is marked by conflict between French, English, Spanish, and Portuguese interests in this historically productive fishing ground. By the 16th century, all of these European nations were undertaking fishing enterprise to exploit the abundant cod stocks of Newfoundland and Labrador (Memorial University of Newfoundland, 2000). There is continuing speculation regarding which of the European settlers first laid claim to the region now known as Placentia Bay.

Historians maintain that early French settlers concentrated fishing efforts north of Bonavista and in the south coast of the island, which encompassed Placentia Bay. From here, the French established a colonial cod fishery, the most important of which was the one founded in Placentia Bay (Memorial University of Newfoundland, 2000). In time, Placentia, then referred to by the French as Plaisance, became an established colony with a strong economy based almost entirely on the cod fishery and cod trade (Memorial University of Newfoundland, 2000). After confederation with Canada, many of the numerous "outports" of Placentia Bay, especially on the western side and on the islands of the bay, were resettled. The largest extant communities in the bay are Placentia, Argentia, Marystown, and Arnold's Cove. However, several isolated communities around Placentia Bay such as Red Island and Merasheen, and communities that did not resettle, have faced formidable challenges such as little or no road access. Despite harsh environmental and economic conditions, several of these isolated communities managed to develop a strong fishery. The economic link of the inhabitants of Placentia to the fishery resources of the region continues today. Despite an economic boost from the substantial oil industry initiatives within the region, Placentia Bay continues to rely on its fisheries resources, not only for economic reasons, but also for its identity and cultural survival.

By 1713, the English took control of Placentia Bay through the Treaty of Utrecht (Memorial University of Newfoundland, 2000). This was an event that served to demonstrate the importance of Placentia Bay as a vital fishing ground for which European nations, particularly the French and English, would endure conflict in order to control. While cod remained the mainstay of the English settlers in Placentia Bay, it was certainly not the only fishery conducted during this period. Several fisheries, including bait fisheries for herring (*Clupea harengus*), were firmly established (Memorial University of Newfoundland, 2000) and continue today alongside the cod fisheries.

3.4 Overview of Some Currently Important Fisheries Resources of Placentia Bay: Critical Life Stages and Habitat Requirements

The fishing industry remains a cornerstone of the Newfoundland and Labrador economy (DFA, 2000a) and is vitally important to employment opportunities in the Province. The fishing industry of Atlantic Canada largely serves foreign markets, and for decades has consistently been among the top fish exporting regions of the world. The fishery of the Newfoundland and Labrador region is a revitalized, multi-species, and largely private sector driven industry that is needed for the future viability and stability of coastal communities. In 1999, the export value for fish products from the province reached $1 billion (DFA, 2000a). Placentia Bay continues to contribute to this global, market-driven industry by exploiting traditional fishery resources, while at the same time working toward fisheries diversification. The following summary of commercial species represented in Placentia Bay is by no means exhaustive. Rather, the listing reflects the diversity of commercial species within the region, and provides an appreciation for the current value and future potential of Placentia Bay as an important fisheries region.

3.4.1 Lobster

The offshore area between the North Atlantic Refining facility and the Whiffen Head Transshipment terminal is an important lobster (*Homarus americanus*) fishing ground and represented 54% of the dominant catch value of all fisheries within the area surrounding the Whiffen Head facility in the decade prior to the 1992 moratorium (Griffiths, 1999). Since that time, lobster has become one of the most economically important species in the area, particularly in northeastern Placentia Bay (Griffiths, 1999). Lobster typically occur in relatively shallow inshore environments ranging in depth from 1 m below low tide, but are also known to occur at depths of more than 700 m in the submarine canyons off the Scotian Shelf. In Newfoundland, lobster are distributed along the entire coast where suitable habitat is available (DFO, 1996a). The life history of lobster within the region is relatively complex, taking about 8-10 years for a lobster to recruit to the commercial fishery. Eggs are brooded under the carapace of the female for approximately one year before hatching. Following hatching there is a 6-10 week planktonic phase, during which three molts occur, with the last molt resulting in a metamorphosis to a post-larval stage (DFO, 1998b). Post-larval lobster are selective in settlement location and prefer inshore habitat consisting of gravel/cobble substrate with kelp cover. As lobsters grow, their habitat requirements change (DFO, 1996a). Following the post-larval stage, young lobsters are equipped to swim and to locate suitable settling habitat. Important factors such as growth and development take place at this point (DFO, 1998b). Adult lobster prefer substrates of more coarse particle size (i.e., large cobble and boulder) in combination with finer substrate composition to allow for burrowing. The presence of kelp beds is also beneficial (DFO, 1996a).

Data on the lobster fishery for the Placentia Bay area were sparse at the time of this report.

3.4.2 Cod

Despite the collapse of the groundfish fishery in Newfoundland and Labrador waters over the past four decades (Rose *et al.*, 2000), cod has remained an important resource for the Placentia Bay region.

Atlantic cod can attain a length of 180 cm and a weight of over 100 kg, although those harvested by local fishermen are typically much smaller (Ryan *et al.*, 1996). Historically, Atlantic cod were distributed throughout the shelf regions off Newfoundland and Labrador (DFO, 1999c) and would over-winter and spawn in coastal areas of the province (Lawson & Rose, 2000a). However, recent evidence suggests that, since the collapse of Atlantic cod stocks in the early 1990's, much of the remaining biomass has been concentrated in coastal regions (Lawson & Rose, 2000b). There is also mounting evidence that coastal cod may be distinct from populations of Atlantic cod from the shelf regions off Newfoundland and Labrador, and Placentia Bay may have its own coastal cod stock (Lawson & Rose, 2000b).

Generally, Atlantic cod spawn on the coast of Newfoundland from March to September (Bradbury *et al.*, 2000) with the heaviest spawning taking place in Placentia Bay from April – June in shallow water (i.e., 20-80 m) (Lawson & Rose, 2000a). Cod are typically batch spawners, capable of releasing up to several million eggs during a single spawning period. Eggs are buoyant, spherical, transparent, and pelagic, and after fertilization rise slowly and remain in the surface mixed layer during their incubation (Scott & Scott, 1988). Survivorship of the fertilized cod eggs is typically low. Several complex factors including environmental conditions, (temperature, salinity, currents) and predation influence the survivorship of eggs and young cod. Surviving eggs float for approximately 10-40 days prior to hatching (Scott & Scott, 1988). Emerging larvae then remain part of the floating plankton for the next several months, where again, they are subject to extremely high mortality rates. Survivors at this stage remain pelagic until they attain a length of 25-50 mm, when they descend to the bottom (Scott & Scott, 1988). The bottom type preferred by cod varies greatly throughout their vast north Atlantic range of distribution (Scott & Scott, 1988). The age at which cod reach sexual maturity has been altered, many believe as a result of heavy fishing mortality imposed upon the Atlantic cod stocks. Evidence suggests that the cod of Placentia Bay are reaching sexual maturity at < 6 years of age (Lawson & Rose, 2000a).

Surveys of the North Atlantic Fisheries Organization (NAFO) subdivision 3Ps that encompass Placentia Bay and the adjacent shelf environment have revealed important cod resources. Acoustic surveys in these areas during the Springs of 1996 and 1998 indicated the presence of 9Kt and 72 Kt of cod respectively. In 1998, cod were more widely distributed and occurred at higher densities than in 1996 (Rose & Lawson, 1999). Among the reasons put forth to account for these differences were changes in detectability between years, or a marked immigration of cod into the area after 1996 (Rose & Lawson, 1999). In 1997, a similar survey estimated a spawning biomass of approximately 45 Kt of cod in the inner and outer portions of Placentia Bay (Rose & Lawson, 1999).

More importantly, three spawning grounds have been identified on the southeastern entrance near Cape St. Mary's, at Oderin Bank along the western side (Figure 5), and at the north head of Placentia Bay (Lawson & Rose, 1999), just west of the Whiffen Head and North Atlantic Refining Limited-NARL facilities. These spawning areas have been used consistently during several years of study in the late 1990's, although there is much inter-annual variability in their usage by spawning cod (Lawson & Rose, 2000a). The results of this investigation were consistent with a related study on transport and development of cod eggs and larvae. The spatial and temporal patterns of egg and larval abundance in Placentia Bay were reflected in the mean counter-clockwise current patterns within the Bay (Bradbury *et al.*, 1999).

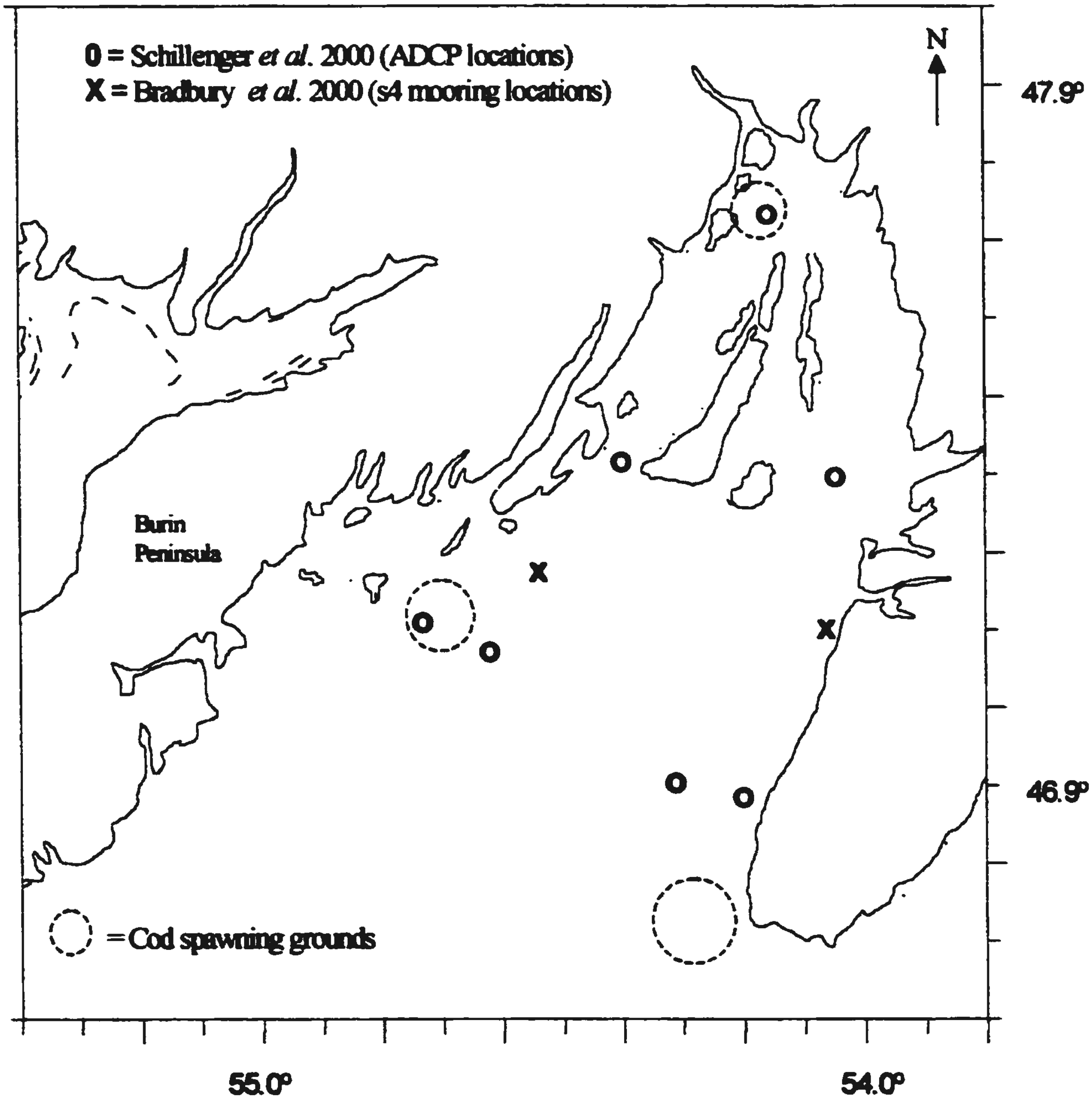


Figure 5: Location of instruments for data collection on current profiles and recently identified cod spawning grounds in Placentia Bay

The study suggested that cod eggs occurring in the Bay were also spawned within Placentia Bay, and the number of larvae that successfully hatched within the bay depends upon temperature-dependent development of the eggs, which in turn is related to spawning times and spawning locations (Bradbury *et al.*, 1999).

3.4.3 Capelin

Acoustic surveys in Placentia Bay during 1998 and 1999 revealed high densities of capelin (*Mallotus villosus*) in Placentia Bay near aggregations of cod (O'Driscoll *et al.*, 2000). As well as being an important commercial species, capelin are an important prey species for many predators including seals, whales, seabirds, various pelagic and groundfish species including cod (DFO, 2000a). Capelin are a small pelagic schooling species with adults ranging in size from about 12 - 23 cm with males larger than the females. Capelin are found in offshore and coastal areas of Newfoundland and Labrador, and occasionally spend the winter and early spring months in deep bays (Scott & Scott, 1988). Capelin are also subject to commercial exploitation. The 1999 catch for all NAFO divisions surrounding Newfoundland and Labrador was approximately 18, 000 tonnes (DFO, 2000a). Despite an operational capelin fishery within Placentia Bay, data to reflect the actual catch for the region (i.e., specifically 3Ps) were unavailable.

Adult spawning populations of capelin are composed of mainly 3-4 year old fish. The short life span of capelin, coupled with extremely variable recruitment, renders the species vulnerable to frequent and often dramatic changes in biomass (DFO, 2000a).

Once mature, schools of adult capelin migrate inshore during June and July to spawn on many beaches in Newfoundland, including the beaches of Placentia Bay. Capelin spawning beaches are believed to make up about 7 percent of the Placentia Bay shoreline (CHART, 1999b).

Beach-spawning capelin spawn on coarse sand or fine gravel, where eggs are buried by wave action, presumably safe from tidal flushing and predation during development (Scott & Scott, 1988). However, not all capelin spawn on beach substrates. Significant egg deposition has been reported from sandy substrates at bottom depths of 2-3 m in a number of locations around Newfoundland (Scott & Scott, 1988). Eggs are spherical, demersal and adhesive, becoming attached to beach gravel or bottom substrate. Upon hatching from the egg, capelin larvae emerge from the beach gravel where many are carried out of the bays rapidly by prevailing currents (DFO, 2000a). Following this largely passive dispersal, larval movement is moderated by vertical migrations bringing the capelin larvae in contact with varied current regimes. Larval dispersal, followed by the movements of juveniles in search of food, forms the migratory pattern of capelin in early life, bringing them inshore in the summer and into deeper offshore waters in autumn (Scott & Scott, 1988). Recent evidence suggests Placentia Bay is an important juvenile area for capelin, and the outer portion of the bay may be a staging area with important implications for adult migration (personal communication – Fisheries Conservation Chair, 2001).

Cod and capelin have exhibited change in spatial distribution in recent years, yet the potential for cod in areas such as Placentia Bay to find capelin prey is high (O'Driscoll *et al.*, 2000). This cod-capelin relationship may well be a major factor in helping cod stocks in the area to rebuild. Since the 1990's, cod have concentrated inshore with low densities offshore, and it has been suggested that cod are unlikely to increase in abundance offshore until offshore capelin increase (O'Driscoll *et al.*, 2000).

3.4.4 Atlantic Herring

Herring (*Clupea harengus*) stocks have supported commercial food as well as bait fisheries (DFO, 1998a) in Placentia Bay, St. Mary's Bay, and surrounding areas. Herring are a pelagic, schooling species that typically occur and spawn in shallow inshore waters (Scott & Scott, 1988). The Placentia Bay herring fishery, as well as the herring fishery along the northeast coast of Newfoundland developed most strongly in the 1970's and peaked later during the same the decade. This increase was in response to growing markets following the collapse of the North Sea herring fishery (DFO, 1998a). Declining stocks marked the 1980's but strong recruitment of the 1982 year-class sustained the fishery through the following decade following a brief closure. The herring fishery is now largely market driven and quotas are not taken in most years. Herring stocks within Placentia Bay are thought to be moderately healthy, and a 1998 mature biomass estimate (integrated catch at age analysis) for St. Mary's – Placentia Bay was determined to be approximately 14, 800 tonnes (DFO, 1998a).

Herring in Placentia Bay are characterized by a predominance of spring-spawners, which typically spawn from mid-May until early-June depending on environmental conditions, principally water temperature (personal communication – J. Carscadden, Herring Research and Assessment Biologist - DFO, 2001). Spring-spawners tend to spawn in waters less than 10 m deep and often in areas near estuaries. Herring often deposit eggs on intertidal vegetation, which hatch after approximately 2 weeks (DFO, 1998a). Other studies have shown the fertilized eggs remaining attached to bottom vegetation at depths from 0.9-4.3 m (Scott & Scott, 1988). The specific location of spawning activity within Placentia Bay varies annually and is often related to herring abundance (personal communication – J. Carscadden, Herring Research and Assessment Biologist - DFO, 2001).

The survival of young is also largely influenced by environmental conditions, including water temperature and salinity (DFO, 1998a). Herring larvae are light sensitive and have a tendency to seek shelter in deeper waters on bright days. Larvae generally remain in surface water for about 5 weeks at which time they metamorphose into the adult form, developing scales and pigmentation. (DFO, 1998a). At this stage, juvenile herring remain inshore in more enclosed areas where they exhibit schooling behaviour and begin feeding actively. Some juvenile herring take part in offshore migrations following these early stages, joining schools of immature and mature adults. Herring generally mature and recruit to a spawning stock at approximately 3 years (DFO, 1998a).

3.4.5 Sand Lance

Sand lance (*Ammodytes dubius*) is not a commercially important species, but is one of the key prey species for several commercially exploited species within Placentia Bay. In addition, sand lance are important as a food source for cod and many other species including marine mammals and seabirds (DFO, 2000b). Sand lance are a small pelagic and bottom dwelling species found both inshore and offshore at depths less than 100 m over sandy or fine gravel substrates (Scott & Scott, 1988). Sand lance have a tendency to school or alternatively to burrow into the substrate to a depth of several centimetres. They generally spawn during winter months where demersal, adhesive eggs are deposited on the sand or gravel substrate. Embryos hatch when they attain approximately 4 mm in length. Young sand lance remain planktonic until they are approximately 35 mm in length, at which time they seek bottom habitat (Scott & Scott, 1988).

3.4.6 Scallops

Western Placentia Bay has also been identified as a potentially important Icelandic scallop (*Chlamys islandica*) area, and nearshore commercial aggregations of scallops near St. Mary's Bay have been exploited for years. Within NAFO subdivision 3Ps, the 1999 catch of scallops was 1,188 tonnes, with nearshore aggregations comprising 40% of the catch (DFO, 2000c). The life history of scallops is complex involving several stages of development and habitat types. In Newfoundland, spawning typically occurs in the fall and is largely dependent on environmental conditions. Uncontaminated water at an appropriate temperature, and adequate food supply is essential for the survival of scallop larvae (DFO, 1996b). Larvae hatch 2 – 3 days after spawning and remain planktonic for over 1 month. During this phase of development, larval movement is determined largely by oceanic currents (DFO, 1996b). Scallop larvae eventually settle to the bottom where they metamorphose and attach themselves to a suitable substrate. Juvenile scallops are found on various substrates but appear to prefer firm gravel and cobble. Once attachment is achieved, development continues toward adulthood. Both juvenile and young adult scallops are effective swimmers (DFO, 1996b), and thus have some capacity to escape predation and other threats, while mature adult scallops are almost entirely sedentary, lying with the flattened valve on the ocean floor (DFO, 1996b).

Adult scallops are usually found in waters from 50-200 m depth and on a hard bottom with variable substrate composition. These substrates can consist of sand, gravel, shell fragments, and stones. Scallops are filter feeders and are therefore usually found in areas with strong currents. They are generally slow growing and long-lived, frequently exceeding thirty years but not usually attaining a size of more than 100 mm (DFO, 2000c).

3.4.7 Snow Crab

Snow crab (*Chionecetes oplilio*) are also found in Placentia Bay. Typically, snow crab are broadly distributed in terms of depth with a range of 50-1500 m (personal communication – D. M. Taylor, DFO Science Branch, 2001). Snow crab are found in most regions of Placentia Bay deeper than 50-70 m, and the commercial fishery for them takes place at depths greater than 150 m (personal communication – D. M. Taylor, DFO Science Branch, 2001). A snow crab fishery in Newfoundland and Labrador began in 1968 and at the time was limited to NAFO divisions 3KL. It has since expanded and is carried out in several divisions including 3Ps (DFO, 2000d). Within this area, including Placentia Bay, landings of snow crab increased from 600 tonnes in 1987 at the start of the 3Ps fishery to 7,900 tonnes in 1999. Although the catch rates remained relatively stable during this period, resource status and future prospects are difficult to predict due to a lack of reliable survey data (DFO, 2000d).

Snow crabs typically mate from February – April (personal communication - D. M. Taylor, DFO Science Branch, 2001). Female crabs lay eggs shortly after copulating, and can store sperm deposited inside by the male for many months. The eggs are fertilized as they are laid by passing through a chamber holding the sperm. Eggs are then brooded in a mass on the abdomen of the female, where the number of eggs depends upon the size of the female crab (Crustacean Laboratory, 2000). Once developed, the eggs hatch into larvae and spend this stage of their life cycle as part of the plankton, where they molt several times. During this planktonic phase of development, the larvae are extremely vulnerable to predation and environmental conditions, and often experience high rates of mortality. Individuals that survive to this stage eventually settle on the sea floor where they continue to molt for a time (Crustacean Laboratory, 2000). Commercial fishery regulation for snow crab in Newfoundland and Labrador ensures that the minimum legal size harvested is 95 mm (carapace width). Females cease to molt when they first spawn, which typically occurs at smaller sizes (40-75 mm) and are therefore excluded from the commercial crab fishery (DFO, 2000d). Hence, the resource is afforded some degree of protection.

3.4.8 Aquaculture

Placentia Bay is the site of several aquaculture initiatives and it is expected that such development will expand over time (DFO, 1999b). Sea Forest Plantation had established a lucrative cod hatchery in Placentia Bay, developed to conduct research to examine the problems associated with mass production of juvenile cod for grow-out in aquaculture operations (Department of Fisheries and Aquaculture - DFA, 1997). The hatchery, unfortunately, was destroyed shortly thereafter by fire in 1997. However its development and achievements demonstrated the value of Placentia Bay as a potentially successful aquaculture site for cod, and other suitable species of finfish. Recently, Seaforest Plantation received a permit for a new cage site in Jerseyside (DFO, 1999b).

Emerging commercial fisheries concepts such as cultured sea urchins (*Stronglyocentrotus drobachiensis*) are being developed and an underwater corral has been set up in Placentia Bay by New Ocean Enterprises for this purpose (DFA, 2000b). Site assessment for scallop culture in Placentia Bay also indicates potential (Dabinett & Clemens, 1996). Four mussel (*Mytilus edulis*) farms are in production along the western side (DFO, 1999b) as well as along the eastern section of the Bay (CHART, 1999a). Geographically, aquaculture initiatives within Placentia Bay are widely distributed (Figure 6).

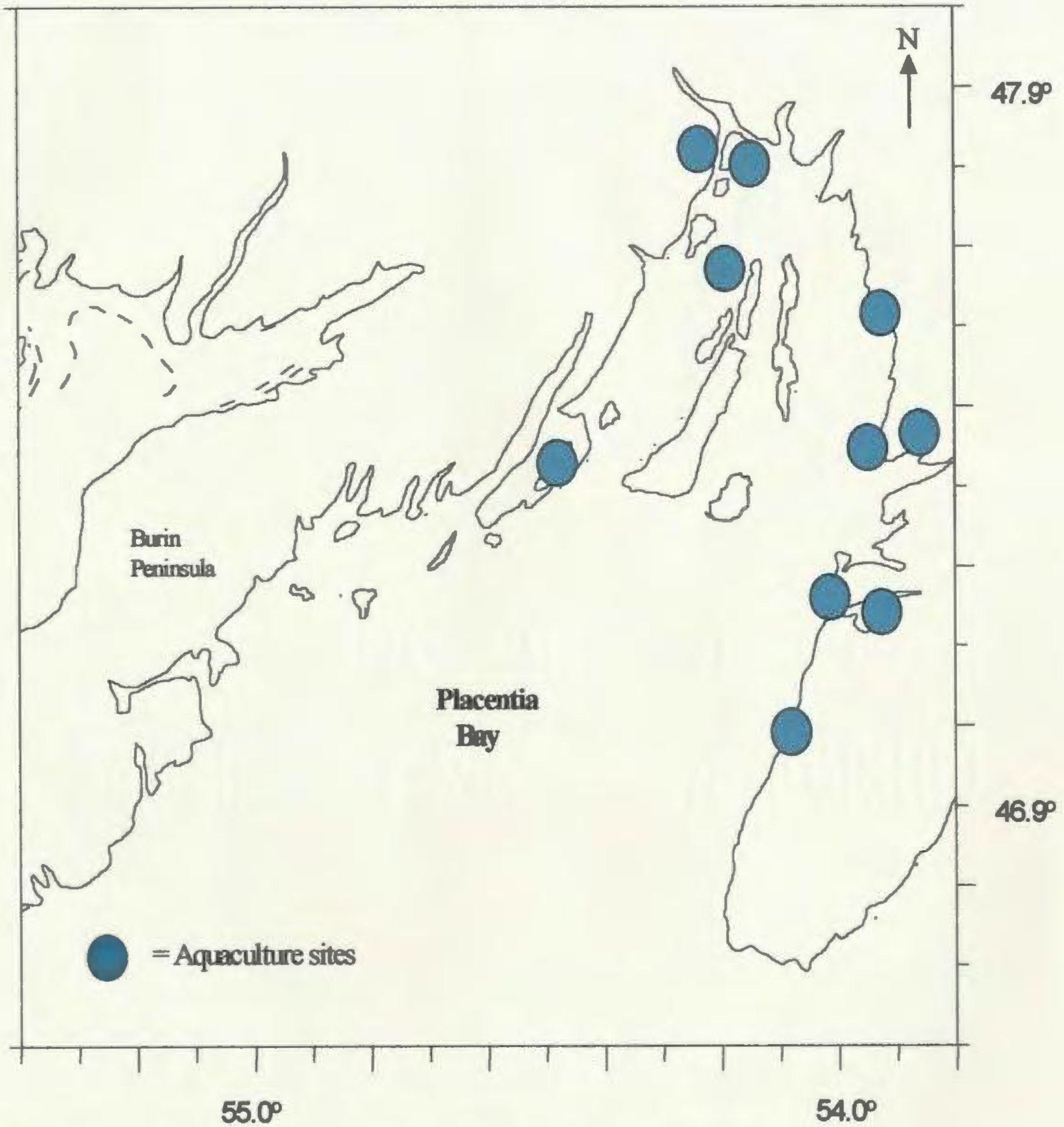


Figure 6: Location of several aquaculture initiatives within Placentia Bay

CHART (1999a) illustrates that the Atlantic cod aquaculture sites are located near the eastern shipping channel, along the west-central coastline, as well as the southwestern mouth of Placentia Bay. The mussel and sea urchin aquaculture sites are generally confined to the north and northwestern sections of the Bay, with at least one in close proximity to a tanker mooring site (personal communication – Fisheries Conservation Chair, 2001). In future, it is likely that diversified fisheries (i.e., various groundfish, pelagic, shellfish), and aquaculture will become standard practice within Placentia Bay and will continue to be vital to the local economy. Therefore, every effort should be made to protect these resources from the threat of oil pollution.

3.5 Oil Development Initiatives within Placentia Bay

In this section, several sources are referenced to illustrate the extensive oil development initiatives within Placentia Bay. The variety of sources presents information from very different points of view, and perhaps, varying interests. It is somewhat problematic to compare information from such varied sources as public information brochures, technical reports, scientific papers, and "grey" literature in the same context. Such sources have varying degrees of authority and hence must be regarded as such while proceeding through the current section.

Significant oil and shipping industry operations (Figure 2) currently coexist with fisheries operations in Placentia Bay. The potential impact of chemical pollution on fisheries resources is not a new concern within the region. Idler (1969) investigated the interaction between fish in the area and the effluent from a large phosphorus plant located in Long Harbour, which had opened the previous year. The effluent entering the Bay impacted several commercially important species, including herring and cod. Furthermore, shortly after the opening of the phosphorus plant, high fish mortality was reported in Long Harbour near the plant itself, with subsequent mortality of fish occurring in a counter-clockwise direction around the Bay. The affected herring in Placentia Bay were referred to as "red herring" due to excessive hemorrhaging, which was most noticeable around the gills (Idler, 1969). The phosphorus plant has not been operational for decades, however, during its productive years in Placentia Bay, it likely had a significant impact on the environment and fishery within the area.

At present, there are several large-scale industrial initiatives operating in Placentia Bay involving the refining, storage, and shipment of oil and petroleum products. The environmental impact that will be left in the wake of these operations, after the province's oil reserves have been exhausted, remains to be seen. The current oil industry operations in Placentia Bay include an oil refinery, a Transshipment terminal, and a substantial increase in oil related vessel traffic within the region associated with both operations. Hence, it appears there are, potentially, new risks posed to the environment and fisheries resources from these more recent developments in Placentia Bay.

3.5.1 Newfoundland Transshipment Limited – Whiffen Head

Newfoundland Transshipment Limited operates a facility from Whiffen Head, Placentia Bay. They refer to the Grand Banks' as "the door to the world", and boast having facilities at the terminal that are second to none (Newfoundland Transshipment Limited, brochure, 1998). The need for a transshipment terminal followed from the success of the

Hibernia development project, the rapid development of the Grand Banks oil resource, and the subsequent requirement for a facility close to oil markets (Newfoundland Transshipment Limited, brochure, 1998). The oil handling and storage capacity of the facility is substantial, including a berth that can accommodate 35,000/155,000 dead weight (dwt) tankers, and 3 heated crude oil storage tanks each with 500,000 barrels of storage capacity. The site has a capacity for expansion for 2 more berths and 13 additional storage tanks (Newfoundland Transshipment Limited, brochure, 1998).

Transshipment of crude oil from Newfoundland and Labrador to world markets is a 2-stage process. Stage one begins at the Hibernia production platform, 300 nm southeast of Newfoundland. Oil is loaded onto a Hibernia shuttle tanker, which then makes the journey to the transshipment terminal in Whiffen Head. Stage two involves the transfer of oil from the transshipment terminal to a conventional tanker (Newfoundland Transshipment Limited, brochure, 1998). Given existing legislation, a "conventional" tanker could be a single or double-hulled vessel, given that single-hulled tankers will not be prohibited in Canadian waters until 2015 (POW Report, Phase II, 1999). Once on board the conventional tanker, oil is then transported from Placentia Bay to various world markets. Hibernia crude is regularly shipped to and stored in the Whiffen Head facility before transport to its final destination on world markets. Operations at the Whiffen Head Transshipment terminal for the near future are forecasted to involve 275,000 barrels of crude oil a day using 119 shuttle and 183 second leg tanker trips annually (DFO, 1999b).

In addition to further encroachment on fishing territory in Placentia Bay and the increased risk of a tanker incident resulting from Transshipment terminal operations, the facility has already negatively altered the local marine and coastal environment. During the construction phase of the Transshipment terminal, particulate and other sediments were released into the marine environment as a result of dredging and underwater blasting (Griffiths, 1999). Research indicates that an influx of particulate matter can smother benthos, physically alter bottom habitats, and suffocate filter-feeding shellfish (World Wide Fund for Nature, 1996).

3.5.2 North Atlantic Refining – Come by Chance

North Atlantic Refining Limited operates an oil refinery at Come-by-Chance, Placentia Bay. Owned by Vitol (North Atlantic Refining Ltd., 1999), one of the world's largest independent oil traders, the refinery plays a significant role in the oil trading objective of worldwide distribution of crude and refined petroleum products. The refinery has a storage capacity in excess of 7.2 million barrels of crude and a deep water dock capable of receiving ships of up to 300,000 dwt (North Atlantic Refining Ltd., 1999). Subsequently there are significant oil and shipping operations associated with the facility, which is closely linked to the offshore oil operations on the Grand Banks. North Atlantic Refining contributes to the increasing trend in tanker traffic for the Placentia Bay region. Overall, tanker movements as a result of operations at both shore based oil handling facilities within Placentia Bay now average over 400 annually (DFO, 1999b).

3.5.3 Marine Traffic in Placentia Bay

Current traffic in Placentia Bay includes tankers, ferries, container and bulk carriers, general cargo, supply, and fishing vessels (DFO, 1999b). Vessel movements already in the Placentia Bay area exceed 3,000 annually (personal correspondence with Coast Guard personnel, Argentia, April 1999). A significant portion of this vessel traffic is attributed to the operations of the various oil industry developments within Placentia Bay.

Some authorities claim that Placentia Bay is not at risk for a significant tanker accident (DFO, 1999b), and indeed, to date, no tanker accidents have occurred. However, in the winter of 2000, the 25-year-old Iraqi registered tanker *Eastern Power* began leaking part of its 150, 000 tonne cargo of crude oil into the waters of the North Atlantic as a result of a crack in the vessel's single hull. Initially, Canadian authorities denied the tanker entry into Canadian ports, only to reverse the decision when the distressed vessel remained unaided for days in rough seas. The vessel was granted permission to enter Placentia Bay to allow the tanker to undergo repairs and off-load its cargo. In the end, weather conditions prevented the vessel from proceeding to Placentia Bay, but the incident raised several issues. These included the need for a tug in Placentia Bay, and, more importantly, the province's inability to handle the volume of oil the vessel was carrying if its hull had been further compromised before the oil was safely off-loaded in Placentia Bay.

There have been several hundred documented cases of oil pollution in the area in recent years. A study carried out in 1992 concluded that a site near Woody Island in the northeast of Placentia Bay and in close proximity to an important cod spawning ground, herring ground, and several aquaculture sites, contained high concentrations of hydrocarbons within the sediment. The mean concentration at the site was 520 ppb, which when compared to deep sea (~ 12 ppb) and other ocean sediments, is relatively high (Kiceniuk, 1992). Although fish continue to spawn near these contaminated sites, the impact upon them is not known. It is plausible that elevated hydrocarbon concentrations in such regions could contribute to some of the problems with the Placentia Bay commercial fishery (i.e.,persistent low groundfish biomass and recruitment). In the absence of supporting data, however, this possibility is highly speculative.

4.0 Risk Assessment in the Event of Oil Release in Placentia Bay

There are two separate issues in terms of risk assessment in the event of oil release into the marine environment of Placentia Bay: the risk posed by the current trend in chronic oil pollution and the potential threat posed to the environment and fisheries resources from a large-scale oil release. In both instances, there are numerous parameters to consider, including impacts upon communities, fishing grounds, shorelines, fish, eggs and larvae, fishing gear, and markets for fish products from Placentia and possibly elsewhere in Newfoundland and Labrador. However, perceptions can widely differ with respect to what should be considered a sensitive area. Griffiths (1999) maintains that inhabited communities and commercial fishing grounds should be among the most important considerations in determining sensitivity of an area to oil spills, followed by the nature of biological ecosystems and organic life. However, these parameters are not mutually exclusive, particularly within areas such as Placentia Bay, where human populations are closely tied to and heavily reliant on the area's natural resources. Determining sensitivity depends on how different components of the ecosystem are valued (Griffiths, 1999), but a reduction in biological diversity and vital habitats as a result of oil pollution would almost certainly impact local residents. Sensitivity, therefore, for the purpose of this report, refers to both biophysical and socio-economic considerations in terms of enduring oil pollution impacts.

A separate but nonetheless important issue is that, in the event of an oil spill, the reputation of a resource-based locale such as Placentia Bay as a provider of quality seafood products would be put at risk. Such an event could jeopardize the ability to penetrate global markets well beyond the time of a spill event, and a negative perception could potentially negatively impact the fishing industry of all of Newfoundland and Labrador.

4.1 Fate of Spilled Oil in the Marine Environment and Impacts upon Life Stages of Select Commercial Fishery Species

Tankers from many different areas load and off-load several types of oil within Placentia

Bay. The Come-by-Chance oil refinery deals in various forms of petroleum including refined products such as diesel, gasoline, and kerosene, among others. Hibernia crude, with a low viscosity, light composition, and increased penetration rate (Griffiths, 1999), is also commonly carried into and out of Placentia Bay.

The behaviour of oil on water following a large-scale spill ultimately determines the degree of environmental damage sustained. Weathering of the discharged oil by wind, waves, evaporation, or other means that results in the break-up of the released oil, is an important factor. Of these, oil evaporation is likely the most important factor during the first 24 - 48 hours following a spill, since this is the most acute phase in terms of damage to wildlife (Keeble, 1991). The amount of evaporation that will occur following a spill depends on many factors, including air and water temperature, (Keeble, 1991), which tend to be low in southeastern Newfoundland, and wind and wave energy which tend to be quite high. In fact, wave driven transport of spilled oil near coastal environments puts shorelines and coastal wetlands at great risk (Sobey & Barker, 1997). Surface wave drift is directed toward adjacent shorelines by natural refraction processes unlike shelf or oceanographic circulations, which tend to parallel coastlines. Wave induced surface transport provides a natural mechanism for the spilled oiled to reach shorelines and beaches and ranks among the most damaging outcomes of a coastal oil spill (Sobey & Barker, 1997).

Dispersion of spilled oil is an important consideration. Dispersion is described as the tendency for crude oil (e.g., Hibernia crude) to break up into droplets and move within the upper layers of the water column (Environment Canada, 2000). The process allows for further dissolution and evaporation of certain hydrocarbons of which the crude is composed. Dispersion may also allow for oil to be emulsified in the water column and potentially remain below the water surface. Some of the dispersed droplets of oil will return to the surface of the water, while some will be ingested by deeper dwelling organisms. The latter may eventually sink to the bottom as fecal pellets or be re-ingested by other organisms en route, allowing the oil to enter the food web at any number of points (Keeble, 1991). Hence, natural dispersion of spilled oil is not necessarily a desired outcome, and quiescent conditions are most favourable for oil containment and the execution of timely and effective clean-up efforts. Chemical dispersion of spilled oil has the potential to exacerbate environmental problems even further. An important by-product of dispersion is a substantial increase in the surface area caused by breaking the oil slick into smaller droplets. Studies have demonstrated a sharp spike in oil toxicity following dispersion of an oil slick via the release of volatile compounds from emulsified oil droplets (DeCola, 1999).

4.1.1 Oil in Sheltered Areas

Inshore areas and areas with restricted or physically contained waters are the most vulnerable in terms of damage to fisheries resources. Species within these types of areas that also have small stock size and restricted spawning areas are most at risk

(International Petroleum Industry Environmental Conservation Association, IPIECA, 1997). As previously established, these risk criteria are present in Placentia Bay for a number of species, especially cod, herring, capelin, and lobster.

The onshore-offshore type of sediment transport identified along several gravel beaches of Placentia Bay, make them vulnerable to hydrocarbon contamination. Once contaminants such as oil are released into the more sheltered embayments of the area, it is plausible that they would impact the shoreline and remain in sediments within the system for extended periods of time (Griffiths, 1999). As demonstrated, several inshore sediments and substrates serve as vital spawning ground and nursery areas for commercially important species. Contamination of these areas with oil would likely compromise the survival of eggs and larvae deposited or developing within these substrates. Wave-induced surface transport of oil could seriously impact capelin spawning beaches and herring spawning beds along the shoreline. Likewise, eggs from commercially important species such as herring and lobster that rely on nearshore vegetation for survival could also be threatened by oil in inshore environments.

Placentia Bay has several sections of coastline that are relatively sheltered from wave energy and high winds (i.e., Bar Haven) and thus would be vulnerable to oil release (Griffiths, 1999). Placentia Bay also has several contained coarse-grained beaches along the coastline and these beach types generally experience greater penetration of contaminants such as oil. As oil penetration increases within these enclosed areas, so does the difficulty associated with clean up. Capelin in particular make use of these coarse grained beaches for spawning, the success of which would likely be threatened if oil infiltrates the inshore environment.

4.1.2 Oil on the Surface and in Suspension

Petroleum products can negatively impact the egg, larval, and juvenile stages of commercial fish species (Griffiths, 1999), as well as adults of several pelagic species that are found at or near the water surface. Several commercial fish species in Placentia Bay could come into direct contact with oil on the water's surface since several have pelagic or planktonic egg and larval stages.

Ongoing ichthyoplankton studies in the bay indicate large numbers of larval capelin, sand lance, and cunner (*Tautogolabrus adspersus*), and a variety of other species, are abundant in surface waters of the periphery of the bay, particularly at the head of the bay and along the western side (Snelgrove *et al.*, unpublished data). Cod eggs and larvae, as well as molluscan (i.e., scallops, mussels) larvae are planktonic during early development. Crustacean (i.e., lobster and snow crab) larvae are abundant during the summer months (Griffiths, 1999) and also spend this stage of their development in the plankton.

In all cases of early life stages of development in these commercially important species, the probability of interaction with oil at the surface is high. Adult stages of several commercial species in Placentia Bay could also come into contact with spilled oil at or just below the surface. Pelagic species such as capelin and herring frequently swim in the surface waters and semi-demersal cod spawn in very shallow waters (Lawson & Rose, 2000a)

Spilled oil on the water surface can be readily transported by wave action to coastal shorelines and beaches where it may persist for extended periods. Wave action can also cause spilled oil at the surface to emulsify, or become suspended in the water column, posing additional risk to fisheries resources. Emulsions can be extremely stable and persist for months or years after a spill (Environment Canada, 2000), thus increasing the probability of exposure for many pelagic species. Research has demonstrated that such emulsified forms of oil are harmful to marine organisms and their ecosystems (DeCola, 1999).

The physiological effects of spilled oil, at or just below the surface, on various commercial fisheries species, such as occur in Placentia Bay, have been demonstrated. Supporting evidence comes from data based upon LC50 (lethal concentration for 50% of experimental population) exposure of commercial fish species to hydrocarbons (Hurlbut *et al.*, 1991). Such studies reveal that pelagic juvenile and adult fish are very sensitive to oil. The lethal concentration for these fish was estimated to be 1-3 ppm of aromatic hydrocarbons (Hurlbut *et al.*, 1991). Research has also revealed lethal effects can occur on capelin eggs at a threshold of 2.5 ppm and that sublethal effects would be expected at much lower concentrations (Hurlbut *et al.*, 1991). Particularly disturbing is the fact that existing legislation and anti-pollution law within Canadian jurisdiction state that a ship's crew may legally discharge oily wastes from their vessels into the sea in concentrations at or below 15 ppm at specified discharge rates (personal communication – Coordinator of Tanker Training – Marine Institute). This is well above the level known to be lethal to many eggs, larvae, and adult fish (Holloway, 1999). Studies on herring larvae in Prince William Sound following the *Exxon Valdez* spill indicated high sensitivity to aromatic hydrocarbons, suggesting that Placentia Bay herring stocks may also be vulnerable to oil release impacts.

Further supporting evidence of the physiological effects of oil on commercially important species comes from a study examining histopathology in preemergent pink salmon (*Oncorhynchus gorbushcha*) and developing alevins exposed to oil that had persisted in the environment for over 2 years (Weidmer *et al.*, 1996). Histopathological lesions were common in those exposed to oil and the hydrocarbons induced detectable physiological changes (in this case, Cytochrome P-4501A induction into tissues) (Weidmer *et al.*, 1996). Further evidence of physiological impacts on commercial fisheries species is contained in section 5.1.1 of this report.

Even where concentrations of hydrocarbons are not necessarily lethal, commercial species with a high body fat content, such as sand lance, capelin, and herring, are easily tainted and will remain so for significantly longer periods than leaner species.

Griffiths (1999) suggests that lobster would be hardest hit in the event of oil spill during the months of July and August, when larvae live at the surface. Although lobster populations in some areas demonstrate some resilience to intense fishing (i.e., Arnold's Cove), recruitment of lobster and other crustaceans is highly variable and poorly understood (DFO, 1998b). However, an oil spill at or near the water surface in Placentia Bay is likely to negatively impact early stages of the life cycle of lobster, and hence recruitment to the lobster fishery.

4.1.3 Oiled Bottom Sediments

Under certain environmental conditions, oil can persist at deeper depths rather than returning to the surface. Oil droplets can adhere to the surfaces of tiny particles in the water column, such as fecal pellets, that may eventually sink to the bottom (Keeble, 1991). It is the weight of the object to which the oil adheres that causes sinking and persistence in bottom sediments. Weathered oil, that may eventually find its way into bottom sediment, can have harmful effects upon marine organisms (Holloway, 1999). Studies have shown that the effects of weathered oil on marine fish can be the same as those of fresh oil, indicating that oil persisting in either inshore or deep water sediment could potentially be harmful over extended periods of time (Holloway, 1999).

Contaminated sediments have been identified in some regions of Placentia Bay in more recent years, including Woody Island (Kiceniuk, 1992). It is reasonable to assume that other areas of Placentia Bay have sediments contaminated from discharged oil, either from shore-based sources or chronic oil pollution.

Contaminated sediments are likely to have adverse effects on local populations of bottom dwelling and demersal species (IPIECA, 1997) such as cod, lobster, and sand lance. Other bottom dwelling or sedentary species are at also risk, particularly bivalves and sedentary cultured shellfish species. These organisms are especially at risk to contamination because they cannot escape from oiled sediments, and may therefore remain tainted for extended periods.

The eggs and larvae of several fish species are associated with various sediment types. Eggs and larvae are also more vulnerable to oil pollution than adults (IPIECA, 1997). Yet, there are risks for later stages of bottom dwelling commercial species. The post-settlement stages of lobster are vulnerable if exposed to contaminated bottom sediments. A study of polyaromatic hydrocarbon accumulation by lobster in Placentia Bay demonstrated that lobster become contaminated with these substances at relatively low concentrations and exposure times (i.e., < 10 hours) (Williams *et al.*, 1985). If oil does reach the sea floor, then species living in fine muddy sediment will be at particular risk of tainting since fine sediments can absorb and retain greater quantities of oil than more coarse sediments (IPIECA, 1997). With the inevitable increase in oil related vessel traffic that Placentia Bay will experience in the near future, particularly in the northeast part of the bay, it is reasonable to infer that lobster and other vital habitat are at risk.

Given the great economic importance of lobster in the area, negative impacts on this important resource could be especially important.

4.1.4 Implications of General Oceanographic Trends in Placentia Bay in the Event of Oil Release

An important concern in terms of potential risks posed to commercial fishery resources relates to the general circulation patterns in Placentia Bay. The two major oil industry developments and associated vessel operations occur along the eastern and northeastern portions of Placentia Bay. In this context, the risks posed to fisheries resources and communities to the northwest and west of the region seem the greatest.

The general flow of water into and out of Placentia Bay is counter-clockwise, entering and flowing north along the east and exiting through the southwest (Bradbury *et al.*, 1999). Therefore, it is probable that a large-scale oil release incident in the east or northeast will be transported toward the head of the bay and then along the western side as it is carried south by the cyclonic flow. The released oil could potentially be transported to several of the identified cod spawning grounds, herring beds, capelin beaches, lobster shores, and other vital commercial fishery habitats in the northwest and western portion of the Bay.

4.2 Potential Indirect Impacts of Oil Pollution to the Fishery of Placentia Bay

Oil pollution, arising from either chronic illegal discharges or a large-scale spill from a tanker or shore based facility, has the potential to directly and adversely affect fisheries. There are also several indirect impacts from oil pollution, which could negatively affect the fisheries.

Commercial species may escape the actual spill only to be contaminated by contact with fishing gear fouled by chronic oil release or a tanker accident. In fact, some fishing gear demonstrates an increased sensitivity to oil contamination by stranded or drifting oil. For instance gear types such as traps, baskets, and fences, are extremely sensitive to damage as a result of oil contamination, while cast, gill, and ring nets as well as purse seines demonstrate a moderate to high sensitivity for contamination (IPIECA, 1997). Persistent oil spills, regardless of size, can result in a loss of fishing opportunity as boats may be left unable or unwilling to fish due to the risk of fouling gear and/or the encroachment of the oil pollution on their fishing ground.

To the consumer, the source of oil pollution or the circumstances surrounding an oil discharge event are of little consequence. In terms of the consumer relationship with a fishery resource, the phrase "oil spill" can destroy the market for products from the effected area. For example, in 1993 following the oil spill from the tanker *Braer*, which spilled 85,000 tonnes of crude oil off Shetland, both wild and farmed fish were contaminated (IPIECA, 1997). The wild fishery was also affected through contamination of equipment and tainting of fish (IPIECA, 1997). A Fishery Exclusion Zone was implemented and the sale of farmed species was banned. One year after the incident, the order was not lifted for many species due to concerns over possible long-term adverse impact on the reputation of the fishery via the marketing of fish known to have once been contaminated, albeit at low levels (IPIECA, 1997). Financial losses sustained by local fishermen were substantial and long-term market effects are still being felt.

The threat to seafood producers in the Placentia Bay region is real. The chronic oil pollution problem in the area, which is one of the worst in the world (POW Report - Phase II, 1999), may affect the reputation and livelihood of the fishing industry in this region, even without a major spill. The potential health hazard associated with consumers eating seafood contaminated with oil is a concern, which could have negative repercussions on the fishing industry. Another potential impact arising from oil pollution in Placentia Bay is the commercial losses to other fisheries operating in Newfoundland and Labrador. Market prices for fish from areas not directly contaminated by or even within geographic proximity to the pollution site may be adversely affected by spills in adjacent regions (Jaques, 1995).

4.3 Risk Assessment for Critical Life Stages of Commercial Species in Placentia Bay: Developing Avoidance Criteria for Tanker Traffic?

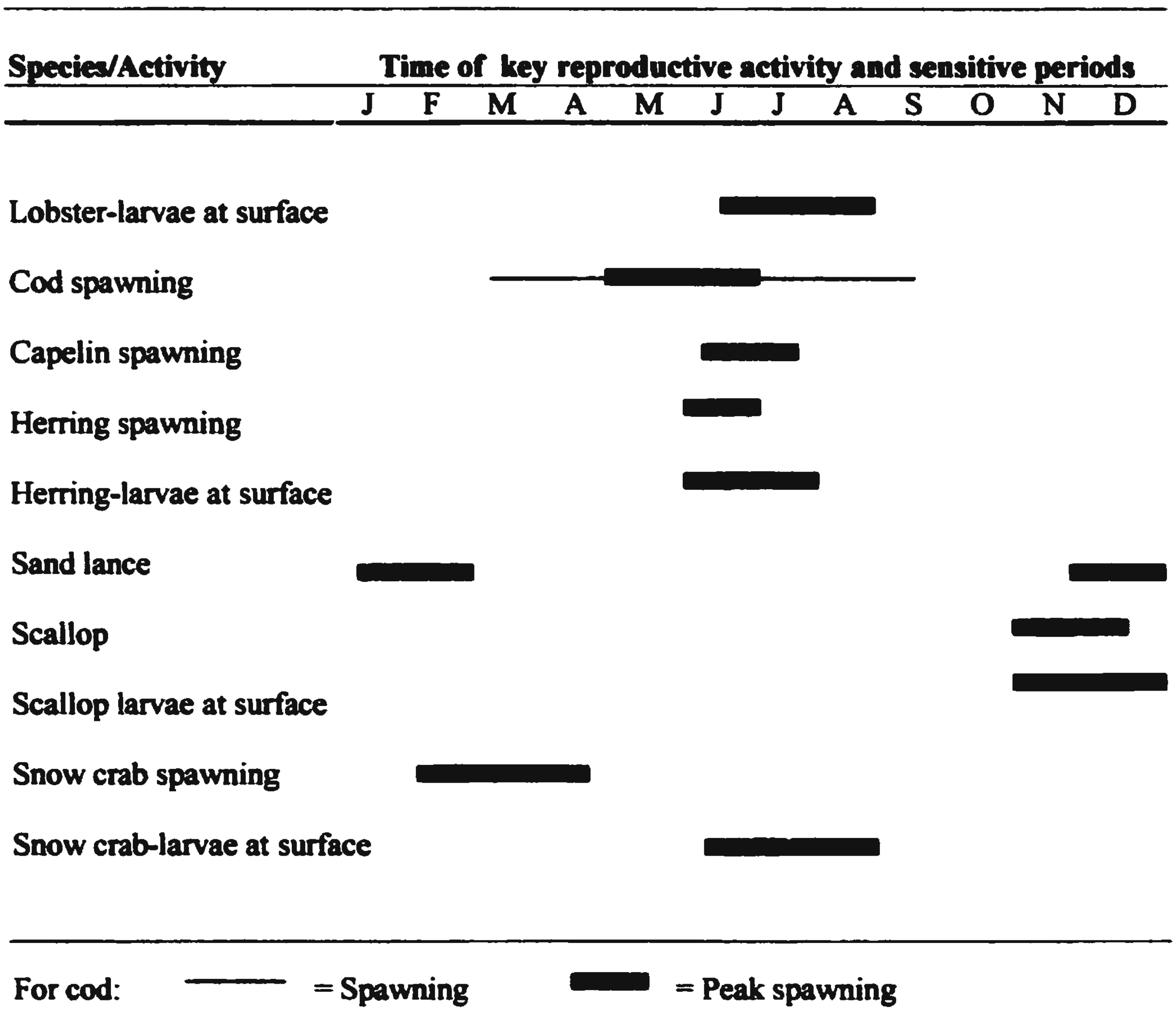
The oil industry and the commercial fishery must exist side by side in the ecologically sensitive environment of Placentia Bay and it is almost certain that the oil industry presence in Placentia Bay is one that will continue into the future. If this co-existence in

Placentia Bay is to be played out in a manner that successfully integrates the economic and environmental needs of both industries, some degree of compromise will be required.

Given the traditional reliance upon the rich fisheries resources of Placentia Bay, the onus should fall upon the oil industry to protect critical habitat. This is particularly applicable during the reproductive and spawning periods of important fish species, as well as during their critical life stages. The oil industry represents a year round venture. By contrast, the fishery of Placentia Bay is largely a seasonal industry. Should an oil spill occur during critical spawning periods or when the larvae of certain species are at the water surface in Placentia Bay (Table 1), the losses to the fishing industry could be severe. Confounding the problem further is the fact that real losses sustained by the fishing industry may not be realized for several years following an oil spill. Poor recruitment and reproductive impairment are effects that may take years to reveal themselves following an oil spill.

Of course, the oil industry cannot plan its business around the life cycles of important commercial fish species. However, it is likely that a reduction in oil tanker traffic during certain times of the year, and avoidance of certain habitat (i.e., inshore) during key periods in the life stages of some commercial fish species may hold promise. It could potentially be a means of reducing risk and allowing the oil and fishing industries to co-exist successfully in the years to come. At the very least, it is a strategy worthy of consideration and study in order to investigate its feasibility.

Table 1: Timing of reproductive activities and location of sensitive larval stages for selected commercial fishery species



Although much variability exists between the species represented in Table 1 with regard to the timing of key events, the data are somewhat clustered between spring and early summer. It is likely that reducing oil related shipping activity and tanker traffic during this period could significantly lower the risk posed to commercial fishery resources in

Placentia Bay. This scenario, however, raises issues of a practical nature where business and operations of the oil industry are concerned.

5.0 Modern Day Coexistence of Oil Development, Wildlife, and the Human Element

Communities like those typical of Placentia Bay that rely on natural resources to sustain them both economically and culturally, face conflicting needs. On the one hand, rich fisheries have been the economic foundation of these communities for centuries. On the other hand, rapid development of the competitive oil industry has injected new economic benefit into this economy after the loss of the United States naval base in Argentia in the 1990's. Ultimately, the oil and shipping industries are almost certain to proceed in this region, and the influence of powerful, yet remote, centres of commerce will remain strong. Placentia Bay is not unique in this respect. The precarious coexistence of oil and shipping industry developments and a largely natural resource-based and subsistence economic locale persists throughout the world. Where oil and shipping interests have dominated local interests, devastation has occurred time and time again (Keeble, 1991). Large-scale oil pollution events have far-reaching and diverse long-term implications. This section examines one such example and the impacts on the environment, the people, and fisheries resources.

5.1 The Prince William Sound Experience

On March 24, 1989, the single-hulled Exxon Valdez tanker went aground in Prince William Sound, spilling approximately 44 million litres of crude oil, affecting over

2000km of shoreline, and spilling oil as far as 1000 km from the grounded tanker (National Oceanic and Atmospheric Administration, NOAA, 1998a).

Prior to this event, Prince William Sound was a thriving resource based economy, and subsistence users and the fishermen were as aware as any other group of the need for stewardship of their resources. Following the Exxon disaster, these same people found themselves cast into a complex confrontation with the oil industry. This confrontation eventually saw the fishermen become divided amongst even themselves (Keeble, 1991).

Several factors contributed to the magnitude of the spill. The tanker, like most others operating in the region, was a single-hulled vessel, navigating an area known to be hazardous, even in optimal weather conditions. Weather conditions similar to Placentia Bay are often observed in Prince William Sound, including sudden squalls, fog, and high winds with only 1 in 6 days being clear (Keeble, 1991). Several factors further exacerbated the environmental devastation following the spill incident. The contingency plan in place to deal with oil spills, within a short period of time prior to the spill, ranged from bright promises to virtually nothing (Keeble, 1991). Prior to the accident, authorities went on record stating that the Valdez terminal had the best in equipment, materials, and expertise available to respond to a large oil spill. Yet, the most impressive aspect of Alaska's overall ability to handle such a spill was the obvious inadequacy in technology and response capacity available at the time (Keeble, 1991). In addition, the frequency of tankers transiting the port, as well as the age and size of the tanker fleet, seemed to indicate that a disaster was inevitable. Even in the wake of the Exxon disaster, single-hulled tankers will not be entirely phased out of operation in American and Canadian waters until 2015.

5.1.1 The Impact of the Exxon Valdez on the Fisheries Resources of Prince William Sound: What can be Learned?

The impacts of the *Exxon Valdez* spill on the fisheries resources of Prince William Sound and adjacent areas were far-reaching. The Prince William Sound experience, while devastating in several respects, represents an environmental incident that has resulted in extensive long-term study and follow-up into the effects of such disasters.

Many adversely affected fisheries resources within Prince William Sound have yet to recover. Among the most vulnerable were the egg, larval, and juvenile stages of commercially important pink salmon (*Oncorhynchus gorbuschca*), Pacific herring (*Clupea pallasi)*, and various shellfish species. Adults were also affected.

Pacific herring are among the most important commercial finfish in Alaska. The *Exxon Valdez* spill occurred a mere few weeks prior to the Pacific herring spawning in Prince William Sound in the spring of 1989. Approximately half of the egg biomass was deposited within the oil trajectory, and an estimated 40-50% sustained oil exposure during early development (Brown *et al.*, 1996). Samples collected following the spill revealed abnormally small herring larvae, which was largely attributed to oil exposure

(Norcross & Frandsen, 1996). Furthermore, herring eggs stressed by factors such as oil pollution or other such toxic events are characterized by decreases in the time to hatching, changes in where eggs survive, and premature and less viable larvae (Norcross & Frandsen, 1996). Other documented effects of oil exposure on larval herring are reduced growth and immune response resulting from generalized metabolic alterations (Brown *et al*., 1996). In 1993, 4 years after the spill, the herring population of Prince William Sound collapsed, suggesting possible reproductive impairment in adults caused by oil exposure, however, it now appears that viral disease and fungal infection precipitated the population crash (Carls *et al*., 1997). Laboratory investigations since the oil spill in Prince William Sound have shown that exposure to very low concentrations of *Exxon Valdez* oil can compromise the immune system of adult herring resulting in the expression of viral disease (Exxon Valdez Oil Spill Trustee Council, 1999a). Slight increase in biomass estimates for 1997 and 1998 indicate that some recovery of Pacific herring was beginning, yet the population still has to recruit a highly successful year-class which will be fundamental to their recovery. Full recovery of the population has not been achieved in over a decade following the incident, and even today, the former Pacific herring fishery remains almost non-existent (Exxon Valdez Oil Spill Trustee Council, 1999a).

There is further evidence pointing to negative impacts of oil exposure on fish in the larval, juvenile, as well as adult stages, particularly for pelagic species. Oil exposure is known to elevate juvenile salmon mortality (Geiger *et al*., 1996). Following the Prince

William Sound spill, it was determined that exposure of walleye pollock (*Theragra chalcogramma*) embryos to water soluble fractions of oil slowed initial development, produced shorter larvae, and caused morphological abnormalities including eye, brain, jaw, and intestine deformities (Norcross & Frandsen, 1996). An estimated 75% of pink salmon in Prince William Sound spawned in intertidal areas where embryos deposited in the gravel had the potential to be chronically exposed to hydrocarbon contaminants in the water column or from oil leeching from adjacent contaminated beaches (Exxon Valdez Trustee Council, 1999b).

In terms of impacts on adult commercial fish species, it was estimated that over 1 million adult pink salmon failed to return to Prince William Sound in the year following the *Exxon Valdez* spill due to oil induced mortality (Geiger *et al.*, 1996). Since the spill, returns of wild pink salmon in the sound have varied from a high of about 12 million to a low of just over 1 million. Pink salmon, like many commercial species, exhibit wide natural fluctuation, making the establishment of a link between the spill and reduction in returning salmon to the Sound problematic. Yet, the fact remains that wild pink salmon returns to the area following the spill declined dramatically, and ten years after the oil spill, full recovery from the effects of the oil has not yet been achieved (Exxon Valdez Oil Spill Trustee Council, 1999b).

Sockeye salmon (*Oncorhynchus nerka*) were also impacted by the 1989 spill. The commercial fishery was closed in Prince William Sound following the *Exxon Valdez* accident in an attempt to avoid market infiltration of contaminated salmon from the region (Exxon Valdez Oil Spill Trustee Council, 1999c). What followed is referred to as "overescapement" where more than desirable numbers of sockeye salmon entered a number of rivers and lakes in the area, producing an overabundance of juvenile sockeye, which subsequently overfed on zooplankton. It has been suggested that this overabundance of juveniles altered the food-web in the nursery lakes, resulting in lowered growth rates in early stages of sockeye development, and declines in numbers of adult returning fish (Exxon Valdez Oil Spill Trustee Council, 1999c).

Important shellfish resources in Prince William Sound did not escape damage from exposure to the spilled oil. Rich clam beds in the region, which suffered high mortality from the oil and the extensive beach cleaning that took place after the spill, have still not recovered or repopulated to their pre-spill levels (NOAA, 1998b). During 1991, high concentrations of unweathered oil were found in some mussels and in the sediments underlying them. These are potential pathways for contamination for several other marine animals, which rely on the mussels as an important food source (Exxon Valdez Oil Spill Trustee Council, 1999d). A decade after the spill, intertidal species in some areas, such as mussels, are still contaminated with oil (NOAA, 1998b). This is largely due to the contamination of intertidal and subtidal sediments (O'Clair *et al.*, 1996), as well as deepwater sediments (Carlson & Kvenvolden, 1996) within Prince William Sound. Thus, fisheries impacts resulted not only from direct contact with the spilled oil within the water column directly following the accident, but also from oil-contaminated habitat that existed for at least a decade after the spill. The full environmental and fisheries resource impacts from the Exxon Valdez oil spill in Prince William Sound is still largely unaccounted for as a consequence of these lingering and persistent sources of oil pollution. More than a decade after the *Exxon Valdez* spill, compromises in habitat quality persist, as do signs of continuing negative impacts on Alaska's coastal fisheries resources from this huge oil pollution incident (NOAA, 1998b).

Economic losses for fishers in Prince William Sound were substantial as a result of reduction in commercial harvests. In fact, the period prior to the spill was particularly prosperous for many commercial fishermen, as 1987-88 saw among the highest ever per pound prices for herring and increased fishery capitalization (Exxon Valdez Oil Spill Trustee Council, 1999e). Not surprisingly, the expectations of the fishermen were also at an all time high. Several fishery closures ensued following the spill. The herring fishery was completely closed from 1993-1996 and was only re-opened as a very limited fishery during 1997-1998 (Exxon Valdez Oil Spill Trustee Council, 1999e). Several other commercial fishery closures followed in 1998. In addition to losses associated with fisheries closures, there were numerous reports of gear fouling and catch contamination for those fisheries that were operational in the period directly following the spill (Keeble, 1991).

Income disruptions for the fishermen of Prince William Sound continue today. Complicating the issue further is the fact that thousands of fishermen from every state in the U.S. also claim to be affected by the *Exxon Valdez* spill in Alaska. Many fishermen from the continental United States travel to Alaska to earn a living during the fishing seasons (Survivors of Exxon Valdez Oil Spill, 2000). Income disruptions are evident in changes in average earnings, ex-vessel prices, and limited entry permit values in the years following the spill. Examples of year-end permit value declines from 1989-1998 include herring purse seines going from US $245,000 in 1989 to US $120,000 in 1998. Salmon drift gillnet permits valued at US $141,115 in 1989 dropped to US $69,300 in 1998 (Survivors of Exxon Valdez Oil Spill, 2000). However, a federal jury ruled that any financial effects on fishermen after 1989, with the exception of the salmon seine fishery in 1992-1993 and the herring fishery in 1993, are not attributable to the spill (Survivors of Exxon Valdez Oil Spill, 2000). This ruling stands despite the fact that oil persists in the environment of Prince William Sound, where commercial species including herring, salmon, and several species of shellfish have still not fully recovered.

Despite Prince William Sound enduring substantial damage to its commercial fishery resources, the question remains "What lessons, if any, can be learned?". It appears that for all the eagerness with which the public consumed and were shocked by the ecological horror stories coming from Alaska following the spill, there are only faint indications of realistic attempts to address the core cause of the spill (Keeble, 1991). Solutions such as better traffic or routing systems for tankers, mandatory use of double-hulled tankers, and similar legislation may offer some degree of prevention in the long term, but as was the case with the Exxon Valdez, it is impossible to legislate against human error.

5.1.2 Prince William Sound: Implications for Placentia Bay

Another lesson to be learned and applied to Placentia Bay from Prince William Sound is the problem of determining accountability for a large-scale oil pollution incident. Logically, it would seem that accountability would be shared for such an environmental catastrophe in Placentia Bay, or anywhere else in Canada. Yet, a highly likely scenario, as was the case in Prince William Sound, is that questions and uncertainties with respect to what agency or agencies are in charge (DFO-Canadian Coast Guard, Environment Canada, Transport Canada, oil or shipping company involved, East Coast Response Corporation) will inevitably arise. Uncertainties about what their relationships are in the midst of such a disaster may also develop. In Prince William Sound, these issues were never resolved (Keeble, 1991), and likely acted to hinder a coordinated and effective clean-up response. In Prince William Sound, the end result was a stand-off between the state of Alaska, the Coast Guard, and Exxon, which contributed to a paralysis that became one of the central features of the initial spill response effort (Keeble, 1991). This apparent paralysis outraged the public, especially fishermen resident in Prince William Sound. Similar confrontations and uncertainties are possible should such a disaster take place in Placentia Bay.

Reaction to the response on behalf of some local fishermen following the spill, for many, became another defining moment in this historic and tragic event. In a desperate effort to protect their fisheries resources immediately following the oil spill, several fishermen began a volunteer effort to clean up some of the oil by any means they could, often using their own boats and equipment (Keeble, 1991). Unfortunately for the fishermen of Prince William Sound, many of whom refused to sit idly by as oil pollution threatened their livelihood, their efforts were rewarded by a dubious offer from the Exxon corporation. Exxon attempted to capitalize on the initial volunteer effort by offering US$ 3,500 or more per day for leases on boats from local fishermen for clean-up purposes, but with one important caveat. Those who accepted the offer were to enter into a gag contract, preventing them from expressing their opinions on the oil spill to the press. Not surprisingly, most fishermen refused the offer (Keeble, 1991). Worse still was the fact that Exxon attempted to work with fishermen only after they had taken action on their own, and after several attempts by Exxon to prevent them from doing so at the outset (Keeble, 1991). The fishermen of Placentia Bay and their representatives would be wise to investigate whether any financial reimbursement would be forthcoming, as well as whether or not they should intervene during clean-up efforts.

The financial liability for response efforts remains uncertain. There is no clear division of responsibility and liability, which may create problems between the regulatory authority (DFO-Coast Guard, Transport Canada), Oil Spill Response Organizations (ECRC), and business interests (oil company or on-shore facility). The Exxon Valdez experience tells us that extreme government intervention, at a federal level in their case, has the potential to allow the responsible oil company to "close their checkbook" and force intervening government agencies to assume the costs (Keeble, 1991). One thing for certain is that in the face of such bureaucracy and conflict, it is unclear what level of protection will be realized for the interests of fishermen and fisheries resources, other than the fishermen and the communities themselves.

During personal correspondence by the author with representatives from various fishermen's committees within Placentia Bay, it appears that fishermen are relying mostly on the word of government agencies and oil industry representatives that they would be compensated for any fisheries impacts resulting from an oil spill. Neither Placentia Bay fishermen nor their committee or association representatives appear to have followed up with an in-depth investigation into compensation for fisheries losses in the event of a catastrophic oil spill. In fact, based on personal correspondence with fishermen from the area, opinions vary greatly on the risks to fisheries resources posed by the oil industry presence in Placentia Bay and the ability of the responsible agencies to clean up a spill should one occur. On the one hand, some fishermen have great confidence in the ability of the CCG and ECRC to respond quickly and effectively to a catastrophic oil spill. Further, many of these fishermen feel the risk of such an incident actually occurring is very small. Additionally, when asked about their knowledge of compensation in the event of fishery losses from an oil spill, many cited the Ship Source Oil Pollution Fund (SSOPF) and felt that these and other oil pollution funds would cover all losses they might sustain. By contrast, other fishermen expressed concern, and fear that an oil spill in Placentia Bay would threaten their livelihood and affect the fishery of the region for years after such an event. Many are knowledgeable about the *Exxon Valdez* disaster, and contend, as many fishermen from Prince William Sound contend even today (Survivors of Exxon Valdez Oil Spill, 2000), that they will be victims if a large-scale oil release occurred in their community.

It seems reasonable to guess that if a catastrophic oil spill were to occur in Placentia Bay, or any other natural resource based locale, a volunteer clean up effort might be initiated by the local community. In fact, the Eastern Canada Response Corporation (ECRC) and the Canadian Coast Guard (CCG) have taken part in an initiative to train fishermen and other residents of Placentia Bay in basic oil spill response techniques (personal communication with Placentia Bay Fishermens' Associations, September 2000). The appropriateness of such an endeavour, to the mind of the author, is questionable. Some members of the public have acknowledged the inadequacies of existing oil spill response capability, and recognize the clean-up efforts by the regulatory agencies will be futile in the event of a large oil spill in Placentia Bay (proceedings from the Regional Advisory Council public forum, St. John's, October 2000). The onus should lie with the responsible agencies and industries to ensure adequate measures are in place to protect the people and natural resources of Placentia Bay. To do anything less while expecting fishermen to risk their safety during such an exercise in futility, as would be the case in the event of a large oil spill in Placentia Bay, is intolerable.

There is also much to be learned from the extensive clean-up efforts in Prince William Sound following the *Exxon Valdez* disaster. Several shoreline treatments and clean-up methods were used in an attempt to recover some of the spilled oil from the environment.

These included but were not limited to low and high-pressure washes (warm and hot water), various dispersants (i.e., Corexit 7664), various bleach cleaners, sorbents, and various bioremediation techniques (Lees *et al.*, 1996). Published data suggests that chemical treatment immediately following the spill removed a mere 4 - 9% of the spilled oil, while high-pressure hot water washing was only twice as effective (Mearns, 1996). However, the high-pressure washing resulted in severe and persistent negative impacts in many of the areas subjected to this type of treatment (Lees *et al.*, 1996). In the case of Prince William Sound, natural wave action, flushing, and environmental dispersal of the oil appears to have been more efficient in restoring the environment than the manual and labour intensive efforts of clean-up crews (Earth & Mineral Sciences Newsletter – Penn State, 2001). It may be, in the event of a large-scale oil spill in Placentia Bay, that an intense effort to remediate the damage caused could be similarly futile. Furthermore, where chemical or other treatments are concerned, application of such measures may act only to exacerbate the problem and further damage the environment.

Clearly, the best possible defense lies in prevention. However, with the level of shipping in the region, some risk is unavoidable and must be accepted. It is therefore imperative that contingency plans be developed together with community input (i.e., identification of sensitive areas, traditional ecological knowledge, concerns) and the lead agencies with regulatory authority.

5.2 The Risk of a Tanker Incident in Placentia Bay

The DFO Termpol Review Process Report on Whiffen Head states that "although all precautions are being taken, and all environmental, Coast Guard, Transport Canada, and international regulations are complied with, accidents can still happen" (DFO, 1999b). One very important preventative measure on behalf of Newfoundland Transshipment Limited, however, is their Ship Acceptance Criteria. Tankers calling at the facility must comply with all International Maritime Organization (IMO) conventions and Industry Guidelines. In addition, vessels are vetted and approved before they are accepted at the terminal (NTL – Terminal Regulations & Information Booklet, 2001).

Despite taking such precautions, however, there are still substantial risks. Based on statistics from world tanker oil spill data, a large (>1000 barrels (bbl)) or very large (>10, 000 bbl) spill would be predicted to occur approximately once every 16 - 27 years of Newfoundland Transshipment Limited operation (DFO, 1999b). This estimate translates into one major spill during the course of operation of the Hibernia oil field (DFO, 1999b), which has been estimated to have a life span of about 20 years. Given these probabilities from global statistics, it is reasonable to infer that the likelihood of a significant oil spill from a tanker accident in a high risk area such as Placentia Bay is even greater than these numbers would suggest.

It is generally accepted that oil tanker accidents will continue to occur as a consequence of human error, despite better ship development and vessel control efforts. Human error accounts for over 75% of oil tanker groundings and collisions (DFO, 1999b). Most groundings and collisions occur in restricted waters, similar to Placentia Bay, and usually only a few miles from land. In most instances, such accidents occur as a result of navigational errors, in which the crew used outdated charts or misread current charts, resulting in the vessel not being where the crew thought it was. With any large tanker, even small misjudgments can lead to major errors in navigation as a consequence of the slow response of the vessels when a correction is made. In addition, where two ships have collided, such events usually take place during times of poor visibility (DFO, 1999b), which is a frequent problem in Placentia Bay. Given the frequency of tanker movements within the Bay along the shipping channel, a collision seems entirely possible. The shipping lanes outside Placentia Bay and to the south of the island of Newfoundland, where environmental conditions can be severe, is also considered a high-risk area for a potential oil tanker mishap (personal correspondence with CCG Regional Contingency Planning Officer, September 2000).

Although collisions and groundings cause most oil tanker accidents, structural failures as experienced on board the *Eastern Power*, explosions, fires, and general mechanical breakdown could also lead to oil spills.

5.2.1 Response Capacity for a Major Oil Spill Event in Newfoundland and Labrador

The CCG has lead agency responsibility for oil spills from oil handling facilities and ships. The Eastern Canada Response Organization (ECRC) is a privately operated business created for oil spill response and clean up and has contractual responsibility from clients to respond to oil spills. The CCG maintains equipment capable of responding to an oil spill of just over 10, 000 tonnes. The CCG states that this response capacity is strategically located throughout the province in St. John's, Twillingate, Stephenville, St. Anthony, Burgeo, Burin, and Goose Bay (personal correspondence with CCG Regional Contingency Planning Officer, September 2000). The ECRC is certified by the CCG to respond to an oil spill of up to 10,000 tonnes within the province. The current legislation allows ECRC to cascade equipment into the province from its other depots in the Maritimes. Within Newfoundland and Labrador, the ECRC maintains equipment capable of immediate response to a 2,500 tonne spill only. The intent during the initial contingency planning phase when the Response Organizations (RO) were developed was for the RO to respond to spills of up to 10,000 tonnes with the CCG providing additional equipment above this amount. The actual circumstance suggests that the CCG will have to initiate a response to a large-scale oil spill (i.e., anything larger than 2,500 tonnes) while the ECRC "cascades" its additional response equipment into the province. Additional response could take several days following a spill.

In addition to the ECRC 2,500 tonne regional capacity, ECRC response equipment capable of handling 150 tonnes of oil is currently located in what are deemed "high risk areas". One of these areas is Come by Chance, Placentia Bay (personal correspondence with CCG Environmental Response Personnel, September 2000). A response capacity for 150 tonnes of oil is not considered adequate to deal with a large-scale oil pollution incident. The equipment currently on stand-by in Placentia Bay includes a barge, skimmer, and a boom line. The combined ECRC and CCG response equipment (12,500 tonne capacity) remains in Donovans Industrial Park, near St. John's (Personal correspondence with CCG Environmental Response Personnel, September 2000). The industrial park is over 150 km away from the high risk Placentia Bay area. It is anticipated that a coordinated response effort, which would see this substantial amount of response equipment delivered to an oil spill emergency in Placentia Bay, would take at least several hours. It is a widely accepted fact that the most critical time in terms of reducing the environmental impact from an oil spill is within the first few hours.

One difficulty in responding quickly to a spill is the vast geographical area of Placentia Bay itself and the distance from the offshore oil production sites to the oil handling facilities within Placentia Bay. An oil spill incident or tanker accident could occur anywhere along the offshore shipping route, or indeed anywhere along the Eastern Channel within Placentia Bay itself. Thus, judgment with respect to strategic placement of stand-by oil spill response equipment is a difficult one. In the event of a major oil spill event on the offshore oil production sites, storing response equipment in a centre such as

St. John's is likely the best location in terms of accessibility and timely transfer to the offshore. However, if a major spill were to occur within Placentia Bay, the existing arrangement will undoubtedly mean that the Placentia Bay environment and fisheries resources are at very high risk of exposure to substantial amounts of oil for several hours or even days before containment efforts could reasonably begin. This could translate into substantial delays, especially if weather conditions are not optimal. Furthermore, the characteristic prevailing flows and unfavourable weather conditions (i.e., high winds and wave energy) of Placentia Bay likely would spread any spilled oil quickly, potentially impacting valuable fisheries resources over a wide region and even beyond Placentia Bay into Fortune Bay and the St. Pierre-Miquelon channel.

Another contentious issue regarding the timing of response efforts is one of legality. By law, in the case of a 10,000 tonne oil spill, the ECRC has 72 hours to respond. This lag time is to allow for any of the ECRC's remaining oil spill (7500 tonnes) response equipment, stored outside Newfoundland, to make its way to the oil spill site if needed. In theory, based on existing legislation, it is possible that a spill of 10,000 tonnes or larger could remain unattended to for up to 72 hours in the manner required to prevent such a spill from spreading. The response equipment available to the CCG for large-scale oil-spill containment and clean up is, however, limited. If ECRC response capacity other than that covered by the 2500 tonne Newfoundland regional allocation were required in a catastrophic oil spill incident, additional delays would likely begin. Placentia Bay, its people, communities, and fishery would have to wait and watch for three days or more as their living environment becomes transformed by oil before additional containment and clean up capability arrives.

The Regional Advisory Council (RAC) is a panel of stakeholders that includes academics, environmentalists, fishermen, and oil industry representatives, and was established to advise regulatory agencies on various issues, including oil spill response capacity. During the RAC public hearings during the winters of 1998 and 2000, the primary focus was that of the available oil spill response capacity for Newfoundland and Labrador. Many, including members of the panel and several members of the public present at both hearings, felt that the current allocation of response resources and available equipment would be insufficient in a major oil discharge incident. Furthermore, it was suggested at both hearings that the available response capacity worked only on paper, and that, in reality, a spill of 12,500 tonnes of oil could not be effectively handled by the CCG and ECRC (meeting of the Regional Advisory Council, St. John's, 1998, 2000). To put this into perspective, vessels such as the *Mattea* or the *Kometik*, which operate between the offshore and the oil industry facilities in Placentia Bay, regularly carry 72 000 tonnes of oil during a single voyage (personal correspondence with CCG Environmental Response personnel, September 2000). It appears that "required" oil spill response capacities of just over 12, 000 for the entire Newfoundland and Labrador region is somewhat arbitrary. The potential clearly exists for much larger volumes of oil to be accidentally discharged into the marine environment, and other regions with substantial oil transport initiatives concede to this fact. For instance in 1990, following the *Exxon*

Valdez disaster, the Alaska legislature passed a bill requiring that sufficient equipment be on stand-by within the state to respond to a spill of approximately 42, 000 tonnes (Keeble, 1991). In addition, legislation requires the state to be prepared to import additional equipment to combat larger spills. Given the vessel traffic, volume of oil transiting the region, and the valuable natural resources of Placentia Bay would seem to warrant a more stringent, reliable, and realistic contingency plan and response capability than are currently available.

When contacted by the author, both the transshipment terminal and North Atlantic Refining expressed assurance that they have adequate environmental response capacity available in the event of a large-scale accidental discharge of oil. When pressed on the matter, representatives from these facilities confirm that they have limited oil spill response equipment and essentially rely on contracts made with the ECRC to respond to significant oil discharges. Furthermore, the oil industry operations within Placentia Bay must pay substantial amounts to the ECRC annually. This is for oil spill response exercises, and for contracting the ECRC as their oil spill response organization. The regional response equipment available for a large-scale oil pollution incident is therefore limited, and this shortcoming appears to be a point of contention between the oil industry operations in Placentia Bay and the oil spill response organization (Personal correspondence with personnel of CCG Environmental Response, September 2000).

The regulating authority in the event of an offshore incident from a drilling platform or exploration rig engaged in operation is the Canada-Newfoundland Offshore Petroleum Board (CNOPB), which has the authority to intervene in an oil spill event at any of the oil production platforms (Burley, 2000). However, the CNOPB itself has no oil spill response equipment or resources other than that which is available on the production platforms or contracted through the CCG and/or the ECRC.

In short, the information available suggests a limited and inadequate capacity to respond to a major oil spill or tanker accident in Newfoundland, particularly in a high-risk area such as Placentia Bay. Moreover, capacity may only be part of the problem. With oil spills, response timing is typically critical. In Newfoundland and Labrador, the location of response resources away from a high-risk area increases the time it would take to get resources to a spill site. An obvious solution would be to have response equipment placed in such high-risk areas. For instance, a stand-by response capacity (i.e., 12 000 tonnes of oil) for an offshore oil spill could be located in a strategic location, in addition to present stand-by response capacity within Placentia Bay itself. The initial costs associated with oil spill response equipment makes such alternative strategies unattractive to those involved. However, the real costs of not doing so to the fishery and the environment may prove to be greater.

6.0 Preventing a Tanker Incident in Placentia Bay

Accidents will continue to occur despite the most well-developed contingency plans and safety precautions. Prevention remains the single most important means of reducing the risk of environmental disaster or quite possibly, avoiding disaster altogether where fisheries and oil development attempt to coexist side by side. There are several preventative measures with varying degrees of effectiveness and practicality. However, all of them offer potential benefit and would likely provide optimal performance when used together. As before, the following list is not an exhaustive one, but rather reflects those methods that are being considered within Canada or that have been successfully implemented locally or internationally.

6.1 Radar

Several strategies have already been developed to prevent a tanker collision or grounding within Placentia Bay and the surrounding area. Radar sites are strategically located in this area of heavy commercial activity. Such technology is considered an important component for preventing an oil tanker pollution incident, by giving Canadian Coast Guard officials a visual representation of the number and types of vessels entering the eastern channel at any given time. A 48-mile range Raytheon radar facility was installed at three different geographic locales within the bay in 1991-92, covering ~80% of the area (Coast Guard representative from MCTS Centre, Argentia, 1999). However, radar does not provide information on exact tanker location, speed, direction, and trajectory in real time. Radar works best for preventing an oil tanker accident when used in conjunction with established technologies such as satellite imaging and emerging technologies such as automatic identification systems (AIS).

6.2 Automatic Identification Systems

The AIS has been developed and essentially operates as an information network for increased marine safety during vessel navigation. The AIS is an amalgamation of existing and familiar technology including Global Positioning Systems (GPS), marine radio frequencies, satellites, computers, and associated software (Ross Engineering Company, 1998). The AIS provides comprehensive monitoring and more importantly gives increased navigational control to mariners. The AIS provides almost real-time feedback from any number of vessels within a broad geographical radius of each other, or from shore. Further, AIS provides exact information on vessel position, identification, cargo, and direction (CCG Base, Argentia, 1999). Although the AIS system can provide more accurate and timely information than radar alone, radar capacity in conjunction with AIS systems can provide optimal monitoring of vessel movements (Ross Engineering Company, 1998). Presently, the AIS technology is being piloted on the *Mattea*, a tanker servicing the offshore production facility at Hibernia in addition to the two tugs and pilot vessel currently servicing Placentia Bay. This technology has considerable promise in the prevention of a tanker collision and chronic oil pollution (POW Report - Phase II, 1999).

Several nations have made progress in the use of AIS technology including parts of the

United Kingdom, United States, Spain, Australia, and Denmark (International Maritime Organization, IMO, 1998), although several remain in the trial stages. However, other countries are further advanced in terms of AIS development and implementation including the Netherlands, Sweden, and Finland (Finnish Maritime Authority, 2000). Despite the apparent potential of the AIS in tanker collision avoidance and general maritime safety, it is far from being universally implemented. To address this concern, the 72th session of the IMO Maritime Safety Committee determined that certain ships must be fitted with this equipment in the near future. It is likely that Canada will ratify this particular IMO convention, but it will only apply to her flag vessels (i.e., vessels of Canadian registry).

Most vessels associated with the Whiffen Head transshipment terminal and the Hibernia development project are modern vessels that comply with all safety regulations (personal communication with CCG Environmental Response personnel, September 2000). These factors alone should significantly reduce the chances of an oil tanker mishap. However, not all vessel traffic associated with the oil industry currently navigating the waters of Placentia Bay meet these same standards. North Atlantic Refining at Come by Chance deals with many different vessels and tanker types, many with international registry. These vessels range from the world's most aged to the most modern. Inevitably, vessels in poor condition will continue to carry oil through Placentia Bay. This situation will remain so until the mandatory implementation of double-hulled vessels in 2015 (Cutter Information Corporation, 1999).

6.3 Hydrographic Charts

Hydrographic charts are also vital for the safe navigation of vessels. Although a number of ecologically sensitive areas are located directly adjacent to Newfoundland's busiest shipping lanes, there are no markers to inform mariners that their vessels may be near these sites. Hydrographic Services have, in fact, designated a symbol for the identification of such zones. This symbol, once placed on a marine chart, would give mariners a prompt to reference their sailing direction books. The sailing directions contained therein would provide information for mariners on the sensitive zone and consequences of oil release on the marine environment of the area, as well as detailed legislative consequences of oil pollution (POW Report - Phase II, 1999).

6.4 Marine Protected Areas

A Marine Protected Area (MPA) could potentially reduce the risk of a large-scale oil spill in ecologically sensitive areas by forcing oil tankers and other vessels in transit to avoid them. Such an area would, in theory, be geographically far from areas at risk from oil tanker incidents in order to allow effective clean up and/or dispersal before any spilled oil reached a sensitive area.

The World Conservation Union (IUCN) defines a marine protected area (MPA) as "any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect all or part of the enclosed environment" (World Conservation

Monitoring Centre, 1992). Unfortunately, a major constraint to establishing an offshore MPA under international law is the freedom of navigation granted to foreign vessels. Ironically, this same freedom of navigation is also the culprit in the increasing death rate of pelagic seabirds (POW Report - Phase II, 1999), and likely has likely had negative effects on Newfoundland and Labrador's fisheries resources. A further obstacle in the way of establishing nearshore MPA's appears to be the uncertainty, particularly within fishing communities, regarding the definition and purpose of an MPA. Proposals for MPAs have failed in the past due to such uncertainties, which included community concerns over losing a degree of control over fishing ground and restricted use of the immediate ocean area of which the MPA would be a part.

6.5 Alternative and Interim Measures

All of the above measures have the potential to reduce the risk of an oil tanker accident within and around the Placentia Bay area. However, because the level of marine traffic in the area is likely to increase in the very near future, the best preventative measure may be the implementation of AIS technology. Those responsible for the safe control of national and international airspace are aware of each aircraft and its type in the skies at any one time. These data are crucial for safe and efficient air travel. Given the value of the marine transport industry to Newfoundland and Labrador and the rest of Canada, the same level of safety and monitoring should be made mandatory for navigation and transport, at least within Canadian marine environments.

AIS technology will be widely available within 3-10 years. Hence, other viable and more immediately available options for preventing, or minimally, monitoring tanker activity have to be considered in the interim (POW Report - Phase II, 1999). Present radar installments cover the majority of the area within Placentia Bay itself, but leave some regions unmonitored. Furthermore, radar does not cover tankers or other vessels for any great distance beyond the mouth of the Placentia Bay, and shore-based facilities are largely unaware of potentially hazardous situations just outside Placentia Bay. A representative from the CCG-Argentia base suggested the implementation of a Tanker Exclusion Zone (TEZ), or at least a Monitoring Control Zone (MCZ). A tanker exclusion zone, as its name suggests, would mean a complete ban on the navigation of oil tankers within areas known to be hazardous for navigation or in proximity to ecologically sensitive environments. Although the shipping channel along the eastern side of Placentia Bay does avoid most dangerous shoals and other hazards, within the channel itself oil tankers still navigate in close proximity to several ecologically sensitive regions and shoals. In the outer part of Placentia Bay, beyond the zone where tankers are normally accompanied by pilot vessels, tankers have been observed close to shoals and the ecologically sensitive areas around Cape St. Mary's (personal communication – Fisheries Conservation Chair, 2000).

Alternatively, an MCZ would require only mariners' cooperation to report in when entering and leaving such a zone. Such a zone can exist within Placentia Bay. If such a zone was declared outside Placentia Bay, extending from Cape St. Mary's to Cape Race, and 40 - 50 nm outside the bay, it could serve a dual role: enforcement and monitoring. On a voluntarily basis, vessels would contact shore upon entry into the zone, identify themselves, as well as report speed, cargo, and course, and then proceed through the MCZ. Upon departure, the vessel would report to shore again (POW Report - Phase II, 1999). Although the effectiveness of voluntary compliance is arguable, initiatives such as an MCZ or TEZ offer some degree of security in an environment where other standard means of effective monitoring (i.e., aerial surveillance) are severely deficient. Such regulation and reporting may guard against the possibility of human induced navigational errors, which cause most tanker accidents, such as the Exxon Valdez.

7.0 The Existing Problem of Chronic Oil Pollution along the Southeast Coast and Placentia Bay, Newfoundland – A Conservation Threat

Oil discharged in many incidents of chronic vessel source oil pollution, as opposed to tankers or specific oil industry operations, originate from unidentified sources. However, vessels in transit are the most likely cause (POW Report – Phase I, 1998). The role that oil tankers specifically play in contributing to the current chronic oil pollution problem is unknown, and likely negligible. The frequency of oil pollution along the southeast coast of Newfoundland is a persistent problem (POW Report – Phase I, 1998). The effect that chronic oil pollution has had upon the highly visible animals of the region, most notably seabirds, has been well documented in recent years. The conclusion thus far is that chronic oil pollution is posing a threat for seabird conservation, and that the problem must be addressed (POW Report - Phase I, 1998). In contrast, the potential impact of persistent oil pollution on the fisheries resources has not been examined to any great extent. However, the fact that 1ppb of oil in the marine environment is damaging to several commercial fish species suggests that several marine organisms are at risk. In particular, intertidal organisms may be affected by such chronic pollution arising from small spills or leaks (Holloway, 1999).

Regular occurrence of oil pollution along the Newfoundland and Labrador coast was noted 4 decades ago in a 1961 report by Les Tuck, a Canadian Wildlife Service scientist. Further data on the impact of oil pollution on the southeast coast of Newfoundland from 1951-1984 revealed frequent mortality among seabird populations of the region, particularly during the winter months (POW Report - Phase I, 1998). Although the quantity and quality of the data collected during these and other studies have limitations that preclude definitive conclusions on the amount and effect of such long-term oil pollution, some valid inferences can be made. Persistent oil pollution from unknown sources is part of a long-term trend that represents a clear conservation threat to wildlife and fisheries resources, with the potential to seriously degrade marine habitat (POW Report - Phase I, 1998). Regardless of the estimates used, the continuing impact on seabird populations of the region provides strong evidence that the problem is significant and not declining. The persistence of this chronic oil pollution problem and the lack of any effective means to reduce discharges from unknown vessels and the effects on wildlife and fisheries remains a major concern in this region (POW Report - Phase I, 1998).

Several hypotheses have been offered to account for the high incidence of released oil reported annually along the coast of Newfoundland and Labrador, particularly along the southeast coast of the island and around the mouth of Placentia Bay (Tuck, 1961; Levy, 1980; Piatt, 1985; POW Report – Phase I, 1998; & POW Report – Phase II, 1999:

- The large number and proximity of large vessel traffic off the southern Avalon Peninsula
- Vessels transiting closer to land during winter months result in increased pollution sightings during this period
- Surveillance and enforcement efforts are hampered by the large geographic area
- Illegal dumping of oily ballast and waste after ships crossing the north Atlantic
- Cost saving and convenience incentives to release waste oil rather than use proper means of disposal such as in-port waste reception facilities
- The tendency of released oil to persist in seasonally extreme cold weather
- Insufficient funding allocated to Canadian Coast Guard for an annual aerial surveillance program

Several regions of the world are subject to much greater volumes of shipping and marine transport than Newfoundland and Labrador (i.e., Baltic and North Sea States), yet problems arising from released oil from unknown sources are far less common (POW Report - Phase I, 1998). Prevention of illegal oil release in the marine environment of Newfoundland and Labrador has been limited by several factors, including a lack of vigilant surveillance and enforcement systems, and a lack of coordinated institutional commitment to adequately address the problem (POW Report - Phase I, 1998). These shortcomings coupled with the immense geographical area for which such surveillance schemes would be responsible, makes the challenge of preventing marine pollution of this nature and volume formidable.

In summary, a successful coordinated effort that effectively reduces the number of oil spills, and the time to respond to a significant oil spill event in the waters of Newfoundland and Labrador does not appear to be forthcoming. The primary obstacle appears to be the inability of governmental lead agencies to work together effectively to devise a program to limit oil pollution in the province's marine environment. The failure to address the current chronic oiling problem suggests that a successful, coordinated response to a large oil spill is remote.

7.1 Curbing Chronic Oil Pollution in Placentia Bay

Several of the preventative measures for avoiding an oil tanker mishap described above have potential application in curbing chronic oil pollution in the waters of southeast Newfoundland and Labrador. In the event of a mystery spill, an operational AIS system would provide information to authorities about vessels even after they are long gone, thus allowing an investigation of vessels known to have recently passed offshore but which were not detected by aerial surveillance. The value of AIS in this regard is that it would allow for timely investigation and prosecution of polluters. Implementation of such technology should be made mandatory as soon as possible. In the interim, several preventative measures that currently exist in Canada and the province of Newfoundland and Labrador can effect some progress in reducing chronic oil pollution.

7.1.1 Preventative Methods in Newfoundland and Labrador to Address Chronic Oil Pollution

The Department of Fisheries and Oceans, Canadian Coast Guard is the lead agency responsible for ship source pollution and spills of unknown origin occurring within Canadian jurisdiction (POW Report - Phase II, 1999). With increasing evidence of marine pollution and wildlife mortality has come escalating public awareness. Hence, regulatory agencies have shifted focus somewhat from response to prevention and preparedness. Also, changes to the Canada Shipping Act places the onus on industry to both prepare and respond to spills that they cause. All Oil Handling Facilities (i.e., Newfoundland Transshipment Limited, NARL) that are in close proximity to the marine environment and involved in the loading and unloading of oil must have an Oil Pollution Emergency Plan. This Plan must outline arrangements with a Response Organization (i.e., ECRC) that has been certified by the Canadian Coast Guard (POW Report - Phase II, 1999). Vessels that visit Canadian Ports must also have similar plans in place, but these plans are intended for response purposes only. Transport Canada monitors the inspection requirements of the International Convention on the Prevention of Marine Pollution from Ships (MARPOL) administered by the International Maritime Organization (IMO) and the Canada Shipping Act (POW Report - Phase II, 1999).

Prosecution of vessels and crew committing pollution violations within Canadian waters also has the potential to send strong messages of non-tolerance to the marine transport industry. A fine of up to $ 1 million can be imposed for such violation under the Canada Shipping Act, but judicial authorities have not sent a message of intolerance. A maximum of 1/3 of the fine possible under the Canada Shipping Act has ever been imposed upon convicted polluters (POW Report - Phase II, 1999). The Canadian Wildlife Service of Environment Canada also pursed enforcement activity involving illegal oil discharge from seagoing vessels in the past. For instance, during the winters of 1995-97 they headed a multi-agency enforcement team that investigated 3 ocean-going vessels for deliberate oil discharge while in transit along the coast of Newfoundland and Labrador. This investigation resulted in prosecution of one vessel and an imposed fine of only $25,000 (POW Report - Phase II, 1999). This amount is insufficient to deter global shipping companies from illegal discharges of oil and likely did not even equal the costs of the investigation by the Canadian Wildlife Service (CWS) and Transport Canada.

Aerial surveillance in concert with stiff fine imposition, in the absence of more sophisticated monitoring and surveillance technology, is perhaps the most effective means of addressing the chronic oil pollution problem along southeastern Newfoundland. Newfoundland and Labrador is currently allocated a $1 million budget from a national budget of just over $3 million for aerial surveillance (POW Report - Phase II, 1999). An increasing trend in oiled bird sightings over the winters of 1995-97 saw aerial surveillance patrols increase slightly. In the winter of 1998-99, 400 hrs were flown but this meager increase is considered limited as a preventative measure (POW Report - Phase II, 1999).

7.1.2 International Initiatives to Address the Problem of Chronic Oil Pollution

Southeastern Newfoundland is not unique in its experience with chronic oil pollution. The Oil Spill Intelligence Report (OSIR) International Oil Spill Statistics illustrate that in 1997, over 165,500 tonnes of oil from various sources entered the world's marine and inland environments. Container ships, tankers barges, and other vessels accounted for 52% of international oil pollution incidences, discharging a combined volume of nearly 85,000 tonnes of oil and oily mixtures into the world's oceans (Cutter Information Corporation, 1997).

Australia has taken a firm stand of non-tolerance for pollution of their marine environment in the form of an effective and aggressive aerial surveillance program. The Australian Customs Service (ACS) carries out surveillance activities and covers 37, 000 km of coastline and an offshore maritime area larger than the Australian mainland itself. Coastwatch aerial surveillance activities include over 15,000 flight hours annually (ACS, 1998). All oil pollution incidents, photographing and recording are reported to the Australian Maritime Safety Authority (AMSA) who have the responsibility for this area (ACS, 1998). Coastwatch's aerial surveillance regime includes 250 hours of dedicated Royal Australian Air Force (RAAF) offshore patrol and assistance from various sea going vessels (ACS, 1998). Coastwatch flying is defined as 'strategic surveillance' and is carried out in an aggressive fashion.

The United States imposes very heavy fines for illegal discharge of oil and oily wastes into the marine environment. For instance, the U.S. Supreme court fined Royal Caribbean Cruise Lines US$ 18 million for illegal discharge of oily contaminated bilge water within US jurisdiction (Cutter Information Corporation, 2000). Fines of this magnitude may be more reflective of the environmental damage caused by oil discharge and clearly serves as a strong disincentive for other vessels to commit similar offences in US jurisdiction.

The Baltic Sea is another area of high marine traffic density. The Helsinki Commission (HELCOM) is the regulatory body governing shipping and marine pollution in the Baltic Sea and is composed of member states from Denmark, Estonia, Germany, Finland, Latvia, Lithuania, Poland, Russia, and Sweden (HELCOM, 1997). Preventative measures on behalf of HELCOM are aimed specifically at the shipping companies themselves and the crew of the vessels they operate. HELCOM attempts to provide incentives for vessels to make use of in-port oily waste reception facilities. Harmonizing of port fee systems for delivery of ship-generated waste has been implemented and appears to be helping reduce illegal oil discharge in the region. (HELCOM, 1997).

The Netherlands port of Rotterdam is another area with heavy marine traffic, and the Port of Rotterdam Authority has developed incentives for ships to use port reception facilities. A Green Award is given to members of the shipping industry in recognition of environmental stewardship, and it appears to be helping to curb illegal vessel discharge.

In addition, the award targets operators of oil tankers who maintain up to date safety standards and sea-worthiness. The award can be granted to tankers over 20,000 dwt after verification that certain technical and management criteria have been met including segregated ballast tanks, protective location of fuel and lubrication oil tanks, and improved bilge water treatment and waste disposal (Port of Rotterdam Authority, 1998). Port Management allows ships with a Green Award a 6% discount on port dues, and a number of Rotterdam service companies offer several benefits to Award recipients (Port of Rotterdam Authority, 1998).

These initiatives do not represent an exhaustive list of international strategies to prevent ship source oil pollution. It does however provide insight into potential measures, which could be applied locally, and in theory, operate effectively to control the chronic oil pollution problems of Placentia Bay and southeastern Newfoundland.

7.1.3 Evaluation of Canadian and International Preventative Measures – What Should Take Priority?

Although Canada and the Province of Newfoundland and Labrador have implemented strategies to address the oil pollution problems of Placentia Bay and southeastern Newfoundland, these strategies have met with limited success. Wildlife mortality continues to rise (Weiss, Canadian Wildlife Service, 2000 unpublished data) and based on information provided from international sources, there is ample room for Canada to improve upon its commitment to protect the marine environment and its fisheries resources.

It is estimated that Australia invests over CAN$85 million in the ACS annually for aerial surveillance (personal correspondence with CCG environmental response). By comparison, Canada commits $3 million for marine aerial surveillance for a similar geographic area. In addition, Australia has developed extensive inter-governmental department cooperation. Some cooperation has developed in Canada, but strong cooperative links between key government agencies (i.e., DFO, Department of National Defense, Transport Canada) is still lacking. There is room for improvement for eastern Canada's aerial surveillance program but significant improvement is unlikely without a federal commitment of additional resources.

The Marine Safety Branch of Transport Canada monitors the status of Oily Waste Reception Facilities. Currently Newfoundland and Labrador does not have an in-port oily waste reception facility. There are, however, small private contractors with vacuum trucks that provide limited service. The lack of reception facilities is clearly a disincentive to comply with laws on ocean dumping. Taking on new cargo and shipping it to world market defines the shipping business. Without proper facilities to off-load operationally produced oily wastes or oily cargo residues, the ship operators are left with little alternative but to prepare for new cargo by discharging the ship's waste at sea.

Many countries are actively developing in-port oily waste reception facilities and making improvements to existing ones. These include countries that historically have been much less prosperous than Canada, such as Lithuania, Latvia, Russia, and Poland. These countries, as part of the Baltic Sea States, recognize the problem of chronic oil pollution (HELCOM, 1997). Despite economic and political challenges, they have taken affirmative action to deter would be polluters from discharging at sea.

Newfoundland and Labrador is currently experiencing prosperity and economic increases directly attributable to provincial oil development initiatives. Canada is economically among the richest countries in the world. Yet, despite the high level of marine traffic routes and incidents of oil pollution, the island of Newfoundland does not have a single in-port waste reception facility and nor are there any plans to develop one (POW Report - Phase II, 1999). Plans to facilitate development of waste reception facilities are readily available, and they outline how to facilitate needs assessment with all stakeholders (Department of Environment Transport and the Regions of the United Kingdom, 1998). Efforts to prevent illegal discharge at sea for the protection of fisheries resources and other marine wildlife are unlikely to be successful without development of oily waste reception facilities and incentives that promote their use.

It appears that the agencies responsible for protecting the marine environment of the province and Atlantic Canada and those benefiting from its rich natural resources, appear unable or unwilling to grasp the threat that oil release could have on the marine environment of Placentia Bay. Prevention should be the priority, yet on several obvious and relatively simply concepts, regulatory agencies and marine resource stakeholders continue to leave the Placentia Bay environment at risk. The absence of the implementation of several key measures to prevent oil pollution in Placentia Bay from a tanker accident and chronic oil release at this very late stage of oil development initiatives within the region is conspicuous. As in Prince William Sound, Alaska, it is likely that the residents, fisheries stakeholders, and other concerned individuals of Placentia Bay must ultimately force the issue of ensuring protection of their environment and fisheries resources from oil pollution. The apparent lack of commitment and coordinated efforts from several government and oil industry organizations to reduce the current trend in oil pollution, and to provide measures to protect Placentia Bay from a catastrophic oil spill, suggests that the situation is unlikely to change without local initiative.

8.0 Concluding Remarks

The conservation of commercially valuable species and important spawning areas such as exist in Placentia Bay should be a component of any long-term plan for regional development and fisheries resource management. Both a large-scale oil spill and the continuing trend in chronic oil pollution pose serious risks for the fisheries resources of Placentia Bay. Furthermore, such events threaten the larger environment and the quality of life for the human inhabitants of region. It must be recognized that the oil industry continues to be important for the economic development of the region, and has provided important opportunities for many where few alternative opportunities existed. Nevertheless, the fishery of the region remains a fundamental part of Placentia Bay's economy and identity, and continues to provide a stable living for many. The coexistence of these two industries within Placentia Bay is at present a precarious one. The fishery is unlikely to be able to withstand a significant oil spill. The fisheries resources of Placentia Bay must, and more importantly can be protected from oil pollution. Prevention must be the top priority.

During the course of this research it has become evident that adequate preventative measures to protect Placentia Bay and its marine environment and fisheries resources have not been implemented. Nor do government agencies, industries, or local residents appear to realize the extent of the inadequacies or the ramifications of a major oil spill.

The Province and Placentia Bay must accept the risks involved if oil industries are to operate in such high-risk areas, even if the most stringent of preventative measures are put in place. In the event of a catastrophic oil spill, such as occurred in Prince William Sound, Alaska, the ecological effects and the effects on people must be recognized at the outset, so that initial salvage responses, environmental mitigation, and safety measures can be as timely and effective as possible. Limiting the spread of spilled oil must also take priority and requires an immediate response capability that does not exist in the Province of Newfoundland and Labrador or Placentia Bay.

In the wake of the *Exxon Valdez*, the *Braer*, and numerous other oil spill catastrophes within regions with highly valued fisheries, Canada should have taken the opportunity to learn from such preventable tragedies. Given the current preventative and response measures in place around Placentia Bay and the entire province, this does not appear to be the case. We can only hope that the need to reduce chronic oil pollution and the likelihood of a major spill, and to be prepared should one occur, is acted upon in a timely manner. This will be necessary in order to secure protection for our valuable marine resources against such preventable disasters.

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