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Geoscience Canada

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Volume 1, Number 1, March 1974

URI: https://id.erudit.org/iderudit/geocan1_1art04

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Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

Explore this journal

Cite this article

Barker, M. L. (1974). Oil Tankers and Canada's Pacific Seaboard. *Geoscience Canada*, *1*(1), 31–34.

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Oil Tankers and Canada's Pacific Seaboard

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The threat of severe oil pollution is an international problem in the Pacific Northwest. The discovery of oil on the north slope of Alaska and the development of superports such as Roberts Bank (south of Vancouver) will increase the number and size of vessels plying the coastal waters of British Columbia and Washington State. All ocean-going traffic entering and leaving ports in the Strait of Georgia and Puget Sound passes through Juan de Fuca Strait (Fig. 1). No major accident has ocured in these waters yet. However a series of smaller spills from groundings and vessel-shore transfers has made many west coast residents aware of the threat of serious damage to other water uses: commercial and sport fisheries, wildlife, and the recreational enjoyment of the shorelands.

The Growth of Ocean Trade and Transport

Potential sources of oil pollution are: (1) large tankers entering or leaving the area with crude petroleum and refined products; (2) barges carrying refined products between local ports; and (3) large dry bulk carriers fueled by bunker oil. More than 7,500 major ocean-going vessels pass through Juan de Fuca Strait every year. As one of the three largest ports on the Pacific seaboard of North America, Vancouver dominates the export trade of the northwest (the others being San Francisco Bay Area and Los Angeles – Long Beach). Vancouver and the new Roberts Bank superport handled almost 37 million tons of cargo in 1972. 50 per cent of Vancouver's trade is with the United States, but there has been a rapid growth in the export of forest products and nonmetallic minerals to Japan in return for manufactured goods. In 1969, Roberts Bank exported $2.1 million of coal to Japan. By 1983 a total of 1.3 billion will have been exported (B.C. Department of Industrial Development, Trade and Commerce, 1971, p. 45). Seattle, as the most important U.S. port in the Pacific Northwest, plays a considerable role in U.S. import trade and coastwise shipping. If the 2.5 per cent annual growth rate continues 67 million tons will be shipped from Puget Sound ports by 1980 (Pacific Northwest River Basins Commission, 1972, p. 223).

The Strait of Georgia – Puget Sound region is not a major trans-shipment centre for crude oil or refined products. The oil refining industry has grown largely to meet local demands. So far, British Columbia and Washington State are supplied by the Trans Mountain Oil Pipeline which links Edmonton to Vancouver, with spur lines Ferndale and Anacortes in Washington. At the present time, tanker imports of crude oil are small. Barges and small tankers move 13 million barrels of refined products a

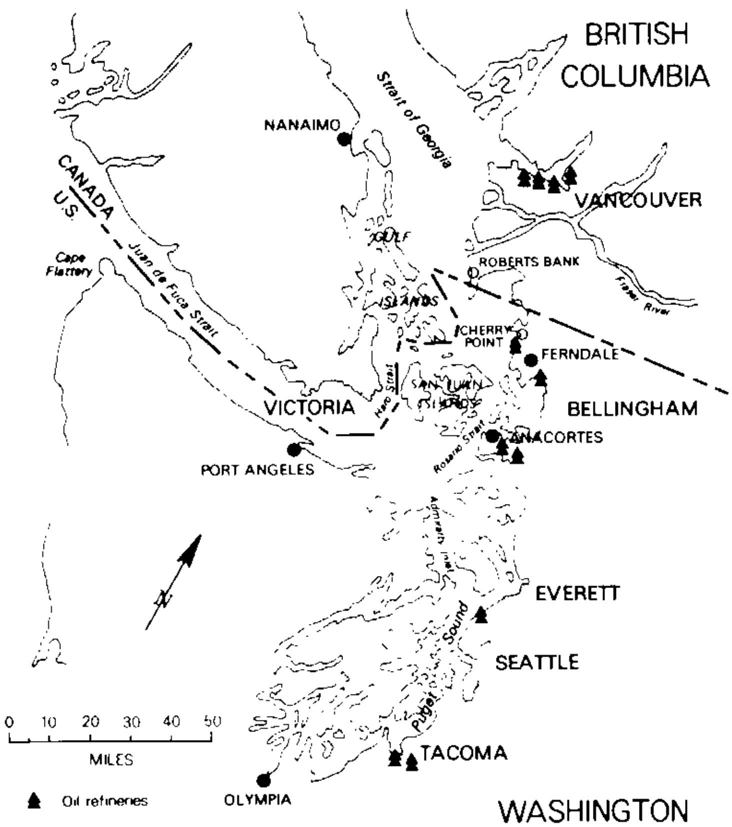

Figure 1
Strait of Georgia – Puget Sound region.

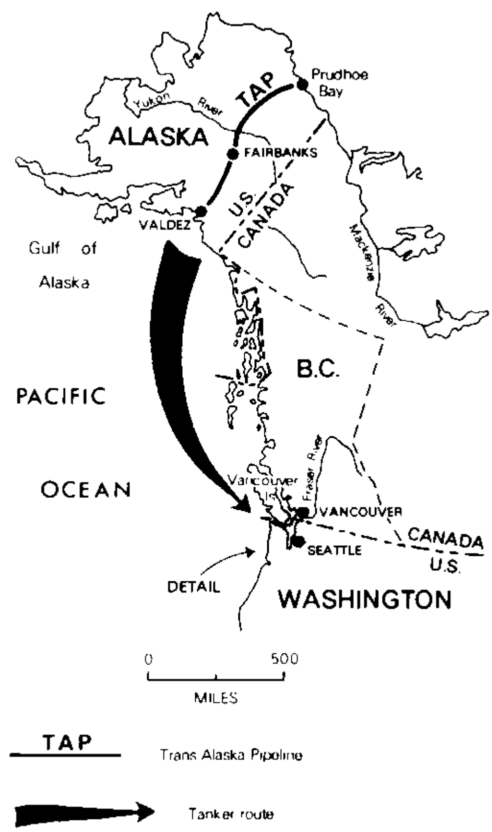

Figure 2
Alaskan north slope development.

year from Vancouver to other B.C. ports. If the demand continues to grow at the present rate, coastwise shipments will double by 1985. Shipments of refined products and some crude petroleum now account for 80 per cent of all coastwise trade in Puget Sound (Ross, 1972, p. 64-65). Tankers began to supply the Atlantic Richfield refinery at Cherry Point, Washington in 1972 (Fig. 1). Increased imports of crude petroleum are expected in the near future as the north slope of Alaska is developed.

On July 17, 1973 the U.S. Senate approved a bill granting the right of way for the Trans-Alaska Pipeline (TAP) from Prudhoe Bay to Valdez (Fig. 2). Provided that there are no further delays, the Alyeska pipeline consortium expects construction to begin in Spring 1974 and reach completion by mid-1977. Estimates of the volume of oil to be shipped from Valdez to Puget Sound vary, depending on assumptions made about oil reserves on the north slope, the growth of demand, and location of markets. There is considerable public uncertainty about the initial flow of oil through the Trans-Alaska Pipeline, where the oil will be marketed in the United States, and whether a pipeline will link Puget Sound to the U.S. Midwest. Alyeska anticipated 70 tanker calls a year in Puget Sound as soon as the pipeline begins operation, to be increased to 150 calls a year when the pipeline reaches full capacity (Ross, 1972, p. 217). Oil deliveries will probably be increased due to U.S. moves to contain the current energy crisis by increasing domestic production.

In anticipation of increased super-tanker deliveries to the west coast, the U.S. Army Corps of Engineers released a study of 11 deepwater port sites in 1973 (U.S. Army Corps of Engineers, 1973). The Corps evaluated three sites in Puget Sound: Ferndale, Anacortes, and Port Angeles (Fig. 1). The deepest U.S. ports are found in Puget Sound and Long Beach, California where existing facilities can handle vessels up to 150,000 deadweight tons (dwt). The study estimated that oil deliveries in Puget Sound would require 190 arrivals a year by 1980 if the west coast continues to be supplied by 150,000 dwt tankers. Using tankers up to 210,000 dwt, arrivals could be reduced to 50 a year (these estimates differ from those of the Alyeska consortium discussed above). For the 1,400 mile trip from Valdez to Puget Sound, the Corps calculated a cost of $2/ton of crude oil in a 50,000 dwt tanker, $1.25/ton in a 150,000 dwt vessel, and $1.20/ton in one of 200,000 dwt. There is considerable disagreement as to whether super-tankers have the manoeuverability suitable for the waters in which they are expected to navigate. The Corps of Engineers considered the use of large tankers would reduce the probability of collision because of the smaller number of vessels needed.

The Oil Spill Hazard

There are three major sources of oil spills from shipping in coastal waters: collision, groundings and vessel-shore transfers in harbours. Vessel-shore transfers generally result in the most frequent, but small spills (State of Washington, Department of Ecology, 1970-1974). The major spills occur from collisions or groundings in confined, congested water, under poor weather conditions, and in rough seas. On April 26, 1971, 210,000 gallons of diesel fuel were spilled near Anacortes. The spill damaged beaches and wildlife in Puget Sound and threatened the southern coast of Vancouver Island. On March 14, 1972 the *Vanlene* ran aground off the west coast of Vancouver Island and lost 37,000 gallons of bunker oil which damaged nearby beaches. On September 25, 1973 the *Erawan* and *Sun Diamond* collided at the entrance of Vancouver harbour and a relatively small spill of bunker oil reached the city's beaches. None of these incidents caused as much damage as the *Torrey Canyon* grounding in the English Channel, or the *Arrow* in Chedabucto Bay, Nova Scotia.

Four studies published in 1972 document the range of threat and magnitude of possible impacts if an oil spill were to occur in Juan de Fuca Strait, Puget Sound and adjacent waters (Vagners, 1972; Howard Paish and Associates Ltd., 1972; Company of Master Mariners of Canada, 1972; Flajser and Wenk, 1971). Under different assumptions about the growth of demand, and total volume of crude and refined products shipped, the predictions range from two to four major collisions in Puget Sound over the next 10 years, to nine collisions a year by 1990. Collisions have occurred in Puget Sound at an average rate of 0.4 per year between 1960 and 1970, the calculation excluding ferries (Wentzel and Lytle, 1971).

A number of areas can be identified as high risk zones: (1) the west coast of Vancouver Island and the entrance to Juan de Fuca Strait (fog, rough seas, gales); (2) Rosario Strait in the San Juan Archipelago (fog, tidal currents, ferries, pleasure craft); and (3) Haro Strait (fogs, tidal currents, ferries, pleasure craft) (Fig. 1).

Weather and Oceanographic Conditions

Juan de Fuca Strait, the Strait of Georgia and Puget Sound do not present a significant navigation problem in clear weather. However, conditions are generally severe along the west coast of Vancouver Island and at the entrance to Juan de Fuca Strait. In winter, a low pressure cell over Alaska moves south increasing wind speeds to gale force off the outer coast of British Columbia. The lower Fraser Valley and Juan de Fuca Strait act as funnels that govern wind patterns in the Strait of Georgia and Puget Sound. The occasional invasion of Arctic continental air in winter brings strong NE. winds to their area. Erratic, rapidly shifting winds are common for the rest of the year. Fog forms as warm air moves in from the Pacific and flows over cold offshore currents. Severe fog is common between July and October in Juan de Fuca Strait. Heavy fog occurs in Puget Sound and southern Strait of Georgia where visibility is reduced by fog to under 1,000 feet on 50 days a year, and reduced by precipitation on 225 days a year.

The movement of oceanic water in the Strait and Sound is dominated by freshwater inflow, particularly from the Fraser River, and by tidal currents. Deep oceanic water probably exchanges once a year between the Pacific Ocean and Strait of Georgia.

The brackish surface layer may flush through more frequently. The two layers mix around the San Juan Islands as the dense seawater moves over a series of sills and basins on the ocean floor (Waldichuk, 1957, p. 432).

Drift bottle studies in the 1930s showed a general counter clockwise movement of surface drift in the Strait of Georgia. This is not a steady feature and the pattern is frequently altered by freshwater inflow, tidal currents and strong surface winds. Short-lived and very localised patterns make it extremely difficult to predict the probable movement of an oil slick. Strong tidal rips and eddies in Rosario and Haro Straits (5 to 8 knots) present navigational problems and pose serious drawbacks to oil clean-up operations. Wave heights of five feet are common, with much heavier seas in open waters off the west coast of Vancouver Island. Waves of this size can prevent the effective use of oil-booms and "slick-lickers" (mechanical suction devices). Tidal ranges vary from eight feet around the Gulf Islands to 15 feet in southern Puget Sound. Oil slicks could be spread over extensive intertidal areas, particularly along gently sloping shorelines (e.g., Fraser delta).

Oil Spill Behaviour

The behaviour of an oil slick depends on the physical properties of the oil, and on local oceanographic conditions. Prudhoe Bay crude oil has a specific gravity of 0.89, which is only slightly less than that of surface water in this region (Glaeser, 1971, p. 481). It would be unlikely to mix except under very turbulent conditions and would probably form an oil-water emulsion. Its viscosity is light enough to allow easy spread and the oil would form a layer not less than five mm thick. Under these conditions wind-induced movement would dominate. Surface tidal currents would influence the direction and speed of oil slick movement. High waves and tidal turbulence would help the oil to disperse. A combination of onshore winds and strong tidal currents would deposit the slick or large chunks of oil on to beaches over several tidal cycles. Here it could permeate beach deposits up to 12 to 18 inches, particularly if the oiling was heavy (Canada, Ministry of Transport, 1970, v. 2, p. 23).

The overall impact of weather and oceanographic conditions indicate that a serious oil spill in Juan de Fuca or southern Strait of Georgia would affect large sections of Canadian and U.S. shorelines. For example, if a spill occurred in Rosario Strait at flood tide, local tidal turbulence could help break up the slick and move the oil northwards. In the absence of wind, surface currents would carry the slick to saltmarshes and beaches south of Vancouver in less than 24 hours. The movement would be accelerated under the strong SE. to SW. prevailing winds of winter and spring. Once in the Strait of Georgia, the slick could travel north up the coast or move west to the Gulf Islands, depending on Fraser River discharge, winds, and the tidal phase.

Ecological Impact

The rich variety of estuaries, shoreland and open water habitats supports over 200 species of fish, 300 species of invertebrates including shellfish, 134 species of marine birds, and 16 species of marine mammals. Colonies of marine plants range from plankton blooms to forests of giant kelp. Oil spill damage to estuaries would be critical because they are the key to the biological productivity of the marine environment. They are nurseries for the young of many species, they collect nutrients brought in from the ocean, and they produce food material in the salt marsh vegetation and marine life of the intertidal zone. Estuaries are important feeding stops for birds migrating along the Pacific Flyway between the Arctic and California. Mallard, pintail, widgeon and snow geese are among the species that winter over in the estuaries of British Columbia and Washington. The resident bird population is dominated by glaucous-winged gulls, ducks, cormorants and loons. These species are particularly sensitive to oil pollution because of their inshore swimming and diving behaviour.

The area has most of the fish species found along the Pacific coast in temperate latitudes. Cod, halibut and sole are significant commercial ground-fish species. The most valuable commercial and sport fish are the five species of anadramous salmon. Oil is a limited hazard to adult fish as long as the oil remains as a slick. However direct gill contact with oil-water emulsion is highly toxic. Juvenile fish and eggs are the stages most susceptible to oil pollution (Mironov, 1968, p. 335-339). There would be heavy mortality among filter-feeding shellfish in the intertidal zone.

Economic and Aesthetic Impact

Specific loss estimates are difficult to calculate because of the uncertainty as to the nature of potential spills and seasonal variations among water uses in the area. The major economic impact would be on commercial fishing and recreational activities (Barker, 1974). British Columbia provides 60 per cent of Canada's total fishery value. Over 20 native species of fish, shellfish, and marine mammals have commercial value. Salmon are the most important species, with a landed value of $50 million in 1972 (66 per cent of total fisheries value). The seascape and mountains have a tremendous appeal, attracting many visitors and providing recreational enjoyment for local residents. Open water and a wide variety of shoreline habitats provide opportunities for sport fishing, boating, swimming, camping and beachcombing. Summer cottage development is intensive on the Gulf and San Juan Islands in the Strait of Georgia.

Government Policies and Programs

Three aspects are important when dealing with oil pollution problems: (1) the prevention of oil spills by enforcing vessel design standards and navigational controls; (2) the containment of oil after a spill has occurred; and (3) recovery of oil before it damages marine life and shorelines.

The U.S. Coast Guard has developed a computerised vessel control system to cover Puget Sound and Juan de Fuca Strait as far as the international boundary. A Canadian system is being developed along similar lines and the two will be linked electronically. Radar surveillance will cover the Strait of Georgia by July 1974. There will be joint control of the linked systems, with communications centres at Vancouver and Seattle controlling traffic movement, arrival and departure times. There will be single lane traffic in the most dangerous areas (e.g., Rosario Strait).

A number of oil pollution contingency programmes have been set up in the area. In Canada, the federal Ministry of Transport is responsible for the prevention and clean-up of oil spills. The Environmental Protection Service of Environment Canada is responsible for clean-up methods and for rehabilitation of the environment. In Washington, the U.S. Coast Guard, federal Environmental Protection Agency and Washington State Department of Ecology are responsible for regional contingency plans. In November 1973 Canada and the United States reached agreement on a joint contingency plan for both west and east coasts. The programme will cover spills in offshore waters from ships, offshore drilling rigs, and onshore storage facilities.

Existing clean-up equipment includes containment booms, "slick-lickers" (suction-type collectors) and chemical dispersants. The largest containment booms will withstand only light to moderate winds, seas, and current motion in sheltered waters. Their use is limited in the rough conditions of the Pacific Northwest. Slick-lickers are most effective in large spills but much less effective on the small scale. The use of solvent-based detergents is severely restricted by the Canadian government because they are highly toxic and inflict heavy damage on wildlife (Canada, Department of Fisheries and Forestry, 1971, p. 56-58). Peat moss and straw are used for beach clean-up operations. The costs of clean-up are borne by the public and they can be high. The *Arrow* clean-up in Chedabucto Bay cost $3 million after 10,000 tons of heavy bunker oil were spilled (Canada, Ministry of Transport, 1970, v. 4, p. 16). The *Torrey Canyon* clean-up cost $7.2 million (Anon., 1969, p. 54).

Three pieces of Canadian federal legislation have some bearing on marine oil pollution: the Canada Shipping Act (amended 1971), the Fisheries Act (amended 1970), and the Navigable Waters Protection Act (amended 1971). The Canada Shipping Act makes the most explicit reference to the regulation of pollution by oil, chemicals, garbage and sewage from ships in Canadian waters. The amended Fisheries Act includes measures against the discharge of chemical substance deleterious to fish. The Navigable Waters Protection Act has provisions for fines not exceeding $5,000 for any obstruction in navigable waters. All these measures impose punishments for deliberate acts of pollution but do not prevent the problem from arising in the first place. There is no specific provincial legislation dealing with marine oil pollution.

Two international agreements refer to marine oil pollution (Dunn and Hargrave, 1971, p. 152-155). One prohibits the discharge of wastes within 100 miles of the coast. The other makes tanker owners liable for damages caused by an oil spill, with certain exceptions. Canada is now proposing a 200-mile territorial limit to protect her coastal waters from pollution.

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