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COMPARISON OF ECOLOGICAL IMPACTS OF POSTULATED OIL SPILLS AT SELECTED ALASKAN LOCATIONS

VOLUME II. RESULTS

MATHEMATICAL SCIENCES NORTHWEST, INCORPORATED

PREPARED FOR
COAST GUARD

JUNE 1975

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COMPARISON OF ECOLOGICAL IMPACTS OF POSTULATED OIL SPILLS AT SELECTED ALASKAN LOCATIONS

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RESULTS

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VOLUME II

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This report consists of two volumes. Volume I contains the introduction, summary, methodology, evaluation, and appendices. Detailed results for each of the study locations are contained in Volume II.

16. Abstract

A ranking of potential environmental impact for spills of crude oil, diesel-2, bunker C, and gasoline in amounts ranging from 100 to 50,000 barrels was made for specific sites at Yakutat Bay, Valdez Harbor, Valdez Narrows, Drift River Channel, Port Graham, Kamishak Bay, Unimak Pass, Port Moller, Kvichak Bay, St. Matthew Island, Offshore Prudhoe, Onshore Prudhoe, Nome, Cape Blossom Channel, Colville River, Yukon River, and Denali Fault. Spills were assumed to disperse from inertial, viscous, surface tension, wind and current forces. Most probable wind and current conditions were utilized. Sites were characterized in terms of eight species habitats. Most probable cases were evaluated.

A rating system was devised to characterize the impact based upon estimated species abundance, importance of species, and the impact of oil on such species over the short and long term. Impacts were estimated with the use of three-dimensional matrices. The highest impact ratings were obtained for spills at Port Graham, Valdez Narrows, Unimak Pass, and the Yukon River Crossing, assuming no spill cleanup.

The same five locations dominated the impact ratings where containment/cleanup were assumed to take place.

Data gaps were noted and future studies are recommended.

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Results

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SECTION 2. RESULTS OF THE ESTIMATED IMPACT OF OIL SPILLS IN THE ALASKAN ENVIRONMENT

This section presents the analysis of the estimated environmental impact of oil spills at 17 locations in Alaska. Thirteen of the locations are along the coast and four are inland near the Colville and Sagavanirktok rivers on the Nortn Slope and the Yukon and Denali Fault Trans-Alaska Pipeline crossings (see Figure 2-1, General Location of Oil Spill Sites).

Hypothetical oil spills at the locations are initially discussed under the assumption that no spill cleanup countermeasures are employed. The analysis addresses the impacts of four oil types--crude, bunker C, diesel-2, and gasoline; seasons of importance or ice and no-ice; spill size--100 to 50,000 barrels, and spill mode--tanker, barge, drilling rig, pipeline, transfer, ballast, and miscellaneous. Each spill was treated as an "instantaneous" discharge, i.e., all the oil was released in a short time rather than leaking out over a period of hours or days. Subsection B treats impact with the associated changes due to applicable cleanup strategies. Numerical scores are tabulated through an impact matrix, and the sites and spill scenarios are ranked in order from highest impact to least impact. Subsection C ranks the various spill cases in estimated order of impact severity.

Each site is described in regard to its location and its physical and biological characteristics. The following paragraphs are intended as a general introduction to the physical and biological characteristics of Alaska.

PHYSICAL CHARACTERISTICS---ALASKA IN GENERAL

Alaska is bounded on three sides by water--the Pacific Ocean, Bering Sea, and Arctic Ocean. The southern coastline is extremely rugged

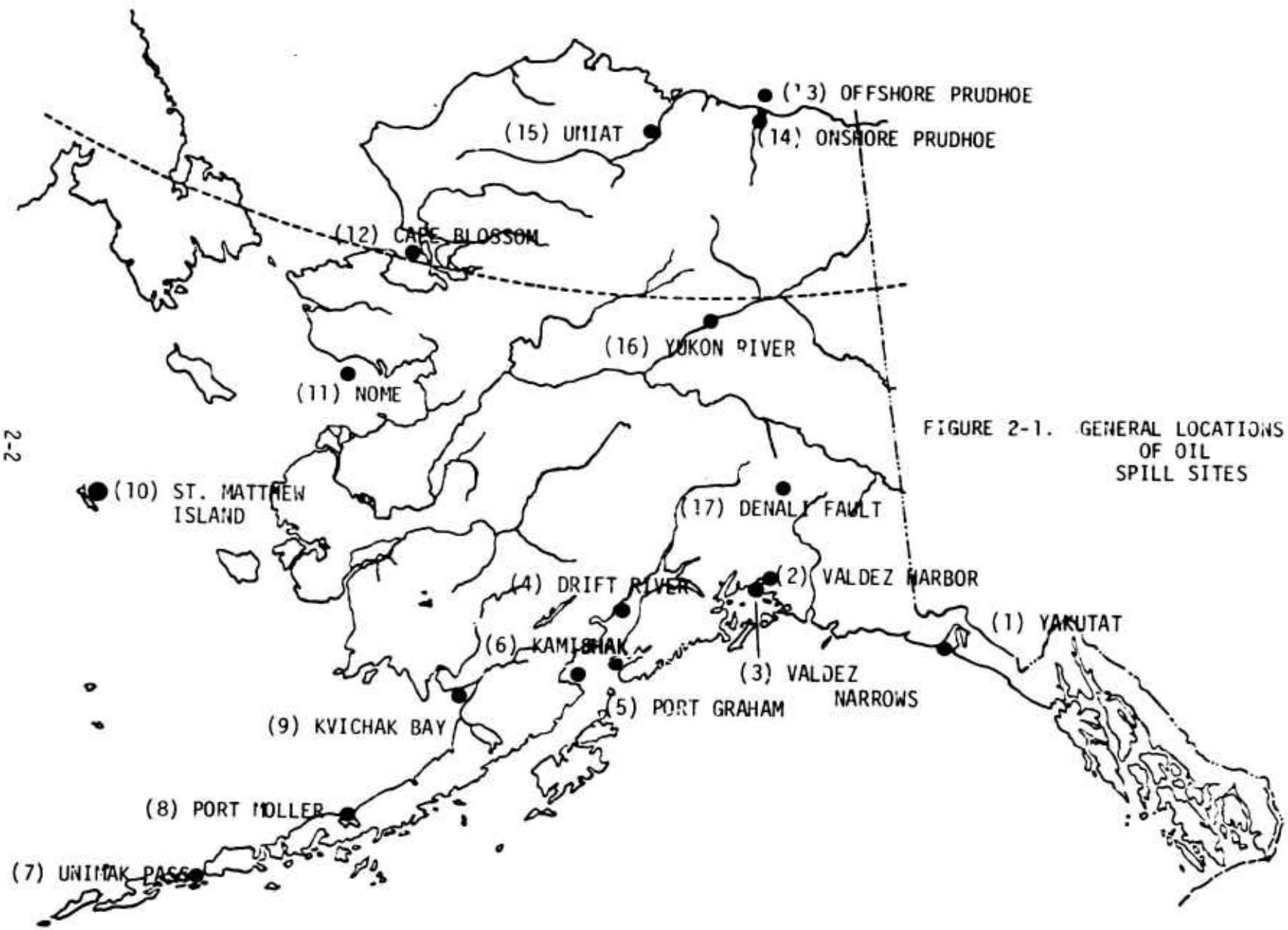


FIGURE 2-1. GENERAL LOCATIONS OF OIL SPILL SITES

with numerous fjords, sounds, bays, and inlets. It is closely bordered by mountains throughout, beginning with the Coast Mountains in the southeast and running through the St. Elias Mountains near Yakutat, the Chugach Mountains near Valdez, the Alaska Range and Kenai Mountains around Cook Inlet, and the Aleutian Range extending down the Alaska Peninsula. In contrast, the North Slope is a broad, gently undulating plain sloping from the foothills of the Brooks Range to the coastline on the Beaufort Sea and Arctic Coast.

The interior is bounded by the Alaska Range to the south, the Kuskokwim, Bendeleben, and Schwatka mountains to the west, and the Brooks Range to the north. The interior is part of the Yukon River Drainage Basin.

The Yukon runs about 1,100 miles from Eagle near the Canadian Border to its delta on Norton Sound. Its major tributaries include the Koyukuk, Porcupine, and Tanana rivers. The Kuskokwim River drains the region between the Kuskokwim Mountains and the Alaska Range. The Kuskokwim and Yukon form a large coastal delta on the Bering Sea, reaching from Norton Sound to Kuskokwim Bay. Other major rivers include the Copper, emptying on the south coast, the Susitna on Cook Inlet, the Nushagak on Bristol Bay, the Kobuk and Noatak at Kotzebue, and the Colville and Sagavanirktok on the North Slope. These major physical features are shown in Figure 2-2.

The climate of Alaska is influenced by topography and proximity to the surrounding seas.[1-4] Four distinct climatic regions have been described[3,4] for Alaska --Maritime, Transitional, Arctic, and Continental. These climatic zones are distinguished by the degree of moderation by exposure to maritime influences. The division of Alaska into the four zones is illustrated in Figure 2-3. The Maritime Zone has the highest precipitation of the four

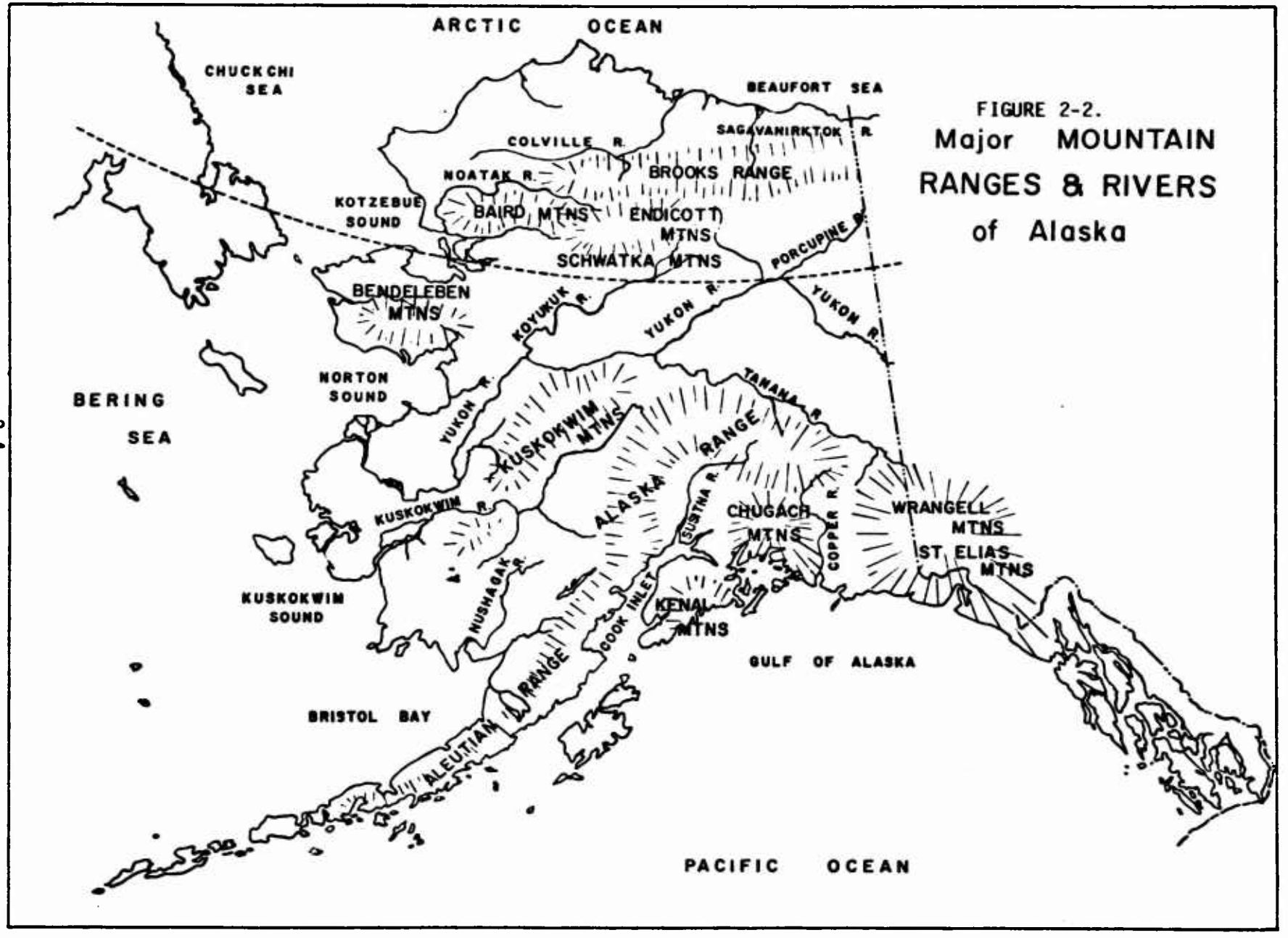
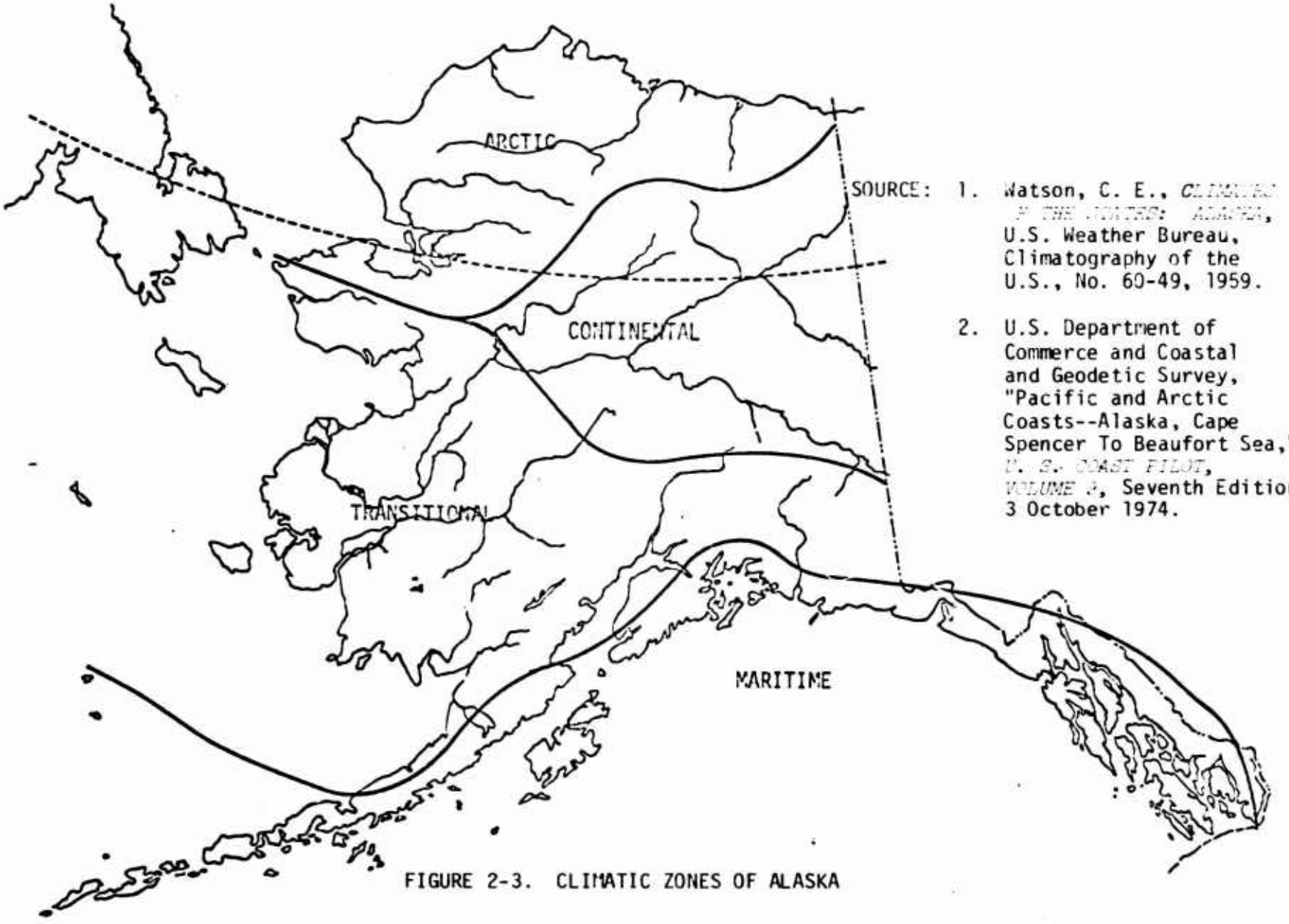


FIGURE 2-2.
Major MOUNTAIN RANGES & RIVERS of Alaska



SOURCE: 1. Watson, C. E., *CLIMATES OF THE UNITED STATES: ALASKA*, U.S. Weather Bureau, Climatography of the U.S., No. 60-49, 1959.

2. U.S. Department of Commerce and Coastal and Geodetic Survey, "Pacific and Arctic Coasts--Alaska, Cape Spencer To Beaufort Sea," *U. S. COAST PILOT, VOLUME 9*, Seventh Edition, 3 October 1974.

FIGURE 2-3. CLIMATIC ZONES OF ALASKA

zones.[1,5] It has the least temperature variation moderated by the proximity to the Pacific Ocean.[1] The Continental Zone has the greatest temperature variation, with hotter Summers and colder Winters than the other zones.[5]

Surface wind data for Alaska[2] exhibit predominant wind directions illustrated in Figure 2-4 during Summer and Figure 2-5 during Winter. Summer and Winter predominant winds for Bristol Bay are illustrated in Figure 2-6.

BIOLOGICAL CHARACTERISTICS - ALASKA IN GENERAL

Alaska is a large and physically diverse state, and the 17 study locations include most of the State except the southeastern panhandle. The flora and fauna of Alaska are just as diverse and have made cataloging the resources of each location a major task. A generally striking feature of most of the locations, particularly the southern ones, is the tremendous abundance of some of the species that man has been able to count or in some way estimate. Many millions of birds and salmon and many thousands of marine mammals inhabit some of these locations.

Generalizations about Alaska's flora and fauna are difficult. However, one can see a decline in diversity of species as the more northern locations are approached. This does not automatically mean a correlated decline in general biological activity, however, as in some of the northern locations the species present have very abundant populations. Another generalization related to the above comments is that ecological systems generally decline in complexity as one moves further north. This is a reflection of the reduced diversity. A general marine flora description is given in Appendix A.

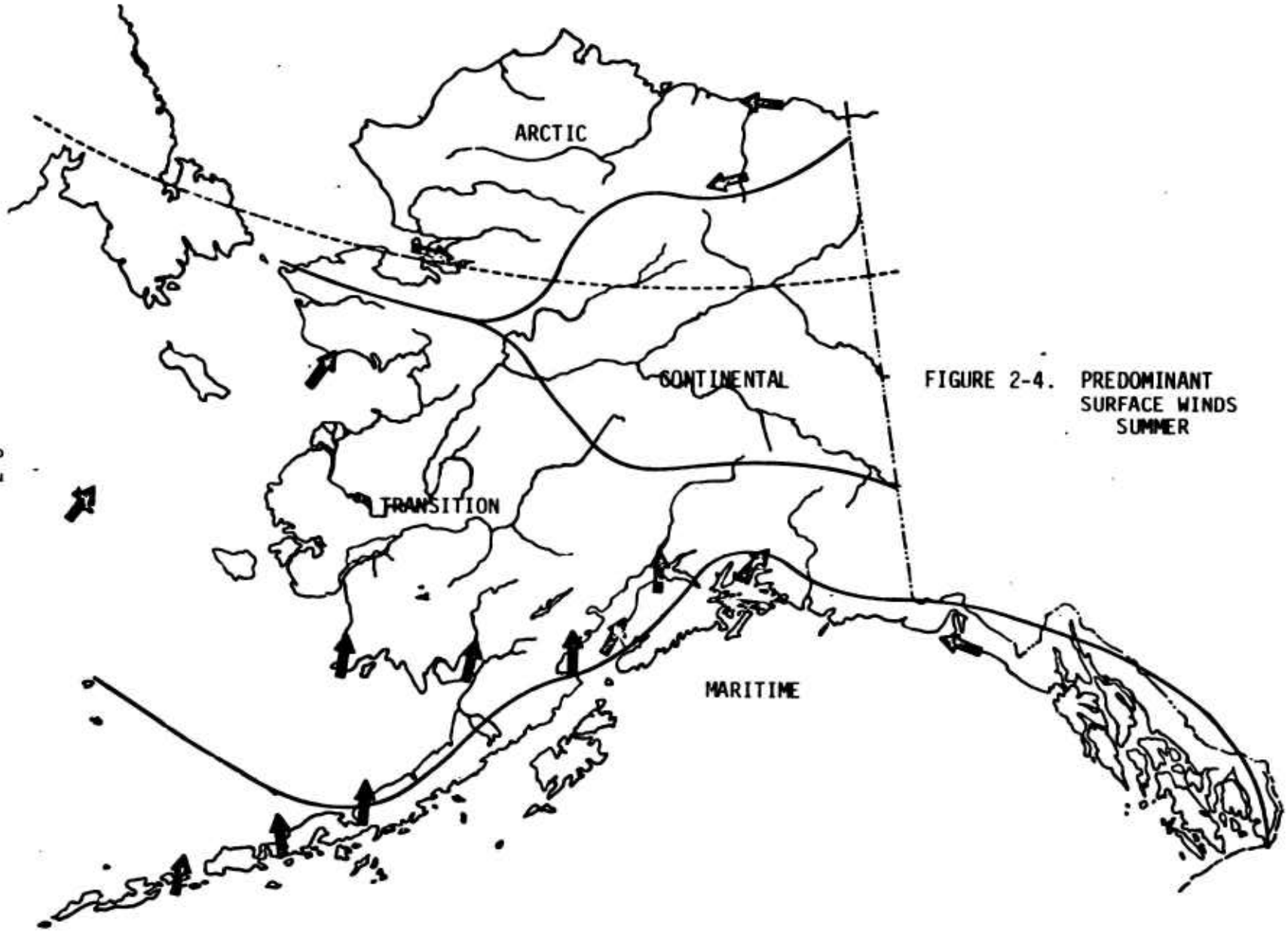


FIGURE 2-4. PREDOMINANT SURFACE WINDS SUMMER

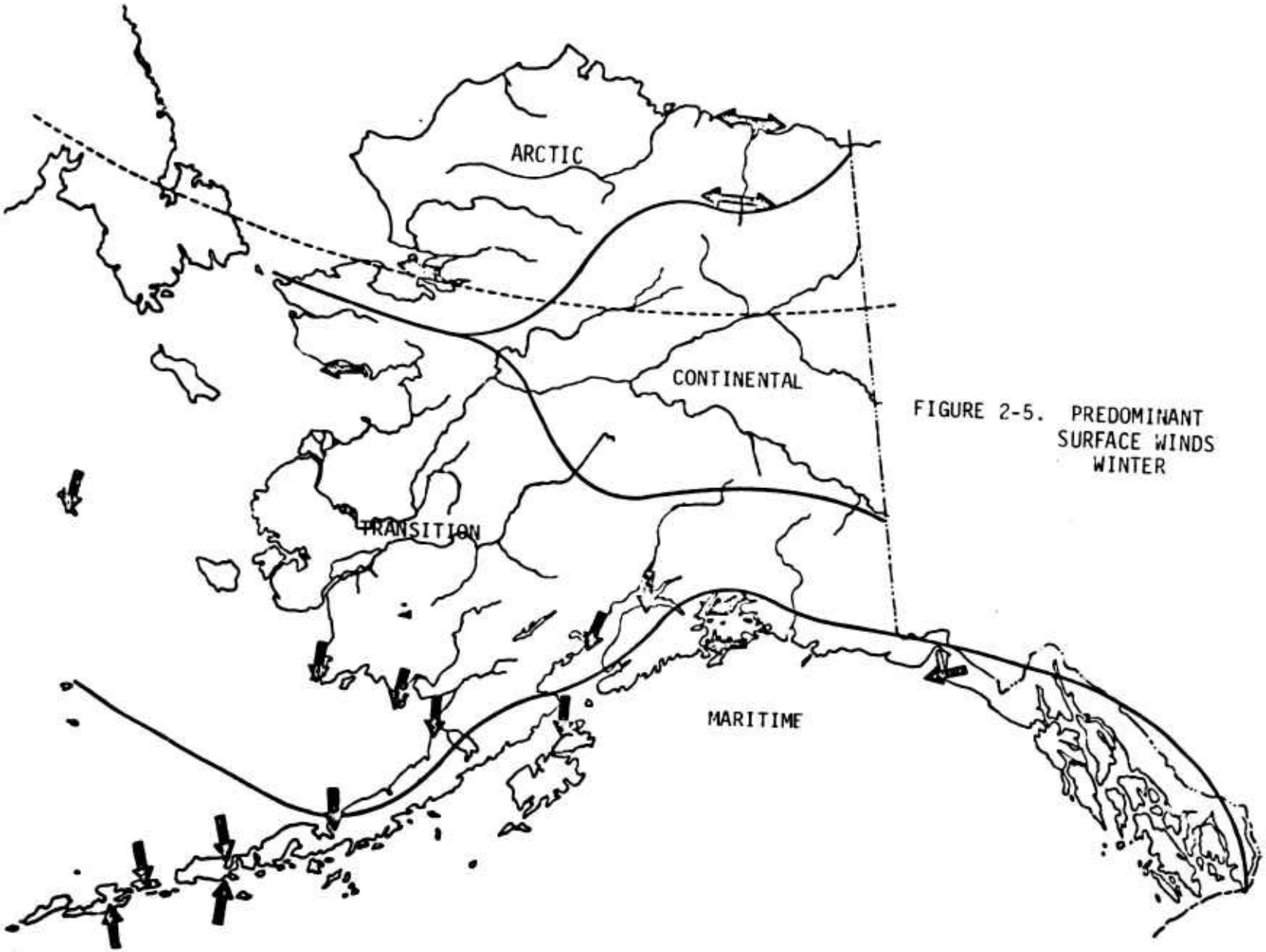
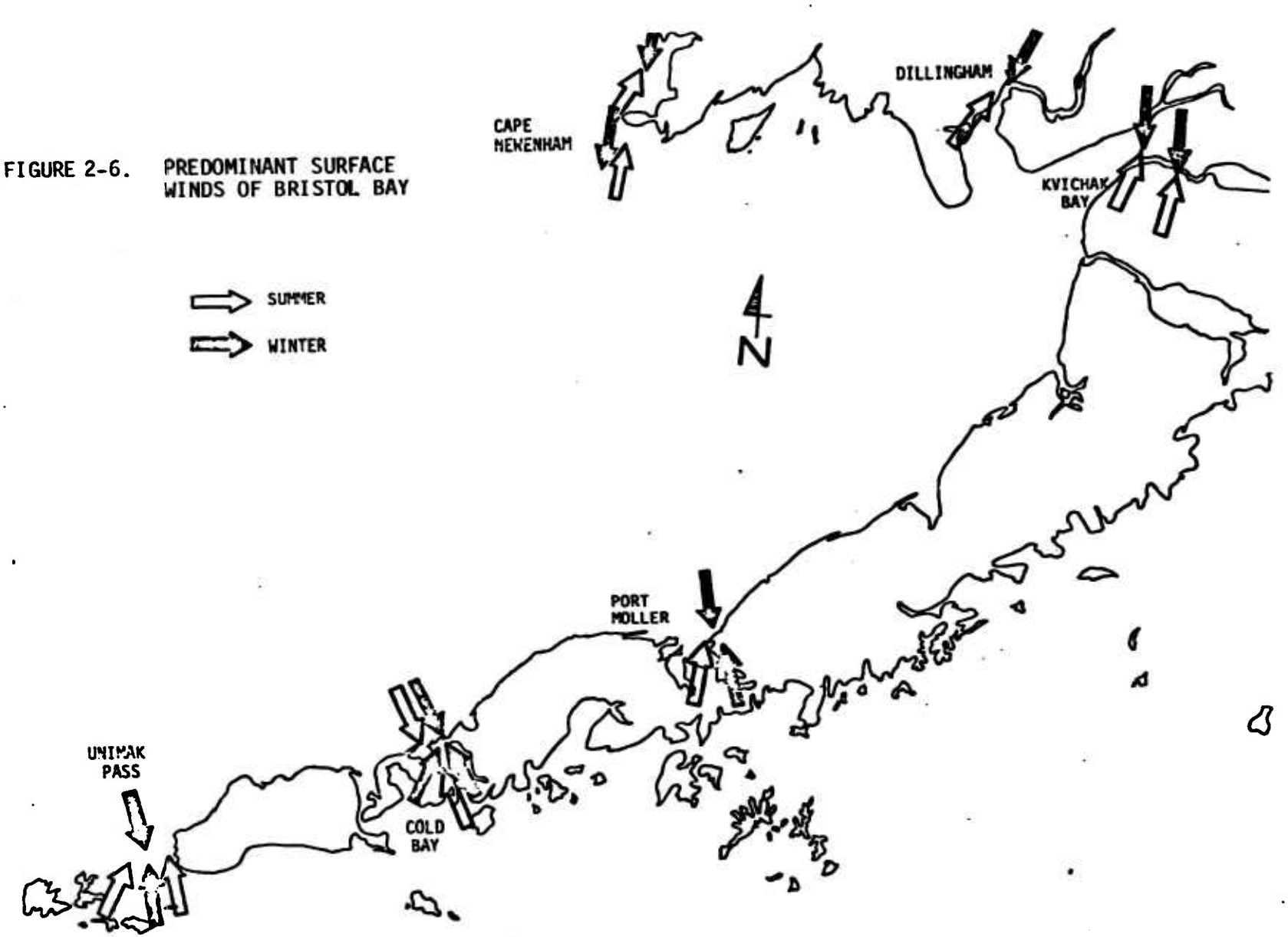


FIGURE 2-5. PREDOMINANT SURFACE WINDS WINTER

FIGURE 2-6. PREDOMINANT SURFACE WINDS OF BRISTOL BAY



In the following text of Section 2, the word "protected" is used with reference to floral and faunal species. In every case, the term is used to indicate a species that has legal protection in the United States. An example is all of the marine mammals which are protected under the Marine Mammal Protection Act of 1972.[44] This Act includes sea otters, seals, and whales, as well as polar bear and Arctic fox. Protected species received a score of 5 in the evaluation matrix (Section 7). Another term used is "endangered species", which are listed in U.S. Fish and Wildlife report.[19] These species received a score of 10 in the evaluation matrix.

SPILL MODES

In order to compare impacts of oil spills on a location-by-location basis, the study was directed to average physical characteristics, instantaneous discharges, single spill events, representative volumes, representative seasons, and representative oil products. In regard to mode of spill, and with the constraints of instantaneous discharge and other factors, it was felt that the modal differences were too small to be analyzed by the method employed. This is not to infer that spill mode is not important for any real spill which may occur. Primary differences of concern are where releases of crude oil or refined products are undetected and/or uncorrected for long time periods. An example of an undetected case could be small discharge from a pipeline. An example of an uncorrected case could be an oil rig discharge under harsh Arctic conditions.

In spite of the assumed equality of spill mode types for analyses purposes of this study, the following list is felt to be a reasonable ranking of spill modes in terms of greatest to least environmental damage:

CRUDE OIL	REFINED PRODUCTS
Drilling Rig Discharge	Tanker Casualty
Pipeline Break or Leak	Barge Casualty
Tanker Casualty	Drilling Rig Accidental Discharge
Miscellaneous Discharge	Miscellaneous Spills
Uncontrolled Tanker Ballast Discharge	Pipeline Break or Leak
Tanker Transfer Operation	Uncontrolled Tanker Ballast Discharge
	Tanker Transfer Operation

IMPACT SCORING

The scoring of impacts that follows in this section results from: (1) the interpretation of oil dispersion modelling results which involves enveloping the computer-plotted spill to give a maximum area of spill influence and the toxicities of the involved oil product; (2) species relative abundance and location, and (3) species relative importance. See Section 7--Matrix Method for Impact Evaluation--for additional details. All figures (i.e., Figures 2-10 and 2-11) showing oil spills at a location are not the computerized plot of the oil spill as shown in Figure 5-7 but a maximum area of influence of the oil spill in the time frame (generally 72 hours) of these evaluations. This maximum area of influence results from an enveloping of the computerized plot (see discussion on p. 2-26).

The time frame of the oil spill scenarios evaluated in the following section was generally assumed to be 72 hours (the time chosen for the computer to plot a scenario) except for gasoline scenarios which were shorter (24 hours). Impacts were judged during this time period with the oil moving in one general direction during the entire scenario. At one location and for two seasons, it is possible that the 72-hour time frame used can result in the seasonal

spills impacting different habitats at a given location. It is also possible that two oil types in two seasons could produce similar effects even though their volumes are different; i.e., a very toxic diesel spill of small volume during Summer and into shallow water area when they are most active biologically may have a similar impact when compared to a larger Winter spill of less toxic crude or bunker C that goes offshore into deeper water that is less biologically active. A Winter oil spill that remained at a location in relatively unaltered form for six months could possibly have an impact ranking approaching the score for that same volume oil spill in the Summer. This is highly unlikely with the physical and biological processes operating to alter the oil, but this illustrates the need to confine impact evaluation to relatively short time windows. The assumed physical and biological conditions at the location for the hypothesized spill also require a restricted time frame.

The location-by-location matrix evaluation that follows presents the results of this investigation. At each location, the cases are presented from the highest scoring case to the lowest scoring case. The scores themselves are relative impact measurements derived from the evaluation matrices. They are useful only in ranking cases as to the estimated severity of environmental impact. Therefore, low scoring cases must not be inferred as insignificant oil spills but as low ranked cases relative to the highest score at a given location. Low ranked cases should be judged as detrimental for the following reasons:

1. Oil spilled is toxic to some life forms in very low concentrations.

2. Oil hydrocarbons may introduce carcinogenic compounds into the environment, either direct or converted.

3. Oil is a scarce resource which should not be wasted.

4. Spilled oil is more costly to clean up per barrel than it is to deliver. (The Metula spill of 52,000 tons crude oil (364,000 barrels) was estimated to cost $25,000,000 to $50,000,000 to clean up. This is equivalent to $68 to $136 per barrel.)

A. RESULTS AT SELECTED LOCATIONS WITHOUT CLEANUP

(1) OFFSHORE YAKUTAT

Yakutat is located on the Gulf of Alaska coast about halfway between Juneau and Valdez. It is on the southeastern end of Yakutat Bay on the coastal flanks of the St. Elias Mountains. The oil spill site is at 59°36'N latitude, 140°1'W longitude, and is slightly less than 4 miles west of Ocean Cape (see Figure 2-7) in the deepest part of the entrance to Yakutat Bay closest to the town of Yakutat.

(a) PHYSICAL CHARACTERISTICS

TEMPERATURES

Yakutat is located in the Maritime Climatic Zone[3,4] and is characterized by moderate temperatures year-round. Average Summer temperatures vary between 42°F and 59°F.[1,8] Winter temperatures vary between 20°F and 35°F.[4,8] Downslope drainage off the St. Elias Mountains can result in wide variations of temperature over short distances.[4] The record high is 86°F and low is -22°F.[4,8]

Sea temperatures normally vary between 40°F and 45°F in the Winter but may vary between 33°F to 50°F.[4] Summer sea temperatures may vary between

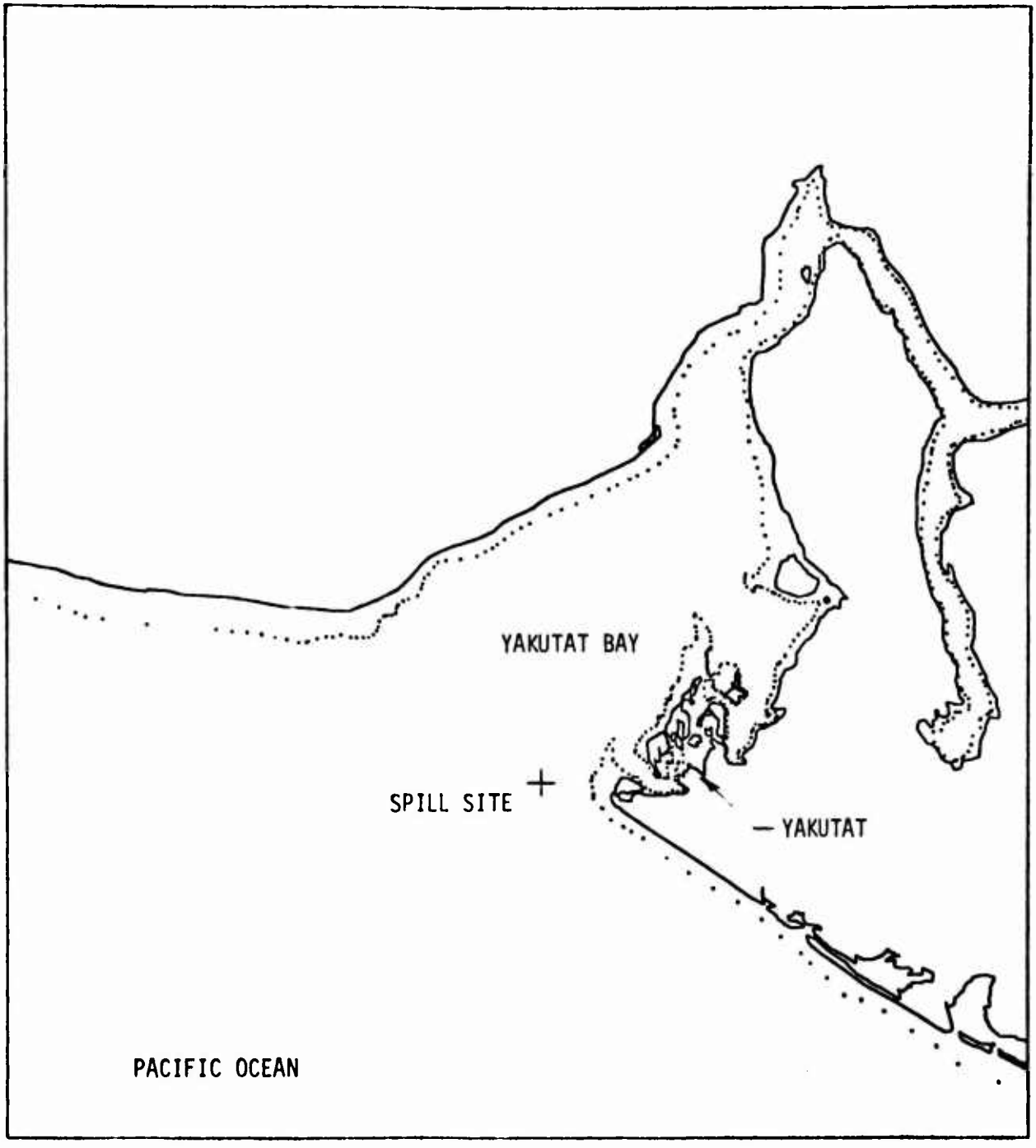


FIGURE 2-7. THE YAKUTAT LOCATION AND SPILL SITE

NOTE: The broken line is the 10 fathom (60 feet) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

45°F to 65°F.[4] Sea ice is not normally present at this location except as bergs from glaciers at the head of Disenchantment Bay.[4,8]

SURFACE WINDS

Yakutat is subject to cyclonic storms which track through the Gulf of Alaska frequently during Fall, Winter, and Spring. Winds are mostly from easterly directions, averaging between 7 and 12 knots in speed.[2] During Summer the winds are more from the east-southeast, interspersed with periods of calm. Representative winds were chosen as east at 9.0 knots in Winter and calm in Summer.

SURFACE CURRENTS

Surface sea currents in the vicinity of Yakutat are not well known. The *COAST PILOT*[8] gave only a diurnal tidal range of 10.1 ft. at Yakutat.

Rosenberg[20] presented information that showed longshore transport off Yakutat Bay trending west-northwest at low velocities. This would agree with a general flow into the Gulf of Alaska forming the Alaskan Gyre farther west.

MSNW assumed surface currents are parallel to the coastline off Yakutat Bay with ebb flow (290°) of 0.2 knots and flood flow (110°) at 0.1 knots. In the Bay itself, MSNW assumed a net outflow at slightly greater velocities due to the constrictions of the Bay. In this area, MSNW assumed surface sea currents to run with the axis of the Bay, itself, with a net outflow due to freshwater input to the upper portions of the Bay. The tidal currents used in Yakutat Bay were ebb (205°) at 0.4 knots and flood (025°) at 0.2 knots. These generalizations were used in the modelling of the spills.

Research in progress in the Gulf of Alaska offshore of Yakutat by the National Oceanographic and Atmospheric Administration (NOAA) and the Gulf of Alaska Operators Committee (consortium of oil companies who hope to drill in

the Gulf's continental shelf) should provide better information in the future as to the tidal and wind driven currents in this area (including Yakutat) .

(b) BIOLOGICAL CHARACTERISTICS

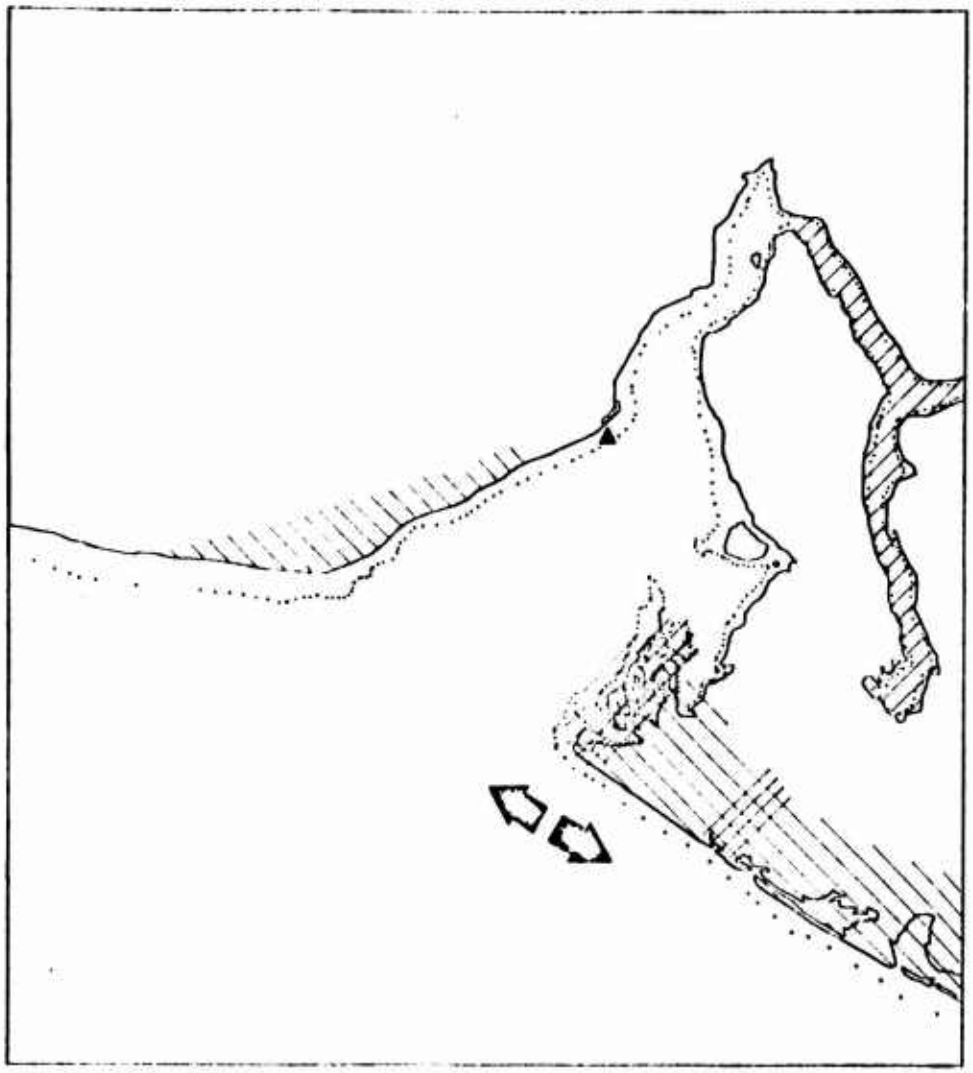
Insufficient biological information exists for Offshore Yakutat vicinity, particularly in the coastal shallow marine and intertidal areas. Basic research on the intertidal area is now underway at Yakutat by National Marine Fisheries Services (NMFS), Auke Bay Laboratory, Alaska. The area is assumed to be fairly rich in resources as is the adjacent Gulf of Alaska area. Resource summaries are shown in Figures 2-8 and 2-9.

FISHES

SALMONIDS - All five species of North American salmon inhabit the vicinity of Yakutat. Sockeye and coho salmon are the most abundant. Estimates [21-23] of salmon abundance (average for 1960 through 1969) are as follows:

SALMON	MEAN
King	6,000
Sockeye	253,000
Coho	333,000
Pink	50,000
Chum	17,000

The timing of the adult runs is thought to be similar to the Bering River District, occurring from June through September. Local spawning populations of sockeye, pink, and coho salmon are found here, with kings and chums in very low abundance. The juveniles move from fresh water in late Spring and early Summer and remain in coastal marine waters until September. Pink



Waterfowl and Seabirds

Nesting-Molting Area

Wintering Area

Major Migration Route

Seabird Colony

FIGURE 2-8. YAKUTAT CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

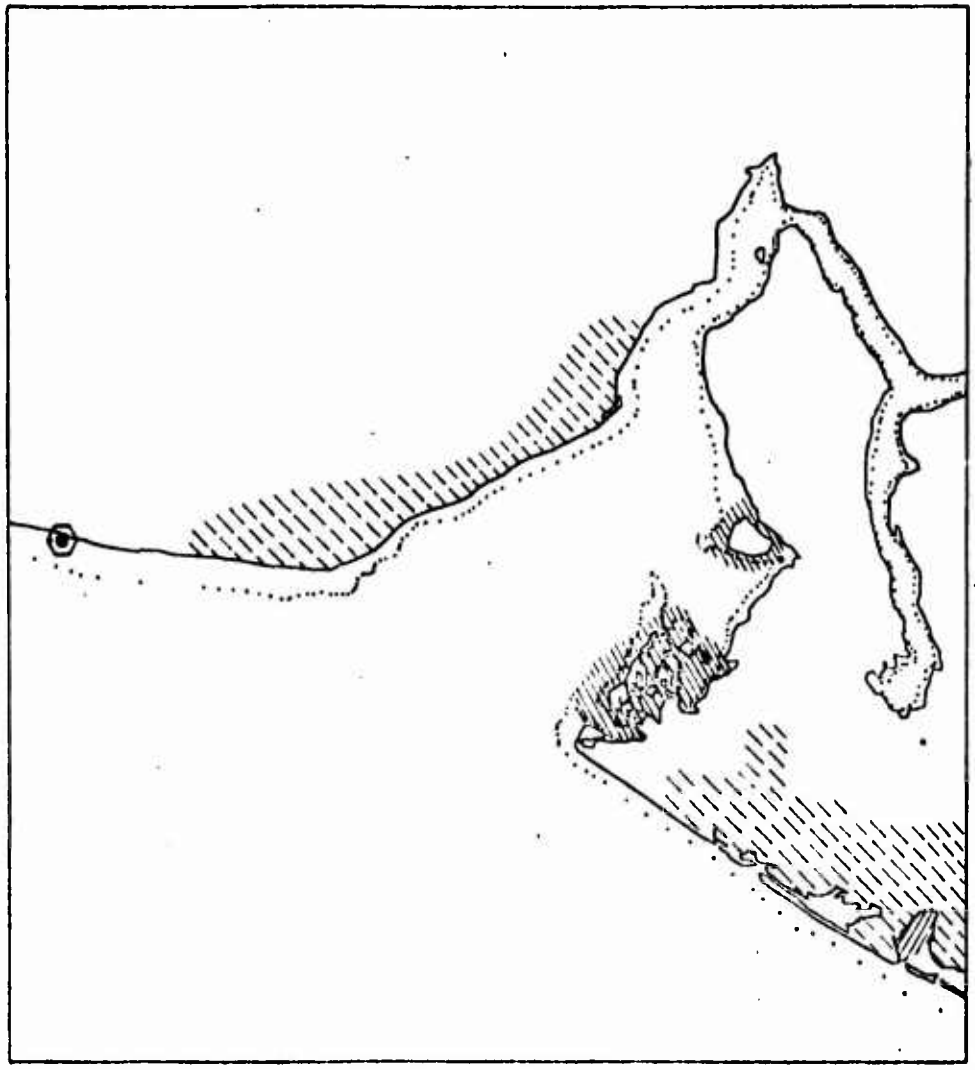


FIGURE 2-9. YAKUTAT CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

salmon juveniles, in particular, probably remain in Yakutat Bay until early September before moving into the Gulf of Alaska.

Dolly Varden are probably abundant in streams and in nearshore marine waters in mid-Summer. Steelhead are also thought to be present.

The migratory habits of adult and juvenile salmonids in the ocean (at or near the surface) are felt to make them vulnerable to oil pollution.

Marine fishes, other than salmon, are not well defined in many locations including Yakutat because a well-established fishery does not presently exist for some species. It is important to realize that commercial operations may start or stop for some marine fishes in any given location in Alaska. The following comments for most marine fishes are based upon limited past and present fisheries. Future potential fisheries were not generally assessed.

PACIFIC HALIBUT are located and fished commercially offshore of this area from May through September, and Yakutat is of moderate importance in landings. Adults spawn in depths of 200 fathoms offshore from December through February. Pelagic eggs and larvae are produced. Juveniles are found on open ocean beaches in small numbers from June through October, with some inside of Yakutat Bay.[13,24]

The adults in deep water are not felt to be directly vulnerable to oil. A Summer-Fall spill could have a severe short-term impact in displacement of adults and mortality to pelagic eggs, larvae, and shallow-water inhabiting juveniles. Long-term impacts are not thought possible with the potential of continued recruitment by pelagic larvae drifting in to the area. Greater long-term impacts could occur with any oil spill damage to food organisms.

OTHER FLATFISH - A variety of other flatfish are located here. Starry flounder are probably numerous in Yakutat Bay, while off the Bay flathead sole are thought to be relatively more numerous. None are now of commercial importance. Some are probably included in the foreign trawl catch. One source [16] showed trace catches of "other" flatfish in this vicinity.

Vulnerability is most probable with the shallower water species such as starry flounder, flathead sole, and butter sole.

OTHER MARINE FISH - International Pacific Halibut Commission (IPHC) catches in this area also included walleye pollock, Pacific tomcod, smelt (eulachon), and cottids (sculpins). [13]

The general vulnerability of this group is quite variable with smelt and tomcod most vulnerable and the sculpins least vulnerable.

SHELLFISHES

KING CRAB are absent. [16]

TANNER CRAB are present in many locations in the Yakutat vicinity. [16] Floating larvae and their surface location increase the vulnerability of this crab with the adults living in deeper waters (see Offshore Port Graham for further life history information).

DUNGENESS CRAB are present in several locations outside of Yakutat Bay and off the east side of the Bay's mouth. [16] The shallow-water habitat of this species and its free-swimming larvae make it quite vulnerable to oil spills on surface waters and in shallow waters (see Offshore Port Graham for further life history information).

SHRIMP are indicated in Yakutat Bay in quantities from trace catches to catches greater than 5,000-lbs per hour of trawling. [16] These animals are probably present year-round. The adult and early life stages are

probably as sensitive to oil pollution as the crab species.[10] Adults make vertical movements in water column which at times place shrimp near the surface and any oil products that might be present.

RAZOR CLAMS are reported at Yakutat.[13] Another source[25] did not report them in a tentative survey report; however, high waves during the sampling period greatly affected this intertidal sampling effort. MSNW assumed razor clams were present and abundant in the intertidal sand/mud habitat and quite vulnerable to oil spills. (See Drift River comments on razor clams.)

SCALLOPS - Weathervane scallops are reported by one source[13] as present. Maturgo[16] indicated that traces to < 200 lbs per hour trawling were taken in NMFS exploratory efforts in this area. A scallop fishery did exist off Yakutat in about 50 to 100 fathoms but is not longer viable.[13] Vulnerability to oil spills was assumed moderate because some oil products could reach the early life stages and adults in shallower waters.

WATERFOWL

Little quantitative information exists for waterfowl at Yakutat. The area is shown as a major waterfowl and seabird migration route by Alaska Department of Fish and Game (ADF&G).[17]

DUCKS - ADF&G[17] list Yakutat as a major migration area for ducks, particularly the intertidal areas and nearshore areas. Untold thousands of ducks are in the entire area during Spring and Fall of the year. Overwintering at Yakutat exists for mallards, some diving ducks, and sea ducks.[17] The area of overwintering includes the southeast shore of Yakutat Bay on both sides of the town of Yakutat.

GEESE also are present during Spring and Fall migration periods. ADF&G [17] estimates 10,000 snow geese and 10,000 Canada geese. Yakutat is also an important overwintering area for large numbers of Canada geese. [17]

SWANS utilize the Yakutat vicinity as an important migration zone (both trumpeter and whistling swans) and a small population of trumpeter swans overwinter in the area. This species is classified as rare and endangered.

SEABIRDS are very numerous with colonies throughout this area. Predominant species include glaucous-winged gulls, pigeon gillemots, and black-legged kittiwakes.[17] Seabirds are assumed to be very sensitive to oil spills.

SHOREBIRDS are numerous at Yakutat on beaches and mud flats but are thought to be less sensitive to direct effects of oil spills as compared to seabirds. However, the food organisms of shorebirds (primarily infauna in beaches and mud flats) are thought to be very susceptible to oil spills. Thus, the indirect effects of oil may be significant. The juvenile shorebirds (Spring season) are also thought to be more sensitive than adults to direct oil spill effects due to their limited mobility.

The entire group of waterfowl is vulnerable to oil spills to the degree that they are dependent on marine waters at Yakutat. (See the waterfowl portion of Section 4 for further comment on the susceptibility of these birds to oil.)

MARINE MAMMALS

SEA OTTERS are not abundant at Yakutat although total numbers are unknown. They were reintroduced in 1966 and have been observed in the Yakutat area.[17] The low population is believed to be increasing.

Pupping peaks in late Spring but may occur at any time of the year. Female otters with dependent pups can, therefore, be in the vicinity year-round.

Otters require insulation (fur) to maintain body temperatures and are felt to be quite sensitive to oil products which mat their fur and cause it to lose its insulating ability. One source[14] believes that most marine mammals can avoid oil slicks. This would seem to be dependent on the magnitude and location of a slick and the amount of occupied sea otter habitat at that location.

HARBOR SEALS are very abundant in the area with heaviest populations in Yakutat Bay.[17] Although now protected, recent past harvest of harbor seals numbered 4,000 to 6,000 per year in this general area.[17] Two areas of high density denoted by ADF&G[17] are west of Yakutat Bay on the open coast at the mouth of Dangerous River and in Dry Bay.

Pupping is known to occur from late May through July in the Chugach Islands at the mouth of Cook Inlet and over 500 miles west of Yakutat.[10]

Harbor seals appear resistant to direct oil impacts but could be affected if food items (including fish) are impacted. Pups are expected to be vulnerable during the first several weeks of life when they possess a fur natal coat (lanugo).

SEA LIONS are present throughout the area with a population of 1,000 at Sitragi Bluffs just off Yakutat Bay and to the west. Sea lion vulnerability to oil appears to parallel harbor seals.

WHALES AND PORPOISES are present at Yakutat, with Dall and harbor porpoises in coastal waters and humpback and finback whales in outer waters.[17] Gray whales migrate through this area. Little direct oil impacts are expected for this group. Indirect impacts via the food web are possible. The porpoises and whales are currently protected in the U.S. and the three whale species are listed as endangered.[19]

TERRESTRIAL MAMMALS

BROWN BEAR are present in this vicinity, but there is no precise estimate of numbers in the area.[17] Hunters take 15 to 20 per year.

BLACK BEAR are present but, again, no population estimates are available. The major concern here is the rare glacier bear-color phase which may be given endangered status in the future.

WOLVES AND WOLVERINES are relatively few in number in this area.[17]

MOOSE are estimated to number 4,000 to 5,000 in the general area, with an annual kill of 30 animals.[17] This herd is said to have the highest productivity of any American moose herd.[17]

SMALL MAMMALS are present in the area in willow flats and marshes.

AQUATIC FURBEARERS (river otter, mink, muskrat, beaver) are present in moderate numbers in the area[18] occupying beaches, estuaries, and marshes. This species will be vulnerable to oil spills which extend into fresh water and/or estuarine areas occupied by these animals. Impact is assumed to parallel those of the sea otter in the marine environment.

The remaining terrestrial mammals do not, as a group, appear particularly vulnerable to direct oil spills. Indirect impacts through the food chain are possible (i.e., impact the salmon eaten by bears) but are not judged to be particularly significant.

Terrestrial mammals may be disturbed by man's activities in monitoring and cleaning up spills. This would include immediate direct disturbance and possibly longer term habitat alteration

FLORA

A number of strand (beach) vegetation species have their northern-most distribution at Yakutat according to Breckon and Barbour.[68] Stair and Pennell[69] reported that small willows and alders also occur near the shore. Based on the digitized shoreline substrate data assumed in spill modeling, about 55 percent of the shoreline within a 50-km square of the spill site might be covered with strand vegetation in Summer. Strand vegegation should be absent in Winter months.

Terrestrial vegetation is not expected to be significantly affected by the spill specified for Yakutat.

MSNW did not find published reports of eelgrass occuring in this area; however, because this species is commonly found north and south of Yakutat[70] and the exposure would appear to favor some eelgrass bed formation, it is assumed that 18 percent of the area, which is sandy, is occupied by this species. Likewise, there are no studies of marine algal vegetation from this area, but the vegetation is assumed to be like the south Alaskan phytogeographical area (see Appendix A). In the Summer, 45 percent of the intertidal and 45 percent of the shallow subtidal bottom areas would be

covered with vegetation. As much as 25 percent of the surface might be occupied by floating kelp beds. In Winter, 13 percent of the intertidal and 22 percent of the shallow subtidal bottom would be covered, while floating kelp would be lacking. According to Tarr and Martin[71] (also see Brongersma-Sanders[72]), this area has been disturbed in the past by elevation changes resulting from earthquakes which have caused extensive marine algal mortalities.

Further details on the physical and biological characteristics for this location are given in Appendix D.

(c) RESULTS

As a consequence of the calm winds and slow currents encountered at Yakutat in the Summer, the spilled oil products reached the shore quite slowly. The Winter conditions, on the other hand, caused the slick to move out into the Gulf of Alaska and not reach land at all. This resulted in totally different Summer and Winter scenarios which makes meaningful comparisons between them impossible.

The greatest impact score at Yakutat was the result of the 50,000-bbl spill of diesel-2 in the Summer. While gasoline spread faster and was comparably toxic, it produced lower scores due to the short life of the spill.

The pelagic habitat contributed 41 percent of the Summer impact with salmon, smelt, and herring being impacted significantly. Shrimp were also heavily impacted in this scenario.

In the Winter cases, herring, smelt, seabirds, shrimp, and scallops contributed heavily to the overall score.

The 10,000-bbl spills of diesel-2 and crude oil also had significant impacts in both the Summer and the Winter cases.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Yakutat. The first scenario, using most probable Summer conditions resulted in oil being primarily dispersed through the spreading dynamics of the spill product rather than wind and current. This scenario used calm as the most probable wind condition and the currents offshore from Yakutat in the Gulf of Alaska were less than one knot. The spreading of diesel-2 reached shore at Ocean Cape in approximately 36 hours and of crude oil in 48 hours. Gasoline and bunker C were judged to not reach the shoreline during the time period examined. The second scenario, using most probable Winter conditions resulted in oil moving in a westerly direction into the Gulf of Alaska parallel to the bluff across Yakutat Bay from Yakutat. This scenario did not impact either intertidal areas or land. The differing habitat impacts and spill trajectories make cross-seasonal comparisons at this site almost meaningless. Summer scenario cases will be compared within themselves, as will Winter cases. Cases will be discussed successively from highest to lowest impact scores. See Figures 2-10 and 2-11 for oil trajectories.

The spill areas, and their time history, were determined using the spreading and dispersion model discussed in Chapter 5. It is recognized that many variables may influence the accuracy of such spill area predictions; for example, uncertainty of the climatic/oceanic variables (wind, current, etc.), as well as uncertainty of physical/chemical property changes with time, temperature, and other environmental factors. Consequently, to estimate most probable scenarios for evaluating impact at Yakutat and following locations, an "enveloping" approach was selected. Enveloping involves the application of multipliers to the calculated slick dimensions at a given instant of time, and hence is an estimate of the maximum likely impacted area at a specific time.

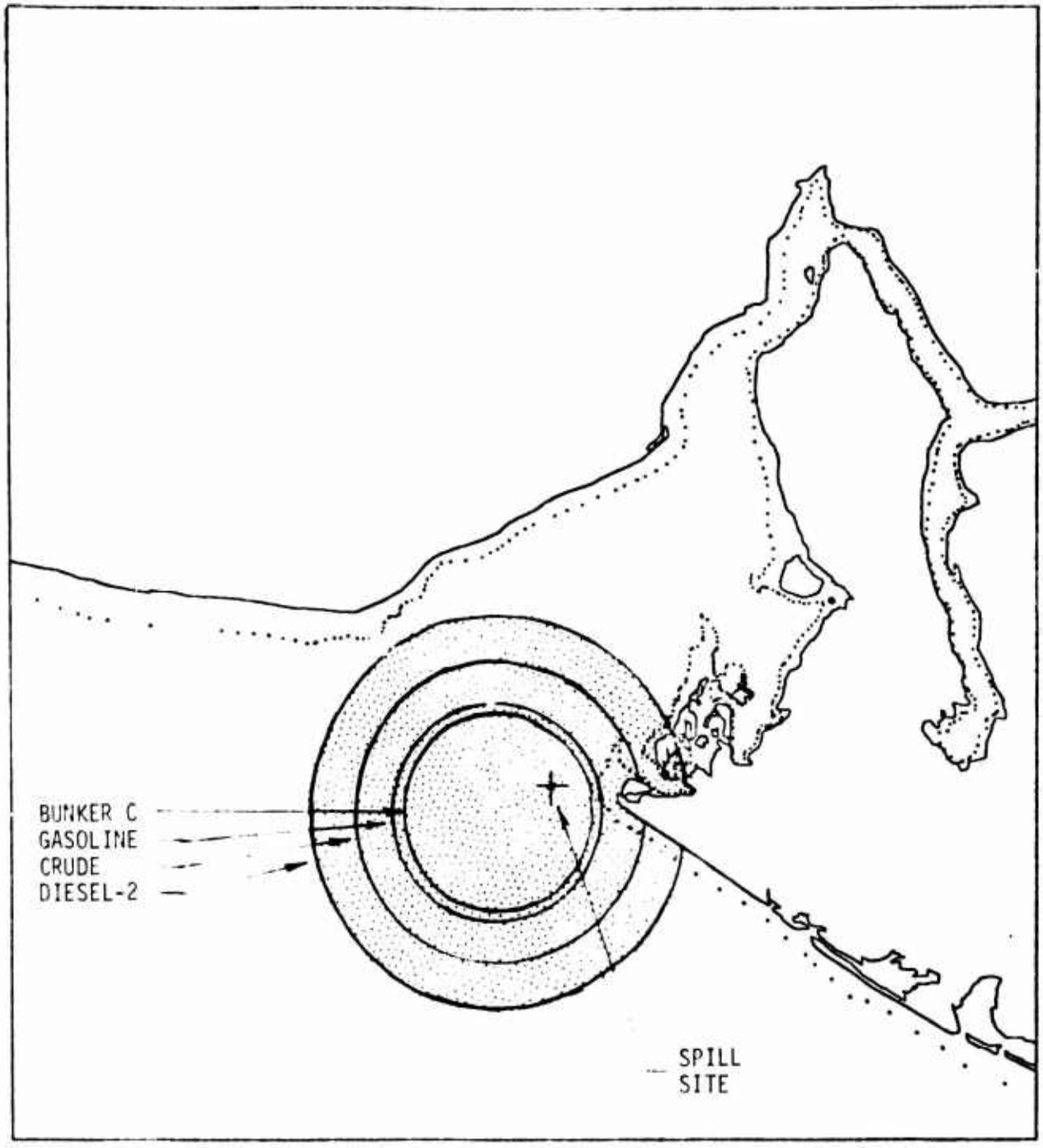


FIGURE 2-10 YAKUTAT SUMMER 50,000 BBL SPILL ENVELOPES

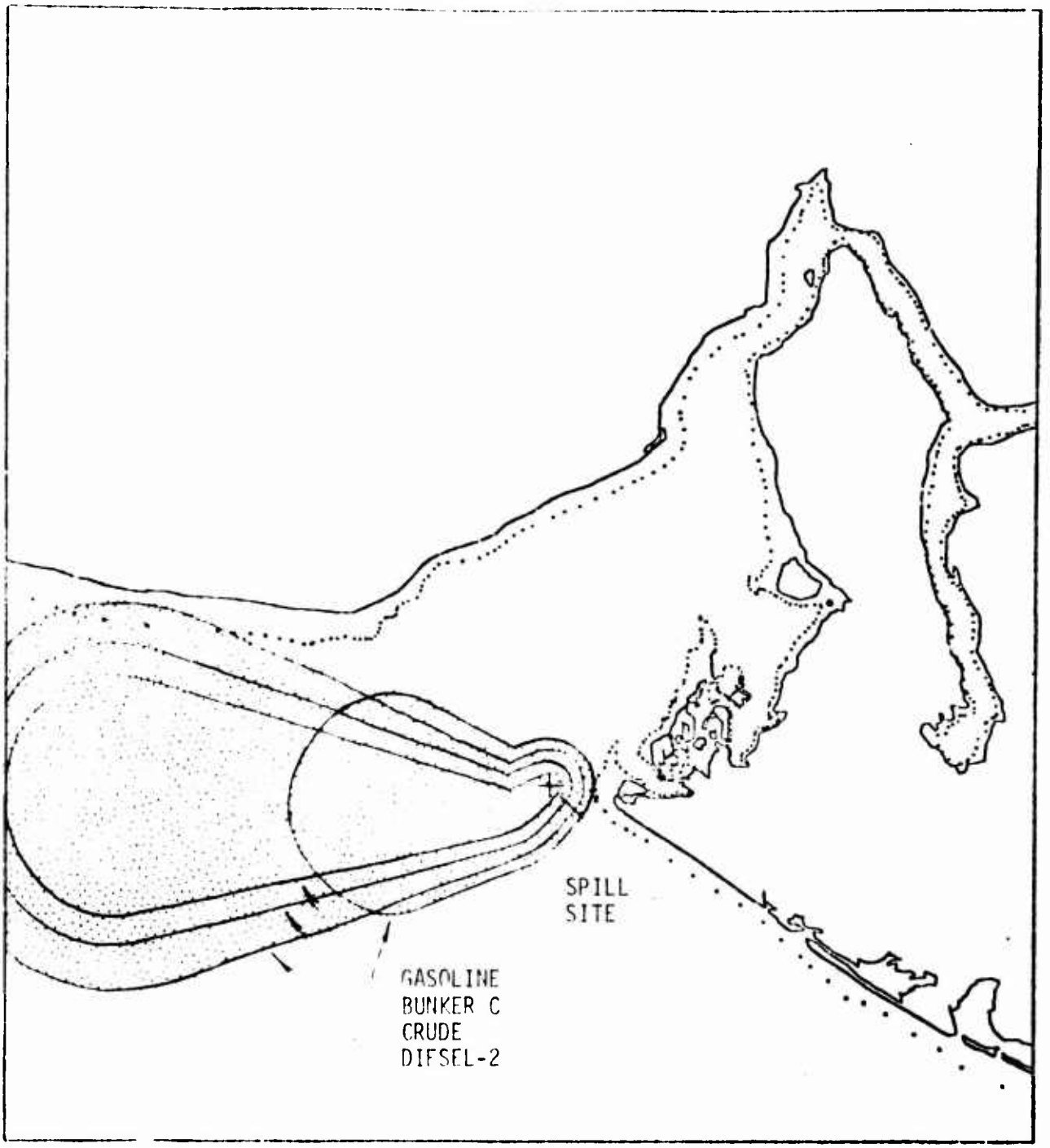


FIGURE 2-11 YAKUTAT WINTER 50,000 BBL SPILL ENVELOPES

Since the different generic oil types (bunker C, crude, diesel, gasoline) exhibit different behavior in spreading, evaporation, dissolution, and transport, a different factor for each type was judged appropriate. The factors of 2 for bunker C, 3 for crude, 4 for diesel, and 5 for gasoline reflect primarily increased viscosity and cohesiveness of the slick, but also differences in evaporation and dissolution properties influencing toxicity. It must be emphasized that the areal extent of the envelope does not represent an area covered by a specific spill, but rather that the spill (of the size calculated by the model) is equally likely to be located in, or have passed over, any region included in the envelope.

CASE DISCUSSION

Table 2-1. presents the results of the oil spill scenarios examined at Yakutat without cleanup.

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 11,351

THE PELAGIC HABITAT contributed 41 percent (4,639)* of the impact score for this case. For this case and following cases with Impact Scores at all sites, those species which were judged to receive the highest impacts in each habitat will be listed. The discussion for the highest cases (one case at a minimum foreach site) will describe the abundance, importance, and impact ratings which were contributory in these species high impact scores. Phytoplankton (164), zooplankton (164), ichthyoplankton (182), Pacific sandlance (164), herring (193), smelt (193), crab larvae (193), sockeye salmon (290),

*Figures in parentheses are the impact scores for the habitat of species being discussed. Some species are present in more than one habitat.

TABLE 2-1. YAKUTAT CASE RESULTS NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000[1]	1,000[1]	100[1]
SUMMER	Diesel-2	11,351 [1][2]	8,357 [2]	3,899 [5]	729 [16]
	Crude Oil	6,583 [3]	4,565 [4]	2,302 [8]	275 [22]
	Bunker C	1,950 [10]	1,101 [14]	638 [17]	134 [25]
	Gasoline	535 [18]	337 [21]	91 [29]	13 [31]
WINTER	Diesel-2	3,111 [6]	2,704 [7]	1,616 [12]	270 [23]
	Crude Oil	2,056 [9]	1,186 [13]	453 [20]	97 [28]
	Bunker C	1,633 [11]	922 [15]	534 [19]	113 [27]
	Gasoline	200 [24]	126 [26]	34 [30]	5 [32]

[1]Scores for all spills less than 50,000 barrels are estimated. See Case 2 below.

[2]Numbers in brackets are the case numbers that follow.

coho salmon (1,450), and seabirds (1,290) were major contributors in this habitat. Ichthyoplankton, coho salmon and seabirds were among the most abundant species in this habitat. Sockeye and coho salmon were rated moderate and herring minor in commercial importance in this habitat. Sockeye and coho salmon were rated minor in recreational importance in this habitat. Herring and the salmon were rated minor in subsistence importance in this habitat. All of these species were judged to be among the most sensitive to a diesel-2 spill in this habitat. Seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 32 percent (3,663) of the impact score for this case. Dungeness crab (387), shrimp (2,700), razor clam (109), and other marine invertebrates (164) were the major contributors in

this habitat. All species were among the most abundant in this habitat. Dungeness crab were rated minor in commercial and subsistence importance and shrimp were rated moderate in commercial importance. The crab and shrimp were judged to be the most sensitive to a diesel-2 spill in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (1,245) of the impact score for this case. Pacific halibut (144), walleye pollock (144), tanner crab (219), scallops (364), and other marine invertebrates were the major contributors in this habitat. These species were the most abundant in this habitat. Halibut and pollock were rated moderate, and crab and scallops were rated minor in commercial importance; pollock and halibut were rated minor in commercial and subsistence importance; crab and scallops were rated minor in subsistence importance in this habitat. Crab, scallops, and invertebrates were judged to be among the most sensitive to a diesel-2 spill in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 7 percent (773) of the impact score for this case. Razor clam (128) and shorebirds (300) were the major contributors in this habitat. Shorebirds were the most abundant species in this habitat. Razor clams were rated minor in recreational importance and moderate in subsistence importance in this habitat. Both species were among the most sensitive to a diesel-2 spill in this habitat. Shorebirds were classified as protected.

THE INTERTIDAL ROCKY HABITAT contributed 1 percent (167) of the impact score in this case. No species was a major contributor to the impact score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (702) of the impact score in this case. Smelt (193), hardshell bivalves (193), and shorebirds (128) were the major contributors in this habitat. Shorebirds were the most abundant species in this habitat. Hardshell bivalves were rated minor in recreational importance, and, along with smelt, were rated minor in subsistence importance. Smelt and bivalves were judged to be among the most sensitive to a diesel-2 spill in this habitat. Shorebirds were classified as protected.

THE TERRESTRIAL HABITAT contributed 1 percent (162) of the impact score in this case. No species was a major contributor to the impact score in this habitat.

Table 2-2. presents the complete results for Case 1.

CASE 2: SUMMER, DIESEL-2, 10,000 BBLS - ESTIMATED SCORE 8,357

Cases having Estimated Scores were not evaluated by using the matrix, but were estimated by extrapolating the results of similar cases either at the same spill location or at other locations judged to be comparable by the study team. Habitat and species scores for these cases were estimated in the same manner. Cases with Estimated Scores will be discussed internally, without cross comparison to cases with Impact Scores.

THE PELAGIC HABITAT contributed 41 percent (3,415) of the score for this case. Ichthyoplankton, herring, smelt, crab larvae, sockeye salmon, coho salmon, and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 32 percent (2,697) of the score for this case. Dungeness crab and shrimp were judged to be the major contributors to the score in this habitat.

TABLE 2-2. IMPACT MATRIX--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	YAKUTAT
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	H	0	0	0	3	9	1	162	18	464
2. ZOOPLANKTON	6	H	0	0	0	3	9	1	162	18	164
3. ICHTHYOPLANKTON	10	E	0	0	0	2	9	1	180	20	182
4. FLOATING SEAWEED	3	H	0	0	0	2	1	0	6	0	6
5. GREENLING	3	E	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	6	E	0	0	0	3	9	1	162	18	164
7. HERRING	3	E	1	0	0	3	9	1	108	96	197
8. SMELT	3	A	0	0	1	3	9	1	108	96	197
9. CRAB LARVAE	6	E	0	0	0	3	9	1	108	96	197
10. KING SALMON	1	A	1	1	1	2	9	1	45	40	81
11. CHUM SALMON	1	A	1	1	1	2	9	1	45	40	81
12. SOCKEYE SALMON	3	A	2	1	1	2	9	1	162	144	290
13. PINK SALMON	1	A	1	1	1	2	9	1	45	40	81
14. COHO SALMON	15	A	2	1	1	2	9	1	810	720	1458
15. RAINBOW-STEELHEAD TROUT	1	E	0	1	1	1	9	1	27	24	49
16. DOLLY VARDEN	3	E	0	0	1	1	9	1	54	48	97
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	15	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	3	A	0	0	0	5	0	0	0	0	0
24. WHALES	6	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	1	A	0	0	0	5	4	0	20	0	20
27. OTHER MARINE MAMMALS	1	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	5	9	8	675	600	1298
									2007	2018	4639
2. SUBTIDAL SAND-MUD											
1. COD	6	A	2	1	1	2	1	0	36	0	36
2. SCULPINS	6	A	0	0	0	2	4	1	48	12	61
3. STARRY FLOUNDER	6	A	1	0	0	2	1	0	12	0	12
4. OTHER FLATFISH	6	A	1	0	0	2	1	0	12	0	12
5. PACIFIC SANDLANCE	6	E	0	0	0	3	4	1	72	18	77

TABLE 2-2. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	6	A	0	0	0	2	4	0	44	0	44
7. DUNGENESS CRAB	6	A	1	0	1	2	4	4	216	192	384
8. SHRIMP	6	A	2	0	0	3	4	27	270	810	2700
9. RAZOR CLAM	6	A	0	0	0	2	4	1	104	12	100
10. OTHER BIVALVES	3	M	0	0	1	1	4	1	54	6	55
11. OTHER MARINE INVERTEBRATES	6	M	0	0	0	3	4	1	162	18	164
									1050	1068	3647
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	3	M	0	0	0	2	1	0	6	0	0
2. SUBTIDAL SEAWEED	3	M	0	0	0	2	1	0	6	0	6
3. CHUM SALMON	1	A	1	1	1	2	4	1	45	5	45
4. PACIFIC HALIBUT	6	A	2	1	1	2	4	0	144	0	144
5. OTHER FLATFISH	3	A	1	0	0	2	4	0	36	0	36
6. GREENLING	1	M	0	0	0	2	4	0	8	0	8
7. ROCKFISH	3	M	1	0	1	2	4	4	48	0	48
8. WALLEYE POLLOCK	6	A	2	1	1	2	4	0	144	0	144
9. OTHER MARINE FISH	3	M	0	0	0	2	4	0	24	0	24
10. KING CRAB	1	A	1	0	1	2	4	1	36	4	36
11. TANNER CRAB	6	A	1	0	1	2	4	1	216	24	219
12. SCALLOPS	10	A	1	0	1	2	4	1	360	40	364
13. OTHER MARINE INVERTEBRATES	6	M	0	0	0	3	4	1	162	18	164
									1235	91	1245
4. INTERTIDAL SAND-MUD											
1. PACIFIC HERRING	6	E	0	0	0	3	4	1	72	18	77
2. RAZOR CLAM	6	A	0	1	2	2	4	1	120	30	128
3. SOFTSHELL BIVALVES	6	M	0	1	0	2	4	1	72	18	77
5. INVERTEBRATE INFAUNA	6	M	0	0	0	3	4	1	72	18	77
7. SHOREBIRDS	15	P	0	0	0	5	4	0	300	0	300
8. SEALS	6	A	1	2	0	1	1	0	24	0	24
9. DUCKS	6	A	1	2	0	2	1	0	30	0	30
10. SWANS	6	A	0	0	0	4	1	0	60	0	60
									750	84	773
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	M	0	0	0	3	1	0	9	0	9
2. HERRING	3	E	1	0	0	2	4	1	36	9	36

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TABLE 2-2. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
4. SESSILE MARINE INVERTEBRATES	3	H	0	0	0	1	4	0	12	0	12
5. MISC. CRUSTACEANS	3	H	0	0	0	2	4	0	24	0	24
6. OTHER INVERTEBRATES	3	H	0	0	0	3	4	0	36	0	36
7. GASTROPODS	6	P	0	0	0	5	1	0	30	0	30
8. SEA DUCKS	6	A	0	0	1	2	1	0	18	0	18
9. MARINE MAMMAL HOOKERIES	3	A	0	0	0	5	0	0	0	0	0
									165	0	165
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL CRAWLERS	3	H	0	0	0	3	1	0	0	0	0
2. CRAB	3	A	0	0	1	3	9	8	108	96	107
3. MEROSHELL BIVALVES	3	H	0	1	1	3	9	8	108	96	107
4. CRUSTACEANS	3	H	0	0	0	3	9	8	54	48	97
5. GASTROPODS	3	H	0	0	0	3	9	1	81	9	82
6. SHOREBIRDS	6	P	0	0	0	5	4	1	120	30	129
									480	279	722
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	1	E	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	1	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	1	1	1	3	0	0	0	0	0
4. CHUM SALMON	1	A	1	1	1	3	0	0	0	0	0
5. SOCKEYE SALMON	3	A	2	1	1	2	0	0	0	0	0
6. PINK SALMON	1	A	1	1	1	2	0	0	0	0	0
7. COHO SALMON	15	A	2	1	1	2	0	0	0	0	0
8. RAINBOW/STEELHEAD TROUT	1	E	0	1	1	1	0	0	0	0	0
9. DOLLY VARDEN	1	E	0	0	1	1	0	0	0	0	0
12. PIKE	1	E	0	0	0	1	0	0	0	0	0
13. STICKLEBACKS	1	E	0	0	0	3	0	0	0	0	0
14. OTHER FISH	1	H	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	0	2	1	2	0	0	0	0	0
16. GEESE	15	A	0	2	1	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	0	0	0	0	0	0
18. RIVER OTTER	3	P	2	0	0	1	0	0	0	0	0
19. MINK	3	P	2	0	0	1	0	0	0	0	0
20. MUSKRAT	3	P	2	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	P	2	0	0	1	0	0	0	0	0
									0	0	0

TABLE 2-2. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RELT.
B. TERRESTRIAL											
2. BIRCH-ASPEN VEGETATION	3	M	0	0	0	2	0	0	0	0	0
3. STUNTED VEGETATION	1	M	0	0	0	1	1	0	1	0	1
4. OTHER VEGETATION	10	A	2	0	0	2	1	0	40	0	40
5. BROWN BEAR	6	A	1	1	0	2	0	0	0	0	0
6. BLACK BEAR	6	A	2	2	0	5	0	0	0	0	0
7. WOLVERINE	6	A	0	0	0	1	1	0	6	0	6
8. WOLF	6	A	0	0	0	1	0	0	0	0	0
9. MOOSE	6	A	0	3	2	2	0	0	0	0	0
10. DEER	8	A	0	2	2	2	0	0	0	0	0
15. GOATS	1	A	0	1	0	1	0	0	0	0	0
16. OTHER MAMMALS	10	A	0	0	0	2	4	0	20	0	20
17. RAPTORS	15	A	0	3	0	5	1	0	75	0	75
18. PTARMIGAN	6	A	0	1	0	2	0	0	0	0	0
19. OTHER BIRDS	10	A	0	0	0	2	1	0	20	0	20
									162	0	162
									6745	3549	11751

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (917) of the score for this case. Tanner crab, scallops and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 7 percent (569) of the score for this case. Shorebirds were judged to be the major contributor to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 2 percent (123) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (517) of the score for this case. Smelt and hardshell bivalves were judged to be the major contributors to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 1 percent (119) of the score for this case. No species was judged to be a major contributor to the score in this case.

CASE 3: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 6,583

THE PELAGIC HABITAT contributed 34 percent (2,238) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 1 is accounted for by the following species:

Harbor Seal	increased	to	75	from	0
Phytoplankton	reduced	to	77	from	164
Zooplankton	reduced	to	77	from	164
Ichthyoplankton	reduced	to	85	from	182
Greenlings	reduced	to	0	from	240
Pacific Sandlance	reduced	to	18	from	164
Smelt	reduced	to	109	from	193

King Salmon	reduced	to	21	from	81
Chum Salmon	reduced	to	21	from	81
Sockeye Salmon	reduced	to	77	from	290
Pink Salmon	reduced	to	21	from	81
Coho Salmon	reduced	to	383	from	1,450
Seabirds	reduced	to	683	from	1,208

THE SUBTIDAL SAND/MUD HABITAT contributed 26 percent (1,683) of the impact score for this case. The change in impact score for this habitat from Case 1 is accounted for by the following species:

Cods	increased	to	153	from	36
Sculpins	increased	to	109	from	51
Pacific Sandlance	increased	to	164	from	77
Razor Clam	increased	to	193	from	109
Other Bivalves	increased	to	97	from	55
Other Flatfish	increased	to	77	from	18
Shrimp	reduced	to	273	from	2,700

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (1,781) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 1 is accounted for by the following species:

King Crab	increased	to	64	from	36
Tanner Crab	increased	to	387	from	219
Scallops	increased	to	644	from	364

THE INTERTIDAL SAND/MUD HABITAT contributed 9 percent (561) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 1 is accounted for by the following species:

Ducks	increased	to	120	from	30
Shorebirds	reduced	to	75	from	300

THE INTERTIDAL ROCKY HABITAT contributed 3 percent (165) of the impact score for this case. With a minor exception, this habitat's result was the same as for Case 1.

THE TERRESTRIAL HABITAT contributed 1 percent (41) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Other Mammals	reduced	to	0	from	20
Raptors	reduced	to	0	from	75
Other Birds	reduced	to	0	from	20

CASE 4: SUMMER, CRUDE OIL, 10,000 BBLS - ESTIMATED SCORE 4,565

THE PELAGIC HABITAT contributed 34 percent (1,552) of the score for this case. Herring, crab larvae, coho salmon, and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 26 percent (1,167) of the score for this case. Dungeness crab, shrimp, and razor clams were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (1,235) of the score for this case. Tanner crab, scallops, and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 9 percent (389), THE INTERTIDAL SAND/MUD HABITAT contributed 2 percent (114), THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 2 percent (79), and THE TERRESTRIAL HABITAT contributed 1 percent (28) of the score for this case. No species in any of these habitats were judged to be major contributors to the score in this case.

CASE 5: SUMMER, DIESEL-2, 1,000 BBLS - ESTIMATED SCORE 3,899

THE PELAGIC HABITAT contributed 41 percent (1,593) of the score for this case. Sockeye salmon, coho salmon, and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 32 percent (1,258) of the score for this case. Dungeness crab and shrimp were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (428) of the score for this case. Tanner crab and scallops were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 7 percent (265) of the score for this case. Shorebirds were judged to be the major contributor to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 1 percent (57), THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (241), and THE TERRESTRIAL HABITAT contributed 1 percent (56) of the score for this case. No species in any of these habitats was judged to contribute significantly to the score.

CASE 6: WINTER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 3,111

THE PELAGIC HABITAT contributed 39 percent (1,215) of the impact score for this case. Herring (193), smelt (193), and seabirds (456) were the major contributors to the impact score in this habitat. Seabirds were one of the most abundant species in this habitat. Herring were rated minor in commercial importance, and smelt were rated minor in subsistence importance. The three species were judged to be among the most sensitive to a diesel-2 spill in this habitat. Seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 32 percent (997) of the impact score for this case. Pacific sandlance (164), Dungeness crab (109), shrimp (273), and razor clam (109) were the major contributors to the impact score in this habitat. Sandlance, shrimp, and razor clam were the most abundant species in this habitat. Shrimp were rated moderate, and crab minor in commercial and subsistence importance.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 29 percent (899) of the impact score for this case. Tanner crab (219) and scallops (364) were the major contributors to the impact score in this habitat. These species were the most abundant, rated minor in commercial and subsistence importance, and judged to be among the most sensitive in this habitat to a diesel-2 spill.

Table 2-3. presents the complete results of Case 6.

CASE 7: WINTER, DIESEL-2, 10,000 BBLS - ESTIMATED SCORE 2,704

THE PELAGIC HABITAT contributed 39 percent (1,056) of the score for this case. Herring, smelt, and seabirds were judged to be the major contributors to the score in this habitat.

TABLE 2-3. IMPACT MATRIX--CASE 6

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	YAKUTAT
SEASON	WINTER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

MARINE SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	1	M	0	0	0	3	0	1	27	7	27
2. ZOOPLANKTON	1	M	0	0	0	3	0	1	27	7	27
3. EUPHAUSIACEAN	3	E	0	0	0	2	0	1	54	6	60
4. PELAGIC SCAVENGER	3	M	0	1	0	2	4	0	24	1	24
5. OPPORTUNIST	1	F	0	0	0	2	4	0	8	0	8
6. PACIFIC SALMON	3	E	0	0	0	3	0	1	81	9	90
7. HERRING	3	E	1	0	0	3	0	0	108	96	108
8. SMELT	3	A	0	0	1	2	0	0	108	96	108
15. RAINBOW-STEELHEAD TROUT	1	E	0	1	1	1	0	0	27	24	48
16. DOLLY VARDEN	1	E	0	0	1	1	0	0	18	16	32
17. NORTHERN FUR SEAL	1	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	1	0	50	0	50
22. SEA LIONS	3	A	0	0	0	5	1	0	15	0	15
24. WHALES	1	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	1	A	0	0	0	5	1	0	5	0	5
26. BIRDS	10	A	0	0	0	5	0	1	450	54	504
									1002	303	1245
2. BENTHIC SAND-MUD											
1. COD	3	A	2	1	1	2	0	1	72	18	72
2. SCULPINS	3	A	0	0	0	2	0	1	24	6	24
3. STARRY FLOUNDER	3	A	1	0	0	2	0	1	36	9	36
4. OTHER FLATFISH	3	A	1	0	0	2	0	1	36	9	36
5. PACIFIC HALIBUT	6	E	0	0	0	3	0	1	162	18	144
6. MISC. MARINE FISH	3	A	0	0	0	2	0	1	24	6	24
7. DUNGENESS CRAB	3	A	1	0	1	2	0	1	108	18	108
8. SHRIMP	6	A	2	0	0	3	0	1	270	90	270
9. RAZOR CLAM	6	A	0	0	0	2	0	1	108	12	108
10. OTHER BIVALVES	3	M	0	0	1	1	0	1	54	6	54
11. OTHER MARINE INVERTEBRATES	3	M	0	0	0	3	0	1	81	9	81
									975	195	957

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TABLE 2-3. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. INTERTIDAL ROCK-COBBLE-GRAVEL											
2. INTERTIDAL SEAWEED	1	M	0	0	0	3	1	0	0	0	0
4. PACIFIC HALIBUT	2	B	2	1	1	2	1	1	22	11	22
5. DUNGY FLATFISH	1	A	1	0	0	2	1	1	10	5	10
6. SANDLANCE	1	M	0	0	0	2	1	1	8	4	8
7. ROCKFISH	1	M	1	0	1	2	1	1	14	7	14
8. MISC. TO POLLOCK	2	B	2	1	1	2	1	1	22	11	22
9. OTHER MARINE FISH	1	M	0	0	0	2	1	1	8	4	8
10. KING CRAB	1	A	1	0	1	2	0	1	36	4	36
11. TANNER CRAB	2	A	1	0	1	2	0	1	216	24	216
12. POLLOCK	10	A	1	0	1	2	0	1	360	40	360
13. OTHER MARINE INVERTEBRATES	3	M	0	0	0	3	0	1	81	9	81
									887	104	899
4. INTERTIDAL SAND-MUD											
2. PACIFIC LAMPREY	2	E	0	0	0	3	0	0	0	0	0
7. RAZOR CLAM	6	A	0	1	2	2	0	0	0	0	0
8. SOFT-SHELL BIVALVE	6	A	0	1	0	2	0	0	0	0	0
9. INTERMITTENT INFAUNA	4	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	6	P	0	0	0	5	0	0	0	0	0
8. GEESE	10	A	1	2	0	1	0	0	0	0	0
9. DUCKS	10	A	1	2	0	1	0	0	0	0	0
10. CRANES	10	A	0	0	0	0	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	1	M	0	0	0	3	0	0	0	0	0
2. MUSSELS	3	E	1	0	0	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	3	M	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	3	M	0	0	0	1	0	0	0	0	0
6. OTHER INVERTEBRATES	1	M	0	0	0	1	0	0	0	0	0
7. SHOREBIRDS	3	P	0	0	0	3	0	0	0	0	0
8. SEA DUCKS	6	A	0	0	1	2	0	0	0	0	0
9. MARINE MAMMAL ROOKERIES	3	P	0	1	0	5	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	1	M	0	0	0	3	0	0	0	0	0

TABLE 2-3. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
E. INTERTIDAL COBBLE-GRAVEL											
2. SMELT	7	A	0	0	1	1	0	0	0	0	0
3. MACOMALL BIVALVES	3	H	0	1	1	2	0	0	0	0	0
4. CRUSTACEANS	1	H	0	0	0	2	0	0	0	0	0
5. GASTROPODS	1	H	0	0	0	3	0	0	0	0	0
6. CHICKEREDS	6	B	0	0	0	5	0	0	0	0	0
									0	0	0
F. FRESHWATER RIVER											
1. AQUATIC VEGETATION	1	E	0	0	0	1	0	0	0	0	0
2. AQUATIC INVERTEBRATES	1	E	0	0	0	1	0	0	0	0	0
3. KING SALMON	1	A	1	1	1	2	0	0	0	0	0
4. COHO SALMON	1	A	1	1	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	2	1	1	2	0	0	0	0	0
6. PINK SALMON	1	A	1	1	1	2	0	0	0	0	0
7. CHUM SALMON	15	A	2	1	1	2	0	0	0	0	0
8. RAINBOW/STEELHEAD TROUT	1	E	0	1	1	1	0	0	0	0	0
9. DOLLY VARDEN	1	E	0	0	1	1	0	0	0	0	0
10. SMELT	1	E	0	0	0	1	0	0	0	0	0
11. HERRING/SHAD	1	E	0	0	0	3	0	0	0	0	0
12. STURGEON	1	H	0	0	0	3	0	0	0	0	0
13. SMELT	6	A	0	2	1	2	0	0	0	0	0
14. HERON	3	A	0	2	1	2	0	0	0	0	0
15. OTTER	3	A	0	0	0	5	0	0	0	0	0
16. OTHER RIVER	1	P	2	0	0	1	0	0	0	0	0
17. MINK	1	P	2	0	0	1	0	0	0	0	0
20. MUSKRAT	1	P	2	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	1	P	2	0	0	1	0	0	0	0	0
									0	0	0
B. TERRESTRIAL											
2. RIPARIAN VEGETATION	1	H	0	0	0	2	0	0	0	0	0
3. UPLAND VEGETATION	1	H	0	0	0	1	0	0	0	0	0
4. OTHER VEGETATION	6	A	2	0	0	2	0	0	0	0	0
7. SMALL MAMMAL	6	A	0	0	0	1	0	0	0	0	0
8. WOLF	6	A	0	0	0	1	0	0	0	0	0
9. WOOD	6	A	0	3	2	2	0	0	0	0	0
11. DEER	6	A	0	2	2	2	0	0	0	0	0
15. BOATS	1	A	0	1	0	1	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	0	0	2	0	0	0	0	0
17. RAPTORS	6	A	0	3	0	5	0	0	0	0	0

TABLE 2-3. CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
12. RECREATION	6	4	0	1	0	2	0	0	0	0	0
13. OTHER BIRDS	6	4	0	0	0	2	0	0	0	0	0
									0	0	0
									2460	542	3111

THE SUBTIDAL SAND/MUD HABITAT contributed 32 percent (867) of the score for this case. Pacific sandlance and shrimp were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 29 percent (2,704) of the score for this case. Tanner crab and scallops were judged to be the major contributors to the score in this habitat.

CASE 8: SUMMER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 2,302

THE PELAGIC HABITAT contributed 34 percent (783) of the score for this case. Coho salmon and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 26 percent (588) of the score for this case. Dungeness crab and shrimp were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (623) of the score in this case. Tanner crabs and scallops were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 9 percent (196), THE INTERTIDAL ROCKY HABITAT contributed 2 percent (57), THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 2 percent (40), and THE TERRESTRIAL HABITAT contributed 1 percent (14) of the score for this case. No species in any of these habitats were judged to be major contributors to the impact score in this case.

CASE 9: WINTER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 2,056

THE PELAGIC HABITAT contributed 45 percent (922) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Sea Otter	increased	to	81	from	5
Ichthyoplankton	reduced	to	26	from	55
Pacific Sandlance	reduced	to	9	from	82
Herring	reduced	to	109	from	193
Smelt	reduced	to	109	from	193
Rainbow/Steelhead Trout	reduced	to	27	from	48

THE SUBTIDAL SAND/MUD HABITAT contributed 27 percent (561) of the impact score for this case. The decrease in impact score for this habitat from Case 6 is accounted for by the following species:

Pacific Sandlance	reduced	to	18	from	164
Dungeness Crab	reduced	to	51	from	109
Shrimp	reduced	to	128	from	273
Razor Clam	reduced	to	51	from	109
Other Bivalves	reduced	to	26	from	55

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 28 percent (573) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 6 is accounted for by the following species:

Tanner Crab	reduced	to	102	from	219
Scallops	reduced	to	170	from	364

CASE 10: SUMMER, BUNKER C, 50,000 BARRELS - IMPACT SCORE 1,950

THE PELAGIC HABITAT contributed 41 percent (788) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Phytoplankton	reduced	to	18	from	77

Zooplankton	reduced	to	18	from	77
Ichthyoplankton	reduced	to	20	from	85
Herring	reduced	to	51	from	193
Smelt	reduced	to	48	from	109
Crab Larvae	reduced	to	51	from	193
Sockeye Salmon	reduced	to	18	from	77
Coho Salmon	reduced	to	90	from	383
Rainbow/Steelhead Trout	reduced	to	13	from	48
Dolly Varden	reduced	to	26	from	97
Seabirds	reduced	to	319	from	683

THE SUBTIDAL SAND/MUD HABITAT contributed 34 percent (667) of the impact score for this case. The change in impact score for this habitat from Case 3 is accounted for by the following species:

Cods	reduced	to	36	from	153
Sculpins	reduced	to	48	from	109
Other Flatfish	reduced	to	18	from	77
Pacific Sandlance	reduced	to	72	from	164
Miscellaneous Marine Fish	reduced	to	12	from	48
Dungeness Crab	reduced	to	102	from	387
Shrimp	reduced	to	120	from	273
Razor Clam	reduced	to	51	from	193
Other Bivalves	reduced	to	26	from	97

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 25 percent (495) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Chum Salmon	reduced	to	20	from 46
Pacific Halibut	reduced	to	36	from 153
Other Flatfish	reduced	to	9	from 38
Rockfish	reduced	to	12	from 51
Walleye Pollock	reduced	to	36	from 153
King Crab	reduced	to	16	from 64
Tanner Crab	reeuced	to	96	from 387
Scallops	reduced	to	160	from 544
Other Marine Invertebrates	reduced	to	72	from 164

CASE 11: WINTER, BUNKER C, 50,000 BBLS - IMPACT SCORE 1,633

THE PELAGIC HABITAT contributed 36 percent (586) of the impact score for this case. The decrease in impact score for this habitat from Case 9 is accounted for by the following species:

Smelt	reduced	to	51	from 109
Sea Otter	reduced	to	46	from 81
Seabirds	reduced	to	213	from 456

THE SUBTIDAL SAND/MUD HABITAT contributed 32 percent (517) of the impact score for this case. Other marine invertebrates, reduced to 38 from 82, accounted for the decrease in impact score for this habitat from Case 9.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 32 percent (530) of the impact score for this case. Other marine invertebrates, reduced to 38 from 82, accounted for the decrease in impact score for this habitat from Case 9.

CASE 12: WINTER, DIESEL-2, 1,000 BBLS - ESTIMATED SCORE 1,616

THE PELAGIC HABITAT contributed 39 percent (631) of the score for this case. Seabirds were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 32 percent (518) of the score for this case. Shrimp were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 29 percent (467) of the score for this case. Tanner crab and scallops were judged to be the major contributor to the score in this habitat.

CASE 13: WINTER, CRUDE OIL, 10,000 BBLS - ESTIMATED SCORE 1,186

THE PELAGIC HABITAT contributed 45 percent (532) of the score for this case. Seabirds were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 27 percent (324) of the score in this case. Shrimp were judged to be the major contributor to the score in this habitat.

THE INTERTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 28 percent (331) of the score in this case. Scallops were judged to be the major contributor to the score in this case.

CASE 14: SUMMER, BUNKER C, 10,000 BBLS - ESTIMATED SCORE 1,101

THE PELAGIC HABITAT contributed 40 percent (445) of the score for this case. Seabirds were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 34 percent (377) of the score for this case. Other marine invertebrates were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 25 percent (279) of the score for this case. Scallops were judged to be the major contributor to the score in this habitat.

CASE 15: WINTER, BUNKER C, 10,000 BBLS - ESTIMATED SCORE 922

THE PELAGIC HABITAT contributed 36 percent (331) of the score for this case. Seabirds were judged to be the major contributor to the score in this case.

THE SUBTIDAL SAND/MUD HABITAT contributed 32 percent (292) and THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 32 percent (299) of the score in this case. No species was judged to be a major contributor to the score in these habitats.

The impact scores for Cases 16 through 32 range from 729 down to 5. The spill sizes for these cases were 50,000 and 10,000 barrels for gasoline, 1,000 for crude oil, bunker C and gasoline, and 100 for all spill types. The array of these scores is shown as follows:

SEASON	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000	100
SUMMER	Diesel-2	Case 1	Case 2	Case 5	729
	Crude Oil	Case 3	Case 4	Case 8	275
	Bunker C	Case 10	Case 14	638	134
	Gasoline	535	337	91	13
WINTER	Diesel-2	Case 6	Case 7	Case 12	270
	Crude Oil	Case 9	Case 13	453	97
	Bunker C	Case 11	Case 15	534	113
	Gasoline	200	126	34	5

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(2) VALDEZ HARBOR

Valdez Harbor is a fjord which forms the northeastern arm of Prince William Sound (see Figure 2-12). Valdez Harbor opens to the south-central Gulf of Alaska through Valdez Narrows (see Location 3), Valdez Arm, and Prince William Sound. The selected spill site is located at 61°5.56'N latitude and 146°22.22'W longitude off the terminus of the Trans-Alaska Pipeline System at the west end of Jackson Point.

(a) PHYSICAL CHARACTERISTICS

TEMPERATURES

Valdez is located in the Maritime Climatic Zone. Temperatures are moderate with some influence by downslope drainage from the glaciated mountains.[4] Summer temperatures range from 34°F to 60°F.[3,4,14] Winter temperatures range from 12°F to 44°F.[3,4,14]

Sea temperatures can vary from 33°F to 48°F in the Winter and from 43°F to 66°F in the Summer.[4] Glacial ice is not common, but during very cold Winter weather, enough ice sometimes forms in the arms of Prince William Sound to impede navigation.[8]

SURFACE WINDS

Calm conditions occur quite often at Valdez throughout the year.[14] Generally, from late Fall through early Spring, east-northeast winds also predominate, with an average speed of about 7.5 knots.[14] From late Spring until early Fall, southwest winds averaging about 3.3 knots are predominant.

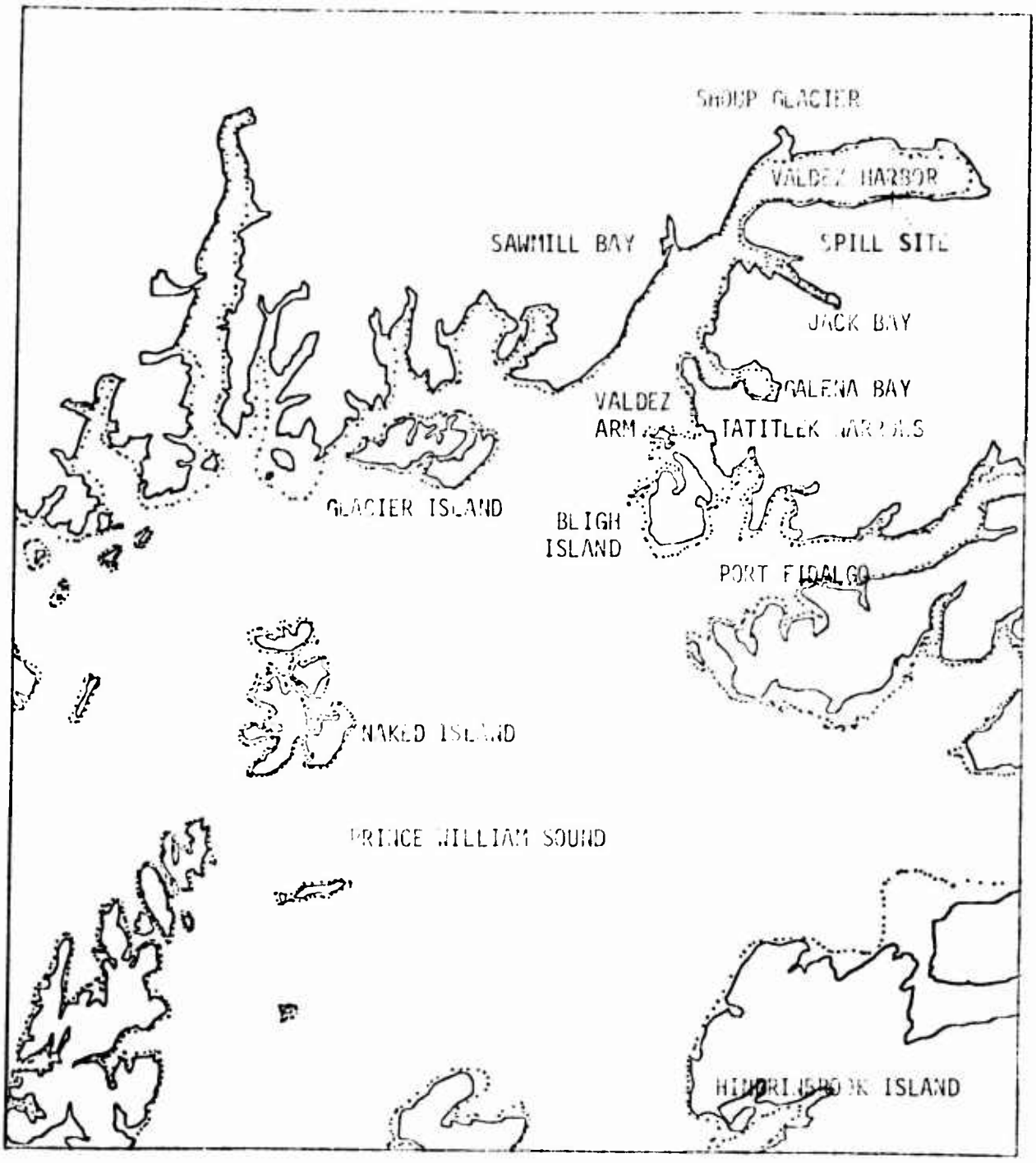


FIGURE 2-12. VALDEZ HARBOR LOCATION AND SPILL SITE.

NOTE: The broken line is the 10 fathom (60 ft.) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

SURFACE CURRENTS

The surface sea currents in the Valdez Harbor vicinity are listed as "too weak and variable to be predicted" by the *TIDAL CURRENT TABLES*.[9] The *COAST PILOT*[8] gives a current flow rate of 0.5 knots in the Harbor and a diurnal tide range of 12.1 ft. in Jack Bay. Hood, et. al.,[31] concludes that circulation in the harbor is controlled by a variety of external influences including tides, precipitation, freshwater runoff, winds, surface air temperatures, and the available water of Prince William Sound. Hood, el. at.,[31] also reported 2 to 3 cm/sec (about 0.05 knots) current speeds. Another source[33] indicated that maximum currents from 0.5 to 1.0 knot are typically recorded in the port and in summary indicates that maximum non-wind driven surface currents are 0.5 knot. With the range of surface currents reported for Valdez Harbor, MSNW selected the higher range of current velocities to allow for the largest probable spreading of oil products.

Surface currents were assumed to be generally aligned with the axis of the harbor in this analysis, with an ebb current (270^{0}) at 0.7 knots and a flood current (090^{0}) at 0.4 knots (see Valdez Narrows for details of currents in the Narrows, Valdez Arm, and Prince William Sound).

(b) BIOLOGICAL CHARACTERISTICS

The Prince William Sound area, including Valdez Arm, Narrows, and Harbor have a wide variety of organisms forming a rich fauna and flora. Hood, et. al.,[31] and others[14,32,39] reported in detail on some of the Harbor's marine resources. Additional information about the vicinity, including Prince William Sound, is yet available from additional sources.[34,35] Resource summaries are shown in Figure 2-13 and Figure 2-14.

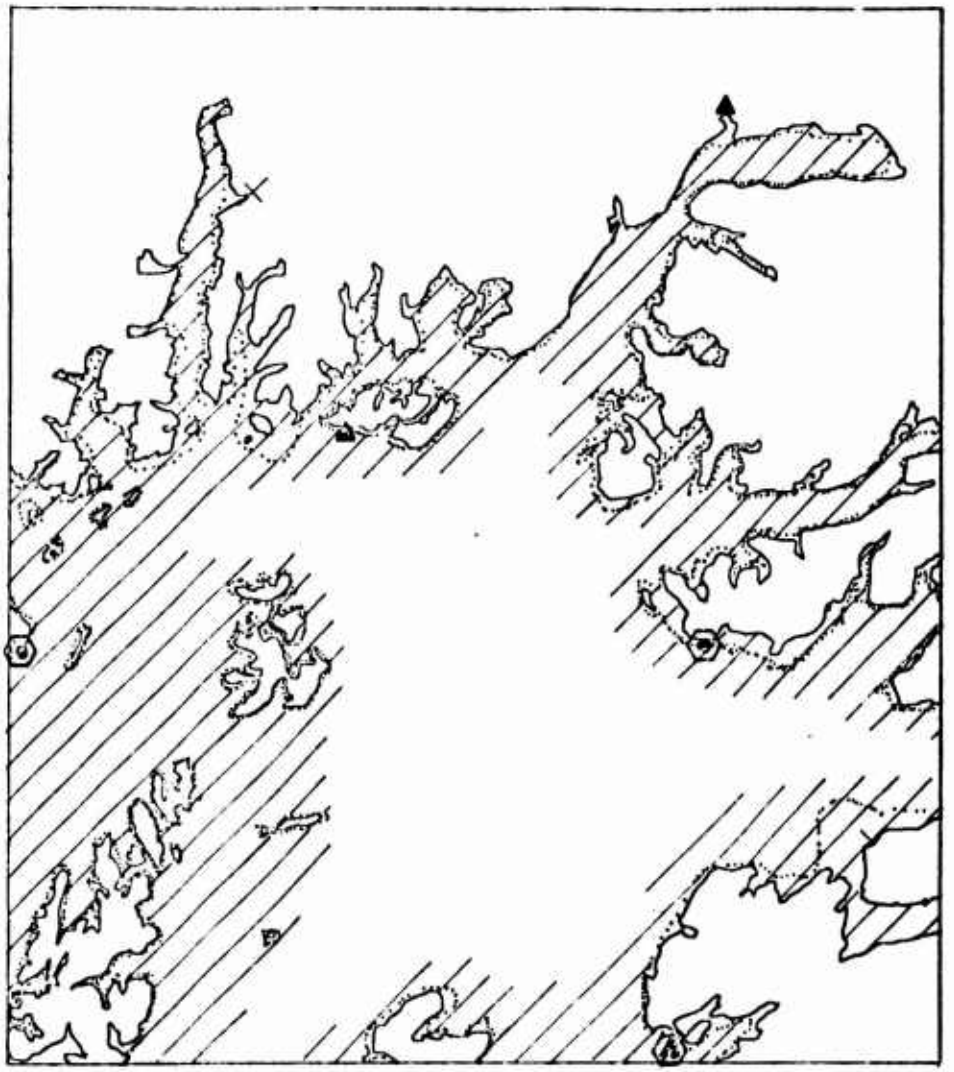


FIGURE 2- 13. VALDEZ HARBOR-NARROWS AND PRINCE WILLIAM SOUND CONCENTRATIONS OF SELECTED RESOURCES.

SOURCES: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

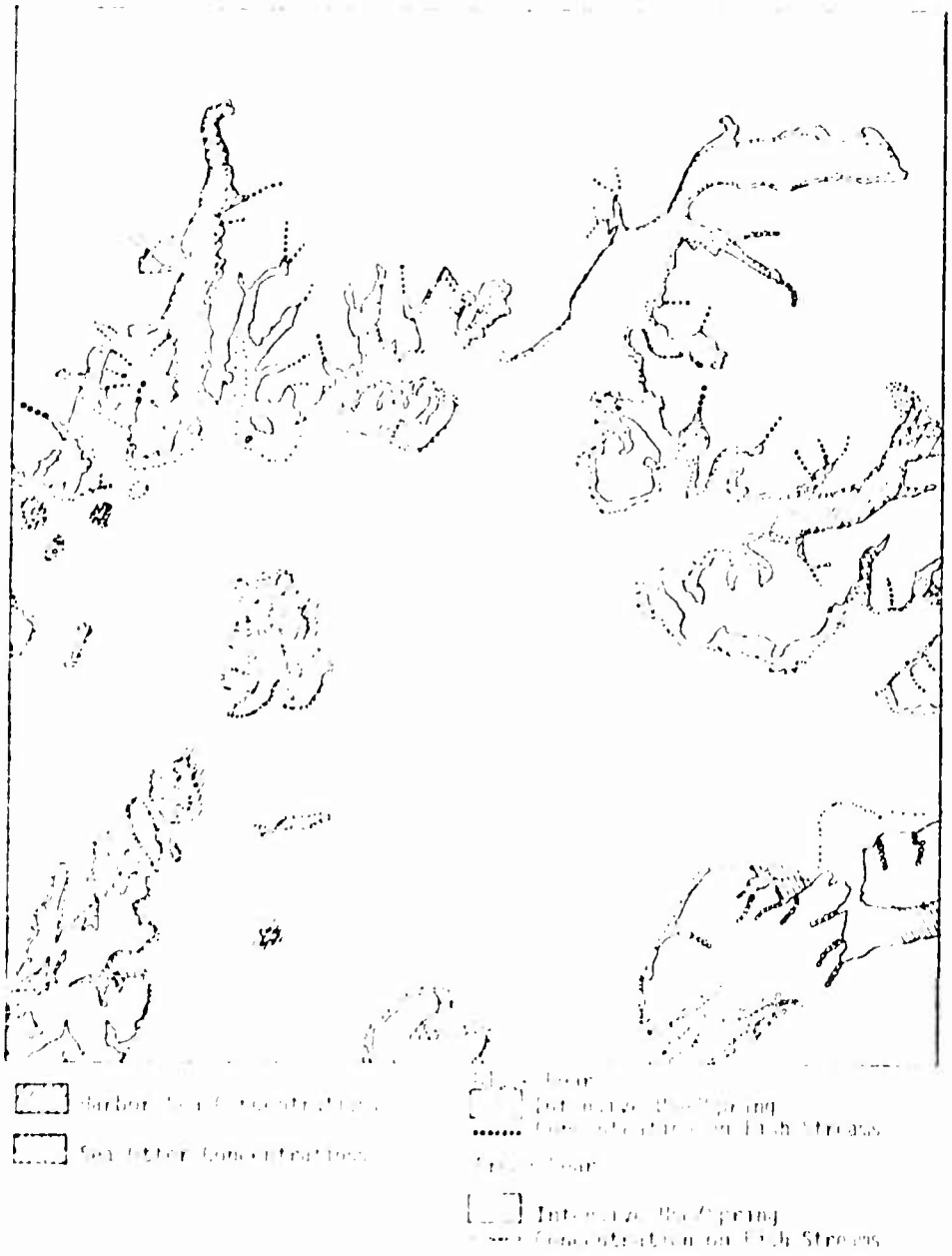


FIGURE 2- 14. [illegible]

SOURCE: [illegible], January 1973.

FISHES

SALMON - All five species of North American salmon inhabit this portion of Prince William Sound. However, Myren[32] reported salmon locations in Prince William Sound and did not indicate any king salmon in the Valdez Harbor area. A few king salmon were reported by another source.[39] The abundance of salmon at the spill site in the Harbor is difficult to ascertain. Pink and chum salmon produced in the Eastern Fishing District, including Valdez Arm, Narrows, and Harbor contribute substantially to other Prince William Sound Districts.[32] The Alaska Department of Fish and Game estimated (post-earthquake) that the Eastern District accounts for about 33 percent of the total Prince William Sound salmon production.[32]

The Harbor environment is probably most important to pink and chum salmon juveniles for early feeding and growth. This would be during the period from May through September.

Based upon the fishery catches, the adult run into Prince William Sound is from June through September. Peak spawning by the most abundant salmonoid, pink salmon (in streams), is from late July to early August, with the major areas being Siwash Creek and the Lowe River system.[39] Although much higher in other Prince William Sound areas, less than 15 percent of the pinks spawn intertidally in Valdez Harbor, probably due to the lack of extensive suitable gravel beds.[39] Eggs develop through the Winter and fry migrate to salt water in Spring. These fish, like chum salmon, may spend 1 to 3 months in the Prince William Sound vicinity before going to the open sea.[33] Pink salmon may spend as much as 50 percent of their lives in the intertidal and estuarine environment.[33]

Chum salmon are quite variable in numbers in the Harbor area from year to year, with most spawning ocurring in late Summer (August) and Fall (up through October).[39] The most important streams appear to be City Limits Creek, Mineral Creek, Sawmill Creek, and Seven Mile Creek.[39] The 1971 chum run spawned intertidally (63 percent) in the northeast quandrant of Valdez Harbor.[39] In streams, the eggs hatch in mid-Winter but stay in the gravel until Spring when they emerge and go to sea for 2 to 4 years before returning to spawn and die.

Coho salmon (less abundant than pinks or chums) spawning is from August to November, with most spawning in the lower Lowe River, Robe River, and Mineral Creek.[39] All spawning is in streams.

Figure 2-15 shows these streams and other physical features of Valdez Harbor.

Average commercial catch statistics for Valdez Harbor, Narrows, and vicinity (ADF&G Statistical Area 221) for 1965 through 1971 are as follow follows:

SALMON	MEAN	(RANGE)
King	90	(20 - 800)
Sockeye	1,000	(300 - 2,500)
Coho	6,900	(1,800 - 18,000)
Pink	840,000	(358,700 - 1,974,800)
Chum	128,700	(27,300 - 200,400)

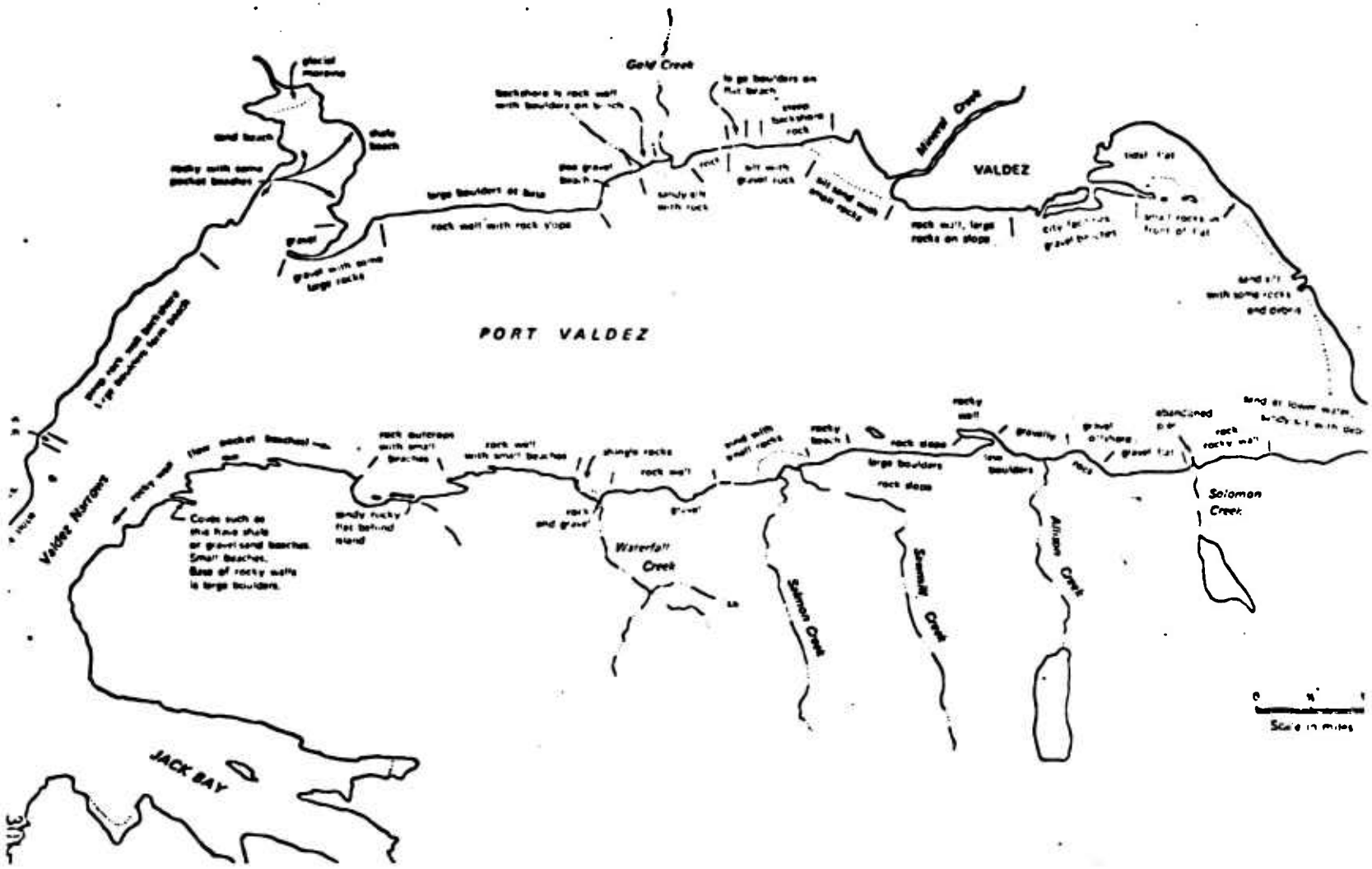


FIGURE 2-15. VALDEZ HARBOR--SHORELINE DESCRIPTION

SOURCE: Alyeska Pipeline Servia Co., *401 BIOLOGICAL ENVIRONMENT*, Oil Spill Contingency Plan, Alyeska Marine Terminal, Vol 1 - The Plan, Vol 2 - Annexe, Woodward-Envicon Inc., Environmental Consultants.

The average total salmon run in Prince William Sound is estimated at about 6.5-million fish with a value to the fishermen of over $2-million. Appendix D provides further salmon data.

Myren[32] described the local salmon sport fishing as follows:

> The areas in which sport fishing is conducted are throughout Valdez Arm and Port Valdez and the adjacent bays of the region. Pink salmon are frequently taken early in the season in such areas as within Jack Bay, Galena Bay, Sawmill Bay, and along the shore to Point Freemantle. Silver salmon are taken later in Port Valdez, primarily in the vicinity of Anderson Bay and Sawmill Creek and near an unnamed stream between these two; from Swan Point to Solomon Creek in the vicinity of Gold Creek on the north side of the bay; and between new and old Valdez. Pink and chum salmon are taken from the Valdez area also. One fishing area from Swan Point to Jackson Point will be the site of the tanker oil loading facility.

Dolly Varden are also present in the Harbor vicinity.[39]

The utilization of intertidal and shallow nearshore areas by most salmonoids, coupled with their pelagic (near-surface) movements, indicate a high potential vulnerability to oil spills.

PACIFIC HALIBUT - This species is not known to support any important fishery in the Valdez vicinity. Halibut may support some recreational and part-time commercial effort. The important halibut commercial fishing area is near the outer part of Prince William Sound facing the Gulf of Alaska and into the Gulf and south to Cape St. Elias. This latter area is also important to juvenile halibut in Summer and Fall.[24] Eggs and larvae from spawning areas in the Gulf of Alaska drift inshore and settle in shallow areas beginning in May.[13]

In the Harbor area, halibut are present but not in large commercial numbers. Halibut would be more vulnerable to large spills originating in the Valdez vicinity that might move out into Prince William Sound and the entrance to the Sound.

ROCKFISH - Exploratory investigations and recreational fishing indicate that rockfish are located in the Valdez vicinity.[31,37] Maturgo[16] indicated trace abundances in the Valdez vicinity, with more rockfish caught in the outer portions of Prince William Sound. Pacific Ocean perch are reported in Valdez Arm.[32]

PACIFIC HERRING - Major abundances of adult herring are located in the outer portions of Prince William Sound (Montague Strait area), with lower abundances noted for mid-Sound regions. However, some past herring roe fishery in Valdez Arm (west shore) and outside the Valdez Arm entrance (east shore) are noted.[32] Herring were not shown in the Harbor itself, but a few would be assumed to occur there.

OTHER MARINE FISHES - Other fishes captured in exploratory efforts in this area were walleye pollock, Pacific cod, black cod, rex sole, turbot, English sole, and flathead sole. Maturgo[16] also noted traces of sablefish (black cod) and "other" flatfish in this general area. Flathead sole and walleye pollock were the bottom fish most abundant in the Harbor.[39]

SHELLFISHES

DUNGENESS CRAB - This species is reported to be supporting the largest shellfish fishery in the vicinity, although utilization of tanner and king crab species are increasing.[32] Myren[32] showed Dungeness crab in Valdez Harbor, Narrows, and Arm, as well as to the east of the Valdez Arm entrance. Catch

data for this specific vicinity were not obtained. Myren[32] gave the following catches (pounds) for the Copper River and Bering River Districts (east of Prince William Sound) with a footnote that these are 1966 through 1968 data and about one-half of the production is from Prince William Sound:

DISTRICT	POUNDS CAUGHT ANNUALLY AVERAGE (MAXIMUM)
Copper River	930,000 (1,085,000)
Bering River	248,000 (661,000)

Dungeness crab are sufficiently abundant to be sought in a fishery for local use and local sale, with best fishing off Dayville and Mineral Creek Flats.[39]

TANNER CRAB - Tanner crab (snow crab) appear distributed throughout Prince Willian Sound, including Valdez Arm, Narrows, and Harbor. The resource potential is greater than the present production would indicate (Copper River District annual catch was 147,000 lbs in 1968 and 1,288,308 lbs in 1970).[32] Tanner crab are present in Valdez Arm.[32] A few tanner crab are taken in the Harbor, probably in pots set for Dungeness crab.[39]

KING CRAB - Several species of king crab exist in Prince William Sound: red king crab are in most of Prince William Sound except the Valdez Arm, Narrows, and Harbor; blue king crabs are in western Prince William Sound (Port Wells), and golden king crab are in the channels and other parts of Prince William Sound.[32] Hood, et. al.,[31] reported a king crab caught in the Harbor. King crab are uncommon in the Harbor.[39] King crab , although present in Valdez Harbor and Narrows, do not appear to be very abundant relative to other portions of Prince William Sound. The

resource potential for king crab is greater than the production would indicate.[32] (Copper River District annual catch--all from Prince William Sound--averaged 33,000 lbs (1966 through 1968), with a maximum amount of 75,000 lbs.)

SHRIMP - Shrimp are present in Valdez Harbor and vicinity.[31,32,39] The following are potential production (pounds) and value in shrimp in Valdez Arm:

SHRIMP	POUNDS	VALUE
Pink	58,000	$ 2,300
Coonstripe	2,000	1,000
Spot	Present	-
Sidestripe	26,000	1,800

Shrimp, as a group, do not rank high in Prince William Sound commercial fishery catches, but they are present and assumed fairly abundant in the area.

RAZOR CLAMS - Razor clams in the Valdez vicinity are apparently not very abundant relative to the Copper and Bering River districts outside and east of Prince William Sound. These bivalves live on intertidal sand beaches and possibly on subtidal sand areas. This species is not indicated in the Harbor.[39] The average (1948-1959) annual harvest of razor clams in Copper River District was 1,196,880 pounds.[32] Razor clams are present: however, there are no quantitative data for the Southeastern District of Prince William Sound.[32]

OTHER CLAMS - Hardshell clams (butter, littleneck, etc.) are present in Galena Bay on Valdez Arm and Prince William Sound in bays east of the Valdez Arm entrance. Hood, et. al.,[31] indicated that many bivalve species

are present in Valdez Harbor and Narrows; some of the soft-shell species *(Macoma)* are in high abundance with concentrations along the south shore of the Harbor, near Point Jackson, and in the Narrows and Valdez Arms. Soft-shell clams are common to very common in the east end of the Harbor.[39] The clam group is quite abundant in species in the Harbor and Narrows.

WATERFOWL

Waterfowl are very numerous in Prince William Sound, including Valdez Arm. The Valdez vicinity is important as a breeding, migration and wintering area.[17] Populations vary with season and weather conditions. A concise list of some waterfowl species in Prince William[32] is as follows:

DUCKS, GEESE, SWANS

WHISTLING SWAN - Very abundant Spring and Fall migrant. Occurs both on mainland and islands--not intertidal.

TRUMPETER SWAN - Population of 500 to 700 birds annually next on the Copper River Delta. This is the largest known nesting population of trumpeters. Winter in limited numbers--primarily on mainland--not intertidal.

DUSKY CANADA GOOSE - Known world population nests on the Copper River Delta--approximately 5,000 to 20,000 birds on mainland--are intertidal.

CACKLING CANADA GOOSE - Abundant Spring and Fall migrants--occurs both on mainland and islands.

LESSER CANADA GOOSE - Abundant Spring and Fall migrant--occurs both on mainland and islands.

BLACK BRANT - Several thousand spring migrants occur in Anderson and Double Bay of Hinchinbrook Island.

EMPEROR GOOSE - Rare occurrence in Winter--both mainland and islands.

PACIFIC WHITE-FRONTED GOOSE - Abundant Spring and Fall migrant--occurs on both mainland and islands.

LESSER SNOW GOOSE - Abundant Spring and Fall migrant on the Copper River Delta--occurs only on the mainland.

MALLARD - Abundant Spring and Fall migrant--few residents during the Winter--more often in intertidal zones--occurs both on mainland and islands.

GADWALL - Small number Spring and Fall--occurs mainland and islands.

GREEN-WINGED TEAL - Very abundant Spring and Fall--occurs mainland and islands.

BLUE-WINGED TEAL - Rare.--occurs mainland and islands.

AMERICAN WIDGEON - Very abundant Spring and Fall--occurs mainland and occasionally on islands.

SHOVELLER - Very abundant Spring, Summer, and Fall--occurs mainland.

SCAUP LESSER, SCAUP GREATER - Abundant year-round-occurs mainland and islands.

AMERICAN GOLDENEYE, BARROW'S GOLDENEYE - Very abundant year-round--occurs mainland and islands.

BUFFLEHEAD - Very abundant--occurs mainland and islands.

CANVASBACK - Rare--occurs on mainland.

OLD SQUAW - Abundant--Winter only. Occurs on islands.

HARLEQUIN DUCK - Abundant--migrant. Occurs on islands.

WESTERN WHITE-WINGED SCOTER - Abundant Spring and Fall--occurs on islands.

SURF SCOTER - Abundant--Winter only. Occurs on islands.

AMERICAN COMMON SCOTER - Rare--occurs on islands.

AMERICAN COMMON MERGANSER - Very abundant year-round--occurs mainland and islands.

RED-BREASTED MERGANSER - Very abundant year-round--occurs mainland and islands.

PACIFIC COMMON EIDER - Rare--Winter only. Occurs on islands.

KING EIDER - Rare--Winter only. Occurs on islands.

SPECTACLED EIDER - Rare--Winter only. Occurs on islands.

STELLER'S EIDER - Rare--Winter only. Occurs on islands.

CRANES (FAMILY - GRUIDAE)

LESSER SANDHILL CRANE - Very abundant--Fall. Occurs on mainland.

DUCKS - Prince William Sound Summer populations of various ducks are estimated as follows: 1,600 mallards, 2,500 scoter ducks, and 7,000 mergansers, as well as many other species.[17] Winter populations of most species would be several times greater than these Summer figures.[17]

GEESE - Prince William Sound Summer estimates were 2,500 geese, mainly dusky and Vancouver (rare) forms of Canada Geese.[17]

SWANS - The large local concentration of swans is the trumpeter swan breeding grounds in the Copper River drainage (1,500 birds -- or about one-half of the world's population).[17] Undoubtedly, some of these swans also breed and nest in Prince William Sound,[18] but no quantitative data were located.

SEABIRDS - This group is very numerous in Prince William Sound. ADF&G[17] reported the following Summer abundances: 100,000 gulls, 58,000 kittiwakes, 48,000 alcids, 22,000 Arctic terns, 16,000 cormorants, 10,000 shearwaters, 2,500 loons, and 1,000 grebes. There are also seabird colonies

in Prince William Sound at Glacier Island (east side of Valdez Arm entrance) and at Shoup Glacier (northwest corner of Valdez Harbor).

SHOREBIRDS are present in the area,[39] but no quantitative data were located.

RAPTORS - Bald eagles are very common year-round residents on the mainland and islands, while hawks are less abundant and usually Summer visitors.[34]

MARINE MAMMALS

SEA OTTERS occur only as far as Galena Bay (Valdez Arm) and in the remainder of Prince William, with concentrations in the outer (southern) portions of Prince William Sound.[17] The population in the Sound is expanding beyond the estimated current population of 5,000 (Unit 6).[17] One source[34] showed sparse populations in Valdez Arm, Narrows, and Harbor, while another[39] stated that sea otters enter the harbor rarely.

HARBOR SEALS are very numerous in Prince William Sound, with dense populations indicated for the Valdez vicinity.[34] A more detailed description by ADF&G[17] indicated harbor seals as being present in the Valdez vicinity and in high densities in the following areas: Jack Bay (Valdez Arm) and Port Fidalgo (east of Valdez Arm entrance) and in several other bays west of Valdez Arm entrance. There is no estimate of the area's overall populations; however, many concentrations in localized areas exceed 1,000 animals.

SEA LIONS are not concentrated in the Valdez vicinity, although habitat suitable for them is noted in Valdez Arm.[11] Areas of sea lion concentrations exist in Prince William Sound to the west of the Valdez Arm entrance at Perry Island (150) and to the east of the entrance of Knowles

Head (200) and Fox Island (20).[17] Higher numbers of sea lions are located in Hinchinbrook Entrance to Prince William Sound (Seal Rocks--1,700 animals).[17]

WHALES AND PORPOISES are present in Prince William Sound. Whales are generally shown as present in the western part of the Sound (Montagne Strait, Port Wells).[17] The following summary is given by ADF&G:[17] Killer and minke whales are present in the outer parts of the Sound, particularly in July; gray whales remain outside the Sound during their migration, with few entering the Sound; and Dall and harbor porpoises are common in the Sound.

Killer whales, harbor porpoises, and possibly Dall porpoise and Pacific blackfish (Pacific pilot whale) are occasional visitors to the Harbor.[39]

OTHER MARINE MAMMALS have included an occasional visit by northern fur seals.[34]

TERRESTRIAL MAMMALS

BROWN BEAR are sparse in this part of Game Unit 6, with an average annual harvest of 36 (1961-1971) and a high of 63 in 1968.[17]

BLACK BEAR are more numerous in this general area, with an estimated 8 to 10 animals per square mile in prime habitat.[17] The rare glacier color phase is occasionally encountered (may some day be classified as rare and endangered).[17]

WOLVES AND WOLVERINES are both sparse in Game Unit 6.

MOOSE are not numerous in the area, with only a trace at the head of Valdez Harbor.

BLACK-TAIL DEER are present only at the entrance of Valdez Arm and east.[17] A vulnerability to marine oil spills could exist in the Winter when

these deer utilize beaches for overwintering, but impacts are thought to be insignificant.

OTHER TERRESTRIAL MAMMALS include red fox, coyote, lynx, red squirrel, and aquatic mammals such as marten, weasel, mink, river otter, beaver, and muskrat.[34] River otter and mink are most vulnerable to marine spills as they utilize estuarine and littoral zones for food gathering.

FLORA

Because of their proximity to each other, the two spill locations near Valdez (Harbor and Narrows) are considered together. The oil spills here would not significantly affect terrestrial vegetation. Strand (beach) vegetation would occur in the Summer on about 33 percent of the shoreline and be lacking in Winter. In the outer portion of Prince William Sound, all muddy areas are reported to have eelgrass beds,[73] but eelgrass was not reported in a biological survey of Valdez Harbor.[74] The muddy and sandy shoreline comprises about 8 percent of the total in this area where eelgrass would be expected to occur both in Summer and Winter. "Salt marshes" are reported to occur on the shoreward side of Mineral Creek flats and on the mud flat between present Valdez and Robe River.[74] The marine algae of Prince William Sound were recently studied by Johansen[73] (Appendix A), but the research was primarily directed toward study of effects of the Alaska earthquake of 1964; consequently, it is difficult to conclude what the "normal" algal vegetation is in this area. The species are south Alaskan but with numerous species whose distributions extend into Washington and California. The intertidal algae would cover about 66 percent of the shoreline in the Summer, 28 percent in Winter. Subtidal algae cover 66 percent of the shallow

bottom in Summer, and 32 percent in Winter. Floating kelps of *Alaria fistulosa* and *Nereocystis*[75,76] would cover about 55 percent of the shallow surface water in Summer and be mostly lacking in Winter.

Further details on the physical and biological characteristics of this location are given in Appendix D.

(c) RESULTS

The confined waters of Valdez Harbor are subject to high long-term oil spill impact due to the slow circulation of the water. The 1,000-bbl spills of diesel-2, crude and bunker C all have comparable impact scores in both Winter and Summer.

The major contributors to these scores are salmon, crab, shrimp, soft and hard-shelled bivalves, and the various marine avifauna. In general, the intertidal habitats were impacted the heaviest in the harbor.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Valdez Harbor. The first scenario; based upon most probable Summer conditions; resulted in oil moving in a northerly direction from the spill location (Figure 2-16) toward the city of Valdez. This spill reaches the shoreline at Valdez approximately 18 hours after a spill. The second scenario, using most probable Winter conditions, resulted in oil moving in a westerly direction towards Valdez Narrows. This spill reaches the shoreline at Valdez terminal approximately one hour after the spill and reaches the north end of Valdez Narrows approximately 60 hours after the spill. The physical impacts of the various products were assessed and are described in Section 4 - Effects of Oil on the Environment. Of particular note at this site is that the trajectories of the spills are in directions which are 90 degrees from each other; the two scenarios were judged to have equal impact on the flora and fauna within Valdez Harbor. The reason for this judgment is that the enveloping procedure used indicates that the spills will generally impact most of Valdez Harbor and therefore the major difference in spill impact scores for spills of the same size and type at this site will result from the abundance of those flora and fauna present during the season of the spill.

See Page 2-27 for discussion of spill enveloping processes.

CASE DISCUSSION

Table 2-4 presents the results of the oil spill scenarios examined at Valdez Harbor without cleanup.

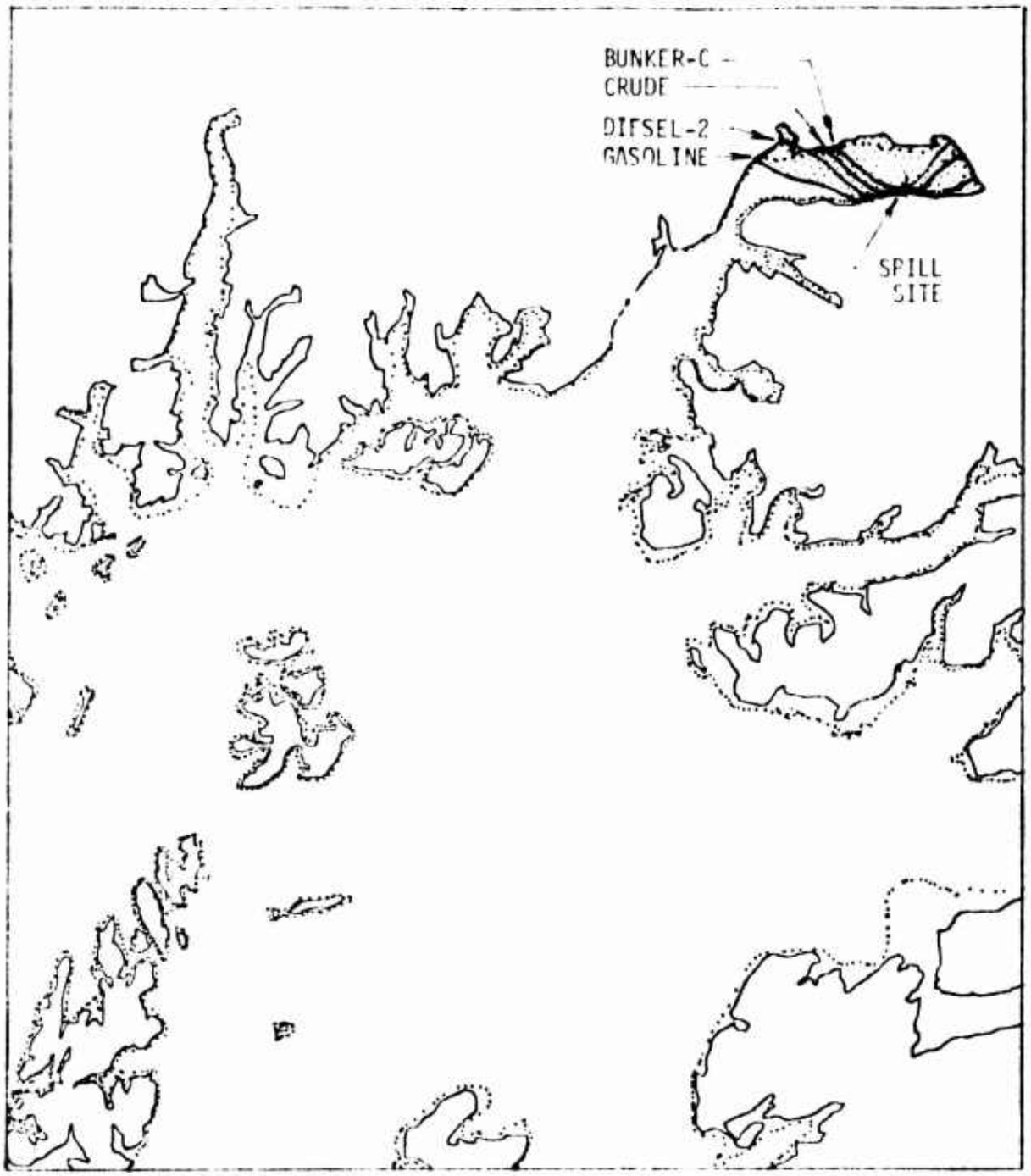


FIGURE 2-16. VALDEZ HARBOR SUMMER 1,000 BBL SPILL ENVELOPES

TABLE 2-4. VALDEZ HARBOR CASE RESULTS--NO CLEANUP

	Spill Product By Season	Spill 1,000	Size in Barrels 100
SUMMER	Diesel-2	9,744 [3](1)	1,769 [13]
	Crude Oil	10,530 [1]	2,606 [8]
	Bunker-C	10,032 [2]	2,749 [7]
	Gasoline	2,500 [9]	404 [15]
WINTER	Diesel-2	7,580 [6]	1,234 [14]
	Crude Oil	8,209 [5]	2,153 [10]
	Bunker-C	8,368 [4]	2,143 [11]
	Gasoline	1,882 [12]	340 [16]

(1) Numbers in brackets are the case numbers that follow.

Oil spills within the confined Valdez Harbor were judged to have the potential for greater long term impact due to the long period for a complete change of water in the harbor. Therefore, spills of equal size and type at this site will generally have a higher impact score than at other sites. In all cases the intertidal rocky and freshwater river habitats do not contribute to the impact score. In the case of the intertidal rocky habitat, the conditions for a shoreline to be so classified within th confines of the Harbor did not exist; in the case of freshwater river habitat, it was judged that the spill would not reach fresh water from a marine origin.

CASE 1: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 10,530

THE PELAGIC HABITAT contributed 16 percent (1,651) of the impact score for this case. The species which were the main contributors to the total were chum salmon (168), pink salmon (480), Dolly Varden (120) and seabirds (300). Of the impacted species pink salmon and seabirds were the most

abundant; the two salmon species and Dolly Varden were considered relatively important for recreation; and the salmon were also considered an important commercial and subsistence resource. Seabirds are also a protected species.

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (1,219) of the impact score for this case. The species which were the main contributors to the total were cods (120), Dungeness crab (219), shrimp (425), and other marine invertebrates (120). Cods, shrimp and other marine vertebrates were among the most abundant at the site. Cods, shrimp and Dungeness crab were all rated as having at least some importance for both commercial and subsistence fishing and in addition cods and shrimp were considered recreational resources.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 9 percent (924) of the impact score for this case. The species which were the main contributors to this total were chum salmon (153), king crab (153), and other marine invertebrates (191). The invertebrates were one of the most abundant of the impacted species; chum salmon and king crab were rated as having importance for commercial, recreational and subsistence fishing; and all three of these species were judged to be among the most sensitive to a crude oil spill at this site.

THE INTERTIDAL SAND/MUD HABITAT contributed 34 percent (3,571) of the impact score for this case. The main contributors to this total were razor clams (360), soft shell bivalves (1,800), invertebrate infauna (410), marine mammal rookeries (273), shorebirds (456), and swans (120). Softshell bivalves and invertebrate infauna were the most abundant species in this habitat. Razor clams and softshell bivalves were judged to have at least

some recreational and subsistence importance. Marine mammal rookeries were categorized as protected in order to account for potential losses of young mammals. Shorebirds are protected and swans were judged endangered due to the presence of some whistling swans in the Valdez area.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 25 percent (2,580) of the impact score for this case. All of the species within the habitat contributed significantly to this score. The scores were:

Intertidal Seaweeds	128
Smelt	360
Hardshell Bivalves	1,500
Crustaceans	182
Gastropods	273
Shorebirds	137

The seaweeds, bivalves, crustaceans and gastropods were all relatively abundant in this habitat. Smelt and bivalves were considered somewhat important both for recreational and subsistence fishing and smelt were also of minor importance for commercial fishing. Shorebirds were classified as protected and all species in this habitat were judged to be moderately sensitive to both short and long term impacts of a crude oil spill.

THE TERRESTRIAL HABITAT contributed 6 percent (595) of the impact score for this case. The main contributors were other vegetation (298), black bear (60) and raptors (75). Other vegetation and raptors were among the most abundant of the species in this habitat. Other vegetation (lumbering) and black bear were rated as having commercial, recreational and subsistence value. Black bears were rated as protected for purposes of

this study at this site due to the presence of the rare glacier phase of this animal. Raptors are protected.

Table 2-5 following, presents the full results of this case.

CASE 2: SUMMER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 10,032

THE PELAGIC HABITAT contributes 7 percent (689) of the impact score for this case. The decrease in the impact score for this habitat compared with Case 1 is accounted for, with minor exceptions, by the following species:

Crab Larvae	reduced to	12	from	48
Chum Salmon	reduced to	42	from	480
Pink Salmon	reduced to	120	from	480
Rainbow/Steelhead Trout	reduced to	12	from	48
Dolly Varden	reduced to	30	from	120
Seabirds	reduced to	75	from	300

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (1,219) of the impact score for this case. This habitat's result was the same as for Case 1.

THE SUBTIDAL ROCK/COBBLE GRAVEL HABITAT contributed 9 percent (924) of the impact score for this case. This habitat's result was the same as for Case 1.

THE INTERTIDAL SAND/MUD HABITAT contributed 39 percent (3,937) of the impact score for this case. The increase in the impact score from Case 1 for this habitat is accounted for by the following species:

TABLE 2-5. MATRIX RESULTS FOR CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	VALDEZ HARBOR
SEASON	SUMMER
SPILL SIZE	1,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

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HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	6	A	0	0	0	2	1	0	12	0	12
4. FLOATING SEAWEED	10	A	0	0	0	2	4	0	80	0	80
5. GREENLINGS	3	A	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	3	A	0	0	0	3	1	0	9	0	9
7. HERRING	10	A	3	0	0	3	1	0	60	0	60
8. SMELT	3	A	1	1	1	3	4	1	72	10	77
9. CRAB LARVAE	6	E	0	0	0	2	4	0	48	0	48
10. KING SALMON	1	A	1	2	1	2	1	0	6	0	6
11. CHUM SALMON	6	A	2	2	1	2	4	0	168	0	168
12. SOCKEYE SALMON	3	A	2	2	1	2	1	0	21	0	21
13. PINK SALMON	15	A	3	2	1	2	4	0	480	0	480
14. COHO SALMON	6	A	3	2	1	2	1	0	48	0	48
15. RAINBOW-STEELHEAD TROUT	6	M	0	1	0	1	4	0	48	0	48
16. DOLLY VARDEN	10	M	0	2	0	1	4	0	120	0	120
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	10	A	0	0	0	5	0	0	0	0	0
24. WHALES	10	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	1	0	30	0	30
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	4	0	300	0	300
									1646	10	1651
2. SUBTIDAL SAND-MUD											
1. COD	10	A	2	1	1	2	1	1	60	60	120
2. SCULPINS	6	A	0	0	0	2	1	1	12	12	24
3. STARRY FLOUNDER	6	A	2	0	0	2	1	1	24	24	48
4. OTHER FLATFISH	10	A	2	0	0	2	1	1	40	40	80
5. PACIFIC SANDLANCE	3	A	0	0	0	3	1	1	9	9	18

TABLE 2-5 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT-SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	10	4	0	0	0	2	1	1	28	28	48
7. DUNGENESS CRAB	6	A	1	0	1	2	9	1	216	24	219
8. SHRIMP	10	A	3	2	2	3	4	1	408	108	425
9. RAZOR CLAM	3	4	0	0	3	2	4	1	24	6	26
10. OTHER BIVALVES	10	A	0	0	0	1	9	1	90	10	91
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	4	1	120	30	120
									1015	335	1219
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	15	4	0	0	0	2	1	0	30	0	30
2. SUBTIDAL SEAWEED	15	4	0	0	0	2	1	0	30	0	30
3. SMOLT SALMON	9	A	2	1	1	2	4	1	144	36	153
4. PACIFIC HALIBUT	6	A	3	1	0	2	1	1	36	36	72
5. OTHER FLATFISH	11	A	2	0	0	2	1	1	40	40	80
6. GREENLINGS	6	A	0	1	0	2	1	0	10	0	10
7. ROCKFISH	11	A	3	1	0	2	1	0	60	0	60
8. WALLEYE POLLOCK	11	A	2	0	0	2	1	0	40	0	40
9. OTHER MARINE FISH	10	A	0	0	0	2	1	0	20	0	20
10. KING CRAB	6	A	2	1	1	2	4	1	144	36	153
11. TANNER CRAB	10	A	1	1	1	2	0	0	0	0	0
12. SCALLOPS	6	A	1	0	0	2	4	1	72	18	77
13. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	4	1	180	45	191
									814	211	924
4. INTERTIDAL SAND-MUD											
1. EELGRASS	1	M	0	0	0	3	1	1	3	3	6
2. PACIFIC SANDLANCE	3	M	0	0	0	3	4	1	36	9	38
3. RAZOR CLAM	3	A	0	2	2	2	4	0	72	144	360
4. SOFTSHELL BIVALVES	15	A	0	3	1	2	4	0	360	720	1008
5. INVERTEBRATE INFAUNA	15	A	0	0	0	3	9	1	405	45	418
6. MARINE MAMMAL ROOKERIES	3	A	0	0	0	5	9	1	270	30	273
7. SHOREBIRDS	10	P	0	0	0	5	9	1	450	50	456
8. GEESE	6	A	1	2	0	1	1	1	24	24	48
9. DUCKS	5	A	1	2	0	2	1	1	30	30	60
10. SWANS	5	A	0	0	0	4	1	1	60	60	120
									1718	1115	3571
5. INTERTIDAL ROCKY											

TABLE 2-5 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
E. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	15	M	0	0	3	3	0	0	0	0	0
2. GREENLINGS	3	A	0	1	0	2	0	0	0	0	0
3. HERRING	14	A	3	0	3	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	15	A	0	0	3	1	0	0	0	0	0
5. MOBILE CRUSTACEANS	9	A	0	1	1	2	0	0	0	0	0
6. OTHER INVERTEBRATES	10	A	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	P	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	3	A	1	2	0	2	0	0	0	0	0
9. MARINE MAMMAL ROOKERIES	10	A	0	0	3	5	0	0	0	0	0
									0	0	0
D. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	M	0	0	0	3	4	1	120	30	120
2. SMELT	3	A	1	1	1	3	4	0	72	144	360
3. HARDSHELL BIVALVES	15	A	0	2	1	2	4	0	300	600	1500
4. CRUSTACEANS	10	A	0	0	0	2	4	1	180	20	180
5. GASTROPODS	10	A	0	0	0	3	4	1	270	30	270
6. SHOREBIRDS	3	P	0	0	0	5	4	1	135	15	135
									1077	839	2580
F. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	M	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	2	1	2	0	0	0	0	0
4. CHUM SALMON	6	A	0	3	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	2	1	2	0	0	0	0	0
6. PINK SALMON	15	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	0	A	0	2	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	M	0	2	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	M	0	2	1	1	0	0	0	0	0
10. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
11. OTHER FISH	0	M	0	0	0	2	0	0	0	0	0
12. DUCKS	3	A	1	2	0	2	0	0	0	0	0
13. GEESE	10	A	1	2	0	2	0	0	0	0	0
14. SWANS	15	A	0	0	0	0	0	0	0	0	0
15. RIVER OTTER	0	A	2	0	1	1	0	0	0	0	0
16. MINK	0	A	2	0	1	1	0	0	0	0	0
17. MUSKRAT	6	A	2	0	1	1	0	0	0	0	0
18. OTHER AQUATIC MAMMALS	6	A	2	0	1	1	0	0	0	0	0
									0	0	0

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TABLE 2-5 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS: ABUNDANCE INV.	CONF.	IMPORTANCE DUR.	REC.	SUB.	ECOL.	IMPACT S.TRM	L.TRM	RESULTS: S.TRM	IMPACT L.TRM	RSLT.
0. TERRESTRIAL											
1. TUNDRA	1	4	0	0	0	0	0	0	0	0	0
2. RIPARIAN VEGETATION	10	4	0	7	0	2	1	0	28	0	28
3. STRAND VEGETATION	6	4	0	2	0	1	9	1	54	6	55
4. OTHER VEGETATION	10	A	2	2	1	2	4	1	288	78	298
5. BROWN BEAR	3	A	2	1	0	2	1	0	15	0	15
6. BLACK BEAR	6	A	1	3	1	5	1	6	60	0	60
7. WOLVERINE	3	A	1	0	3	1	1	0	6	0	6
8. WOLF	3	A	1	0	3	1	1	0	6	0	6
9. MOUSE	1	A	0	1	1	2	0	0	0	0	0
11. DEER	0	A	1	1	1	2	6	0	0	0	0
12. SQUIRTS	0	A	1	2	1	1	0	0	0	0	0
16. OTHER MAMMALS	6	A	2	0	1	2	1	0	30	0	30
17. RAPTORS	15	A	0	0	0	5	1	0	75	0	75
18. PTARMIGAN	0	P	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	10	P	6	0	0	2	1	0	20	0	20
									566	76	585
									6828	2594	18538

Eelgrass	increased to	13	from 6
Pacific Sandlance	increased to	82	from 38
Invertebrate Infauna	increased to	725	from 410

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 27 percent (2,725) of the impact score for this case. The increase in the impact score from Case 1 for this habitat is accounted for by intertidal seaweeds (273 vs. 128).

THE TERRESTRIAL HABITAT contributed 5 percent (538) of the impact score for this case. The decrease in impact score from Case 1 for this habitat is accounted for by the following species:

Strand Vegetation	reduced to	26	from 55
Other Vegetation	reduced to	280	from 298

CASE 3: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 9,744

THE PELAGIC HABITAT contributed 20 percent (1,979) of the impact score for this case. The difference between this habitat's score in this case and Case 2 is accounted for, with minor exceptions, by the following species:

Smelt	increased to	360	from 72
Crab Larvae	increased to	51	from 12
Chum Salmon	increased to	179	from 42
Pink Salmon	increased to	510	from 120
Coho Salmon	increased to	48	from 0
Rainbow/Steelhead Trout	increased to	51	from 12
Dolly Varden	increased to	128	from 30

Seabirds	reduced to	20 from 80
Floating Seaweed	reduced to	20 from 80

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (1,219) and the SUBTIDAL ROCK/COBBLE GRAVEL HABITAT contributed 9 percent (924) of the impact score for this case. The result of both of these habitats was the same as for Case 2.

THE INTERTIDAL SAND/MUD HABITAT contributed 29 percent (2,827) of the impact score for this case. The decrease in the impact score from Case 2 for this habitat is accounted for, with minor exceptions, by the following species:

Pacific Sandlance	reduced to	18 from 82
Invertebrate Infauna	reduced to	191 from 725
Marine Mammal Rookeries	reduced to	128 from 273
Shorebirds	reduced to	213 from 456
Geese	reduced to	24 from 48
Ducks	reduced to	30 from 60
Swans	reduced to	60 from 120

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 23 percent (2,257) of the impact score for this case. The decrease in impact score from Case 2 for this habitat is accounted for by the following species:

Intertidal Seaweeds	reduced to 120 from 273
Crustaceans	reduced to 35 from 182
Gastropods	reduced to 128 from 273
Shorebirds	reduced to 64 from 137

THE TERRESTRIAL HABITAT contributed 6 percent (538) of the impact score for this case. This habitat's result was the same as for Case 2.

CASE 4: WINTER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 8,368

THE PELAGIC HABITAT contributed 4 percent (309) of the impact score for this case. This habitat's result is significantly different from the Case 3 result (309 vs. 1979) as this case is the first Winter scenario. The major factor accounting for this lower score is the decrease in abundance or absences of species from Valdez Harbor during Winter. The species which were present during Summer scenarios, but are now absent from this habitat, are crab larvae and the five species of salmon; this accounts for a total impact score difference of 937. Other major contributors to the reduced impact score include:

Smelt	reduced to 72 from 360
Rainbow/Steelhead Trout	reduced to 6 from 51
Dolly Varden	reduced to 9 from 128
Seabirds	reduced to 30 from 319

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (926) of the impact score for this case. The decrease in the impact score from Case 3 for this habitat is accounted, with minor exceptions, by the following species:

Cod	reduced to 72 from 120
Starry Flounder	reduced to 24 from 48
Other Flatfish	reduced to 48 from 80
Dungeness Crab	reduced to 109 from 219
Other Marine Invertebrates	reduced to 77 from 128

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (555) of the impact score for this case. The decrease in impact score from Case 3 for this habitat is accounted for by the absence of chum salmon (153 in Case 3) and the reduction in score, with some minor exceptions, of the following species:

Floating Seaweed	reduced to 12 from 30
Pacific Halibut	reduced to 36 from 72
Other Flatfish	reduced to 48 from 80
Rockfish	reduced to 36 from 60
Other Marine Invertebrates	reduced to 128 from 191

THE INTERTIDAL SAND/MUD HABITAT contributed 45 percent (3,751) of the impact score for this case. The increase in impact score from Case 3 for this habitat is accounted for, with minor exceptions, by the following species:

Invertebrate Infauna	increased to 483 from 191
Marine Mammal Rookeries	increased to 273 from 128
Shorebirds	increased to 456 from 213
Geese	increased to 48 from 24
Ducks	increased to 100 from 30
Swans	increased to 200 from 60

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 28 percent (2,343) of the impact score for this case. The change in impact score from Case 3 for this habitat is accounted for by the following species:

Intertidal Seaweeds	increased to 164 from 120
Crustaceans	increased to 109 from 85
Gastropods	increased to 164 from 128
Shorebirds	reduced to 46 from 64

THE TERRESTRIAL HABITAT contributed 6 percent (484) of the impact score for this case. The species which were either absent from the site in Winter (eelgrass) or were considered to be denned for the Winter (bears) and, therefore not impacted, reduced the impact score for this habitat a total of 101 compared to Case 3. Other significant changes in the impact score were contributed by the following species:

Other Vegetation	reduced to 168 from 280
Raptor	reduced to 50 from 75
Deer	increased to 200 from 0

CASE 5: WINTER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 8,209

THE PELAGIC HABITAT contributed 6 percent (452) of the impact score for this case. The increase in impact score from Case 4 for this habitat is accounted for, with minor exceptions, by the following species:

Rainbow/Steelhead Trout	increased to 24 from 6
Dolly Varden	increased to 36 from 9
Seabirds	increased to 120 from 30

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (926) and the SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (555) of the impact score for this case. The result of both of these habitats was the same as for Case 4.

THE INTERTIDAL SAND/MUD HABITAT contributed 43 percent (3,525) of the impact score for this case. The decrease in impact score from Case 4 for this habitat is accounted for by invertebrate infauna (273 vs. 483), with only minor decreases in some other species.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 27 percent (2,256) of the impact score for this case. The decrease in impact score from Case 4 for this habitat is accounted for by intertidal seaweeds (77 vs. 164).

THE TERRESTRIAL HABITAT contributed 6 percent (495) of the impact score for this case. This habitat's result was the same as Case 4, with only minor exceptions (495 vs. 484).

CASE 6: WINTER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 7,580

THE PELAGIC HABITAT contributed 10 percent (724) of the impact score for this case. The difference in impact score from Case 5 for this habitat is accounted for, with minor exceptions, by the following species:

Floating Seaweed	reduced to 12 from 48
Smelt	increased to 360 from 77

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (926) and the SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (555) of the impact score for this case. The result of both these habitats was the same as for Case 5.

THE INTERTIDAL SAND/MUD HABITAT contributed 37 percent (2,810) of the impact score for this case. The decrease in impact score from Case 5 for this habitat is accounted for with minor exceptions, by the following species:

Invertebrate Infauna	reduced to 128 from 273
Marine Mammal Rookeries	reduced to 128 from 273
Shorebirds	reduced to 213 from 456
Geese	reduced to 24 from 48
Ducks	reduced to 50 from 100
Swans	reduced to 100 from 200

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 27 percent (2,081) of the impact score for this case. The decrease in impact score from Case 5 for this habitat is accounted for, with minor exceptions, by the following species:

Crustaceans	reduced to 51 from 109
Gastropods	reduced to 77 from 164
Shorebirds	reduced to 21 from 46

THE TERRESTRIAL HABITAT contributed 6 percent (484) of the impact score for this case. This habitat's result was the same as for Case 5, with only minor exceptions (484 vs. 495).

Cases 7 through 14 have impact scores which are significantly lower than the cases previously discussed. The total impact score for Case 7 is only 2,749 or 36 percent of the impact score for Case 6. This large difference in scores makes comparison between these cases and the previously discussed almost

meaningless. A more fruitful approach, which shall be taken for these cases, is to compare them beginning with Case 7.

CASE 7: SUMMER, BUNKER-C, 100 BBLS - IMPACT SCORE 2,749

THE PELAGIC HABITAT contributed 3 percent of the impact score for this case. The four species which contributed to this score for this habitat were those which were judged the most sensitive to bunker-C spills. The impact scores for these species were:

Phytoplankton	18
Zooplankton	18
Floating Seaweed	20
Smelt	18

THE SUBTIDAL SAND/MUD HABITAT contributed 16 percent (427) of the impact score for this case. The species which were the major contributors to this impact score for this habitat were:

Cods	60
Other Flatfish	40
Dungeness Crab	96
Shrimp	100
Other Bivalves	40

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (211) of the impact score for this case. The six species which contributed to this impact score for this habitat were:

Chum Salmon	36
Pacific Halibut	36
Other Flatfish	40
King Crab	36
Scallops	18
Other Marine Invertebrates	45

THE INTERTIDAL SAND/MUD HABITAT contributed 42 percent (1,150) of the impact score for this case. The species which were the major contributors to this impact score for this habitat were:

Razor Clams	77
Softshell Bivalves	383
Invertebrate Infauna	191
Marine Mammal Rookeries	128
Shorebirds	213
Swans	60

THE INTERTIDAL COBBLE/GRAVEL HABITAT cntributed 29 percent (801) of the impact score for th's case. All species within this habitat contributed significantly to this impact score. Species impact scores were:

Intertidal Seaweeds	128
Smelt	77
Hardshell Bivalves	319
Crustaceans	85
Gastropods	128
Shorebirds	64

THE TERRESTRIAL HABITAT contributed 3 percent (76) of the impact score for this case. Only two species were judged to have any impact for this case. These were:

Strand Vegetation	6
Other Vegetation	70

CASE 8: SUMMER, CRUDE OIL, 100 BBLS - IMPACT SCORE 2606

THE PELAGIC HABITAT contributed 14 percent (365) of the impact score for this case. In addition to the impacts for Case 7, the following species were judged to be impacted by the crude oil spill:

Crab Larvae	12
Chum Salmon	42
Pink Salmon	120
Rainbow/Steelhead Trout	12
Dolly Varden	30
Seabirds	75

THE SUBTIDAL SAND/MUD HABITAT contributed 17 percent (437) and the SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (211) of the impact score for this case. The result for both of these habitats was the same as for Case 7.

THE INTERTIDAL SAND/MUD HABITAT contributed 35 percent (913) of the impact score for this case. The decrease in impact score from Case 7 for this habitat is accounted for by the following species:

Invertebrate Infauna	reduced to 90 from 191
Shorebirds	reduced to 100 from 213

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 22 percent (586) of the impact score for this case. The decrease in impact score from Case 7 for this habitat is accounted for by the following species:

Intertidal Seaweeds	reduced to 60 from 128
Crustaceans	reduced to 40 from 85
Gastropods	reduced to 60 from 128
Shorebirds	reduced to 30 from 64

THE TERRESTRIAL HABITAT contributed 4 percent (94) of the impact score for this case. The increase in impact score from Case 7 for this habitat is accounted for by strand vegetation (24 vs. 6).

CASE 9: SUMMER, GASOLINE, 1,000 BBLS - IMPACT SCORE 2,500

THE PELAGIC HABITAT contributed 14 percent (342) of the impact score for this case. The change in impact score from Case 8 for this habitat is accounted for by the following species:

Ichthyoplankton	increased to 12 from 0
Herring	increased to 60 from 0
Seabirds	reduced to 0 from 75

THE SUBTIDAL SAND/MUD HABITAT contributed 17 percent (437) of the impact score for this case. This habitat's result was the same as for Case 8.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (135) of the impact score for this case. The decrease in impact score from Case 8 for this habitat is accounted for by the following species:

Chum Salmon	reduced	to	0	from	36
Pacific Halibut	reduced	to	0	from	40

THE INTERTIDAL SAND/MUD HABITAT contributed 35 percent (878) of the impact score for this case. All species contributed to the change in impact score relative to Case 8 for this habitat. The changes were:

Eelgrass	reduced	to	0	from	3
Razor Clams	reduced	to	72	from	77
Softshell Bivalves	reduced	to	360	from	383
Marine Mammal Rookeries	reduced	to	30	from	128
Geese	reduced	to	0	from	24
Ducks	reduced	to	0	from	30
Swans	reduced	to	0	from	60
Invertebrate Infauna	increased	to	180	from	90
Pacific Sandlance	increased	to	200	from	100
Shorebirds	increased	to	200	from	100

THE INTERTIDAL COBBLE/GRAVEL/HABITAT contributed 25 percent (632) of the impact score for this case. All species contributed to the change in impact score relative to Case 8 for this habitat. The changes were:

Intertidal Seaweeds	reduced	to	0	from	60
Smelt	reduced	to	72	from	77
Hardshell Bivalves	reduced	to	300	from	319
Crustaceans	increased	to	80	from	40
Gastropods	increased	to	120	from	60
Shorebirds	increased	to	60	from	30

THE TERRESTRIAL HABITAT contributed 3 percent (76) of the impact score for this case. The decrease in impact score from Case 8 in this habitat is accounted for by strand vegetation (6 vs. 24).

CASE 10: WINTER, CRUDE OIL, 100 BBLS - IMPACT SCORE 2,153

THE PELAGIC HABITAT contributed 4 percent (93) of the impact score for this case. Only seven species contributed to the impact score in this habitat, these were:

Phytoplankton	9
Zooplankton	9
Greenlings	12
Smelt	18
Rainbow/Steelhead Trout	6
Dolly Varden	9
Seabirds	30

All other species which contributed to this habitat's impact score in Case 9 were either not present during the Winter or not affected by the crude oil spill.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (311) of the impact score for this case. The major contributing species for the decrease in impact score from Case 9 in this habitat is Dungeness crab (48 vs. 96). Changes in other species ranged from 6 to 24.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 6 percent (126) of the impact score for this case. The change in impact score from Case 9 in this habitat is accounted for by the following species:

Chum Salmon	reduced	to	0	from	36
Other Marine Invertebrates	reduced	to	30	from	45
Pacific Halibut	increased	to	18	from	0
Other Flatfish	increased	to	24	from	0

THE INTERTIDAL SAND/MUD HABITAT contributed 48 percent (1,029) of the impact score for this case. All species in this habitat contributed to the change in impact score relative to Case 9. The changes were:

Eelgrass	increased	to	3	from	0
Razor Clams	increased	to	77	from	72
Softshell Bivalves	increased	to	383	from	360
Marine Mammal Rookeries	increased	to	128	from	30
Geese	increased	to	24	from	0
Ducks	increased	to	50	from	0
Swans	increased	to	200	from	0
Pacific Sandlance	reduced	to	4	from	36
Invertebrate Infauna	reduced	to	60	from	180
Shorebirds	reduced	to	100	from	200

INTERTIDAL COBBLE/GRAVEL HABITAT contributed 23 percent (502) of the impact score for this case. All species in this habitat contributed to the change in impact score relative to Case 9. The changes were:

Intertidal Seaweeds	increased	to	36	from	0
Smelt	increased	to	77	from	72
Hardshell Bivalves	increased	to	319	from	300
Crustaceceans	reduced	to	24	from	80
Gastropods	reduced	to	36	from	120
Shorebirds	reduced	to	10	from	60

THE TERRESTRIAL HABITAT contributed 4 percent (92) of the impact score for this case. The change in impact score from Case 9 for this habitat is accounted for by the following species:

Strand Vegetation	reduced	to	50	from	0
Other Vegetation	reduced	to	42	from	70
Deer	increased	to	50	from	0

CASE 11: WINTER, BUNKER-C, 100 BARRELS - IMPACT SCORE 2,143

THE PELAGIC HABITAT contributed 2 percent (48) of the impact score for this case. The decrease in impact score from Case 10 in this habitat is accounted for by the following species:

Rainbow/Steelhead Trout	reduced	to	0	from	6
Dolly Varden	reduced	to	0	from	0
Seabirds	reduced	to	0	from	30

THE SUBTIDAL SAND/MUD HABITAT contributed 15 percent (311) and the SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 6 percent of the impact score for this case. The result for both these habitats was the same as for Case 10.

THE INTERTIDAL SAND/MUD HABITAT contributed 44 percent (944) of the impact score for this case. The change in impact score from Case 10 in this habitat is accounted for, with minor exception, by the following species:

Invertebrate Infauna	increased	to	128	from	60
Shorebirds	increased	to	213	from	100
Geese	reduced	to	0	from	24
Ducks	reduced	to	0	from	50
Swans	reduced	to	0	from	200

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 29 percent (622) of the impact score for this case. The increase in impact score from Case 10 in this habitat is accounted for by the following species:

Intertidal Seaweeds	increased	to	77	from	36
Crustaceans	increased	to	51	from	24
Gastropods	increased	to	77	from	36
Shorebirds	increased	to	21	from	10

THE TERRESTRIAL HABITAT contributed 4 percent (92) of the impact score for this case. This habitat's impact score is the same as for Case 10.

CASE 12: WINTER, GASOLINE 1,000 BBLS - IMPACT SCORE 1,882

THE PELAGIC HABITAT contributed 5 percent of the impact score for this case. The change in impact score from Case 11 in this habitat is accounted for by the following species:

Ichthyoplankton	increased	to	6	from	0
Herring	increased	to	36	from	0
Rainbow/Steelhead Trout	increased	to	6	from	0
Dolly Varden	increased	to	9	from	0
Floating Seaweed	reduced	to	0	from	12

THE SUBTIDAL SAND/MUD HABITAT contributed 17 percent (311) of the impact score for this case. This habitat's result was the same as for Case 11.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 4 percent (84) of the impact score for this case. The decrease in impact score from Case 11 for this habitat is accounted for by the following species:

Pacific Halibut	reduced	to	0	from	18
Other Flatfish	reduced	to	0	from	24

THE INTERTIDAL SAND/MUD HABITAT contributed 42 percent (790) of the impact score for this case. The decrease in impact score from Case 11 for this habitat is accounted for, with minor exceptions, by the following species:

Softshell Bivalves	reduced	to	360	from	383
Marine Mammal Rookeries	reduced	to	30	from	128

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 27 percent (512) of the impact score for this case. With minor changes to other species, intertidal seaweed (0 vs. 77) accounts for the decrease in impact score from Case 11 in this habitat.

THE TERRESTRIAL HABITAT contributed 5 percent (92) of the impact score for this case. This habitat's impact score is the same as in Case 11.

CASE 13: SUMMER, DIESEL-2, 100 BBLS - IMPACT SCORE 1,769

THE PELAGIC HABITAT contributed 22 percent (384) of the impact score for this case. The change in impact score from Case 12 for this habitat is accounted for, with minor exceptions, by the following species:

Herring	reduced	to	0	from 36
Smelt	increased	to	36	from 18
Chum Salmon	increased	to	24	from 0
Pink Salmon	increased	to	120	from 0
Dolly Varden	increased	to	30	from 9
Seabirds	increased	to	75	from 0

THE SUBTIDAL SAND/MUD HABITAT contributed 25 percent (437) of the impact score for this case. The increase in impact score from Case 12 in this habitat is accounted for, with minor exceptions, by the following species:

Cods	increased	to	60	from 36
Other Flatfish	increased	to	40	from 24
Dungeness Crab	increased	to	96	from 48

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 12 percent (211) of the impact score for this case. The increase in impact score from Case 12 in this habitat is accounted for by the following species:

Chum Salmon	increased	to	36	from 0
Pacific Halibut	increased	to	36	from 0
Other Flatfish	increased	to	40	from 0
Other Marine Invertebrates	increased	to	45	from 30

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (380) of the impact score for this case. The change in impact score from Case 12 in this habitat is accounted for with minor exceptions, by the following species:

Marine Mammal Rookeries	increased	to	60	from 30
Razor Clams	reduced	to	36	from 72
Softshell Bivalves	reduced	to	180	from 360
Invertebrate Infauna	reduced	to	45	from 120
Shorebirds	reduced	to	50	from 200

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 16 percent (281) of the impact score for this case. The change in impact score from Case 12 in this habitat is accounted for by the following species:

Intertidal Seaweeds	increased	to	30	from 0
Smelt	reduced	to	36	from 72
Hardshell Bivalves	reduced	to	150	from 300
Crustaceans	reduced	to	20	from 48
Gastropods	reduced	to	30	from 72
Shorebirds	reduced	to	15	from 20

THE TERRESTRIAL HABITAT contributed 4 percent (76) of the impact score for this case. The change in impact score from Case 12 in this habitat is accounted for by the following species:

Strand Vegetation	increased	to	6	from	0
Other Vegetation	increased	to	70	from	42
Deer	reduced	to	0	from	50

CASE 14: WINTER, DIESEL-2, 100 BARRELS - IMPACT SCORE 1,234

THE PELAGIC HABITAT contributed 9 percent (108) of the impact score for this case. The species not present in the Winter scenarios account for 210 of the decrease in impact score from Case 13 in this habitat. With minor exceptions, the remainder of the decrease is accounted for by the following species:

Dolly Varden	reduced	to	9	from	30
Seabirds	reduced	to	30	from	75

THE SUBTIDAL SAND/MUD HABITAT contributed 25 percent (311) of the impact score for this case. The decrease in impact score from Case 13 in this habitat is accounted for, with minor exceptions, by the following species:

Cods	reduced	to	36	from	60
Other Flatfish	reduced	to	24	from	40
Dungeness Crab	reduced	to	48	from	96

THE INTERTIDAL SAND/MUD HABITAT contributed 29 percent (358) of the impact score for this case. The decrease in impact score from Case 13 for this habitat is accounted for by the following species:

Pacific Sandlance	reduced	to	2	from	9
Invertebrate Infauna	reduced	to	30	from	45

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 19 percent (239) of the impact score for this case. The decrease in impact score from Case 13 for this habitat is accounted for by the following species:

Intertidal Seaweeds	reduced	to	18	from	30
Crustaceans	reduced	to	12	from	20
Gastropods	reduced	to	18	from	30
Shorebirds	reduced	to	5	from	15

THE TERRESTRIAL HABITAT contributed 7 percent (92) of the impact score for this case. The change in impact score from Case 13 for this habitat is accounted for by the following species:

Strand Vegetation	reduced	to	0	from	6
Other Vegetation	reduced	to	42	from	70
Deer	increased	to	50	from	0

Case 15 and 16 impact scores are significantly lower than the cases previously discussed. The total impact score for Case 15 is only 404 or 33 percent for Case 14. This large difference in scores makes comparison between these cases and those previously discussed almost meaningless;

therefore the cases will be discussed and compared together, rather than with the earlier cases.

CASE 15: SUMMER, GASOLINE, 100 BBLS - IMPACT SCORE 404

and

CASE 16: WINTER, GASOLINE, 100 BBLS - IMPACT SCORE 340

Only three habitats contribute to the impact scores of these cases and, therefore, only these three will be compared.

THE SUBTIDAL SAND/MUD HABITAT contributed 8 percent (34) of the impact score for Case 15; this habitat contributed 6 percent (22) of the impact score for Case 16. The decrease in impact score for this habitat is accounted for by Dungeness crab being reduced to 12 from 24.

THE INTERTIDAL SAND/MUD HABITAT contributed 52 percent (212) of the impact score for Case 15; this habitat contributed 56 percent (190) of the impact score for Case 16. The decrease in impact score is accounted for by the following species:

Pacific Sandlance	reduced	to	2	from	9
Invertebrate Infauna	reduced	to	30	from	45

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 39 percent (158) of the impact score for Case 15; this habitat contributed 38 percent (128) of the impact score for Case 16. The decrease in impact score is accounted for by the following species:

Crustaceans	reduced	to	12	from	20
Gastropods	reduced	to	18	from	30
Shorebirds	reduced	to	5	from	15

3. VALDEZ NARROWS

Valdez Narrows leads from Valdez Arm into the Valdez Harbor past the southeast flank of Mount Thomas (see Fig. 2-17). The Narrows are about 0.8 mile wide and about 2 miles long. The selected spill site is off Potato Point at the southwest entrance into the Narrows at 61°5.56'N latitude and 146°22.22'W longitude.

(a) PHYSICAL CHARACTERISTICS

Much of the previous characterization of Valdez Harbor also applies to Valdez Narrows. Temperatures are similar. Winds are also expected to be similar with frequent calms and with predominant winds shifted slightly in direction from east-northeast to north-northeast in Winter and from southwest to south-southwest in Summer due to the alignment of the Narrows. Frequent wind gusts are also to be expected in and around the Narrows due to the complex topography.

SURFACE CURRENTS

In Valdez Narrows, both the *TIDAL CURRENT TABLES* [9] and the *COAST PILOT* [8] concur that tidal currents are too weak and variable to be predicted. The nearest reference to tides and currents is at the entrance to Port Fidalgo (east of Valdez Arm entrance) and north of Goose Island where current velocity is about 0.5 knot.[8] Diurnal tide range at nearby Snug Harbor is 12 ft.[8] Currents usually flow eastward with an average velocity of 0.8 knot. between Eleanor and Naked Islands in the middle of Prince William Sound. Hood, et al., [31] report current speeds in Valdez Narrows during December 1971 and March 1972: maximum tidal current of about 20-cm per sec (about 1 knot) and mean non-tidal currents of about 2 to 3-cm per sec (about 0.05 knot).

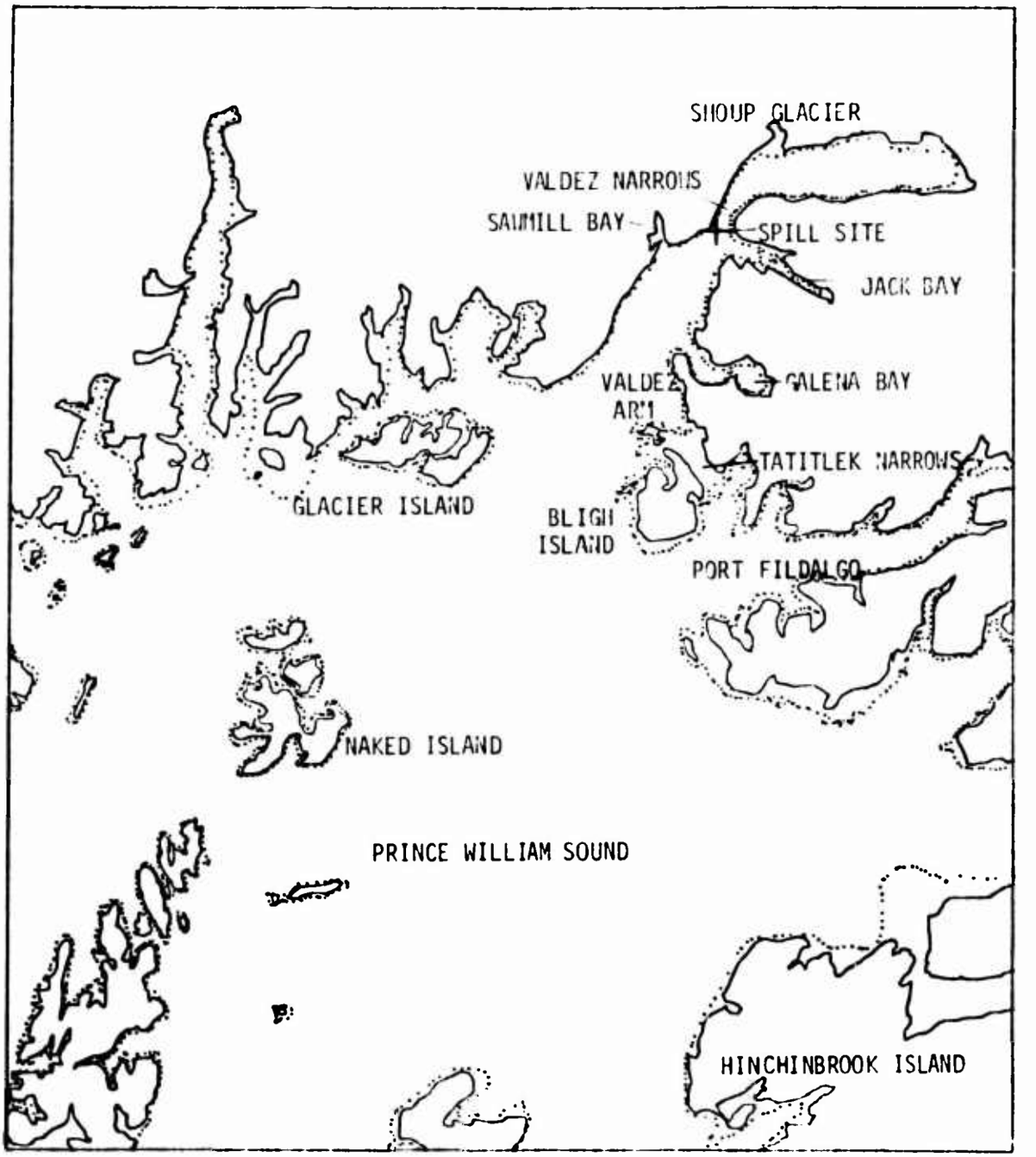


FIGURE 2-17. VALDEZ NARROWS LOCATION AND SPILL SITE.

NOTE: The broken line is the 10 fathom (60 ft.) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

These authors[31] also indicate that the above period is when runoff was at a minimum from December 1971 through April 1972. Therefore, higher surface velocities could exist during May through October when runoff is greater.

With these limited data, MSNW was required to make numerous assumptions in preparing surface current data as input for the oil dispersion modelling at Valdez Narrows. The following are the current directions and velocities used:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY (DIRECTION)	FLOOD VELOCITY (DIRECTION)
Valdez Narrows	0.8 K (210°)	0.5 k (030°)
Valdez Arm	0.7 K (210°)	0.4 K (030°)
Sawmill Bay (west side of Arm)	0.6 K (165°)	0.3 K (345°)
Jack Bay (east side of Arm)	0.6 K (300°)	0.3 K (120°)
Galena Bay (east side of Arm)	0.6 K (298°)	0.3 K (110°)
Tatitlek Narrows (east side of Arm entrance	0.6 K (330°)	0.4 K (150°)
Port Fidalgo	0.6 K (255°)	0.3 K (075°)
Glacier Island Channel (west side of Arm entrance)	0.5 K (250°)	0.4 K (070°)
Main Body of Prince William Sound adjacent to Valdez Arm	0.4 K (210°)	0.2 K (030°)

These represent MSNW's best approximations of most probable surface currents in the Valdez Narrows and vicinity.

(b) BIOLOGICAL CHARACTERISTICS

The greater portion of the previous section's (Valdez Harbor) biological characterization was generalized to Prince William Sound or combined Valdez Arm, Narrows, and Harbor comments. This common characterization of these two locations biologically is primarily due to the generalizations MSNW found in the available literature.

The common characterization of Valdez Harbor and Narrows was also completed because of MSNW's choice of a 50-km square area to encompass what was initially expected to be a maximum area of oil spill dispersion. With this physical characterization of study locations, these two locations overlap and also include a portion of the main body of Prince William Sound. This is consistent with the biological literature and with the assumption that oil spills of sufficient size in the Narrows and in the Harbor could reach the main body of the Sound.

Therefore, except for the portion of Valdez Harbor's biological description that was stated as specific to the Harbor, MSNW has assumed a similar distribution and abundance for Valdez Narrows, Valdez Arm, and the adjacent main portion of Prince William Sound.

Further details on the physical and biological characteristics are given in Appendix D .

(c) RESULTS

Spills in Valdez Narrows will block many of the passages in upper Prince William Sound, greatly affecting salmon and herring runs. Other species greatly impacted are shrimp and hard and soft-shelled bivalves.

The greatest impact is caused by the 50,000-bbl spill of diesel-2 in the Summer, followed by the 10,000-bbl spill of the same product. The large spills of crude and bunker C also resulted in high impact scores. The Winter impacts are lower in all cases due to the absence of many species.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Valdez Narrows. Both Summer and Winter scenarios resulted in oil moving from the spill site in a south-southwesterly direction in Prince William Sound (Fig. 2-18). The spills effectively blocked passage through the upper portion of Valdez Arm and moved along the north shore of the Sound to the west. The shoreline was judged to have been impacted on both sides of the Narrows within the first hour after spill.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-6 presents the results of the oil spill scenarios examined at Valdez Narrows without cleanup.

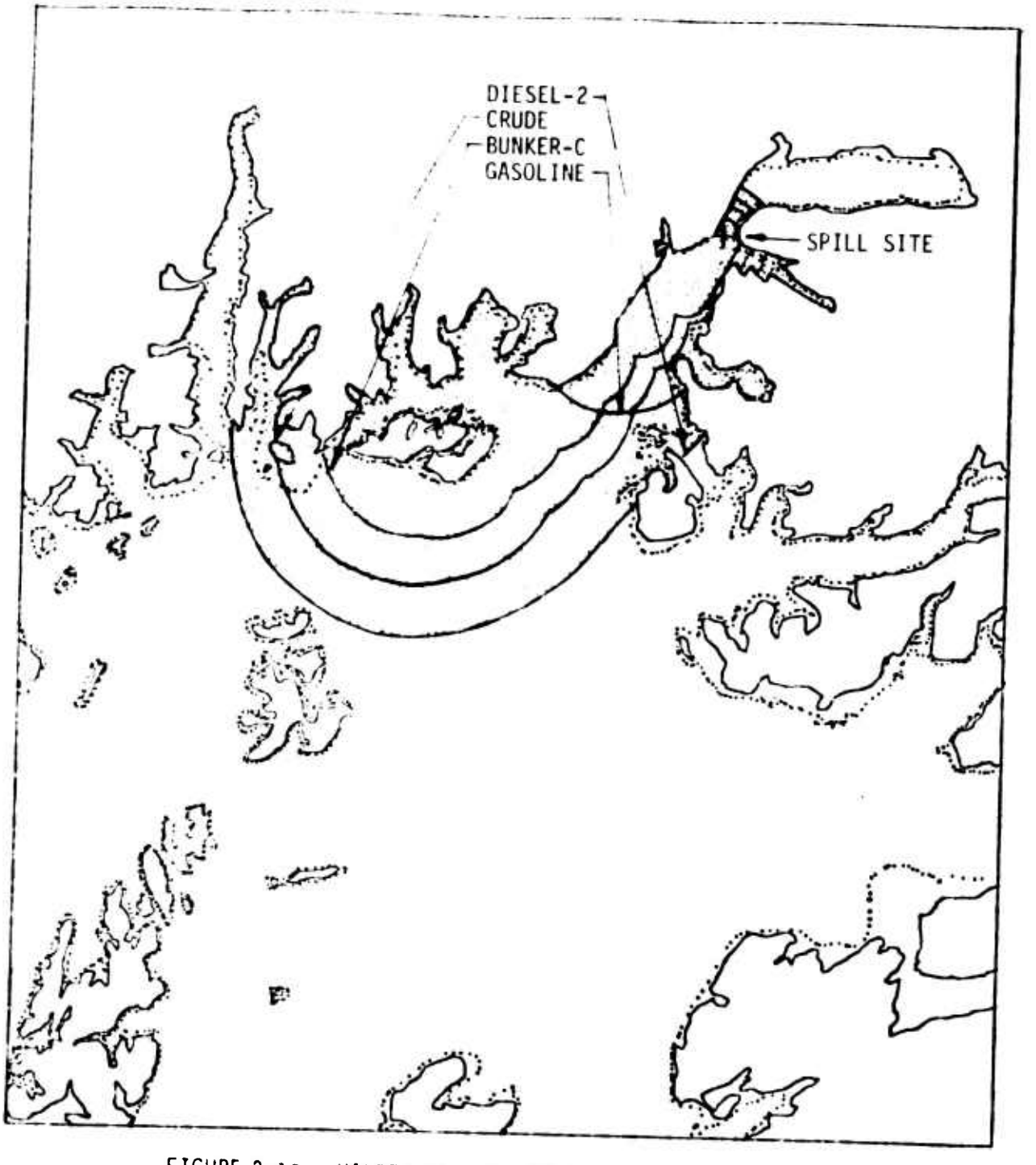


FIGURE 2-18. VALDEZ NARROWS 50,000 BBL SPILL ENVELOPES

TABLE 2-6. VALDEZ NARROWS CASE RESULTS, NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000	100
SUMMER	Diesel-2	21,898[1][2]	19,812 [2]	8,962 [13]	1,241 [22]
	Crude Oil[1]	19,437[3]	13,479 [7]	6,798 [14]	812 [24]
	Bunker-C [1]	13,609[6]	10,972 [10]	5,939 [16]	441 [27]
	Gasoline (1)	2,554[19]	1,394 [21]	388 [28]	31 [21]
WINTER	Diesel-2	14,018[5]	12,593 [8]	6,223 [15]	787 [25]
	Crude Oil[1]	14,338[4]	9,943 [11]	5,015 [17]	599 [26]
	Bunker-C [1]	11,486[9]	9,260 [12]	5,013 [18]	372 [29]
	Gasoline [1]	1,593[20]	870 [23]	242 [30]	22 [32]

[1]Case results for spill less than 50,000 bbls are estimated scores (see Yakutat Case Discussion).

[2]Numbers in brackets are the case numbers that follow.

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 21,898

THE PELAGIC HABITAT contributed 33 percent (7,191) of the impact score for this case. The species which were the main contributors to this impact score were phytoplankton (164), zooplankton (164), ichthyoplankton (109), herring (967), smelt (290), crab larvae (193), chum salmon (677), sockeye salmon (338), pink salmon (1,289), coho salmon (773), rainbow/steelhead trout (193), Dolly Varden (483), sea otter (120), and seabirds (1,208). Herring, pink salmon, Dolly Varden, and seabirds were among the most abundant species in this habitat. Herring, pink salmon, and coho salmon were rated an important commercial resource. Sockeye salmon, chum salmon and smelt were less important commercially. The salmon species, smelt, trout, and Dolly Varden were rated

somewhat important as a recreational resource. The smelt and salmon were rated as of minor importance for subsistence fishing. With the exception of sea otter, all of these species were judged to be among the most sensitive to a diesel-2 spill in this habitat. Sea otter and seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (2,726) of the impact score for this case. The species which were the main contributors to this impact score were Dungeness crab (387), shrimp (1,611), and other marine invertebrates (273). The shrimp and invertebrates were among the most abundant species in the habitat. Shrimp were rated as an important commercial resource and crab of minor commercial importance. Shrimp were rated as of moderate recreational and subsistence importance and crabs of minor subsistence importance. All three species were among those judged to be the most sensitive to a diesel-2 spill in this habitat.

THE SUBTIDAL/ROCK/COBBLE/GRAVEL HABITAT contributed 12 percent (2,602) of the impact score for this case. The species which were the main contributors to this impact score were chum salmon (328), Pacific halibut (144), other flatfish (160), rockfish (240), walleye pollock (160), king crab (328), Tanner crab (456), scallops (164), and other marine invertebrates (410). The flatfish, rockfish, pollock, Tanner crab, and invertebrates were among the most abundant in this habitat. Halibut and rockfish were rated as important commercial resources. The salmon, flatfish, pollock, and king crab were rated as moderately important as commercial resources. Tanner crab and scallops were rated as of minor importance for subsistence fishing. The salmon, crabs, and invertebrates were judged to be the most sensitive to a diesel-2 spill in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 18 percent (3,913) of the impact score for this case. The species which were the main contributors to this impact score were Pacific sandlance (145), razor clams (290), softshell bivalves (1,450), invertebrate infauna (725), shorebirds (806), geese (102), ducks (128), and swans (255). The bivalves, infauna and shorebirds were the most abundant species in this habitat. Geese and ducks were rated as having minor commercial importance. Bivalves were rated as having major recreational importance and clams, geese and ducks were rated as having moderate recreational importance. Clams and bivalves were rated as moderate and minor in subsistence importance. Sandlance, clams, bivalves, infauna and shorebirds were judged to be the most sensitive to a diesel-2 spill in this habitat. Shorebirds were classified as protected and swans were classified as endangered due to the probable presence of trumpeter swans.

THE INTERTIDAL ROCKY HABITAT contributed 10 percent (2,157) of the impact score for this case. The species which were the main contributors to this impact score were intertidal seaweeds (180), herring (806), sessile marine invertebrates (137), miscellaneous crustaceans (219), other invertebrates (273), shorebirds (242), and marine mammal rookeries (200). With the exception of crustaceans and shorebirds, these species were the most abundant in this habitat. Herring was rated as having major commercial importance. Crustaceans were rated as having minor recreational and subsistence importance. With the exception of seaweed and rookeries, these species were judged to be the most sensitive to a diesel-2 spill in this habitat. Shorebirds and rookeries were classified as protected.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 11 percent (2,350) of the impact score for this case. All species in this habitat contributed substantially to the impact score for this case. The results were intertidal seaweed (120), smelt (290), hardshell bivalves (1,208), crustaceans (322), gastropods (273), and shorebirds (137). Seaweed, bivalves, crustaceans, and gastropods were the most abundant species in this habitat. Smelt were rated as of minor importance commercially, recreationally and for subsistence. Bivalves were rated as of moderate recreational value and of minor subsistence value. With the exception of seaweed, all species were judged to be relatively sensitive to a diesel-2 spill in this habitat. Shorebirds were classified as protected.

THE TERRESTRIAL HABITAT contributed 4 percent (959) of the impact score for this case. The species which were the main contributors in this habitat were other vegetation (280), other mammals (120), and raptors (300). The vegetation and raptors were among the most abundant species in this habitat. The vegetation and mammals were of moderate commercial importance and of minor subsistence importance. Vegetation was also of moderate recreational importance. Raptors were classified as protected. Table 2-7 presents the full results for Case 1.

CASE 2: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 19,812

THE PELAGIC HABITAT contributed 33 percent (6,532) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Pacific Sandlance	reduced to	38	from	82

TABLE 2-7. MATRIX RESULTS-- CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	VALDEZ NARROWS
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

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RESOURCE/SPECIES	FACTORS: ABUNDANCE ANN.	ABUNDANCE CONF.	IMPORTANCE COM.	IMPORTANCE REC.	IMPORTANCE SUB.	IMPORTANCE ECOL.	IMPACT S.TRM	IMPACT L.TRM	RESULTS: IMPACT S.TRM	IMPACT L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	5	A	0	0	0	3	4	1	162	18	180
2. ZOOPLANKTON	6	A	0	0	0	3	4	1	162	18	180
3. ICHTHYOPLANKTON	5	A	0	0	0	2	4	1	108	12	120
4. HERRING SCHOOLS	1	A	0	0	0	2	1	0	40	0	40
5. HERRING EGGS	3	A	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	3	A	0	0	0	3	4	1	81	9	90
7. HERRING	10	A	3	0	0	3	4	0	240	480	960
8. SMELT	3	A	1	1	1	3	4	0	162	144	240
9. SMELT LARVAE	6	C	0	0	0	2	4	0	108	96	192
10. KING SALMON	1	A	1	2	1	2	0	0	54	48	97
11. CHUM SALMON	3	A	2	2	1	2	4	0	324	336	677
12. SOCKEYE SALMON	3	A	2	2	1	2	4	0	189	168	336
13. PINK SALMON	10	A	3	2	1	2	4	0	720	640	1280
14. COHO SALMON	6	A	3	2	1	2	4	0	432	384	773
15. ADULT SCHOOLING RED TROUT	3	A	0	1	0	1	4	0	108	96	193
16. ADULT HERRING	10	A	0	2	0	1	4	0	270	240	483
17. NO IMPACT FOR SEAL	3	A	0	0	0	5	0	0	0	0	0
18. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
19. SEA LIONS	10	A	0	0	0	5	0	0	0	0	0
20. WHALES	10	A	0	0	0	5	0	0	0	0	0
21. SEA OTTER	5	A	0	0	0	5	4	3	120	0	120
22. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
23. SEABIRDS	15	A	0	0	0	5	4	3	675	600	1208
									4313	3289	7191
2. INTERTIDAL SAND-MUD											
1. CLAMS	10	A	2	1	1	2	1	0	60	0	60
2. BENTHOS	6	A	0	0	0	2	4	1	48	12	51
3. STARRY FLOUNDER	10	A	2	0	0	2	1	0	40	0	40
4. OTHER FLATFISH	10	A	2	0	0	2	1	0	40	0	40
5. PACIFIC SANDLANCE	3	A	0	0	0	3	4	1	36	9	38

TABLE 2-7 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	10	4	0	0	0	2	4	0	80	0	80
7. [illegible] CRAB	0	A	1	0	1	2	9	0	216	192	387
8. SHRIMP	10	A	3	2	2	3	9	0	900	800	1611
9. RAZOR CLAM	3	M	0	0	0	2	9	1	54	6	55
10. OTHER BIVALVES	10	A	0	0	0	1	9	1	90	10	91
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	9	1	270	30	273
									1834	1059	2726
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. [illegible] SEAWEED	10	M	0	0	0	2	1	0	30	0	30
2. SUBTIDAL SEAWEED	10	M	0	0	0	2	1	0	30	0	30
3. OTHER KELPS	0	A	4	1	4	2	9	1	324	36	328
4. PACIFIC HALIBUT	0	A	3	1	3	2	4	0	144	0	144
5. OTHER FLATFISH	10	A	4	0	3	2	4	0	160	0	160
6. [illegible]	0	A	0	1	3	2	4	0	72	0	72
7. ROCKFISH	10	A	3	1	3	2	4	0	240	0	240
8. [illegible] MOLLUSK	10	A	2	0	3	2	4	0	160	0	160
9. OTHER MARINE FISH	10	A	0	0	0	2	4	0	80	0	80
10. KING CRAB	0	A	2	1	1	2	9	1	324	36	328
11. TANNER CRAB	10	A	1	1	1	2	9	1	450	50	456
12. DUNGENESS	3	A	1	0	0	2	9	1	162	18	164
13. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	9	1	405	45	410
									2581	185	2602
4. INTERTIDAL SAND-MUD											
1. [illegible]	1	4	0	0	4	3	4	0	12	0	12
2. PACIFIC [illegible]	3	M	0	0	0	3	9	0	81	72	145
3. RAZOR CLAM	5	A	0	2	2	2	9	0	162	144	290
4. [illegible]	15	A	0	4	1	2	9	0	810	720	1456
5. INVERTEBRATE INFAUNA	15	A	0	0	0	3	9	0	405	360	725
6. MARINE MAMMAL HOUSERIES	0	A	0	0	0	5	0	0	0	0	0
7. SHOREBIRDS	10	P	0	0	0	5	9	0	450	400	806
8. GEESE	0	A	1	2	0	1	4	1	96	24	102
9. DUCKS	0	A	1	2	0	2	4	1	120	30	128
10. SWANS	0	A	0	0	0	0	4	1	240	60	255
									2376	1810	3913

5. INTERTIDAL ROCK

TABLE 2-7 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	ENV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	15	4	0	0	0	3	4	0	180	0	180
2. BARNACLES	3	A	0	1	0	2	4	0	36	0	36
3. MUSSELS	10	A	3	0	0	2	9	8	460	460	860
4. SESSILE MARINE INVERTEBRATES	15	A	0	0	3	1	9	1	135	15	137
5. MOBILE CRUSTACEANS	8	A	0	1	1	2	9	1	216	24	219
6. OTHER INVERTEBRATES	10	A	0	0	0	3	9	1	270	30	273
7. SHOREBIRDS	3	P	0	0	0	5	9	8	135	120	242
8. SEA BIRDS	3	A	1	2	0	2	4	1	60	15	64
9. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	4	0	200	0	200
									1682	604	2157
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	4	0	0	0	3	4	0	120	0	120
2. SMELT	3	A	1	1	1	3	9	8	162	144	290
3. MARSHALL BIVALVES	15	A	0	2	1	2	9	8	675	900	1208
4. CRUSTACEANS	10	A	0	0	0	2	9	8	180	160	322
5. SHOREBIRDS	10	A	0	0	0	3	9	1	270	30	273
6. SHOREBIRDS	3	P	0	0	0	5	9	1	135	15	137
									1542	949	2350
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	4	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	4	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	2	1	2	0	0	0	0	0
4. CHUM SALMON	6	A	0	3	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	2	1	2	0	0	0	0	0
6. PINK SALMON	15	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	6	A	0	2	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	9	A	0	2	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	A	0	2	1	1	0	0	0	0	0
10. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
11. OTHER FISH	6	A	0	0	0	2	0	0	0	0	0
12. DUCKS	8	A	1	2	0	2	0	0	0	0	0
13. GEESE	10	A	1	2	0	2	0	0	0	0	0
14. SWANS	15	A	0	0	0	4	0	0	0	0	0
15. RIVER OTTER	6	A	2	0	1	1	0	0	0	0	0
16. MINK	8	A	2	0	1	1	0	0	0	0	0
17. MUSKRAT	8	A	2	0	1	1	0	0	0	0	0
18. OTHER AQUATIC MAMMALS	8	A	2	0	1	1	0	0	0	0	0
									0	0	0

TABLE 2-7 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS: ABUNDANCE INV.	ABUNDANCE CONF.	IMPORTANCE COM.	IMPORTANCE REC.	IMPORTANCE SUB.	IMPORTANCE ECOL.	IMPACT S.TRM	IMPACT L.TRM	RESULTS: IMPACT S.TRM	IMPACT L.TRM	RSLT.
B. TERRESTRIAL											
1. TUNDRA	1	A	0	0	0	3	0	0	0	0	0
2. MARSHLAND VEGETATION	10	M	0	0	0	2	1	0	20	0	20
3. SEAWEED VEGETATION	6	M	0	0	0	1	9	0	54	0	54
4. OTHER VEGETATION	10	A	2	2	1	2	4	0	280	0	260
5. BROWN BEAR	3	A	2	1	0	2	1	0	15	0	15
6. BLACK BEAR	5	A	1	3	1	5	1	0	60	0	60
7. MUSKRATS	3	A	1	0	0	1	4	0	24	0	24
8. MOOSE	3	A	1	0	0	1	1	0	6	0	6
9. DEER	1	A	0	1	1	2	0	0	0	0	0
10. BEAR	6	A	1	1	1	2	0	0	0	0	0
11. BEARS	6	A	1	2	1	1	0	0	0	0	0
12. OTHER MAMMALS	6	A	2	0	1	2	4	0	120	0	120
13. RAPTORS	15	A	0	0	0	5	4	0	300	0	300
14. PTARMIGAN	6	P	0	1	1	2	0	0	0	0	0
15. OTHER BIRDS	10	P	0	0	0	2	4	0	80	0	80
									959	0	959
									15287	7896	21898

Sea Otter	reduced to	30	from 120
Seabirds	reduced to	683	from 1,208

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (2,439) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Miscellaneous Marine Fish	reduced to	20	from 80
Razor Clams	reduced to	26	from 55
Other Bivalves	reduced to	43	from 91
Other Marine Invertebrates	reduced to	128	from 273

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 13 percent (2,602) of the impact score for this case. This habitat's result was the same as for Case 1.

THE INTERTIDAL SAND/MUD HABITAT contributed 18 percent (3,525) of the impact score for this case. Only shorebirds reduced to 456 from 806 contributed significantly to the decreased impact score for this habitat from Case 1.

THE INTERTIDAL ROCKY HABITAT contributed 10 percent (1,902) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Shorebirds	reduced to	137 from 242
Marine Mammal Rookeries	reduced to	50 from 200

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 10 percent (1,921) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Intertidal Seaweed	reduced	to	30	from	120
Smelt	reduced	to	164	from	290
Crustaceans	reduced	to	182	from	322
Shorebirds	reduced	to	64	from	137

THE TERRESTRIAL HABITAT contributed 4 percent (891) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Riparian Vegetation	reduced	to	0	from	20
Strand Vegetation	reduced	to	24	from	54

CASE 3: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 19,437

THE PELAGIC HABITAT contributed 21 percent (4,008) of the impact score for this case. With minor exceptions, the change in impact score from Case 2 is accounted for by the following species:

Floating Seaweed	increased	to	80	from	20
Harbor Seal	increased	to	50	from	0
Sea Otter	increased	to	128	from	30
Phytoplankton	reduced	to	77	from	164
Zooplankton	reduced	to	77	from	164
Ichthyoplankton	reduced	to	51	from	109
Greenlings	reduced	to	0	from	24
Pacific Sandlance	reduced	to	9	from	38
Smelt	reduced	to	164	from	290
King Salmon	reduced	to	26	from	97
Chum Salmon	reduced	to	179	from	677

Sockeye Salmon	reduced	to	89	from 338
Pink Salmon	reduced	to	340	from 1,289
Coho Salmon	reduced	to	204	from 773

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (2,565) of the impact score for this case. The change in impact score for this habitat from Case 2 is accounted for by the following species:

Cod	increased	to	255	from 60
Sculpins	increased	to	109	from 48
Other Flatfish	increased	to	170	from 40
Pacific Sandlance	increased	to	82	from 36
Miscellaneous Marine Fish	increased	to	80	from 20
Razor Clams	increased	to	97	from 23
Other Bivalves	increased	to	161	from 46
Other Marine Invertebrates	increased	to	273	from 128
Shrimp	reduced	to	911	from 1,611

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (3,564) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 2 is accounted for by the following species:

Floating Seaweed	increased	to	120	from 30
Subtidal Seaweed	increased	to	120	from 30
King Crab	increased	to	580	from 328
Tanner Crab	increased	to	806	from 456
Scallops	increased	to	290	from 164

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (4,016) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 2 is accounted for by the following species:

Marine Mammal Rookeries	increased	to 120	from	0
Ducks	increased	to 483	from	120
Swans	increased	to 547	from	240
Invertebrate Infauna	reduced	to 410	from	725

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (2,621) of the impact score for this case. The increase in impact score for this habitat from Case 2 is accounted for by the following species:

Sessile Marine Invertebrates	increased	to 242	from	137
Miscellaneous Crustaceans	increased	to 387	from	219
Other Invertebrates	increased	to 483	from	137
Sea Ducks	increased	to 137	from	64
Marine Mammal Rookeries	increased	to 213	from	50

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (1,685) of the impact score for this case. The change in impact score for this habitat from Case 2 is accounted for by the following species:

Intertidal Seaweed	increased	to 120	from	30
Smelt	increased	to 290	from	164
Shorebirds	increased	to 137	from	64
Hardshell Bivalves	reduced	to 683	from	1,208

THE TERRESTRIAL HABITAT contributed 5 percent (978) of the impact score for this case. With minor exceptions, the increase in impact score for

this habitat from Case 2 is accounted for by the following species:

Riparian Vegetation	increased	to	20	from	0
Strand Vegetation	increased	to	55	from	24

CASE 4: WINTER, CRUDE OIL, 50,000 BBLS, VALDEZ NARROWS - IMPACT SCORE 14,338

THE PELAGIC HABITAT contributed 11 percent (1,575) of the impact score for this case. Crab larvae and the five salmon species not present in Winter case account for a decrease of 1,031 in the impact score for this habitat from Case 3. With minor exceptions, the remainder of the decrease in impact score for this habitat is accounted for by the following species:

Phytoplankton	reduced	to	38	from	77
Zooplankton	reduced	to	38	from	77
Ichthyoplankton	reduced	to	26	from	51
Floating Seaweed	reduced	to	48	from	80
Herring	reduced	to	580	from	967
Rainbow/Steelhead Trout	reduced	to	97	from	193
Dolly Varden	reduced	to	145	from	483
Harbor Seal	reduced	to	30	from	50
Seabirds	reduced	to	273	from	683

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (1,977) of the impact score for this case. The decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Cod	reduced	to	153	from	255
Starry Flounder	reduced	to	12	from	40
Other Flatfish	reduced	to	102	from	170

Pacific Sandlance	reduced	to	27	from	82
Miscellaneous Marine Fish	reduced	to	48	from	80
Dungeness Crab	reduced	to	193	from	387
Other Marine Invertebrates	reduced	to	164	from	273

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (2,600) of the impact score for this case. The decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Chum Salmon	not present			from	328
Floating Seaweed	reduced	to	48	from	120
Subtidal Seaweed	reduced	to	80	from	120
Pacific Halibut	reduced	to	77	from	153
Other Flatfish	reduced	to	102	from	170
Greenlings	reduced	to	38	from	77
Rockfish	reduced	to	153	from	255
Walleye Pollock	reduced	to	102	from	170
Other Marine Fish	reduced	to	51	from	85
Other Marine Invertebrates	reduced	to	273	from	410

THE INTERTIDAL SAND/MUD HABITAT contributed 28 percent (3,967) of the impact score for this case. The change in impact score for this habitat from Case 3 is accounted for by the following species:

Ducks	increased	to	806	from	483
Pacific Sandlance	reduced	to	32	from	145
Invertebrate Infauna	reduced	to	273	from	410
Swans	reduced	to	425	from	547

THE INTERTIDAL ROCKY HABITAT contributed 14 percent (2,066) of the impact score for this habitat. The change in impact score for this habitat from Case 3 is accounted for by the following species:

Sea Ducks	increased	to	273 from	137
Intertidal Seaweed	reduced	to	120 from	180
Greenlings	reduced	to	12 from	36
Herring	reduced	to	483 from	806
Other Invertebrates	reduced	to	290 from	483
Shorebirds	reduced	to	46 from	137

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 10 percent (1,364) of the impact score for this case. The decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Intertidal Seaweed	reduced	to	72 from	120
Crustaceans	reduced	to	109 from	182
Gastropods	reduced	to	164 from	273
Shorebirds	reduced	to	46 from	137

THE TERRESTRIAL HABITAT contributed 6 percent (789) of the impact score for this case. Strand vegetation, brown and black bears not present in Winter accounted for a decrease in impact score of 130 for this habitat from Case 3. With minor exceptions, the remaining change in impact score is accounted for by the following species:

Deer	increased	to	200 from	0
Other Vegetation	reduced	to	129 from	278
Raptors	reduced	to	200 from	300
Other Birds	reduced	to	48 from	80

CASE 5: WINTER, DIESEL-2, 50,000 BBLS - IMPACT SCOPE 14,018

THE PELAGIC HABITAT contributed 14 percent (1,975) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Phytoplankton	increased	to	82	from	38
Zooplankton	increased	to	82	from	38
Ichthyoplankton	increased	to	55	from	26
Pacific Sandlance	increased	to	27	from	3
Smelt	increased	to	290	from	164
Seabirds	increased	to	483	from	273
Floating Seaweed	reduced	to	12	from	48
Harbor Seal	reduced	to	0	from	30

THE SUBTIDAL SAND/MUD HABITAT contributed 16 percent (2,298) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Shrimp	increased	to	1,611	from	911
Cod	reduced	to	36	from	153
Sculpins	reduced	to	51	from	109
Other Flatfish	reduced	to	24	from	102
Razor Clams	reduced	to	55	from	97
Other Bivalves	reduced	to	91	from	161

THE SUBTIDAL/ROCK/COBBLE GRAVEL HABITAT contributed 13 percent (1,837) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Pacific Halibut	increased	to	164	from 77
Floating Seaweed	reduced	to	12	from 48
Subtidal Seaweed	reduced	to	20	from 80
King Crab	reduced	to	328	from 580
Tanner Crab	reduced	to	456	from 806
Scallops	reduced	to	164	from 290

THE INTERTIDAL SAND/MUD HABITAT contributed 27 percent (3,813) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Invertebrate Infauna	increased	to	483	from 273
Shorebirds	increased	to	806	from 456
Marine Mammal Rookeries	reduced	to	0	from 120
Ducks	reduced	to	213	from 806

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (1,544) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Shorebirds	increased	to	81	from 46
Sessile Marine Invertebrates	reduced	to	137	from 242
Miscellaneous Crustaceans	reduced	to	219	from 387
Other Invertebrates	reduced	to	164	from 290
Sea Ducks	reduced	to	128	from 273

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 14 percent (1,973) of the impact score for this case. The increase in impact score for this habitat from Case 4 is accounted for by the following species:

Hardshell Bivalves	increased to 1,208 from 683
Crustaceans	increased to 193 from 109

THE TERRESTRIAL HABITAT contributed 4 percent (578) of the impact score for this case. With a minor exception, deer reduced to 0 from 200 accounted for the decrease in impact score for this habitat from Case 4.

CASE 6: SUMMER, BUNKER-C, 50,000 BBLS - IMPACT SCORE 13,609

THE PELAGIC HABITAT contributed 9 percent (1,236) of the impact score for this case. The species not present in Winter cases accounted for an increase of 248 in the impact score for this habitat from Case 5. With minor exceptions, remaining change in impact score is accounted for by the following species:

Harbor Seal	increased to 50 from 0
Phytoplankton	reduced to 18 from 82
Zooplankton	reduced to 18 from 82
Ichthyoplankton	reduced to 12 from 55
Herring	reduced to 255 from 580
Smelt	reduced to 72 from 290
Rainbow/Steelhead Trout	reduced to 51 from 97
Seabirds	reduced to 319 from 483

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (1,604) of the impact score for this habitat. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Cod	increased to 60 from 36
Starry Flounder	increased to 40 from 12

Pacific Sandlance	increased	to	36	from 13
Dungeness Crab	increased	to	219	from 193
Razor Clam	increased	to	97	from 55
Other Bivalves	increased	to	161	from 91
Other Marine Invertebrates	increased	to	483	from 164
Miscellaneous Marine Fish	reduced	to	20	from 48
Shrimp	reduced	to	400	from 1,611

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 21 percent (2,855) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Chum Salmon	increased	to	144	from not present
Floating Seaweed	increased	to	120	from 12
King Crab	increased	to	720	from 328
Tanner Crab	increased	to	1,000	from 456
Scallops	increased	to	360	from 164
Pacific Halibut	reduced	to	72	from 164
Rockfish	reduced	to	60	from 144
Walleye Pollock	reduced	to	40	from 96
Other Marine Fish	reduced	to	20	from 48
Other Marine Invertebrates	reduced	to	191	from 273

THE INTERTIDAL SAND/MUD HABITAT contributed 38 percent (5,197) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Razor Clams	increased	to	1,620	from 290
Invertebrate Infauna	increased	to	725	from 483

Marine Mammal Rookeries	increased	to	60	from	0
Ducks	reduced	to	128	from	213
Swans	reduced	to	255	from	425

THE INTERTIDAL ROCKY HABITAT contributed 9 percent (1,198) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Intertidal Seaweed	increased	to	191	from	120
Sessile Marine Invertebrates	increased	to	300	from	137
Herring	reduced	to	213	from	483
Miscellaneous Crustaceans	reduced	to	24	from	219
Other Invertebrates	reduced	to	128	from	164
Shorebirds	reduced	to	60	from	81
Sea Ducks	reduced	to	60	from	128

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (934) of the impact score for this case. All species had significantly changed impact scores in this habitat from Case 5. The changes were as follows:

Intertidal Seaweed	increased	to	128	from	72
Shorebirds	increased	to	300	from	46
Smelt	reduced	to	72	from	290
Hardshell Bivalves	reduced	to	319	from	1,208
Crustaceans	reduced	to	85	from	193
Gastropods	reduced	to	30	from	164

THE TERRESTRIAL HABITAT contributed 4 percent (585) of the impact score for this case. The species not present in the Winter case accounted for an

increase of 130 in this habitat from Case 5. With minor exceptions, the remaining change was accounted for by the following species:

Other Vegetation	increased to 298 from 168
Other Mammals	reduced to 30 from 120
Raptors	reduced to 75 from 200
Other Birds	reduced to 20 from 48

CASE 7: SUMMER, CRUDE OIL, 10,000 BBLS - ESTIMATED SCORE 13,479

THE PELAGIC HABITAT contributed 21 percent (2,729) of the score for this case. The main contributing species to this score in this habitat were judged to be herring, crab larvae, chum salmon, pink salmon, coho salmon, rainbow/steelhead trout, Dolly Varden and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (1,779) of the score for this case. The main contributing species to this score in this habitat were judged to be cod, other flatfish, Dungeness crab, shrimp, and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (2,472) of the score for this case. The main contributing species to this score in this habitat were judged to be chum salmon, other flatfish, rockfish, walleye pollock, king crab, tanner crab, scallops, and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (2,785) of the score for this case. The main contributing species to this score in this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, shorebirds, ducks, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (1,818) of the score for this case. The main contributing species to this score in this habitat

were judged to be intertidal seaweed, herring, sessile marine invertebrates, miscellaneous crustaceans, other invertebrates, and marine mammal rookeries.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (1,168) of the score for this case. The main contributing species to this score in this habitat were judged to be smelt, hardshell bivalves, crustaceans, and gastropods.

THE TERRESTRIAL HABITAT contributed 5 percent (678) of the score for this case. The main contributing species to this score in this habitat were judged to be other vegetation, other mammals and raptors.

CASE 8: WINTER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 12,593

THE PELAGIC HABITAT contributed 13 percent (1,661) of the impact score for this case. The species not present in Winter cases in this habitat accounted for a decrease of 248 from Case 6. The remaining change in impact score is accounted for by the following species:

Phytoplankton	increased	to	82	from	18
Zooplankton	increased	to	82	from	18
Ichthyoplankton	increased	to	55	from	12
Herring	increased	to	580	from	255
Smelt	increased	to	290	from	72
Rainbow/Steelhead Trout	increased	to	97	from	51
Harbor Seal	reduced	to	0	from	50
Seabirds	reduced	to	273	from	319

THE SUBTIDAL SAND/MUD HABITAT contributed 17 percent (2,094) of the impact score for this case. With minor exceptions, the change in impact score

for this habitat from Case 6 is accounted for by the following species:

Shrimp	increased	to	1,611	from	400
Cod	reduced	to	36	from	60
Starry Flounder	reduced	to	12	from	40
Pacific Sandlance	reduced	to	12	from	36
Dungeness Crab	reduced	to	193	from	219
Razor Clams	reduced	to	26	from	97
Other Bivalves	reduced	to	43	from	161
Other Marine Invertebrates	reduced	to	77	from	483

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 15 percent (1,837) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Pacific Halibut	increased	to	164	from	72
Rockfish	increased	to	144	from	60
Walleye Pollock	increased	to	96	from	40
Other Marine Invertebrates	increased	to	273	from	191
Other Marine Fish	increased	to	48	from	20
Chum Salmon	not present			from	144
Floating Seaweed	reduced	to	12	from	120
King Crab	reduced	to	328	from	720
Tanner Crab	reduced	to	456	from	1,000
Scallops	reduced	to	164	from	360

THE INTERTIDAL SAND/MUD HABITAT contributed 27 percent (3,410) of the impact score for this case. With minor exceptions, the change in impact score

for this habitat from Case 6 is accounted for by the following species:

Ducks	increased	to	200	from	128
Swans	increased	to	400	from	255
Razor Clams	reduced	to	290	from	1,620
Invertebrate Infauna	reduced	to	483	from	725
Marine Mammal Rookeries	reduced	to	0	from	60
Shorebirds	reduced	to	456	from	806

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (1,359) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Miscellaneous Crustaceans	increased	to	219	from	24
Other Invertebrates	increased	to	164	from	128
Sea Ducks	increased	to	128	from	60
Intertidal Seaweed	reduced	to	120	from	191
Herring	reduced	to	483	from	213
Sessile Marine Invertebrates	reduced	to	137	from	300
Marine Mammal Rookeries	reduced	to	50	from	213

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 13 percent (168) of the impact score for this case. All species impact scores were significantly changed in this habitat from Case 6. The impact scores were as follows:

Smelt	increased	to	164	from	72
Hardshell Bivalves	increased	to	1,208	from	319
Crustaceans	increased	to	109	from	85
Gastropods	increased	to	164	from	30

Intertidal Seaweed	reduced	to	18	from	128
Shorebirds	reduced	to	21	from	300

THE TERRESTRIAL HABITAT contributed 4 percent (548) of the impact score for this case. The species not present in Winter cases accounted for a decrease of 130 in this habitat from Case 6. The remaining change in impact score is accounted for by the following species:

Raptors	increased	to	200	from	75
Other Birds	increased	to	48	from	20
Other Mammals	increased	to	120	from	30
Riparian Vegetation	reduced	to	0	from	20
Other Vegetation	reduced	to	168	from	298

CASE 9: WINTER, BUNKER-C, 50,000 BBLS - IMPACT SCORE 11,486

THE PELAGIC HABITAT contributed 4 percent (518) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Harbor Seal	increased	to	30	from	0
Phytoplankton	reduced	to	9	from	82
Zooplankton	reduced	to	9	from	82
Ichthyoplankton	reduced	to	6	from	55
Herring	reduced	to	153	from	580
Smelt	reduced	to	72	from	290
Rainbow/Steelhead Trout	rediced	to	26	from	97
Dolly Varden	reduced	to	38	from	145
Seabirds	reduced	to	128	from	273

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (1,201) of the impact score for this case. The change in impact score for this habitat from Case 8 is accounted for by the following species:

Razor Clams	increased	to	97	from	26
Other Bivalves	increased	to	161	from	43
Other Marine Invertebrates	increased	to	290	from	77
Dungeness Crab	reduced	to	109	from	193
Shrimp	reduced	to	400	from	1,611

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 21 percent (2,441) of the impact score for this case. The change in impact score for this habitat from Case 8 is accounted for by the following species:

Floating Seaweed	increased	to	48	from	12
King Crab	increased	to	720	from	328
Tanner Crab	increased	to	1,000	from	456
Scallops	increased	to	360	from	164
Pacific Halibut	reduced	to	36	from	164
Other Flatfish	reduced	to	48	from	96
Greenlings	reduced	to	9	from	36
Rockfish	reduced	to	36	from	144
Walleye Pollock	reduced	to	24	from	96
Other Marine Fish	reduced	to	12	from	48
Other Marine Invertebrates	reduced	to	128	from	273

THE INTERTIDAL SAND/MUD HABITAT contributed 45 percent (5,181) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 8 is accounted for by the following species:

Razor Clam	increased	to	1,620	from	290
Marine Mammal Rookeries	increased	to	60	from	0
Shorebirds	increased	to	806	from	456
Swans	increased	to	425	from	400

THE INTERTIDAL ROCKY HABITAT contributed 9 percent (1,013) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Sessile Marine Invertebrates	increased	to	300	from	137
Marine Mammal Rookeries	increased	to	213	from	50
Herring	reduced	to	128	from	483
Miscellaneous Crustaceans	reduced	to	24	from	219
Other Invertebrates	reduced	to	77	from	164
Shorebirds	reduced	to	20	from	46

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (637) of the impact score for this case. All species impact scores were significantly reduced in this habitat from Case 8. The changes were as follows:

Intertidal Seaweed	increased	to	77	from	18
Shorebirds	increased	to	100	from	21
Smelt	reduced	to	72	from	164
Hardshell Bivalves	reduced	to	319	from	1,208
Crustaceans	reduced	to	51	from	109
Gastropods	reduced	to	18	from	164

THE TERRESTRIAL HABITAT contributed 4 percent (495) of the impact score for this case. With minor exceptions, the change in impact score for

this habitat from Case 8 is accounted for by the following species:

Deer	increased to 200 from 0
Other Mammals	reduced to 30 from 120
Raptors	reduced to 50 from 200
Other Birds	reduced to 12 from 48

CASE 10: SUMMER, BUNKER-C, 10,000 BBLS - ESTIMATED SCORE 10,972

THE PELAGIC HABITAT contributed 9 percent (997) of the score for this case. The main contributing species to the score in this habitat were judged to be herring, Dolly Varden, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (1,293) of the score for this case. The main contributing species to the score in this habitat were judged to be Dungeness crab, shrimp, other bivalves, and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 21 percent (2,302) of the score for this case. The main contributing species to the score in this habitat were judged to be floating seaweed, chum salmon, king crab, Tanner crab, scallops, and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 38 percent (4,189) of the score for this case. The main contributing species to the score in this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, shorebirds, geese, ducks, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 9 percent (966) of the score for this case. The main contributing species to the score in this habitat were judged to be intertidal seaweed, herring, sessile marine invertebrates, other invertebrates, and marine mammal rookeries.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (753) of the score for this case. The main contributing species to the score in this habitat were judged to be intertidal seaweed, hardshell bivalves, and shorebirds.

THE TERRESTRIAL HABITAT contributed 4 percent (472) of the score for this case. The main contributing species to the score in this habitat were judged to be other vegetation, raptors, and bears.

CASE 11: WINTER, CRUDE OIL, 50,000 BBLS - ESTIMATED SCORE 9,943

THE PELAGIC HABITAT contributed 11 percent (1,092) of the score for this case. The main contributing species to the score in this habitat were judged to be herring, smelt, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (1,371) of the score for this case. The main contributing species to the score in this habitat were judged to be cod, Dungeness crab, shrimp, other bivalves, and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (1,803) of the score for this case. The main contributing species to the score in this habitat were judged to be rockfish, king crab, Tanner crab and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 28 percent (2,751) of the score for this case. The main contributing species to the score in this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, shorebirds, ducks, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 14 percent (1,433) of the score for this case. The main contributing species to the score in this habitat were

judged to be herring, sessile marine invertebrates, miscellaneous crustaceans, other invertebrates, sea ducks, and marine mammal rookeries.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 10 percent (946) of the score for this case. The main contributing species to the score in this habitat were judged to be smelt, hardshell bivalves, and gastropods.

THE TERRESTRIAL HABITAT contributed 6 percent (547) of the score for this case. The main contributing species to the score in this habitat were judged to be other vegetation, deer, other mammals, and raptors.

CASE 12: WINTER, BUNKER-C, 10,000 BBLS - ESTIMATED SCORE 9,260

THE PELAGIC HABITAT contributed 5 percent (418) of the score for this case. The main contributing species to the score in this habitat were judged to be herring and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (968) of the score for this case. The main contributing species to this score in this habitat were judged to be Dungeness crab, shrimp, other bivalves, and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 21 percent (1,968) of the score for this habitat. The main contributing species to this score in this habitat were judged to be king crab, Tanner crab, scallops, and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 45 percent (4,176) of the score for this habitat. The main contributing species to this score in this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, shorebirds, ducks, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 9 percent (817) of the score for this case. The main contributing species to this score in this habitat were judged to be intertidal seaweed, herring, sessile marine invertebrates, sea ducks, and marine mammal rookeries.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (514) of the score for this case. The main contributing species to this score in this habitat were judged to be hardshell bivalves and shorebirds.

THE TERRESTRIAL HABITAT contributed 4 percent (399) of the score for this case. The main contributing species to this score in this habitat were judged to be other vegetation and deer.

CASE 13: SUMMER, DIESEL-2, 1000 BBLS - IMPACT SCORE 8,962

THE PELAGIC HABITAT contributed 28 percent (2,484) of the impact score for this case. The species not present in Winter cases increased the impact score 989 in this habitat from Case 9. With minor exceptions, the remaining increase in impact score is accounted for by the following species:

Phytoplankton	increased to	77	from 9
Zooplankton	increased to	77	from 9
Ichthyoplankton	increased to	51	from 6
Herring	increased to	547	from 153
Rainbow/Steelhead Trout	increased to	109	from 26
Dolly Varden	increased to	273	from 38
Seabirds	increased to	319	from 128

THE SUBTIDAL SAND/MUD HABITAT contributed 17 percent (1,495) of the impact score for this case. With minor exceptions, the change in impact

score for this habitat from Case 9 is accounted for by the following species:

Cod	increased	to	60	from	36
Starry Flounder	increased	to	40	from	12
Dungeness Crab	increased	to	219	from	109
Shrimp	increased	to	911	from	400
Sculpins	reduced	to	12	from	48
Razor Clams	reduced	to	24	from	97
Other Bivalves	reduced	to	40	from	161
Other Marine Invertebrates	reduced	to	120	from	290

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (1,001) of the impact score for this case. With minor exeptions, the change in impact score for this habitat from Case 9 is accounted for by the following species:

Chum Salmon	increased	to	153	from	not present
Rockfish	increased	to	60	from	36
Other Marine Invertebrates	increased	to	191	from	128
Floating Seaweed	reduced	to	0	from	48
Subtidal Seaweed	reduced	to	0	from	20
King Crab	reduced	to	153	from	720
Tanner Crab	reduced	to	213	from	1,000
Scallops	reduced	to	77	from	360

THE INTERTIDAL SAND/MUD HABITAT contributed 20 percent (1,806) of the impact score for this case. With minor exception, the change in impact score for this habitat from Case 9 is accounted for by the following species:

Pacific Sandlance	increased	to	82	from	9
Razor Clams	reduced	to	164	from	1,620

Softshell Bivalves	reduced	to	820	from	1,450
Invertebrate Infauna	reduced	to	410	from	483
Marine Mammal Rookeries	reduced	to	0	from	60
Shorebirds	reduced	to	213	from	803
Geese	reduced	to	24	from	102
Ducks	reduced	to	30	from	213
Swans	reduced	to	60	from	425

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (1,013) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 9 is accounted for by the following species:

Herring	increased	to	456	from	128
Miscellaneous Crustaceans	increased	to	102	from	24
Other Invertebrates	increased	to	128	from	77
Shorebirds	increased	to	60	from	20
Intertidal Seaweed	reduced	to	45	from	128
Sessile Marine Invertebrates	reduced	to	64	from	300
Sea Ducks	reduced	to	60	from	120
Marine Mammal Rookeries	reduced	to	0	from	213

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (1,033) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 9 is accounted for by the following species:

Hardshell Bivalves	increased	to	683	from	319
Crustaceans	increased	to	85	from	51
Gastropods	increased	to	128	from	18

Intertidal Seaweed	reduced	to	0	from	77
Shorebirds	reduced	to	60	from	100

THE TERRESTRIAL HABITAT contributed 2 percent (219) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 9 is accounted for by the following species:

Strand Vegetation	increased	to	24	from	not present
Raptors	increased	to	75	from	50
Other Vegetation	reduced	to	70	from	179
Deer	reduced	to	0	from	200

CASE 14: SUMMER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 6,798

THE PELAGIC HABITAT contributed 21 percent (1,402) of the score for this case. The main contributing species to this score in this habitat were judged to be herring, pink salmon, coho salmon, Dolly Varden, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (897) of the score for this case. The main contributing species to this score in this habitat were judged to be cod, Dungeness crab, shrimp, and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (1,246) of the score for this case. The main contributing species to this score in this habitat were judged to be chum salmon, rockfish, king crab, Tanner crab, scallops and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (2,066) of the score for this case. The main contributing species to this score in this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, shorebirds, ducks, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (917) of the score for this case. The main contributing species to this score in this habitat were judged to be herring, sessile marine invertebrates, miscellaneous crustaceans, other invertebrates, and marine mammal rookeries.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (589) of the score for this case. The main contributing species to this score in this habitat were judged to be smelt, hardshell bivalves, and gastropods.

THE TERRESTRIAL HABITAT contributed 5 percent (342) of the score for this case. The main contributing species to this score in this habitat were judged to be other vegetation, other mammals, and raptors.

CASE 15: WINTER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 6,223

THE PELAGIC HABITAT contributed 13 percent (819) of the impact score for this case. The species not present in Winter case accounted for a decrease of 989 from Case 13 in this habitat. With minor exceptions, the remaining decrease is accounted for by the following species:

Phytoplankton	reduced	to	38	from 77
Zooplankton	reduced	to	38	from 77
Ichthyoplankton	reduced	to	26	from 51
Herring	reduced	to	328	from 547
Rainbow/Steelhead Trout	reduced	to	55	from 109
Dolly Varden	reduced	to	82	from 273
Seabirds	reduced	to	128	from 319

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (1,255) of the impact score for this case. With minor exceptions, the decrease in impact

score for this habitat from Case 13 is accounted for by the following species:

Cod	reduced	to	36	from 60
Starry Flounder	reduced	to	12	from 40
Dungeness Crab	reduced	to	109	from 219
Other Marine Invertebrates	reduced	to	72	from 120

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 12 percent (753) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 13 is accounted for by the following species:

Pacific Halibut	increased	to	77	from 36
Chum Salmon	not present			from 153
Rockfish	reduced	to	36	from 60
Other Marine Invertebrates	reduced	to	128	from 191

THE INTERTIDAL SAND/MUD HABITAT contributed 27 percent (1,665) of the impact score for this case. The change in impact score for this habitat from Case 13 is accounted for by the following species:

Ducks	increased	to	50	from 30
Swans	increased	to	100	from 60
Pacific Sandlance	reduced	to	18	from 82
Invertebrate Infauna	reduced	to	273	from 410

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (689) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 13 is accounted for by the following species:

Sea Ducks	increased	to	120	from 60
Herring	reduced	to	273	from 456

Other Invertebrates	reduced	to	77	from	128
Shorebirds	reduced	to	20	from	60

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 15 percent (908) of the impact score for this case. The decrease in impact score for this habitat from Case 13 is accounted for by the following species:

Crustaceans	reduced	to	51	from	85
Gastropods	reduced	to	77	from	128
Shorebirds	reduced	to	20	from	60

THE TERRESTRIAL HABITAT contributed 2 percent (134) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 13 is accounted for by the following species:

Strand Vegetation	not present			from	24
Other Vegetation	reduced	to	42	from	70
Raptors	reduced	to	50	from	75

CASE 16: SUMMER, BUNKER-C, 1,000 BBLS - ESTIMATED SCORE 5,939

THE PELAGIC HABITAT contributed 9 percent (539) of the score for this case. The main contributing species to this score in this habitat were judged to be herring and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (700) of the score for this case. The main contributing species to this score in this habitat were judged to be Dungeness crab, shrimp, and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 21 percent (1,246) of the score for this case. The main contributing species to this score in this habitat were judged to be king crab, Tanner crab, scallops, and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 38 percent (2,268) of the score for this case. The main contributing species to this score in this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, shorebirds, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 9 percent (523) of the score for this habitat. The main contributing species to this score in this habitat were judged to be herring, sessile marine invertebrates, and marine mammal rookeries.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (408) of the score for this case. The main contributing species to this score in this habitat were judged to be smelt and shorebirds.

THE TERRESTRIAL HABITAT contributed 4 percent (255) of the score for this case. The main contributing specie to this score for this habitat was judged to be other vegetation.

CASE 17: WINTER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 5,015

THE PELAGIC HABITAT contributed 11 percent (551) of the score for this case. The main contributing species to this score for this habitat were judged to be herring and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (691) of the score for this case. The main contributing species to this score for this habitat were judged to be Dungeness crab and shrimp.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (909) of the score for this case. The main contributing species to this score for this habitat were judged to be king crab, Tanner crab, scallops, and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 28 percent (1,388) of the score for this case. The main contributing species to this score for this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, shorebirds, ducks, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 14 percent (723) of the score for this case. The main contributing species to this score for this habitat were judged to be herring, sessile marine invertebrates, miscellaneous crustaceans, other invertebrates, sea ducks and marine mammal rookeries.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 10 percent (477) of the score for this case. The main contributing species to this score for this habitat were judged to be smelt and hardshell bivalves.

THE TERRESTRIAL HABITAT contributed 6 percent (276) of the score for this case. The main contributing species to this score for this habitat were judged to be other vegetation, deer, and raptors.

CASE 18: WINTER, BUNKER-C, 1,000 BBLS - ESTIMATED SCORE 5,013

THE PELAGIC HABITAT contributed 5 percent (206) of the score for this case. The main contributing species to this score for this habitat were judged to be herring and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (524) of the score for this case. The main contributing species to this score for this habitat were judged to be shrimp and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 21 percent (1,065) of the score for this case. The main contributing species to this score for this habitat were judged to be king crab, Tanner crab, and scallops.

THE INTERTIDAL SAND/MUD HABITAT contributed 45 percent (2,261) of the score for this case. The main contributing species to this score for this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, shorebirds, ducks, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 9 percent (442) of the score for this case. The main contributing species to this score for this habitat were judged to be sessile marine invertebrates and marine mammal rookeries.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (278) of the score for this case. The main contributing specie to this score for this habitat was judged to be hardshell bivalves.

THE TERRESTRIAL HABITAT contributed 4 percent (216) of the score for this case. The main contributing species to this score for this habitat were judged to be other vegetation and deer.

CASE 19: SUMMER, GASOLINE, 50,000 BBLS - IMPACT SCORE 2,554

THE PELAGIC HABITAT contributed 35 percent (890) of the impact score for this case. The species not present in this habitat in Winter cases account for an increase of 306 in the impact score from Case 15. With minor exceptions, the remaining change in impact score is accounted for by the following species:

Dolly Varden	increased	to	128	from	82
Phytoplankton	reduced	to	18	from	38
Zooplankton	reduced	to	18	from	38
Seabirds	reduced	to	0	from	128
Herring	reduced	to	240	from	328

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (482) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 15 is accounted for by the following species:

Cod	reduced	to	0	from	36
Pacific Sandlance	reduced	to	0	from	24
Dungeness Crab	reduced	to	24	from	109
Shrimp	reduced	to	400	from	911
Other Bivalves	reduced	to	10	from	40
Other Marine Invertebrates	reduced	to	30	from	72

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 22 percent (550) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 15 is accounted for by the following species:

Chum Salmon	increased	to	153	from	not present
Rockfish	increased	to	60	from	36
Other Marine Invertebrates	increased	to	191	from	128
Pacific Halibut	reduced	to	0	from	77
Other Flatfish	reduced	to	0	from	24
King Crab	reduced	to	0	from	153
Tanner Crab	reduced	to	50	from	213
Scallops	reduced	to	18	from	77

THE INTERTIDAL SAND/MUD HABITAT contributed 6 percent (165) of the impact score for this case. With minor exceptions, the change in the impact score for this habitat from Case 15 is accounted for by the following species:

Marine Mammal Rookeries	increased	to	30	from	0
Razor Clams	reduced	to	0	from	164

Softshell Bivalves	reduced	to	90	from 820
Invertebrate Infauna	reduced	to	45	from 273
Shorebirds	reduced	to	0	from 213
Geese	reduced	to	0	from 24
Ducks	reduced	to	0	from 50
Swans	reduced	to	0	from 100

THE INTERTIDAL ROCKY HABITAT contributed 6 percent (164) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 15 is accounted for by the following species:

Intertidal Seaweed	reduced	to	0	from 30
Herring	reduced	to	50	from 273
Miscellaneous Crustaceans	reduced	to	24	from 102
Other Invertebrates	reduced	to	30	from 77
Shorebirds	reduced	to	0	from 20
Sea Ducks	reduced	to	0	from 120

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (227) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 15 is accounted for by the following species:

Crustaceans	increased	to	80	from 51
Hardshell Bivalves	reduced	to	75	from 683
Gastropods	reduced	to	0	from 77
Snorebirds	reduced	to	0	from 20

THE TERRESTRIAL HABITAT contributed 3 percent (76) of the impact score for this case. With minor exceptions, the change in impact score for this

habitat from Case 15 is accounted for by the following species:

Other Vegetation	increased	to	70	from	42
Other Mammals	reduced	to	0	from	30
Raptors	reduced	to	0	from	50

CASE 20: WINTER, GASOLINE, 50,000 BBLS - IMPACT SCORE 1,593

THE PELAGIC HABITAT contributed 21 percent (339) of the impact score for this case. The species not present in Winter cases account for a decrease of 306 in this habitat from Case 19. With minor exceptions the remaining decrease in impact score is accounted for by the following species:

Herring	reduced	to	144	from	240
Rainbow/Steelhead Trout	reduced	to	26	from	51
Dolly Varden	reduced	to	38	from	128

THE SUBTIDAL SAND/MUD HABITAT contributed 29 percent (458) of the impact score for this case. With minor exceptions, this habitat's result was the same as for Case 19.

THE SUBTIDAL/ROCK/COBBLE/GRAVEL HABITAT contributed 17 percent (277) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 19 is accounted for by the following species:

Chum Salmon	not present			from	153
Rockfish	reduced	to	36	from	60
Other Marine Invertebrates	reduced	to	128	from	191

THE INTERTIDAL SAND/MUD HABITAT contributed 9 percent (150) of the impact score for this case. With a minor exception, this habitat's result was the same as for Case 19.

THE INTERTIDAL ROCKY HABITAT contributed 8 percent (132) of the impact score for this case. With a minor exception, herring reduced to 30 from 50, accounted for the decrease in impact score in this habitat from Case 19.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (195) of the impact score for this case. Crustaceans, reduced to 48 from 80, accounted for the decrease in impact score in this habitat from Case 19.

THE TERRESTRIAL HABITAT contributed 3 percent (42) of the impact score for this case. With a minor exception, other vegetation reduced to 42 from 70, accounted for the decrease in impact score in this habitat from Case 19.

CASE 21: SUMMER, GASOLINE, 10,000 BBLS - ESTIMATED SCORE 1,394

THE PELAGIC HABITAT contributed 35 percent (486) of the score for this case. The main contributing species to this score in this habitat were judged to be herring, crab larvae, and Dolly Varden.

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (263) of the score for this case. Only shrimp were judged to contribute significantly to the score in this habitat.

THE SUBTIDAL/ROCK/COBBLE/GRAVEL HABITAT contributed 22 percent (300) of the score for this case. The main contributing species to this score in this habitat were judged to be chum salmon and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 6 percent (90) of the score for this case. Only softshell bivalves were judged to contribute significantly to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 6 percent (90) of the score for this case. Only herring were judged to contribute significantly to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (124) of the score for this case. Only hardshell bivalves were judged to contribute significantly to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 3 percent (41) of the score for this case.

CASE 22: SUMMER, DIESEL-2, 100 BBLS - IMPACT SCORE 1,241

THE PELAGIC HABITAT contributed 36 percent (452) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 19 is accounted for by the following species:

Seabirds	increased	to	75	from	0
Herring	reduced	to	60	from	240
Smelt	reduced	to	18	from	72
Crab Larvae	reduced	to	12	from	109
Rainbow/Steelhead Trout	reduced	to	12	from	51
Dolly Varden	reduced	to	30	from	128
Sea Otter	reduced	to	0	from	30

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (124) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 19 is accounted for by the following species:

Shrimp	reduced	to	100	from	400
Other Marine Invertebrates	reduced	to	0	from	30

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 15 percent (185) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 19 is accounted for by the following species:

King Crab	increased	to	36	from	0
Chum Salmon	reduced	to	36	from	153
Rockfish	reduced	to	0	from	60
Walleye Pollock	reduced	to	0	from	40
Other Marine Fish	reduced	to	0	from	20
Other Marine Invertebrates	reduced	to	45	from	191

THE INTERTIDAL SAND/MUD HABITAT contributed 17 percent (212) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 19 is accounted for by the following species:

Shorebirds	increased	to	50	from	0
Marine Mammal Rookeries	reduced	to	0	from	30

THE INTERTIDAL ROCKY HABITAT contributed 10 percent (119) of the impact score for this case. Sessile marine invertebrates, reduced to 15 from 60, accounted for the decrease in impact score in this habitat from Case 19.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (143) of the impact score for this case. The change in impact score for this habitat from Case 19 is accounted for by the following species:

Gastropods	increased	to	30	from	0
Smelt	reduced	to	18	from	72
Crustaceans	reduced	to	20	from	80

THE TERRESTRIAL HABITAT contributed less than one percent (6) of the impact score for this case. Other vegetation, reduced to 0 from 70, accounted for the decrease in impact score for this habitat from Case 19.

The impact score for Cases 23 through 32 range from 870 down to 22. The spill sizes for these cases is 10,000 barrels and 1,000 barrels for gasoline and 100 barrels for all spill products. The array of these scores is shown below.

S P I L L S I Z E B Y S E A S O N

	10,000 BBLS		1,000 BBLS		100 BBLS
SPILL TYPE	WINTER	SUMMER	WINTER	SUMMER	WINTER
Diesel-2	Case 8	Case 13	Case 15	Case 22	787
Crude Oil	Case 11	Case 14	Case 17	812	599
Bunker C	Case 12	Case 16	Case 18	441	372
Gasoline	870	388	242	31	22

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(4) DRIFT RIVER

Drift River is located midway up Cook Inlet in Redoubt Bay, northeast of Kalgin Island (see Figure 2-19). The selected spill site is east-southeast of the present Drift River terminal in the narrowest part of the channel at 60°34.44'N latitude, 152°0.0'W longitude. The spill site lies about three miles northeast of Kalgin Island.

(a) PHYSICAL CHARACTERISTICS

Cook Inlet lies in the Transitional Climatic Zone. Maritime influences grow stronger as one moves toward lower Cook Inlet.[4,7] The inlet is surrounded by mountains on three sides--the Aleutian Range to the west, the Alaska Range to the north, the Talkeetna Mountains to the northeast, the Chugach Mountains to the east, and the Kenai Mountains to the east and southeast. Climatic conditions are expected to be similar to those recorded at Kenai.

TEMPERATURES

Middle Cook Inlet has cold Winters and mild Summers. Winter temperatures typically vary between 4°F and 20°F,[1] with extended periods of above-freezing temperatures not uncommon.[10] Summer temperatures range from 40° to 60°F.[1] Record low and high temperatures at Kenai are -48°F and 89°F.[1]

Ice in Cook Inlet typically interferes with navigation from late November through March.[4] Typical freezeup at Kenai is December 10th, and typical breakup is April 2nd.[8]

SURFACE WINDS

Surface winds are generally from the southwest during Summer and from the north and northeast in the Winter.[2] Predominant winds for the Drift

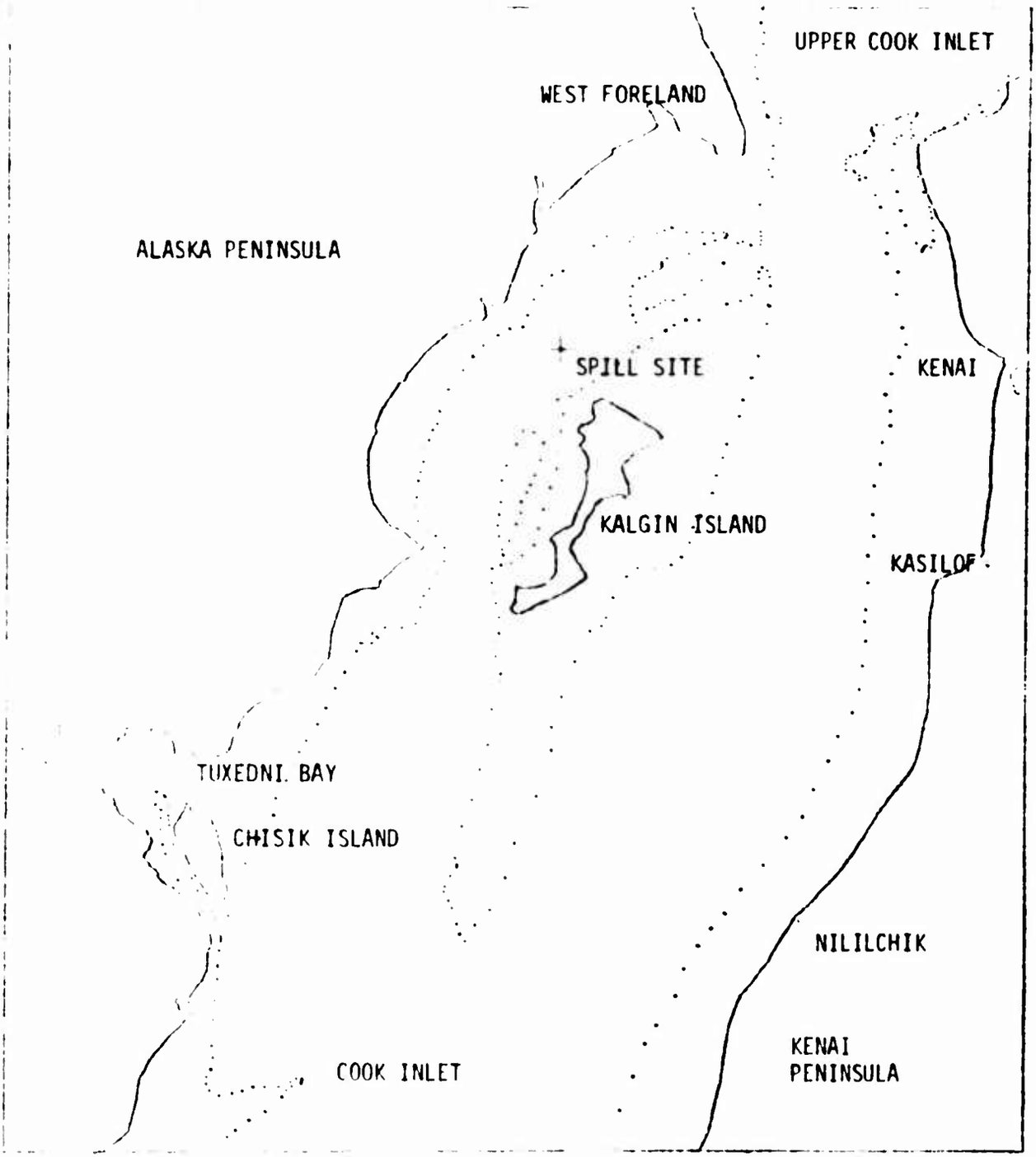


FIGURE 2-19. THE DRIFT RIVER LOCATION AND SPILL SITE

NOTE: The broken line is the 10 fathom (60 feet) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

River site were chosen as north-northeast at 6 knots for Winter and south-west at 8.7 knots for Summer.

SURFACE CURRENTS

MSNW attempted to define the surface currents in the mid area of Cook Inlet for the Drift River spill location--the region between the Forelands above Kalgin Island to the region off Tuxedni Bay.

Unlike most other locations in this study, this part of Cook Inlet has more information on existing currents as noted in the *COAST PILOT*[8] and the *TIDAL CURRENT TABLES*,[9] although good specific information is lacking for the immediate Drift River vicinity.

The *TIDAL CURRENT TABLES*[9] provided information for the following middle Cook Inlet areas:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
East Side:		
West 1 mile from Cape Ninilchik	1.4 K (205°)	2.2 K (020°)
West 3 miles from Cape Kasilof	2.3 K (205°)	3.0 K (020°)
Southwest 6 miles from Kenai	2.6 K (195°)	2.4 K (020°)
West 0.8 mile from Nikiski	3.6 K (175°)	3.8 K (345°)
West Side:		
Mid-channel off West Foreland	3.8 K (205°)	3.8 K (025°)
Tuxedni Channel	1.9 K (160°)	1.1 K (330°)

The *COAST PILOT*[8] provided the following comments for middle Cook Inlet:

AREA	COMMENT
East Side:	
Kenai River Mouth	Attain velocities of 5 knots or more.
West Side:	
East 1.5 miles of Granite Point (above Forelands)	Flood velocity of 4 to 5 knots and ebb of 2 to 3 knots.
Both sides of Kalgin Island	Velocity 3 to 4 knots at times.
North 0.5 mile from Harriet Pt. (mainland off south end of Kalgin Island)	Ebb current has a velocity of 2 to 3 knots while the flood is weak and of short duration.
Tuxedni Channel	Diurnal tide range is 16.6 ft. Flood currents are northwestward at 1.1 knots, and ebb currents are southward at 1.9 knots.

Evans[10] provided additional information for the Forelands region where currents reach a mean maximum velocity of 3.8 knots with maximum velocities exceeding 6.5 knots at tidal extremes. Evans[10] also provided a generalized representation of Cook Inlet surface circulation (Figure 2-20). The important aspect of this figure for Drift River is that there appears to be a general influx of Gulf of Alaska waters into Cook Inlet along the eastern shore up to the Forelands, while there is an outflow from the center of Cook Inlet to the western shore.

National Ocean Survey of the National Oceanic and Atmospheric Administration has conducted tide and current surveys in the Summer of 1973 and 1974 in lower Cook Inlet. This information should be consulted as it becomes



FIGURE 2-20. SURFACE CIRCULATION, COOK INLET, ALASKA.

SOURCE: Kinney, P. J., J. Groves, and D. K. Button, *COOK INLET ENVIRONMENTAL DATA. R/V ACONA CRUISE 066 - MAY 21-28, 1966*, Institute of Marine Science, University of Alaska, Report No. R-70-2.

available for a better understanding of the Drift River vicinity tidal currents and of the locations in lower Cook Inlet.

On the basis of this information, MSNW assumed the following current direction and velocities:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
East side of Inlet and offshore from 4 to 7 miles	Used *TIDAL CURRENT TABLE* Values	
Midchannel areas on sides of Kalgin Island	2.55 K (200^{o})	2.15 K (020^{o})
Redoubt Bay, adjacent to Kalgin Island	2.20 K (215^{o})	1.40 K (035^{o})
Harriet Point vicinity	2.20 K (130^{o})	1.40 K (345^{o})
West Foreland vicinity	2.20 K (165^{o})	1.40 K (105^{o})
North end of Kalgin Island	2.55 K (200^{o})	0.00 K
South end of Kalgin Island	0.00 K	2.15 K (020^{o})

(b) BIOLOGICAL CHARACTERISTICS

The biological resources of the Drift River location are felt to be less rich than the lower portion of Cook Inlet (Offshore Port Graham and Kamishak Bay). Clam beaches and sockeye salmon set net fishing areas are probably the notable exceptions as these both exist on the west and east shores of middle Cook Inlet (see Figure 2-21). The fact that ice forms at the Drift River location and not at the southern locations also contributes to the relatively lower biological activity at this study location.

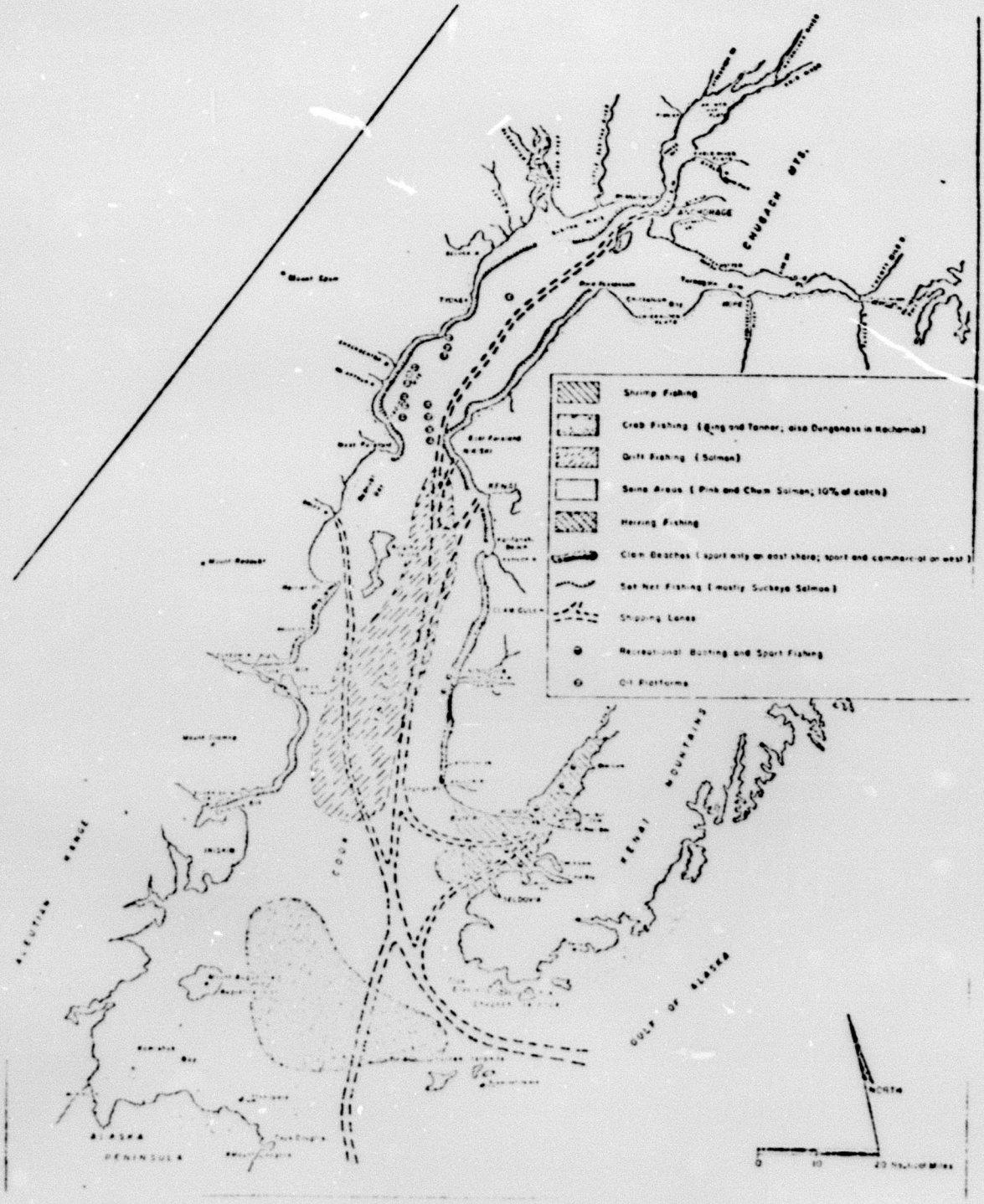


FIGURE 2-21. BIOLOGICAL RESOURCES OF COOK INLET.

SOURCE: Alaska University, *COOK INLET ENVIRONMENT, A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, National Technical Information Service, U.S. Department of Commerce, COM-73-10337, August 1972.

Fish and shellfish form the major resource of the Drift River vicinity. Kalgin Island is a State Game Refuge and the Alaska legislature has designated parts of the Island as "critical habitat."[17]

Resource summaries are shown in Figures 2-22 and 2-23 .

FISHES

SALMONIDS - All five species of North American salmon probably inhabit or travel through this portion of Cook Inlet to areas in the Upper Inlet. Based upon catch statistics for the area, including the Drift River location, salmon catches are larger than Offshore Port Graham and Kamishak Bay, with sockeye salmon the most abundant species caught. The mean catches (1965-1971) for the Drift River area are as follows:

SALMON	MEAN	(RANGE)
King	3,800	(300 - 7,100)
Sockeye	245,800	(120,100 - 479,800)
Coho	46,500	(28,300 - 77,100)
Pink (even year)	123,800	(78,300 - 192,800)
(odd year)	57,800	(2,400 - 192,800)
Chum	144,100	(75,800 - 254,200)

Sockeye salmon spawning systems in the Drift River vicinity include Packers Lake on Kalgin Island, on the west shore--Blue Lake (near Harriet Point), and Grecian Lake (or Crescent Lake) near Tuxedni Bay, and on the east shore--the lake systems of the Kenai and Kasilof rivers.[19]



Waterfowl and Seabirds: Nesting-Molting Area

▲ Seabird Colony

FIGURE 2-22 DRIFT RIVER CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.



FIGURE 2-23. DRIFT RIVER CONCENTRATIONS OF SELECTED RESOURCES.
SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

Salmon fishing activities in the Drift River vicinity are shown in Figure 2-21 . Set net fishing areas (for sockeye primarily) are reported along the east north of Ninilchik and on west shore from Chinitna Bay north, except at Redoubt Bay (Drift River site). Salmon drift fishing areas are located between Kalgin Island and the east shore.

Comments on salmonid life history and vulnerability regarding Offshore Port Graham, are also applicable here, with the exception of adult salmon runs being later by 1 to 2 weeks.

Additional salmon information is located in Appendix D . Figure 2-24 presents probable timing of salmon in significant numbers into Cook Inlet.

Steelhead (rainbow) trout are known to run into rivers south of the Drift River location and on the eastern shore of Cook Inlet in the Anchor River, Ninilchik River, Deep Creek, and Stariski Creek, with the largest runs to the Anchor River (about 500 fish).[10] These fish move downstream in late May and June to the Inlet and the open sea, remain there for over a year, and return from August 15th until about October 14th.[10] Evans[10] also commented that steelhead are probably underutilized (as of 1972).

Dolly Varden are widely distributed throughout the Inlet and are assumed to move out under the ice.[10] These fish move down the Inlet in the Summer and back up the streams in July through September. Evans[10] presented information on a 1954 Anchor River run of 7,000 fish which began July 4th, peaked on July 18th, and continued into early October. This species is considered an important sport fish in streams draining into Cook Inlet.

PACIFIC HALIBUT do not occur significantly in the Drift River vicinity as Kalgin Island is given as the upper boundary of their distribution in the

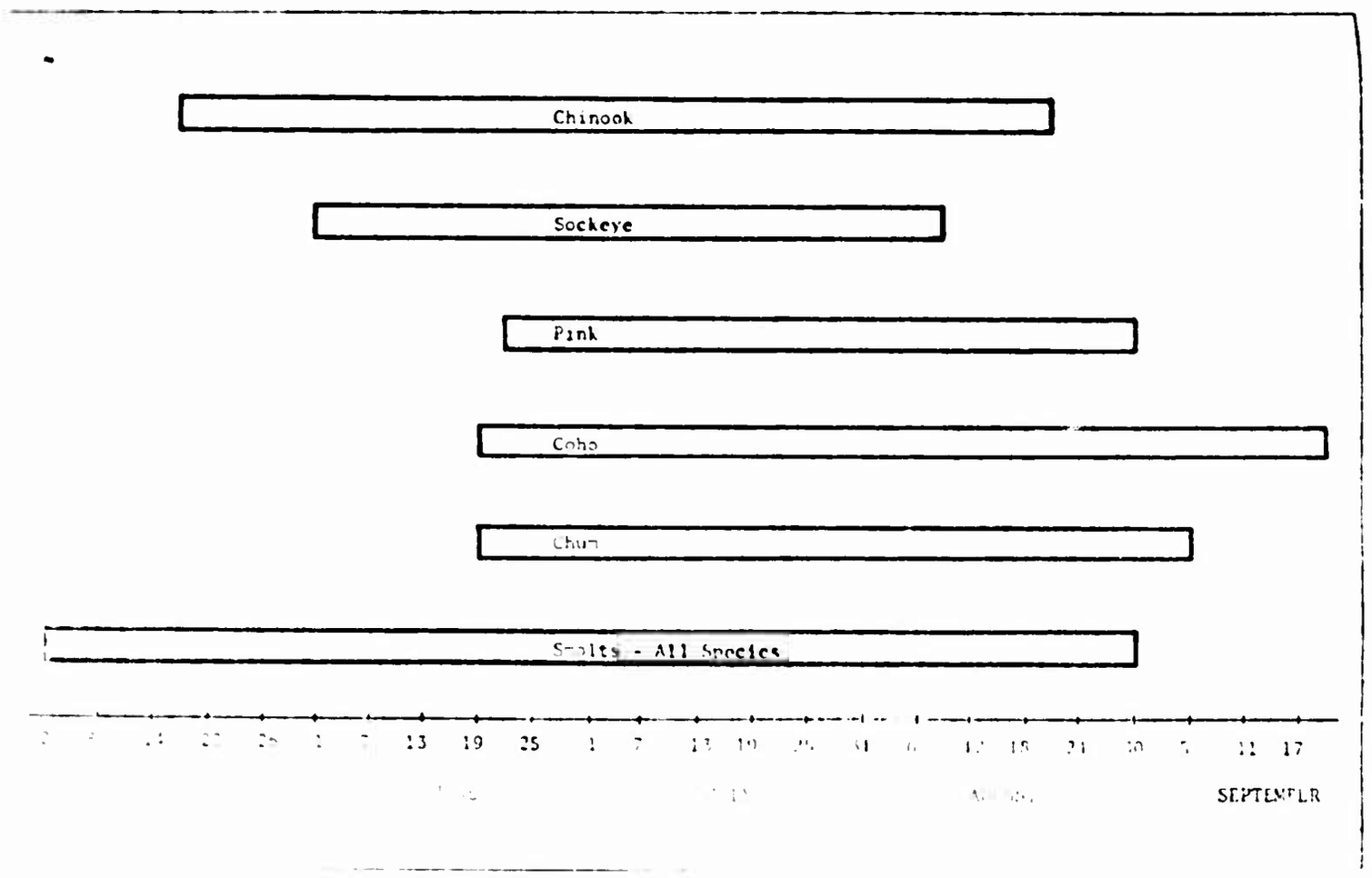


FIGURE 2-24. PROBABLE PERIOD DURING WHICH SIGNIFICANT NUMBERS OF ADULT SALMON ARE IN COOK INLET. BASED ON CATCH DATA, SHAPE OF CATCH CURVE AND STREAM SURVEYS

SOURCE: Alaska University, *COOK INLET ENVIRONMENT, A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, National Technical Information Service, U.S. Department of Commerce, COM-73-10337, August 1972.

Inlet from May through August, and none apparently overwinter in this vicinity.[10,15] The local centers of concentration of halibut are in the adjacent Gulf of Alaska and the lower portions of Cook Inlet (particularly Kachemak Bay).

PACIFIC HERRING are not known to come this far up Cook Inlet, but a few probably get to the Drift River vicinity. As with halibut, the local concentration is farther south in Cook Inlet (see Offshore Port Graham section).

SMELT (EULACHON) migrate to and beyond the Drift River vicinity from approximately May 8th through 12th, with a peak about the end of May.[10] The Kenai River in the Drift River vicinity supports a smelt run, while the remainder of these fish pass through on their way to several rivers in the upper Inlet.[10,15]

Other smelt (capelin) probably use gravel beaches in this vicinity to spawn in early Spring.

OTHER MARINE FISHES at this location would include flatfish and sculpin species.

SHELLFISHES

KING CRAB, TANNER CRAB, DUNGENESS CRAB are not known to exist as far up Cook Inlet as the Drift River vicinity.[10,15,16] All three of these kinds of crab are numerous in lower Cook Inlet (see Offshore Port Graham description).

MSNW assumed that some of these three crab types do get up to the Drift River vicinity, at least in the lower part of the possible area of influence (50-km square area) which extends from the Drift River vicinity to south Tuxedni Bay.

See Offshore Port Graham for life history information and vulnerability to oil spills of these crab types.

SHRIMP apparently are not very abundant this far up Cook Inlet according to exploratory efforts which MSNW assumed to extend up to the Drift River vicinity. Known abundances of shrimp end off Anchor Point[10] northwest of Homer.

Again, because the area of influence for the Drift River oil spills was a 50-km square area, MSNW assumed that some shrimp species possibly extend up Cook Inlet to southern parts of this study area.

As with the crab species, shrimp are more common in lower Cook Inlet, and information on their life history and vulnerability is given in the Offshore Port Graham description.

SCALLOPS, as shrimp, would not appear to be very numerous as the illustrated distribution ends north of Augustine Island in Kamishak Bay.[10,15] As with crab and shrimp species, MSNW assumed a few scallops probably exist in the Drift River-Kalgin Island area, and some probably exist in the southern part of the study area--Tuxedni Bay and south.

See the Kamishak Bay description for further scallop information.

RAZOR CLAMS, unlike the previously discussed shellfish, are much more important in this area compared to lower Cook Inlet. Razor clam beaches are shown[10,15] to extend from Anchor Point to the Kasilof River on the eastern shore and from Tuxedni Bay to Harriet Point (off the south end of Kalgin Island) on the western shore of middle Cook Inlet (see Figure 2-21).

Razor clams are found from intertidal beaches to sandy-bottom areas several fathoms deep. In Cook Inlet, razor clams are found in substrata

which varies from coarse white sand (Deep Creek area) to a fine sand-clay-gravel mixture (Clam Gulch area).

Razor clams spawn from late June to early August,[10] producing free-floating eggs. Within a few hours to a few days, these eggs hatch into larvae (veliger) which exist in a free-swimming form for 5 to 16 weeks.[20] Evans[10] gave the time as about eight weeks. After this stage, the larvae form shells, settle to the bottom, and "set" in the top layer of sand.[20] Phenominal numbers of eggs (6 to 10-million annually for one female) are produced and, at times, result in very heavy "sets" with as many as 1,000 to 1,500 young clams per square foot.[20] Because of their delicate nature, high mortalities exist at this stage.[20] Rosenberg[20] provided greater detail about razor clam life history. Cook Inlet clams reach a harvestable size in their third year.[20]

In 1972, more than 400,000 clams were harvested by sport diggers; heavy clam concentrations are located on the west shore at Polly Creek and the northeast side of Chiritna Bay.

Adults and larvae are felt to be especially susceptible to toxic oil products that contact beaches and cover the waters pelagic larvae inhabit. A spill history on the Washington Coast[26,27] provided some insight into the vulnerability of razor clams to oil products and is summarized as follows:

> A barge carrying gasoline and diesel oil went aground on the Moclips beach in March 1964. This resulted in an estimated 50 percent razor clam mortality within one-half mile of the barge. Spotty kills of clams (as indicated by dead clams washed up on beaches) were seen north and south of the spill site as far as Ocean Shores. Dead clams were observed over 20 miles of beach and a minimal estimate of the kill was 300,000 clams. Recovery was later observed at the spill site (several years). Small spills of what appeared to be bunker C type oil products have not been shown as damaging to razor clams.

Preliminary bioassays on razor clams also indicate that razor clams were very sensitive to oil spills.[61] MSNW assumed razor clams to be quite vulnerable to oil products such as diesel-2 and gasoline (if the gasoline reaches clam areas before evaporating), with lesser chemical vulnerability assumed for crude oil and bunker C. However, the latter products are suspected as being also physically damaging to the free-swimming larvae if the material is moved into the water column in droplets and to the adults if beaches with clams are severely coated.

WATERFOWL

Although numerous in Cook Inlet, little quantitative information exists for waterfowl in this area. The open-sea Gulf of Alaska area, south of Cook Inlet, has some 208 species of birds of which 128 species are primarily water-related. This source also provided a detailed species list. The inshore areas of the Gulf of Alaska (50 fathoms to shore) are utilized by about 70 species of which loons, grebes, and cormorants, waterfowl, and gulls are the most abundant.[20] Estimated numbers of some species are very large (common murre, black-legged kittiwake, and others "exceed millions"[20]).

The Drift River location is bordered on both the east and west shores by waterfowl and seabird habitat and is an important waterfowl migration corridor.[17] A study in August of 1972[10] showed increasing abundance of birds as one moved down Cook Inlet, with high abundances in the Southern Commercial Fishery Management District (see the following two locations).

Abundances were low in the North Central and South Central districts (including the Drift River location).[10] An exception for the Drift River study area would be the Tuxedni National Wildlife Refuge where Chisik Island's

"steep cliffs and rocky shorelines make them a nesting haven for large numbers of colonial seabirds."[38]

DUCKS - The U.S. Fish and Wildlife Service estimates 12 breeding ducks per square mile in Game Unit 16 (Kenai side and marshy land areas) and 32 breeding ducks per square mile in Game Unit 16 (western shore and marshy land areas).[17] The Drift River area is also a heavy migration area;[17] however, the presence of ice prevents overwintering for most waterfowl.

GEESE - The description for geese is similar to that for ducks. Geese have the additional vulnerability of being more sensitive than ducks when disrupted while nesting.[17,18]

SWANS include breeding trumpeter swans (endangered) and some whistling swans in Game Unit 16 (western shore).[17]

SEABIRDS are numerous in the area, particularly in the southern part of the Drift River location (mixed species colonies occur at Chisik Island, Duck Island, and Tuxedni Bay), and at Kalgin Island where there are small colonies of glaucous-winged gulls.[17] The mixed species colonies include black-legged kittiwakes which inhabit a colony on the southwestern end of Chisik Island over one-mile long.[38] Other birds include:[38] double-crested cormorants, horned and tufted puffins, common murres, pigeon guillemots, glaucous-winged gulls, lesser yellowlegs, common eiders, peregrine falcons, willow ptarmigan, spruce grouse, ravens, pine grosbeaks, and golden-crowned sparrows. Kalgin Island and Redoubt Bay (the spill site) are designated "Key Waterfowl Habitat Areas."[17]

SHOREBIRDS are in moderate numbers in the Summer months and include the sandhill crane (formerly classified as endangered).

See Offshore Port Graham for further discussion of Cook Inlet waterfowl.

MARINE MAMMALS

SEA OTTERS inhabit only the southern part of the Drift River vicinity and are in low abundance.[17] However, the sea otters to the south are increasing in number and more may recolonize the area in the future, at least in the ice-free months. For comments on vulnerability to oil, see Offshore Port Graham.

HARBOR SEALS occur along the entire middle Cook Inlet shoreline, including Kalgin Island.[17] High densities are shown for West Foreland, north and south ends of Kalgin Island, Harriet Point, and the extensive tide flats of Tuxedni Bay.[17] For vulnerability to oil, see Offshore Port Graham.

SEA LIONS are in low abundance in middle Cook Inlet. No rookeries are located in the Drift River vicinity. For vulnerability to oil, see Offshore Port Graham.

BELUGA WHALES move into Cook Inlet with the presence of salmon (smolts and adults); thus, their presence in the Inlet would be keyed to the timing of the salmon involved.[10] Summer populations are estimated as 300 to 400; Winter populations and movements are not known.[10]

Limited sport hunting was formerly practiced in Cook Inlet. This animal is now protected under the Marine Mammal Protection Act.

Evans[10] reported that these whales probably mate in May and June, with 12 months gestation. The calf then feeds from the female for eight months and remains with her for several years.[10]

Beluga whales are expected to be little affected by oil.[10]

TERRESTRIAL MAMMALS

BROWN BEAR occupy beaches, grass flats, and estuaries, and make extensive Spring and Fall use of the coast and land area adjoining Redoubt Bay (at the spill site). The species is moderately abundant here, with some high concentration on several fish streams draining into Redoubt Bay and into Cook Inlet just south of Tuxedni Bay.[17] The timing of these stream concentrations would be concurrent with adult salmon runs to these streams. Brown bear also occasionally visit Chisik Island.[38]

Direct oil impacts do not seem likely to be a major importance; however, indirect impacts through their utilization of salmon as food could indirectly impact these bear.

BLACK BEAR occupy similar habitats that brown bear do, but are located adjacent to the coast in different areas--south side of West Foreland, south end of Redoubt Bay around Harriet Point to Polly Creek, and the north shore of Tuxedni Bay. Other black bear are located inland. In the Drift River vicinity, the only black bear stream concentration is with brown bear on Kustatan River which drains into Redoubt Bay.

Black bear sensitivity to oil would be similar to brown bear.

WOLVES AND WOLVERINES - Wolverines are not present near this location. Wolves often occur in high numbers in Game Unit 16 (west shore and land) and are present across the Inlet on the east shore and land. These carnivores would not seem directly vulnerable to oil but may come in contact with spill in their feeding (i.e., consume oil-contaminated animals).

MOOSE are distributed on both shores of this location and on Kalgin Island.[17] Moose occasionally visit Chisik Island in Tuxedni Bay.[38] Notable moose concentration areas during all seasons is the shore and adjacent lowland areas on the east shore opposite Kalgin Island from Kenai south to the vicinity of Clam Gulch. A Winter area for moose is located in the coastal vicinity of Ninilchik and approximately 10 miles up the Ninilchik River.

Moose would not seem directly affected by oil spills.

SMALL MAMMALS are variable in number, depending on location, and include field mice, voles, lemmings, etc.[18] These occupy marsh edges and willow flats and are probably not too susceptible to marine oil spills at the Drift River site.

AQUATIC FURBEARERS include river otter, mink, muskrat, and beaver.[18] These would be expected to be most vulnerable with losses of young during the Spring denning period if oil products reach them.[18]

Terrestrial mammal vulnerability is generally discussed in the following section (see Offshore Port Graham).

FLORA

The same general comments apply here as at Offshore Port Graham except that this area is more estuarine and protected and ice-scouring (which destroys shallow vegetation) is probably significant in the Winter. About 92 percent of the shoreline would be covered with strand species in the Summer and completely lacking in the Winter. It is not known whether eelgrass beds or salt marshes occur in this area. Marine algae would occupy, at most, 5 percent of the shoreline in Summer both in the intertidal and shallow subtidal (however, some species can survive and grow on mud flats - this is not included

in the 5 percent), and 2 percent or none in Winter. Floating kelp beds are probably lacking in this area altogether.

Further details on the physical and biological characteristics are given in Appendix D.

(c) RESULTS

The Drift River spill site, located between Kalgin Island and the mainland in Cook Inlet, was most severely impacted by the large spills of diesel-2, crude, and bunker C in the Summer. The 50,000-bbl spill of diesel-2 had the highest impact score owing to its rapid spreading and high toxicity. The 50,000-bbl spills of crude and bunker C and the 10,000-bbl spills of diesel-2 and crude also had relatively high Summer impact scores.

These high Summer impact scores were due to the sensitivity of smelt, salmon, clams, and the marine avifauna during their breeding and brooding periods and to some extent during their Spring and Summer migrations.

In the Winter, the 50,000 and 10,000-bbl spills of diesel-2 and the 50,000-bbl spills of crude and bunker C had the highest impact scores. They were only about one-half the respective Summer impact scores, however, owing to the absence or dormancy of many species.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Drift River. The first scenario, using most probable Summer conditions, resulted in oil moving north parallel to the shoreline (see Fig. 25). The oil impacted the western shore of Kalgin Island within the first eight hours and the western shore of Cook Inlet approximately 18 hours after the spill. The spill eventually moves north of the Island and eastward into the main channel of Cook Inlet where it is carried by wind and current to the eastern shore of the Island. The second scenario, based on most probable late Fall/early Winter conditions, resulted in oil moving south parallel to the shoreline (see Fig. 26). The oil impacted the western shore of Kalgin Island and Cook Inlet approximately 18 hours after the spill. The Fall/Winter scenario is the period of time just before ice sets in at this location.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-8 presents the results of the oil spill scenarios examined at Drift River without cleanup.

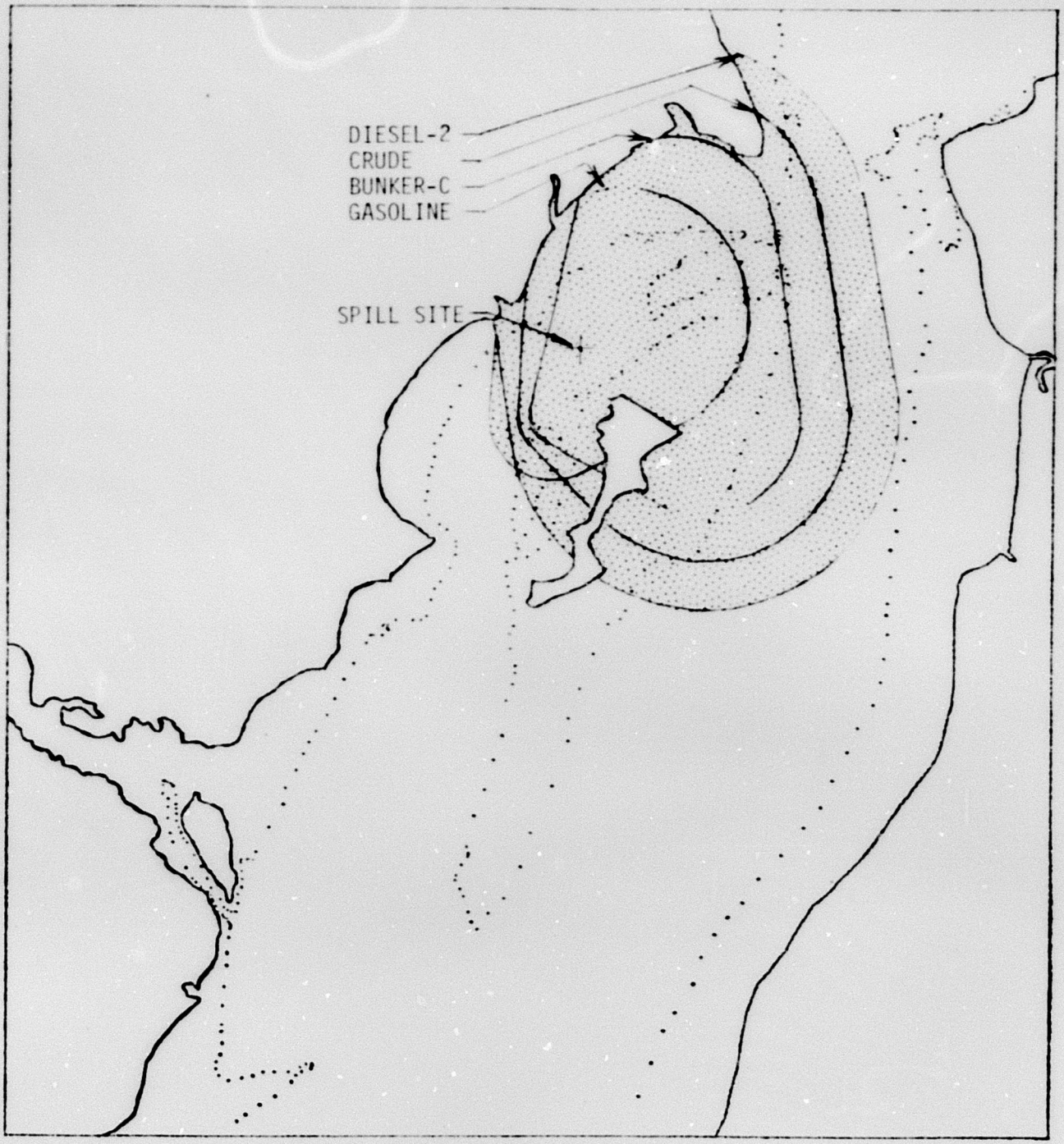


FIGURE 2-25. DRIFT RIVER SUMMER 50,000 BBL SPILL ENVELOPES

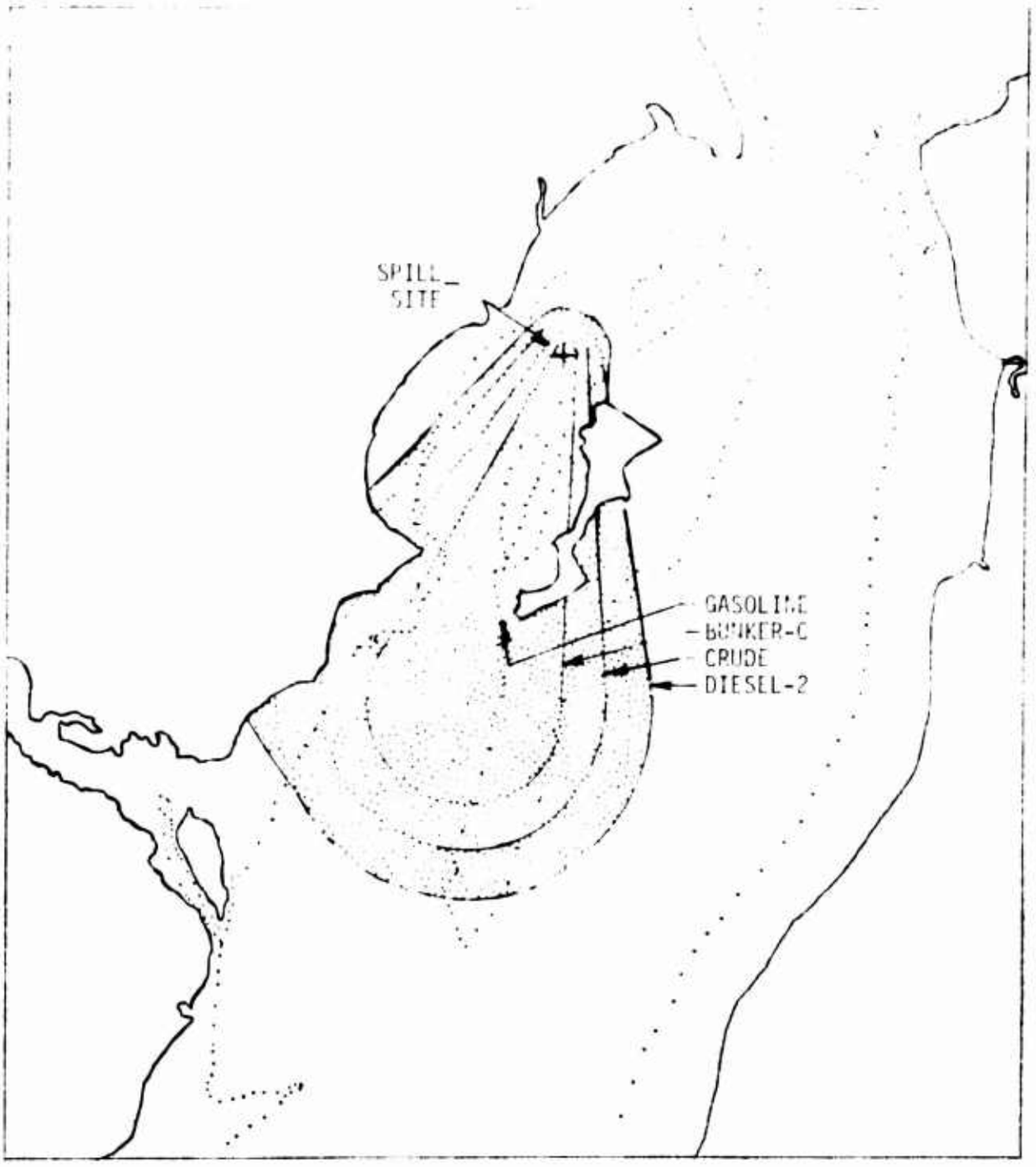


FIGURE 2-26. DRIFT RIVER WINTER 50,000 BBL SPILL ENVELOPES

TABLE 2-8. DRIFT RIVER CASE RESULTS - NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000	100
SUMMER	Diesel-2	17,920 [1](1)	13,194 [3]	6,156 [11]	1,150 [20]
	Crude Oil	15,615 [2]	10,829 [5]	5,461 [12]	653 [23]
	Bunker C	11,031 [4]	8,893 [6]	4,814 [14]	358 [27]
	Gasoline	1,826 [19]	997 [21]	277 [28]	25 [31]
WINTER	Diesel-2	8,283 [8]	7,202 [10]	4,302 [15]	718 [22]
	Crude Oil	8,731 [7]	5,037 [13]	1,925 [18]	414 [26]
	Bunker C	7,327 [9]	4,135 [16]	2,397 [17]	505 [25]
	Gasoline	580 [24]	167 [29]	45 [30]	7 [32]

(1) Numbers in brackets are the case numbers that follow.

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 17,920

THE PELAGIC HABITAT contributed 37 percent (6,671) of the impact score for this case. The species which were the main contributors to the impact score in this habitat were phytoplankton (164), herring (580), smelt (1,289), king salmon (338), chum salmon (338), sockeye salmon (677), pink salmon (338), coho salmon (1,128), rainbow/steelhead trout (387), Dolly Varden (290), and seabirds (806). The smelt, coho salmon and seabirds were the most abundant species in this habitat. The herring and all salmon species were rated as an important commercial resource, and smelt were rated as being of minor commercial importance. The smelt, salmon, trout and Dolly Varden were rated as being of minor recreational importance. The smelt were rated as high, the trout moderate, and the salmon and Dolly Varden as minor in subsistence

importance. All of the species were judged to be among the most sensitive to a diesel-2 spill in this habitat. Seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 8 percent (1,451) of the impact score for this case. The species which were the main contributors to the impact score in this habitat were Dungeness crab (242), shrimp (290), razor clam (547), and other marine invertebrates (164). Razor clams were the most abundant in this habitat. Razor clams were rated as moderate, and the shrimp and crab as minor in commercial importance. The crab and shrimp were rated as minor in recreational and subsistence importance. All of the species were judged to be among the most sensitive to a diesel-2 spill in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 3 percent (598) of the impact score for this case. The species which were the main contributors to the impact score for this habitat were chum salmon (191) and king crab (109). The salmon were rated as high and the crab as minor in commercial importance. The salmon were rated as minor in recreational and subsistence importance. The crab were rated as minor in subsistence importance. Both species were judged to be among the most sensitive to a diesel-2 spill in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 32 percent (5,763) of the impact score for this habitat. All species in this habitat contributed significantly to the impact score for this case. The species results were Pacific sandlance (145), razor clam (2,417), softshell bivalves (806), invertebrate infauna (483), marine mammal rookeries (200), shorebirds (1,208), geese (120), ducks (144), and swans (240). The clams, bivalves, infauna,

rookeries, and shorebirds, were the most abundant in this habitat. Clams were rated as moderate, and geese and ducks were rated as minor in commercial importance. Clams, geese and ducks were rated as major and bivalves as moderate in recreational importance. The clams were rated as major and the bivalves as minor in subsistence importance. The sandlance, clams, bivalves, infauna and shorebirds were judged to be the most sensitive to a diesel-2 spill in this habitat. The rookeries and shorebirds were classified as protected. The swans were classified as endangered due to the presence of trumpeter swans.

THE INTERTIDAL ROCKY HABITAT contributed 4 percent (805) of the impact score for this case. The species which was the main contributor to the impact score in this habitat was herring (483). Herring was the most abundant, of major commercial importance and judged to be among the most sensitive to an oil spill in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 13 percent (2,250) of the impact score for this case. The species which were the main contributors to the impact score in this habitat were smelt (1,611) and hardshell bivalves (387). Smelt were rated as minor in commercial importance. Smelt were rated as major in recreational and subsistence importance. Bivalves were rated as minor in recreational and shoreline importance. Both species were judged to be among the most sensitive to a diesel-2 spill in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (382) of the impact score for this case. The species which were the main contributors to the impact score in this habitat were strand vegetation (90) and other vegetation (160).

These species were among the most abundant in this habitat and were judged to be the most sensitive to a diesel-2 spill. Other vegetation was rated as moderate in commercial importance.

Table 2-9 presents the full results for Case 1.

CASE 2: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 15,615

THE PELAGIC HABITAT contributed 23 percent (3,516) of the impact score for this case. With minor exceptions, the change in imoact score for this habitat from Case 1 is accounted for by the following species:

Harbor Seal	increased	to	30	from	0
Phytoplankton	reduced	to	77	from	164
Zooplankton	reduced	to	38	from	82
Ichthyoplankton	reduced	to	26	from	55
Pacific Sandlance	reduced	to	36	from	82
Smelt	reduced	to	729	from	1,289
King Salmon	reduced	to	89	from	338
Chum Salmon	reduced	to	89	from	338
Sockeye Salmon	reduced	to	179	from	677
Pink Salmon	reduced	to	89	from	338
Coho Salmon	reduced	to	298	from	1,128
Seabirds	reduced	to	456	from	806

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (1,974) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 1 is accounted for by the following species:

TABLE 2-9. MATRIX RESULTS--CASE I

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	DRIFT RIVER
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	0	A	0	0	0	3	9	1	162	18	164
2. ZOOPLANKTON	3	A	0	0	0	3	9	1	81	9	82
3. ICHTHYOPLANKTON	3	A	0	0	0	2	9	1	54	6	55
6. PACIFIC SANDLANCE	3	A	0	0	0	3	9	1	81	9	82
7. HERRING	6	A	3	0	0	3	9	8	324	288	580
8. SMELT	10	A	1	1	3	3	9	8	720	640	1289
9. CRAB LARVAE	3	A	0	0	0	2	9	8	54	48	97
10. KING SALMON	3	A	3	1	1	2	9	8	189	168	338
11. CHUM SALMON	3	A	3	1	1	2	9	8	189	168	338
12. SOCKEYE SALMON	0	A	3	1	1	2	9	8	378	336	677
13. PINK SALMON	3	A	3	1	1	2	9	8	189	168	338
14. COHO SALMON	10	A	3	1	1	2	9	8	630	560	1125
15. RAINBOW-STEELHEAD TROUT	6	A	0	1	2	1	9	8	216	192	387
16. DOLLY VARDEN	6	A	0	1	1	1	9	8	162	144	290
17. NORTHERN FUR SEAL	1	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	5	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	3	A	0	0	0	5	0	0	0	0	0
24. WHALES	0	A	0	-	0	5	0	0	0	0	0
25. SEA OTTER	1	A	0	0	0	5	4	0	20	0	20
27. OTHER MARINE MAMMALS	6	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	9	8	450	400	826
									3099	3154	6671
2. SUBTIDAL SAND-MUD											
1. COD	1	A	1	1	1	2	1	0	5	0	5
2. SCULPINS	3	A	0	0	0	2	4	1	24	6	26
3. STARRY FLOUNDER	0	A	0	1	0	2	1	0	18	0	18
4. OTHER FLATFISH	0	A	1	1	1	2	1	0	30	0	30
5. PACIFIC SANDLANCE	3	A	0	0	0	3	4	1	36	9	38
6. MISC. MARINE FISH	3	A	0	1	0	2	4	0	36	0	36
7. BOTTOMFISH CRAB	3	A	1	1	1	2	9	8	135	120	242

TABLE 2-9. (CONT'D)

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U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
8. SHRIMP	3	A	1	1	1	3	9	8	162	144	298
9. RAZOR CLAM	15	A	2	0	0	2	9	1	540	60	547
10. OTHER BIVALVES	6	A	0	0	0	1	9	1	54	6	55
13. OTHER MARINE INVERTEBRATES	6	A	0	0	0	3	9	1	162	18	164
									1202	363	1451
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	3	A	0	0	0	2	1	0	6	0	6
3. CHUM SALMON	3	A	3	1	1	2	9	1	189	21	191
4. PACIFIC HALIBUT	3	A	1	2	1	2	4	0	72	0	72
5. OTHER FOOTFISH	3	A	0	1	0	2	4	0	36	0	36
6. GREENLING	1	A	0	0	0	2	4	0	0	0	0
8. WALLEYE POLLOCK	1	A	1	0	1	2	4	0	16	0	16
9. OTHER MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
10. KING CRAB	3	A	1	0	1	2	9	1	108	12	109
11. TANNER CRAB	1	A	1	0	1	2	9	1	36	4	36
12. DUNGENESS	1	A	0	0	0	2	9	1	18	2	18
13. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	9	1	81	9	82
									594	48	598
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	9	8	81	72	145
3. RAZOR CLAM	15	A	2	3	3	2	9	8	1350	1200	2417
4. SOFTSHELL BIVALVES	10	A	0	2	1	2	9	8	450	400	806
5. INVERTEBRATE INFAUNA	10	A	0	0	0	3	9	8	270	240	483
6. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	4	0	200	0	200
7. SHOREBIRDS	15	A	0	0	0	5	9	8	675	600	1208
8. GEESE	6	A	1	3	0	1	4	0	120	0	120
9. DUCKS	6	A	1	3	0	2	4	0	144	0	144
10. BEARS	6	A	0	0	0	5	4	0	240	0	240
									3538	2512	5763
5. INTERTIDAL ROCK											
1. INTERTIDAL SEAWEEDS	3	A	0	0	0	3	1	0	9	0	9
2. GREENLINGS	1	A	0	0	0	2	4	0	8	0	8
3. HERRING	6	A	3	0	0	2	9	8	270	240	483
4. SESSILE MARINE INVERTEBRATES	3	E	0	0	0	1	9	1	27	3	27
5. MISC. CRUSTACEANS	3	A	0	0	0	2	9	1	54	6	55

TABLE 2-9. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CON.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	3	A	0	0	0	3	9	1	81	9	82
7. SHOREBIRDS	3	A	0	0	0	5	4	1	63	15	64
8. SEA DUCKS	3	A	1	3	0	2	4	1	72	18	77
									581	291	885
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	A	0	0	0	3	1	0	9	0	9
2. SMELT	10	A	1	3	3	3	9	8	900	800	1611
3. MARISMELL BIVALVES	6	A	0	1	1	2	9	8	216	192	387
4. CRUSTACEANS	3	A	0	0	0	2	9	8	54	48	97
5. GASTROPODS	3	E	0	0	0	3	9	1	81	9	82
6. SHOREBIRDS	3	A	0	0	0	5	4	1	60	15	64
									1320	1064	2250
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	3	A	2	2	2	2	0	0	0	0	0
4. CHUM SALMON	3	A	2	0	0	2	0	0	0	0	0
5. SOCKEYE SALMON	6	A	2	2	2	2	0	0	0	0	0
6. PINK SALMON	3	A	2	2	2	2	0	0	0	0	0
7. COHO SALMON	10	A	2	2	2	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	3	2	1	0	0	0	0	0
9. DOLLY VARDEN	3	A	0	3	2	1	0	0	0	0	0
13. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	A	0	0	0	2	0	0	0	0	0
15. DUCKS	10	A	1	3	0	2	0	0	0	0	0
16. GEESE	10	A	1	3	0	2	0	0	0	0	0
17. SWANS	10	A	0	0	0	0	0	0	0	0	0
18. RIVER OTTER	6	A	2	1	1	1	0	0	0	0	0
19. MINK	6	A	2	1	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	1	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	1	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	1	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	10	A	0	0	0	2	0	0	0	0	0

TABLE 2-9. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
3. STRAND VEGETATION	10	A	0	0	0	1	9	0	90	0	90
4. OTHER VEGETATION	10	A	2	0	0	2	4	0	160	0	160
5. BROWN BEAR	6	A	2	2	0	2	0	0	0	0	0
6. BLACK BEAR	6	A	1	2	1	2	0	0	0	0	0
7. WOLVERINE	3	A	1	2	1	1	1	0	15	0	15
8. WOLF	3	A	1	2	1	1	1	0	15	0	15
9. MOOSE	15	A	3	2	3	2	0	0	0	0	0
10. CARIBOU	3	A	0	2	1	2	0	0	0	0	0
11. OTHER MAMMALS	6	A	0	0	0	2	1	0	12	0	12
17. RAPTORS	10	A	0	0	0	5	1	0	50	0	50
18. PTARMIGAN	6	A	0	2	1	2	0	0	0	0	0
19. OTHER BIRDS	10	A	0	1	1	2	1	0	40	0	40
									382	0	382
									11508	7432	17920

Razor clams	increased	to	967	from 547
Other Bivalves	increased	to	97	from 55
Sculpins	increased	to	55	from 26
Other Flatfish	increased	to	128	from 30
Pacific Sandlance	increased	to	82	from 38
Shrimp	reduced	to	164	from 290

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (753) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 1 is accounted for by the following species:

King Crab	increased	to	193	from 109
Tanner Crab	increased	to	64	from 36

THE INTERTIDAL SAND/MUD HABITAT contributed 37 percent (5,779) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 1 is accounted for by the following species:

Ducks	increased	to	580	from 144
Swans	increased	to	547	from 240
Invertebrate Infauna	reduced	to	273	from 483
Shorebirds	reduced	to	683	from 1,208

THE INTERTIDAL ROCKY HABITAT contributed 7 percent (1,118) of the impact score for this case. The increase in impact score for this habitat from Case 1 is accounted for by the following species:

Intertidal Seaweed	increased	to	36	from	9
Sessile Marine Invertebrates	increased	to	48	from	27
Miscellaneous Crustaceans	increased	to	97	from	55
Other Invertebrates	increased	to	145	from	82
Shorebirds	increased	to	137	from	64
Sea Ducks	increased	to	164	from	77

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 14 percent (2,140) of the impact score for this case. The change in impact score for this habitat from Case 1 is accounted for by the following species:

Intertidal Seaweeds	increased	to	36	from	9
Shorebirds	increased	to	137	from	64
Hardshell Bivalves	reduced	to	219	from	387
Crustaceans	reduced	to	55	from	97

THE TERRESTRIAL HABITAT contributed 2 percent (335) of the impact score for this case. Strand vegetation, reduced to 43 from 90, accounted for the decrease in impact score in this nabitat from Case 1.

CASE 3: SUMMER, DIESEL-2, 10,000 BBLS - ESTIMATED SCORE 13,194

THE PELAGIC HABITAT contributed 37 percent (4,912) of the score for this case. The species which were judged to be the main contributors to this score were herring, smelt, king salmon, chum salmon, sockeye salmon, pink salmon, coho salmon, rainbow/steelhead trout, Dolly Varden and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 8 percent (1,068) of the score for this habitat. The species which were judged to be the main contributors to this score were Dungeness crab, shrimp, razor clam and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 3 percent (44) of the score for this case. Chum salmon were judged to be the only species which contributed significantly to this score.

THE INTERTIDAL SAND/MUD HABITAT contributed 32 percent (4,243) of the score for this case. The species which were judged to be the main contributors to this score were razor clam, softshell bivalves, invertebrate infauna, marine mammal rookeries, shorebirds, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 4 percent (593) of the score for this case. Herring were judged to be the only species which contributed significantly to this score.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 13 percent (1,657) of the score for this case. Smelt and hardshell bivalves were judged to be the species which contributed significantly to this score.

THE TERRESTRIAL HABITAT contributed 2 percent (281) of the score for this case. Other vegetation was judged to be the only species which contributed significantly to this score.

CASE 4: SUMMER, BUNKER C, 50,000 BBLS - IMPACT SCORE 11,031

THE PELAGIC HABITAT contributed 11 percent (1,175) of the impact score for this case. With a minor exception, the decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Phytoplankton	reduced	to	18	from	77
Zooplankton	reduced	to	9	from	38
Ichthyoplankton	reduced	to	6	from	26
Herring	reduced	to	153	from	580
Smelt	reduced	to	320	from	729
Crab Larvae	reduced	to	26	from	97
King Salmon	reduced	to	21	from	89
Chum Salmon	reduced	to	21	from	89
Sockeye Salmon	reduced	to	42	from	179
Pink Salmon	reduced	to	21	from	89
Coho Salmon	reduced	to	70	from	298
Rainbow/Steelhead Trout	reduced	to	102	from	387
Dolly Varden	reduced	to	77	from	290
Seabirds	reduced	to	213	from	956

THE SUBTIDAL SAND/MUD HABITAT contributed 15 percent (1,685) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 2 is accounted for by the following species:

Sculpins	reduced	to	24	from	55
Other Flatfish	reduced	to	30	from	128
Pacific Sandlance	reduced	to	36	from	82
Miscellaneous Marine Fish	reduced	to	9	from	36
Dungeness Crab	reduced	to	137	from	242
Shrimp	reduced	to	72	from	164
Other Marine Invertebrates	increased	to	298	from	164

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (572) of the score for this case. With minor exceptions, the change in impact score for this habitat from Case 2 is accounted for by the following species:

King Crab	increased	to	240	from	193
Chum Salmon	reduced	to	84	from	191
Pacific Halibut	reduced	to	36	from	77
Other Flatfish	reduced	to	18	from	38
Other Marine Fish	reduced	to	6	from	26
Other Marine Invertebrates	reduced	to	38	from	82

THE INTERTIDAL SAND/MUD HABITAT contributed 51 percent (5,588) of the impact score for this case. The change in impact score for this habitat from Case 2 is accounted for by the following species:

Invertebrate Infauna	increased	to	483	from	273
Shorebirds	increased	to	1,202	from	683
Pacific Sandlance	reduced	to	38	from	145
Marine Mammal Rookeries	reduced	to	100	from	200
Ducks	reduced	to	153	from	580
Swans	reduced	to	255	from	547

THE INTERTIDAL ROCKY HABITAT contributed 8 percent (901) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 2 is accounted for by the following species:

Shorebirds	increased	to	300	from	137
Sea Ducks	increased	to	360	from	164
Herring	reduced	to	128	from	483
Miscellaneous Crustaceans	reduced	to	6	from	97
Other Invertebrates	reduced	to	9	from	145

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (855) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 2 is accounted for by the following species:

Shorebirds	increased	to	300	from	137
Smelt	reduced	to	400	from	1,611
Hardshell Bivalves	reduced	to	102	from	219
Crustaceans	reduced	to	26	from	55
Gastropods	reduced	to	9	from	82

THE TERRESTRIAL HABITAT contributed 2 percent (255) of the impact score for this case. Other vegetation, reduced to 80 from 160, accounted for the decrease in impact score for this habitat from Case 2.

CASE 5: SUMMER, CRUDE OIL, 10,000 BBLS - ESTIMATED SCORE 10,829

THE PELAGIC HABITAT contributed 23 percent (2,435) of the score for this case. The main contributing species to this score in this habitat were judged to be herring, smelt, sockeye salmon, coho salmon, rainbow/steelhead trout, Dolly Varden and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (1,366) of the score for this case. The main contributing species to this score in this habitat were judged to be Dungeness crab, shrimp, razor clam and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (521) of the score for this case. The main contributing species to this score in this habitat were judged to be chum salmon and king crab.

THE INTERTIDAL SAND/MUD HABITAT contributed 37 percent (4,000) of the score for this case. The main contributing species to this score in this habitat were judged to be razor clam, softshell bivalves, invertebrate infauna, marine mammal rookeries, shorebirds, ducks and swans.

THE INTERTIDAL ROCKY HABITAT contributed 7 percent (774) of the score for this case. The main contributing species to this score in this habitat were judged to be herring and sea ducks.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 14 percent (1,481) of the score for this case. The main contributing species to this score in this habitat were judged to be smelt and hardshell bivalves.

THE TERRESTRIAL HABITAT contributed 2 percent (232) of the score for this case. Other vegetation was judged to be the main contributing species to this score in this habitat.

CASE 6: SUMMER, BUNKER C, 10,000 BBLS - ESTIMATED SCORE 8,893

THE PELAGIC HABITAT contributed 11 percent (947) of the score for this case. The main contributing species to this score in this habitat were judged to be herring, smelt and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 15 percent (1,358) of the score for this case. The main contributing species to this score in this habitat were judged to be razor clam and other marine invertebrates.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (461) of this score for this case. King crab was judged to be the main contributing species to this score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 50 percent (4,505) of the score for this case. The main contributing species to this score in this habitat were judged to be razor clam, softshell bivalves, invertebrate infauna, shorebirds, ducks and swans.

THE INTERTIDAL ROCKY HABITAT contributed 8 percent (726) of the score for this case. The main contributing species to this score in this habitat were judged to be shorebirds and sea ducks.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (689) of the score for this case. The main contributing species to this score in this habitat were judged to be smelt and shorebirds.

THE TERRESTRIAL HABITAT contributed 2 percent (206) of this score for this case.

CASE 7: WINTER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 8,731

THE PELAGIC HABITAT contributed 8 percent (702) of the impact score for this case. Crab larvae and the five salmon species not present in Winter scenarios accounted for a decrease of 221 in impact score for this habitat from Case 4. With minor exceptions, the remaining change in impact score is accounted for by the following species:

Phytoplankton	increased	to	38	from	18
Herring	reduced	to	97	from	153
Smelt	reduced	to	219	from	320
Rainbow/Steelhead Trout	reduced	to	69	from	102
Dolly Varden	reduced	to	48	from	77
Seabirds	reduced	to	137	from	213

THE SUBTIDAL SAND/MUD HABITAT contributed 18 percent (1,639) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Sculpins	increased	to	55	from	24
Other Flatfish	increased	to	64	from	30
Pacific Sandlance	increased	to	82	from	36
Shrimp	increased	to	164	from	72
Dungeness Crab	reduced	to	81	from	137
Other Marine Invertebrates	reduced	to	82	from	290

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 4 percent (398) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 4 is accounted for by the following species:

Chum Salmon	not present			from	84
King Crab	reduced	to	193	from	240

THE INTERTIDAL SAND/MUD HABITAT contributed 50 percent (4,496) of the impact score for this case. With a minor exception, the change in impact sco. for this habitat from Case 4 is accounted for by the following species:

Marine Mammal Rookeries	increased	to	200	from 100
Ducks	increased	to	290	from 153
Pacific Sandlance	increased	to	195	from 38
Invertebrate Infauna	reduced	to	164	from 483
Shorebirds	reduced	to	137	from 1,208
Geese	reduced	to	64	from 128

THE INTERTIDAL ROCKY HABITAT contributed 6 percent (504) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Miscellaneous Crustaceans	increased	to	97	from 6
Other Invertebrates	increased	to	48	from 9
Herring	reduced	to	81	from 128
Shorebirds	reduced	to	46	from 300
Sea Ducks	reduced	to	164	from 360

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (805) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Smelt	increased	to	438	from 400
Hardshell Bivalves	increased	to	219	from 102
Shorebirds	reduced	to	46	from 300

THE TERRESTRIAL HABITAT contributed 2 percent (192) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Strand Vegetation	not present	from 43
Raptors	reduced to 30	from 50

CASE 8: WINTER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 8,283

THE PELAGIC HABITAT contributed 13 percent (1,067) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 7 is accounted for by the following species:

Phytoplankton	increased to 82	from 38
Pacific Sandlance	increased to 82	from 36
Smelt	increased to 387	from 219
Seabirds	increased to 242	from 137

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (1,160) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 7 is accounted for by the following species:

Shrimp	increased to 290	from 164
Sculpins	reduced to 26	from 55
Other Flatfish	reduced to 15	from 64
Pacific Sandlance	reduced to 38	from 82
Razor Clam	reduced to 547	from 967
Other Bivalves	reduced to 55	from 97

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 3 percent (260) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 7 is accounted for by the following species:

King Crab	reduced	to	109	from 193
Tanner Crab	reduced	to	36	from 64

THE INTERTIDAL SAND/MUD HABITAT contributed 53 percent (4,352) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 7 is accounted for by the following species:

Invertebrate Infauna	increased	to	290	from 164
Shorebirds	increased	to	242	from 137
Ducks	reduced	to	72	from 290
Swans	reduced	to	120	from 273

THE INTERTIDAL ROCKY HABITAT contributed 4 percent (299) of the impact score for this case. With a minor exception, the decrease in impact score for this habitat from Case 7 is accounted for by the following species:

Sessile Marine Invertebrates	reduced	to	27	from 48
Miscellaneous Crustaceans	reduced	to	55	from 97
Other Invertebrates	reduced	to	27	from 48
Shorebirds	reduced	to	21	from 46
Sea Ducks	reduced	to	77	from 164

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (953) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 7 is accounted for by the following species:

Hardshell Bivalve	increased	to	387	from 219
Shorebirds	reduced	to	21	from 46

THE TERRESTRIAL HABITAT contributed 2 percent (192) of the impact score for this case. This habitat's result was the same as for Case 7.

CASE 9: WINTER, BUNKER C, 50,000 BBLS - IMPACT SCORE 7,327

THE PELAGIC HABITAT contributed 4 percent (291) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Phytoplankton	reduced	to	9	from	82
Zooplankton	reduced	to	3	from	27
Pacific Sandlance	reduced	to	36	from	82
Herring	reduced	to	26	from	97
Smelt	reduced	to	96	from	387
Rainbow/Steelhead Trout	reduced	to	17	from	64
Dolly Varden	reduced	to	13	from	48
Seabirds	reduced	to	64	from	242

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (1,419) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Razor clam	increased	to	967	from	547
Other Bivalves	increased	to	97	from	55
Other Marine Invertebrates	increased	to	145	from	82
Dungeness Crab	reduced	to	46	from	81
Shrimp	reduced	to	72	from	290

THE SUBTIDAL ROCK/GRAVEL HABITAT contributed 6 percent (407) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

King Crab	increased	to	240	from 109
Tanner Crab	increased	to	80	from 36
Scallops	increased	to	40	from 18

THE INTERTIDAL SAND/MUD HABITAT contributed 57 percent (4,162) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Pacific Sandlance	reduced	to	38	from 145
Marine Mammal Rookeries	reduced	to	100	from 200

THE INTERTIDAL ROCKY HABITAT contributed 8 percent (564) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Sessile Marine Invertebrates	increased	to	61	from 27
Shorebirds	increased	to	100	from 21
Sea Ducks	increased	to	360	from 77
Herring	reduced	to	21	from 81
Miscellaneous Crustaceans	reduced	to	6	from 55
Other Invertebrates	reduced	to	3	from 27

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (340) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Shorebirds	increased	to	100	from	21
Smelt	reduced	to	120	from	483
Hardshell Bivalves	reduced	to	102	from	387
Crustaceans	reduced	to	9	from	32
Gastropods	reduced	to	3	from	27

THE TERRESTRIAL HABITAT contributed 2 percent (144) of the impact score for this case. Other vegetation, reduced to 48 from 96, accounted for the decrease in impact score for this habitat from Case 8.

CASE 10: WINTER, DIESEL-2, 10,000 BBLS - ESTIMATED SCORE 7,202

THE PELAGIC HABITAT contributed 13 percent (928) of the score for this case. The main contributing species to this score in this habitat were judged to be smelt and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (1,009) of the score for this case. The main contributing species to this score in this habitat were judged to be shrimp and razor clam.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 3 percent (226) of the score for this case.

THE INTERTIDAL SAND/MUD HABITAT contributed 60 percent (4,352) of the score for this case. The main contributing species to this score were judged to be razor clams, softshell bivalves, invertebrate infauna, marine mammal rookeries, and shorebirds.

THE INTERTIDAL ROCKY HABITAT contributed 4 percent (260) of the score for this case.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (829) of the score for this case. The main contributing species to this score for this habitat were judged to be smelt and hardshell bivalves.

THE TERRESTRIAL HABITAT contributed 2 percent (167) of the score for this case.

CASE 11: SUMMER, DIESEL-2, 1,000 BBLS - ESTIMATED SCORE 6,156

THE PELAGIC HABITAT contributed 37 percent (2,293) of the score for this case. The main contributing species to this score in this habitat were judged to be herring, smelt, king salmon, chum salmon, sockeye salmon, pink salmon, coho salmon, rainbow/steelhead trout, Dolly Varden, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 8 percent (498) of the score for this case. The main contributing species to this score in this habitat were judged to be Dungeness crab, shrimp and razor clam.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 3 percent (205) of the score for this case. Chum salmon were the only species judged to contribute significantly to this score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 32 percent (1,979) of the score for this case. The main contributing species to this score in this habitat were judged to be razor clam, softshell bivalves, invertebrate infauna and swans.

THE INTERTIDAL ROCKY HABITAT contributed 4 percent (277) of the score for this case. Herring were the only species judged to contribute significantly to the score in this case.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 13 percent (773) of the score for this case. Smelt and hardshell bivalves were the only species judged to contribute significantly to the score in this case.

THE TERRESTRIAL HABITAT contributed 2 percent (131) of the score in this case.

CASE 12: SUMMER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 5,461

THE PELAGIC HABITAT contributed 23 percent (1,231) of the score for this case. The main contributing species to this score in this habitat were judged to be herring, smelt, coho salmon, rainbow/steelhead trout, Dolly Varden and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (690) of the score for this case. Dungeness crab and razor clam were the only species judged to contribute significantly to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (263) of the score for this case.

THE INTERTIDAL SAND/MUD HABITAT contributed 37 percent (2,021) of the score for this case. The main contributing species to this score in this habitat were judged to be razor clam, softshell bivalves, invertebrate infauna, marine mammal rookeries, shorebirds, ducks and swans.

THE INTERTIDAL ROCKY HABITAT contributed 7 percent (391) of the score for this case. Herring were the only species judged to contribute significantly to the impact in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 14 percent (748) of the score for this case. Smelt and hardshell bivalves were the only species judged to contribute significantly to the impact score in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (117) of the score for this case.

CASE 13: WINTER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 5,037

THE PELAGIC HABITAT contributed 8 percent (405) of the score for this case. Smelt was the only species judged to contribute significantly to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (943) of the score for this case. Shrimp and razor clam were the only species judged to contribute significantly to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 6 percent (230) of the score for this case. King crab was the only species judged to contribute significantly to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 51 percent (2,494) of the score in this case. The main contributing species to this score in this habitat were judged to be razor clams, softshell bivalves, invertebrate infauna, marine mammal rookeries, ducks and swans.

THE INTERTIDAL ROCKY HABITAT contributed 6 percent (291) of the score for this case. Sea ducks were the only species judged to contribute significantly to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (464) of the score for this case. Smelt and hardshell bivalves were the only species judged to contribute significantly to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (111) of the score for this case.

CASE 14: SUMMER, BUNKER C, 1,000 BBLS - IMPACT SCORE 4,814

THE PELAGIC HABITAT contributed 11 percent (513) of the score for this case. Smelt and seabirds were judged to be the main contributing species to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 15 percent (735) of the score for this case. Razor clam and other marine invertebrates were judged to be the main contributing species for this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (250) of the impact score. King crab were judged to be the only significantly contributing species.

THE INTERTIDAL SAND/MUD HABITAT contributed 51 percent of the score. Razor clam, softshell bivalves, invertebrate infauna, shorebirds, and swans were judged to be the main contributing species.

THE INTERTIDAL ROCKY HABITAT contributed 8 percent (393) of the impact score. Shorebirds and sea ducks were judged to be the main contributors to the score.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (373) of the score. Smelt and shorebirds were the main contributing species.

THE TERRESTRIAL HABITAT contributed 2 percent (111) of the score. No single species was judged to contribute significantly.

CASE 15: WINTER, DIESEL-2, 1,000 BBLS - ESTIMATED SCORE 4,302

THE PELAGIC HABITAT contributed 13 percent (554) of the score for this case. Smelt and seabirds were judged to be the main contributing species for this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (602) of the score. Shrimp and razor clam were judged to be the main contributors.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 3 percent (135) of the score. No single species was judged to be a significant contributor.

THE INTERTIDAL SAND/MUD HABITAT contributed 53 percent (2,260) of the score. Razor clams, softshell bivalves, invertebrate infauna, marine mammal rookeries, and shorebirds were judged significant contributors.

THE INTERTIDAL ROCKY HABITAT contributed 4 percent (155) of the score. No single species contributed significantly.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (495) of the score. Smelt and hardshell bivalves contributed significantly.

THE TERRESTRIAL HABITAT contributed 2 percent (100) of this score. No species was a significant contributor.

CASE 16: WINTER, BUNKER C, 10,000 BBLS - ESTIMATED SCORE 4,135

THE PELAGIC HABITAT contributed 4 percent (164) of the score. No single species contributed significantly to the score.

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (801) of the score. Razor clams and other marine invertebrates were the significant contributors.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 6 percent (230) of the score. King crab was the significant contributing species.

THE INTERTIDAL SAND/MUD HABITAT contributed 57 percent (2,349) of the score. Significant contributors were razor clam, softshell bivalves, invertebrate infauna, marine mammal rookeries, shorebirds and swans.

THE INTERTIDAL ROCKY HABITAT contributed 8 percent (318) of the score. Significant contributors were shorebirds and seaducks.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (192) of the score. Significant contributors were smelt, hardshell bivalves and shorebirds.

THE TERRESTRIAL HABITAT contributed 2 percent (81) of the score. There were no significant contributions.

CASE 17: WINTER, BUNKER C, 1,000 BBLS - ESTIMATED SCORE 2,397

THE PELAGIC HABITAT contributed 4 percent (95) of the score. No species contributed significantly.

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (464) of the score. Razor claims were the only significant contributors.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 6 percent (133) of the score. King crabs were the significant contributors.

THE INTERTIDAL SAND/MUD HABITAT contributed 57 percent (2,349) of the score. Significant contributors were razor clam, softshell bivalves, invertebrate infauna, and shorebirds.

THE INTERTIDAL ROCKY HABITAT contributed 8 percent (185) of the score. Sea ducks were the significant contributor.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (111) of the score with no significant contributors.

THE TERRESTRIAL HABITAT contributed 2 percent (47) of the score.

CASE 18: WINTER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 1,925

THE PELAGIC HABITAT contributed 8 percent (155) of the score. Smelt were the only significant contributor.

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (360) of the score. Razor clams were the only significant contributor.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (88) of the score, with no significant contributions.

THE INTERTIDAL SAND/MUD HABITAT contributed 51 percent of the score. Significant contributors were razor clam, softshell bivalves, marine mammal rookeries, ducks, and swans.

THE INTERTIDAL ROCKY HABITAT contributed 6 percent (111) of the score, with no significant contributors.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (177) of the score. Significant contributors were smelt and hardshell bivalves.

THE TERRESTRIAL HABITAT contributed 2 percent (42) of the impact score, with no significant contributors.

CASE 19: SUMMER, GASOLINE, 50,000 BBLS - IMPACT SCORE 1,826

THE PELAGIC HABITAT contributed 50 percent (920) of the impact score for this case. The main contributing species were herring (144), smelt (320), crab larvae (55), coho salmon (70), rainbow/steelhead trout (102), and Dolly Varden (77).

THE SUBTIDAL SAND/MUD HABITAT contributed 6 percent (111) of the impact score. The species impacted were Dungeness crab (15), shrimp (72), and other marine invertebrates (18).

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (145) of the impact score. The main species impacted were chum salmon (89) and other marine invertebrates (38).

THE INTERTIDAL SAND/MUD HABITAT contributed 4 percent (80) of the impact score. Impacts were softshell bivalves (50) and invertebrate infauna (30).

THE INTERTIDAL ROCKY HABITAT contributed 4 percent (72) of the impact score. Main impacts were to herring (30) and sessile marine invertebrates (27).

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 25 percent (448) of the impact score. Impacts were to smelt (400), hardshell bivalves (24), and crustaceans (24).

THE TERRESTRIAL HABITAT contributed 3 percent (50) of the impact score. Impacts were to strand vegetation (10) and other vegetation (40).

CASE 20: SUMMER, DIESEL-4 100 BBLS - ESTIMATED SCORE 1,150

THE PELAGIC HABITAT contributed 37 percent (428) of the score. Significant contributors were herring, smelt, king salmon, chum salmon, sockeye salmon, pink salmon, rainbow/steelhead trout, Dolly Varden trout and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 8 percent (93) of the score. The significant contributor was razor clam.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 3 percent (38) of the score, with no significant contributors.

THE INTERTIDAL SAND/MUD HABITAT contributed 32 percent (370) of the score. Significant contributors were razor clam, softshell bivalves, invertebrate infauna, and shorebirds.

THE INTERTIDAL ROCKY HABITAT contributed 5 percent (52) of the score, with herring the significant contributor.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 13 percent (144) of the score. Significant contributors were smelt and hardshell bivalves.

THE TERRESTRIAL HABITAT contributed 2 percent (25) of the score with no significant contributors.

CASE 21: SUMMER, GASOLINE, 10,000 BBLS - ESTIMATED SCORE 997

THE PELAGIC HABITAT contributed 50 percent (502) of the score. Significant contributors were the herring and smelt.

THE SUBTIDAL SAND/MUD HABITAT contributed 6 percent (61) of the score, with no significant contributors.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (79) of the score, with no significant contributors.

THE INTERTIDAL SAND/MUD HABITAT contributed 4 percent (44) of the score, with no significant contributors.

THE INTERTIDAL ROCKY HABITAT contributed 4 percent (39) of the score, with no significant contributors.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 24 percent (244) of the score, with smelt the significant contributor.

THE TERRESTRIAL HABITAT contributed 3 percent (27) to the score, with no significant contributors.

The remaining cases 22 through 32 ranged in impact scores from 718 to 7. All these cases were for 100-bbl spills except for gasoline. The array of these cases is as follows:

SPILL TYPE	SPILL SIZE AND SEASON				
	10,000		1,000		100
	WINTER	SUMMER	WINTER	SUMMER	WINTER
Diesel-2	Case 10	Case 11	Case 15	Case 20	718
Crude Oil	Case 13	Case 12	Case 18	653	414
Bunker C	Case 16	Case 14	Case 17	358	505
Gasoline	167	277	45	25	7

The relatively low scores for these cases and the minor differences between cases makes case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(5) OFFSHORE PORT GRAHAM

Port Graham is located at the southwest end of the Kenai Peninsula on the east side of lower Cook Inlet. The selected spill site is shown in Figure 2-27 and is about 3.5 miles west of Dangerous Cape ($59^{o}23.89'N$ $152^{o}W$) in 25 fathoms of water and at the southern part of the opening into Kachemak Bay.

(a) PHYSICAL CHARACTERISTICS

Cook Inlet is characterized as being in the Transitional Climatic Zone, but lower Cook Inlet is strongly influenced by the maritime climate of the Gulf of Alaska.

TEMPERATURES

Temperatures at Port Graham are more moderate than those of upper portions of Cook Inlet due to the greater maritime influence. Summer temperatures typically vary between $35^{o}F$ to $60^{o}F$, and Winter temperatures vary between $16^{o}F$ and $46^{o}F$.[1,4] The record low temperature is $-21^{o}F$ at Homer, and the record high is $80^{o}F$ at both Homer and Seldovia.[1,4]

Sea surface temperatures vary from $30^{o}F$ to $48^{o}F$ in Winter and from $43^{o}F$ to $62^{o}F$ in Summer.[4] Normally there is not sufficient sea ice present to impede navigation.[4,8]

SURFACE WINDS

Prevailing winds in Cook Inlet are northerly in Winter and southerly in Summer.[2,3,10] Typical winds were estimated as north-northeast at 9.0 knots in Winter and southwest at 9.0 knots in Summer.

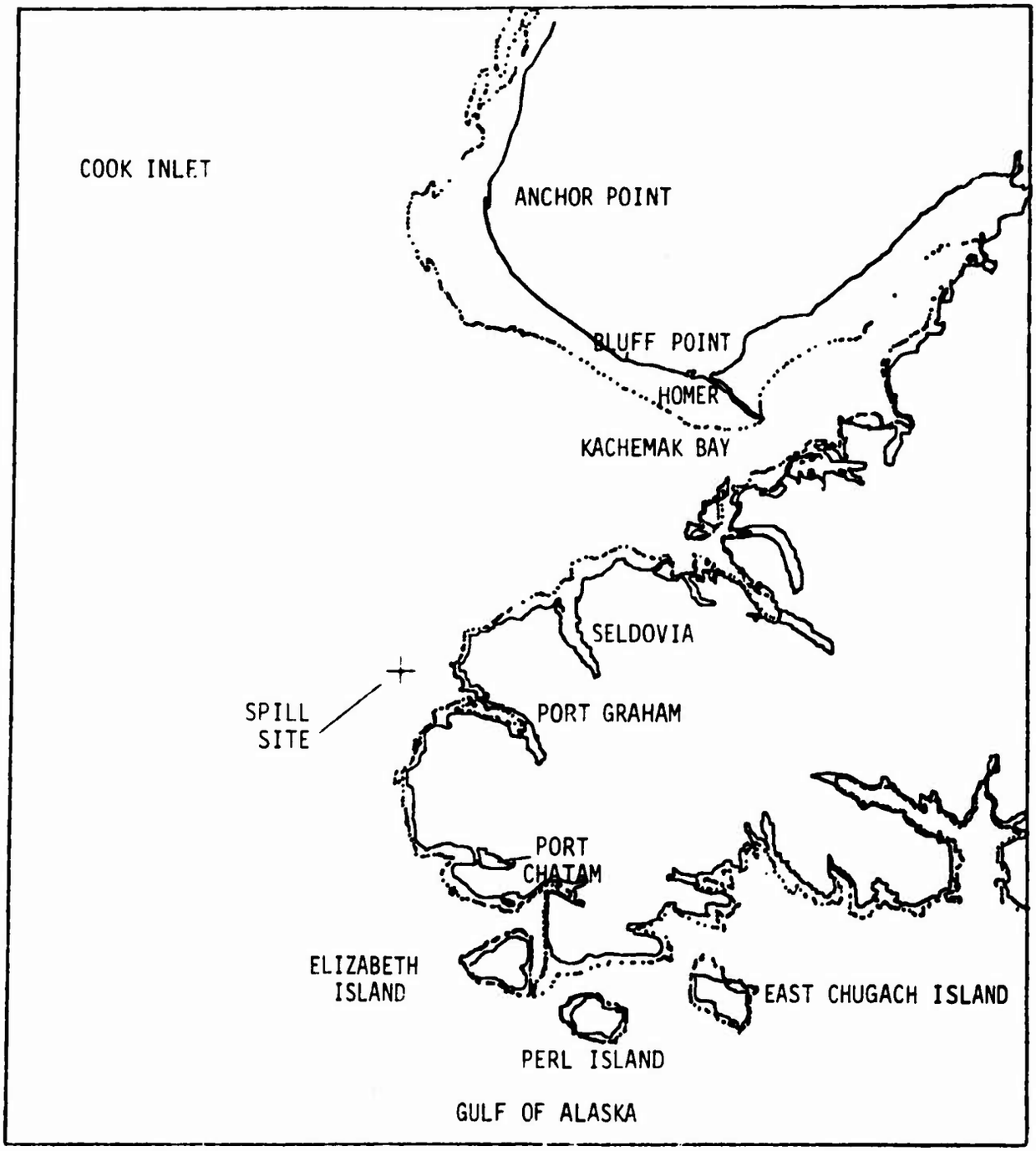


FIGURE 2-27. THE OFFSHORE PORT GRAHAM LOCATION AND SPILL SITE

NOTE: The broken line is the 10 fathom (60 feet) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

SURFACE CURRENTS

The generalized surface currents are shown in Figure 2-20. The Offshore Port Graham spill site is in the east shore influx of ocean water from the Gulf of Alaska. Review of the *COAST PILOT*[8] and *TIDAL CURRENT TABLES*[9] yielded limited information about this location.

The *TIDAL CURRENT TABLES*[9] provided the following information for the Port Graham vicinity:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Southwest 3 miles of Anchor Point	1.9 K (195°)	2.4 K (000°)
Chugach Passage	1.8 K (170°)	3.1 K (355°)

The *COAST PILOT*[8] provided the following information:

AREA	COMMENT
Homer	Diurnal tide range is 18.2 ft.
Seldovia	Diurnal tide range is 17.8 ft. and tidal currents are estimated at 1 to 2 knots.
Port Graham	Diurnal tide range is about 16.5 ft. Strong ebb and flood currents set across the harbor mouth with little current at or inside of Passage Island. With opposing wind and current, heavy tide rips occur off and well northward and southward of the Port Graham entrance.
Port Chatum	Diurnal tide range is 14.3 ft. and tidal currents are weak in the harbor and the entrance.

Elizabeth Island (both sides)	Strong tidal currents and at times tide rips.
Barren Islands, passages North and South	Tidal currents of considerable velocity with flood current setting approximately northwestward and the ebb southwestward. Heavy tide rips occur with strong winds.
North of Barren Islands	Ebb currents set strongly to the east. Flood currents are steady to the westward and, in general, currents do not exceed 4 knots.

Evans[10] provided a general current pattern for this location (Figure 2-20 in Drift River location description) which would indicate that net surface currents move from out of the Gulf of Alaska and into Cook Inlet along the Offshore Port Graham vicinity.

From this information, MSNW assumed the following current regions for oil dispersion modelling completed at Port Graham.

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Cook Inlet Offshore Port Graham	1.9 K (195°)	2.4 K (000°)
Outer Kachemak Bay (to Homer Spit)	1.5 K (240°)	1.3 K (060°)
Inner Kachemak Bay	1.5 K (280°)	1.5 K (060°)
Passage North of Elizabeth Island	1.0 K (075°)	1.8 K (255°)
Chugach Passage	1.8 K (170°)	3.1 K (350°)
East Chugach Island Vicinity	1.0 K (075°)	1.8 K (255°)
South and West of Elizabeth Island	1.0 K (140°)	1.8 K (320°)

(b) BIOLOGICAL CHARACTERISTICS

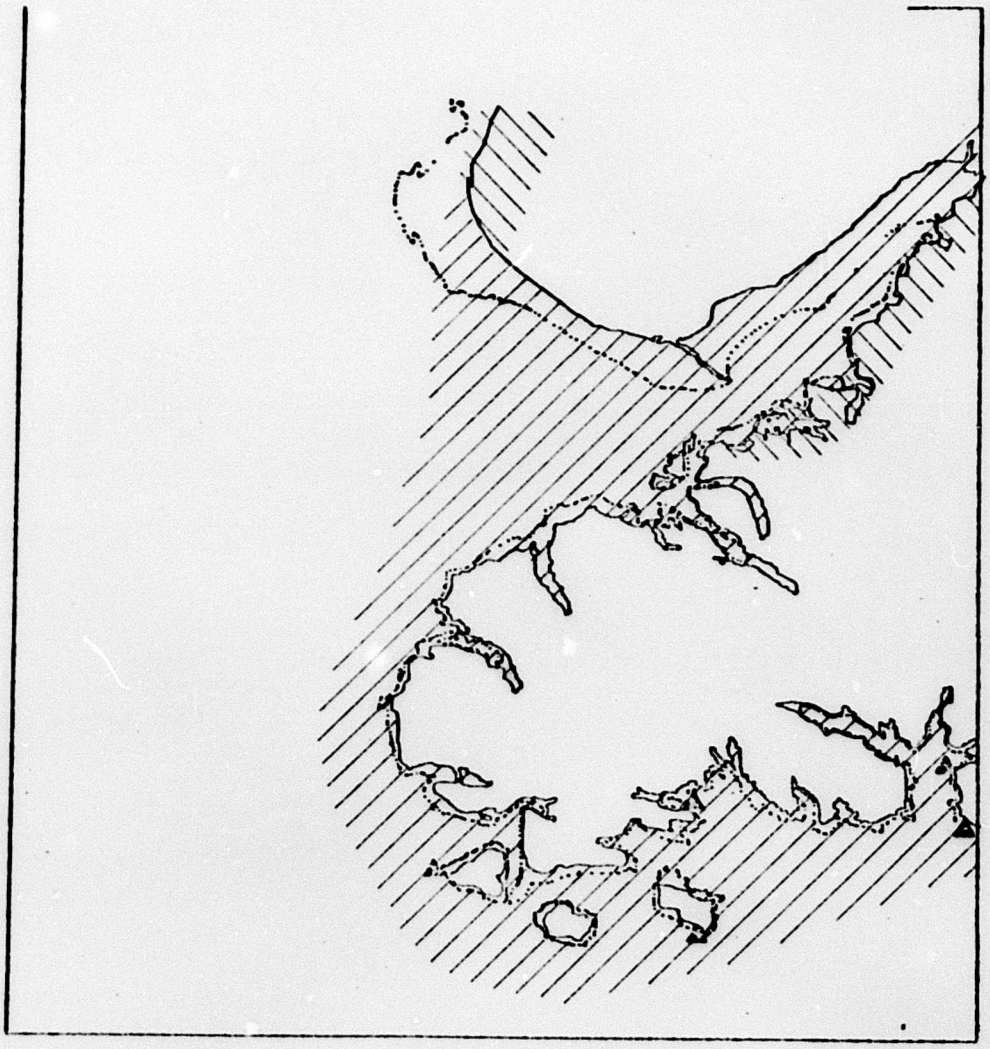
The region in the vicinity of Offshore Port Graham is a biologically rich area, particularly the adjacent Kachemak Bay area. This Bay has been labeled "possibly one of the most productive bays in the world and certainly one of the most beautiful."[11] In early 1974, Kachemak Bay was declared a "critical habitat area" by the Alaska State Legislature. The boundary line for this area is a straight line across the Bay's mouth from Anchor Point south to Point Pogibishi just north of Port Graham.[41] Kachemak Bay represents only 2.6 percent of Cook Inlet's marine waters yet produces 62 percent of the Inlet's commercial shellfish.[7] A state park is located on the south side of Kachemak Bay.[12] The general Offshore Port Graham vicinity is on a major migration route for the adult and smolt salmon movements into and out of Cook Inlet.

Fish and shellfish form a major resource of the Offshore Port Graham vicinity. Waterfowl and marine mammals are also important resources at this location.

Resource summaries are shown in Figures 2-28 and 2-29.

FISHES

SALMONIDS - All five species of North American salmon inhabit this portion of Cook Inlet or travel through this location to other parts of Cook Inlet. Based upon catch statistics of the Port Graham-Kachemak Bay region, pink salmon are the most abundant species with even-year runs being at least double the odd-year runs.[10,15] The catch statistics, 1965 through 1971, for the region are listed below:



Waterfowl and Seabirds

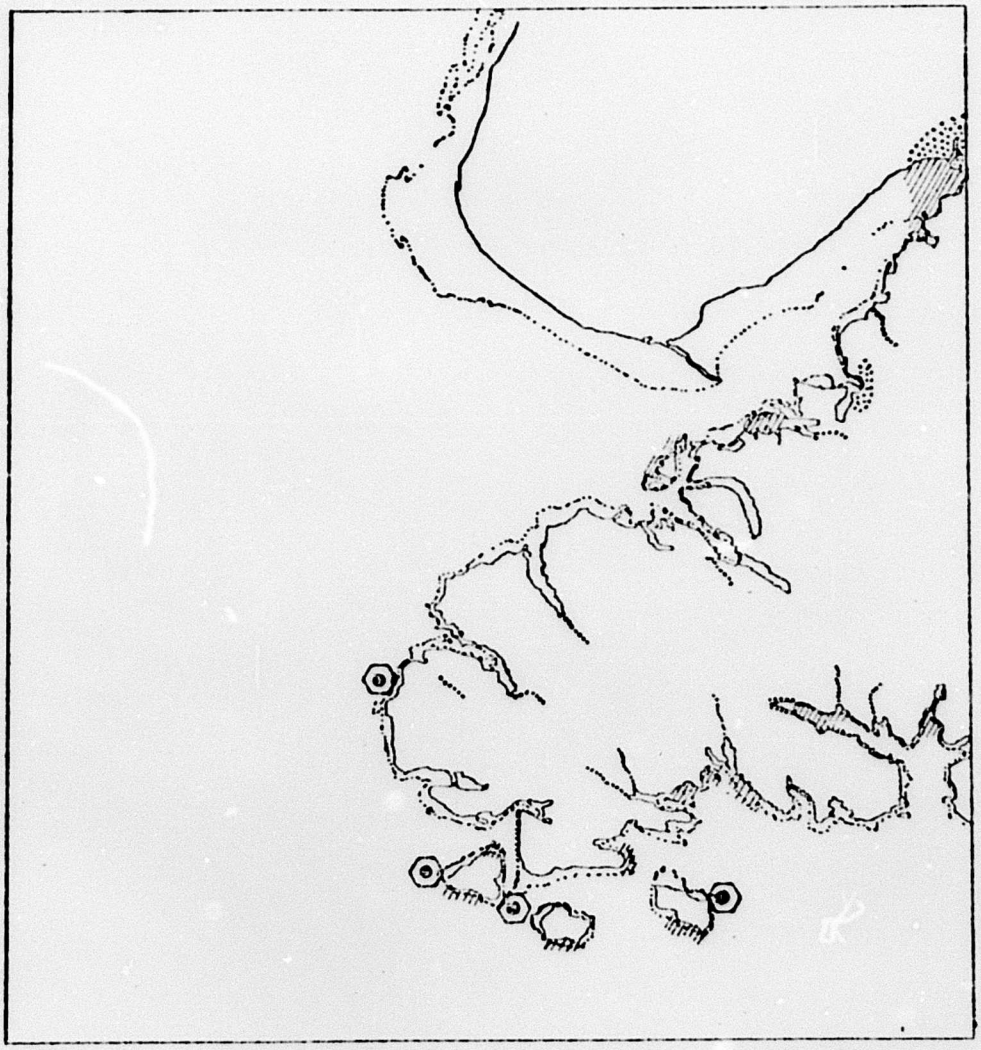
Wintering Area

Nesting-Molting Area

Seabird Colony

FIGURE 2-28 PORT GRAHAM (SELDOVIA) CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.



Harbor Sea Concentration

Sea Lion Concentration/Rookery

Black Bear

Intensive Use

..... Concentration on Fish Stream

FIGURE 2- 29. PORT GRAHAM (SELDOVIA) CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

SALMON	MEAN	(RANGE)
King	75	(10 - 175)
Sockeye	15,900	(11,200 - 26,300)
Coho	2,800	(500 - 4,700)
Pink	123,700	(60,500 - 217,900)
Chum	34,000	(2,500 - 117,300)

Major pink salmon spawning occurs in rivers in the Port Graham-Seldovia area.[10] Escapement of pinks is estimated at twice the catch; thus, estimated abundance can be achieved by multiplying the catch by three.[10,23] The pink salmon fishery occurs from June 1st to mid-August, with fry present in the local bays during the Summer.[10,15] Adult salmon are present in the inlet from about May 15th (king) to September 20th (coho) (see Figure 2-24).

Evans[10] indicated that local sockeye salmon spawning areas include the English Bay Lakes just southwest of Port Graham and Caribou Lake at the head of Kachemak Bay.

There is an extensive sport fishery in this region for both salmon and trout. The Anchor River (northwest of Homer) is important for king salmon, steelhead, and Dolly Varden.

Dolly Varden move out of their home rivers and to the Inlet in the Spring before ice melts and creel census data (July-August) indicates presence in fair numbers along shorelines.[10]

PACIFIC HALIBUT are located in this region of Cook Inlet from May through August, with most of these bottom-dwelling individuals wintering offshore in the Gulf.[10] The local center of high halibut production is the

Gulf of Alaska, but juvenile halibut utilize lower Cook Inlet as a nursery area.[13] Highest concentrations of halibut located in Cook Inlet were in Kachemak Bay.[10]

Commercial halibut fishing is increasing with the development of a small boat fleet.[13] Sport fishing in lower Cook Inlet is generally from May through August.[10]

PACIFIC HERRING harvests in Cook Inlet have reached almost 20-million lb. (1925) and have been lower and declining in more recent years (5.4-million lbs in 1970).[10] They actively spawn in Kachemak Bay and are most abundant in this Bay.[10]

SMELT (EULACHON) migrate through this location in early May, with a peak towards the end of May on their way to streams of the upper Inlet.[10] The young move out of the streams in about a month and reenter the marine environment.[10] Other smelt (capelin) probably utilize gravel beaches to spawn in early Spring.[13] Adhesive eggs are spawned at the water's edge at high tide.[13]

OTHER MARINE FISHES - Numerous other flatfish species and sculpin species are also found in this area.

SHELLFISHES

KING CRAB are found at this location principally in the mouth of Kachemak Bay as shown by U.S. Bureau of Commercial Fisheries (now National Fisheries Service) data.[10,15,16] Based upon catch statistics, this location does not have the apparent numbers of king crab as does Kamishak Bay (across the mouth of Cook Inlet). There are both small resident populations in

Kachemak Bay as well as large migratory populations (Winter in Kachemak; Summer and Fall near Barren Islands and Kodiak).[10]

The king crab life cycle begins with the crabs moving to shallower waters (10 to 30 fathoms) following the February to May female moult to breed.[10] The eggs are laid in the spring, carried a year by the female, and hatched the following Spring (peak - late April), and the free-swimming young occupy the middle and bottom of shallow waters (15 to 30 fathoms).[10]

Their greatest vulnerability to oil is thought to be at those times that they venture into shallower waters and while larvae remain in shallow water. Rosenberg[20] provided a detailed life history and biological description of this crab.

TANNER CRAB are also abundant in lower Cook Inlet. Kachemak Bay has lesser numbers than the Kamishak side of the Inlet.[16] However, tanners are still present in great numbers in Kachemak Bay. In 1971, the pound harvest of tanner crabs was about equal that of king crabs in the Southern District of Cook Inlet.[10] King and tanner crabs are of great economic value to the local commercial fishing industry.

The tanner crab life history movements are like those of king crab except that tanners breed and moult in June and July.[10] The young spend 0.5 to 4.0 months (depending on species) as floating larvae.[10] Planktonic (not free-swimming) larvae and their surface location make tanner crab larvae more vulnerable greater than king crab larvae.[10] Rosenberg[20] provided a detailed life history and biological description of this crab.

DUNGENESS CRAB are not as abundant as king and tanner crabs (1971 Cook Inlet: king crab--4.1-million lbs; tanner crab--2.0-million lbs, and

Dungeness crab--100,000 lbs) in this area. They do move in and out of Kachemak Bay (shallow water Spring and Summer; deeper waters--Fall and Winter).[10] They mate in May and June; eggs laid in the Fall are carried by the female until the following Spring when they hatch into free-swimming larvae. Their shallower water existence and larvae make them more vulnerable than the king or tanner crabs. Rosenberg provided a detailed life history and biological description of this crab.

SHRIMP are very abundant in the vicinity of Offshore Port Graham, particularly in Kachemak Bay. The 1971 Cook Inlet harvest of shrimp was almost 5.5-million lbs.[10] Numerous species are involved (Pandalids: pink, humpy, coonstripe, spot, and sidestripe, and others). Monthly harvest distribution was relatively even in 1971, with high catches in March and low catches in January, May, and December (due to poor weather).[10] Thus, shrimp are here year-round. A small sport fishery is developing off Homer Spit.[10]

Summary of Bureau of Commercial Fisheries data located high numbers of shrimp (mostly pink shrimp) in Kachemak Bay, with lesser numbers off the Bay entrance.16

Shrimp generally breed in September (with molting), with eggs laid in October and carried through May when they hatch. Early life stages and adults are probably as sensitive to pollution as crabs.[10]

RAZOR CLAMS do not occur in the immediate vicinity of Port Graham but do occur in the vicinity of Homer Spit (north side of Kachemak) and north along the eastern shore of Cook Inlet. Harvest is mostly sport, with more than 400,000 clams taken in 1972.[10] See the Drift River location description for further information on their biology and vulnerability to oil.

SCALLOPS do not appear to be an abundant resource in the Offshore Port Graham vicinity, although they are found in significant numbers in Kamishak Bay across the Inlet. See the Kamishak Bay location description for the scallop biology and vulnerability to oil.

Figure 2-21 with Drift River description provided a composite of fish and shellfish resources utilization for Cook Inlet, including the Offshore Port Graham vicinity.[10]

WATERFOWL

Little quantitative data exists on Cook Inlet waterfowl. Evans [10] provided a summary of available information. The entire shore area at this location is reported as duck nesting and wintering areas--on the southern shore and land of inner Kachemak Bay and on the shore and land in the vicinity of Anchor Point and further north.[17]

Scoters, kittiwakes, and tufted puffins with other seabirds are abundant. A survey in August 1972 showed increasing abundance of birds as one went south in Cook Inlet, with very high abundances in the Southern District.[10] Kachemak Bay has numerous scoters.[17] Fulmars averaged about 30 per square mile south of Port Graham in the vicinity of northeast of Barren Islands.[10] Rosenberg[20] described the abundant waterfowl in the adjacent Gulf of Alaska.

DUCKS - ADF&G[17] reported Kachemak Bay to be a major wintering area for ducks. This area is also in a major migration zone.

Sea ducks inhabit open sea; dabbling-type ducks (i.e., mallards) inhabit estuaries, mud flats, and small ponds; diving ducks (i.e., eiders) inhabit nearshore areas, estuaries, and small ponds.[18]

GEESE inhabit mud flats, estuaries, and small ponds in this area. Lesser Canada geese are the dominant species.[10]

SWANS inhabit mud flats, estuaries, and ponds, with the Kenai Peninsula a major breeding area with some overwintering in mild Winters.[17]

SEABIRDS involved at this location inhabit nearshore seas and beaches and are in moderate numbers in the Port Graham vicinity. Colonies of mixed seabird species exist at Elizabeth Island, Perl Island, East Chugach Island, Windy Bay, Rocky Bay, Port Dick, and Novka Point.[13]

SHOREBIRDS inhabit beaches, mud flats, and estuaries and are present, but no information was found for this location.

Migratory waterfowl movements in Cook Inlet are not well defined. Upper Inlet marshes have the Fall waterfowl buildup starting in early August and peaking in late September, and with the freezeup in late October, most waterfowl have left.[10] Highest populations in marsh areas occur in the Spring of the year.[10]

Recreational hunting is present in the Inlet, but there is little quantitative data on this activity.[10]

The vulnerability of waterfowl is directly related to the dependence of a species or group of species to the marine areas involved in a sea spill. Seabirds are the most vulnerable because of their dependence on the sea for survival. Oil spills in locations where abundant seabirds exist are assumed to be disastrous to these birds.

Shorebirds are also assumed very vulnerable to oil spills because of potential damage to the invertebrates utilized by the birds as food. Shorebirds are also vulnerable to the direct effects of oil but markedly less so than seabirds.

Ducks, geese, and swans are felt to be less vulnerable to spills than seabirds because they are usually somewhat less dependent on marine areas (i.e., there are alternate water areas in many cases). However, some species of geese and ducks are sea oriented. For example, black brant and emperor geese are heavily dependent on eelgrass beds and shore areas, respectively, while the entire group of sea ducks (scoters, cormorants, etc.) are almost entirely sea oriented and would be expected to be as vulnerable to spills as seabirds.

All waterfowl are felt to generally be more vulnerable when young are present because the young are probably more directly vulnerable, and the birds are tied to specific areas during nesting and brooding.

MARINE MAMMALS

SEA OTTERS are not as abundant in the vicinity of Port Graham as they are across the Inlet in Kamishak Bay. Sea otters are reported ranging out of the Gulf of Alaska on the east side of the Cook Inlet entrance only up past Port Graham to Dangerous Cape.[17] No concentrations of sea otters were shown. The ADF&G estimates a population of several hundred sea otters east of the Inlet.

Pupping peaks in the late Spring but may occur at any time of the year.[10] Therefore, female otters with dependent pups can, be in the vicinity year-round.

HARBOR SEALS are located along all coastlines in the vicinity of Port Graham.[17] High concentrations of harbor seals occur at Yukon Island, Cohen Island, China Poot Bay in Kachemak Bay, as well as in the entire head of Kachemak Bay.[10,17] Harbor seals are distributed from Homer north up the east coast of the Inlet.[17] The species seldom occurs north of Kachemak Bay.[10]

South of Port Graham there are high harbor seal concentrations on the south shores of Elizabeth, Perl, and East Chugach Islands in the Chugach Island group, and in other locations east of Cook Inlet.[17] No population estimates were identified for this vicinity.

Pupping of harbor seals occurs from late May through July in the Chugach Islands.[10]

SEA LIONS are located along all coastlines in the vicinity of Port Graham, with rookeries at Flat Islands (300) just south of Port Graham at Cape Elizabeth (30) on Elizabeth Island in the Chugach Island group.[17] Other rookeries near Perl Island (50) on East Chugach Island (20) and in other land points on each of the Chugach Island group.[17]

BELUGA WHALES - See Drift River location description.

OTHER MARINE MAMMALS occupy lower Cook Inlet. These include killer whales (Kachemak Bay) and Dall porpoises and harbor porpoises in lower Cook Inlet.[10]

TERRESTRIAL MAMMALS

BROWN BEAR are few in number and distributed from Kachemak Bay and north.[17]

BLACK BEAR are in high densities with many local concentrations on streams draining into Port Graham. An extensive population utilizes the delta region (Fox River) at the head of Kachemak Bay in the Spring.[17]

WOLVES AND WOLVERINES are scattered throughout the land area in the Port Graham vicinity but are not numerous.[17] They occupy almost all terrestrial areas including willow flats and beach areas.

MOOSE are located from the vicinity of Kachemak Bay and north.[17] The moose range in the area north is considered to be the world's best with densities of 15 per square mile and total population of 15,000 to 17,000

SMALL MAMMALS (i.e., field mice, voles, lemmings, etc.) are in moderate numbers in the area, occupying willow flats and marshes.[18]

AQUATIC FURBEARERS (i.e., river otter, beaver, muskrat, mink) exist in moderate numbers in the area, occupying beaches, estuaries, and marshes.[18]

FLORA

Terrestrial vegetation is not expected to be significantly affected at this area. Practically nothing is known of the marine vegetation of Cook Inlet. Strand vegetation would occupy 50 percent of the shoreline in Summer and be lacking in the Winter. It is not known whether eelgrass occurs here, but it is likely that up to 50 percent of the shallow bottom could be occupied by this species in Summer and Winter. The marine algal vegetation is of the south Alaskan type. Intertidal algae could occur along 40 percent of the shallow subtidal in Summer, 20 percent in Winter. Floating kelp beds of

Nereocystis are reported from this area which would possibly occupy 31 percent of the surface area above shallow water.

Further details on the physical and biological characteristics for this location are given in Appendix D .

(c) RESULTS

The highest impact score at Port Graham was caused by a spill of 50,000 barrels of diesel-2 in the Summer when the southwest wind moved the oil slick up the shoreline. The intertidal sand/mud habitat absorbed a full 40 percent of the impact, affecting all species groups except marine mammal rookeries.

The 10,000 barrel and 1,000-bbl diesel-2 spills also created relatively high impacts in the Summer season as did the large spills of crude and bunker C. The gasoline spills had lower scores due to their shorter duration.

The wind moved the oil slick offshore during the Winter so that the pelagic habitat was the most affected. The Winter impact scores are markedly lower than the Summer scores.

The main contributors to the Summer impact scores were crab, shrimp, clams, hard and soft-shelled bivalves, and invertebrate infauna.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Port Graham. The first scenario, using most probable Summer conditions, resulted first in oil moving southerly on the ebb tide to the short at Port Graham in approximately 5 hours. The spill was then carried north by wind and current across the mouth of Kachemak Bay where it reached the eastern shore at Cook Inlet near Anchor Point in approximately 60 hours (see Figure 2-30). The second scenario, using most probable Winter conditions, resulted in the oil moving southerly parallel to the shoreline for approximately 6 hours on the ebb tide and then moving into the open waters at lower Cook Inlet in a west-southwest direction (see Figure 2-31). The Summer trajectory impacts seven habitats and the Winter trajectory impacts five habitats at this location. Only those habitats impacted will be discussed in each case.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-10 presents the results of the oil spill cases at Port Graham without cleanup.

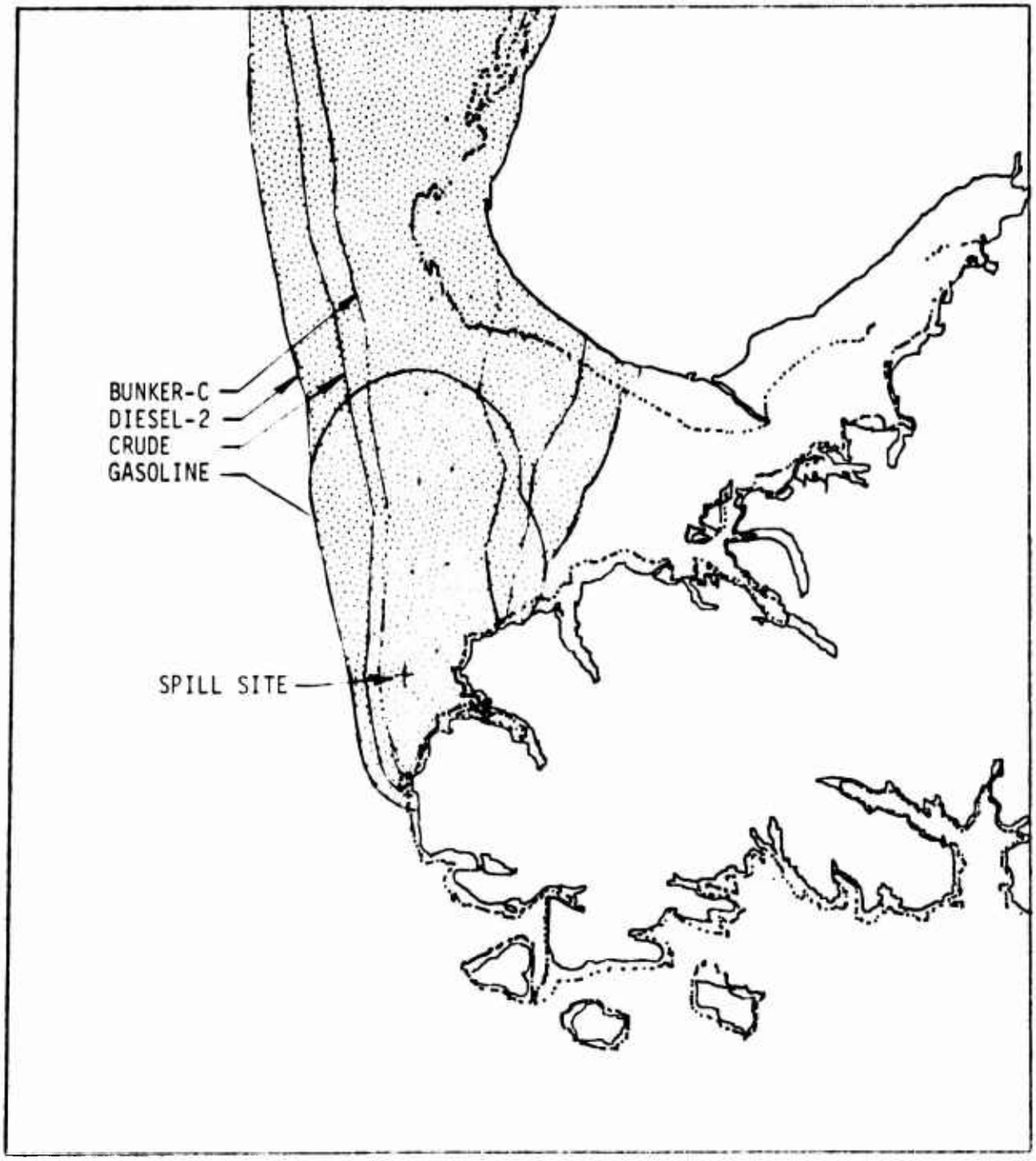


FIGURE 2-30. PORT GRAHAM SUMMER 50,000 BBL SPILL ENVELOPES

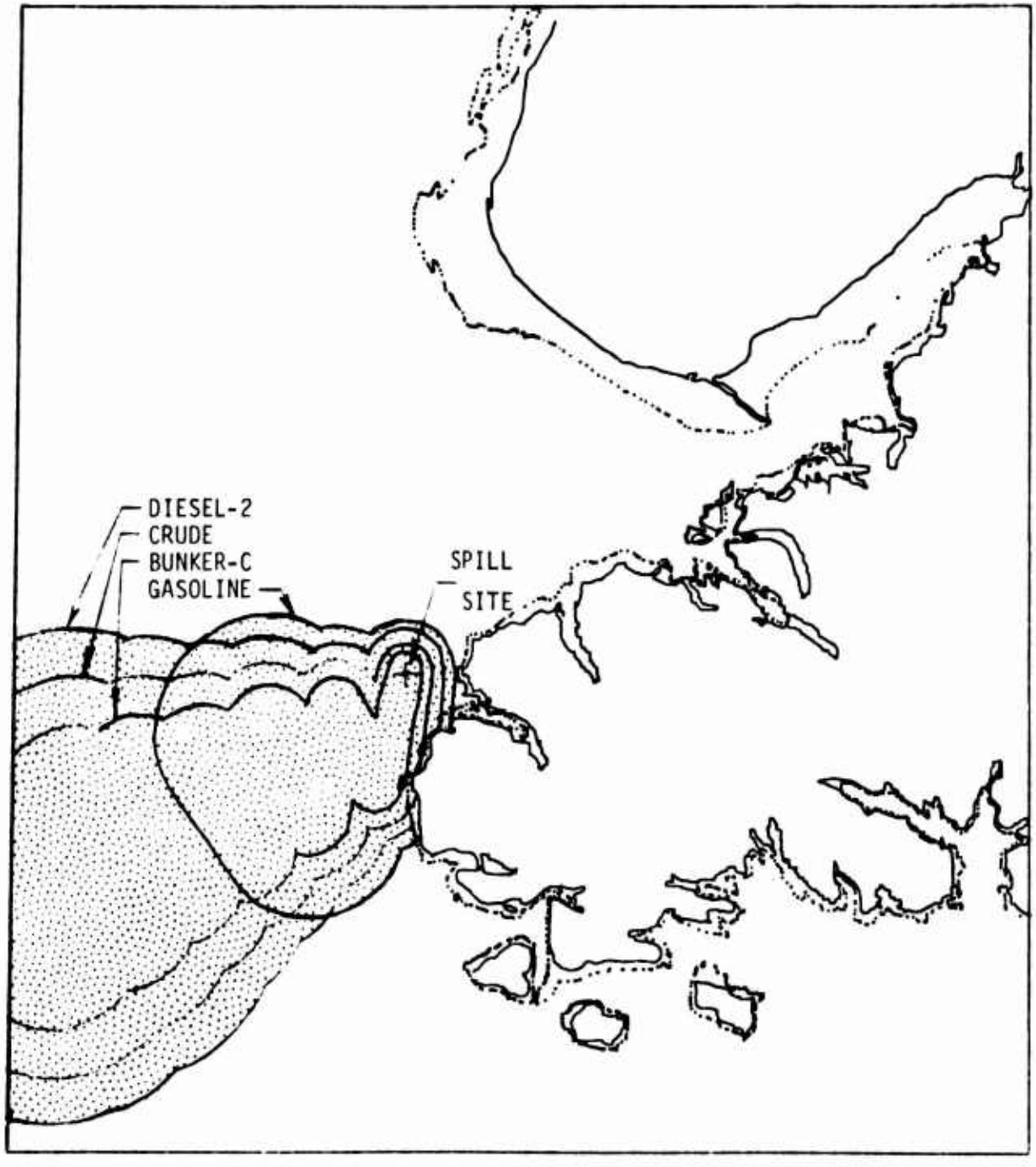


FIGURE 2-31. PORT GRAHAM WINTER 50,000 BBL SPILL ENVELOPES

TABLE 2-10. PORT GRAHAM CASE RESULTS NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000	100[1]
SUMMER	Diesel-2	31,46[illegible] [1][2]	23,167 [2]	10,805 [7]	2,020 [17]
	Crude Oil	18,919 [3]	13,120 [5]	6,617 [11]	791 [23]
	Bunker-C	12,443 [illegible]	10,838 [6]	5,867 [12]	436 [27]
	Gasoline	2,962 [illegible]	[illegible]17 [19]	450 [26]	40 [31]
WINTER	Diesel-2	7,623 [8]	6,628 [10]	3,959 [14]	661 [27]
	Crude Oil	7,615 [9]	4,393 [13]	1,679 [18]	361 [28]
	Bunker-C	2,711 [16]	1,530 [20]	887 [21]	187 [29]
	Gasoline	837 [22]	527 [25]	142 [30]	21 [32]

[1]Impact scores are estimates for 100-bbl spills (see Yakutat Discussion).
[2]Numbers in brackets are the case numbers that follow.

At this site the case results for the 100-bbl spills are estimated impact scores, extrapolating from 100-bbl diesel-2 spills at Valdez Harbor. (See Yakutat Case Discussion for estimated impact score methodology.)

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 31,465

THE PELAGIC HABITAT contributed 20 percent (6,387) at the impact score for this case. The species which were the main contributors in this habitat were phytoplankton (273), zooplankton (273), ichthyoplankton (182), herring (1,933), smelt (387), crab larvae (483), sockeye salmon (242), pink salmon (580), rainbow/steelhead trout (290), Dolly Varden (483), sea otter (120), and seabirds. The planktonic species, herring, crab larvae, Dolly Varden and seabirds were among the most abundant species in the habitat. Herring and the salmon species were rated as important commercial, recreational and

and subsistence resources. With the exception of sea otter, these species were judged to be among the most sensitive to a diesel-2 spill. Sea otters and seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 15 percent (4,722) of the impact score for this case. The species which were the main contributors in this habitat were Dungeness crab (1,611), shrimp (2,417), razor clams (182), and other marine invertebrates (273). These species were the most abundant in this habitat, as well as being among the most sensitive to a diesel-2 spill. Dungeness crab and shrimp were rated as important commercial, recreational and subsistence resources.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 10 percent (3,082) of the impact score for this case. The species which were the main contributors in this habitat were Pacific halibut (600), greenlings (120), rockfish (144), walleye pollock (144), king crab (638), tanner crab (638), scallops (182) and other marine invertebrates (364). The halibut, greenlings, both crab species, scallops and the invertebrates were among the most abundant species in this habitat. The halibut, rockfish, pollock and tanner crab were rated as important commercial, recreational and subsistence resources. King crab was rated as important commercially and recreationally. The crabs, scallops and invertebrates were judged to be among the most sensitive to a diesel-2 spill.

THE INTERTIDAL SAND/MUD HABITAT contributed 40 percent (12,429) of the impact score for this case. Only marine mammal rookeries did not contribute to this impact score. The impact scores for the other species were Pacific sandlance (810), razor clam (5,400), softshell bivalves (2,700), invertebrate

infauna (2,700), shorebirds (483), geese (96), ducks (120) and swans (120). The clams and infauna were the most abundant species in this habitat. Bivalves were rated as being of minor importance as a commercial, recreational and subsistence resource. Razor clams were rated important as a recreational resource. Geese and ducks were rated as somewhat important as commercial and recreational resources. Sandlance, clams, bivalves and infauna were judged to be particularly sensitive to diesel-2 spills in this habitat, and shorebirds were judged only slightly less sensitive. Shorebirds and swans were classified as protected.

THE INTERTIDAL ROCK HABITAT contributed 9 percent (2,767) at the impact score for this case. The species which were the main contributors in this habitat were greenlings (120), herring (1,692), sessile marine invertebrates (91), miscellaneous crustaceans (182), other invertebrates (410) and sea ducks (128). With the exception of sea ducks, these species were among the most abundant in this habitat. Herring were rated important and sea ducks of minor import as a commercial resource. Greenlings, herring and sea ducks were of minor to moderate importance as recreational resources. Herring were of minor importance as a subsistence resource. Herring, crustaceans and the invertebrates were judged to be the most sensitive to diesel-2 spills in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (1,868) of the impact score for this case. The species which were the main contributors in this habitat were smelt (773), hardshell bivalves (644), crustaceans (193) and gastropods (164). These species were among the most abundant in this habitat. The bivalves and smelt were rated as somewhat important commercial

and recreational resources. In addition, smelt were rated as of minor importance as a subsistence resource. These four species were judged to be the most sensitive to diesel-2 spills in this habitat.

THE TERRESTRIAL HABITAT contributed 1 percent (210) of the impact score for this habitat. Only riparian vegetation (90) and other vegetation (120) were contributors to the impact score in this habitat. These species were among the most abundant in this habitat.

Table 2-11 following presents the full results of Case 1.

CASE 2· SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 23,167

THE PELAGIC HABITAT contributed 25 percent (5,903) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Pacific Sandlance	reduced to 38 from 82
Sea Otter	reduced to 30 from 120
Sea Birds	reduced to 456 from 806

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (4,393) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Sculpins	reduced to 6 from 26
Miscellaneous Marine Fish	reduced to 12 from 48
Razor Clam	reduced to 85 from 182
Other Bivalves	reduced to 26 from 55
Other Marine Invertebrates	reduced to 128 from 273

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 13 percent (3,022) at the impact score for this case. Other marine fish reduced to 20 from 80

TABLE 2-11. MATRIX RESULTS -- CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

Reproduced from best available copy.

AREA	PORT GRAHAM
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	POLY.
1. PELAGIC											
1. PHYTOPLANKTON	10	A	0	0	0	3	9	1	270	30	270
2. ZOOPLANKTON	10	A	0	0	0	3	9	1	270	30	270
3. ICHTHYOPLANKTON	10	H	0	0	0	2	9	1	180	20	182
4. FLOATING SEAWEED	10	E	0	0	0	2	1	0	20	0	20
5. SCREENLINGS	3	H	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	3	E	0	0	0	3	9	1	81	9	87
7. HERRING	15	A	3	1	1	3	9	4	1080	360	1332
8. SMELT	6	A	1	0	0	3	4	0	216	108	387
9. CRAB LARVAE	15	A	0	0	0	2	9	0	270	360	486
10. KING SALMON	1	A	0	1	1	2	4	3	36	72	54
11. CHUM SALMON	1	A	1	0	1	2	9	0	36	72	54
12. SOCKEYE SALMON	3	A	1	1	1	2	9	3	135	127	242
13. PINK SALMON	6	A	2	1	1	2	9	3	324	288	540
14. COHO SALMON	1	A	1	1	1	2	9	0	45	45	81
15. RAINBOW-STEELHEAD TROUT	6	A	0	0	2	1	9	0	162	144	299
16. DOLLY VARDEN	10	A	0	0	2	1	9	3	270	240	495
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	6	A	0	0	0	5	0	0	0	0	0
24. WHALES	0	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	0	A	0	0	0	5	4	0	120	0	120
27. OTHER MARINE MAMMALS	6	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	9	8	450	480	906
									3939	2777	6797
2. SUBTIDAL SAND-MUD											
1. CODS	3	H	2	1	1	2	1	0	18	0	18
2. SCULPINS	3	A	0	0	0	2	4	1	24	6	26
3. STARRY FLOUNDER	6	H	1	0	0	2	1	0	18	0	18
4. OTHER FLATFISH	6	A	2	1	1	2	1	0	36	0	36
5. PACIFIC SANDLANCE	3	A	0	0	0	3	4	1	36	9	39

TABLE 2-11 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	6	A	0	0	0	2	4	0	44	0	44
7. DUNGENESS CRAB	10	A	3	3	2	2	9	9	900	900	1611
8. SHRIMP	15	A	3	2	2	3	9	9	1350	1200	2417
9. RAZOR CLAM	10	A	0	0	0	2	9	1	180	20	182
10. OTHER BIVALVES	6	M	0	0	0	1	9	1	54	6	55
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	9	1	270	30	272
									2934	2071	4722
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	10	M	0	0	0	2	1	0	20	0	20
2. SUBTIDAL SEAWEED	10	E	0	0	0	2	1	0	20	0	20
3. CHUM SALMON	1	A	1	0	1	2	9	1	36	4	36
4. PACIFIC HALIBUT	15	A	3	3	2	2	4	0	600	0	600
5. OTHER FLATFISH	6	A	2	0	0	2	4	0	96	0	96
6. GREENLINGS	10	M	0	1	0	2	4	0	120	0	120
7. ROCKFISH	6	M	2	1	1	2	4	0	144	0	144
8. WALLEYE POLLOCK	6	M	2	1	1	2	4	0	144	0	144
9. OTHER MARINE FISH	10	M	0	0	0	2	4	0	80	0	80
10. KING CRAB	10	A	3	2	0	2	9	1	630	70	639
11. TANNER CRAB	10	A	3	1	1	2	9	1	630	70	639
12. SCALLOPS	10	A	0	0	0	2	9	1	180	20	182
13. OTHER MARINE INVERTEBRATES	10	A	1	0	0	3	9	1	360	40	364
									3063	204	3092
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	9	27	81	243	810
3. RAZOR CLAM	10	A	0	3	1	2	9	27	540	1620	5400
4. SOFTSHELL BIVALVES	6	E	1	1	1	2	9	27	270	810	2700
5. INVERTEBRATE INFAUNA	10	E	0	0	0	3	9	27	270	810	2700
6. MARINE MAMMAL ROOKERIES	3	A	0	0	0	5	0	0	0	0	0
7. SHOREBIRDS	6	P	0	0	0	5	9	6	270	240	647
8. GEESE	6	P	1	2	0	1	4	0	96	0	96
9. DUCKS	6	A	1	2	0	2	4	0	120	0	120
10. SWANS	6	A	0	0	0	5	4	0	120	0	120
									1767	3723	12429
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	10	E	0	0	0	3	1	0	30	0	30

TABLE 2-11 CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	COMP.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
2. GREENLINGS	10	M	0	1	0	2	4	0	120	0	120
3. HERRING	15	A	3	1	1	2	9	9	945	945	1692
4. SESSILE MARINE INVERTEBRATES	10	E	0	0	0	1	9	1	90	10	91
5. MISC. CRUSTACEANS	10	E	0	0	0	2	9	1	180	20	182
6. OTHER INVERTEBRATES	15	E	0	0	0	3	9	1	405	45	410
7. SHOREBIRDS	3	P	0	0	0	5	4	1	60	15	64
8. SEA DUCKS	6	A	1	2	0	2	4	1	120	30	128
9. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	1	0	50	0	50
									2000	960	2767
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	E	0	0	0	3	1	0	30	0	30
2. SMELT	6	A	1	3	1	3	9	9	432	396	777
3. HARDSHELL BIVALVES	10	E	1	1	0	2	9	8	360	320	666
4. CRUSTACEANS	6	E	0	0	0	2	9	8	104	96	193
5. GASTROPODS	6	E	0	0	0	3	9	1	157	29	164
6. SHOREBIRDS	3	P	0	0	0	5	4	1	60	15	64
									1152	933	1869
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	3	2	2	0	0	0	0	0
4. CHUM SALMON	1	A	0	0	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	3	1	2	0	0	0	0	0
6. PINK SALMON	6	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	1	A	0	3	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	A	0	3	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	A	0	2	2	1	0	0	0	0	0
13. STICKLEBACKS	10	M	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	M	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	1	2	0	2	0	0	0	0	0
16. GEESE	6	P	1	2	0	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	6	P	1	1	1	1	0	0	0	0	0
19. MINK	6	P	1	1	1	1	0	0	0	0	0
20. MUSKRAT	6	P	1	1	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	P	1	1	1	1	0	0	0	0	0
									0	0	0

TABLE 2-11 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
8. TEP-ESTRIAL											
1. TUNDRA	1	P	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	6	P	0	0	0	2	0	0	0	0	0
3. STRAND VEGETATION	10	E	0	0	0	1	9	0	90	0	90
4. OTHER VEGETATION	10	P	1	0	0	2	6	0	120	0	120
5. BROWN BEAR	3	A	1	2	0	2	0	0	0	0	0
6. BLACK BEAR	10	A	1	3	1	2	0	0	0	0	0
7. WOLVERINE	3	A	1	0	0	1	0	0	0	0	0
8. WOLF	3	A	1	0	0	1	0	0	0	0	0
9. MOOSE	3	A	1	1	1	2	0	0	0	0	0
14. SHEEP	6	M	1	1	0	1	0	0	0	0	0
15. GOATS	6	M	1	1	0	1	0	0	0	0	0
16. OTHER MAMMALS	6	M	0	0	0	2	0	0	0	0	0
17. RAPTORS	10	P	0	0	0	5	0	0	0	0	0
18. PTARMIGAN	10	P	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	0	0	0	0	0
									210	0	210
									15117	10568	71465

accounted for the decrease in impact score for this habitat from Case 1.

THE INTERTIDAL SAND/MUD HABITAT contributed 24 percent (5,644) of the impact score for this case. The change in impact score for this habitat from Case 1 is accounted for by the following species:

Razor Clam	reduced	to	967	from 5,400
Invertebrate Infauna	reduced	to	483	from 2,700
Geese	reduced	to	24	from 96
Ducks	reduced	to	30	from 120
Swans	reduced	to	30	from 120
Shorebirds	increased	to	600	from 483

THE INTERTIDAL ROCKY HABITAT contributed 12 percent (2,717) of the impact score for this case. Marine mammal rookeries reduced to 0 from 50 accounts for the decreased impact score for this habitat from Case 1.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (1,418) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Intertidal Seaweed	reduced	to 0	from 30
Smelt	reduced	to 437	from 773
Crustaceans	reduced	to 109	from 193

THE TERRESTRIAL HABITAT contributed less than one percent of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Strand Vegetation	reduced	to 40	from 120
Other Vegetation	reduced	to 30	from 90

CASE 3: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 18,919

THE PELAGIC HABITAT contributed 19 percent (3,583) of the impact score for this case. The major change in impact score for this habitat resulted in most species having large differences in impact scores from Case 2. The species with major changes are listed below:

Floating Seaweed	increased	to	80	from	20
Northern Fur Seal	increased	to	15	from	0
Harbor Seal	increased	to	50	from	0
Sea Otter	increased	to	128	from	30
Phytoplankton	reduced	to	128	from	273
Zooplankton	reduced	to	128	from	273
Ichthyoplankton	reduced	to	85	from	182
Greenlings	reduced	to	0	from	24
Pacific Sandlance	reduced	to	9	from	38
Herring	reduced	to	1,093	from	1,933
Smelt	reduced	to	219	from	387
King Salmon	reduced	to	17	from	64
Chum Salmon	reduced	to	17	from	64
Sockeye Salmon	reduced	to	64	from	242
Pink Salmon	reduced	to	153	from	580
Coho Salmon	reduced	to	21	from	81
Dolly Varden	reduced	to	164	from	290
Rainbow/Steelhead Trout	reduced	to	273	from	483

THE SUBTIDAL SAND/MUD HABITAT contributed 18 percent (3,403) at the impact score for this case. Most species in this habitat had significantly different impact scores than in Case 2. The changes are listed below:

Cod	increased	to	77	from 18
Sculpins	increased	to	55	from 6
Other Flatfish	increased	to	153	from 36
Pacific Sandlance	increased	to	82	from 36
Miscellaneous Marine Fish	increased	to	48	from 12
Razor Clam	increased	to	322	from 85
Other Bivalves	increased	to	97	from 26
Other Marine Invertebrates	increased	to	273	from 128
Dungeness Crab	reduced	to	911	from 1,611
Shrimp	reduced	to	1,367	from 2,417

THE SUBTIDAL ROCK HABITAT contributed 18 percent (3,412) of the impact score for this case. The increase in impact score for this habitat from Case 2 is accounted for by the following species:

Floating Seaweed	increased	to	80	from 20
Subtidal Seaweed	increased	to	80	from 20
Pacific Halibut	increased	to	638	from 600
Other Marine Fish	increased	to	80	from 20
Scallops	increased	to	322	from 182

THE INTERTIDAL SAND/MUD HABITAT contributed 16 percent (3,059) of the impact score for this case. Most species in this habitat have significantly different scores than in Case 2. The changes in impact scores are as follows:

Marine Mammal Rookeries	increased	to	60	from 0
Geese	increased	to	102	from 24

Ducks	increased	to 483	from 30
Swans	increased	to 273	from 30
Pacific Sandlance	reduced	to 145	from 810
Softshell Bivalves	reduced	to 483	from 2,700
Invertebrate Infauna	reduced	to 273	from 483
Shorebirds	reduced	to 273	from 600

THE INTERTIDAL ROCKY HABITAT contributed 19 percent (3,550) of the impact score for this case. The increase in impact score for this habitat from Case 2 is accounted for by the following species:

Intertidal Seaweed	increased	to 120	from 30
Sessile Marine Invertebrates	increased	to 161	from 91
Miscellaneous Crustaceans	increased	to 322	from 182
Other Invertebrates	increased	to 725	from 410
Shorebirds	increased	to 137	from 64
Sea Ducks	increased	to 273	from 128

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (1,667) of the impact score for this case. The change in impact score in this habitat from Case 2 is accounted for by the following species:

Hardshell Bivalves	reduced	to 364	from 644
Intertidal Seaweed	increased	to 120	from 0
Smelt	increased	to 773	from 437
Shorebirds	increased	to 137	from 64

THE TERRESTRIAL HABITAT contributed 1 percent (245) of the impact score for this case. With minor exceptions, the increase in impact score for this

habitat from Case 2 is accounted for by the following species:

Other Vegetation	increased	to	120	from 30
Other Mammals	increased	to	12	from 0
Raptors	increased	to	50	from 0
Other Birds	increased	to	20	from 0

CASE 4: SUMMER, BUNKER-C, 50,000 BBLS - IMPACT SCORE 13,443

THE PELAGIC HABITAT contributed 10 percent (1,411) of the impact score for this case. With minor exception, the decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Phytoplankton	reduced	to	30	from 128
Zooplankton	reduced	to	30	from 128
Ichthyoplankton	reduced	to	20	from 85
Floating Seaweed	reduced	to	20	from 80
Herring	reduced	to	510	from 1,093
Smelt	reduced	to	96	from 219
Crab Larvae	reduced	to	128	from 483
Sockeye Salmon	reduced	to	15	from 64
Pink Salmon	reduced	to	36	from 153
Rainbow/Steelhead Trout	reduced	to	77	from 164
Dolly Varden	reduced	to	128	from 273
Sea Otter	reduced	to	30	from 128
Seabirds	reduced	to	213	from 456

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (2,557) of the impact score for this case. The change in impact score for this habitat

from Case 3 is accounted for by the following species:

Cod	reduced	to	18	from	77
Sculpins	reduced	to	24	from	55
Other Flatfish	reduced	to	36	from	153
Pacific Sandlance	reduced	to	36	from	82
Miscellaneous Marine Fish	reduced	to	12	from	48
Shrimp	reduced	to	500	from	1,367
Other Marine Invertebrates	increased	to	483	from	273

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 29 percent (2,956) of the impact score for this case. All species except one have significantly different impact scores than in Case 3. The changes in this habitat are as follows:

Other Marine Invertebrates	reduced	to	170	from	364
Subtidal Seaweed	reduced	to	20	from	80
Chum Salmon	reduced	to	16	from	36
Pacific Halibut	reduced	to	300	from	638
Other Flatfish	reduced	to	48	from	102
Greenlings	reduced	to	30	from	128
Rockfish	reduced	to	36	from	153
Walleye Pollock	reduced	to	36	from	153
Other Marine Fish	reduced	to	20	from	80
King Crab	increased	to	1,400	from	638
Tanner Crab	increased	to	1,400	from	638
Scallops	increased	to	400	from	322

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (2,842) of the impact score for this case. The change in impact score for this habitat from Case 3 is accounted for by the following species:

Invertebrate Infauna	increased	to	483	from 273
Shorebirds	increased	to	483	from 273
Pacific Sandlance	reduced	to	38	from 145
Marine Mammal Rookeries	reduced	to	30	from 60
Ducks	reduced	to	128	from 483
Swans	reduced	to	128	from 273

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (1,701) of the impact score for this case. All impacted species had significantly different scores than in Case 3. The changes in this habitat are as follows:

Sessile Marine Invertebrates	increased	to	200	from 161
Shorebirds	increased	to	300	from 137
Sea Ducks	increased	to	600	from 273
Intertidal Seaweed	reduced	to	60	from 120
Greenlings	reduced	to	30	from 120
Herring	reduced	to	446	from 1,692
Miscellaneous Crustaceans	reduced	to	20	from 322
Other Invertebrates	reduced	to	45	from 725

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (791) of the impact score for this case. All species had significantly different scores than in Case 3. The changes in this habitat are as follows:

Shorebirds	increased	to	600	from 137
Intertidal Seaweeds	reduced	to	60	from 120
Smelt	reduced	to	192	from 773
Hardshell Bivalves	reduced	to	170	from 364
Crustaceans	reduced	to	51	from 109
Gastropods	reduced	to	18	from 164

THE TERRESTRIAL HABITAT contributed 1 percent (185) of the impact score for this case. Other vegetation reduced to 60 from 120 accounted for the change in impact score for this habitat from Case 3.

CASE 5: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 13,120

THE PELAGIC HABITAT contributed 23 percent (2,968) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 4 is accounted for by the following species:

Phytoplankton	increased	to	120	from 30
Zooplankton	increased	to	120	from 30
Ichthyoplankton	increased	to	80	from 20
Floating Seaweed	increased	to	80	from 20
Herring	increased	to	1,093	from 510
Crab Larvae	increased	to	273	from 128
Sockeye Salmon	increased	to	60	from 15
Pink Salmon	increased	to	144	from 36
Rainbow/Steelhead Trout	increased	to	164	from 77
Dolly Varden	increased	to	273	from 128
Sea Otter	increased	to	120	from 30

THE SUBTIDAL SAND/MUD HABITAT contributed 17 percent (2,260) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Cod	increased	to	72	from 18
Other Flatfish	increased	to	144	from 36
Shrimp	increased	to	638	from 600
Miscellaneous Marine Fish	increased	to	48	from 12
Razor Clam	reduced	to	182	from 322
Other Bivalves	reduced	to	55	from 97
Other Marine Invertebrates	reduced	to	128	from 483

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 22 percent (2,991) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Pacific Halibut	increased	to	600	from 300
Greenlings	increased	to	120	from 30
Rockfish	increased	to	144	from 36
Walleye Pollock	increased	to	144	from 36
Other Marine Invertebrates	increased	to	364	from 170
Other Marine Fish	increased	to	80	from 20
Other Flatfish	reduced	to	24	from 48
King Crab	reduced	to	638	from 1,400
Tanner Crab	reduced	to	638	from 1,400
Scallops	reduced	to	182	from 400

THE INTERTIDAL SAND/MUD HABITAT contributed 16 percent (2,111) of the impact score for this case. Most species in this habitat had increased impact scores from Case 4. The changes in scores for this case are as follows:

Pacific Sandlance	increased	to 82	from 38
Ducks	increased	to 273	from 128
Swans	increased	to 273	from 128
Razor Clams	reduced	to 547	from 967
Invertebrate Infauna	reduced	to 273	from 483
Softshell Bivalves	reduced	to 273	from 483
Shorebirds	reduced	to 273	from 483

THE INTERTIDAL ROCKY HABITAT contributed 12 percent (1,594) of the impact score for this case. Most species in this habitat had increased impact scores from Case 4. The changes in scores for this case are as follows:

Intertidal Seaweed	increased	to 120	from 60
Miscellaneous Crustaceans	increased	to 182	from 20
Other Invertebrates	increased	to 410	from 45
Marine Mammal Rookeries	increased	to 50	from 0
Sessile Marine Invertebrates	reduced	to 91	from 200
Shorebirds	reduced	to 137	from 300
Sea Ducks	reduced	to 128	from 600

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (1,064) of the impact score for this case. Most species in this habitat had increased

impact scores from Case 4. The changes in scores for this case are as follows:

Intertidal Seaweed	increased	to	120	from 60
Smelt	increased	to	437	from 192
Crustaceans	increased	to	109	from 51
Gastropods	increased	to	164	from 18
Shorebirds	reduced	to	64	from 300

THE TERRESTRIAL HABITAT contributed 1 percent (132) of the impact score for this case. With a minor exception, the decrease in impact score from Case 4 is accounted for by the following species:

Other Vegetation	reduced	to	30	from 60
Other Birds	reduced	to	0	from 20

CASE 6: SUMMER, BUNKER-C, 10,000 BBLS - IMPACT SCORE 10,838

THE PELAGIC HABITAT contributed 13 percent (1,411) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 5 is accounted for by the following species:

Phytoplankton	reduced	to	30	from 120
Zooplankton	reduced	to	30	from 120
Ichthyoplankton	reduced	to	20	from 80
Floating Seaweed	reduced	to	20	from 80
Herring	reduced	to	510	from 1,093
Crab Larvae	reduced	to	128	from 273

Sockeye Salmon	reduced	to	15	from	60
Pink Salmon	reduced	to	36	from	144
Rainbow/Steelhead Trout	reduced	to	77	from	164
Dolly Varden	reduced	to	128	from	273
Sea Otter	reduced	to	30	from	120

THE SUBTIDAL SAND/MUD HABITAT contributed 21 percent (2,289) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Razor Clams	increased	to	400	from	182
Other Bivalves	increased	to	120	from	55
Other Marine Invertebrates	increased	to	600	from	128
Cod	reduced	to	18	from	72
Other Flatfish	reduced	to	36	from	144
Miscellaneous Marine Fish	reduced	to	12	from	48
Dungeness Crab	reduced	to	425	from	911
Shrimp	reduced	to	600	from	638

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 16 percent (1,740) of impact score for this case. With a minor exception, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Floating Seaweed	increased	to	80	from	20
Other Flatfish	increased	to	48	from	24
Scallops	increased	to	400	from	182
Pacific Halibut	reduced	to	300	from	600

Greenlings	reduced	to 30	from 120
Rockfish	reduced	to 36	from 144
Walleye Pollock	reduced	to 36	from 144
Other Marine Fish	reduced	to 20	from 40
King Crab	reduced	to 298	from 638
Tanner Crab	reduced	to 298	from 638
Other Marine Invertebrates	reduced	to 170	from 364

THE INTERTIDAL SAND/MUD HABITAT contributed 29 percent (3,193) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 5 is accounted for by the following Species:

Razor Clams	increased to	967	from 547
Softshell Bivalves	increased to	600	from 273
Invertebrate Infauna	increased to	600	from 273
Shorebirds	increased to	600	from 273
Pacific Sandlance	reduced	to 38	from 82
Ducks	reduced	to 128	from 273
Swans	reduced	to 128	from 273

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (1,229) at the impact score for this case. The change in impact score for this habitat from Case 5 is accounted for by the following species:

Sessile Marine Invertebrates	increased to	200	from 91
Shorebirds	increased to	300	from 137
Intertidal Seaweed	reduced	to 60	from 120

Miscellaneous Crustaceans	reduced	to	20	from 182
Other Invertebrates	reduced	to	45	from 410
Marine Mammal Rookeries	reduced	to	0	from 50

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (791) of the impact score for this case. All impacted species had significantly different scores than for Case 5. The changes for this habitat were as follows:

Shorebirds	increased	to	300	from 64
Intertidal Seaweed	reduced	to	60	from 120
Smelt	reduced	to	192	from 437
Crustaceans	reduced	to	51	from 109
Gastropods	reduced	to	18	from 164

THE TERRESTRIAL HABITAT contributed 2 percent (185) of the impact score for this case. With a minor exception, the increase in impact score for this habitat from Case 5 is accounted for by the following species:

Other Vegetation	increased	to	60	from 30
Other Birds	increased	to	20	from 0

CASE 7: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 10,805

THE PELAGIC HABITAT contributed 25 percent (2,678) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Phytoplankton	increased	to	128	from 30
Zooplankton	increased	to	128	from 30

Ichthyoplankton	increased	to	85	from	20
Pacific Sandlance	increased	to	36	from	0
Herring	increased	to	1,093	from	510
Sockeye Salmon	increased	to	64	from	15
Pink Salmon	increased	to	153	from	36
Rainbow/Steelhead Trout	increased	to	164	from	77
Dolly Varden	increased	to	273	from	128
Harbor Seal	reduced	to	0	from	50

THE SUBTIDAL SAND/MUD HABITAT contributed 24 percent (2,601) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Dungeness Crab	increased	to	911	from	425
Shrimp	increased	to	1,367	from	600
Pacific Sandlance	reduced	to	9	from	36
Razor Clams	reduced	to	80	from	400
Other Bivalves	reduced	to	24	from	120
Other Marine Invertebrates	reduced	to	120	from	600

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (1,164) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 6 is accounted for by the following species:

Floating Seaweed	reduced	to	0	from	80
Subtidal Seaweed	reduced	to	0	from	20

Pacific Halibut	reduced	to	150	from 300
Other Flatfish	reduced	to	24	from 48
Scallops	reduced	to	85	from 400

THE INTERTIDAL SAND/MUD [illegible] contributed 19 percent (2,080) of the impact score for this case. The change in impact score for this habitat from Case 6 is accounted for by the following species:

Pacific Sandlance	increased	to	145	from 38
Softshell Bivalves	reduced	to	483	from 600
Invertebrate Infauna	reduced	to	273	from 600
Marine Mammal Rookeries	reduced	to	0	from 30
Shorebirds	reduced	to	128	from 600
Geese	reduced	to	24	from 102
Ducks	reduced	to	30	from 128
Swans	reduced	to	30	from 128

THE INTERTIDAL ROCKY HABITAT contributed 14 percent (1,486) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Herring	increased	to	957	from 446
Miscellaneous Crustaceans	increased	to	85	from 20
Other Invertebrates	increased	to	191	from 45
Intertidal Seaweed	reduced	to	0	from 60
Sessile Marine Invertebrates	reduced	to	43	from 200
Shorebirds	reduced	to	60	from 300

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (756) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Hardshell Bivalves	increased	to	364	from	170
Gastropods	increased	to	77	from	18
Intertidal Seaweed	reduced	to	0	from	60
Shorebirds	reduced	to	60	from	300

THE TERRESTRIAL HABITAT contributed less than 1 percent (40) of the impact score for this case. All impacted species were reduced from their scores in Case 6. The changes for this habitat were as follows:

Strand Vegetation	reduced	to	10	from	43
Other Vegetation	reduced	to	30	from	60
Other Mammals	reduced	to	0	from	12
Raptors	reduced	to	0	from	50
Other Birds	reduced	to	0	from	20

CASE 8: WINTER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 7,623

THE PELAGIC HABITAT contributed 36 percent (2,769) of the impact score for this case. The species which are absent from this habitat in Winter at this site (crab larvae and all salmon) account for a decrease of 420 in impact score from Case 7 in this habitat. The following species received significantly higher scores:

Phytoplankton	increased	to	164	from	128
Zooplankton	increased	to	164	from	128

Floating Seaweed	increased to	80	from	20
Pacific Sandlance	increased to	82	from	36
Herring	increased to	1,289	from	1,093
Smelt	increased to	145	from	102
Harbor Seal	increased to	30	from	0
Sea Otter	increased to	60	from	30
Seabirds	increased to	242	from	213

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 28 percent (2,140) of the impact score for this case. With minor exceptions, the change in habitat impact score for this habitat from Case 7 is accounted for by the following species:

Other Flatfish	increased to	51	from	24
Greenlings	increased to	72	from	30
Rockfish	increased to	77	from	36
Walleye Pollock	increased to	72	from	36
Other Marine Fish	increased to	51	from	20
King Crab	increased to	638	from	298
Tanner Crab	increased to	638	from	298
Scallops	increased to	182	from	85
Other Marine Invertebrates	increased to	219	from	170
Pacific Halibut	reduced to	128	from	150

THE INTERTIDAL ROCKY HABITAT contributed 27 percent (2,055) of the impact score for this case. With minor exceptions, the change in habitat impact score for this habitat from Case 7 is accounted for by the following species:

Greenlings	increased	to	164	from	30
Herring	increased	to	1,128	from	957
Sessile Marine Invertebrates	increased	to	91	from	43
Miscellaneous Crustaceans	increased	to	182	from	85
Other Invertebrates	increased	to	273	from	191
Marine Mammal Rookeries	increased	to	50	from	0
Shorebirds	reduced	to	21	from	60

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (641) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 7 is accounted for by the following species:

Smelt	reduced	to	102	from	204
Shorebirds	reduced	to	20	from	60

THE TERRESTRIAL HABITAT contributed less than 1 percent (18) of the impact score for this case. Strand vegetation not present in Winter accounts for a reduction of 10 in the habitat's impact score from Case 7.

CASE 9: WINTER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 7,615

THE PELAGIC HABITAT contributed 22 percent (1,680) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Phytoplankton	reduced	to	77	from	164
Zooplankton	reduced	to	77	from	164
Ichthyoplankton	reduced	to	26	from	55

Floating Seaweed	reduced	to	20	from	80
Pacific Sandlance	reduced	to	9	from	82
Herring	reduced	to	729	from	1,289
Smelt	reduced	to	82	from	145
Rainbow/Steelhead Trout	reduced	to	82	from	145
Dolly Varden	reduced	to	164	from	290
Seabirds	reduced	to	137	from	242

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 51 percent (3,886) of the impact score for this case. With minor exception, the increase in impact score for this habitat from Case 8 is accounted for by the following species:

King Crab	increased	to	1,400	from	638
Tanner Crab	increased	to	1,400	from	638
Scallops	increased	to	400	from	182

THE INTERTIDAL ROCKY HABITAT contributed 21 percent (1,589) of the impact score for this case. The change in impact score for this habitat from Case 8 is accounted for by the following species:

Shorebirds	increased	to	46	from	21
Sea Ducks	increased	to	273	from	128
Greenlings	reduced	to	18	from	164
Herring	reduced	to	638	from	1,128

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (400) of the impact score for this habitat from Case 8 is accounted for by the following species:

Shorebirds	increased	to	46	from	20
Hardshell Bivalves	reduced	to	170	from	364
Crustaceans	reduced	to	26	from	55
Gastropods	reduced	to	38	from	82

THE TERRESTRIAL HABITAT contributed 1 percent (60) of the impact score for this case. The increase in impact score for this habitat from Case 8 is accounted for by the following species:

Other Mammals	increased	to	12	from	0
Raptors	increased	to	30	from	0

CASE 10: WINTER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 6,628

THE PELAGIC HABITAT contributed 37 percent (2,455) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 9 is accounted for by the following species:

Phytoplankton	increased	to	164	from	77
Zooplankton	increased	to	164	from	77
Ichthyoplankton	increased	to	55	from	26
Pacific Sandlance	increased	to	38	from	9
Herring	increased	to	1,289	from	729
Smelt	increased	to	145	from	82
Rainbow/Steelhead Trout	increased	to	75	from	82
Dolly Varden	increased	to	290	from	164
Harbor Seal	reduced	to	0	from	30
Sea Otter	reduced	to	0	from	242

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 30 percent (2,017) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 9 is accounted for by the following species:

Greenlings	reduced	to	18	from	77
Walleye Pollock	reduced	to	18	from	77
King Crab	reduced	to	638	from	1,400
Tanner Crab	reduced	to	638	from	1,400
Scallops	reduced	to	182	from	400

THE INTERTIDAL ROCKY HABITAT contributed 28 percent (1,877) of the impact score for this case. All species in this habitat were changed in impact from Case 9. The scores for this case were as follows:

Greenlings	increased	to	72	from	18
Herring	increased	to	1,400	from	638
Intertidal Seaweed	reduced	to	0	from	18
Sessile Marine Invertebrates	reduced	to	43	from	91
Miscellaneous Crustaceans	reduced	to	85	from	182
Other Invertebrates	reduced	to	128	from	273
Shorebirds	reduced	to	21	from	46
Sea Ducks	reduced	to	128	from	273
Marine Mammal Rookeries	reduced	to	0	from	50

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 4 percent (261) of the impact score for this case. With minor exceptions, the change in impact score

for this habitat from Case 9 is accounted for by the following species:

Smelt	reduced	to	24	from	102
Shorebirds	reduced	to	5	from	46

THE TERRESTRIAL HABITAT contributed less than 1 percent (18) of the impact score for this case. The decrease in impact score for this habitat from Case 9 is accounted for by the following species:

Other Mammals	reduced	to	0	from	12
Raptors	reduced	to	0	from	30

CASE 11: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE - 6,617

THE PELAGIC HABITAT contributed 20 percent (1,295) of the impact score in this case. The crab larvae and salmon species, which were not present in Case 10, account for an increase of 184 in impact score. Other changes in impact score for this habitat were for the following species:

Sea Otter	increased	to	30	from	0
Seabirds	increased	to	200	from	137
Phytoplankton	reduced	to	30	from	164
Zooplankton	reduced	to	30	from	164
Ichthyoplankton	reduced	to	20	from	55
Pacific Sandlance	reduced	to	0	from	38
Herring	reduced	to	480	from	1,289
Smelt	reduced	to	96	from	145
Rainbow/Steelhead Trout	reduced	to	77	from	145
Dolly Varden	reduced	to	128	from	290

THE SUBTIDAL SAND/MUD HABITAT contributed 21 percent (1,408) of the impact score for this case. This habitat was not impacted in Case 10. The entire habitat impact score adds to the total for this case. The main contributing species were Dungeness crab (425), shrimp (600) and other marine invertebrates (128).

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (1,203) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 10 is accounted for by the following species:

Floating Seaweed	increased	to	20	from not present
Chum Salmon	increased	to	16	from not present
Pacific Halibut	increased	to	150	from 128
Subtidal Seaweed	increased	to	20	from 0
Other Flatfish	reduced	to	24	from 51
Rockfish	reduced	to	36	from 77
Other Marine Fish	reduced	to	20	from 48
King Crab	reduced	to	298	from 638
Tanner Crab	reduced	to	298	from 638
Scallops	reduced	to	85	from '82
Other Marine Invertebrates	reduced	to	150	from 219

THE INTERTIDAL SAND/MUD HABITAT contributed 16 percent (1,044) of the impact score for this case. This habitat was not impacted in Case 10. The entire habitat impact score adds to the total for th case. The main con-

Ichthyoplankton	increased	to	85	from	20
Pacific Sandlance	increased	to	36	from	0
Herring	increased	to	1,093	from	510
Sockeye Salmon	increased	to	64	from	15
Pink Salmon	increased	to	153	from	36
Rainbow/Steelhead Trout	increased	to	164	from	77
Dolly Varden	increased	to	273	from	128
Harbor Seal	reduced	to	0	from	50

THE SUBTIDAL SAND/MUD HABITAT contributed 24 percent (2,601) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Dungeness Crab	increased	to	911	from	425
Shrimp	increased	to	1,367	from	600
Pacific Sandlance	reduced	to	9	from	36
Razor Clams	reduced	to	80	from	400
Other Bivalves	reduced	to	24	from	120
Other Marine Invertebrates	reduced	to	120	from	600

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (1,164) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 6 is accounted for by the following species:

Floating Seaweed	reduced	to	0	from	80
Subtidal Seaweed	reduced	to	0	from	20

Pacific Halibut	reduced	to	150	from 300
Other Flatfish	reduced	to	24	from 48
Scallops	reduced	to	85	from 400

THE INTERTIDAL SAND/MUD HABITAT contributed 19 percent (2,080) of the impact score for this case. The change in impact score for this habitat from Case 6 is accounted for by the following species:

Pacific Sandlance	increased	to	145	from 38
Softshell Bivalves	reduced	to	483	from 600
Invertebrate Infauna	reduced	to	273	from 600
Marine Mammal Rookeries	reduced	to	0	from 30
Shorebirds	reduced	to	128	from 600
Geese	reduced	to	24	from 102
Ducks	reduced	to	30	from 128
Swans	reduced	to	30	from 128

THE INTERTIDAL ROCKY HABITAT contributed 14 percent (1,486) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Herring	increased	to	957	from 446
Miscellaneous Crustaceans	increased	to	85	from 20
Other Invertebrates	increased	to	191	from 45
Intertidal Seaweed	reduced	to	0	from 60
Sessile Marine Invertebrates	reduced	to	43	from 200
Shorebirds	reduced	to	60	from 300

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (756) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Hardshell Bivalves	increased	to	364	from	170
Gastropods	increased	to	77	from	18
Intertidal Seaweed	reduced	to	0	from	60
Shorebirds	reduced	to	60	from	300

THE TERRESTRIAL HABITAT contributed less than 1 percent (40) of the impact score for this case. All impacted species were reduced from their scores in Case 6. The changes for this habitat were as follows:

Strand Vegetation	reduced	to	10	from	43
Other Vegetation	reduced	to	30	from	60
Other Mammals	reduced	to	0	from	12
Raptors	reduced	to	0	from	50
Other Birds	reduced	to	0	from	20

CASE 8: WINTER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 7,623

THE PELAGIC HABITAT contributed 36 percent (2,769) of the impact score for this case. The species which are absent from this habitat in Winter at this site (crab larvae and all salmon) account for a decrease of 420 in impact score from Case 7 in this habitat. The following species received significantly higher scores:

Phytoplankton	increased	to	164	from	128
Zooplankton	increased	to	164	from	128

Phytoplankton	increased to 72 from 30
Zooplankton	increased to 72 from 30
Herring	increased to 729 from 480
Dolly Varden	increased to 164 from 120
Harbor Seal	increased to 30 from 0
Sea Otter	increased to 137 from 0
Seabirds	reduced to 64 from 200

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 37 percent (1,623) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 12 is accounted for by the following species:

Greenlings	increased to 72 from 30
Rockfish	increased to 72 from 36
Walleye Pollock	increased to 72 from 36
Other Marine Fish	increased to 48 from 20
Scallops	increased to 400 from 85
Other Marine Invertebrates	increased to 219 from 160
Pacific Halibut	reduced to 120 from 150

THE INTERTIDAL ROCKY HABITAT contributed 21 percent (909) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 12 is accounted for by the following species:

Miscellaneous Crustaceans	increased to 85 from 20
Other Invertebrates	increased to 273 from 45
Herring	reduced to 298 from 420

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (355) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 12 is accounted for by the following species:

Smelt	increased	to	96	from	48
Crustaceans	reduced	to	24	from	48
Shorebirds	reduced	to	21	from	64

THE TERRESTRIAL HABITAT contributed 1 percent (60) of the impact score for this case. The decrease in impact score for this habitat from Case 12 is accounted for by the following species:

Strand Vegetation	not present			from	40
Other Vegetation	reduced	to	18	from	30
Raptors	reduced	to	30	from	60
Other Birds	reduced	to	0	from	20

CASE 14: WINTER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 3,959

THE PELAGIC HABITAT contributed 49 percent (1,925) of the impact store for this case. With minor exceptions, the change in impact score for this habitat from Case 13 is accounted for by the following species:

Pacific Sandlance	increased	to	36	from	9
Herring	increased	to	1,289	from	729
Smelt	increased	to	82	from	38
Harbor Seal	reduced	to	0	from	30
Sea Otter	reduced	to	0	from	137

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 28 percent (1,107) of the impact score for this case. The change in impact score for this habitat from Case 13 is accounted for by the following species:

Other Flatfish	increased	to	48	from	12
Greenlings	reduced	to	18	from	72
Walleye Pollock	reduced	to	18	from	72
Scallops	reduced	to	85	from	400
Other Marine Invertebrates	reduced	to	102	from	219

THE INTERTIDAL ROCKY HABITAT contributed 18 percent (696) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 13 is accounted for by the following species:

Other Invertebrates	reduced	to	120	from	273
Shorebirds	reduced	to	20	from	46

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (231) of the impact score for this case. The decrease in impact score for this habitat from Case 13 is accounted for by the following species:

Intertidal Seaweed	reduced	to	0	from	18
Smelt	reduced	to	24	from	96
Crustaceans	reduced	to	6	from	24
Shorebirds	reduced	to	5	from	21

CASE 15: SUMMER, GASOLINE, 50,000 BBLS - IMPACT SCORE 2,962

THE PELAGIC HABITAT contributed 42 percent (1,243) of the impact

score for this case. The species which are present in this habitat in Summer, but not in Winter, account for an increase of 337 in impact score. Other species contributing to the change at impact score from Case 14 are as follows:

Sea Otter	increased	to	30	from	0
Phytoplankton	reduced	to	30	from	77
Zooplankton	reduced	to	30	from	77
Floating Seaweed	reduced	to	0	from	20
Pacific Sandlance	reduced	to	9	from	36
Herring	reduced	to	480	from	1,289
Dolly Varden	reduced	to	128	from	164
Seabirds	reduced	to	0	from	64

THE SUBTIDAL SAND/MUD HABITAT contributed 25 percent (736) of the impact score for this case. This habitat was not impacted in Case 14. The entire habitat impact score adds to the total for this case. The main contributing species were Dungeness Crab (100) and shrimp (600).

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 12 percent (343) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 14 is accounted for by the following species:

Other Marine Invertebrates	increased	to	170	from	102
Pacific Halibut	reduced	to	0	from	120
Other Flatfish	reduced	to	0	from	48
Rockfish	reduced	to	0	from	72

Other Marine Fish	reduced	to	0	from	48
King Crab	reduced	to	0	from	298
Tanner Crab	reduced	to	70	from	298
Scallops	reduced	to	20	from	85

THE INTERTIDAL SAND/MUD HABITAT contributed 2 percent (60) of the impact score for this habitat. This habitat was not impacted in Case 14. The entire habitat impact score adds to the total for this case. The only contributing species were softshell bivalves (30) and invertebrate infauna (30).

THE INTERTIDAL ROCKY HABITAT contributed 9 percent (260) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 14 is accounted for by the following species:

Sessile Marine Invertebrates	increased	to	90	from	40
Herring	reduced	to	105	from	298
Miscellaneous Crustaceans	reduced	to	20	from	80
Other Invertebrates	reduced	to	45	from	120
Shorebirds	reduced	to	0	from	20
Sea Ducks	reduced	to	0	from	120

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (280) of the impact score for this case. With a minor exception, the change in impact score for this habitat is accounted for by the following species:

Smelt	increased	to	192	from	24
Crustaceans	increased	to	48	from	6

Hardshell Bivalves	reduced	to	40	from 160
Gastropods	reduced	to	0	from 36

THE TERRESTRIAL HABITAT contributed 1 percent (40) of the impact score for this case. This habitat was not impacted in Case 14. The entire habitat impact score adds to the total for this case. The only contributing species were strand vegetation (10) and other vegetation (30).

CASE 16: WINTER, BUNKER-C, 50,000 BBLS - IMPACT SCORE 2,711

THE TERRESTRIAL HABITAT contributed 54 percent (1,458) of the impact score for this case. The species not present in this habitat in Winter account for a decrease of 337 from the impact score of Case 15. Other species contributing to the change in impact score for this case were as follows:

Phytoplankton	increased	to	77	from 30
Zooplankton	increased	to	77	from 30
Floating Seaweed	increased	to	20	from 0
Herring	increased	to	729	from 480
Dolly Varden	increased	to	164	from 128
Harbor Seal	increased	to	30	from 0
Sea Otter	increased	to	137	from 30
Seabirds	increased	to	64	from 0
Smelt	reduced	to	38	from 96

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 46 percent (1,253) of the impact score for this case. All species in this habitat had increased

impact scores from Case 15. The results for this habitat were as follows:

Subtidal Seaweed	increased	to	12	from 0
Pacific Halibut	increased	to	128	from 0
Other Flatfish	increased	to	48	from 0
Greenlings	increased	to	77	from 30
Rockfish	increased	to	77	from 0
Walleye Pollock	increased	to	77	from 36
Other Marine Fish	increased	to	51	from 0
King Crab	increased	to	298	from 0
Tanner Crab	increased	to	298	from 70
Scallops	increased	to	85	from 20
Other Marine Invertebrates	reduced	to	102	from 170

CASE 17: SUMMER, DIESEL-2, 100 BBLS - ESTIMATED SCORE 2,020

THE PELAGIC HABITAT contributed 25 percent (505) of the score for this case. The species contributing significantly to this score were judged to be herring, pink salmon, rainbow/steelhead trout, Dolly Varden, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 24 percent (485) of this score for this case. The species contributing significantly to this score were judged to be Dungeness crab and shrimp.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 10 percent (202) of the score for this case. The species contributing significantly to this score were judged to be king crab, Tanner crab and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 19 percent (384) of the score for this case. The species contributing signiticantly to this score were judged to be razor clams, softshell bivalves, invertebrate infauna and shorebirds.

THE INTERTIDAL ROCKY HABITAT contributed 14 percent (283) of the score for this case. The species contributing significantly to this score were judged to be herring, miscellaneous crustaceans and other invertebrates.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (141) of the score for this case. The species contributing significantly to this score were judged to be smelt, hardshell bivalves, crustaceans and gastropods.

THE TERRESTRIAL HABITAT contributed 1 percent (20) of the score for this case. Only minor impacts were judged to occur for strand and other vegetation.

CASE 18: WINTER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 1,679

THE PELAGIC HABITAT contributed 49 percent (818) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 16 is accounted for by the following species:

Herring	reduced	to	340	from 729
Rainbow/Steelhead Trout	reduced	to	38	from 82
Dolly Varden	reduced	to	77	from 164
Harbor Seal	reduced	to	0	from 30
Sea Otter	reduced	to	64	from 137

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 51 percent (861) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 16 is accounted for by the following species:

Pacific Halibut	reduced	to	30	from	128
Other Flatfish	reduced	to	12	from	48
Greenlings	reduced	to	18	from	77
Rockfish	reduced	to	18	from	77
Walleye Pollock	reduced	to	18	from	77
Other Marine Fish	reduced	to	12	from	51

CASE 19: SUMMER, GASOLINE, 10,000 BBLS - IMPACT SCORE 1,617

THE PELAGIC HABITAT contributed 57 percent (921) of the impact score for this case. The species not present in Winter scenarios account for an increase of 184 in impact score for this case. Other species contributing significantly to the change in score from Case 18 in this habitat were as follows:

Ichthyoplankton	increased	to	80	from	24
Herring	increased	to	480	from	340
Phytoplankton	reduced	to	30	from	72
Zooplankton	reduced	to	30	from	72
Floating Seaweed	reduced	to	0	from	20
Rainbow/Steelhead Trout	reduced	to	18	from	38
Dolly Varden	reduced	to	30	from	77

Sea Otter	reduced	to	30	from	64
Seabirds	reduced	to	0	from	64

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (186) of the impact score for this case. This habitat was not impacted in Case 18. The entire score is an addition to the impact in this habitat for this case. The main contributing species were shrimp (150) and other marine invertebrates (30).

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (130) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 18 is accounted for by the following species:

King Crab	reduced	to	0	from	280
Tanner Crab	reduced	to	0	from	280
Scallops	reduced	to	20	from	85
Other Marine Invertebrates	reduced	to	40	from	96

THE INTERTIDAL SAND/MUD HABITAT contributed 4 percent (60) of the impact score for this case. This habitat was not impacted in Case 18. The entire score is an addition to the impact in this habitat for this case. The only contributing species were softshell bivalves (30) and invertebrate infauna (30).

THE INTERTIDAL ROCK HABITAT contributed 13 percent (210) of the impact score for this case. This habitat was not impacted in Case 18. The entire score is an addition to the impact in this habitat for this case. The only

contributing species were herring (105), sessile marine invertebrates (40), Miscellaneous crustaceans (20), and other invertebrates (45).

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (100) of the impact score for this case. This habitat was not impacted in Case 18. The entire score is an addition to the impact in this habitat for this case. The only contributing species were smelt (48), hardshell bivalves (40) and crustaceans (12).

THE TERRESTRIAL HABITAT contributed 1 percent (10) of the impact score for this case. Only strand vegetation (10) was judged to have any impact score for this habitat in this case.

CASE 20: WINTER, BUNKER-C, 10,000 BBLS - IMPACT SCORE 1,530

THE PELAGIC HABITAT contributed 53 percent (806) of the impact score for this case. Crab larvae and the salmon species were not present in this case. The other species with significant changes in impact score for this habitat from Case 19 were as follows:

Phytoplankton	increased to	77	from	30
Zooplankton	increased to	77	from	30
Floating Seaweed	increased to	20	from	0
Rainbow/Steelhead Trout	increased to	38	from	18
Dolly Varden	increased to	77	from	30
Sea Otter	increased to	64	from	30
Seabirds	increased to	60	from	0

Ichthyoplankton	reduced	to	26	from	80
Herring	reduced	to	340	from	480

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 47 percent (724) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 19 is accounted for by the following species:

Pacific Halibut	increased	to	120	from	0
Greenlings	increased	to	72	from	30
Rockfish	increased	to	72	from	0
Walleye Pollock	increased	to	72	from	36
Other Marine Fish	increased	to	48	from	0
King Crab	increased	to	70	from	0
Tanner Crab	increased	to	70	from	0
Scallops	increased	to	80	from	20
Other Marine Invertebrates	increased	to	96	from	40

CASE 21: WINTER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 887

THE PELAGIC HABITAT contributed 66 percent (583) or the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 20 is accounted for by the following species:

Herring	reduced	to	320	from	340
Rainbow/Steelhead Trout	reduced	to	9	from	38
Dolly Varden	reduced	to	18	from	77

Sea Otter	reduced	to	15	from	64
Seabirds	reduced	to	15	from	60

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 34 percent (304) of the impact score for this case. The decrease in impact score for this habitat from Case 20 is accounted for by the following species:

Pacific Halibut	reduced	to	30	from	120
Greenlings	reduced	to	18	from	72
Rockfish	reduced	to	18	from	72
Walleye Pollock	reduced	to	18	from	72
Other Marine Fish	reduced	to	12	from	48
Scallops	reduced	to	20	from	80
Other Marine Invertebrates	reduced	to	24	from	96

CASE 22: WINTER, GASOLINE, 50,000 BBLS - IMPACT SCORE 837

THE PELAGIC HABITAT contributed 64 percent (539) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 21 is accounted for by the following species:

Phytoplankton	reduced	to	18	from	72
Zooplankton	reduced	to	18	from	72
Floating Seaweed	reduced	to	0	from	20
Smelt	increased	to	36	from	9
Rainbow/Steelhead Trout	increased	to	38	from	9
Dolly Varden	increased	to	77	from	18

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (228) of the impact score for this habitat from Case 21 and is accounted for by the following species:

Other Marine Invertebrates	increased	to	102	from	24
Pacific Halibut	reduced	to	0	from	30
King Crab	reduced	to	0	from	70

THE INTERTIDAL ROCKY HABITAT contributed 5 percent (40) of the impact score for this case. Only sessile marine invertebrates (40) contributed to the impact score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (30) of the impact score for this case. Only smelt (24) and crustaceans (6) contributed to the impact score in this habitat.

The impact scores for Cases 22 through 32 range from 791 down to 21. The spill sizes for these cases are 10,000 barrels of gasoline in the Winter, 1,000 barrels of gasoline in both seasons, and 100 barrels for all spills. The array of these scores is shown as follows:

SPILL SIZE BY SEASON

	10,000 BBLS		1,000 BBLS		100 BBLS
SPILL TYPE	WINTER	SUMMER	WINTER	SUMMER	WINTER
Diesel-2	Case 10	Case 7	Case 14	Case 17	661
Crude Oil	Case 13	Case 11	Case 18	791	361
Bunker C	Case 20	Case 12	Case 21	436	187
Gasoline	527	450	142	40	21

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills. The Summer cases are a moderately higher set of scores than the Winter cases. This is accounted for in the Summer spill trajectory, which carries the spill to a greater number of habitats, and the greater abundance of organisms present during Summer.

(6) KAMISHAK BAY

Kamishak Bay is located in the western side of lower Cook Inlet The Bay is sheltered on the west and south by mountains of the Aleutian Range. Augustine Island is an active volcano lying in the northern and outer portion of Kamishak Bay, bordering Cook Inlet proper. The spill site was located at 59°11.11'N latitude and 153°43.79'W longitude, about 13 miles southwest of Augustine Island (Figure 2-32).

(a) PHYSICAL CHARACTERISTICS

Cook Inlet is characterized as being in the Transitional Climatic Zone, with lower Cook Inlet strongly influenced by the Maritime Climate of the Gulf of Alaska.[3]

TEMPERATURES

Climatic data for the western side of Cook Inlet are sporadic south of Tyonek. Temperatures are expected to be similar to those for Port Graham located on the eastern portion of lower Cook Inlet. Summer temperatures should range from 35°F to 60°F and Winter temperatures from 15°F to 45°F. Sea ice is not normally present in Winter sufficient to impede navigation.[27]

SURFACE WINDS

Prevailing winds in Cook Inlet are northerly in Winter and southerly in Summer.[2,3,7] Downslope drainage from the Aleutian range can result in wide variation of wind in short distances.[3] Representative winds at the spill site were chosen as north at 8.0 knots during Winter and southeast at 9.0 knots during Summer.

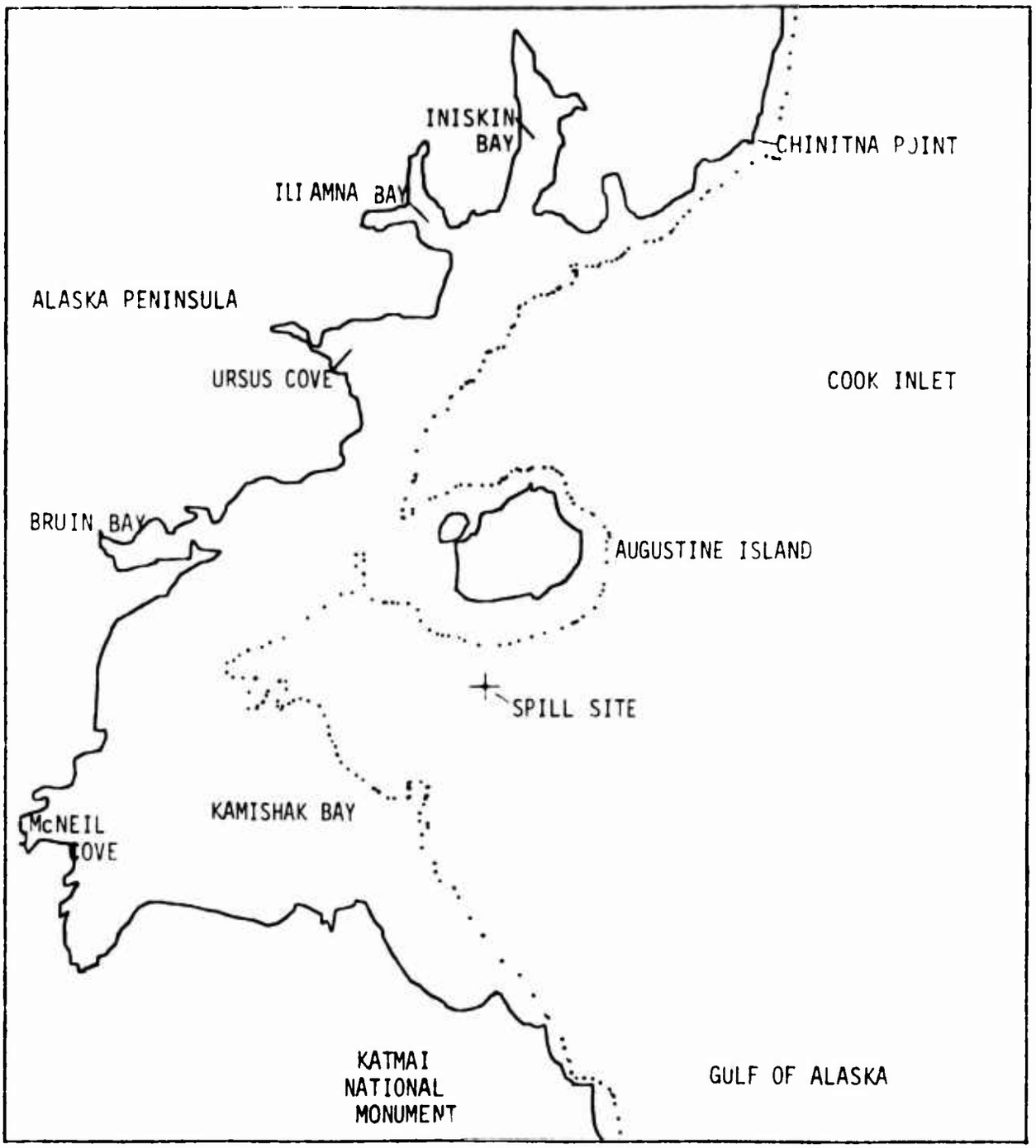


FIGURE 2-32. THE KAMISHAK BAY LOCATION AND SPILL SITE

NOTE: The broken line is the 10 fathom (60 feet) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

SURFACE CURRENTS

The *COAST PILOT*[8] and the *TIDAL CURRENT TABLES*[9] have little information on Kamishak Bay, possibly because the south and west parts of the Bay are shallow and hazardous for vessel operation. As contrasted with Offshore Port Graham on the other side of Cook Inlet, the Kamishak Bay vicinity would be influenced by outgoing waters from Cook Inlet according to the generalized current patterns (see Figure 2-20) for Cook Inlet.

The *TIDAL CURRENT TABLES*[9] provided information for only one area in the study location---Iniskin Bay on the north of Kamishak Bay--and for one adjacent Bay--Chinitna Bay north of the study location. This information is as follows:

	MAXIMUM CURRENTS (AVERAGE VELOCITY)	
AREA	EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Iniskin Bay	1.2 K (180°)	0.9 K (000°)
Chinitna Bay	1.1 K (080°)	1.0 K (260°)

The *COAST PILOT*[8] provided the following local information:

AREA	COMMENT
West of Nordyke Island (western Kamishak Bay)	Currents set south-southwest on the flood and north-northeast on the ebb.
Iliamna Bay (north of Kamishak Bay)	The diurnal tidal range is 14.5 ft with currents of 1 to 2 knots.

From this limited information, MSNW assumed the following tidal currents for Kamishak Bay and vicinity:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Cook Inlet (east of Kamishak Bay)	2.55 K (200^{o})	2.15 K (020^{o})
Kamishak Bay (south of Augustine Island)	1.10 K (120^{o})	1.00 K (300^{o})
West and North of Augustine Island	1.10 K (230^{o})	1.00 K (050^{o})
Iniskin Bay Vicinity	1.20 K (180^{o})	0.90 K (000^{o})
East of Iniskin Bay	1.10 K (080^{o})	1.00 K (260^{o})

(b) BIOLOGICAL CHARACTERISTICS

The region in the vicinity of Kamishak Bay is a biologically rich area somewhat like the Port Graham-Kachemak Bay vicinity on the other (eastern side) of lower Cook Inlet. Information is generally lacking for the non-exploited Bay proper, with crabs an important resource on the margin of where Kamishak Bay adjoins lower Cook Inlet. Information is generally lacking for the non-exploited fauna at this location requiring many extrapolations from other areas.

Resource summaries are shown in Figures 2-33 and 2-34 .

FISHES

SALMONOIDS - All five species of North American salmon probably inhabit or travel through this area to and from other portions of Cook Inlet. Kamishak Bay is probably more important as a rearing area for juvenile salmon than as a place of adult salmon activity. The adult commercial catches in Kamishak Bay are low. Average catches (1965-1971) are as follows:

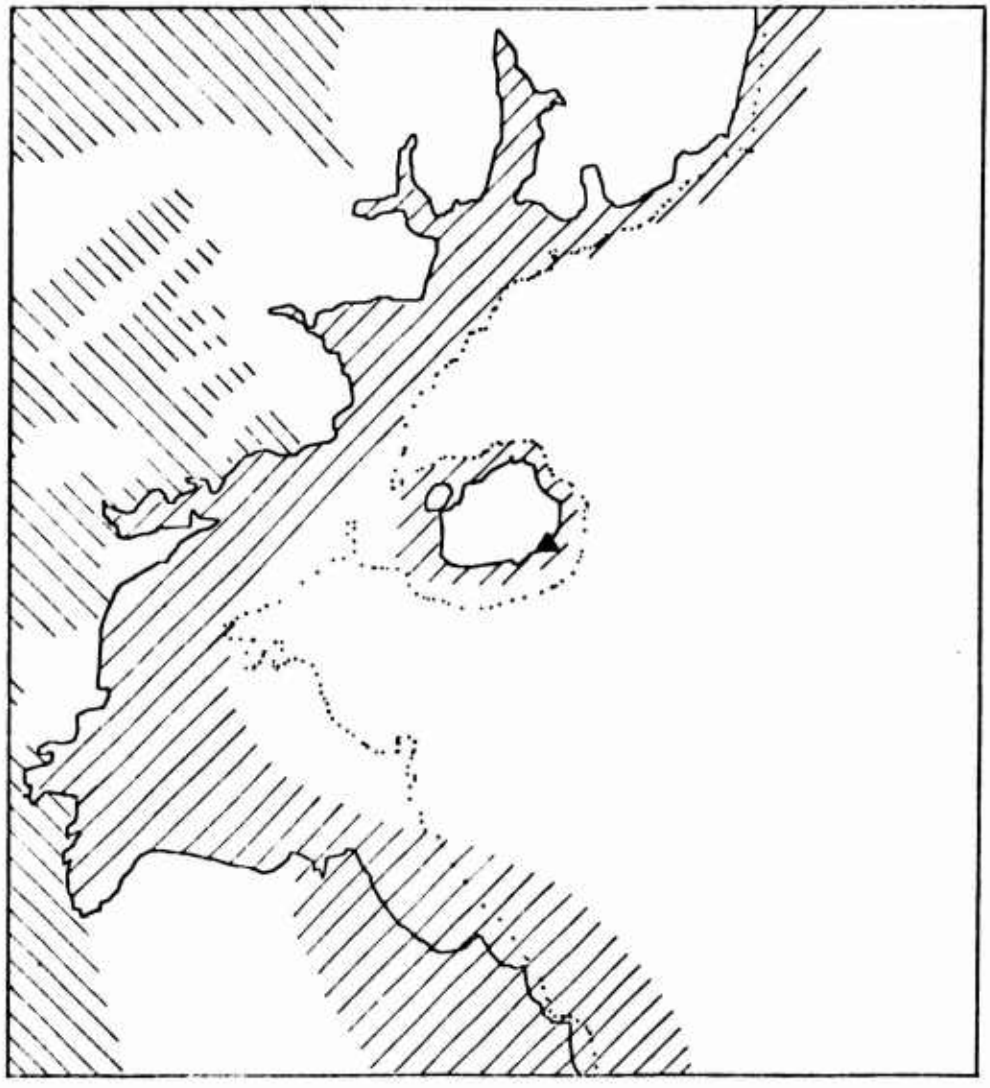
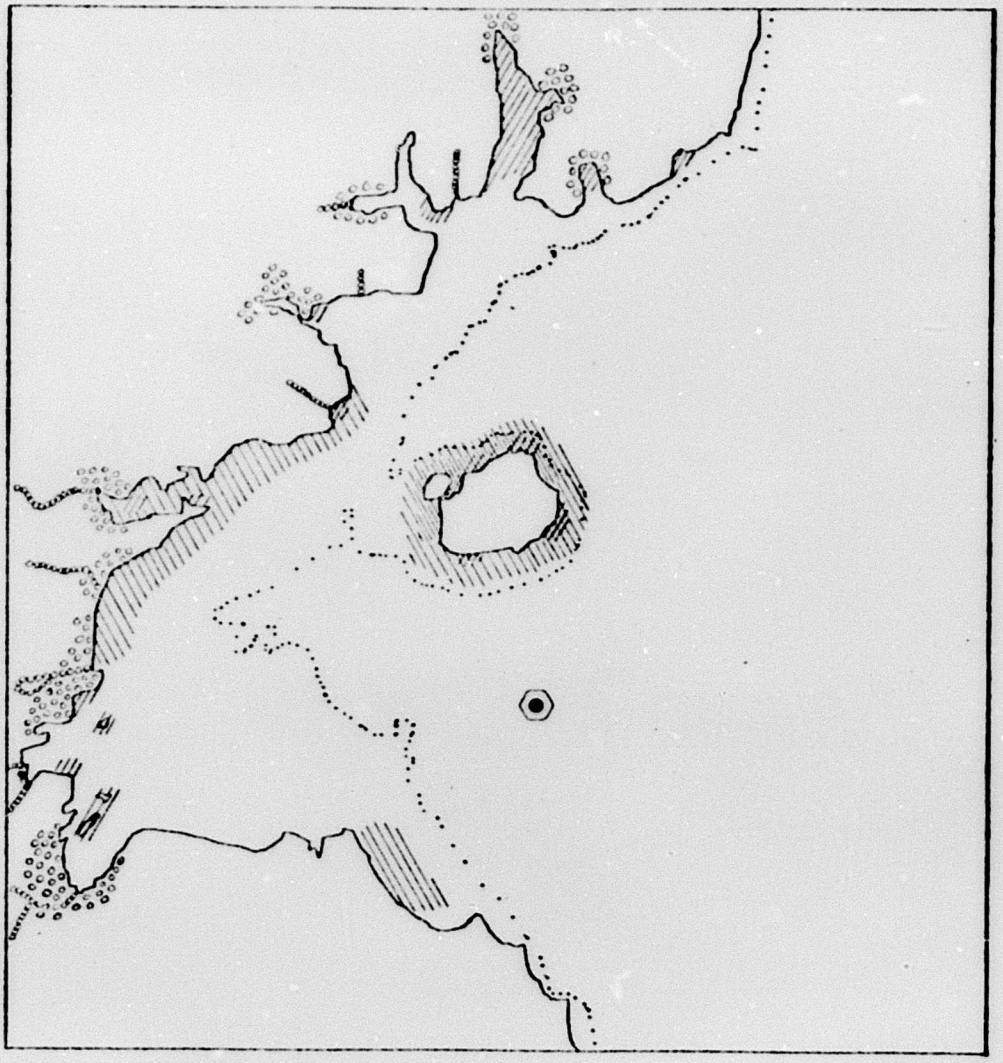


FIGURE 2- 33. KAMISHAK BAY CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.



Harbor Seal Concentraction
Sea Otter Area
Sea Otter Concentration
Sea Lion Concentration/Rookery
Brown Bear
Intensive Use/Spring
Concentration on Fish Streams

FIGURE 2- 34. KAMISHAK BAY CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

SALMON	MEAN	(RANGE)
Sockeye	7,239	(21 - 38,400)
Coho	159	(74 - 300)
Pink	52,403	(2,945 - 208,325)
Chum	37,500	(3,175 - 95,900)

The total runs would be something greater with a conservative estimate to be twice the above catch. Estimates are difficult with the little information located on fishing effort in this area.

Salmon runs for adults would be from mid-May to late August and for juveniles from early May to late August. Pink and chum salmon juveniles would be most important in the Kamishak Bay vicinity as they inhabit shallow waters along shorelines during the Summer months (particularly early Summer) while feeding and prior to moving out into the Gulf of Alaska.

Salmon spawning (based upon limited data) appears minimal in this area with the exception of sizable chum salmon runs into the McNeil River (southwestern corner of the Bay). No sockeye salmon systems are located in this part of Cook Inlet.[10]

The distribution of other salmonids (Dolly Varden and steelhead trout) in Cook Inlet is not well understood; however, they are probably in Kamishak Bay. Dolly Varden should be similar in general location and timing as those at the Offshore Port Graham location.

The McNeil River supports a significant chum salmon sport fishery.[10]

PACIFIC HALIBUT - This bottom-dwelling fish is assumed to be in the outer parts of Kamishak Bay (east of Augustine Island) in lower Cook Inlet -- similar to those across the Inlet at Port Graham.[10] Some regions in Kamishak

Bay may also be nursery areas for juvenile halibut. Other comments about halibut at Port Graham would also be applicable here.

PACIFIC HERRING in Kamishak Bay are not specifically mentioned,[10] but they would be expected to be present. Herring would be expected to be less abundant at Kamishak Bay as compared to the Port Graham vicinity. Other comments on herring at Port Graham would be applicable here.

SMELT (EULACHON) may pass through Kamishak Bay on their way to upper Cook Inlet. Their timing and behavior would be similar to the Port Graham vicinity. Other smelt (capelin) may utilize gravel beaches in the Bay to spawn in early Spring.

OTHER MARINE FISHES - Numerous flatfish, sculpins, and greenlings would also be assumed to be located in Kamishak Bay.

SHELLFISHES

KING CRAB are shown off Kamishak Bay in the mouth of Cook Inlet.[16] Commercial landings in the Kamishak District for 1971 indicated catches greater in this district than for the Southern District, including the Port Graham vicinity.[10] These data indicated more adults were caught in August and September (1,007,566 and 916,419 lbs, respectively), but more effort was also expended.[10] No catches are indicated for April through July when the fishery may not be operational.

See Port Graham comments on the biology, life history, and vulnerability of these crabs.

TANNER CRAB are very abundant in the lower part of Cook Inlet to the east of Kamishak Bay.[16] Commercial landings in the Kamishak District for 1971 indicate comparable catches to the Southern District.[16] Catches were landed

in all months except August, September, November, and December, with maximum landings in May, June, and July (175,22, 349,115, and 268,925 lbs, respectively).[10] No effort information was given to interpret these data as to the timing of tanner crab abundance in the Kamishak District.[10] Greater numbers of tanner crabs are taken in the deeper waters of the mouth of Cook Inlet midway between Augustine and Barren Islands.[10]

Comments on tanner crab biology, life history, and vulnerability to oil would be comparable to those given in the Port Graham location description.

DUNGENESS CRAB were not separated by landing area by Evans[10] so that it is not possible to accurately define Kamishak Bay's importance for this species. Kachemak Bay (adjacent to Port Graham and across Cook Inlet) is the predominant source of catches during June through October.

Dungeness crabs were assumed to be in the Kamishak Bay vicinity, particularly in the Spring and Summer when they move into shallower waters.

Further comments on this crab's biology, life history, and vulnerability to oil are given in the Port Graham description.

SHRIMP are similar in occurrence to Dungeness crab, with the Port Graham vicinity having shrimp in greater abundance than the Kamishak Bay area, although little data was found on distribution. Shrimp are abundant on the outer edge of Kamishak Bay in the mouth of Cook Inlet.[16] Some shrimp probably also move into the shallower waters of Kamishak Bay.

Other general comments about Cook Inlet shrimp species, biology, life history, and vulnerability to oil are given in the Port Graham location description.

RAZOR CLAMS are not thought to be abundant in Kamishak Bay compared to middle Cook Inlet (Drift River vicinity); however, they are in scattered sandy beaches on the west shore southward of Harriet Point.[10] A heavy concentration is on the northeast side of Chinitna Bay (just north of the Kamishak Bay study area).[10] Razor clams were assumed to be in scattered locations in parts of Kamishak Bay.

Commercial effort in Kamishak Bay was not mentioned,[10] and sport effort would be limited because of the remoteness of many Kamishak beaches (exceptions by shallow draft boats and float planes).

For additional comments on this clam's biology, life history, and vulnerability to oil, see the Drift River location description.

SCALLOPS are present in greatest abundance in the Kamishak District between Augustine and the Barren Islands (east of Kamishak Bay proper).[10] Presently all districts are closed to commercial fisheries.[10] The only commercial effort on scallops in 1969 resulted in 240 lbs taken from the Kamishak Bay.

Hennick[41] indicated that most scallops in the Kodiak area spawned between June 3rd and 8th, with some spawning continuing into July. Evans[10] reported that no seasonal movements are known for this species.

The sensitivity of scallops to oil in the laboratory has been shown to be high; however, the generally deep location of these mollusks suggests that their vulnerability is probably similar to deepwater shellfish such as king crab.[10]

WATERFOWL

As indicated for the other two Cook Inlet study locations (Drift River and Port Graham), little quantitative information is available for waterfowl in Cook Inlet. Breeding populations of waterfowl and seabirds are present along the entire coast of Kamishak Bay and Augustine Island.[17] This area is also an important wintering area for waterfowl and seabirds.[17] Scoters, kittiwakes, and tufted puffins are the most abundant birds in Cook Inlet. Common species in the Kamishak vicinity are the following: fulmar, white-winged scoter, surf scoter, common eider, and the glaucous-winged gull, from an August 1972 survey.[10] This later survey rated bird abundance in the adjacent Southern District of Cook Inlet as very high.

DUCKS - 32 pair of breeding ducks per square mile were reported in Game Unit 9 (all of Alaska Peninsula),[17] although the Kamishak Bay area would be expected to be below this.[18] Kamishak Bay is also an overwintering area for some ducks.[17] Ducks inhabit inshore seas, mud flats, and estuaries of this Bay.

GEESE utilize the nearshore areas, mud flats, and estuaries of Kamishak Bay. This is an important goose nesting area and is also important as a migration route. Numerous species are involved including black brant.

SWANS - An estimated two whistling swans occur per square mile in one part of Game Unit 9. Trumpeter swans (endangered) breed north of this location in Tuxedni Bay[17] and some may breed in this part of Cook Inlet.

SEABIRDS are the most numerous waterfowl group at this site and are found along all of the coastlines of Kamishak Bay and Augustine Island. A colony of seabirds exists on the southeast coast of Augustine Island and includes fulmars, Cassin's auklet, and least auklet.

SHOREBIRDS are abundant in this Bay with heavy Spring and Fall migration.[17] The area has a heavy migration of sandhill cranes.[18]

General waterfowl comments for Cook Inlet and the vulnerability of waterfowl to oil products is discussed with the Port Graham location description.

MARINE MAMMALS

SEA OTTERS are very abundant in Kamishak Bay, particularly on the north and west shores of Augustine Island.[17] They are also indicated as present along all the coast areas of the Bay and Island except for the southwestern shore of the Bay. The estimated population is 1,000 otters and increasing in the Augustine Island-Paule Bay area.[17] Additional sea otter information is discussed with the Port Graham location description.

HARBOR SEALS are shown as present along all Kamishak Bay and Augustine Island coastlines, with numerous high density areas scattered throughout this distribution area.[17] No quantified data were located for harbor seals, but numerous concentrations occur. Further comments on harbor seals are discussed with the Port Graham location description.

SEA LIONS are abundant in Kamishak Bay. A rookery is located at Augustine Rocks (500 animals) about 8 miles south-southeast of Augustine Island.[17]

BELUGA WHALES - See Drift River location description.

TERRESTRIAL MAMMALS

BROWN BEAR are very numerous in the vicinity of Kamishak Bay. This is one of the best brown bear areas in the State with the world's most important

brown bear photography area in the McNeil River sanctuary. The local population is perhaps 500 bears, while an estimated 2,000 bears occur in Game Unit 9 (all of Alaska Peninsula).[17] Intensive Spring use is made of much of the west shore of the Bay, and concentrations on rivers in this area occur with adult salmon runs.[17]

BLACK BEAR are in low numbers in the vicinity of Kamishak Bay, with the southern edge of their distribution in the north portion of the Bay (just south of Bruin Bay).[17] No concentration points are known for this location.

WOLVES AND WOLVERINES are indicated as present throughout the Kamishak Bay vicinity.

MOOSE are distributed along the coastline of Kamishak Bay, with no known concentration areas.[17] The population is thought to be low but increasing here.[18]

CARIBOU are indicated as present only along the south shore of Kamishak Bay.[17] This is the extreme eastern edge of their range, and they would be expected here in low numbers.[18]

SMALL MAMMALS are thought to be in low numbers in low-lying vegetation areas.[18]

AQUATIC FURBEARERS include land otter, mink, beaver, and muskrat and are thought to be in low abundance in this vicinity.[18]

FLORA

No specific information on plants were located for Kamishak Bay and vicinity. All comments for Port Graham-Kachemak Bay are thought to be applicable here also.

Additional physical and biological information for Kamishak Bay and vicinity is located in Appendix D .

(c) RESULTS

The highest impact score at Kamishak Bay was the result of a 1,000-bbl spill of diesel-2 during the Summer. The magnitude of this score was approached by 1,000-bbl spills of crude and bunker C in the same season. The Winter impacts were much lower owing to the absence of many species.

The pelagic habitat was the most severely impacted in the Summer, and the pelagic and subtidal were the most severely impacted in the Winter.

The main contributors to the impact scores were herring, crab, sea otter, and seabirds.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Kamishak Bay. The first scenario, using most probable Summer conditions, resulted in oil moving in a northerly direction to the shores of Augustine Island in approximately 18 hours after a spill (Fig. 2-35). The second scenario resulted in oil moving in a southerly direction to the south shore of Kamishak Bay near Cape Douglas approximately 48 hours after a spill (, . 2- . The 1,000 and 100-bbl spills of diesel-2 crude oil and bunker C generally impacted all habitats except intertidal sand/mud and freshwater river. The shorter lived gasoline spills did not reach the other intertidal and terrestrial habitats in the Winter scenarios.

See Page 2-26 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-12 presents the results of the oil spill scenarios examined at Kamishak Bay without cleanup.

TABLE 2-12. KAMISHAK BAY CASE RESULTS, NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 1,000		SPILL SIZE 100	
SUMMER	Diesel-2	7,565	[1](1)	2,661	[6]
	Crude Oil	5,722	[2]	1,593	[8]
	Bunker-C	5,319	[3]	1,641	[7]
	Gasoline	1,507	[9]	154	[14]
WINTER	Diesel-2	3,254	[4]	372	[12]
	Crude Oil	2,877	[5]	457	[11]
	Bunker-C	1,279	[10]	255	[13]
	Gasoline	111	[15]	33	[16]

(1) Numbers in brackets are the case numbers that follow.

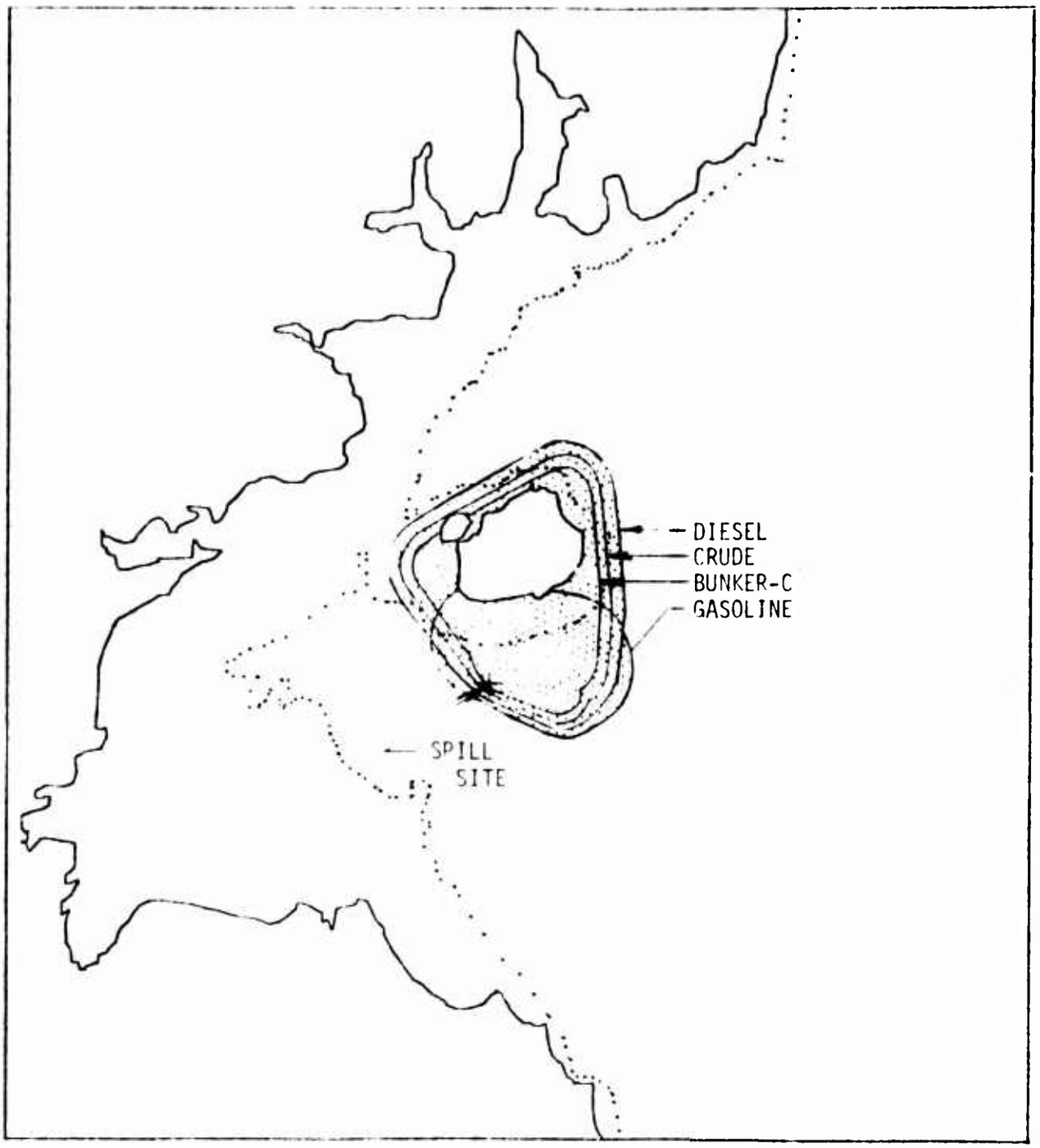


FIGURE 2-35. KAMISHAK SUMMER 1,000 BBL SPILL ENVELOPES

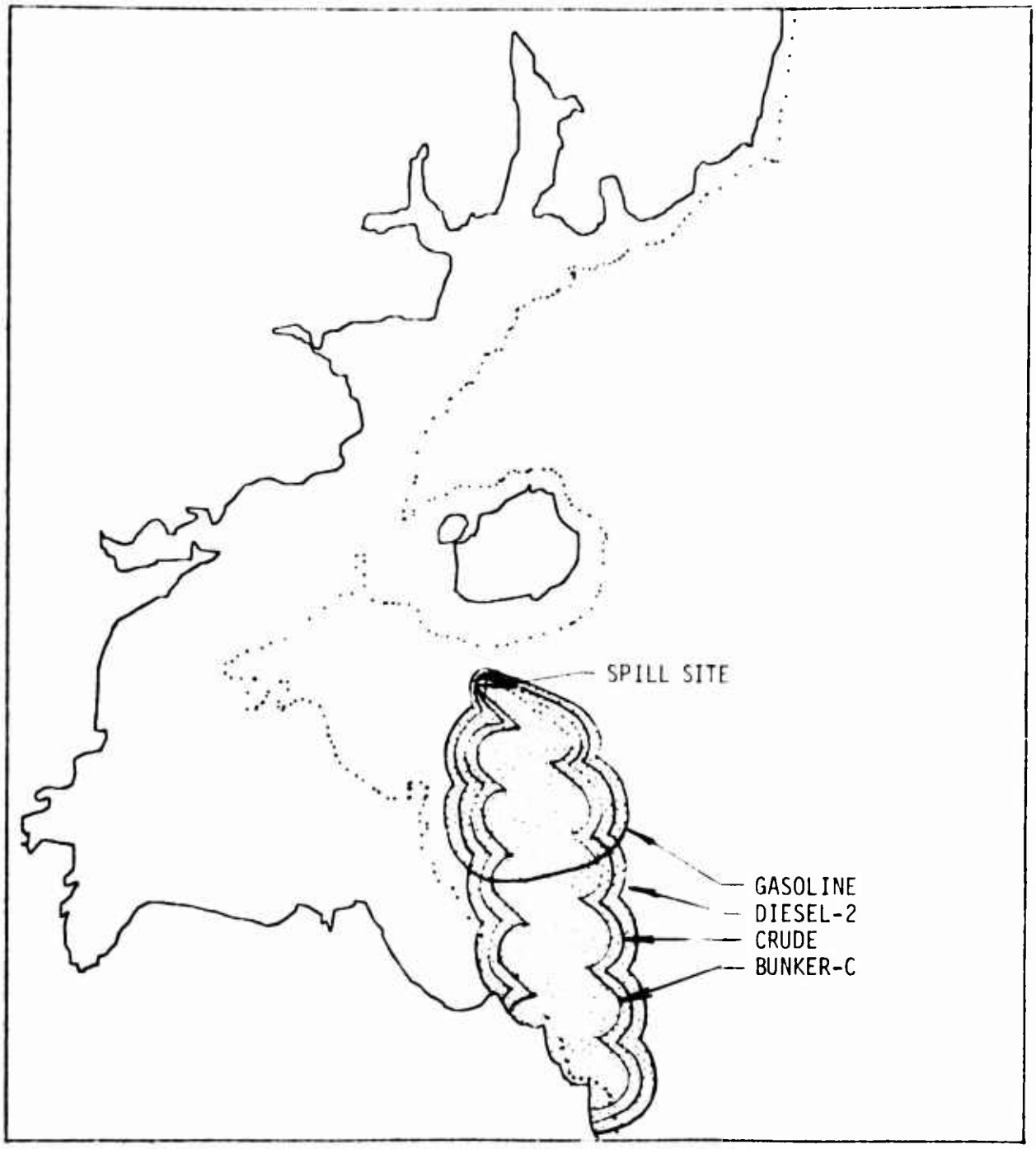


FIGURE 2-36. KAMISHAK WINTER 1,000 BBL SPILL ENVELOPES

CASE 1: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 7,565

THE PELAGIC HABITAT contributed 36 percent (2,694) of the impact score for this case. The species which were the main contributors to this impact score were herring (729), smelt (102), rainbow/steelhead trout (164), Dolly Varden (273), sea otter (456), and seabirds (456). These species were among the most abundant in this habitat and with the exception of smelt, they were judged to be the most sensitive to a diesel-2 spill. Herring were rated as important commercially and of minor importance to recreation and subsistence fishing. Smelt were rated to be of minor importance commercially. Rainbow/steelhead trout and Dolly Varden were rated of moderate importance for subsistence fishing. Sea otter and seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (1,094) of the impact score for this case. The species which were the main contributors to this impact score were Dungeness crab (492), shrimp (273), and other marine invertebrates (170). These species were among the most abundant in this habitat. Dungeness crab were rated to be an important commercial resource and moderately important as as recreational and subsistence resource. The crab and shrimp were judged to be the most sensitive to a diesel-2 spill.

THE SUBTIDAL ROCK/GRAVEL HABITAT contributed 16 percent (1,781) of the impact score for this case. The species which were the main contributors to this impact score were Pacific halibut (100), king crab (298), Tanner crab (446), scallops (128), and other marine invertebrates (102). With the exception of the invertebrates, these species were the most abundant in this habitat. Halibut and crabs were rated as important commercial resources, while scallops and invertebrates were of minor importance commercially. Halibut were rated as an important recreational resource and crab as somewhat

less important. The halibut and Tanner crab resource was rated as of some importance for subsistence fishing. The crabs, scallops and invertebrates were judged to be the most sensitive to a diesel-2 spill in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 17 percent (1,301) of the impact score for this case. The species which were the main contributors to this impact score were herring (638), miscellaneous crustaceans (109), other invertebrates (164), and marine mammal rookeries (135). Herring, crustaceans and invertebrates were among the most abundant species of this site. Herring were rated as an important commercial resource and as of minor importance for recreational and subsistence fishing. All major contributors were among the most sensitive to a diesel-2 spill in this habitat. Marine mammal rookeries were classified as protected as the breeding grounds of protected species.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 13 percent (984) of the impact score for this case. All impact species contributed substantially to this impact score. The results were smelt (219), hardshell bivalves (219), crustaceans (109), gastropods (169), and shorebirds (273). All species were rated as average in abundance and were judged to be of moderate sensitivity to a diesel-2 spill. Smelt and bivalves were rated as being of minor commercial importance and bivalves were rated as being of minor recreational importance. Shorebirds were classified as protected.

THE TERRESTRIAL HABITAT contributed 4 percent (314) of the impact score for this case. Raptors (200) and other birds (80) were the main contributors to this impact score. Both species were among the more abundant in this habitat and were judged to be the most sensitive to a diesel-2 spill. Raptors were classified as protected.

Table 2-13 following presents the full results of Case 1.

CASE 2: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 5,722

THE PELAGIC HABITAT contributed 36 percent (2,067) of the impact score for this case. With minor exceptions, the chance in impact scores for this habitat from Case 1 is accounted for by the following species:

Sea Otter	increased	to	806	from 456
Phytoplankton	reduced	to	18	from 72
Zooplankton	reduced	to	18	from 72
Pacific Sandlance	reduced	to	0	from 36
Herring	reduced	to	320	from 729
King Salmon	reduced	to	12	from 51
Pink Salmon	reduced	to	18	from 77
Rainbow/Steelhead Trout	reduced	to	77	from 164
Dolly Varden	reduced	to	128	from 273

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (737) of the impact score for this case. With minor exceptions, the change in impact score for this habitat is accounted for by the following species:

Pacific Sandlance	increased	to	36	from 9
Dungeness Crab	reduced	to	230	from 492
Shrimp	reduced	to	120	from 273

TABLE 2-13. MATRIX RESULTS--CASE 1

AREA	KAMISHAK
SEASON	SUMMER
SPILL SIZE	1,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	M	0	0	0	3	4	0	72	0	72
2. ZOOPLANKTON	6	M	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	6	A	0	0	0	2	4	0	48	0	48
4. FLOATING SEAWEED	6	M	0	0	0	2	1	0	12	0	12
5. GREENLINGS	1	M	0	0	0	2	1	0	2	0	2
6. PACIFIC SANDLANCE	3	A	0	0	0	3	4	0	36	0	36
7. HERRING	10	A	3	1	1	3	9	1	720	99	729
8. SMELT	6	A	1	0	0	3	4	1	36	24	102
9. CRAB LARVAE	10	E	0	0	0	2	4	1	80	20	85
10. KING SALMON	3	E	0	1	1	2	4	1	48	12	51
11. CHUM SALMON	1	A	1	0	1	2	4	1	16	4	17
12. SOCKEYE SALMON	1	A	1	1	1	3	4	1	20	5	21
13. PINK SALMON	3	A	2	1	1	2	4	1	72	18	77
14. COHO SALMON	1	A	1	1	1	2	4	1	20	5	21
15. RAINBOW-STEELHEAD TROUT	6	E	0	0	2	1	9	1	162	18	164
16. DOLLY VARDEN	10	E	0	0	3	1	9	1	270	30	273
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	6	A	0	0	0	5	0	0	0	0	0
24. WHALES	3	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	10	A	0	0	0	5	9	1	450	50	456
27. OTHER MARINE MAMMALS	3	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	9	1	450	50	456
									2646	396	2694
2. SUBTIDAL SAND-MUD											
1. CODS	3	A	2	1	1	2	1	0	18	0	18
2. SCULPINS	3	A	0	0	0	2	1	0	6	0	6
3. STARRY FLOUNDER	10	A	2	0	0	2	1	0	40	0	40
4. OTHER FLATFISH	10	A	2	1	1	2	1	0	60	0	60
5. PACIFIC SANDLANCE	3	A	0	0	0	3	1	0	9	0	9

TABLE 2-13. (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	6	M	0	0	0	2	1	0	12	0	12
7. DUNGENESS CRAB	6	A	3	2	2	2	9	1	486	54	492
8. SHRIMP	10	E	0	0	0	3	9	1	270	30	273
9. RAZOR CLAM	3	M	0	0	0	2	4	0	24	0	24
10. OTHER BIVALVES	10	M	0	0	0	1	4	0	40	0	40
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	4	0	120	0	120
									1095	84	1094
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	6	M	0	0	0	2	6	0	0	0	0
2. SUBTIDAL SEAWEED	6	M	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	1	A	1	0	1	2	4	1	15	4	17
4. PACIFIC HALIBUT	10	A	3	3	2	2	1	0	100	0	100
5. OTHER FLATFISH	6	A	2	0	0	2	1	0	24	0	24
6. GREENLINGS	6	A	0	1	0	2	1	0	18	0	18
7. ROCKFISH	3	A	2	1	1	2	1	0	18	0	18
8. WALLEYE POLLOCK	3	A	1	1	1	2	1	0	15	0	15
9. OTHER MARINE FISH	6	M	0	0	0	2	1	0	12	0	12
10. KING CRAB	10	A	3	2	0	2	4	1	280	70	298
11. TANNER CRAB	15	A	3	1	1	2	4	1	420	105	446
12. SCALLOPS	10	A	1	0	0	2	4	1	120	30	128
13. OTHER MARINE INVERTEBRATES	6	M	1	0	0	3	4	1	96	24	102
									1119	233	1178
4. INTERTIDAL SAND-MUD											
1. EELGRASS	6	M	0	0	0	3	0	0	0	0	0
2. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
3. RAZOR CLAM	3	M	0	1	0	2	0	0	0	0	0
4. SOFTSHELL BIVALVES	10	M	1	1	1	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	6	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	10	A	0	0	0	5	0	0	0	0	0
8. GEESE	6	A	0	1	0	1	0	0	0	0	0
9. DUCKS	6	A	0	1	0	2	0	0	0	0	0
10. SWANS	6	A	0	0	0	*	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	6	M	0	0	0	3	0	0	0	0	0

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TABLE 2-13. (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
2. GREENLINGS	6	H	0	1	0	2	4	0	72	0	72
3. HERRING	10	A	3	1	1	2	9	1	639	70	639
4. SESSILE MARINE INVERTEBRATES	6	H	0	0	0	1	9	1	54	6	55
5. MISC. CRUSTACEANS	6	H	0	0	0	2	9	1	108	12	109
6. OTHER INVERTEBRATES	6	H	0	0	0	3	9	1	162	18	164
7. SHOREBIRDS	2	A	0	0	0	5	4	1	60	15	64
8. SEA DUCKS	3	A	1	2	0	2	4	1	60	15	64
9. MARINE MAMMAL ROOKERIES	3	A	0	0	0	5	9	0	135	0	135
									1281	136	1301
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	H	0	0	0	3	0	0	0	0	0
2. SMELT	6	A	1	0	0	3	9	1	216	24	219
3. HARDSHELL BIVALVES	6	H	1	1	0	2	9	1	216	24	219
4. CRUSTACEANS	6	H	0	0	0	2	9	1	108	12	109
5. GASTROPODS	6	H	0	0	0	3	9	1	162	18	164
6. SHOREBIRDS	6	A	0	0	0	5	9	1	270	30	273
									972	108	984
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	6	H	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	15	H	0	0	0	3	0	0	0	0	0
3. KING SALMON	3	A	0	1	1	2	0	0	0	0	0
4. CHUM SALMON	1	A	1	0	1	2	0	0	0	0	0
5. SOCKEYE SALMON	1	A	1	1	1	2	0	0	0	0	0
6. PINK SALMON	3	A	2	1	1	2	0	0	0	0	0
7. COHO SALMON	1	A	1	1	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	E	0	1	1	1	0	0	0	0	0
9. DOLLY VARDEN	6	E	0	1	2	1	0	0	0	0	0
13. STICKLEBACKS	6	H	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	H	0	0	0	2	0	0	0	0	0
15. DUCKS	10	A	0	1	0	2	0	0	0	0	0
16. GEESE	10	A	0	1	0	2	0	0	0	0	0
17. SWANS	10	A	0	0	0	2	0	0	0	0	0
18. RIVER OTTER	6	A	1	1	1	1	0	0	0	0	0
19. MINK	6	A	1	1	1	1	0	0	0	0	0
20. MUSKRAT	6	A	1	1	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	1	1	1	0	0	0	0	0	0

TABLE 2-13. (CONT'D)

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	COMP.	SOC.	REG.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
A. TERRESTRIAL											
1. TUNDRA	1	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	3	H	0	0	0	2	0	0	0	0	0
3. UPLAND VEGETATION	10	H	0	0	0	1	1	0	10	0	10
4. OTHER VEGETATION	9	H	0	0	0	1	1	0	10	0	10
5. GRIZZLY BEAR	15	A	2	2	0	2	1	0	4	0	4
6. BLACK BEAR	3	1	1	1	0	2	0	0	0	0	0
7. WOLVERINE	6	A	1	1	0	1	0	0	0	0	0
8. WOLF	6	A	1	1	0	1	0	0	0	0	0
9. MOOSE	6	1	2	2	1	2	0	0	0	0	0
10. CARIBOU	3	E	1	1	1	2	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	0	0	2	1	0	10	0	10
17. RAPTORS	10	A	0	0	0	3	4	0	200	0	200
18. PTARMIGAN	14	P	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	4	0	80	0	80
									314	0	314
									7.17	977	7965

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 21 percent (1,201) of the impact score for this case. With minor exceptions, this habitat's result was the same as for Case 1.

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (729) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 1 is accounted for by the following species:

Greenlings	reduced	to	18	from 72
Herring	reduced	to	280	from 638
Sessile Marine Invertebrates	reduced	to	27	from 55
Miscellaneous Crustaceans	reduced	to	51	from 109
Other Invertebrates	reduced	to	77	from 164

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 11 percent (608) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 1 is accounted for by the following species:

Smelt	reduced	to	102	from 219
Hardshell Bivalves	reduced	to	96	from 219
Crustaceans	reduced	to	51	from 109
Gastropods	reduced	to	77	from 164

THE TERRESTRIAL HABITAT contributed 7 percent (380) of the impact score for this case. The increase in impact score from Case 1 is accounted for by the following species:

Strand Vegetation	increased	to	40	from	10
Other Vegetation	increased	to	48	from	12

CASE 3: SUMMER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 5,319

THE PELAGIC HABITAT contributed 37 percent (1,982) of the impact score for this case. With minor exceptions, smelt(reduced to 24 from 96)accounted for the decrease in impact score for the habitat from Case 2.

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (588) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Pacific Sandlance	reduced	to	9	from	36
Shrimp	reduced	to	30	from	120

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 24 percent (1,261) of the impact score for this case. The change in impact score for this habitat from Case 2 is accounted for by the following species:

Floating Seaweed	increased	to	48	from	12
Subtidal Seaweed	increased	to	48	from	12
Chum Salmon	reduced	to	4	from	16

THE INTERTIDAL ROCKY HABITAT contributed 14 percent (733) of the impact score for this case. With a minor exception, this habitat's result was the same as for Case 2.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (621) of the impact score for this case. With minor exceptions, intertidal seaweeds (increased to 36 from 9) accounted for the increase in impact score for this habitat from Case 2.

THE TERRESTRIAL HABITAT contributed 3 percent (134) of the impact score for this case. The decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Other Vegetation	reduced	to	12 from 48
Raptors	reduced	to	50 from 200
Other Birds	reduced	to	20 from 80

CASE 4: WINTER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 3,254

THE PELAGIC HABITAT contributed 33 percent (1,067) of the impact score for this case. Crab larvae and the five salmon species not present in the Winter cases reduced the impact score for this habitat 124 from Case 3. With minor exceptions, the remainder of the change in impact score is accounted for by the following species:

Phytoplankton	increased	to	38 from 18
Zooplankton	increased	to	77 from 18
Herring	increased	to	437 from 320
Smelt	increased	to	109 from 24
Dolly Varden	reduced	to	82 from 120
Sea Otter	reduced	to	120 from 806
Seabirds	reduced	to	64 from 456

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (463) of the impact score for this case. With minor exceptions the change in impact score for this habitat from Case 3 is accounted for by the following species:

Shrimp	increased	to	120	from	30
Other Flatfish	reduced	to	36	from	60
Dungeness Crab	reduced	to	108	from	216
Other Marine Invertebrates	reduced	to	72	from	128

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 35 percent (1,153) of the impact score for this case. Floating seaweed and chum salmon not present in the Winter cases reduced the impact score for this habitat 52 from Case 3. With minor exceptions, the majority of the change in impact score is accounted for by the following species:

Pacific Halibut	increased	to	120	from	100
Other Flatfish	increased	to	48	from	24
Subtidal Seaweed	reduced	to	0	from	48
Other Marine Invertebrates	reduced	to	51	from	102

THE INTERTIDAL ROCKY HABITAT contributed 12 percent (376) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Herring	reduced	to	179	from	280
Shorebirds	reduced	to	36	from	64
Seaducks	reduced	to	20	from	64
Marine Mammal Rookeries	reduced	to	60	from	135

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 4 percent (141) of the impact score for this case. The decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Intertidal Seaweeds	reduced	to	0	from 36
Smelt	reduced	to	12	from 96
Crustaceans	reduced	to	6	from 48
Gastropods	reduced	to	12	from 72
Shorebirds	reduced	to	15	from 273

THE TERRESTRIAL HABITAT contributed 2 percent (54) of the impact score for this habitat. Strand vegetation not present in the Winter cases reduced the impact score for this habitat 40 from Case 3. With minor exceptions, raptors reduced to 30 from 50, accounted for the remainder of the decrease in impact score.

CASE 5: WINTER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 2,877

THE PELAGIC HABITAT contributed 23 percent (670) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 4 is accounted for by the following species:

Herring	reduced	to	204	from 437
Smelt	reduced	to	51	from 109
Rainbow/Steelhead Trout	reduced	to	38	from 82
Dolly Varden	reduced	to	38	from 82

THE SUBTIDAL SAND/MUD HABITAT contributed 18 percent (525) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 4 is accounted for by the following species:

Sculpins	increased	to	24	from 6
Pacific Sandlance	increased	to	36	from 9

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 35 percent (997) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Pacific Halibut	reduced	to	30	from 120
Other Flatfish	reduced	to	12	from 48

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (382) of the impact score for this case. With minor exceptions, this habitat's result was the same as for Case 4.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 9 percent (249) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 4 is accounted for by the following species:

Smelt	increased	to	51	from 12
Crustaceans	increased	to	26	from 6
Shorebirds	increased	to	60	from 15

THE TERRESTRIAL HABITAT contributed 2 percent (54) of the impact score for this case. This habitat's result was the same as for Case 4.

CASE 6: SUMMER, DIESEL-2, 100 BBLS - IMPACT SCORE 2,661

THE PELAGIC HABITAT contributed 40 percent of the impact score for this case. The species not present in the Winter cases increased the impact score for this habitat 74 from Case 5. With minor exceptions, the remaining change in impact score is accounted for by the following species:

Herring	increased	to	320	from	204
Rainbow/Steelhead Trout	increased	to	72	from	38
Dolly Varden	increased	to	120	from	38
Sea Otter	increased	to	200	from	128
Seabirds	increased	to	200	from	64
Zooplankton	reduced	to	18	from	72
Smelt	reduced	to	54	from	51

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (382) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Dungeness Crab	increased	to	216	from	115
Sculpins	reduced	to	0	from	24
Starry Flounder	reduced	to	0	from	24
Other Flatfish	reduced	to	0	from	36
Pacific Sandlance	reduced	to	0	from	36
Razor Clams	reduced	to	6	from	26
Other Bivalves	reduced	to	10	from	43
Other Marine Invertebrates	reduced	to	30	from	77

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 9 percent (233) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 5 is accounted for by the following species:

Pacific Halibut	reduced	to	0	from	30
King Crab	reduced	to	70	from	298
Tanner Crab	reduced	to	105	from	446
Scallops	reduced	to	30	from	128
Other Marine Invertebrates	reduced	to	24	from	51

THE INTERTIDAL ROCKY HABITAT contributed 18 percent (487) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Herring	increased	to	280	from	168
Other Invertebrates	increased	to	72	from	38
Sea Ducks	reduced	to	15	from	60

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 16 percent (432) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 5 is accounted for by the following species:

Smelt	increased	to	96	from	51
Crustaceans	increased	to	48	from	26
Gastropods	increased	to	72	from	13
Shorebirds	increased	to	120	from	60

THE TERRESTRIAL HABITAT contributed 3 percent (70) of the impact score for this case. The changes in this habitat's impact score from Case 5 were as follows:

Raptors	increased	to	50	from	30
Other Birds	increased	to	20	from	6
Other Mammals	reduced	to	0	from	12
Other Vegetation	reduced	to	0	from	6

CASE 7: WINTER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 1,641

THE PELAGIC HABITAT contributed 25 percent (414) of the impact score for this case. The species not present in Winter cases accounted for a decrease in impact score in this habitat of 74 from Case 6. With minor exceptions, the remaining change in impact score is accounted for by the following species:

Zooplankton	increased	to	72	from	18
Herring	reduced	to	192	from	320
Rainbow/Steelhead Trout	reduced	to	9	from	72
Dolly Varden	reduced	to	9	from	120
Sea Otter	reduced	to	30	from	200
Seabirds	reduced	to	15	from	200

THE SUBTIDAL SAND/MUD HABITAT contributed 23 percent (373) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Starry Flounder	increased	to	24	from 0
Other Flatfish	increased	to	36	from 0
Other Bivalves	increased	to	40	from 10
Other Marine Invertebrates	increased	to	72	from 30
Dungeness Crab	reduced	to	108	from 216
Shrimp	reduced	to	30	from 120

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (291) of the impact score for this case. Minor changes in impact scores for seven species accounted for the change of score.

THE INTERTIDAL ROCK HABITAT contributed 19 percent (311) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Sea Ducks	increased	to	60	from 15
Herring	reduced	to	168	from 48
Miscellaneous Crustaceans	reduced	to	12	from 48
Other Invertebrates	reduced	to	9	from 72

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (198) of the impact score for this case. With a minor exception, the decrease in impact score for this habitat from Case 6 is accounted for by the following species:

Smelt	reduced	to	12	from 96
Crustaceans	reduced	to	24	from 48
Gastropods	reduced	to	3	from 72
Shorebirds	reduced	to	60	from 120

THE TERRESTRIAL HABITAT contributed 3 percent (54) of the impact score for this case. The change in impact score for this habitat from Case 6 is accounted for by the following species:

Other Vegetation	increased	to	6	from	0
Other Mammals	increased	to	12	from	0
Raptors	reduced	to	30	from	60
Other Birds	reduced	to	6	from	20

CASE 8: SUMMER, CRUDE OIL, 100 BBLS - IMPACT SCORE 1,593

THE PELAGIC HABITAT contributed 46 percent (729) of the impact score for this case. With minor exceptions, the change in impact score for this habitat is accounted for by the following species:

Rainbow/Steelhead Trout	increased	to	72	from	9
Dolly Varden	increased	to	120	from	9
Sea Otter	increased	to	213	from	30
Seabirds	increased	to	200	from	15
Phytoplankton	reduced	to	0	from	36
Zooplankton	reduced	to	0	from	72
Ichthyoplankton	reduced	to	0	from	192
Herring	reduced	to	80	from	192

THE SUBTIDAL SAND/MUD HABITAT contributed 9 percent (145) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 7 is accounted for by the following species:

Starry Flounder	reduced	to	0	from	24
Other Flatfish	reduced	to	0	from	36
Dungeness Crab	reduced	to	54	from	108
Other Bivalves	reduced	to	10	from	40
Other Marine Invertebrates	reduced	to	30	from	72

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 15 percent (233) of the impact score for this case. Minor decreases in impact scores for seven species accounted for the reduction in impact score for this habitat from Case 7.

THE INTERTIDAL ROCKY HABITAT contributed 12 percent (196) of the impact score for this case. With minor exceptions, the change in impact score for this habitat is accounted for by the following species:

Marine Mammals Rookeries	increased	to	60	from	0
Herring	reduced	to	70	from	168
Sea Ducks	reduced	to	15	from	60

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (198) of the impact score for this case. With minor exceptions, the changes in impact scores for this habitat from Case 7 were for the following species:

Shorebirds	increased	to	120	from	60
Hardshell Bivalves	reduced	to	24	from	96

THE TERRESTRIAL HABITAT contributed 6 percent (92) of the impact score for this case. The changes in impact scores for this habitat from Case 7 were as follows:

Strand Vegetation	increased	to	10	from	not present
Other Vegetation	increased	to	12	from	6
Raptors	increased	to	50	from	30
Other Birds	increased	to	20	from	6
Other Mammals	reduced	to	0	from	12

CASE 9: SUMMER, GASOLINE, 1,000 BBLS - IMPACT SCORE 1,507

THE PELAGIC HABITAT contributed 54 percent (810) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Sea Otter	increased	to	450	from	213
Smelt	reduced	to	0	from	80
Rainbow/Steelhead Trout	reduced	to	18	from	72
Dolly Varden	reduced	to	30	from	120

THE SUBTIDAL SAND/MUD HABITAT contributed 7 percent (100) of the impact score for this case. Only Dungeness crab reduced to 0 from 30 contributed significantly to the reduction in impact score for this habitat from Case 8.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 15 percent (229) of the impact score for this case. With a minor exception this habitat's result was the same as for Case 8.

THE INTERTIDAL ROCKY HABITAT contributed 10 percent (151) of the impact score for this case. Only marine mammal rookeries reduced to 15 from 30 contributed to the decrease in impact score for this habitat from Case 8.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 14 percent (207) of the impact score for this case. With a minor exception, this habitat's result was the same as Case 8.

THE TERRESTRIAL HABITAT contributed 1 percent (10) of the impact score of this case. The decreases in impact scores for this habitat from Case 8 were as follows:

Other Vegetation	reduced	to	0 from 12
Raptors	reduced	to	0 from 50
Other Birds	reduced	to	0 from 20

CASE 10: SUMMER, BUNKER-C, 100 BBLS - IMPACT SCORE 1,279

THE PELAGIC HABITAT contributed 40 percent (513) of the impact score for this case. The decreases in impact scores for this habitat from Case 9 were as follows:

Ichthyoplankton	reduced	to	0 from 12
Rainbow/Steelhead Trout	reduced	to	0 from 18
Dolly Varden	reduced	to	0 from 30
Sea Otter	reduced	to	213 from 450

THE SUBTIDAL SAND/MUD HABITAT contributed 8 percent (100), the INTERTIDAL COBBLE/GRAVEL HABITAT contributed 16 percent (207), and the TERRESTRIAL HABITAT contributed 1 percent (10) of the impact score for this case. These habitat's results were the same as for Case 9.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 20 percent (253) of the impact score for this case. The increase in impact score for this

habitat from Case 9 is accounted for by the following species:

Floating Seaweed	increased to	12	from 0
Intertidal Seaweed	increased to	12	from 0

THE INTERTIDAL ROCKY HABITAT contributed 15 percent (196) of the impact score for this case. Only marine mammal rookeries, increased to 60 from 15, contributed to the increase in impact score for this habitat from Case 9.

The impact scores for Cases 11 through 16 range from 457 down to 33. The spill sizes for these cases are 1,000 barrels of gasoline in Winter and 100 barrels of all products for the other cases. The array of these scores is:

	SPILL SIZE BY SEASON			
	1,000 BBLS		100 BBLS	
SPILL TYPE	SUMMER	WINTER	SUMMER	WINTER
Diesel-2	See Case 1	See Case 4	See Case 6	372
Crude Oil	See Case 2	See Case 5	See Case 8	457
Bunker-C	See Case 3	See Case 10	See Case 7	255
Gasoline	See Case 9	111	154	33

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(7) UNIMAK PASS

Unimak Pass is the first major vessel route through the Aleutian Islands westward of the Alaskan Peninsula.[8] It lies between Unimak Island to the east, Akun Island to the west, and Ugamak Island to the southwest. The passage between Scotch Cap on Unimak Island and Ugamak Island is about 10 miles wide. The spill point was selected in about the middle of the pass in the deepest water at 54°18.38'N latitude, 164°52.50'W longitude (Fig. 2-37).

(a) PHYSICAL CHARACTERISTICS

Unimak Pass is in the Maritime Climatic Zone due to the exposure to the Gulf of Alaska. Frequent cyclonic storms track along the Aleutian Islands.[3] The weather is extremely localized and is typically characterized by overcast, windy, and stormy conditions.[8]

TEMPERATURES

Due to the exposure to the Gulf of Alaska, temperatures are moderated throughout the year. Winter temperatures typically vary between 25°F and 45°F, and Summer temperatures vary between 40°F and 56°F.[1,4] Record high and low temperatures at Scotch Cap are 74°F and 9°F.[1,4] Sea ice is not normally present to impede navigation, although Unimak Pass is approximately the southernmost extent of the Bering Sea ice pack.[4,8]

SURFACE WINDS

The region is subject to frequent cyclonic storms. Average wind velocities increase as one moves westward along the Aleutian chain.[2] Winds chosen to represent the spill site were south-southwest at 13.0 knots during Summer, north-northwest at 10.0 knots during Fall and Spring, and south-southeast at 15.0 knots in Winter.

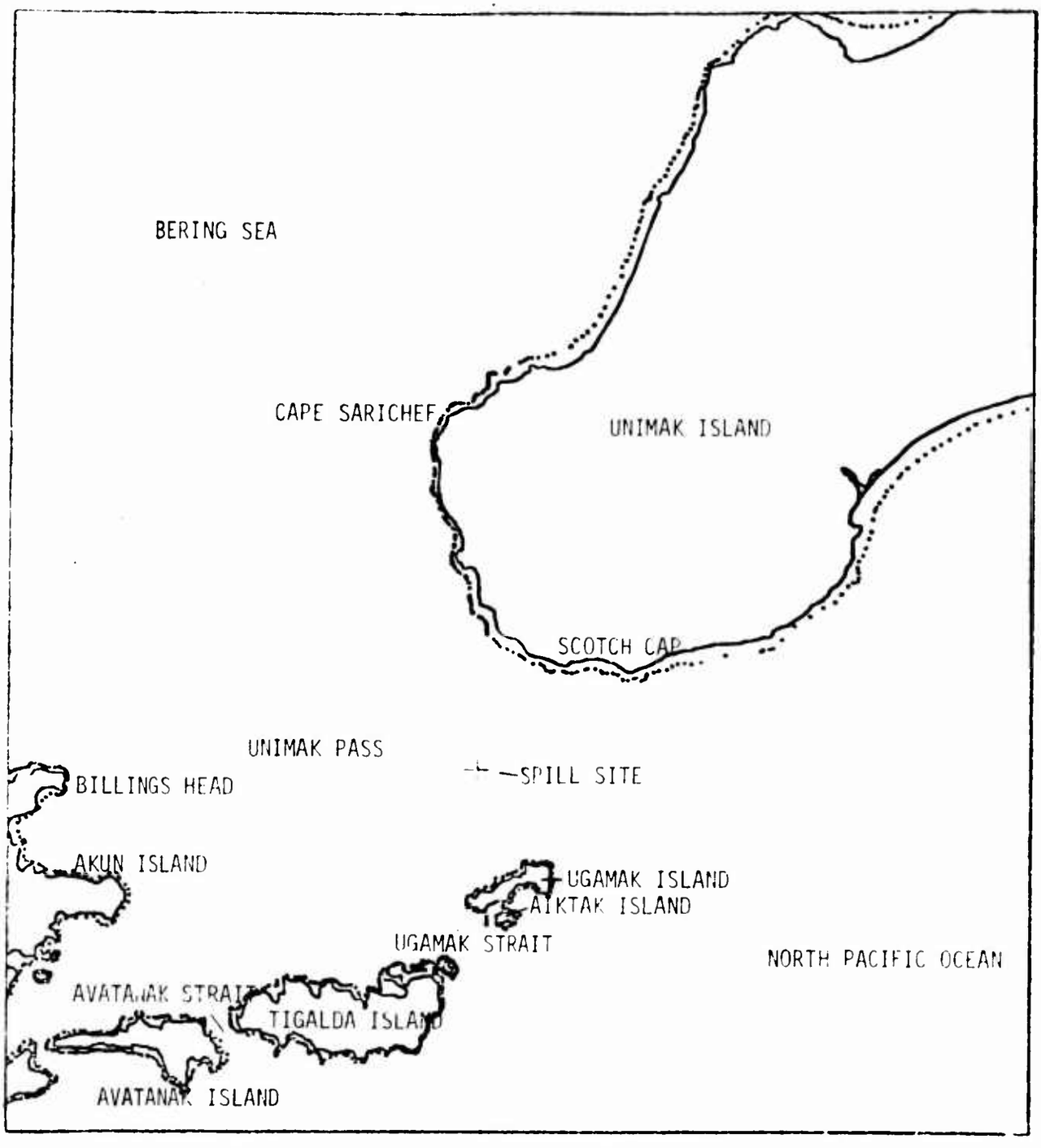


FIGURE 2-37 THE UNIMAK PASS LOCATION AND SPILL SITE

NOTE: The broken line is the 10 fathom (60 feet) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

SURFACE CURRENTS

The *COAST PILOT*[8] and *TIDAL CURRENT TABLES*[9] presented a good deal of information about the currents in the Unimak Pass vicinity because this is an important navigational area between the North Pacific and Bering Seas. Unimak Pass is on the boundary of two other reports on the Western Gulf[43] and Bristol Bay.[44]

The *TIDAL CURRENT TABLES*[9] gave the following information for locations near the selected spill site:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Unimak Pass (off Scotch Cap)	3.0 K (105°)	3.4 K (295°)
Unimak Pass (11 miles off Sennett Point)	0.7 K (105°)	2.0 K (300°)
Unimak Pass (2.4 miles north of Tanginak Island)	1.5 K (145°)	1.3 K (300°)
Ugamak Strait (north end)	1.8 K (120°)	3.3 K (320°)
Ugamak Strait (off Kaligagan Island)	4.0 K (115°)	3.5 K (325°)

The *COAST PILOT*[8] gave the following information for Unimak Pass locations near the selected spill site.

AREA	COMMENT
Cape Sarichef	Current velocities reach 4 to 6 knots.
East end of Ugamak Island	Strong currents and heavy tide rips occur.
Ugamak Strait	Current is 3.8 knots, with greater than 6 knots observed.

Other information from these sources[8,9] was also reviewed for the area west of the Unimak Pass spill site.

In the Unimak Pass area, MSNW assumed the following currents:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
General Offshore Unimak Pass	0.7 K (105^{o})	2.0 K (300^{o})
Offshore northwest end of Unimak Island	3.0 K (230^{o})	3.4 K (070^{o})
Offshore west end of Unimak Island	3.0 K (150^{o})	3.4 K (000^{o})
Offshore southwest end of Unimak Island	3.0 K (105^{o})	3.4 K (295^{o})
West shore of Ugamak Island	1.8 K (120^{o})	3.3 K (320^{o})
Ugamak Strait	4.0 K (115^{o})	3.5 K (325^{o})
West of Tigalda Island	5.3 K (150^{o})	5.8 K (340^{o})

(b) BIOLOGICAL CHARACTERISTICS

Unimak Pass is the first major pass between mainland Alaska and the Aleutian Islands and, because of this, it is a major highway for migratory marine animals going from the North Pacific Ocean to the Bering Sea and vice-versa. Adult salmon returning to Bristol Bay are one example. Northern fur seals and whales going into the Bering Sea are other examples. Major resources in the Unimak Pass vicinity are these transitory salmon, bottom fish and shellfish, transient and resident marine mammals, and seabirds. The Pass is a major mixing area of Bering and Pacific waters and this provides nutrients for this highly productive area.

Resource summaries are shown in Figures 2-38 and 2-39.

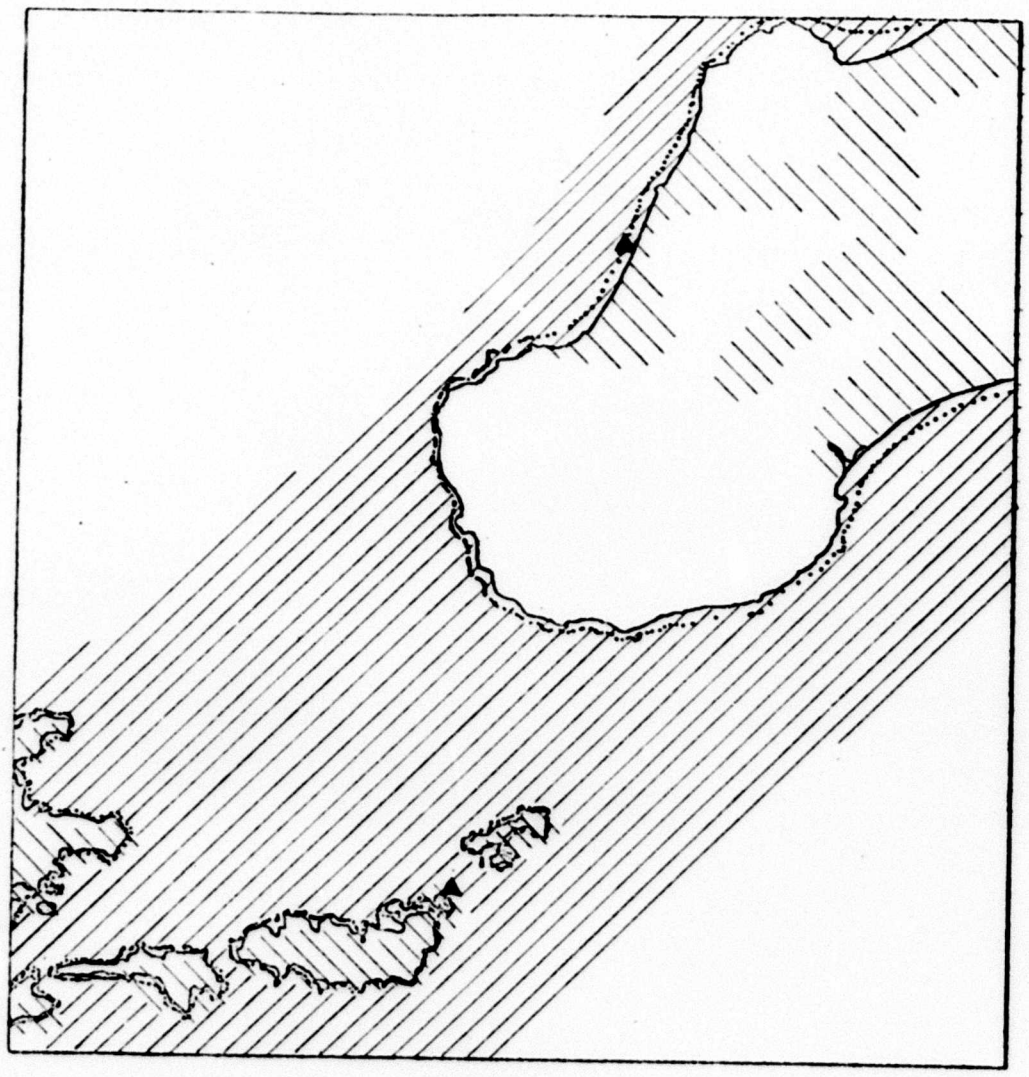


FIGURE 2-38. UNIMAK PASS CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.



Sea Otter Present

Sea Otter Concentration

Sea Lion Concentration/Rookery

Brown Bear Concentration on Fish Streams

FIGURE 2-39. UNIMAK PASS CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

FISHES

SALMONIDS are important at Unimak Pass because of local salmon populations (and fisheries) and because the Pass is a migratory route for part of the Bristol Bay adult salmon runs. The percentage of these runs that migrate through this Pass in unknown. This Pass is known to be an important route for returning adult salmon migrating from the Gulf of Alaska. The timing of this migration is approximately June 1st to August 31st, with a peak about June 5th to June 10th. See the Kvichak Bay location description for more details on these salmon returning to Bristol Bay.

The local salmon catches in the Unimak Pass vicinity are small, but important to local economies. The average catches (fishery--June and July) in recent years have been approximately:

SALMON	MEAN
Sockeye	400,000
Coho	20,000
Pink	70,000
Chum	320,000

Abundance estimates in the Unimak Pass can be speculated to be approximately several million Bristol Bay adult salmon in some years. Local salmon abundance could be reasonably estimated at twice the above catches except for chum salmon since only 25 percent of those caught are from local stocks. Chum salmon abundance may be in the millions in the Unimak Pass vicinity, with some Asian origin (Kamchatka and Anadys rivers). Some pink salmon in the Unimak Pass vicinity may also be of Asian origin.

Four salmon species (no king salmon) use Pacific and Bering coast streams on Unimak Island for spawning.[45] King salmon migrate through the vicinity of the Pass. Salmon runs are an important Fall food resource of brown bear on Unimak Island.

Dolly Varden are quite abundant in many of Unimak Island's streams[45] and would be expected to be in the coastal marine areas. This source[45] also provided a list of Unimak streams their salmon species, and the relative run sizes.

PACIFIC HALIBUT are relatively unimportant in commercial fishery efforts in Unimak Pass, with small numbers of these fish taken along the Aleutian Islands each year. The area, however, is extremely important as a nursery area for young halibut (both Bering[45] and Pacific sides of Unimak Island). Sampling in May revealed young halibut in tide pool areas on the Pacific side of the Alaska Peninsula.

Japan, USSR, Canada, and the United States harvest this species from the vicinity of Unimak Pass. Large catches of adult halibut are rare in waters less than 80 m deep.[44] Halibut are present just north of Unimak Pass in January through April of the year.[44]

WALLEYE POLLOCK support the largest harvest of food fish by weight in Bristol Bay[44] and probably are numerous in the Unimak Pass area. Large catches were made just north of the Pass. Japan and the USSR are the major harvestors. A domestic fishery of any magnitude does not exist at the present time.

PACIFIC OCEAN PERCH are a rockfish species that is fished by foreign fleets in deep waters just south of Unimak Pass. These bottom fish are also

taken by Japan and the USSR in the Bering Sea north of Unimak Pass and west of Bristol Bay.[44] They are also in the Unimak Pass area.[45]

PACIFIC COD are abundant in Bering Sea and Bristol Bay areas and are taken by Japan and the USSR there. These fish are also in the Unimak Pass vicinity.[45]

BLACKCOD OR SABLEFISH also support substantial fisheries by Japan and the USSR in Bering Sea areas west of Bristol Bay.[44] These bottom fish are probably also in the Unimak Pass vicinity.

OTHER MARINE FISHES inhabiting the Unimak Pass vicinity in large numbers include other flatfish, smelt, sculpins, greenlings (some 22 incidental species beyond the above list of commercially important fishes[45]). Herring would be expected at Unimak Pass as they are north and east of the Pass in the Bering Sea[44] and along the Aleutian Islands.

SHELLFISHES

KING CRAB are an important domestic fishery along the Bering and Pacific shores of Unimak Island and in Unimak Pass. Commercial-sized males are described as in high numbers immediately north of Unimak Pass during Summer while females in Summer and Winter and males in Winter are described to be in lesser abundances north and east of Unimak Pass in the Bering Sea.[44] King crab are said to be especially abundant in Unimak Bight (Pacific side just east of Pass) and heavily harvested there.[45] The biology of these crabs in the Bering Sea and their depth distribution with time are shown in Figures 2-40 and 2-41. More details on this species in this region are located in *THE BRISTOL BAY ENVIRONMENT*.[44]

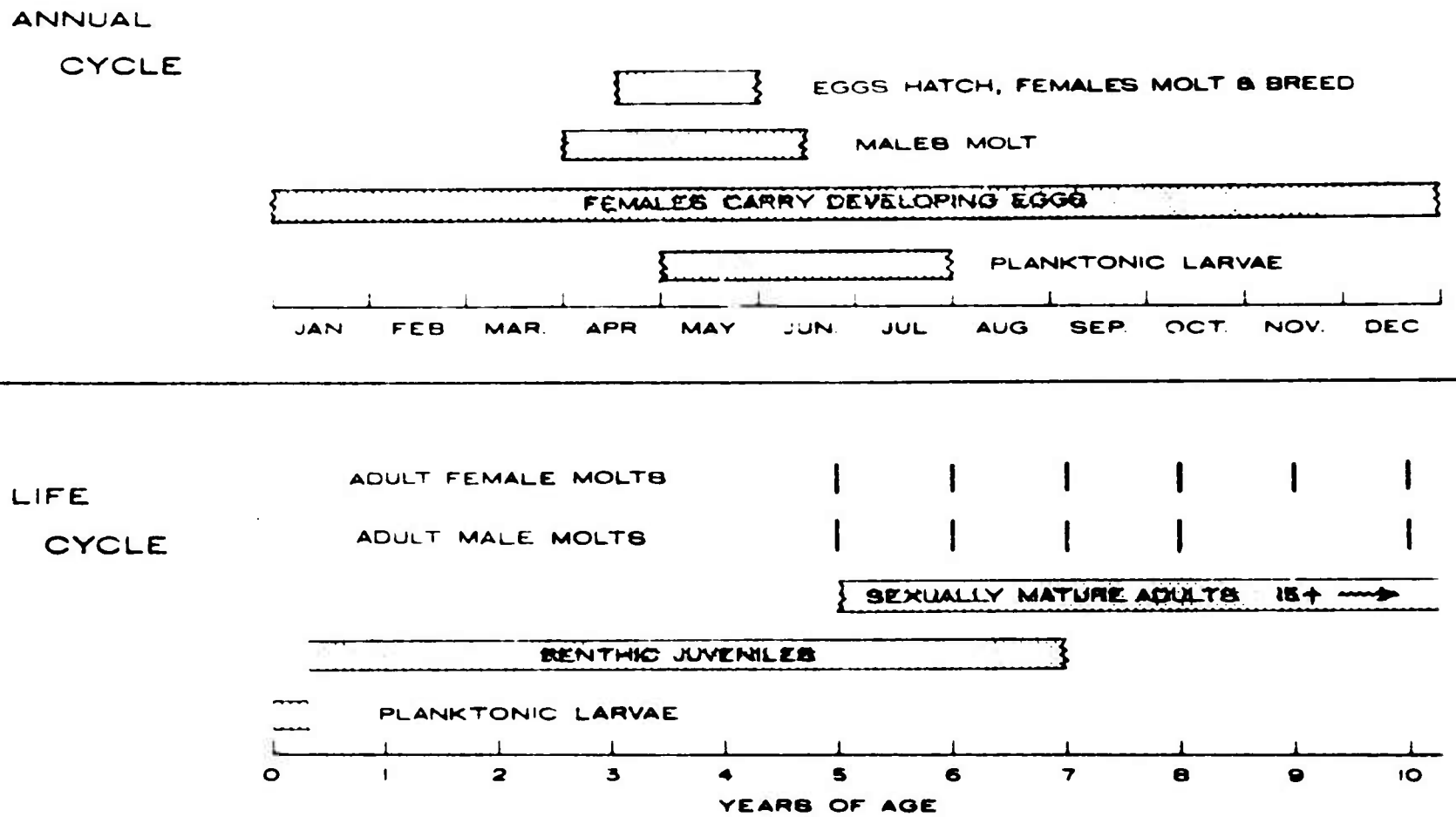


FIGURE 2-40. ANNUAL AND LIFE CYCLES OF THE KING CRAB IN BRISTOL BAY.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

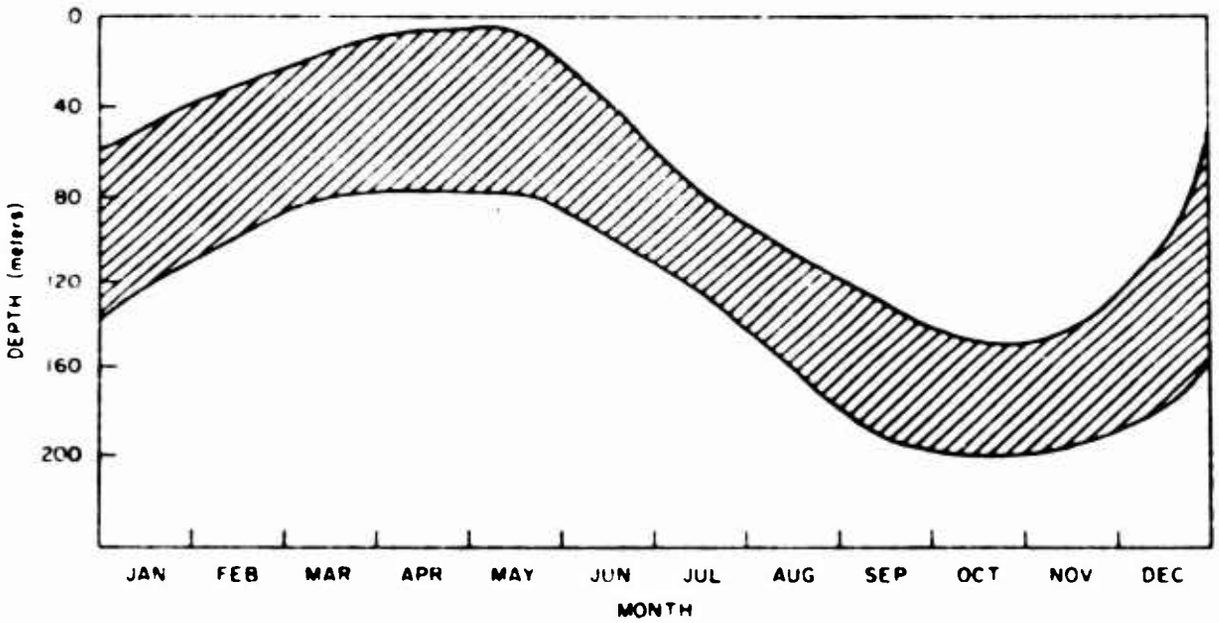


FIGURE 2-41. SEASONAL VERTICAL MIGRATION OF ADULT KING CRABS. PATTERNED AREA INDICATES DEPTH OF MAJOR CONCENTRATIONS.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

TANNER CRAB are also involved in important domestic fisheries on the Bering and Pacific shores of Unimak Island and in Unimak Pass. Tanner crab are common in Offshore Unimak waters and are being increasingly harvested.[45] Exploratory catches in the Bering Sea showed large tanner crab numbers just north of the Pass.[44] This source also provided a diagrammed life cycle of tanner crab in this region (see Figure 2-42).

DUNGENESS CRAB are not reported in commercial quantities in Bristol Bay, but a small population is located off the extreme northwestern corner of Unimak Island in the Pass.[44] Exploratory efforts in the Pass by National Marine Fisheries Service also revealed small numbers of this crab.[44] Unlike king and tanner crab, Dungeness appear as a minor resource in the Unimak Pass area. Figure 2-43 provides a diagrammed life cycle of this crab in this region.

SHRIMP are not in commercial abundance in the Pass.[44] Five species (pink, humpback, coonstripe, spotted, and sidestripe) are reported in Bristol Bay north and east of Unimak Pass. Large fisheries do exist to the west in bays and inlets of the Aleutian Islands. Unlike the crabs, the adult shrimp make diel movements, increasing their vulnerability to sea-surface pollutants such as oil. In Autumn, they migrate to shallower waters to breed. These vertical movements and a pink shrimp life cycle in this region are illustrated in Figures 2-44 and 2-45.

RAZOR CLAMS are reported in large numbers in inshore waters and in lagoons on the Bering side of Unimak Island.[44,45] These are important for personal use by local residents.[44] Some are dug by people at False Pass and by commercial fishermen in the Unimak vicinity.[45] Their life cycle in this region is illustrated in Figure 2-46.

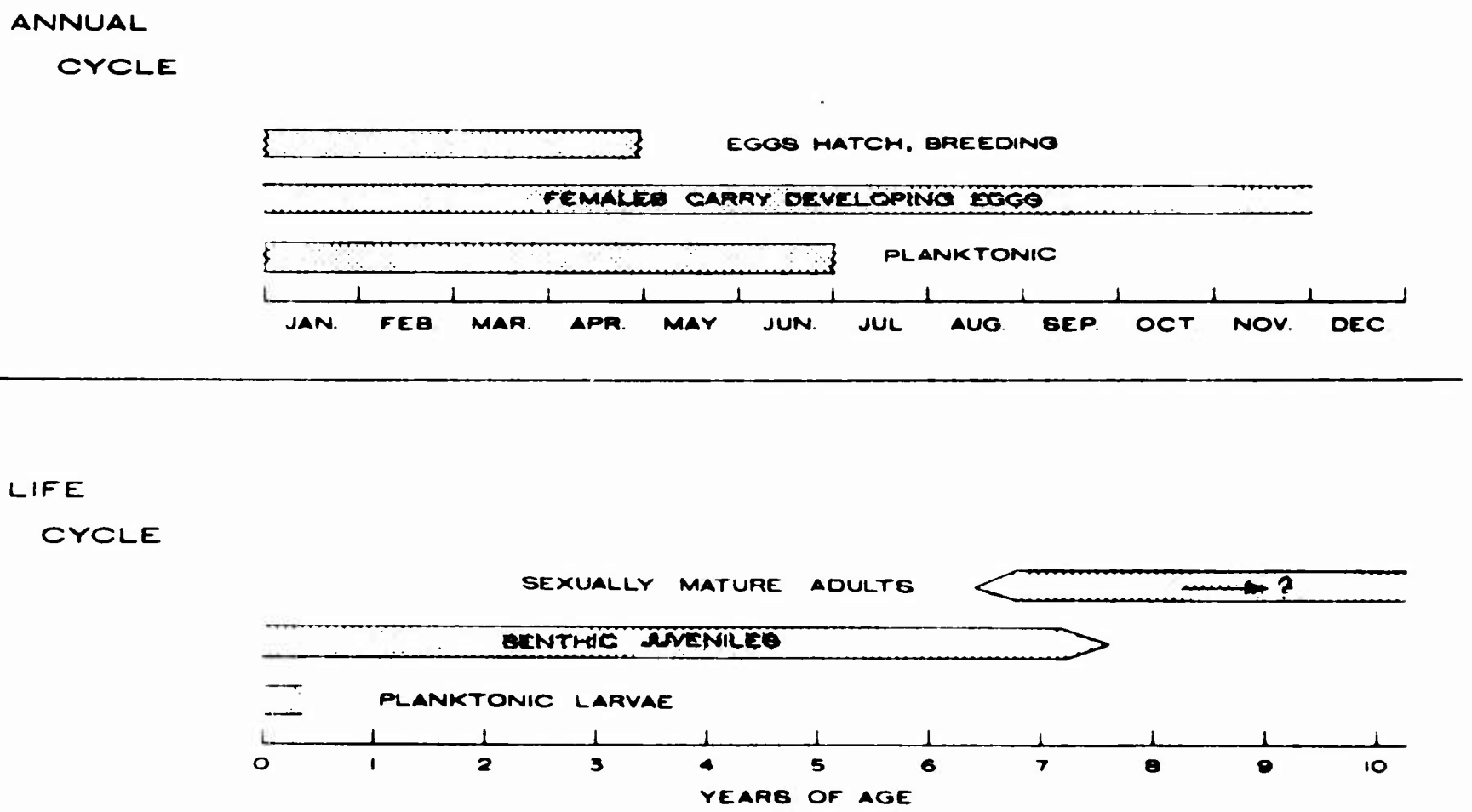


FIGURE 2-42. ANNUAL AND LIFE CYCLES OF THE TANNER CRAB IN BRISTOL BAY.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

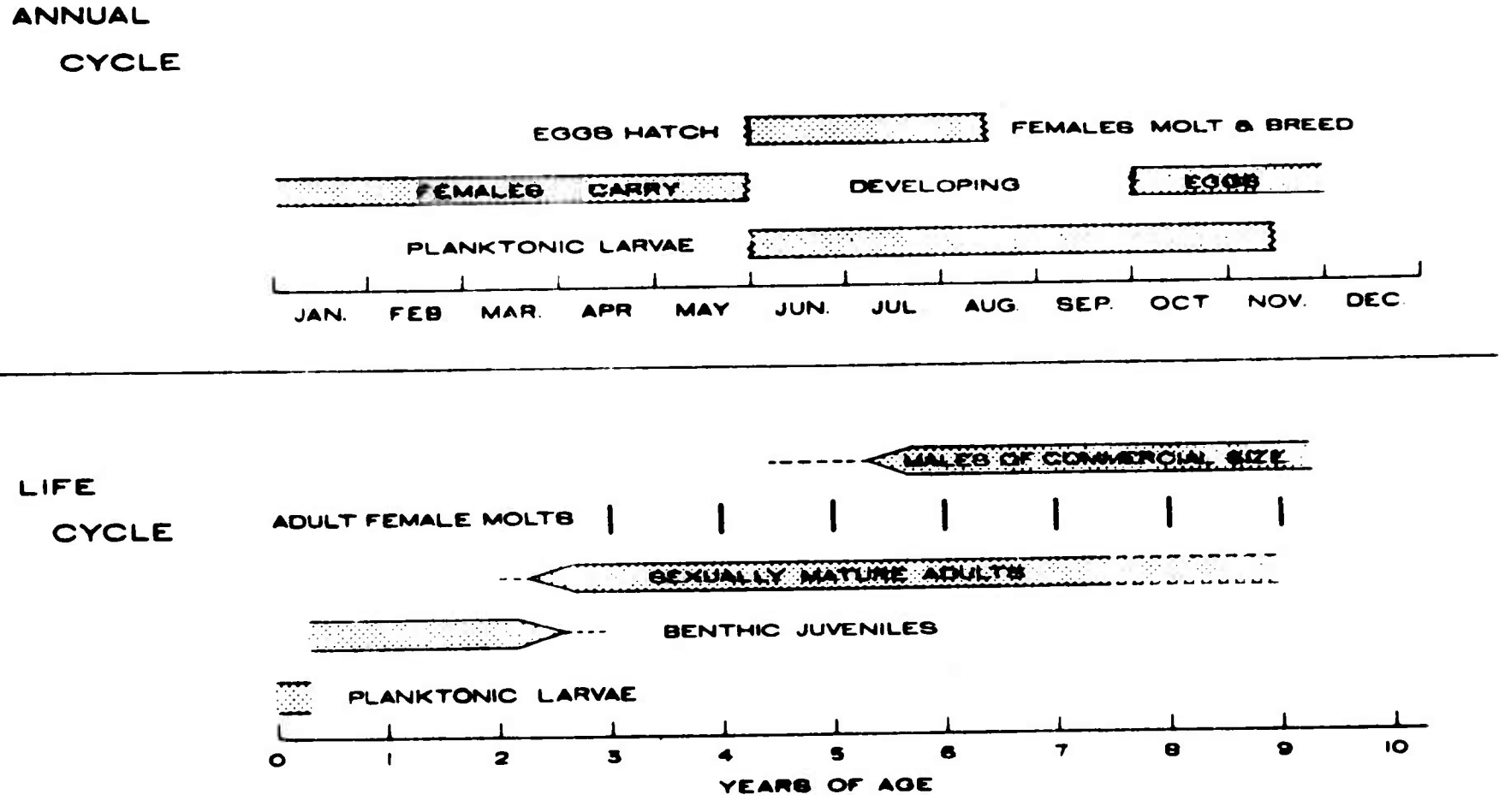


FIGURE 2-43. ANNUAL AND LIFE CYCLES OF THE DUNGENESS CRAB IN BRISTOL BAY.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT- A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

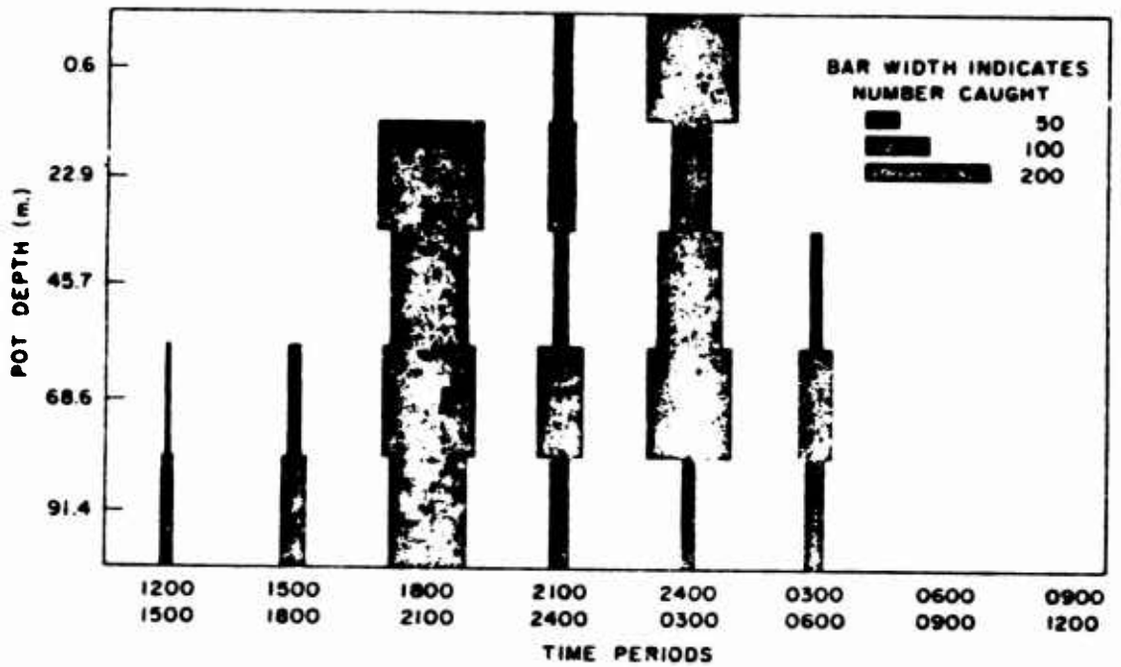


FIGURE 2-44. VERTICAL DAILY MOVEMENTS OF PING SHRIMP, PANDALUS BOREALIS.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

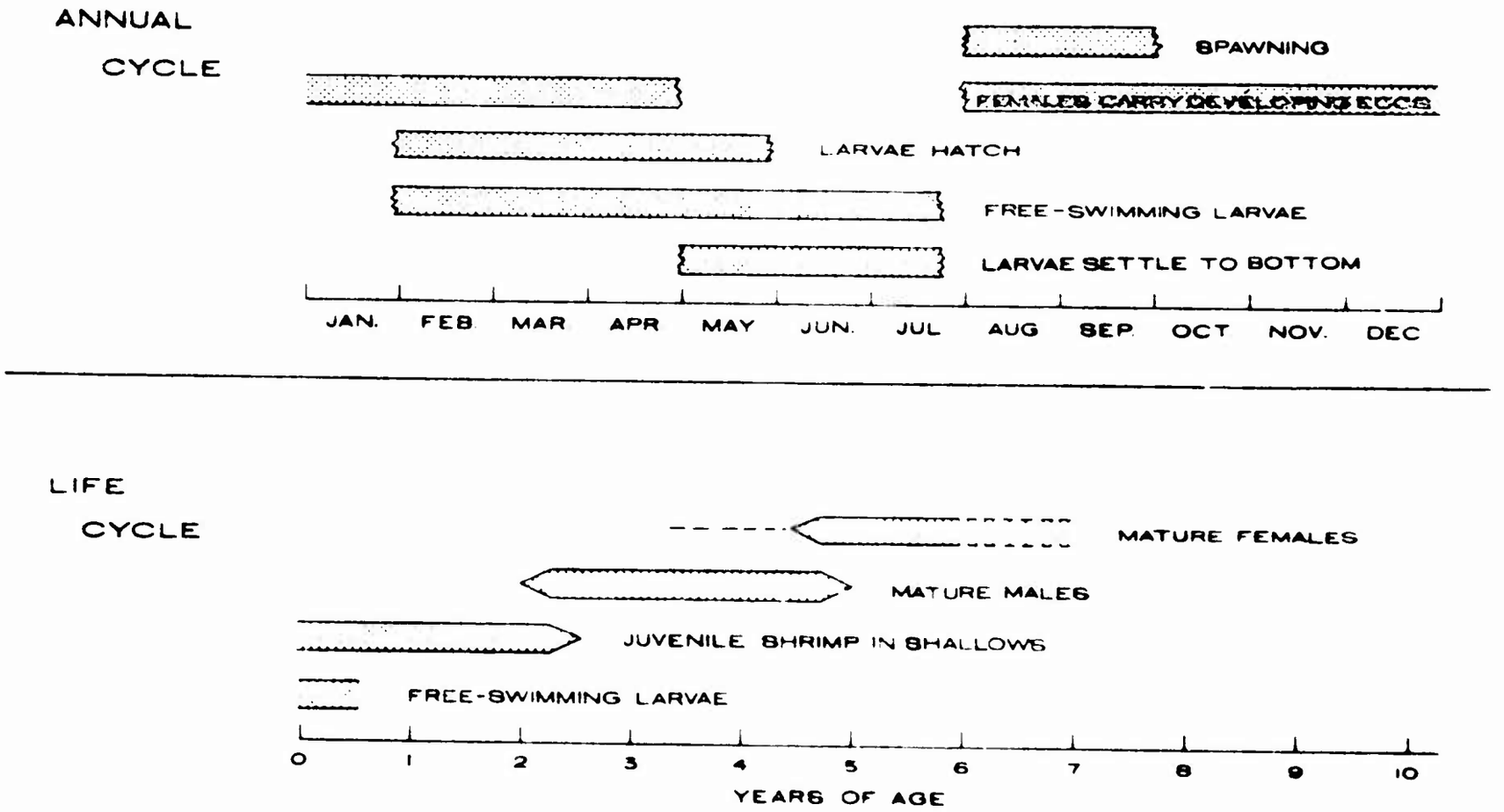


FIGURE 2-45. ANNUAL AND LIFE CYCLES OF THE PINK SHRIMP IN BRISTOL BAY.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY AREA, ALASKA - A PLANNING STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

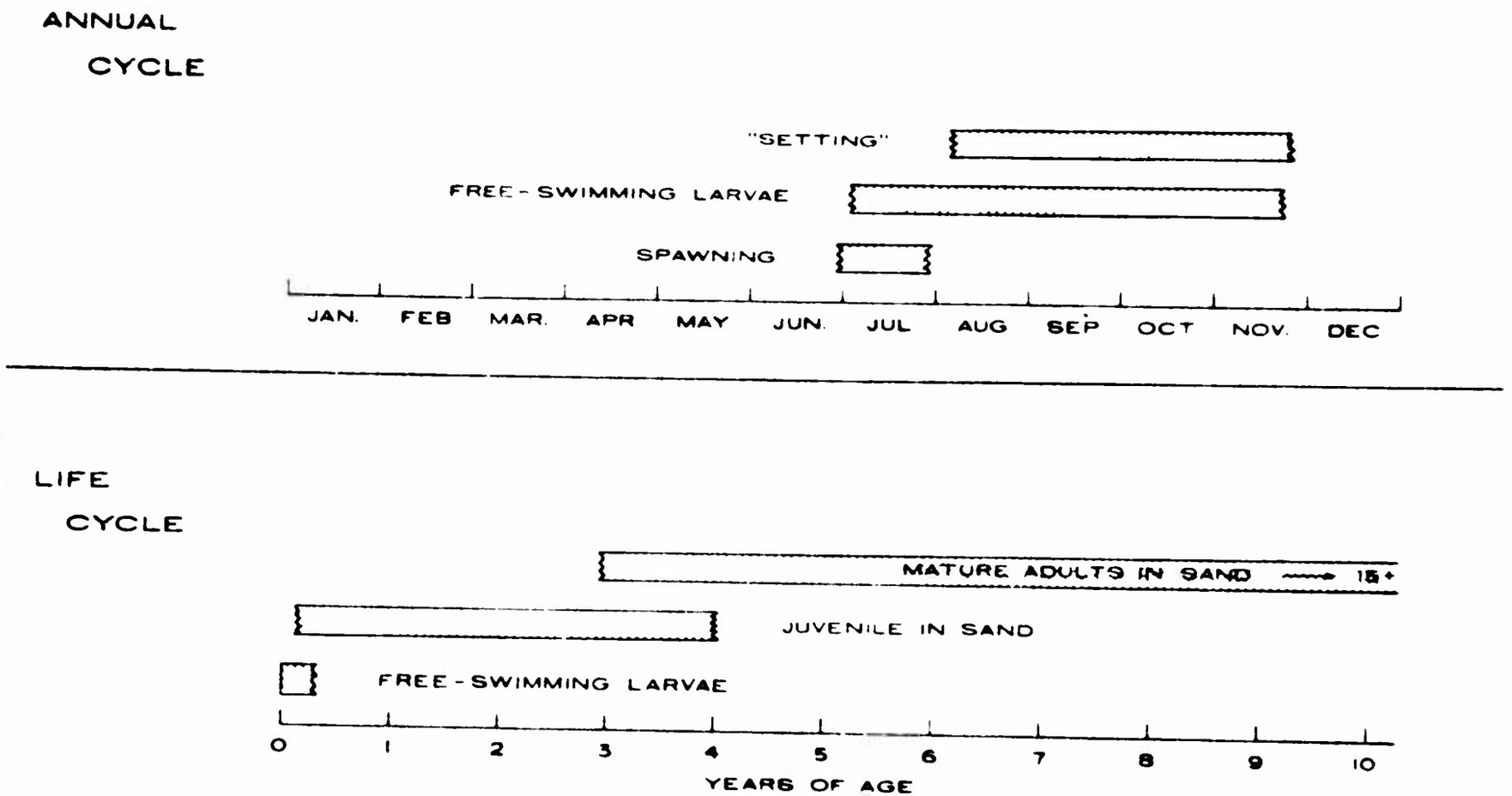


FIGURE 2-46. ANNUAL AND LIFE CYCLES OF THE RAZOR CLAM, SILIQUA PATULA.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

SCALLOPS were reported as insignificant in brief explorations by Alaska Department of Fish and Game in waters from Unimak Pass to the northwestern corner of Unimak Island.[45]

WATERFOWL

Waterfowl are very abundant in the Unimak Pass vicinity, but little quantitative information is available. The waters of Unimak Pass are indicated as waterfowl and seabird wintering areas while the islands west of the Pass are nesting and molting areas.[17] Of 91 species of birds listed for Unimak Island,[45] about half are waterfowl.

DUCKS - The area is a major migration zone for birds passing to Asia and the Americas. This is also a major wintering area for sea ducks. No numerical estimates were located, but ducks were assumed to be quite abundant here.

GEESE migrate through the Pass area and over 100,000 emperor geese are known to winter in the Aleutian Islands.[17] Unimak Island is at the eastern end of this Island chain.

SWANS (whistling swans) dominate the avifauna of Unimak Island.[45]

SEABIRDS are extremely abundant but few firm population estimates exist. Literally hundreds of thousands of these birds are here in numerous species. Adjacent seabird colonies[17] in the Unimak Pass area are as follows:

AREA	SEABIRDS
Kaligagan Island	Cassin's auklet, parakeet auklet,
Unimak Island (Bering Coast)	double-crested cormorant, black-legged kittiwake, Aleutian tern,
Aukutan Island	tufted puffin

One source[44] provided additional details on seabird abundance.

SHOREBIRDS are assumed numerous in the area, but no quantified data were located for the Pass area. Black oystercatchers, plovers, sandpipers, yellowlegs, and turnstones are expected to be present in the area as they are on the Bering shore of the adjacent Alaska Peninsula.

MARINE MAMMALS

SEA OTTERS suffered high mortalities in this vicinity during extreme ice conditions in 1971 and 1972.[18] Abundance is high in the general area, with current populations estimated at 8,000 to 10,000 and increasing for north Unimak Island and the Alaska Peninsula. In the Unimak Pass vicinity, sea otter densities are high on the Bering shore of Unimak Island from Cape Mordvinov and east and sparse on the eastern end of Tigalda Island.[17] The population of Unimak Island is low compared to the central Aleutians due to the lack of protected waters and Winter ice.[45] The Unimak population is thought to be increasing with at least one pod of over 1,000 observed between Unimak and Amak Islands.[45]

HARBOR SEALS are considered quite abundant throughout this area and occur (without high density areas) along all coastlines in the Unimak Pass vicinity.[45]

NORTHERN FUR SEAL migrate through Unimak Pass on their way to and from the Pribilof Islands (north in the Bering Sea).[45] The present population on the Pribilofs is estimated at 1.25-million seals.[17] There is no record of this species hauling out on Unimak Island.[45]

SEA LIONS are common around Unimak Island, with the entire Pass vicinity considered suitable habitat for the species.[17] Numerous concentration areas exist in the Unimak Pass vicinity and those near the Pass itself include:[17]

AREA	POPULATION
Cape Sarichef (Unimak)	200
Ugamak Island (north shore)	13,400
Round Island (south of Ugamak Island)	6,000
Aiktak Island (south of Ugamak Island)	600
Tigalda Island (northeast end)	750
Tanginak Island	600
Akun Island (Billings Head)	100
Akun Island (Akun Head)	2,000

WHALES AND PORPOISES are common at Unimak Pass as many pass through this area during migrations to and from the Bering Sea. Harbor porpoises, Dall porpoises, and killer whales are very common in the coastal waters of the Aleutian Islands.[45] The most common whales in waters adjacent to Unimak Island are Pacific killer whale, finback whale, and sei whale. Figure 2-47 presents the occurrence of whales in Unimak Pass and Bristol Bay. The relative abundance of whales in adjacent Bristol Bay waters is as follows:[44]

SPECIES	ABUNDANCE
Toothed Whales:	
Killer Whale	Moderately Common
Harbor Porpoise	Moderately Common
Beluga Whale	Moderately Common
Baleen Whales:	
Minke Whale	Common
Gray Whale	Moderately Common

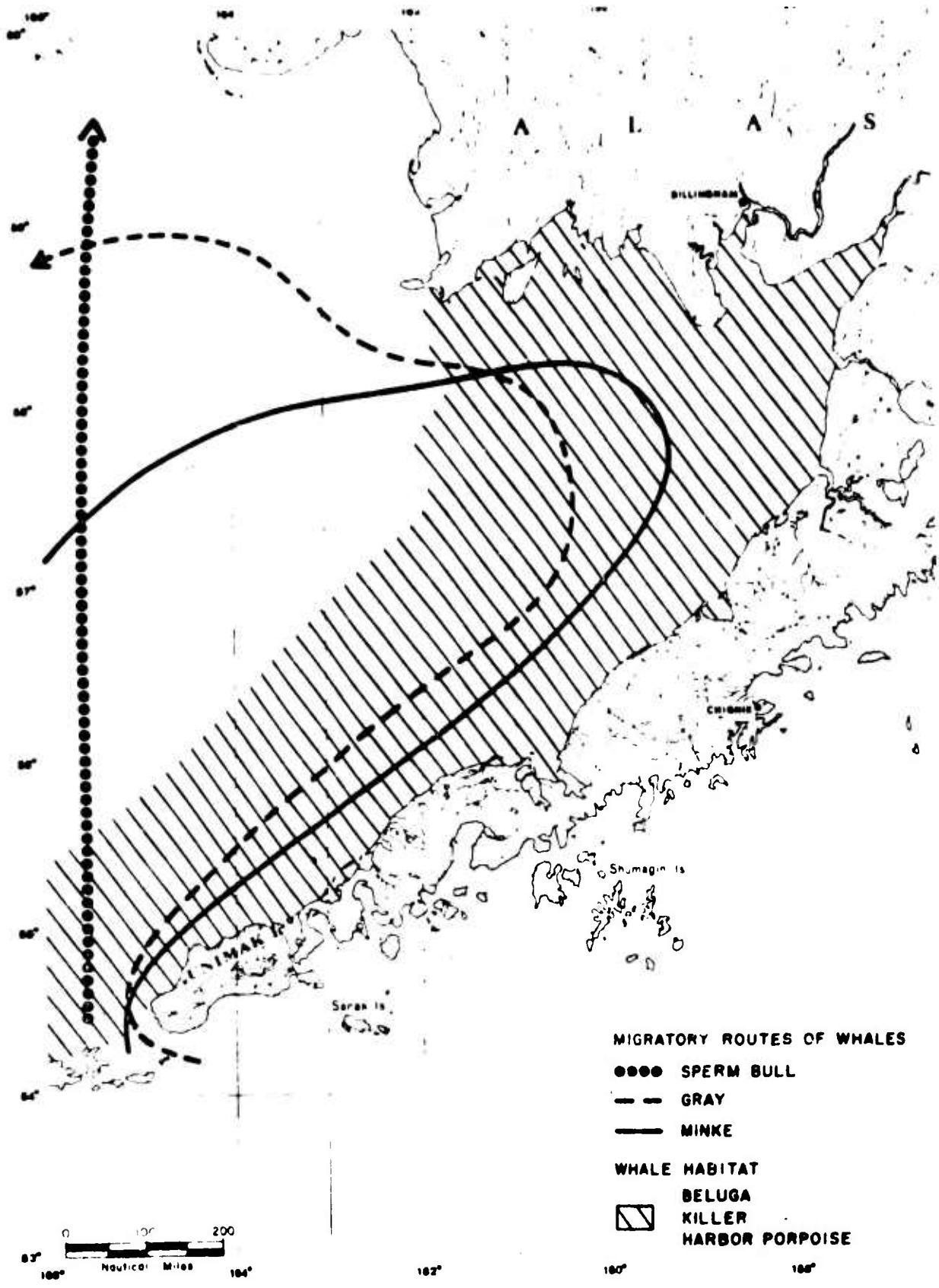


FIGURE 2-47. OCCURRENCE OF WHALES IN THE BRISTOL BAY AREA.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, Februar 1974.

Other whales listed for the Aleutian Islands as relatively uncommon are Pacific pilot whales, Baird's beaked whales, and Cuvier's beaked whales.[17] Finback, humpback, and bowhead whales are also known in the Aleutian Island vicinity.[17]

TERRESTRIAL MAMMALS

Fourteen terrestrial mammals are reported as observed on Unimak Island.[45]

BROWN BEAR on Unimak Island in 1968 were indicated as a minimal population of 65 to 85 animals with productivity (in terms of cubs and yearlings) less than that of the Alaska Peninsula and the Izembek National Wildlife Range.[45] Concentration areas are along Urilla Bay (Bering side) streams.[17]

CARIBOU on Unimak Island are considered part of the Alaska Peninsula herd, with a minimum estimate of 3,000 animals on the Island.[17,45] The animals are concentrated on the Bering and western sides of the Island.[45] Calving occurs throughout the lowlands along the length of Unimak Island.

WOLVES AND WOLVERINES are present in low numbers on Unimak Island.[17,45]

SMALL MAMMALS on Unimak Island include high numbers of red fox, with a major part of the population within three miles of the coastline of Unimak Island.[45] This source[45] listed six other small land mammals.

AQUATIC FURBEARERS include river otter (Island's periphery and streams), mink, and weasel.[45]

FLORA

Terrestrial vegetation is not expected to be adversely affected by the specified oil spill, but alder thickets are reported to reach to the sea[69] which could be affected and if a spill occurred during rough sea conditions,

oil could be carried up into the terrestrial vegetation by the sea spray.

Strand vegetation is well developed in the sand beaches surrounding the Pass. It is dominated by beach rye *(Elymus arenarius)* and *Heracleum*, with secondary species being beach pea *(Lathyrus venosus)*, and fireweed *(Epilobium*, sp.).[77] According to the digitized shoreline substrate data assumed in spill modelling, 24 percent of the shoreline within a 50-km square area of the spill location could be occupied by strand vegetation. Eelgrass beds occur in the lagoons on the north side of Unimak Island, and are particularly heavy in Swanson Lagoon, the easternmost one.[77] These lagoons are mostly outside the area expected to be affected by the spill in Unimak Pass. The marine algae are listed in Appendix A as of the Aleutian type in this area, but it is likely that there are admixtures of species from the south Alaskan and Arctic types also. The digitized physical shoreline makeup indicate that about 66 percent of the intertidal shoreline is covered with marine algae. According to *UNIMAK ISLAND WILDERNESS STUDY*,[77] there are large growths of *Fucus* and *Ulva*; the latter is utilized as a food item by emperor geese. In the Winter, the intertidal algal vegetation may be reduced by about one-half. In the shallow subtidal, there are undoubtedly rich beds of marine algae on about 66 percent of the bottom area. *Alaria fistulosa* forms extensive floating kelp beds[77] and according to the reported geographical distribution, *Nereocystis* also should occur in this area.[76]

See Appendix D for further physical and biological information on Unimak Pass.

(c) RESULTS

The 50,000-bbl spills of diesel-2 and crude oil in Summer caused the greatest impact at Unimak Pass. In Winter, the greatest impact was caused by the 50,000-bbl crude oil spill.

The pelagic habitat received the larger share of the impact with herring, salmon, and seabirds contributing greatly to the score. Crabs and other invertebrates also contributed to the overall score.

The lower scores in Winter were partly accounted for by the absence of crab larvae and the several salmon species.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Unimak Pass. The first scenario used most probable Summer conditions and the second most probable Winter conditions. Both scenarios resulted in oil moving generally in a northerly direction through the Pass along the western shoreline of Unimak Island. The spill reached the shore in approximately 15 hours after the spill (see Fig. 2-48). The spill moved north around Cape Sarichef and reached the north shore of the island within the 72-hour time frame. Both scenarios impacted all habitats with the exception of Freshwater River.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-14 presents the results of the oil spill scenarios examined at Unimak Pass without cleanup.

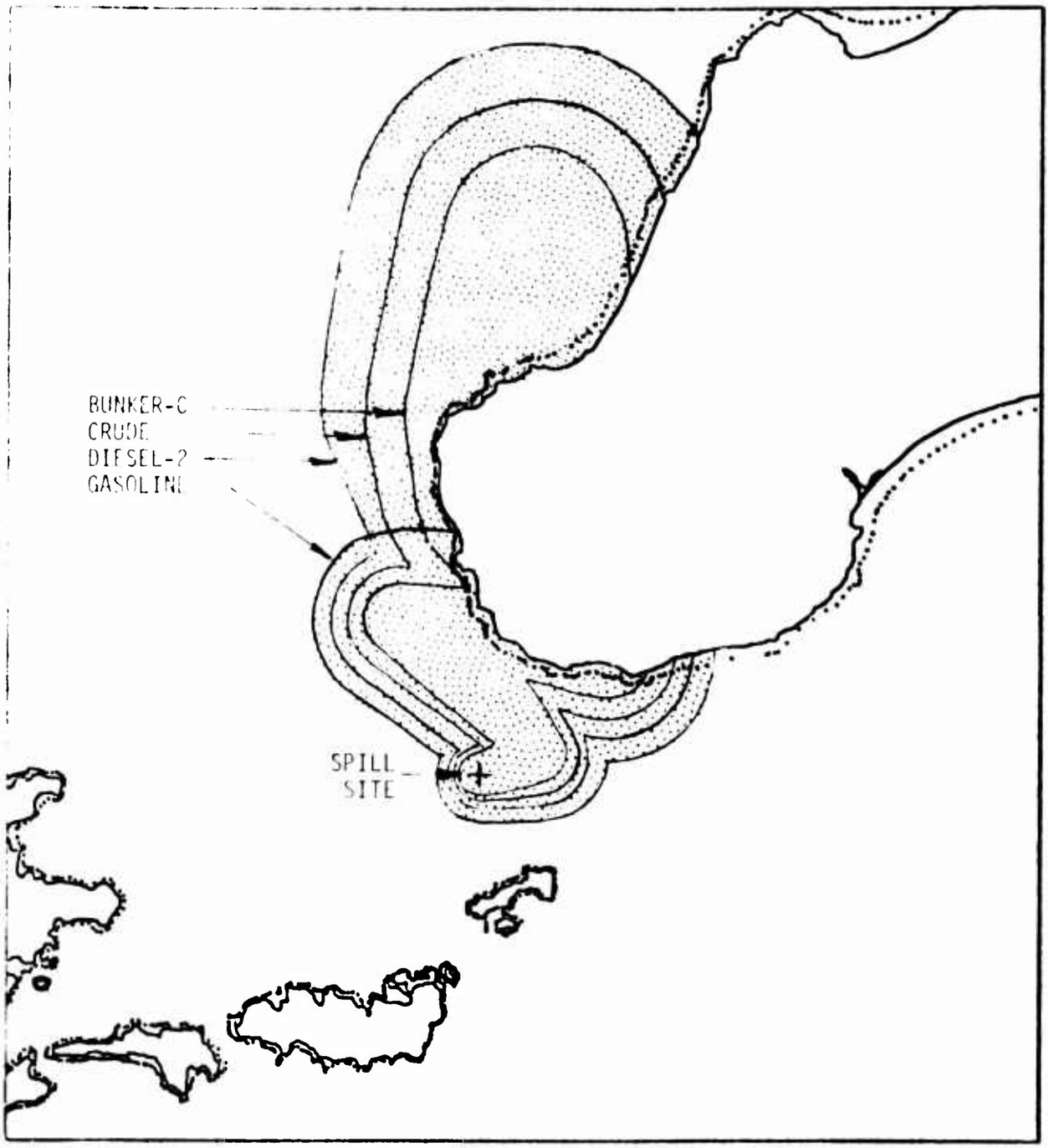


FIGURE 2-48. UNIMAK PASS SUMMER AND WINTER 50,000-BBL SPILL ENVELOPES

TABLE 2-14 . UNIMAK PASS CASE RESULTS NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000[1]	1,000[1]	100[1]
SUMMER	Diesel-2	15,668 [1][2]	11,536 [3]	5,382 [12]	1,006 [22]
	Crude Oil	15,427 [2]	10,698 [4]	5,396 [11]	645 [25]
	Bunker-C	6,938 [8]	5,593 [10]	3,028 [15]	225 [28]
	Gasoline	2,350 [17]	1,283 [20]	357 [27]	32 [31]
WINTER	Diesel-2	8,841 [6]	7,687 [7]	4,592 [14]	767 [23]
	Crude Oil	10,052 [5]	5,799 [9]	2,216 [18]	477 [26]
	Bunker-C	4,735 [13]	2,672 [16]	1,549 [19]	327 [28]
	Gasoline	1,138 [21]	717 [24]	193 [30]	29 [32]

[1]Scores for spills under 50,000 barrels are estimated scores.
[2]Numbers in brackets are the case numbers that follow.

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 15,668

THE PELAGIC HABITAT contributed 37 percent (5,749) of the impact score for this case. The main contributing species to the impact score in this habitat were phytoplankton (405), zooplankton (405), ichthyoplankton (270), Pacific sandlance (270), herring (683), smelt (164), crab larvae (182), king salmon (328), chum salmon (547), sockeye salmon (729), pink salmon (164), coho salmon (328), Dolly Varden (164), sea otter (300), and seabirds (683). The plankton species, sandlance, herring, crab larvae, chum salmon, sockeye salmon, sea otter, and seabirds were among the most abundant in this habitat. Herring and the salmon species were rated at some importance commercially. Pink, sockeye, king and coho salmon, and Dolly Varden were rated as minor in recreational importance.

The five salmon were rated moderate and Dolly Varden minor in subsistence importance. With the exception of sea otter, all of these species were judged to be among the most sensitive to a diesel-2 spill in this habitat. Sea otter and seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 7 percent (1,024) of the impact score for this case. The main contributing species to the impact score for this habitat were Pacific sandlance (120), miscellaneous marine fish (120), Dungeness crab (137), shrimp (164), razor clam (108), and other marine invertebrates (162). The sandlance and marine fish were among the most abundant species in this habitat. Dungeness crab were rated minor in commercial, recreational and subsistence importance. Crab, razor clam and invertebrates were judged to be among the most sensitive species in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 26 percent (4,007) of the impact score for this case. The main contributing species to the impact score in this habitat were chum salmon (540), Pacific halibut (120), other flatfish (200), greenling (120), rockfish (200), walleye pollock (300), other marine fish (300), king crab (810), Tanner crab (810), scallops (162), and other marine invertebrates (405). With the exception of scallops, all species were very abundant in this habitat. Only greenling and invertebrates had no commercial importance. The crab were rated as minor in recreational importance and chum salmon as moderate in subsistence importance. The salmon, crabs, scallops and invertebrates were judged to be the most sensitive species to a diesel-2 spill in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 12 percent (1,830) of the impact score for this case. The main contributing species to the impact score

in this habitat were Pacific sandlance (273) razor clam (219), softshell bivalves (164), invertebrate infauna (164), shorebirds (496), geese (192), ducks (120), and swans (120). Sandlance and shorebirds were among the most abundant in this habitat. Geese and ducks were rated minor in commercial importance. Clam, bivalves, geese and ducks were rated minor in recreational importance. Clams, geese and ducks were rated minor in subsistence importance. The sandlance, clams, bivalves, infauna and shorebirds were judged to be the most sensitive to a diesel-2 spill in this habitat. Shorebirds, geese and swans were classified as protected.

THE INTERTIDAL ROCKY HABITAT contributed 12 percent (1,902) of the impact score for this case. All species in this habitat contributed substantially to the impact score. The results were: intertidal seaweeds (120), greenlings (120), herring (457), sessile marine invertebrates (135), miscellaneous crustaceans (180), other invertebrates (415), shorebirds (200), and sea ducks (120). With the exception of sea ducks, all species were very abundant in this habitat. Herring were rated moderate in commercial importance. Sea ducks were rated minor in commercial, recreational and subsistence importance. The herring, crustaceans and invertebrates were judged to be the most sensitive to a diesel-2 spill in this habitat. Shorebirds were classified as protected.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (836) of the impact score in this case. Smelt (164), crustaceans (182), gastropods (270), and shorebirds (120) were the main contributors to the impact score in this habitat. Smelt, crustaceans and gastropods were judged to be among the most sensitive species to a diesel-2 spill in this habitat. Shorebirds were classified as protected.

THE TERRESTRIAL HABITAT contributed 2 percent (150) of the impact score for this case. Raptors were the only species contributing significantly to the impact score in this habitat. They were the most abundant species in this habitat and were rated endangered as peregrine falcons were a potential member of this group at this site.

Table 2-15 presents the complete results of Case 1.

CASE 2: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 15,427

THE PELAGIC HABITAT contributed 25 percent (3,783) of the impact score for this case. With minor exceptions, the change in impact score in this habitat from Case 1 is accounted for by the following species:

Floating Seaweed	increased	to	80	from 20
Northern Fur Seal	increased	to	50	from 0
Harbor Seal	increased	to	30	from 0
Phytoplankton	reduced	to	180	from 405
Zooplankton	reduced	to	180	from 405
Ichthyoplankton	reduced	to	120	from 270
Greenlings	reduced	to	0	from 80
Pacific Sandlance	reduced	to	30	from 270
King Salmon	reduced	to	144	from 328
Chum Salmon	reduced	to	240	from 547
Sockeye Salmon	reduced	to	320	from 729
Pink Salmon	reduced	to	72	from 164
Coho Salmon	reduced	to	144	from 328

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (1,573) of the impact score for this case. With a minor exception, the increase in impact score in

TABLE 2-15. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	UNIMAK PASS
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	SOLI.
1. PELAGIC											
1. PHYTOPLANKTON	15	A	0	0	0	3	9	0	405	0	405
2. ZOOPLANKTON	15	A	0	0	0	3	9	0	405	0	405
3. ICHTHYOPLANKTON	15	E	0	0	0	2	9	0	270	0	270
4. FLOATING SEAWEED	10	E	0	0	0	2	1	0	20	0	20
5. SPEENLINGS	10	A	0	0	0	2	4	0	80	0	80
6. PACIFIC SARDINE	10	A	0	0	0	3	9	0	270	0	270
7. HERRING	15	A	2	0	0	3	9	1	675	75	883
8. SMELT	6	A	0	0	0	3	9	1	162	18	189
9. GRAY LEMON	10	A	0	0	0	2	9	1	180	20	232
10. KING SALMON	6	A	1	1	2	2	9	1	324	36	363
11. CHUM SALMON	10	A	2	0	2	2	9	1	540	0	547
12. SOCKEYE SALMON	10	A	3	1	2	2	9	1	720	0	729
13. PINK SALMON	3	A	1	1	2	2	9	1	162	18	184
14. COHO SALMON	6	A	1	1	2	2	9	1	324	36	368
15. RAINBOW-STEELHEAD TROUT	1	E	0	1	1	1	9	1	27	0	27
16. DOLLY VARDEN	6	A	0	1	1	1	9	1	162	18	184
17. NORTHERN FUR SEAL	10	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	6	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	15	A	0	0	0	5	0	0	0	0	0
24. WHALES	15	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	15	A	0	0	0	5	4	0	300	0	300
27. OTHER MARINE MAMMALS	15	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	5	9	1	675	75	883
									5761	435	6279
2. SUBTIDAL SAND-MUD											
1. COD	10	M	2	0	1	2	1	0	50	0	50
2. SCULPINS	10	A	0	0	0	2	4	0	80	0	80
3. STARRY FLOUNDER	3	A	0	0	0	2	1	0	6	0	6
4. OTHER FLATFISH	10	A	3	0	0	2	1	0	50	0	50
5. PACIFIC SANDLANCE	10	A	0	0	0	3	4	0	120	0	120

TABLE 2-15. (CONT'D)

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U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS									RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			Impact		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	TOT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	15	A	0	0	0	2	6	0	120	0	120
7. DUNGENESS CRAB	3	A	1	1	1	2	9	1	135	45	180
9. SHRIMP	6	A	0	0	0	3	9	1	162	18	180
9. RAZOR CLAM	6	A	0	0	0	2	9	0	108	0	108
10. OTHER BIVALVES	3	A	0	0	0	1	9	0	27	0	27
11. OTHER MARINE INVERTEBRATES	6	A	0	0	0	3	9	0	162	0	162
									1020	38	1064
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	10	E	0	0	0	2	1	0	20	0	20
2. SUBTIDAL SEAWEED	10	E	0	0	0	2	1	0	20	0	20
3. CHUM SALMON	10	E	2	0	2	2	9	0	540	0	540
4. PACIFIC HALIBUT	10	A	1	0	0	2	6	0	120	0	120
5. OTHER FLATFISH	10	A	3	0	0	2	6	0	200	0	200
6. GREENLING	15	A	0	0	0	2	6	0	120	0	120
7. ROCKFISH	10	A	3	0	0	2	6	0	200	0	200
8. WALLEYE POLLOCK	15	A	3	0	0	2	6	0	300	0	300
9. OTHER MARINE FISH	15	A	3	0	0	2	6	0	300	0	300
10. KING CRAB	15	A	3	1	0	2	9	0	810	0	810
11. TANNER CRAB	15	A	3	1	0	2	9	0	810	0	810
12. SCALLOPS	6	A	1	0	0	2	9	0	162	0	162
13. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	9	0	405	0	405
									4007	0	4007
4. INTERTIDAL SAND-MUD											
1. EELGRASS	6	A	0	0	0	3	6	0	72	0	72
2. PACIFIC SANDLANCE	10	A	0	0	0	3	9	1	270	30	270
3. RAZOR CLAM	6	A	0	1	1	2	9	1	216	24	219
4. SOFTSHELL BIVALVES	6	E	0	1	0	2	9	1	162	18	180
5. INVERTEBRATE INFAUNA	6	A	0	0	0	3	9	1	162	18	180
6. MARINE MAMMAL ROOKERIES	10	A	0	6	0	5	1	0	50	0	50
7. SHOREBIRDS	10	A	0	0	0	5	9	1	456	50	456
8. SEINE	6	A	1	1	1	5	4	0	192	0	192
9. DUCKS	6	A	1	1	1	2	4	0	120	0	120
10. SWANS	6	A	0	0	0	5	4	0	120	0	120
									1818	140	1838

TABLE 2-15. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	10	E	0	0	0	3	4	0	120	0	120
2. SHELLFISH	15	A	0	0	0	2	4	0	120	0	120
3. HERRING	15	A	2	0	0	2	9	1	540	60	447
4. SESSILE MARINE INVERTEBRATES	15	M	0	0	0	1	9	0	135	0	135
5. MISC. CRUSTACEANS	10	M	0	0	0	2	9	0	180	0	180
6. OTHER INVERTEBRATES	15	M	0	0	0	3	9	0	405	0	405
7. SHOREBIRDS	10	A	0	0	0	5	4	0	200	0	200
8. SEA LIONS	6	A	1	1	1	2	4	0	120	0	120
9. MARINE MAMMAL ROOKERIES	15	A	0	0	0	5	1	0	75	0	75
									1895	60	1902
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	0	E	0	0	0	3	1	0	18	0	18
2. SMELT	6	A	0	0	0	3	9	1	162	18	144
3. RAZOR CLAM BIVALVES	3	A	0	1	0	2	9	1	81	9	72
4. CRUSTACEANS	10	M	0	0	0	2	9	1	180	20	160
5. SALT-CODS	10	M	0	0	0	3	9	0	270	0	270
6. SHOREBIRDS	6	A	0	0	0	5	4	0	120	0	120
									831	47	830
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	6	E	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	6	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	0	A	2	1	1	2	0	0	0	0	0
4. CHUM SALMON	10	A	2	1	1	2	0	0	0	0	0
5. SOCKEYE SALMON	10	A	2	1	1	2	0	0	0	0	0
6. PINK SALMON	3	A	2	1	1	2	0	0	0	0	0
7. COHO SALMON	0	A	2	1	1	2	0	0	0	0	0
9. DOLLY VARDEN	6	A	0	1	1	1	0	0	0	0	0
13. STICKLEBACKS	3	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	3	A	0	0	0	3	0	0	0	0	0
15. DUCKS	0	A	1	1	1	2	0	0	0	0	0
16. GEESE	10	A	1	1	1	5	0	0	0	0	0
17. SWANS	10	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	3	A	1	0	0	1	0	0	0	0	0
19. MINK	3	A	1	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	1	0	0	1	0	0	0	0	0
									0	0	0

TABLE 2-15. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
6. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	2	0	0	0	0
2. RIPARIAN VEGETATION	6	A	0	0	0	2	0	0	0	0	0
3. UPLAND VEGETATION	6	A	0	0	0	1	9	0	54	0	54
4. OTHER VEGETATION	6	A	0	0	0	2	4	0	48	0	48
5. BROWN BEAR	10	A	1	0	2	2	0	0	0	0	0
7. MUSKOXEN	6	A	0	0	0	1	1	0	6	0	6
8. WOLF	6	A	0	0	0	1	1	0	6	0	6
15. CARIBOU	6	A	1	0	1	2	0	0	0	0	0
16. OTHER MAMMALS	3	M	0	0	0	2	1	1	5	0	5
17. RAPTORS	15	A	0	0	0	*	1	0	150	0	150
18. PTARMIGAN	6	M	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	10	A	0	0	0	5	1	0	50	0	50
									320	0	320
									15588	7.9	15088

this habitat from Case 1 is accounted for by the following species:

Cods	increased to 200 from 50
Sculpins	increased to 180 from 80
Other Flatfish	increased to 200 from 50
Pacific Sandlance	increased to 270 from 120

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (4,149) of the impact score for this case. With minor exceptions, the increase in impact score in this habitat from Case 1 is accounted for by the following species:

Floating Seaweed	increased to 80 from 20
Subtidal Seaweed	increased to 80 from 20

THE INTERTIDAL SAND/MUD HABITAT contributed 15 percent (2,275) of the impact score for this case. With minor exceptions, the change in impact score in this habitat from Case 1 is accounted for by the following species:

Marine Mammal Rookeries	increased to 200 from 50
Ducks	increased to 273 from 120
Swans	increased to 270 from 120

THE INTERTIDAL ROCKY HABITAT contributed 15 percent (2,311) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 1 is accounted for by the following species:

Shorebirds	increased to 450 from 200
Sea Ducks	increased to 270 from 120

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (1,046) of e impact score for this case. With a minor exception, the increase in impact ore for this habitat from Case 1 is accounted for by the following species:

Intertidal Seaweeds	increased to 72 from 18
Shorebirds	increased to 273 from 120

THE TERRESTRIAL HABITAT contributed 2 percent (290) of the impact score or this case. Strand vegetation, reduced to 24 from 54, accounted for the de-:rease in impact score for this habitat from Case 1.

CASE 3: SUMMER, DIESEL-2, 10,000 BBLS - ESTIMATED SCORE 11,536

THE PELAGIC HABITAT contributed 37 percent (4,233) of the score for this case. The main contributing species to this score were judged to be phyto-plankton, zooplankton, ichthyoplankton, Pacific sandlance, herring, crab larvae, king salmon, chum salmon, sockeye salmon, coho salmon, sea otter, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 7 percent (754) of the score for this case. Shrimp and other marine invertebrates were judged to contribute significantly to the score for this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 26 percent (2,950) of the score for this case. Chum salmon, other flatfish, rockfish, walleye pollock, other marine fish, king crab, Tanner crab, and other marine inverte-brates were judged to contribute significantly to the score for this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 12 percent (1,347) of the score for this case. Pacific sandlance, razor clam, shorebirds, and geese were judged to contribute significantly to the score for this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 12 percent (1,400) of the score for this case. Herring, miscellaneous crustaceans, other invertebrates, and shorebirds were judged to contribute significantly to the score for this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (616) of the score for this case. Crustaceans and gastropods were judged to contribute significantly to the score for this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (236) of the score for this case. Raptors were judged to contribute significantly to the score for this habitat.

CASE 4: SUMMER, CRUDE OIL, 10,000 BBLS - ESTIMATED SCORE 10,698

THE PELAGIC HABITAT contributed 25 percent (2,623) of the score for this case. Phytoplankton, zooplankton, herring, crab larvae, chum salmon, sockeye salmon, sea otter, and seabirds were judged to contribute significantly to the score for this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (1,091) of the score for this case. Cods, other flatfish, and Pacific sandlance were judged to contribute significantly to the score for this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (2,877) the score for this case. Chum salmon, other flatfish, rockfish, walleye pollock, other marine fish, king crab, Tanner crab, and other marine invertebrates were judged to contribute significantly to the score for this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 15 percent (1,578) of the score for this case. Pacific sandlance, razor clam, marine mammal rookeries, shorebirds, ducks and swans were judged to contribute significantly to the score for this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 15 percent (1,603) of the impact score for this case. Herring, miscellaneous crustaceans, other invertebrates, shorebirds, and sea ducks were judged to contribute significantly to the score for this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (725) of the score for this case. Crustaceans, gastropods, and shorebirds were judged to contribute significantly to the score for this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (201) of the score for this case. Raptors were judged to contribute significantly to the score for this habitat.

CASE 5: WINTER, DIESEL 2, 50,000 BBLS - IMPACT SCORE 10,052

THE PELAGIC HABITAT contributed 16 percent (1,573) of the impact score for this case. Crab larvae and the five salmon species, not present in Winter cases, accounted for a decrease of 1,102 in impact score from Case 2. With minor exceptions, the remaining decrease in impact score for this habitat is accounted for by the following species:

Phytoplankton	reduced	to 72	from 180
Zooplankton	reduced	to 72	from 180
Ichthyoplankton	reduced	to 48	from 120
Pacific Sandlance	reduced	to 9	from 30
Herring	reduced	to 456	from 683
Smelt	reduced	to 81	from 162
Dolly Varden	reduced	to 27	from 164
Sea Otter	reduced	to 200	from 300
Seabirds	reduced	to 450	from 675

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (1,044) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 2 is discounted for by the following species:

Cods	reduced	to 120	from 200
Other Flatfish	reduced	to 80	from 200
Pacific Sandlance	reduced	to 81	from 270
Miscellaneous Marine Fish	reduced	to 80	from 120
Dungeness Crab	reduced	to 46	from 137

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 29 percent (2,878) of the impact score for this case. The decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Floating Seaweed	not present		from 80
Chum Salman	not present		from 540
Subtidal Seaweed	reduced	to 48	from 80
Pacific Halibut	reduced	to 36	from 120
Other Flatfish	reduced	to 120	from 200
Greenlings	reduced	to 80	from 120
Rockfish	reduced	to 120	from 200
Walleye Pollock	reduced	to 200	from 300
Other Marine Fish	reduced	to 200	from 300
Other Marine Invertebrates	reduced	to 270	from 405

THE INTERTIDAL SAND/MUD HABITAT contributed 20 percent (1,974) of the impact score for this case. The change in impact score for this habitat from

Case 2 is accounted for by the following species:

Ducks	increased	to	456	from 273
Pacific Sandlance	reduced	to	82	from 273
Invertebrate Infauna	reduced	to	81	from 162
Shorebirds	reduced	to	270	from 450
Geese	reduced	to	160	from 192

THE INTERTIDAL ROCKY HABITAT contributed 18 percent (1,811) of the impact score for this case. The change in impact score for this habitat from Case 2 is accounted for by the following species:

Sea Ducks	increased	to	675	from 220
Intertidal Seaweeds	reduced	to	72	from 120
Greenlings	reduced	to	80	from 120
Herring	reduced	to	182	from 547
Other Invertebrates	reduced	to	273	from 410
Shorebirds	reduced	to	135	from 450

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (610) of the impact score for this case. The decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Intertidal Seaweeds	reduced	to	36	from 72
Smelt	reduced	to	82	from 162
Crustaceans	reduced	to	109	from 182
Gastropods	reduced	to	164	from 273
Shorebirds	reduced	to	137	from 273

THE TERRESTRIAL HABITAT contributed 2 percent (157) of the impact score for this case. The decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Strand Vegetation	not present			from	24
Other Vegetation	reduced	to	24	from	48
Raptors	reduced	to	100	from	150
Other Birds	reduced	to	15	from	50

CASE 6: WINTER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 8,841

THE PELAGIC HABITAT contributed 21 percent (1,829) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Phytoplankton	increased	to	162	from	72
Zooplankton	increased	to	152	from	72
Ichthyoplankton	increased	to	108	from	48
Greenlings	increased	to	48	from	0
Pacific Sandlance	increased	to	81	from	9
Floating Seaweed	reduced	to	20	from	80
Northern Fur Seal	reduced	to	0	from	36

THE SUBTIDAL SAND/MUD HABITAT contributed 9 percent (755) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 5 is accounted for by the following species:

Cods	reduced	to	30	from	120
Sculpins	reduced	to	80	from	180

Other Flatfish	reduced	to	20	from 80
Pacific Sandlance	reduced	to	36	from 81

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 32 percent (2,820) of the impact score for this case. Subtidal seaweed, reduced to 12 from 48, accounted for the majority of the decrease in impact score for this habitat from Case 5.

THE INTERTIDAL SAND/MUD HABITAT contributed 16 percent (1,422) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 5 is accounted for by the following species:

Marine Mammal Rookeries	reduced	to	50	from 200
Ducks	reduced	to	200	from 456
Swans	reduced	to	120	from 270

THE INTERTIDAL ROCKY HABITAT contributed 15 percent (1,354) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 5 is accounted for by the following species:

Shorebirds	reduced	to	60	from 135
Sea Ducks	reduced	to	300	from 375

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (504) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 5 is accounted for by the following species:

Intertidal Seaweeds	reduced	to	9	from 36
Shorebirds	reduced	to	60	from 137

THE TERRESTRIAL HABITAT contributed 2 percent (157) of the impact score for this case. This habitat's result was the same as for Case 5.

CASE 7: WINTER, DIESEL-2, 10,000 BBLS - ESTIMATED SCORE 7,687

THE PELAGIC HABITAT contributed 21 percent (1,590) of the score for this case. Herring, sea otter, and seabirds were judged to be major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 9 percent (656) of the score for this case. Shrimp and other marine invertebrates were judged to be major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 32 pe 3) of the score for this case. Walleye pollock, other mar e fish, king ab. anner crab and other marine invertebrates were judged to be major contribut to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 16 percent (1,23[illegible]) of the score for this case. Razor clam, shorebirds, and ducks were judged to be major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 15 percent (1,177) of the score for this case. Herring, miscellaneous crustaceans, other invertebrates, and sea ducks were judged to be major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (438) of the score for this case. Gastropods were judged to be the only major contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (137) of the score for this case. Raptors were judged to be the only major contributor to the score in this habitat.

CASE 8: SUMMER, BUNKER-C, 50,000 BBLS - IMPACT SCORE 6,938

THE PELAGIC HABITAT contributed 20 percent (1,361) of the impact score for this case. The species not present in Winter cases accounted for an increase of 310 in impact score from Case 6 in this habitat. With minor exceptions, the remaining change in impact score is accounted for by the following species:

Dolly Varden	increased	to	72	from 27
Northern Fur Seal	increased	to	50	from 0
Harbor Seal	increased	to	30	from 0
Phytoplankton	reduced	to	45	from 162
Zooplankton	reduced	to	45	from 162
Ichthyoplankton	reduced	to	30	from 108
Greenlings	reduced	to	0	from 48
Pacific Sandlance	reduced	to	0	from 81
Herring	rediced	to	300	from 456
Sea Otter	reduced	to	75	from 200
Seabirds	reduced	to	300	from 456

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (843) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Cods	increased	to	50	from 30
Other Flatfish	increased	to	50	from 20
Pacific Sandlance	increased	to	120	from 36
Dungeness Crab	increased	to	135	from 46

Miscellaneous Marine Fish	reduced	to	30	from 80
Shrimp	reduced	to	72	from 164

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 24 percent (1,673) of the impact for this case. With minor exceptions, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Floating Seaweed	increased	to	80	from not present
Chum Salmon	increased	to	240	from not present
Other Flatfish	reduced	to	50	from 120
Greenlings	reduced	to	30	from 80
Rockfish	reduced	to	50	from 120
Walleye Pollock	reduced	to	75	from 200
Other Marine Fish	reduced	to	75	from 200
King Crab	reduced	to	383	from 810
Tanner Crab	reduced	to	383	from 810
Scallops	reduced	to	77	from 162
Other Marine Invertebrates	reduced	to	180	from 270

THE INTERTIDAL SAND/MUD HABITAT contributed 24 percent (1,677) of the impact score for this case. The change in impact score for this habitat from Case 6 is accounted for by the following species:

Pacific Sandlance	increased	to	120	from 82
Invertebrate Infauna	increased	to	164	from 82
Shorebirds	increased	to	456	from 273
Geese	increased	to	192	from 160
Ducks	reduced	to	120	from 200

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (766) of the impact score for this case. All species in this habitat received substantially different scores than in Case 6. The resultant changes for this case were as follows:

Herring	increased	to	240	from	182
Snowbirds	increased	to	213	from	60
Intertidal Seaweeds	reduced	to	30	from	72
Greenlings	reduced	to	30	from	80
Sessile Marine Invertebrates	reduced	to	60	from	135
Miscellaneous Crustaceans	reduced	to	20	from	180
Other Invertebrates	reduced	to	45	from	270
Sea Ducks	reduced	to	128	from	300
Marine Mammal Rookeries	reduced	to	0	from	75

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (364) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Shorebirds	increased	to	128	from	60
Hardshell bivalves	reduced	to	36	from	82
Crustaceans	reduced	to	80	from	109
Gastropods	reduced	to	30	from	162

THE TERRESTRIAL HABITAT contributed 4 percent (254) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 6 is accounted for by the following species:

Strand Vegetation	increased	to	24	from	not presnt

Raptors	increased to 150 from 100
Other Birds	increased to 50 from 15

CASE 9: WINTER, CRUDE OIL, 10,000 BBLS - ESTIMATED SCORE 5,799

THE PELAGIC HABITAT contributed 16 percent (907) of the score for this case. Herring, sea otter, and seabirds were judged to be major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (605) of the score for this case. Sculpins, shrimp, and other marine invertebrates were judged to be major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 29 percent (1,660) of the score for this case. Walleye pollock, other marine fish, king crab, Tanner crab, scallops, and other marine invertebrates were judged to be major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 20 percent (1,139) of the score for this case. Razor clam, marine mammal rookeries, shorebirds, ducks, and swans were judged to be major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 18 percent (1,045) of the score for this case. Herring, miscellaneous crustaceans, other invertebrates, and sea ducks were judged to be major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (352) of the score for this case. Gastropods were judged to be the major contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (91) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

CASE 10: SUMMER, BUNKER-C, 10,000 BBLS - ESTIMATED SCORE 5,593

THE PELAGIC HABITAT contributed 20 percent (1,097) of the score for this case. Herring and seabirds were judged to be major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (680) of the score for this case. Other marine invertebrates were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 24 percent (1,350) of the score for this case. Chum salmon, king crab, Tanner crab, and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 24 percent (1,352) of the score for this case. Razor clam, softshell bivalves, invertebrate infauna, shorebirds, and geese were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (618) of the score for this case. Herring and shorebirds were judged to be major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (293) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 4 percent (205) of the score in this case. Raptors were judged to be the major contributor to the score in this habitat.

CASE 11: SUMMER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 5,396

THE PELAGIC HABITAT contributed 25 percent (1,323) of the score for this case. Herring, chum salmon, sockeye salmon, sea otter, and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (550) of the score for this case. Cods, other flatfish, and Pacific sandlance were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (1,452) of the score for this case. Chum salmon, other flatfish, rockfish, walleye pollock, other marine fish, king crab, Tanner crab, and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 15 percent (796) of the score in this case. Pacific sandlance, razor clam, marine mammal rookeries, shorebirds, ducks, and swans were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 15 percent (808) of the score for this case. Herring, other invertebrates, shorebirds, and sea ducks were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (366) of the score for this case. Gastropods and shorebirds were judged to be the major contributors to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (101) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

CASE 12: SUMMER, DIESEL-2, 1,000 BBLS - ESTIMATED SCORE 5,382

THE PELAGIC HABITAT contributed 37 percent (1,975) of the score for this case. Phytoplankton, Zooplankton, ichthyoplankton, Pacific sandlance, herring, king salmon, chum salmon, sockeye salmon, coho salmon, sea otter, and seabirds were judged to be major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 7 percent (352) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 26 percent (1,376) of the score for this case. Chum salmon, other flatfish, rockfish, walleye pollock, other marine fish, king crab, Tanner crab, and other marine invertebrates were judged to be major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 12 percent (629) of the score for this case. Pacific sandlance, razor clam, and shorebirds were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 12 percent (653) of the score for this case. Herring, other invertebrates, and shorebirds were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (287) of the score for this case. Gastropods were the major contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (110) of this score for this case. No species was judged to be a major contributor to the score in this habitat.

CASE 13: WINTER, BUNKER-C, 50,000 BBLS - IMPACT SCORE 4,735

THE PELAGIC HABITAT contributed 13 percent (629) of the impact score for this case. The species not present in Winter cases accounted for a decrease of 310 in impact score from Case 8. With minor exceptions, the remaining decrease in this habitat is accounted for by the following species:

Phytoplankton	reduced	to	18	from 45
Zooplankton	reduced	to	18	from 45
Herring	reduced	to	200	from 300
Smelt	reduced	to	36	from 72
Dolly Varden	reduced	to	12	from 72
Sea Otter	reduced	to	50	from 75
Seabirds	reduced	to	200	from 300

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (605) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 8 is accounted for by the following species:

Cods	reduced	to	30	from 50
Other Flatfish	reduced	to	20	from 50
Pacific Sandlance	reduced	to	36	from 120
Dungeness Crab	reduced	to	45	from 135

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 25 percent (1,164) of the impact score for this case. The species not present in Winter cases accounted for a decrease in impact score of 320 from Case 8. With minor exceptions, the remaining decrease is accounted for by the following species:

Pacific Halibut	reduced	to	9	from 30

Other Flatfish	reduced	to	30	from	50
Rockfish	reduced	to	30	from	50
Walleye Pollock	reduced	to	50	from	75
Other Marine Fish	reduced	to	50	from	75
Other Marine Invertebrates	reduced	to	120	from	180

THE INTERTIDAL SAND/MUD HABITAT contributed 29 percent (1,376) of the impact score for this case. The change in impact score for this habitat from Case 8 is accounted for by the following species:

Ducks	increased	to	200	from	120
Pacific Sandlance	reduced	to	36	from	120
Invertebrate Infauna	reduced	to	82	from	164
Shorebirds	reduced	to	273	from	456
Geese	reduced	to	160	from	192

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (611) of the impact score for this case. With minor exceptions, the change in impact score in this habitat from Case 8 is accounted for by the following species:

Sea Ducks	increased	to	319	from	28
Herring	reduced	to	80	from	240
Shorebirds	reduced	to	64	from	213

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 4 percent (211) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 8 is accounted for by the following species:

Smelt	reduced	to	36	from	72
Crustaceans	reduced	to	48	from	80
Shorebirds	reduced	to	64	from	128

THE TERRESTRIAL HABITAT contributed 3 percent (139) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 8 is accounted for by the following species:

Strand Vegetation	not present	from 24
Raptors	reduced to 100	from 150
Other Birds	reduced to 15	from 50

CASE 14: WINTER, DIESEL-2, 1,000 BBLS - ESTIMATED SCORE 4,592

THE PELAGIC HABITAT contributed 21 percent (950) of the score for this case. Herring, sea otter, and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 9 percent (392) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 32 percent (1,465) of the score for this case. Walleye pollock, other marine fish, king crab, Tanner crab, and other marine invertebrates were judged to be major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 16 percent (739) of the score for this case. Razor clam, shorebirds, and ducks were judged to be major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 15 percent (703) of the score for this case. Other invertebrates and sea ducks were judged to be major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (262) of the

score for this case. No species was judged to be a major contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (81) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

CASE 15: SUMMER, BUNKER-C, 1,000 BBLS - ESTIMATED SCORE 3,028

THE PELAGIC HABITAT contributed 20 percent (594) of the score for this case. Herring and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (368) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 24 percent (730) of the score for this case. Chum salmon, king crab, and Tanner crab were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 24 percent (732) of the score for this case. Razor clam and shorebirds were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (334) of the score for this case. Herring and shorebirds were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (159) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 4 percent (111) of the score for this case. No species was judged to be a major contributor to the score in this habitat.

CASE 16: WINTER, BUNKER-C, 10,000 BBLS - ESTIMATED SCORE 2,672

THE PELAGIC HABITAT contributed 13 percent (355) of the score for this case. Herring and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (341) of the score for this case. Other marine invertebrates were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 25 percent (657) of the score for this case. King crab and Tanner crab were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 29 percent (776) of the score for this case. Razor clam, softshell bivalves, shorebirds, geese and ducks were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (345) of the score for this case. Sea ducks were judged to be the major contributor to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 4 percent (119) and THE TERRESTRIAL HABITAT contributed 3 percent (78) of the score for this case. No species was judged to be a major contributor to the score in either of these habitats.

CASE 17: SUMMER, GASOLINE, 50,000 BBLS - IMPACT SCORE 2,350

THE PELAGIC HABITAT contributed 47 percent (1,111) of the impact score for this case. Herring (300) and crab larvae (180) were the largest contributors to the impact score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 5 percent (125) of the impact score for this case. Shrimp (72) was the largest contributor to the impact score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (633) of the impact score for this case. Chum salmon (240) and other marine invertebrates (180) were the largest contributors to the impact score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 2 percent (42) of the impact score for this case. Individual species made only minor contributions to this score.

THE INTERTIDAL ROCKY HABITAT contributed 11 percent (260) of the impact score for this case. Sessile marine invertebrates (135) were the largest contributors to the impact score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (161) and THE TERRESTRIAL HABITAT contributed 1 percent (18) of the impact score for this case. Individual species made only minor contributions to this score.

CASE 18: WINTER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 2,216

THE PELAGIC HABITAT contributed 16 percent (347) of the score for this case. Herring, sea otter, and seabirds were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (231) of the score for this case. No species were judged to make major contributions to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 29 percent (635) of the score for this case. Walleye pollock, other marine fish, king crab, Tanner crab, and other marine invertebrates were judged to be major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 20 percent (435) of the score for this case. Razor clam, marine mammal rookeries, shorebirds, ducks, and swans were judged to be major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 18 percent (399) of the score for this case. Other invertebrates and seabirds were judged to be major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (134) of the score for this case. No species were judged to be major contributors to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (35) of the score in this case. No species were judged to be major contributors to the score in this habitat.

CASE 19: WINTER, BUNKER-C, 1,000 BBLS - ESTIMATED SCORE 1,549

THE PELAGIC HABITAT contributed 13 percent (206) of the score in this case. Herring and seabirds were judged to be major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (198) of the score

in this case. [illegible]ecies were judged to be major contributors to the score in this habitat

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 25 percent (381) of the score for this case. King crab and Tanner crab were judged to be major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 29 percent (450) of the score for this case. Razor clam, shorebirds, and ducks were judged to be major contributors to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 13 percent (200) of the score for this case. Sea ducks were judged to be the major contributor to the score in this case.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 4 percent (69) and THE TERRESTRIAL HABITAT contributed 3 percent (45) of the score in this case. No species were judged to be major contributors to the score in either of these habitats.

CASE 20: SUMMER, GASOLINE, 10,000 BBLS - ESTIMATED SCORE 1,283

THE PELAGIC HABITAT contributed 47 percent (607) of the score for this case. Herring were judged to be the major contributor to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 5 percent (68) of the score in this case. No species were judged to be major contributors in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 27 percent (346) of the score in this case. Chum salmon and other marine invertebrates were judged to be major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 2 percent (23), THE INTERTIDAL ROCKY HABITAT contributed 11 percent (142), THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 7 percent (88), and THE TERRESTRIAL HABITAT contributed 1 percent (10) of the score for this case. No species was judged to be a major contributor to the score in any of these habitats.

CASE 21: WINTER, GASOLINE, 50,000 BBLS - IMPACT SCORE 1,138

THE PELAGIC HABITAT contributed 33 percent (379) of the impact score for this case. Herring (200) was the major contributor to the impact score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (115) of the impact score for this case. Dungeness Crab (72) was the largest contributor to the impact score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 26 percent (298) of the impact score for this case. Tanner crab (90) and other marine invertebrates (120) were the largest contributors to the impact score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 4 percent (42) of the impact score for this case.

THE INTERTIDAL ROCKY HABITAT contributed 18 percent (205) of the impact score for this case. Sessile marine invertebrates (135) were the largest contributor in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (93) of the impact score for this case. Crustaceans (48) were the largest contributor to the impact score in this habitat.

THE TERRESTRIAL HABITAT contributed 1 percent (6) of the impact score for this case.

CASE 22: SUMMER, DIESEL-2, 100 BBLS - ESTIMATED SCORE 1,006

THE PELAGIC HABITAT contributed 37 percent (369) of the score for this case. Phytoplankton, zooplankton, herring, king salmon, chum salmon, sockeye salmon, coho salmon, sea otter, and seabirds were judged to be major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 7 percent (66) of the score for this case. No species were judged to be major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 26 percent (257) of the score for this case. Chum salmon, walleye pollock, other marine fish, king crab, Tanner crab and other marine invertebrates were judged to be major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 12 percent (117) of the score for this case. Shorebirds were judged to be the major contributor to the score in this habitat.

THE INTERTIDAL ROCKY HABITAT contributed 12 percent (122) of the score for this case. Herring and other invertebrates were judged to be major contributors to the score in this case.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (54) and THE TERRESTRIAL HABITAT contributed 2 percent (21) of the score in this case. No species were judged to be major contributors to the score in either of these habitats.

The estimated scores for Cases 23 through 32 range from 767 down to 29. The spill sizes for these cases is 10,000 and 1,000 barrels for gasoline and 100

barrels for all spill products. The array of these scores is:

	SPILL SIZE BY SEASON				
	10,000 BBLS	1,000 BBLS		100 BBLS	
SPILL TYPE	WINTER	SUMMER	WINTER	SUMMER	WINTER
Diesel-2	Case 7	Case 12	Case 14	Case 22	767
Crude Oil	Case 9	Case 11	Case 18	645	477
Bunker-C	Case 16	Case 15	Case 19	225	327
Gasoline	717	357	193	32	29

The relatively low scores for these cases and the minor differences between cases makes case by case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(8) PORT MOLLER

Port Moller is located on the northern coast of the Alaska Peninsula, about halfway between Kvichak Bay and Unimak Pass. It is separated from the maritime influence of the Gulf of Alaska by the Aleutian Mountain Range. The spill site is located about 3 miles west-northwest of Port Moller at $56^{o}0'N$ latitude, $160^{o}37.87'^{W}$ longitude in the entrance of the Bay leading to either Port Moller or Hague Channel (Fig. 2-49).

(a) PHYSICAL CHARACTERISTICS

Port Moller is characterized by the Transitional Climatic Zone due to the separation from the Gulf of Alaska by the Aleutian Range.

TEMPERATURES

Temperatures on the southern coast of Bristol Bay vary between $30^{o}F$ to $60^{o}F$ in the Summer and $15^{o}F$ to $45^{o}F$ in the Winter.[4] Record lows and highs have not been established at Port Moller because of the short climatic record. Record temperatures for Port Heiden to the east are $82^{o}F$ and $-19^{o}F$.[1,4]

Sea surface temperatures vary between $29^{o}F$ to $44^{o}F$ in the Winter and $31^{o}F$ to $60^{o}F$ in the Summer.[4] Although Port Moller does not freeze up during Winter, it is continually influenced by the Arctic ice pack in the Bering Sea.[4,8] Coverage during January and February ranges from 10 to 40 percent or scattered, and the ice coverage is usually gone by April or May.[4]

SURFACE WINDS

Winds in Bristol Bay are generally southerly in Summer and northerly in Winter.[8] Calms frequently occur (15.3 percent of the time) during the year at Port Moller. Representative winds chosen at the spill site were

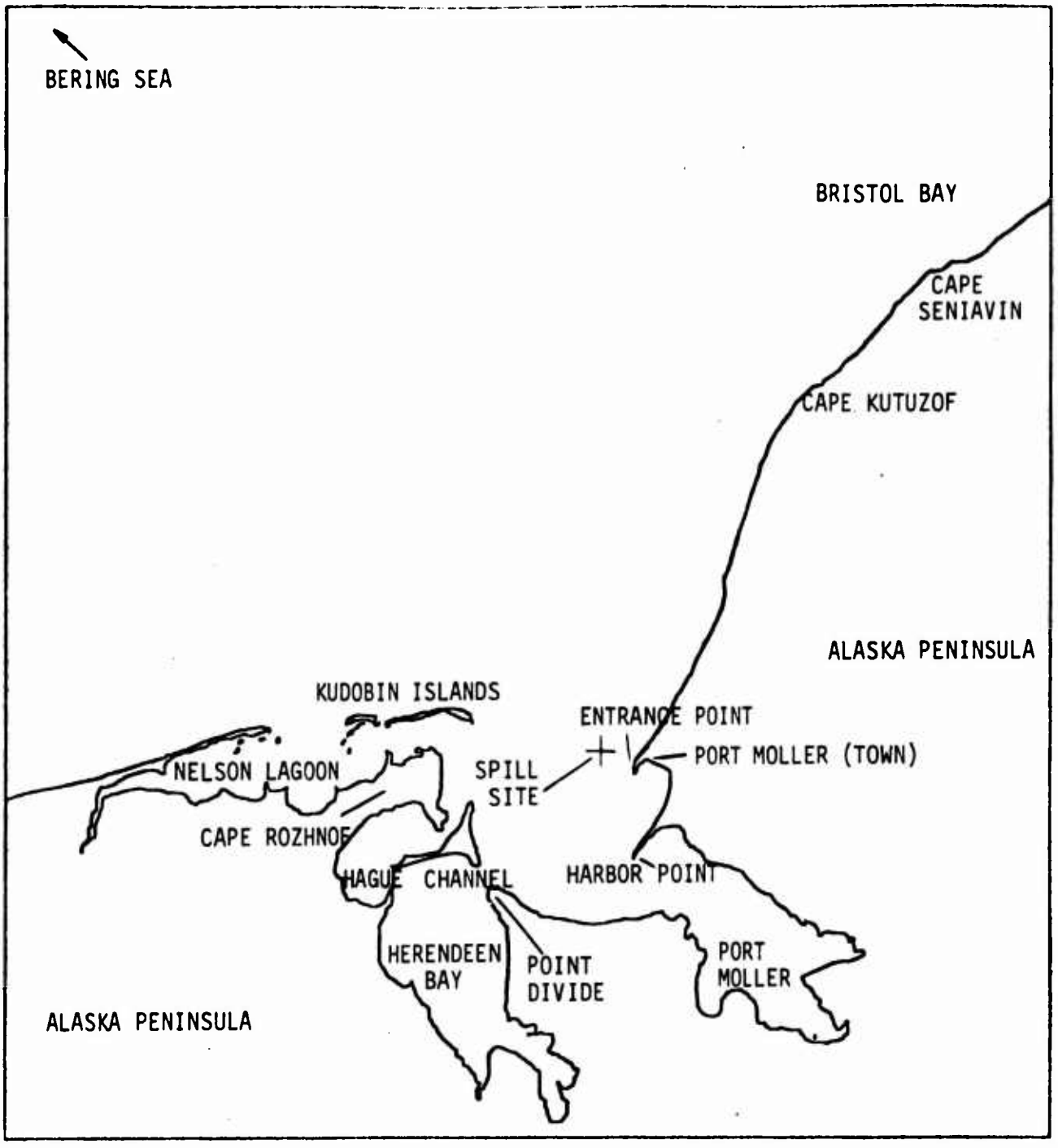


FIGURE 2-49. THE PORT MOLLER LOCATION AND SPILL SITE

NOTE: Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

calm, south-southwest at 11.5 knots during Summer, and west-northwest at 12.0 knots during Fall.

SURFACE CURRENTS

As for the Unimak Pass location, a good deal more information was given in the *COAST PILOT*[8] and the *TIDAL CURRENT TABLES*[9] about the Port Moller area than for most other marine study locations. Information in the *TIDAL CURRENT TABLES*[9] for Port Moller and near the selected spill site is as follows:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Entrance Point	1.6 K (000°)	1.2 K (180°)
West 3 miles of above	2.0 K (000°)	1.7 K (175°)
Harbor Point	1.9 K (335°)	0.9 K (160°)
Hague Channel (east of Doe Point)	1.4 K (035°)	2.3 K (220°)
Johnston Channel (off Halftide Rock)	1.3 K (335°)	1.2 K (180°)

The *COAST PILOT*[8] gave the following information for Port Moller near the selected spill site:

AREA	COMMENT
At Port Moller	Current velocities are 1.5 to 2 knots and diurnal tide range is 10.8 feet.
Between Point Divide and Doe Point	Tide rips are produced on flooding tides.
Hague Channel	Tidal currents are very strong, as much as 4 knots on the Spring flood.
Halftide Rock	Current velocity is about 1.5 knots.

In the center of Bristol Bay off Port Moller, surface currents have been measured as high as 1.3 knots and bottom currents as high as 0.8 knot.[44] Some of the ebb tidal currents exceed the flood due to the influence of river flow into Bristol Bay.[44] Based upon these inputs, the following currents were assumed for oil dispersion modelling by MSNW:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Central Port Moller	2.0 K (000°)	1.7 K (175°)
Off Entrance Point	1.6 K (000°)	1.2 K (180°)
Port Moller, inside Harbor Point	1.9 K (335°)	0.9 K (160°)
Hague Channel	1.4 K (035°)	2.3 K (220°)
Herendeen Bay	1.3 K (335°)	1.2 K (180°)
Offshore Port Moller	0.3 K (225°)	0.6 K (045°)

(b) BIOLOGICAL CHARACTERISTICS

Port Moller is a biologically rich shallow-water bay located off of Bristol Bay on the Alaska Peninsula. Abundant resources in the Port Moller area and adjacent waters include several groups of fish (salmon, herring) and waterfowl. Unless otherwise specified, Port Moller is used here to include Nelson Lagoon and Herendeen Bay.

Resource summaries are shown in Figures 2-50 and 2-51.

FISHES

SALMONIDS are an important and numerous resource in the Port Moller vicinity. Similar to Unimak Pass, this location has both a migratory offshore



FIGURE 2-50. PORT MOLLER CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

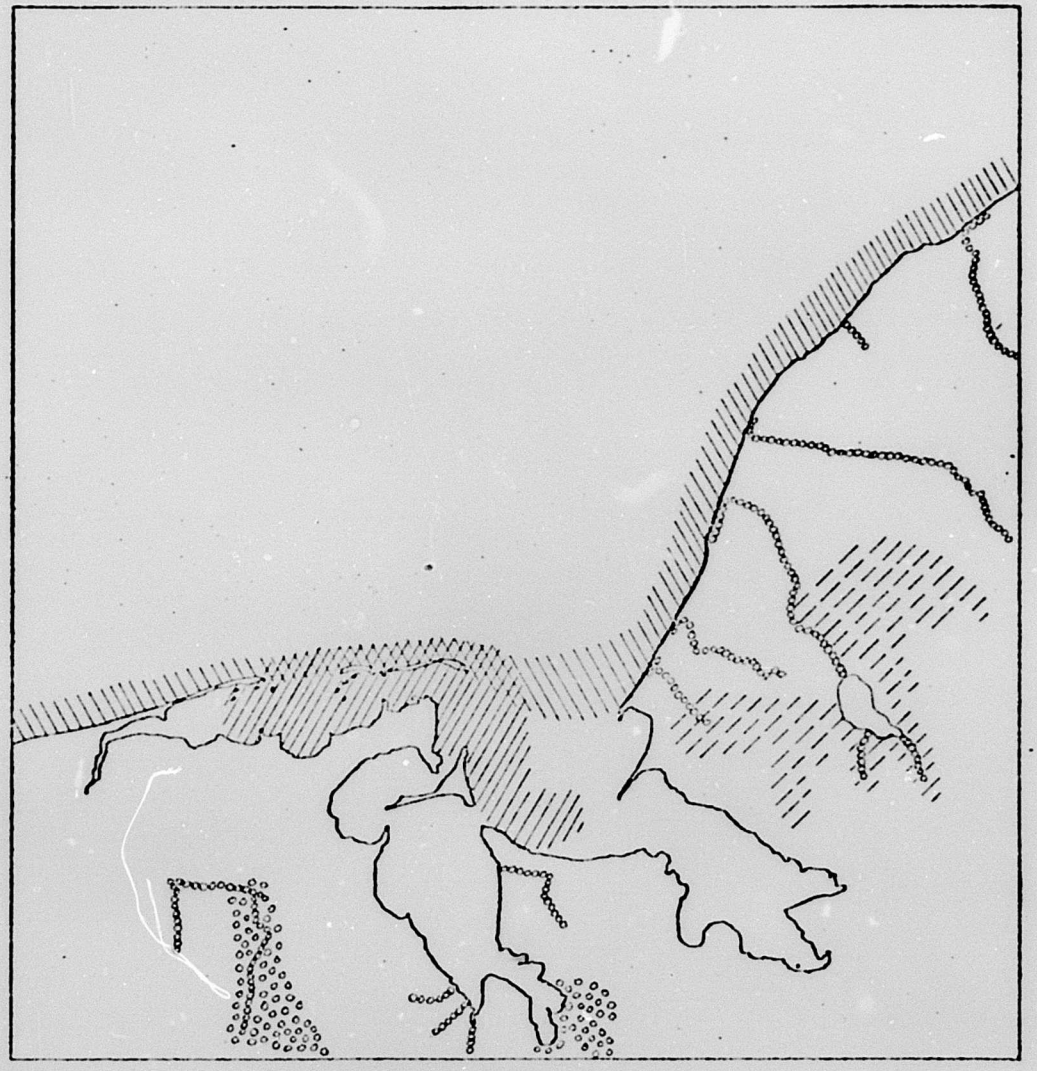


FIGURE 2-51. PORT MOLLER CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

population going to and from Bristol Bay rivers as well as local salmon populations.

Juvenile sockeye salmon leaving Bristol Bay, after migrating from their home streams, tend to congregate off the Port Moller vicinity (from shore to about 25 miles offshore) where they begin feeding. These fish remain in the area from mid-June until late August. The number of juvenile sockeye salmon in the Port Moller area could be staggering (500 million) if one uses adult run sizes and assumes a 90 percent marine mortality in a given year. The number on any given date would be less but would still be in the millions.

This early life history is critical to this and other salmon species as they are under a good deal of natural stress, and oil pollution could become a critical parameter in this life history period.

Adult sockeye salmon returning to Bristol Bay peak at Port Moller from about June 15th to July 1st. Again, the number on any given day would not equal that year's sockeye run to Bristol Bay, but during the peak it would be several million (mean Bristol Bay adult sockeye run for 1956-1972 is 16.6 million with a range of 53.1 million to 2.4 million).

Local sockeye salmon at Port Moller are also frequent. In 1971, nearly 2.5 million sockeye salmon were caught at Bear River and Herendeen Bay in Port Moller.

Information on other salmon species is sparse, but their behavior is generally similar. King salmon adults pass Port Moller (about 40 to 55 miles offshore), with 75 percent of the run between June 14th and 28th. Coho salmon adults would be in the Port Moller area mid-July to Late August. Both king and coho salmon are transitory as local spawning stocks are small.

Chum salmon adults pass Port Moller between June 20th and July 10th about 25 to 60 miles offshore. Local populations exist so they would also be in Port Moller. Adult pink salmon pass Port Moller about the same time as the Bristol Bay sockeye salmon run. A conservative estimate of these adult salmon (other than sockeye) runs to Bristol Bay (assuming 50 percent exploitation) is as follows based on 1951 to 1967 catch data:

SALMON	MEAN
King	165,400
Coho	74,300
Pink (even year)	1,650,200
Chum	928,800

Local significant salmon spawning areas and timing for Port Moller are as follows:[44]

SALMON	AREA	TIMING (PEAK)
King (small runs)	Nelson Lagoon System, Bear River System	All of June (mid-June)
Sockeye (large runs)	Nelson Lagoon System, Bear River System	Late June - late July (early July)
Coho (large runs?)	Nelson Lagoon System	Late August-September (late August)
Pink	None	--
Chum (small runs)	Nelson Lagoon System, Port Moller System	Early July - late August (late July)

Dolly Varden are present at Port Moller, while rainbow trout rarely migrate to salt water (steelhead) in Bristol Bay.[44] See the Kvichak Bay location description for more information on Bristol Bay salmon and Dolly Varden.

PACIFIC HALIBUT are present in the Port Moller area, but do not appear in great numbers as adults. Juvenile halibut inhabit the shallow waters of Port Moller and may be present in small numbers inside the Bay. Abundant stocks of halibut are shown off Port Moller in May some 80 to 90 miles offshore. Figure 2-52 shows halibut distribution and movement within Bristol Bay. Additional halibut information is presented with the Unimak Pass location description.

WALLEYE POLLOCK were found in large quantities offshore of Port Moller (one catch within about 50 miles),[44] while another survey from the same source[44] showed the edge of their Spring/Summer distribution is much closer and contacts the western side of the Port Moller vicinity. This species is assumed to be in the area but probably not in the abundances seen in other parts of the Bering Sea. This deeper water bottom fish produces pelagic eggs along with young juveniles which occupy the upper 10 m of surface waters[44] which would increase this species' vulnerability to oil products. Additional information is presented with the Unimak Pass location description.

PACIFIC COD AND SAFFRON COD inhabit the Port Moller area. Large numbers of small Pacific cod were taken inshore near Cape Seniavin while saffron cod were more abundant on the north side of Bristol Bay--Togiak vicinity.[42] Additional information is presented in the Unimak Pass location description.

PACIFIC HERRING probably are the most abundant marine fish (excluding salmon) in this area, particularly when they migrate to the Port Moller area to spawn from late April to early June.[44] See Figures 2-53 and 2-54 for their distribution in Bristol Bay and their life cycle.

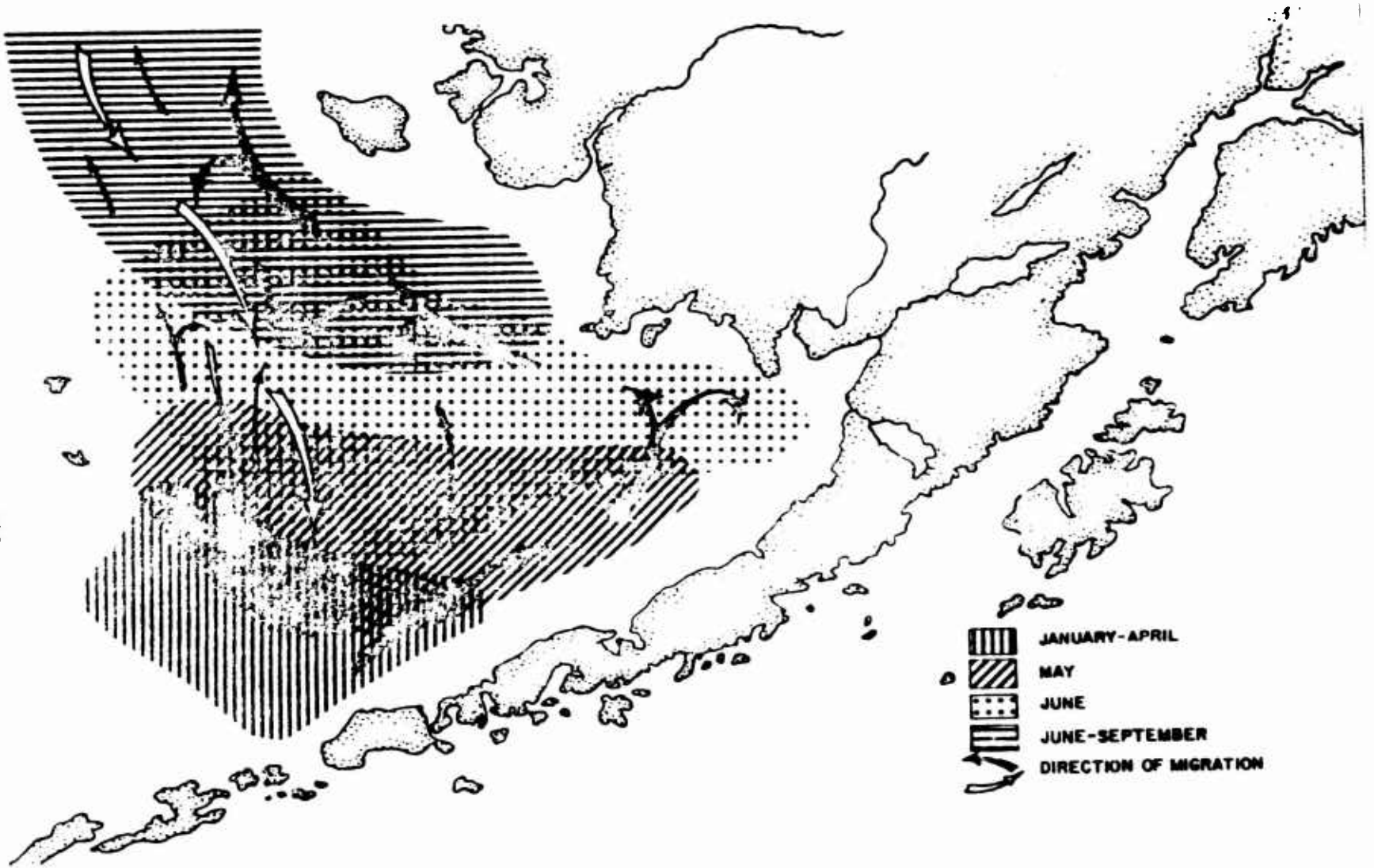


FIGURE 2-52. DISTRIBUTION AND MIGRATION OF HALIBUT IN THE SOUTHEASTERN BERING SEA.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

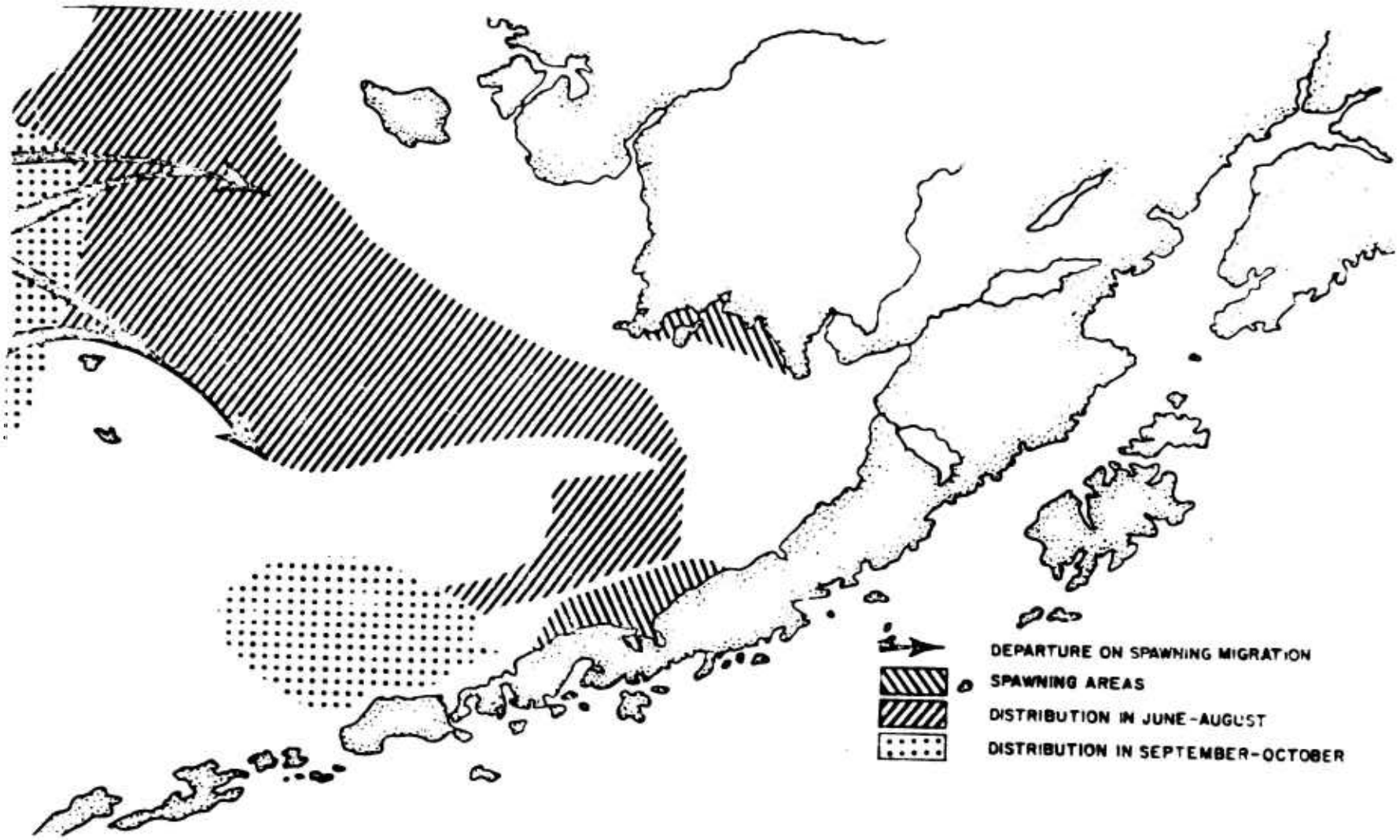


FIGURE 2-53. DISTRIBUTION OF HERRING IN THE SOUTHEASTERN BERING SEA.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

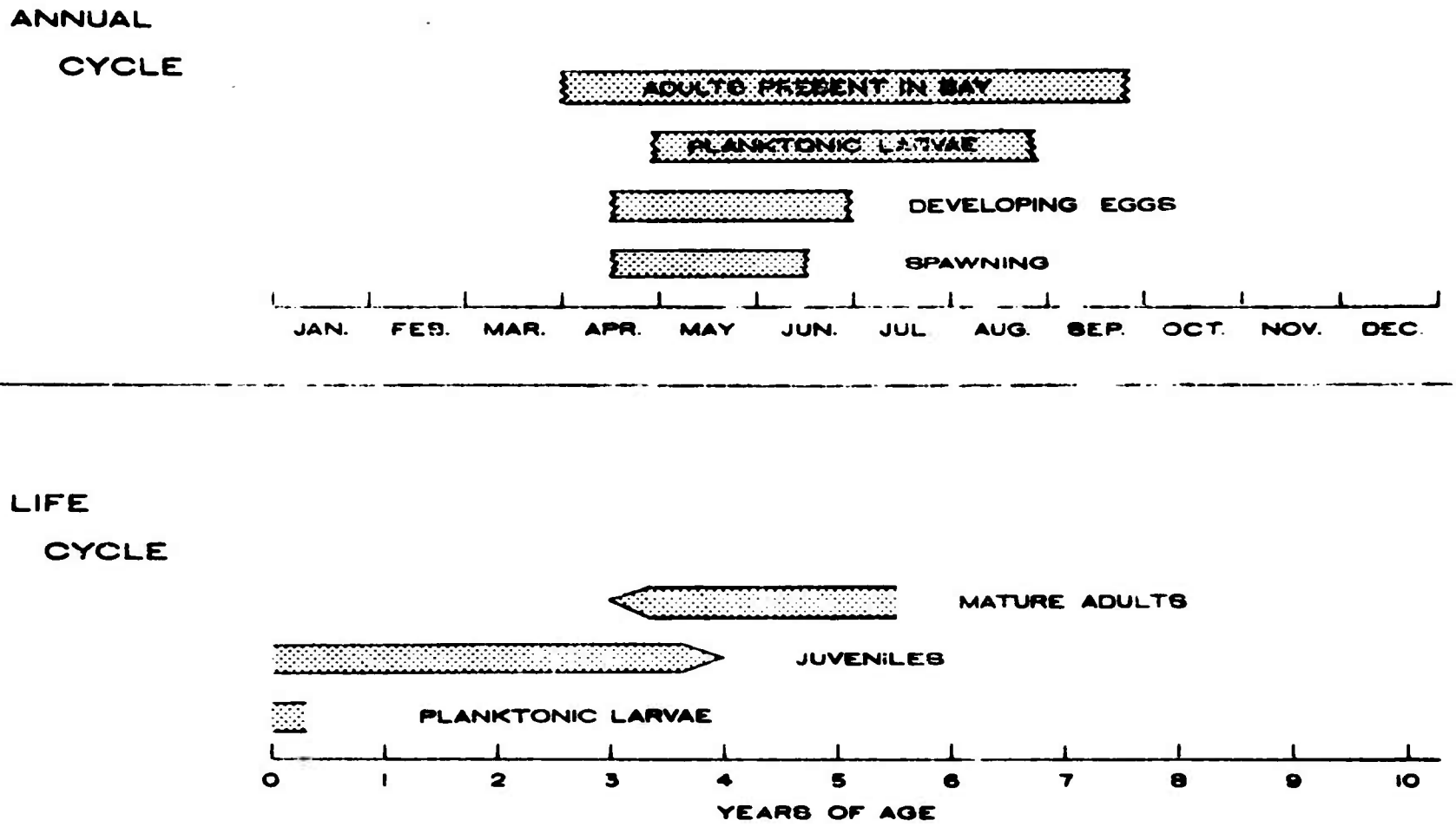


FIGURE 2-54. ANNUAL AND LIFE CYCLES OF THE HERRING IN THE BERING SEA.

SOURCE: Arctic Environmental Information and Data Center, *THE BRISTOL BAY ENVIRONMENT - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, prepared for the Department of the Army, Alaska District, Corps of Engineers, February 1974.

In spawning, the female releases an average of 20,000 eggs per year which are fertilized in the water and then become attached to kelp, eelgrass, or any convenient substrate in the shallow waters near Port Moller.[44] The eggs develop in 23 days and form planktonic larvae which form into juveniles after two months.[44]

Adult herring remain nearshore throughout the Summer and leave Bristol Bay in September and October to form wintering schools northwest of the Pribilof Islands and along the southern margin of the ice pack.[44] These adults move to spawning areas beginning in late March and April.[44]

See the Port Graham location description for information about herring vulnerability to oil.

OTHER MARINE FISHES in the Port Moller vicinity include several smelt species, several greenling species, sandlance, numerous sculpins, and several other miscellaneous fishes.

SHELLFISHES

KING CRAB are shown to be just offshore Port Moller in the Summer months and further east in Bristol Bay in Winter months.[44] The distribution shown would indicate low numbers of this crab in the Port Moller area and the shallow waters of Port Moller would also seem to limit the numbers of this deeper water crab species. See the Unimak Pass location description for more information on this crab species. King crab larvae (Summer of 1965) are shown in high abundance just north of Port Moller.[44]

TANNER CRAB distributions[44] are generally concentrated some distance offshore of Port Moller. However, low concentrations of tanner crabs are

expected in Port Moller. See the Unimak Pass location description for more information on this crab.

DUNGENESS CRAB are reported on the north side of the Alaska Peninsula,[44] but no specific information was found for Port Moller. MSNW assumed a few to be present here. More details on the species is located in the Unimak Pass location description.

SHRIMP are not in the commercial quantities in Bristol Bay[44] but were assumed to be present in the Port Moller area. See the Unimak Pass description for more information on the species involved.

RAZOR CLAMS occur in large numbers in the inshore waters and lagoons on the Bering side of Unimak Island[45] and on up this shore on the Alaska Peninsula to Izembek Lagoon.[44] They are assumed to be present and abundant on the sandy beaches of Port Moller. However, they were not reported for the Naknek-Kvichak area[44] further east of Port Moller in Kvichak Bay.

WATERFOWL

Again, little quantified information on waterfowl exists for the Port Moller vicinity; however, they are known to be abundant in this area. Port Moller is probably similar but possibly somewhat less important than Izembek Lagoon (west of Port Moller) as a major Fall-Spring stop-over area for ducks and geese.

Port Moller is indicated as a wintering area as well as nesting and molting area (lagoon areas).[17]

DUCKS utilize Port Moller (main bays) as a major wintering area. Production estimates are high (32 breeding pair per square mile) west of

Port Moller. Many species are involved and are fully described by one source.[44] This source[44] indicated that mallards and teal frequent the mouths of rivers and bays until freezeup while pintails frequent the tidal lagoons in large numbers in the Summer.

The ducks most vulnerable to oil are those more dependent on the marine areas--diving and sea ducks (scaup, eiders, scoters, etc.).[44] These birds inhabit bays and estuaries.

GEESE are numerous along the Bering Coast of the Alaska Peninsula and include such species as the Canada goose which occasionally feeds along coastal beaches and emperor geese and black brant which feed extensively on eelgrass that is present at Port Moller. The seeds of eelgrass are a concentrated energy source utilized by these birds over a several-week period (early November for brant in Izembek Lagoon; late October for emperor geese) prior to migration to wintering areas.[44]

SWANS (whistling swans) are probably the most spectacular bird in this vicinity but have little direct contact with the sea, as they feed and nest in small freshwater ponds. The surrounding general area is a major migration and production area (two whistling swans per square mile).[17]

SEABIRDS are not shown in any major colonies in the Port Moller vicinity;[17] however, some beach colonies are known.[18] One source[44] provided a detailed distribution of many seabirds in the Bristol Bay vicinity. This source indicated that slender-billed shearwaters, fulmars, glaucous-winged gulls, black-legged kittiwakes, common murres, horned puffins, and tufted puffins are numerous in the Port Moller vicinity.

SHOREBIRDS inhabit beaches and mud flats in the Port Moller area. Two plover species are probably the dominant birds in the Port Moller area.

Other shorebirds in the area include snipe, yellowlegs, two species of sandpipers, dowitcher, and two species of turnstones, as well as several others. These birds frequent the shorelines where they feed on marine infauna and other small marine life.[44]

MARINE MAMMALS

SEA OTTERS are in low numbers in the Port Moller area as the result of a major Winter die-off in 1971 and 1972. The population is probably in a recovery phase. They are present on the Bering Sea shore from the center of Port Moller and west, with no areas of concentration.[17]

HARBOR SEALS are present throughout the Port Moller vicinity, with high densities in the western half of Port Moller (in Nelson Lagoon but not in Herendeen Bay).[17] No estimates of abundance were located; however, past harvests amounted to 1,500 animals annually.[17]

NORTHERN FUR SEALS are assumed to occasionally come as far east from Unimak Pass as Port Moller. See the Unimak Pass location description for more information on this seal.

SEA LIONS are not shown in any concentrations in the Port Moller vicinity, although they inhabit parts of Bristol Bay west and north of this location.[17,44] They were assumed to be present in small numbers at this vicinity.

WALRUS have hauling grounds along the north and west shores of Bristol Bay. The west shore rookery is over 50 miles west of Port Moller at Sealion Rocks off Izembek Lagoon and west of this location. They are expected to be rare at Port Moller.

WHALES are present in the Port Moller vicinity. Figure 2-47 indicates beluga whale, killer whale, and harbor porpoise habitat exists at Port Moller. The killer whales and particularly the beluga whales are probably the most numerous.

TERRESTRIAL MAMMALS

BROWN BEAR are very abundant in the Port Moller vicinity, with heavy beach use and stream feeding on returning adult salmon. The latter use is prevalent at the southeast end of Herendeen Bay and in the south end of Port Moller (Bay).

CARIBOU occur along all shores of Port Moller, with Winter range on the west shore of Nelson Lagoon and Herendeen Bay and continuing west down the Alaska Peninsula.[17] An estimated 15,000 animals occur on the Alaska Peninsula.

MOOSE are distributed around most of the shores of Port Moller, with a year-round concentration area just east of the town of Port Moller.[17] The population is expanding. Calving takes place on low-lying coastal plains.

WOLVES AND WOLVERINES are indicated as present in the Port Moller vicinity.

SMALL TERRESTRIAL MAMMALS are assumed present and similar to those described on Unimak Island (see Unimak Pass location description).

AQUATIC FURBEARERS are assumed to be in low to moderate abundance at this location.

FLORA

Most of the strand species in this area are Bering and Eastern North American. Because sea ice occurs here in the Winter and beach scouring is extensive, strand vegetation is probably poorly developed and sporadic in its occurrence. However, 100 percent of the shoreline would be available for growth of these plants in the Summer ice-free period. There is no published information on the eelgrass beds of this area,[70,79] but because of the proximity of Izembek Lagoon, which is one of the largest beds of eelgrass in the world,[79] it is likely that there are extensive areas covered by this species in the shallow subtidal. According to the digitized physical shoreline information, about 72 to 74 percent of the shallow subtidal bottom would be available for growth of eelgrass. The marine algae of this area are of the Arctic type. There is very little rock substrate available for growth of these algae (about 12 percent of the shoreline and only cobble/gravel). The lack of substrate and the effects of Winter and ice-scouring probably preclude the development of much algal vegetation either in the intertidal or subtidal. Floating kelp species are lacking.

For further physical and biological information on this location, see Appendix D.

(c) RESULTS

Due to the fact that the Summer spill scenario impacts the pelagic habitat to a great extent and the Winter scenario impacts,it very little, it is impossible to make meaningful comparisons between them.

The 10,000-bbl diesel-2 spill in Summer produces the greatest impact score with the pelagic habitat contributing 62 percent. The largest contributors in this habitat are herring, salmon, crab larvae, and seabirds.

Diesel-2 also produces the largest impact in Winter, followed by crude oil. The pelagic habitat contributed only 2 percent in Winter, however, with the subtidal and intertidal habitats making up the difference. The largest contributors in Winter are invertebrate infauna and other marine invertebrates.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Port Moller. The first scenario, using most probable Summer conditions, resulted in oil moving in a north-north-easterly direction parallel with the shoreline north of Port Moller (Fig.2-55). This spill trajectory carries oil to the shore in approximately 12 hours after the spill occurs. The second scenario, using most probable Winter conditions, resulted in oil moving north-northeasterly for six hours and then easterly toward the shoreline off the City of Port Moller (Fig.2-56). This spill trajectory reaches the shore approximately 9 hours after the spill occurs. The Summer scenario impacts five habitats, and the Winter scenario impacts six habitats. The additional habitat which is impacted in Winter is the Intertidal Sand/Mud area at the eastern end of Port Moller.

The trajectories of the two spills change the impact scores between the two scenarios for individual habitats. The major differences in impact scores are not reflected in the total impact for this site. Cross-seasonal comparisons result in almost meaningless listings of species with major changes in impact score. Therefore, the Summer scenario cases will be compared only to each other in the discussion and the Winter scenario cases will be compared only with each other. The discussion will begin with the case with the highest impact score and proceed to the lowest.

See Page 2-27 for discussion of spill enveloping process.

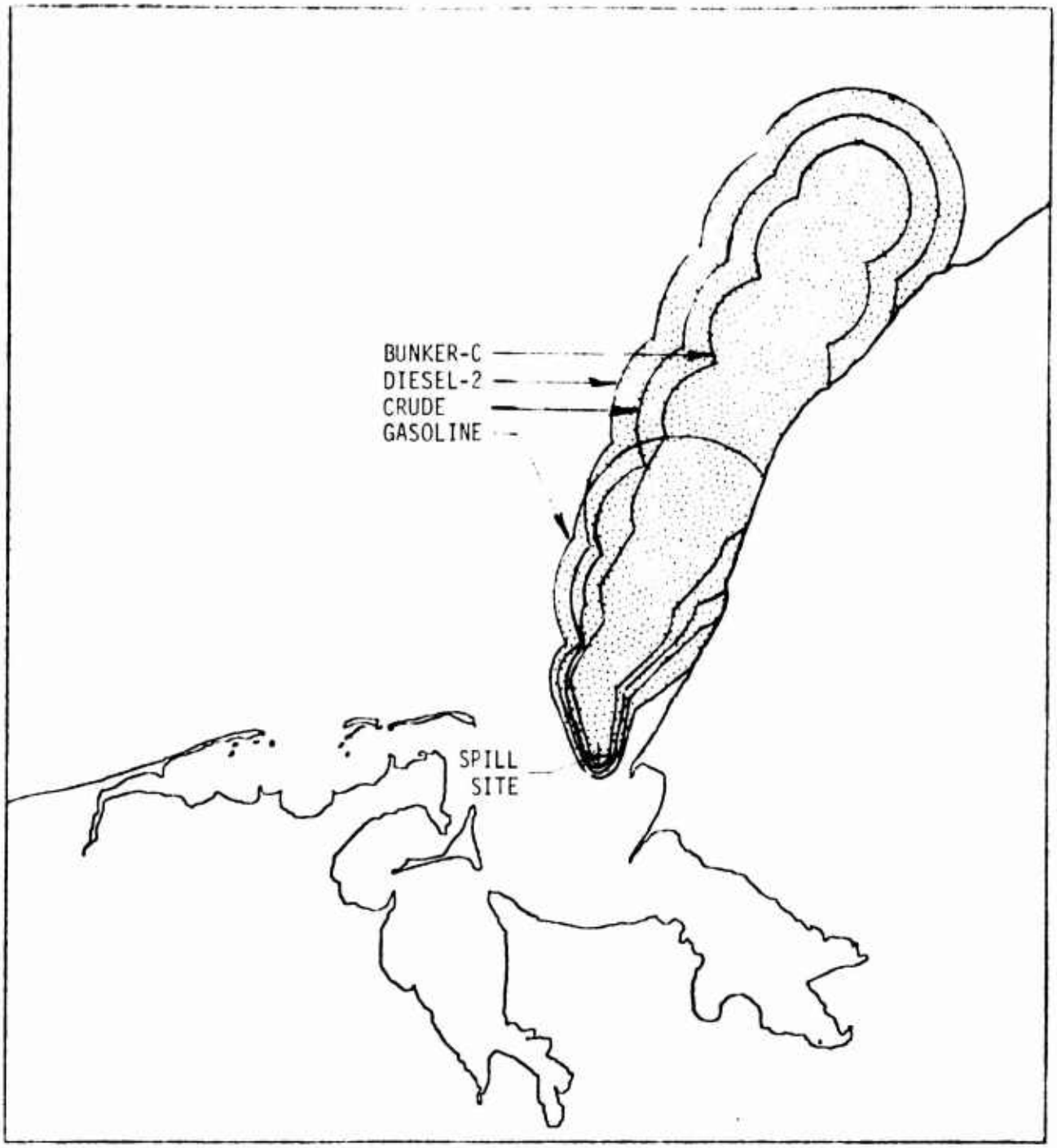


FIGURE 2-55. PORT MOLLER SUMMER 10,000 BBL SPILL ENVELOPES

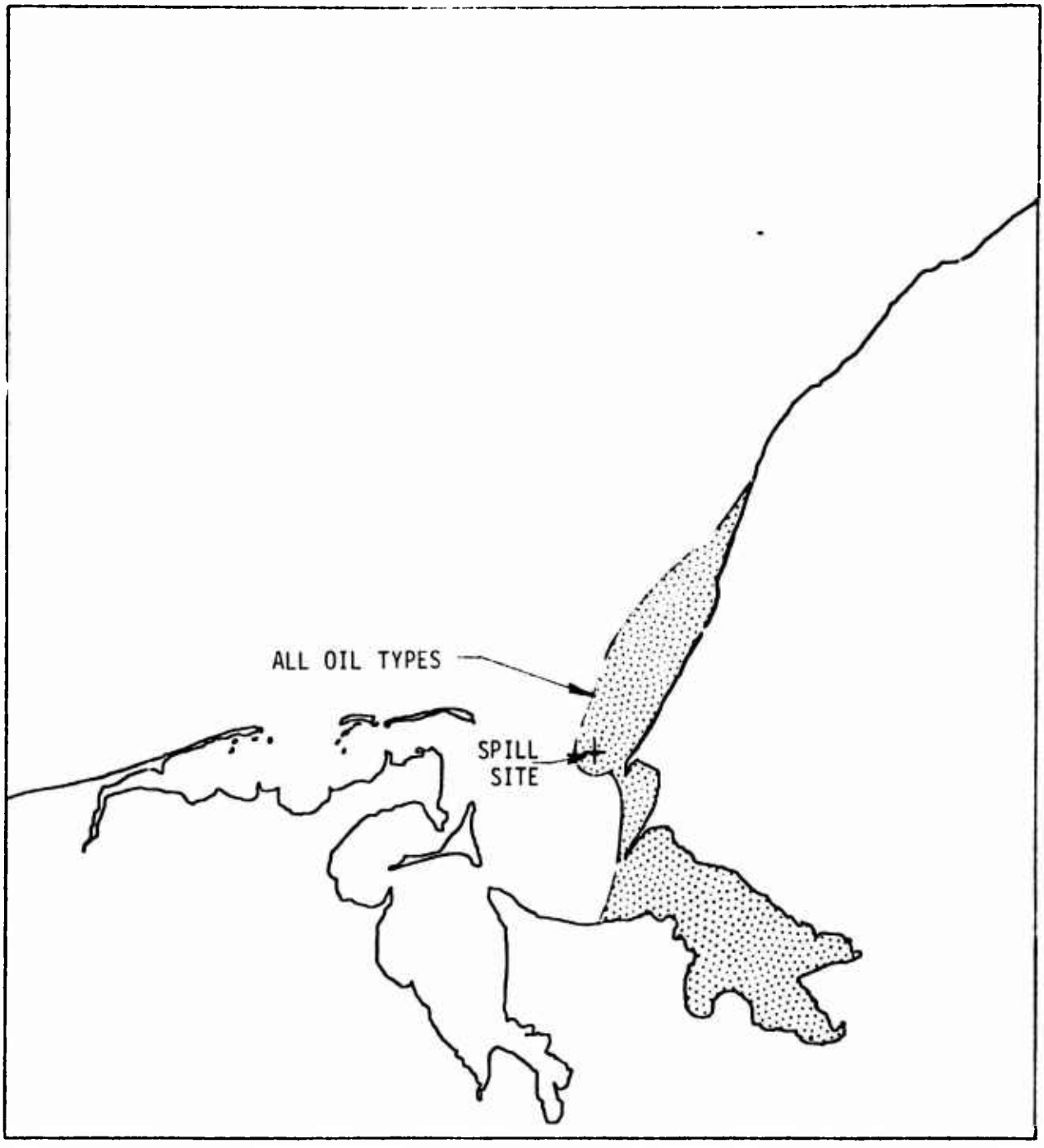


FIGURE 2-56. PORT MOLLER WINTER 10,000 BBL ENVELOPE

CASE DISCUSSION

Table 2-16 presents the results of the oil spill scenarios examined at Port Moller without cleanup.

TABLE 2-16 . PORT MOLLER CASE RESULTS NO CLEANUP

	SPILL TYPE AND SEASON	10,000	1,000	100
SUMMER	Diesel-2	10,782 [1] (1)	5,724 [6]	1,138 [15]
	Crude Oil	8,613 [2]	3,512 [8]	548 [17]
	Bunker C	6,382 [4]	2,561 [9]	597 [16]
	Gasoline	1,587 [12]	286 [18]	50 [23]
WINTER	Diesel-2	7,877 [3]	2,420 [10]	184 [21]
	Crude Oil	5,888 [5]	1,945 [11]	264 [19]
	Bunker C	4,782 [7]	1,180 [14]	105 [22]
	Gasoline	1,188 [13]	214 [20]	38 [24]

(1) Numbers in brackets are the case numbers that follow.

CASE 1: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 10,782

THE PELAGIC HABITAT contributed 62 percent (6,669) of the impact score for this case. The major contributing specie to this impact score in this habitat were phytoplankton (120), zooplankton (120), Pacific sandlance (120), herring (806), smelt (164), crab larvae (483), king salmon (820), chum salmon (547) sockeye salmon (1,933), pink salmon (547), coho salmon (328), Dolly Varden (145), and seabirds (456). With the exceptions of smelt, coho salmon, and Dolly Varden, these species were among the most abundant in this habitat. King, pink and coho salmon were rated minor, chum salmon and herring moderate, and sockeye salmon major in commercial importance. King, sockeye, pink and coho salmon and Dolly Varden were rated minor in recreational importance.

Dolly Varden were rated minor and all the salmon moderate in subsistence importance. With the exception of Pacific sandlance, all fish species and seabirds were judged to be most sensitive to a diesel-2 spill in this habitat. Seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (1,523) of the impact score for this case. The major contributing species to this impact score in this habitat were cods (200), sculpins (120), other flatfishes (300), Pacific sandlance (273), and other marine invertebrates (410). These species were the most abundant in this habitat. Cods and flatfish were rated moderate in commercial importance and minor in subsistence importance. Sandlance and invertebrates were judged to be among the most sensitive to a diesel-2 spill in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (1,896) of the impact score for this case. The major contributing species to this score in this habitat were chum salmon (547), Pacific halibut (200), king crab (360), tanner crab (240), and other marine invertebrates (273). With the exception of the invertebrates, these species were the most abundant in this habitat. The crabs and halibut were rated major and the salmon moderate in commercial importance. The invertebrates were rated minor in recreational and subsistence importance. Chum salmon were rated moderate and the crabs minor in subsistence importance. The salmon and invertebrates were judged to be the most sensitive to a diesel-2 spill in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (563) of the impact score for this case. The major contribution species to this impact score for this habitat were smelt (184), gastropods (128), and shorebirds (137). Gastropods were one of the most abundant species in this habitat. Smelt and

shorebirds were judged to be the most sensitive to a diesel-2 spill in this habitat. Shorebirds were classified as protected.

THE TERRESTRIAL HABITAT contributed 1 percent (131) of the impact score for this case. Raptors (75) were the largest contributor to the impact score in this habitat. Raptors were classified as protected.

Table 2-17 following presents the full results of case 1.

CASE 2: SUMMER. CRUDE OIL, 10,000 BBLS - ESTIMATED SCORE 8,613

THE PELAGIC HABITAT contributed 35 percent (3,004) of the score for this case. The major contributing species to this score in this habitat were judged to be herring, crab larvae, king salmon, pink salmon, coho salmon, sockeye salmon, chum salmon, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 15 percent (1,249) of the score for this case. The major contributing species to this score in this habitat were judged to be cods and other flatfish.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 38 percent (3,299) of the score for this case. The major contributing species to this score in this habitat were judged to be chum salmon and Pacific halibut.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 10 percent (831) of the score for this case. Smelt, shorebirds and gastropods were judged to be the major contributors to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 3 percent (230) of the score for this case. Raptors were judged to be the only substantial contributor to the score in this habitat.

CASE 3: WINTER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 7,877

THE PELAGIC HABITAT contributed 2 percent (157) of the impact score for this case. Seabirds (60) were the largest contributor to the impact score in

TABLE 2-17. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	PORT MOLLER
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	10	A	0	0	0	3	4	0	120	0	120
2. ZOOPLANKTON	10	A	0	0	0	3	4	0	120	0	120
3. ICHTHYOPLANKTON	10	A	0	0	0	2	4	0	80	0	80
5. SCREENLING	1	A	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	10	A	0	0	0	3	4	0	120	0	120
7. HERRING	10	A	2	0	0	3	9	8	450	400	806
8. SMELT	6	A	0	0	0	3	9	1	162	18	164
9. COD LARVAE	15	A	0	0	0	2	9	8	270	240	483
10. KING SALMON	15	A	1	1	2	2	9	1	810	90	820
11. CHUM SALMON	10	A	2	0	2	2	9	1	540	60	547
12. SOCKEYE SALMON	15	A	3	1	2	2	9	8	1080	360	1073
13. PINK SALMON	10	A	1	1	2	2	9	1	540	60	547
14. COHO SALMON	6	A	1	1	2	2	9	1	324	36	328
15. JOLLY MARDEN	3	A	0	1	1	1	9	8	81	72	145
17. NORTHERN FUR SEAL	6	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	6	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	10	A	0	0	0	5	0	0	0	0	0
23. WALRUS	3	A	0	0	0	5	0	0	0	0	0
24. WHALES	1	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	1	P	0	0	0	5	0	0	0	0	0
31. SEABIRDS	10	P	0	0	0	5	9	1	450	54	455
									5147	1386	6669
2. SUBTIDAL SAND-MUD											
1. COD	10	A	2	0	1	2	4	0	200	0	200
2. SCULPINS	15	A	6	0	0	2	4	0	120	0	120
3. STARRY FLOUNDER	6	A	0	0	0	2	4	0	48	0	48
4. OTHER FLATFISH	15	A	2	0	1	2	4	0	300	0	300
5. PACIFIC SANDLANCE	10	A	0	0	0	3	9	1	270	30	272
6. MISC. MARINE FISH	6	A	0	0	0	2	4	0	48	0	48

TABLE 2-17. (CONT'D)

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U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. SUBTIDAL SAND-MUD											
7. DUNGENESS CRAB	1	A	1	1	1	2	4	0	20	0	20
8. SHRIMP	1	A	0	0	0	2	9	1	27	3	27
9. RAZOR CLAM	6	A	0	0	0	2	4	1	48	12	54
10. OTHER BIVALVES	6	A	0	0	0	1	4	1	24	6	26
11. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	9	1	405	45	410
									1519	96	1523
5. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	2	E	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	10	A	2	0	2	2	9	1	540	60	547
4. PACIFIC HALIBUT	10	A	3	0	0	2	4	0	200	0	200
5. OTHER FLATFISH	6	A	2	0	0	2	4	0	96	0	96
6. GREENLINGS	3	A	0	0	0	2	4	0	24	0	24
8. WALLEYE POLLOCK	3	A	2	0	0	2	4	0	60	0	60
9. OTHER MARINE FISH	6	A	2	0	0	2	4	0	96	0	96
10. KING CRAB	15	A	3	0	1	2	4	0	360	0	360
11. TANNER CRAB	10	A	3	0	1	2	4	0	240	0	240
13. OTHER MARINE INVERTEBRATES	6	A	0	1	1	3	9	1	270	30	273
									1886	90	1896
4. INTERTIDAL SAND-MUD											
1. EELGRASS	10	A	0	0	0	3	0	0	0	0	0
2. PACIFIC SANDLANCE	10	A	0	0	0	3	0	0	0	0	0
3. RAZOR CLAM	6	A	1	2	2	2	0	0	0	0	0
4. SOFTSHELL BIVALVES	6	A	0	1	0	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	10	E	0	0	0	2	0	0	0	0	0
7. SHOREBIRDS	6	D	0	0	0	5	0	0	0	0	0
9. GEESE	10	A	1	1	1	1	0	0	0	0	0
9. DUCKS	6	A	1	1	2	2	0	0	0	0	0
10. SWANS	10	A	0	0	0	5	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	1	E	0	0	0	2	0	0	0	0	0
2. GREENLINGS	3	A	0	0	0	2	0	0	0	0	0
3. HERRING	10	A	2	0	0	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	1	H	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	3	H	0	0	0	2	0	0	0	0	0

TABLE 2-17. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	3	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	P	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	3	A	0	0	1	2	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	1	F	0	0	0	3	1	0	3	0	3
2. SNAILS	6	A	0	0	0	3	9	1	162	18	164
3. HARDSHELL BIVALVES	3	F	6	1	1	2	4	1	48	12	51
4. CRUSTACEANS	10	M	0	0	0	2	4	0	80	0	80
5. BACTERIOIDS	10	M	0	0	0	3	4	1	120	10	123
6. SHOREBIRDS	3	P	0	0	0	5	9	1	135	15	137
									548	75	567
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	6	F	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	6	F	0	0	0	3	0	0	0	0	0
3. KING SALMON	15	A	1	1	2	2	0	0	0	0	0
4. CHUM SALMON	10	A	2	0	2	2	0	0	0	0	0
5. SOCKEYE SALMON	15	A	3	1	2	2	0	0	0	0	0
6. PINK SALMON	10	A	1	1	2	2	0	0	0	0	0
7. COHO SALMON	6	A	1	1	2	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	7	A	0	1	1	1	0	0	0	0	0
9. DOLLY VARDEN	3	A	0	1	1	1	0	0	0	0	0
11. ARCTIC GRAYLING	6	E	0	1	0	2	0	0	0	0	0
12. PIKE	3	F	0	1	0	1	0	0	0	0	0
13. STICKLEBACKS	3	E	0	0	0	3	0	0	0	0	0
14. OTHER FISH	3	F	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	1	1	2	2	0	0	0	0	0
16. GEESE	15	A	1	1	1	2	0	0	0	0	0
17. SWANS	10	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	6	P	1	0	0	1	0	0	0	0	0
19. MINK	6	P	1	0	0	1	0	0	0	0	0
20. MUSKRAT	6	P	1	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	P	1	0	0	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											

TABLE 2-17. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	DSIT.
S. TERRESTRIAL											
1. FORBS	6	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	9	E	0	0	0	2	0	0	0	0	0
3. UPLAND VEGETATION	10	E	0	0	0	1	1	0	10	0	10
4. OTHER VEGETATION	3	A	0	0	0	2	1	0	6	0	6
5. SMALL BIRDS	10	A	3	1	0	2	0	0	0	0	0
7. RODENTS	6	A	1	1	0	1	0	0	0	0	0
8. APES	6	A	1	1	0	1	0	0	0	0	0
9. DEER	10	A	2	1	1	2	0	0	0	0	0
10. CARIBOU	10	A	2	1	1	2	0	0	0	0	0
16. OTHER MAMMALS	10	A	1	1	0	2	1	0	40	0	40
17. PREDATORS	15	A	0	0	0	5	1	0	75	0	75
18. PTARMIGAN	6	E	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	10	A	0	0	0	2	0	0	0	0	0
									131	0	131
									2222	2247	10799

this habitat. Seabirds were classified as protected and were judged to be the most sensitive to a diesel-2 spill in this habitat in Winter.

THE SUBTIDAL SAND/MUD HABITAT contributed 43 percent (3,405) of the impact score for this case. The major contributors to this impact score in this habitat were cods (120), other flatfish (200), and other marine invertebrates (2,700). The flatfish and invertebrates were among the most abundant in this habitat. Cods and flatfish were rated moderate in commercial importance and minor in subsistence importance. The invertebrates were judged to be the most sensitive to a diesel-2 spill in this habitat in Winter.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (848) of the impact score for this case. King crab (360) and tanner crab (240) were the major contributors to the impact score in this habitat. The crabs were the most abundant species in this habitat. Both species were rated major in commercial importance and minor in subsistence importance.

THE INTERTIDAL SAND/MUD HABITAT contributed 38 percent (3,023) of the impact score for this case. The major contributors to this impact score in this habitat were eelgrass (128), razor clams (179), softshell bivalves (290), invertebrate infauna (1,620), geese (102), ducks (328), and swans (213). Eelgrass and swans were the most abundant species in this habitat in Winter. Clams, geese and ducks were rated minor in commerical importance. Clams were rated moderate and bivalves, geese and ducks minor in recreational importance. Clams and ducks were rated moderate and geese minor in subsistence importance. Infauna and ducks were judged to be among the most sensitive to a diesel-2 spill in this habitat in Winter. Swans were classified as protected.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 3 percent (238) of the impact score for this case. Gastropods (77) were the largest contributor to the impact score in this habitat. They were among the most abundant and among the most sensitive to a diesel-2 spill in this habitat in Winter.

THE TERRESTRIAL HABITAT contributed 3 percent (206) of the impact score for this case. Raptors (120) were the only significant contributors to the impact score in this habitat. They were judged to be the most sensitive to a diesel-2 spill in this habitat in Winter and were classified as protected.

Table 2-18 following presents the full results of Case 3.

CASE 4: SUMMER, BUNKER-C, 10,000 BBLS - ESTIMATED SCORE 6,382

THE PELAGIC HABITAT contributed 30 percent (1,930) of the score for this case. Herring, crab larvae, king salmon, chum salmon, sockeye salmon, pink salmon, coho salmon, and seabirds were judged to be major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 19 percent (1,198) of the score for this case. Pacific sandlance and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 37 percent (2,380) of the score for this case. Chum salmon, king crab, and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (515) of the score for this case. Smelt were judged to be the only substantial contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 6 percent (359) of the score for this case. Raptors were judged to be the only substantial contributor to the score in this habitat.

TABLE 2-18. MATRIX RESULTS--CASE 3.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	PORT MOLLER
SEASON	WINTER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PLAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	1	0	18	0	18
2. ZOOPLANKTON	6	A	0	0	0	3	1	0	18	0	18
3. ICHTHYOPLANKTON	3	A	0	0	2	2	1	0	12	0	12
5. SQUID	1	A	0	0	0	3	0	0	3	0	3
6. PACIFIC HALIBUT	3	A	0	0	0	3	1	0	9	0	9
7. HERRING	6	A	2	0	0	3	1	0	30	0	30
8. SMELT	3	A	0	0	0	3	1	0	9	0	9
16. DUSKY SHARK	1	A	0	0	0	1	1	0	1	0	1
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	6	A	0	0	0	5	0	0	0	0	0
23. SEA LIONS	6	A	0	0	0	5	0	0	0	0	0
24. WALRUS	1	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	0	0	0	0	0
29. SEABIRDS	3	P	0	0	0	5	4	0	60	0	60
									157	0	157
3. BENTHIC/DEMERSAL											
1. COD	6	A	2	0	1	2	4	0	120	0	120
2. POLLOCK	10	A	0	0	0	2	4	0	80	0	80
3. OTHER FLOUNDER	3	A	0	0	0	2	4	0	24	0	24
4. OTHER GROUNDFISH	10	A	2	0	1	2	4	0	200	0	200
5. PACIFIC HALIBUT	3	A	0	0	0	2	0	1	51	9	60
6. MISC. MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
8. SHRIMP	1	A	0	0	0	3	0	1	27	9	27
9. RAZOR CLAM	6	A	0	0	0	2	4	1	48	12	60
10. OTHER BIVALVES	6	A	0	0	0	1	0	9	54	48	60
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	2	0	27	270	810	2700
									928	882	3405

TABLE 2-18. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	1	F	0	0	0	2	0	0	0	0	0
4. PACIFIC HALIBUT	2	A	3	3	0	2	4	0	60	0	60
5. OTHER FLATFISH	3	A	2	3	0	2	4	0	48	0	48
6. GREENLING	1	A	0	0	0	2	4	0	0	0	0
8. WALLEYE POLLOCK	1	A	2	3	0	2	4	0	20	0	20
9. OTHER MARINE FISH	3	A	2	0	0	2	4	0	48	0	48
10. KING CRAB	15	A	3	0	1	2	4	0	360	0	360
11. TANNER CRAB	10	A	3	0	1	2	4	0	240	0	240
13. OTHER MARINE INVERTEBRATES	3	A	0	1	1	3	4	1	60	15	64
									836	15	840
4. INTERTIDAL SAND-MUD											
1. CRUSTACEANS	10	A	0	0	0	3	4	1	120	30	120
2. RAZOR CLAM	3	A	0	0	0	2	9	1	41	9	42
3. BEAN CLAM	6	A	1	2	2	2	4	1	168	42	170
4. SOFT-SHELL BIVALVES	6	A	0	1	0	2	9	9	162	144	200
5. INVERTEBRATE INFAUNA	6	E	0	0	0	3	9	27	162	486	1620
7. SHOREBIRDS	1	P	0	0	0	5	9	8	45	40	81
8. GEESE	6	A	1	1	1	1	4	1	96	24	102
9. DUCKS	6	A	1	1	2	2	9	1	324	36	329
10. SWANS	10	A	0	0	0	5	4	1	200	50	217
									1759	961	2023
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	1	E	0	0	0	3	0	0	0	0	0
2. SEALIONS	2	A	0	0	0	2	0	0	0	0	0
7. HERRING	6	A	2	0	0	2	0	0	0	0	0
4. SPECIALE MARINE INVERTEBRATES	1	M	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	1	M	0	0	0	2	0	0	0	0	0
6. OTHER INVERTEBRATES	1	M	0	0	0	2	0	0	0	0	0
7. SHOREBIRDS	1	P	0	0	0	5	0	0	0	0	0
9. SEA DUCKS	3	A	0	0	0	2	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INVERTEBRATE STRANDERS	1	F	0	0	0	3	1	0	9	0	9
2. SHELF	2	A	0	0	0	3	4	1	36	9	38

TABLE 2-18. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUR.	ECOL.	S.TON	L.TON	S.TON	L.TON	RSLT.
6. INTERTIDAL COBBLE-GRAVEL											
3. HARDSHELL BIVALVES	3	F	0	1	1	2	4	1	44	12	51
4. CRUSTACEANS	6	M	0	0	0	3	4	1	48	8	44
5. GASTROPODS	6	M	0	0	0	3	4	1	72	19	77
6. POLYCHAETES	1	P	0	0	0	5	4	1	20	5	21
									227	44	293
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	1	E	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	1	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	15	A	1	1	2	2	0	0	0	0	0
4. CHUM SALMON	10	A	2	0	2	2	0	0	0	0	0
5. SOCKEYE SALMON	15	A	2	1	2	2	0	0	0	0	0
6. PINK SALMON	10	A	1	1	2	2	0	0	0	0	0
7. COHO SALMON	6	A	1	1	2	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	1	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	A	0	1	1	1	0	0	0	0	0
11. ARCTIC GRAYLING	3	E	0	1	0	2	0	0	0	0	0
12. DACE	1	E	0	1	0	1	0	0	0	0	0
13. STICKLEBACKS	1	E	0	0	0	3	0	0	0	0	0
14. OTHER FISH	1	E	0	0	0	3	0	0	0	0	0
15. JUNCOS	6	A	1	1	2	2	0	0	0	0	0
16. GEESE	3	A	1	1	1	2	0	0	0	0	0
17. SWANS	3	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	6	P	1	0	0	1	0	0	0	0	0
19. MINK	6	P	1	0	0	1	0	0	0	0	0
20. MUSKRAT	6	P	1	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	P	1	0	0	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	6	A	0	0	0	3	1	0	18	0	18
2. RIPARIAN VEGETATION	1	E	0	0	0	2	1	0	2	0	2
4. OTHER VEGETATION	1	A	0	0	0	2	1	0	2	0	2
7. WOLVERINE	6	A	1	1	0	1	1	0	18	0	18
8. MOLE	6	A	1	1	0	1	0	0	0	0	0
9. MOOSE	6	A	2	1	1	2	0	0	0	0	0
10. CARIBOU	6	A	2	1	1	2	0	0	0	0	0
16. OTHER MAMMALS	10	A	1	1	0	2	1	0	40	0	40
17. RAPTORS	6	A	0	0	0	5	4	0	120	0	120
19. PTARMIGAN	6	P	0	0	0	2	0	0	0	0	0

TABLE 2-18. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
17. OTHER BIRDS	3	8	0	0	0	2	1	8	6	0	6
									236	0	708
									7720	1902	7877

CASE 5: WINTER, CRUDE OIL, 10,000 BBLS - ESTIMATED SCORE 5,888

THE PELAGIC HABITAT contributed 2 percent (117) of the score for this case. Seabirds were judged to be the largest contributor to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 43 percent (2,543) of the score for this case. Cods, other flatfish, and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (634) of the score for this case. King crab and tanner crab were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 38 percent (2,260) of the score for this case. Razor clams, softshell bivalves, invertebrate infauna, ducks, and swans were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 3 percent (178) of the score for this case. No individual species was judged to be a major contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 3 percent (154) of the score in this case. Raptors were judged to be the largest contributor to the score in this habitat.

CASE 6: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 5,724

THE PELAGIC HABITAT contributed 63 percent (3,590) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Pacific Sandlance	reduced	to	30	from	120
Herring	reduced	to	456	from	806
Smelt	reduced	to	77	from	164
Crab Larvae	reduced	to	273	from	483
King Salmon	reduced	to	383	from	820
Chum Salmon	reduced	to	255	from	547
Sockeye	reduced	to	1,093	from	1,933
Pink Salmon	reduced	to	255	from	547
Coho Salmon	reduced	to	153	from	328
Dolly Varden	reduced	to	82	from	145
Seabirds	reduced	to	213	from	456

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (1,125) of the impact score for this case. With minor exceptions, the decrease in impact score in this habitat from Case 1 is accounted for by the following species:

Pacific Sandlance	reduced	to	128	from	273
Other Marine Invertebrates	reduced	to	191	from	410

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (1,009) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Chum Salmon	reduced	to	255	from	547
King Crab	reduced	to	90	from	360
Tanner Crab	reduced	to	60	from	240
Other Marine Invertebrates	reduced	to	128	from	273

THE INTERTIDAL and TERRESTRIAL HABITATS were not impacted by the smaller spill sizes in the Summer scenario.

CASE 7: WINTER, BUNKER C, 10,000 BBLS - ESTIMATED SCORE 4,782

THE PELAGIC HABITAT contributed 2 percent (95) of the score for this case. No individual species was judged to be a major contributor to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 43 percent (2,068) of the score for this case. Other flatfish and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (515) of the score for this case. King crab and tanner crab were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 38 percent (1,835) of the score for the case. Softshell bivalves, invertebrate infauna, ducks, and swans were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 3 percent (144) of the score for this case. No individual species was judged to be a major contributor to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 3 percent (125) of the score for this case. No individual species was judged to be a major contributor to the score in this habitat.

CASE 8: SUMMER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 3,512

THE PELAGIC HABITAT contributed 63 percent (2,202) of the score in this case. Herring, crab larvae, king salmon, chum salmon, sockeye salmon, pink

salmon and seabirds were judged to be major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (690) of the score for this case. Cods, other flatfish and other marine invertebrates were judged to be major contributors to the score in this case.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (619) of the score for this case. Chum salmon and Pacific halibut were judged to be the major contributors to the score in this case.

CASE 9: SUMMER, BUNKER C, 1,000 BBLS - ESTIMATED SCORE 2,561

THE PELAGIC HABITAT contributed 63 percent (1,606) of the score for this case. Herring, crab larvae, king salmon, chum salmon, sockeye salmon, and pink salmon were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (503) of the score for this case. Other flatfish were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (451) of the score for this case. Chum salmon were judged to be the major contributor to the score in this habitat.

CASE 10: WINTER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 2,420

THE PELAGIC HABITAT contributed 4 percent (102) of the impact score for this case. With minor exceptions, seabirds reduced to 15 from 60 accounted for the decrease in habitat score from Case 3 in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 35 percent (846) of the impact score for this case. With minor exceptions, the decrease in impact score for

this habitat from Case 3 is accounted for by the following species:

Pacific Sandlance	reduced	to	38	from	82
Other Bivalves	reduced	to	26	from	97
Other Marine Invertebrates	reduced	to	273	from	2,700

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (256) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Pacific Halibut	reduced	to	15	from	60
Other Flatfish	reduced	to	12	from	48
Other Marine Fish	reduced	to	12	from	48
King Crab	reduced	to	90	from	360
Tanner Crab	reduced	to	60	from	240

THE INTERTIDAL SAND/MUD HABITAT contributed 42 percent (1,028) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Softshell Bivalves	reduced	to	77	from	290
Invertebrate Infauna	reduced	to	164	from	1,620
Shorebirds	reduced	to	21	from	81
Ducks	reduced	to	144	from	328

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (188) of the impact score for this case. With minor exceptions, crustaceans reduced to 12 from 48 accounted for the decrease in impact score for this habitat from Case 3.

CASE 11: WINTER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 1,945

THE PELAGIC HABITAT contributed 4 percent (82) of the score for this case. No individual species was judged to be a major contributor to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 35 percent (680) of the score for this case. Other flatfish and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (206) of the score for this case. No individual species was judged to be a major contributor to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 42 percent (826) of the score for this case. Razor clam, invertebrate infauna, and swans were judged to be the major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (151) of the score for this case. No individual species was judged to be a major contributor to the score in this habitat.

CASE 12: SUMMER, GASOLINE, 10,000 BBLS - IMPACT SCORE 1,587

THE PELAGIC HABITAT contributed 57 percent (883) of the impact score for this case. With the exception of ichthyoplankton, all species impact scores were substantially changed in this habitat from Case 6. The results in this habitat were as follows:

Pacific Sandlance	increased	to	120	from 30
Phytoplankton	reduced	to	30	from 120
Zooplankton	reduced	to	30	from 120
Herring	reduced	to	200	from 456

Smelt	reduced	to	18	from	77
Crab Larvae	reduced	to	30	from	277
King Salmon	reduced	to	90	from	383
Chum Salmon	reduced	to	60	from	255
Sockeye Salmon	reduced	to	120	from	1,093
Pink Salmon	reduced	to	60	from	255
Coho Salmon	reduced	to	36	from	153
Dolly Varden	reduced	to	9	from	82
Seabirds	reduced	to	0	from	213

THE SUBTIDAL SAND/MUD HABITAT contributed 18 percent (278) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 6 is accounted for by the following species:

Cods	reduced	to	0	from	200
Sculpins	reduced	to	30	from	120
Starry Flounder	reduced	to	0	from	48
Other Flatfish	reduced	to	0	from	300
Pacific Sandlance	reduced	to	30	from	128
Miscellaneous Marine Fish	reduced	to	12	from	48
Razor Clam	reduced	to	12	from	48

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (180) of the impact score for this case. With a minor exception, the decrease in impact score for this habitat from Case 6 is accounted for by the following species:

Chum Salmon	reduced	to	60	from	255
Pacific Halibut	reduced	to	0	from	200

Other Flatfish	reduced	to	0	from	96
Greenlings	reduced	to	0	from	24
Walleye Pollock	reduced	to	0	from	60
Other Marine Fish	reduced	to	0	from	96
King Crab	reduced	to	0	from	90
Tanner Crab	reduced	to	0	from	60

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 14 percent (230) of the impact score for this case. This habitat was not impacted in Case 6. The species impact scores in this habitat for this case were smelt (18), hardshell bivalves (12), crustaceans (20), gastropods (120), and shorebirds (60).

THE TERRESTRIAL HABITAT contributed 1 percent (16) of the impact score for this case. This habitat was not impacted in Case 6. The species impact score in this habitat for this case were strand vegetation (10) and other vegetation (6).

CASE 13: WINTER, GASOLINE, 10,000 BBLS - IMPACT SCORE 1,188

THE PELAGIC HABITAT contributed 4 percent (51) of the impact score for this case. The change in impact score for this habitat from Case 10 is accounted for by minor changes in six species.

THE SUBTIDAL SAND/MUD HABITAT contributed 33 percent (388) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 10 is accounted for by the following species:

Cods	reduced	to	0	from	120
Sculpins	reduced	to	20	from	80
Starry Flounder	reduced	to	0	from	24

Other Flatfish	reduced	to	0	from	200
Pacific Sandlance	reduced	to	9	from	38
Miscellaneous Marine Fish	reduced	to	0	from	24

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 1 percent (15) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 10 is accounted for by the following species:

King Crab	reduced	to	0	from	90
Tanner Crab	reduced	to	0	from	60
Other Marine Invertebrates	reduced	to	15	from	60

THE INTERTIDAL SAND/MUD HABITAT CONTRIBUTED 56 percent (661) of the impact score for this case. The change in impact score for this habitat from Case 10 is accounted for by the following species:

Softshell Bivalves	increased	to	164	from	77
Invertebrate Infauna	increased	to	290	from	164
Eelgrass	reduced	to	30	from	120
Pacific Sandlance	reduced	to	9	from	38
Shorebirds	reduced	to	0	from	21
Geese	reduced	to	0	from	96
Ducks	reduced	to	0	from	144
Swans	reduced	to	0	from	200

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 16 percent (188) of the impact score for this case. The decrease in impact score for this habitat from Case 10 is accounted for by the following species:

Smelt	reduced	to	9	from	36
Hardshell Bivalves	reduced	to	12	from	48
Gastropods	reduced	to	18	from	72
Shorebirds	reduced	to	0	from	20

THE TERRESTRIAL HABITAT contributed 2 percent (22) of the impact score for this case. This habitat was not impacted in Case 10. The largest contributor to the impact score in this habit was tundra (18).

CASE 14: WINTER, BUNKER C, 1,000 BBLS - ESTIMATED SCORE 1,180

THE PELAGIC HABITAT contributed 4 percent (50) of the score for this case. No individual species was judged to be a major contributor to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 35 percent (413) of the score for this case. Other flatfish and other marine invertebrates were judged to be the major contributors to the score in this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (125) of the score for this case. King crab were judged to be the largest contributor to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 42 percent (501) of the score for this case. Razor clam, invertebrate infauna and swans were judged to be major contributors to the score in this habitat.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (92) of the score for this case. Gastropods were judged to be the largest contributor to the score in this habitat.

CASE 15: SUMMER, DIESEL-2, 100 BBLS - IMPACT SCORE 1,138

THE PELAGIC HABITAT contributed 85 percent (970) of the impact score for this case. The change in impact score for this habitat from Case 12 is accounted for by the following species:

Sockeye Salmon	increased	to	480	from	120
Seabirds	increased	to	50	from	0
Dolly Varden	increased	to	36	from	9
Ichthyoplankton	reduced	to	0	from	80
Pacific Sandlance	reduced	to	0	from	120
Herring	reduced	to	50	from	200

THE SUBTIDAL SAND/MUD HABITAT contributed 7 percent (78) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 12 is accounted for by the following species:

Sculpins	reduced	to	0	from	30
Other Marine Invertebrates	reduced	to	45	from	180

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (90) of the impact score for this case. Other marine invertebrates, reduced to 30 from 120, accounted for the change in impact score for this habitat from Case 12.

The impact scores for Cases 16 through 24 range from 597 down to 38. The spill sizes for these cases are 1,000 barrels for gasoline and 100 barrels for all products in both seasons. The array of these scores is:

	SPILL SIZE BY SEASON			
	1,000 BBLS		100 BBLS	
SPILL TYPE	SUMMER	WINTER	SUMMER	WINTER
Diesel-2	See Case 6	See Case 10	See Case 15	184
Crude Oil	See Case 8	See Case 11	584	264
Bunker-C	See Case 9	See Case 14	597	105
Gasoline	286	214	50	38

The relatively low scores for these cases and the minor differences between cases makes case-by-case comparison have little meaning. These nine cases were judged to be of minimal impact without cleanup and a cleanup scenario is not addressed to them.

(9) KVICHAK BAY

Kvichak Bay is located at the eastern end of Bristol Bay where the Alaska Peninsula meets the mainland. The Kvichak, Alagnak, and Naknek rivers empty into Kvichak Bay. The oil spill site was chosen at a spot about 20 miles west-southwest of Naknek at 58°35.56'N latitude, 157°30'W longitude (Fig. 2-57).

(a) PHYSICAL CHARACTERISTICS

Kvichak Bay is located in the transitional climatic zone. It is shielded from the maritime influence of the Gulf of Alaska by the Aleutian Range to the south and east and from the continental influence of the interior by the Ahklum Mountains to the north. The coastal areas are gently rolling tundra.

TEMPERATURES

Temperatures typically range from 35°F to 63°F in Summer and from 6°F to 43°F in Winter at King Salmon. Record high and low temperatures are 88°F and -43°F.[1,4]

Ice forms in Kvichak Bay beginning in November. The average date of freezeup at Naknek is November 17th. The average date of breakup is April 9th.[8]

SURFACE WINDS

Strong winds are experienced during Winter due to cyclonic storm activity. Winds prevail generally from the north in Winter and from the south in Summer,[2] typical of much of Bristol Bay. Representative winds were chosen as south-southwest at 8.5 knots during Summer and north at 7.0 knots during Fall for the ice-free periods.

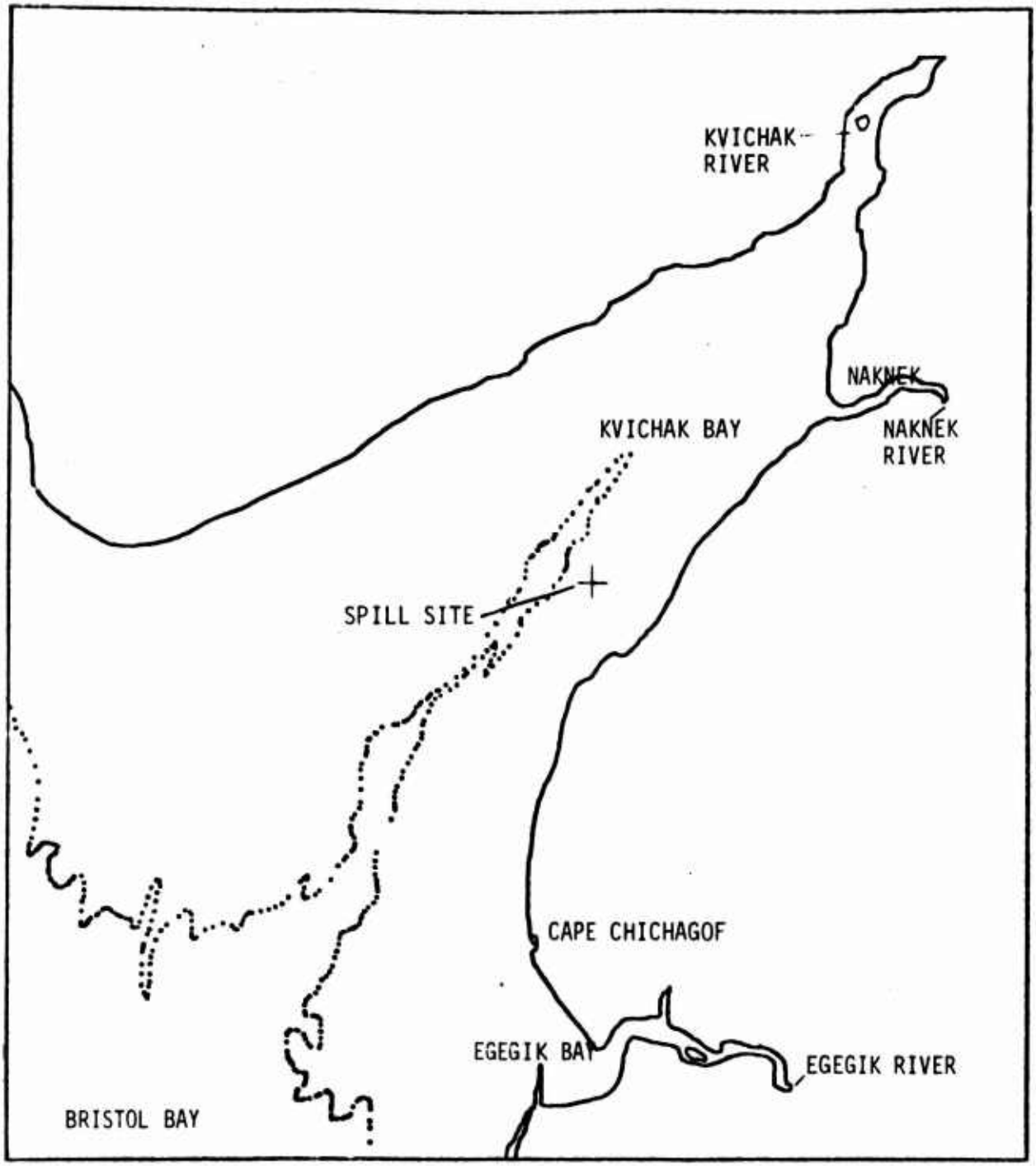


FIGURE 2-57. THE KVICHAK BAY LOCATION AND SPILL SITE

NOTE: The broken line is the 10 fathom (60 feet) contour. Scale can be determined from an axis of the spill site cross (equal about 2 miles or 3.3 km).

SURFACE CURRENTS

Little information was located on Kvichak Bay's surface currents in the study area.

The *TIDAL CURRENT TABLES* [9] indicated the following information:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Kvichak Bay (off Naknek river entrance)	2.5 knots(240°)	2.5 knots(055°)
KVICHAK RIVER	3.0 knots(260°)	1.7 knots(080°)

The *COAST PILOT* [8] provided the following information about currents in the vicinity of the Kvichak Bay spill site:

AREA	COMMENT
Naknek River Entrance	Diurnal tidal range is 22.6 feet.
Kvichak Bay and River	Current is very strong with velocity of 3.5 knots in lower part of Bay and 2.5 knots in the main ship anchorage at Naknek.
Naknek River(Morakas Point)	Current velocities 1 knot on the flood, 2 knots on the ebb.

The information on currents used by MSNW in oil dispersion modelling of Kvichak Bay was as follows:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Kvichak River Entrance into Bay	3.0 knots (260°)	1.7 knots (080°)
Naknek Vicinity	2.0 knots (290°)	1.0 knot (070°)
Egegik Bay	2.0 knots (290°)	1.0 knot (080°)
General Kvichak Bay	2.5 knots (240°)	2.5 knots (055°)

See the Port Moller location description for additional information on currents in Bristol Bay west of Kvichak Bay.

(b) BIOLOGICAL CHARACTERISTICS

The Kvichak Bay vicinity is known primarily for its huge runs of sockeye salmon. The largest run in the world is into the Kvichak River, which drains into Kvichak Bay. The marine resources have not been studied in detail in Kvichak Bay and the intertidal shore areas. Waterfowl and terrestrial mammals are abundant in this area. The main source of information on the marine environment was *THE BRISTOL BAY ENVIRONMENT*[44] and terrestrial information was obtained from several sources.[17,47,48]

Resource summaries are shown in Figure 2-58.

FISHES

SALMONIDS - The Kvichak River, which drains into Kvichak Bay, is the largest single producer of sockeye salmon in the world. The run of returning adult sockeye salmon has varied from 1 to nearly 50 million in recent years. This system determines the magnitude of the Bristol Bay run, since it constitutes up to 90 percent of the total.

Juvenile sockeye salmon leave their home rivers and move through the selected spill site on their out-migration from May 15th to July 15th (peak about mid-June). From Kvichak Bay they move fairly fast until they reach an area in the vicinity of Port Moller where they slow their migration and begin feeding. The numbers of juveniles transiting the spill site could amount to several million on any one day at their peak out-migration.

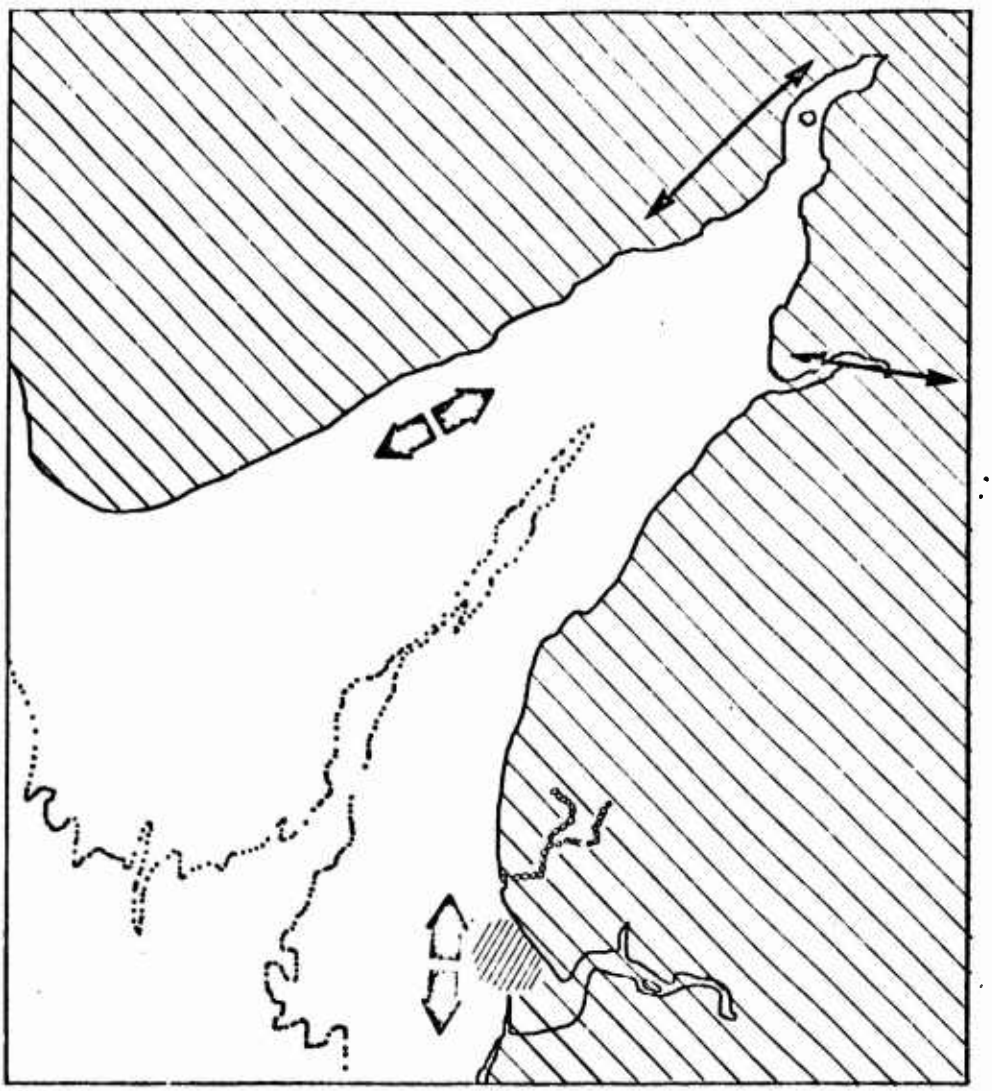


FIGURE 2-58. KVICHAK BAY CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

Returning adult sockeye salmon begin appearing in Kvichak Bay in early June (peak July 1st to 5th). The fishery usually operates from about June 20th through July, with 90 percent of the catch taken in the mid 15- to 20-day period. The returning sockeye adults often congregate at the river mouths before entering so the abundance at the selected spill site at any given location could potentially be very large--20 to 40 million fish.

The value of the sockeye salmon captured in the Naknek-Kvichak district can only be estimated from the total Bristol Bay fishery. If one assumes 60 to 70 percent as a good estimate of the Naknek-Kvichak districts' contribution, these mean (1967-1971) sockeye catches have the following values:

	Mean Value (Range)	
To the fishermen	About $8.6 million	(2.9 to 18.3)
Wholesale value	About $16.4 million	(8.2 to 31.1)

These values speak for themselves. The sockeye fishery is the economic base of the entire area and the Naknek-Kvichak district is the largest contributor.

Compared to the sockeye salmon, other species of salmon seem of little abundance or value; however, they do serve as an "economic buffer" in years of low sockeye abundance.

The other salmon species do not modify the sockeye "critical time windows" described. Adult king salmon enter earlier than the sockeye--in June, while adult chum and pink salmon enter the area about the same time as the sockeye salmon. Adult coho salmon enter the area late--late July to early August.

The juvenile out-migrants of king and coho leave within the time frame of sockeye smolts, and the pink and chum fry leave during early summer--late May to early June.

These salmon species have a value to the fishermen as follows, using mean catches (1951-1967) and 1967 prices:

SALMON	VALUE
Chinook (medium size)	$17,962
Coho	2,072
Pink (total)	5,113
Odd year	25
Even year	10,838
Chum	72,396

Dolly Varden are present in Kvichak Bay and occupy almost all freshwater systems in the Bristol Bay area.[44] Those in the marine waters represent anadromous populations of many of these freshwater stocks. Significant Dolly Varden systems near the Kvichak Bay spill site are the Ugashik and Nushagak river systems (south and west, respectively).[44]

Adult Dolly Varden overwinter in fresh water and out-migrate to the sea in the Spring, while juveniles probably out-migrate in late Spring and early Summer.[44] The rigors of this process are indicated by the suggestion that half or less survive to spawn a second time.

These char do not apparently make large excursions to sea as do the salmon but rather stay in the nearshore shallow waters near their home streams. This assumed behavior would keep them in a vulnerable position

with respect to oil products for the duration of their time in the marine environment.

PACIFIC HERRING are distributed far enough east in Bristol Bay to be present in Kvichak Bay. Herring appear to be in low numbers in the Kvichak Bay area. They spawn northwest of the Bay (Constantine Point - Togiak Bay). One study[46] showed herring to also be numerous in the adjacent Naknek River estuary. See the Port Moller location description for more information on this species.

FLATFISHES occupy the Kvichak Bay vicinity as moderate catches (yellowfin sole) were made off Constantine Point west of the Bay. Starry flounder and longhead dab are also present.

MISCELLANEOUS MARINE FISHES include such fish as sandlance, poachers, cottids, smelt, and tom cod.

SHELLFISHES

KING CRAB are possibly in low numbers in Kvichak Bay with numbers increasing toward the center of Bristol Bay. No quantified information for Kvichak Bay was located.

TANNER CRAB, as king crab, are probably in low numbers in Kvichak Bay and increase in abundance toward the center of Bristol Bay. Again, no quantified information for Kvichak Bay was located.

SHRIMP, as king crab, are probably in low numbers in Kvichak Bay, but no specific data for the Bay were located.

RAZOR CLAMS were assumed to be in low numbers in the outer parts of Kvichak Bay.

WATERFOWL

The entire shore area of Kvichak Bay is waterfowl nesting and molting habitat.[17] The east and west shores of Kvichak Bay are major migration routes for waterfowl. The Naknek drainage and the lower Kvichak drainage are minor migration areas.[17]

DUCKS are extremely abundant in the vicinity of Kvichak Bay, with an estimated breeding density of 32 ducks per square mile.[17] The area is an important migration area for ducks. Production in the Bristol Bay lowlands averaged 350,000 ducks from 1956 to 1970.[48] In addition to these nesting populations, many thousands of migrant waterfowl occupy these lowlands during Spring and Fall.[48] The predominant ducks are pintail, mallard, green-winged teal, and American widgeon. Sea ducks are even more abundant with scaup, scoter, and oldsquaw the most numerous.[48]

GEESE are very abundant in Kvichak Bay and include all species found in Alaska. Good production is evident in this vicinity, but estimated production is not known. This is also an important migration area for geese. See Unimak Pass and Port Moller location descriptions for more details on these geese.

SWANS are abundant in the Kvichak vicinity, with a density estimate of two whistling swans per square mile in the adjacent lowlands.[17] Lowland surveys indicated 12,000 whistling swans occupying this general vicinity.[48] These large white birds are probably the most conspicuous waterfowl at this location.[48]

SEABIRDS are not present in colonies at this location;[17] nonetheless they are present in moderate numbers. The principal species in Kvichak Bay

are glaucous-winged gull, mew gull, herring gull, black-legged kittiwake, and northern phalarope. [44]

SHOREBIRDS - Of the shorebirds present in the Kvichak Bay vicinity, plovers are probably the most numerous and turnstones are also present here.[44] Specific information on shorebirds in this area was not located.

MARINE MAMMALS

HARBOR SEALS occur throughout Kvichak Bay and into the lower Kvichak River. [17] The only high density of seals is south of Kvichak Bay at the mouth of the Egegik River.[17] No population estimates were located, but they are in fair numbers here. They can be expected to be more numerous and concentrated in the Kvichak Bay concurrent with the presence of salmon.

BEARDED SEAL would be expected in small numbers on pack ice and near ice in the Winter months when ice is present in this vicinity.

SEA LIONS are assumed to be sparse in Kvichak Bay, as the nearest rookery is several hundred miles to the west.

WALRUS are assumed to come into Kvichak Bay from their center of activity in Bristol Bay in only a few numbers. Their nearest hauling ground is at Walrus Island (south of Togiak).

WHALES - The species of whales occurring in Kvichak Bay are the beluga and killer whales and the harbor porpoise)--see Figure 2-47 in Unimak Pass location description. Another source indicated these may all be beluga whales.[17] The beluga whales travel in groups, feed extensively on salmon, and often run up the estuaries of rivers.[17,48] Their presence in the Kvichak River mouth is of such importance that the Alaska Department of Fish and Game has been experimenting there with underwater sounds of killer whales to

frighten beluga whales away.[17] Major concentrations of beluga whales occur in the Summer months, with the presence of salmon.

TERRESTRIAL MAMMALS

BROWN BEAR are present but not very abundant in the Kvichak Bay vicinity. No intensive use areas areas are shown.[17] Concentrations occur inland on upper tributaries of the Naknek River (town of King Salmon vicinity) and on rivers in the Egegik Bay vicinity.[17]

CARIBOU range on all shores of Kvichak Bay with a Winter range shown along the eastern shore lowlands (Alaska Peninsula). The number of caribou near the potentially impactable areas was assumed to be small.

MOOSE are shown as present on all shore areas of Kvichak Bay, but the areas of concentration in Fall and Winter are inland (north and south of the town of King Salmon on the Naknek River).[17] Moose are expected to be low in number near potential impact areas.

WOLVES AND WOLVERINES are present throughout the vicinity.[17] Wolves are believed to be in low numbers in the area. Wolverines may be somewhat more numerous (or conspicuous) as they are commonly seen on beaches.

SMALL TERRESTRIAL MAMMALS include red fox and lynx, in the Iliamna - Lake Clark area inland and northeast of Kvichak Bay.

AQUATIC FURBEARERS are thought to be quite numerous[18] in nearshore areas, beaches, and marshes and include river otter, mink, and muskrat.[48]

FLORA

Terrestrial vegetation is not expected to be affected by the oil spills hypothesized at this area. Very little specific information is

available on the marine vegetation of this area. The digitized physical shoreline substrate information that MSNW interpreted from charts indicated that rock and cobble-gravel shores are lacking. Strand (beach) vegetation thus probably could occur on 100 percent of the shoreline in the area. Because of Winter ice-scouring, any vegetation which would develop in the Summer is probably sporadic and certainly destroyed during the Winter. Eelgrass beds are probably present but not extensive because of the lack of lagoons. Perhaps 10 percent of the shallow subtidal shoreline might be occupied by this species. Any marine algae present in this area are probably of the Arctic type, but the lack of rocky substrate indicates that there is little if any marine algae vegetation in the area. Floating kelps are absent.

For further physical and biological information on this location, see Appendix D .

(c) RESULTS

Five habitats were impacted by oil spills at this location. The pelagic and intertidal sand/mud habitats contributed the majority of the impact score for each case.

Oil spills were postulated for all four products. No 50,000-bbl spills were postulated. For similar spill sizes, the highest impact scores were for diesel-2 spills, followed by crude-oil, bunker C, and gasoline.

Species contributing significantly to the impact scores included herring, sockeye salmon, seabirds, shorebirds, and ducks. Although the spill trajectories were different for the two seasons, the majority of the seasonal difference in impact scores was attributable to species abundance changes.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Kvichak. The first scenario, using most probable Summer conditions, resulted in oil moving in a northerly direction to the north shore of Kvichak Bay (Fig. 2-59). The spills reach the shoreline approximately 50 hours after release. The second scenario resulted in oil moving in a southerly direction to the south shore of Kvichak Bay (Fig.2-60).The spill reached the shoreline approximately 24 hours after release. While both scenarios impact the same five habitats, there are wide variations in abundance of species within these habitats from Summer to Winter. The season described as Winter at this location is more accurately described as being late Fall, or just prior to the formation of the icepack in Kvichak Bay.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-19 presents the results of the oil spill scenarios examined at Kvichak without cleanup.

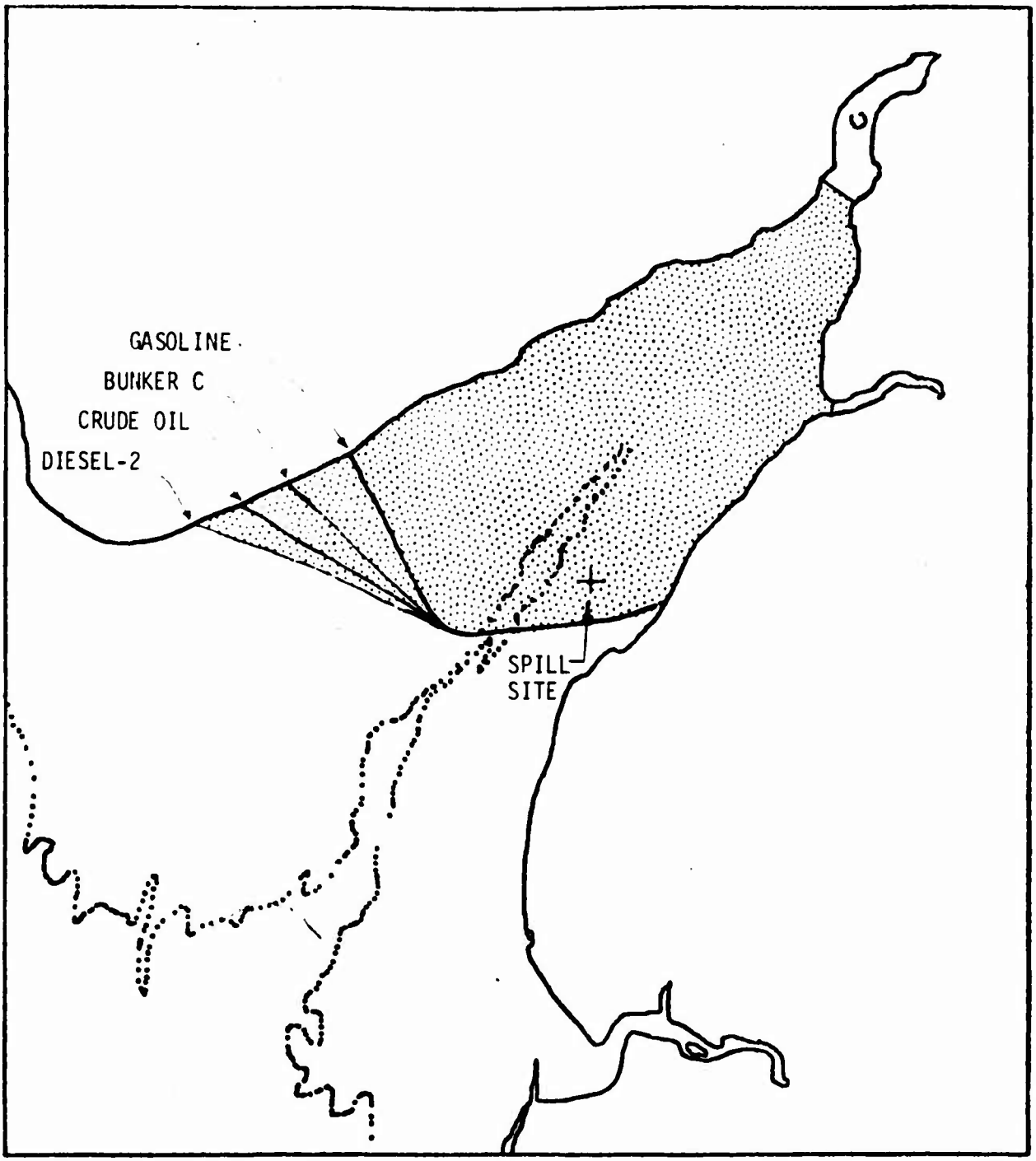


FIGURE 2- 59. KVICHAK SUMMER 10,000-BBL SPILL ENVELOPE

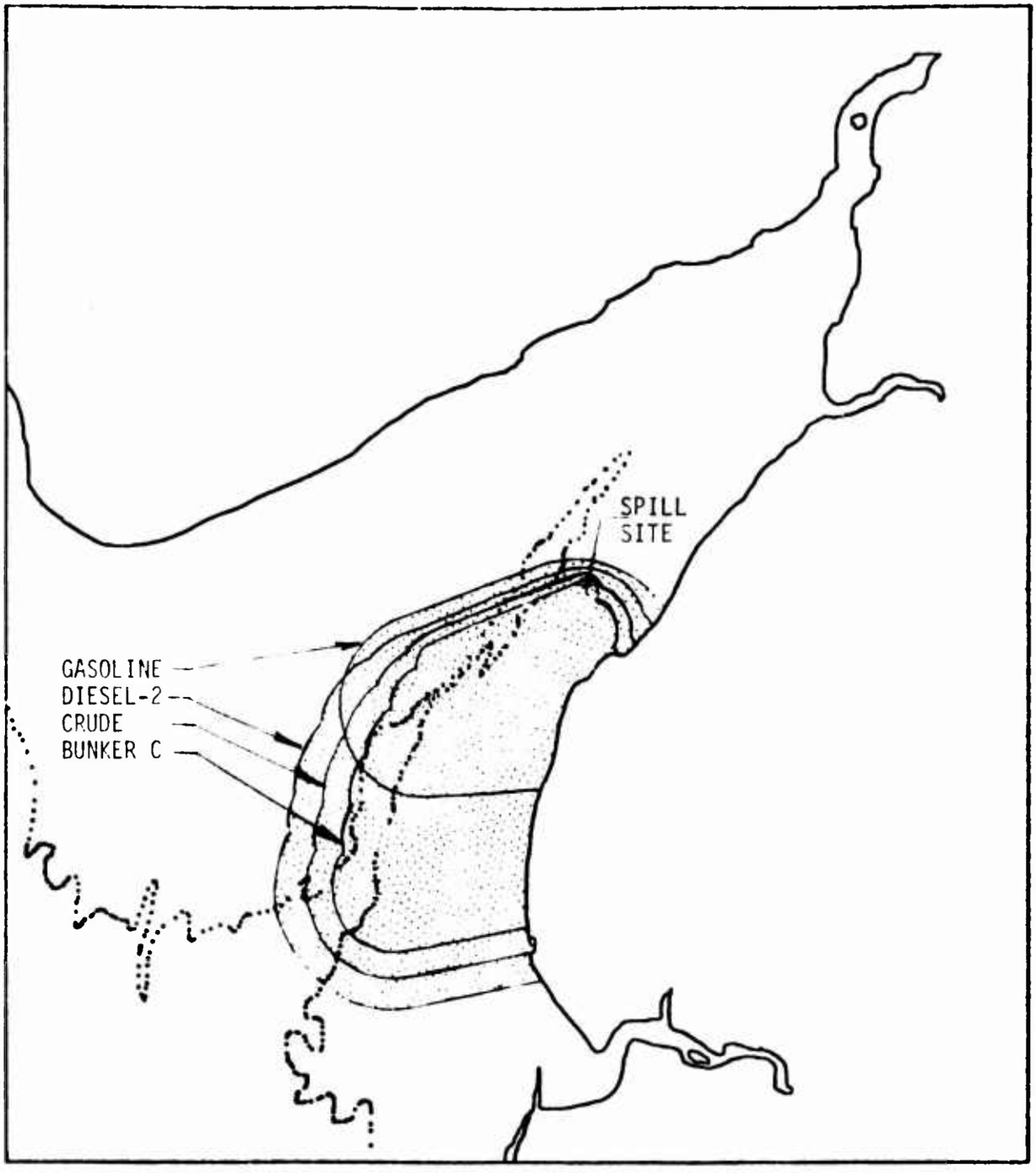


FIGURE 2-60. KVICHAK AUTUMN/WINTER 10,000-BBL SPILL ENVELOPE

TABLE 2-19. KVICHAK CASE RESULTS NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 10,000	1,000	100
SUMMER	Diesel-2	7,378 [1](1)	4,596 [3]	785 [13]
	Crude Oil	5,894 [2]	2,894 [5]	378 [16]
	Bunker C	4,367 [4]	2,118 [7]	412 [15]
	Gasoline	948 [12]	171 [19]	30 [23]
WINTER	Diesel-2	2,214 [6]	1,304 [10]	124 [20]
	Crude Oil	1,655 [8]	1,048 [11]	178 [18]
	Bunker C	1,344 [9]	636 [14]	71 [22]
	Gasoline	363 [17]	79 [21]	18 [24]

(1) Numbers in brackets are the case numbers that follow.

Only those habitats impacted by the spills will be discussed for the cases at Kvichak. Three habitats were not impacted by either the Summer or Winter scenarios.

CASE 1: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 7,378

THE PELAGIC HABITAT contributed 51 percent (3,729) of the impact score for this case. The species which were the main contributors to this impact score were herring (483), smelt (164), crab larvae (193), chum salmon (242), sockeye salmon (1692), and seabirds (456). Sockeye salmon and seabirds were the most abundant species in this habitat. Chum and sockeye salmon were judged to have importance for commercial, recreational and subsistence fishing. Seabirds were classified as protected. All six species were judged to be among the most sensitive to diesel-2 spills within this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (836) of the impact score for this case. The species which were the main contributors to this impact score were other flatfish (120), Pacific sandlance (164) and other marine invertebrates (273). The flatfish and marine invertebrates were among the most abundant species in this habitat. The three species were judged to be the most sensitive to diesel-2 spills within this habitat.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent of the impact score for this case. The species which were the main contributors to this impact score were chum salmon (242) and other marine invertebrates (164). The marine invertebrates were the most abundant species in this habitat. Chum salmon were noted as important to both commercial and subsistence fishing. These two species were judged to be the most sensitive to diesel-2 spills within this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 28 percent (2,070) of the impact score for this case. The species which were the main contributors to this impact score were Pacific sandlance (164), softshell bivalves (213), invertebrate infauna (273), shorebirds (806), geese (128) and ducks (328). These species were the most abundant in this habitat. The bivalves, geese and ducks were rated of some importance as recreational subsistence resources; in addition, geese and ducks were rated of minor importance as commercial resurce. The sandlance, infauna, shorebirds and ducks were judged to be the most sensitive species to diesel-2 spills in the habitat.

THE TERRESTRIAL HABITAT contributed 2 percent (151) of the impact score for this case. Raptors (75) were the only species which were major contributors to this impact score. They were the most abundant species in this habitat and were classified as protected.

Table 2-20 following presents the full results of Case 1.

CASE 2: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 5,894

THE PELAGIC HABITAT contributed 49 percent (2,888) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Herring	reduced	to 273 from 483
Smelt	reduced	to 77 from 164
Crab Larvae	reduced	to 109 from 193
Chum Salmon	reduced	to 137 from 242
Pink Salmon	reduced	to 46 from 81
Coho Salmon	reduced	to 46 from 81
Dolly Varden	reduced	to 55 from 97

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (590) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Pacific Sandlance	reduced	to 77 from 164
Other Marine Invertebrate	reduced	to 127 from 273

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (400) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Chum Salmon	reduced	to 137 from 242
Other Marine Invertebrates	reduced	to 77 from 164

TABLE 2-20. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA: KVICHAK
SEASON: SUMMER
SPILL SIZE: 10,000 BBLS.
SPILL TYPE: NO. 2 DIESEL OIL
SPILL MODE: TANKER CASUALTY
RELEASE TYPE: INSTANTANEOUS
SPILL CLEANUP: NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	3	A	0	0	0	2	4	0	24	0	24
5. GREENLINGS	1	A	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	6	A	0	0	0	3	4	0	72	0	72
7. HERRING	5	A	2	0	0	3	9	8	270	240	483
8. SMELT	6	A	0	0	0	3	9	1	162	18	164
9. CRAB LARVAE	6	A	0	0	0	2	9	8	108	96	193
11. CHUM SALMON	3	A	2	0	1	2	9	8	135	120	242
12. SOCKEYE SALMON	15	A	3	1	1	2	9	8	945	840	1692
13. PINK SALMON	1	A	1	1	1	2	9	8	45	40	81
14. COHO SALMON	1	A	1	1	1	2	9	8	45	40	81
16. DOLLY VARDEN	3	A	0	1	0	1	9	8	54	48	97
17. NORTHERN FUR SEAL	1	A	0	0	0	5	0	0	0	0	0
20. BEARDED SEAL	1	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	3	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	3	A	0	0	0	5	0	0	0	0	0
23. WALRUS	3	P	0	0	0	5	0	0	0	0	0
24. WHALES	6	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	6	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	P	0	0	0	5	9	1	450	50	456
									2454	1492	3729
2. SUBTIDAL SAND-MUD											
1. CODS	3	A	1	0	0	2	4	0	36	0	36
2. SCULPINS	6	A	0	0	0	2	4	0	48	0	48
3. STARRY FLOUNDER	10	A	0	0	0	2	4	0	80	0	80
4. OTHER FLATFISH	10	A	1	0	0	2	4	0	120	0	121
5. PACIFIC SANDLANCE	6	A	0	0	0	3	9	1	162	18	164
6. MISC. MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
8. SHRIMP	1	A	0	0	0	3	9	1	27	3	27

TABLE 2-20 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
9. RAZOR CLAM	3	E	1	0	0	2	4	1	36	9	38
10. OTHER BIVALVES	6	E	0	0	0	1	4	1	24	6	26
11. OTHER MARINE INVERTEBRATES	10	E	0	0	0	3	9	1	270	30	273
									827	66	836
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	1	E	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	3	A	2	0	1	2	9	8	135	128	242
4. PACIFIC HALIBUT	1	A	3	1	1	2	4	0	28	0	28
5. OTHER FLATFISH	3	A	0	0	0	2	4	0	24	0	24
6. GREENLINGS	1	A	0	0	0	2	4	0	8	0	8
9. OTHER MARINE FISH	3	A	1	0	0	2	4	0	36	0	36
10. KING CRAB	3	A	3	0	1	2	1	0	18	0	18
11. TANNER CRAB	3	A	3	0	1	2	4	0	72	0	72
12. OTHER MARINE INVERTEBRATES	6	E	0	0	0	3	9	1	162	18	164
									483	138	592
4. INTERTIDAL SAND-MUD											
1. EELGRASS	3	E	0	0	0	3	1	0	9	0	9
2. PACIFIC SANDLANCE	6	A	0	0	0	3	9	1	162	18	164
3. RAZOR CLAM	3	E	1	2	2	2	4	1	84	21	89
4. SOFTSHELL BIVALVES	10	E	0	1	2	2	4	1	200	50	213
5. INVERTEBRATE INFAUNA	10	A	0	0	0	3	9	1	270	30	273
7. SHOREBIRDS	10	P	0	0	0	5	9	8	450	400	806
8. SEAL	6	A	1	1	2	1	4	1	120	30	126
9. DUCKS	6	A	1	1	2	2	9	1	324	36	328
10. SWANS	3	A	0	0	0	5	4	0	60	0	60
									1679	585	2070
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	0	0	0	0	0
2. GREENLINGS	1	A	0	0	0	2	0	0	0	0	0
3. HERRING	6	A	2	0	0	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	1	M	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	1	M	0	0	0	2	0	0	0	0	0
6. OTHER INVERTEBRATES	1	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	P	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	3	A	0	0	0	2	0	0	0	0	0
									0	0	0

TABLE 2-20 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	0	0	0	0	0
2. SMELT	0	A	0	0	0	3	0	0	0	0	0
3. HARDSHELL BIVALVES	1	A	1	1	1	2	0	0	0	0	0
4. CRUSTACEANS	3	A	0	0	0	2	0	0	0	0	0
5. GASTROPODS	3	A	0	0	0	3	0	0	0	0	0
6. SHOREBIRDS	3	P	0	0	0	3	0	0	0	0	0
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	6	P	0	0	0	3	0	0	0	0	0
4. CHUM SALMON	3	A	2	0	1	2	0	0	0	0	0
5. SOCKEYE SALMON	15	A	3	1	1	2	0	0	0	0	0
6. PINK SALMON	1	A	1	1	1	2	0	0	0	0	0
7. COHO SALMON	1	A	1	1	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	1	0	1	0	0	0	0	0
9. DOLLY VARDEN	3	A	0	1	0	1	0	0	0	0	0
11. ARCTIC GRAYLING	0	A	0	2	1	2	0	0	0	0	0
12. PIKE	0	A	0	2	1	1	0	0	0	0	0
13. STICKLEBACKS	10	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	3	A	0	0	0	2	0	0	0	0	0
15. DUCKS	10	A	1	1	2	2	0	0	0	0	0
16. GEESE	15	A	1	1	2	2	0	0	0	0	0
17. SWANS	0	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	0	A	2	0	1	1	0	0	0	0	0
19. MINK	0	A	2	0	1	1	0	0	0	0	0
20. MUSKRAT	0	A	2	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	0	A	2	0	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	6	A	0	0	0	2	0	0	0	0	0
3. SWAMP VEGETATION	10	E	0	0	0	1	4	0	40	0	40
4. OTHER VEGETATION	6	A	0	0	0	2	1	0	12	0	12
5. BROWN BEAR	3	A	2	1	0	2	0	0	0	0	0
7. WOLVERINE	3	A	1	0	0	1	0	0	0	0	0
8. WOLF	3	A	1	0	0	1	0	0	0	0	0
9. MOOSE	6	A	2	2	0	2	0	0	0	0	0

TABLE 2-20 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
6. TERRESTRIAL											
15. CARIBOU	0	A	1	2	2	2	0	0	0	0	0
16. OTHER MAMMALS	0	A	0	1	1	2	1	0	24	0	24
17. RAPTORS	15	A	0	0	0	5	1	0	75	0	75
18. PTARMIGAN	0	A	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	6	A	0	0	0	2	0	0	0	0	0
									151	0	151
									5594	2281	7378

THE INTERTIDAL SAND/MUD HABITAT contributed 32 percent (1,865) of the mpact score for this case. The change in impact score for this habitat from ase 1 is accounted for by the following species:

Eelgrass	increased	to	36	from 9
Pacific Sandlance	reduced	to	77	from 164
Softshell Bivalves	reduced	to	128	from 273

THE TERRESTRIAL HABITAT contributed 3 percent (151) of the impact score or this case. This habitat's result was the same as for Case 1.

ASE 3: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 4,596

THE PELAGIC HABITAT contributed 59 percent (2,707) of the impact score or this case. The decrease in impact score for this habitat from Case 2 is counted for by the following species:

Pacific Sandlance	reduced	to	18	from 72
Chum Salmon	reduced	to	64	from 137
Coho Salmon	reduced	to	21	from 46
Dolly Varden	reduced	to	26	from 55

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (586) of the pact score for this case. This habitat's result, with minor exceptions, the same as for Case 2.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 6 percent (255) the impact score for this case. The decrease in impact score for this itat from Case 2 is accounted for by the following species:

Chum Salmon	reduced	to	64	from 137
King Crab	reduced	to	0	from 18
Tanner Crab	reduced	to	18	from 72

THE INTERTIDAL SAND/MUD HABITAT contributed 22 percent (1,026) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Eelgrass	reduced	to	0	from 36
Shorebirds	reduced	to	213	from 806
Ducks	reduced	to	144	from 328

THE TERRESTRIAL HABITAT contributed less than one percent (22) of the impact score for this case. The decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Strand Vegetation	reduced	to	10	from 40
Other Mammals	reduced	to	0	from 24
Raptors	reduced	to	0	from 75

CASE 4, SUMMER, BUNKER-C, 10,000 BBLS - IMPACT SCORE 4,367

THE PELAGIC HABITAT contributed 37 percent (1,600) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 3 is accounted for by the following species:

Phytoplankton	reduced	to	18	from	72
Zooplankton	reduced	to	18	from	72
Herring	reduced	to	128	from	273
Crab Larvae	reduced	to	51	from	109
Sockeye Salmon	reduced	to	957	from	1692
Pink Salmon	reduced	to	21	from	46

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (498) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 3 is accounted for by the following species:

Cods	reduced	to	9	from	36
Sculpins	reduced	to	12	from	48
Starry Flounder	reduced	to	20	from	80
Other Flatfish	reduced	to	30	from	120
Other Marine Invertebrates	increased	to	273	from	128

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (290) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 3 is accounted for by the following species:

Chum Salmon	reduced	to	7	from	28
Pacific Halibut	reduced	to	6	from	24
Other Marine Fish	reduced	to	9	from	36
King Crab	increased	to	18	from	0
Other Marine Invertebrates	increased	to	164	from	7

THE INTERTIDAL SAND/MUD HABITAT contributed 42 percent (1,825) of the impact score. With minor exceptions, shorebirds increased to 1,000 from 213, account for the change in impact score for this habitat from Case 3.

THE TERRESTRIAL HABITAT contributed 4 percent (154) of the impact score for this case. The increase in impact score for this habitat from Case 3 is accounted for by the following species:

Strand vegetation	increased	to	43	from	10
Other Mammals	increased	to	24	from	0
Raptors	increased	to	75	from	0

CASE 5: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 2,994

THE PELAGIC HABITAT contributed 55 percent (1593) of the impact score for this case. With minor exceptions, this habitat's result was the same as for Case 4 (1,593 vs. 1,600).

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (296) of the impact score for this case. The decrease in impact score for this habitat from Case 4 is accounted for by the following species:

Razor Clams	reduced	to	0	from	38
Other Bivalves	reduced	to	6	from	26
Other Marine Invertebrates	reduced	to	120	from	273

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 6 percent (174) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 4 is accounted for by the following species:

King Crab	reduced	to	0	from 18
Other Marine Invertebrates	reduced	to	72	from 164

THE INTERTIDAL SAND/MUD HABITAT contributed 28 percent (809) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 4 is accounted for by the following species:

Razor Clams	reduced	to	21	from 84
Softshell Bivalves	reduced	to	50	from 200
Shorebirds	reduced	to	213	from 1000

THE TERRESTRIAL HABITAT contributed 1 percent (22) of the impact score for this case. The decrease in impact score for this habitat from Case 4 is accounted for by the following species:

Strand Vegetation	reduced	to	10	from 43
Other Mammals	reduced	to	0	from 24
Raptors	reduced	to	0	from 75

CASE 6: WINTER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 2,214

THE PELAGIC HABITAT contributed 12 percent (270) of the impact score for this case. Only seabirds (137) contributed substantially to the impact score in this habitat. Seabirds were one of the most abundant species and were judged the most sensitive species to a diesel-2 spill. They were also classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (434) of the impact score for this case. The species which were the main contributors to this impact score were other flatfish (72) and other marine invertebrates (164). These species were among the most abundant in this habitat. The flatfish were rated of minor importance for commercial fishing. The invertebrates were judged to be one of the most sensitive species to a diesel-2 spill.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 5 percent (114) of the impact score for this case. The largest contribution to the impact score were from king crab (24), Tanner crab (24) and other marine invertebrates (38). The invertebrates were the most abundant species in this habitat, as well as being judged the most sensitive to diesel-2 spills. The two crab species were rated ad highly important for commercial fishing and of low importance for subsistence fishing.

THE INTERTIDAL SAND/MUD HABITAT contributed 52 percent (1,156) of the impact score for this case. The species which were the main contributors bo this impact score were softshell bivalves (213), invertebrate infauna (164), shorebirds (242) and ducks (328). The bivalves, infauna and ducks were the most abundant species within this habitat. Ducks were rated of minor importance commercially and along with bivalves were rated of minor importance recreationally and of moderate importance for subsistence. The infauna, shorebirds and ducks were judged to be among the most sensitive species to diesel-2 spills. Shorebirds were classified as protected.

THE TERRESTRIAL HABITAT contributed 11 percent (240) of the impact score for this case. The species which were the main contributors to this impact score were other mammals (96) and raptors (120). These species were judged the most sensitive to oil spills at this site. Other mammals were rated as having minor importance as recreational and subsistence resources. Raptors were classified as protected.

Table 2-21 following presents the full results of Case 6.

CASE 7: SUMMER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 2,118

THE PELAGIC HABITAT contributed 39 percent (822) of the impact score for this case. The decrease in impact score for this habitat from Case 5 is accounted for, with minor exceptions, by the following species:

Smelt	reduced	to	18	from 72
Sockeye Salmon	reduced	to	420	from 957
Seabirds	reduced	to	50	from 200

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (286) of the impact score for this case. The change in impact score for this habitat from Case 5 is accounted for, with minor exceptions, by the following species:

Pacific Sandlance	reduced	to	18	from 72
Razor Clams	increased	to	36	from 9
Other Bivalves	increased	to	24	from 6

TABLE 2-21. MATRIX RESULTS--CASE 6

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U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	KVICHAK
SEASON	WINTER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	ING.	CONF.	CUM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S. TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	3	A	0	0	0	3	4	1	36		36
2. ZOOPLANKTON	1	A	0	0	0	3	4	1	12	3	15
3. ICHTHYOPLANKTON	1	A	0	0	0	2	4	1		2	
5. GREENLINGS	1	A	0	0	0	2	2	0	0	0	0
6. PACIFIC SANDLANCE	2	A	0	0	0	3	4	0	8	4	12
7. HERRING	3	A	0	0	0	3	4	1	24	6	30
8. SMELT	1	A	2	0	0	3	4	1	20	9	21
16. BULLY BARDEN	1	A	0	1	0	1	1	0	2	0	2
17. NORTHERN FUR SEAL	1	A	0	0	0	5	0	0	0	0	0
20. BEARDED SEAL	1	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	3	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	1	A	0	0	0	5	0	0	0	0	0
23. WALRUS	1	D	0	0	0	5	0	0	0	0	0
28. SEABIRDS	3	A	0	0	0	5	4	1	135	33	137
									261	43	270
2. SUBTIDAL SAND-MUD											
1. CODS	1	E	1	0	0	2	4	0	12	0	12
2. SCULPINS	6	A	0	0	0	2	4	0	48	0	48
3. STARRY FLOUNDER	3	A	0	0	0	2	4	0	24	0	24
4. OTHER FLATFISH	6	A	1	0	0	2	4	0	72	0	72
5. PACIFIC SANDLANCE	1	A	0	0	0	3	4	1	27	3	27
6. MISC. MARINE FISH	1	M	0	0	0	2	4	0	6	0	6
9. SHRIMP	1	M	0	0	0	3	4	1	27	3	27
10. RAZOR CLAM	3	A	0	0	0	2	4	1	24	2	26
13. OTHER BIVALVES	6	A	0	0	0	1	4	1	24	5	26
11. OTHER MARINE INVERTEBRATES	6	E	0	0	0	3	4	1	102	14	104
									428	55	434

TABLE 2-21 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	CUL.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	1	E	0	0	0	2	0	0	0	0	0
5. OTHER FLATFISH	1	A	0	0	0	2	4	0	8	0	8
6. GREENLINGS	1	A	0	0	0	2	4	0	8	0	8
9. OTHER MARINE FISH	1	A	1	0	0	2	4	0	12	0	12
10. KING CRAB	1	A	3	0	1	2	4	0	24	0	24
11. TANNER CRAB	1	A	3	0	1	2	4	0	24	0	24
13. OTHER MARINE INVERTEBRATES	3	E	0	0	0	3	4	1	36	9	36
									112	9	114
4. INTERTIDAL SAND-MUD											
1. EELGRASS	3	E	0	0	0	3	1	0	9	0	9
2. PACIFIC SANDLANCE	1	A	0	0	0	3	3	1	27	9	27
3. RAZOR CLAM	3	A	1	2	2	2	4	1	84	21	84
4. SOFTSHELL BIVALVES	10	A	0	1	2	2	4	1	200	50	213
5. INVERTEBRATE INFAUNA	6	A	0	0	0	3	4	1	102	18	104
7. SHOREBIRDS	3	A	0	0	0	3	4	4	120	120	240
8. GEESE	3	A	1	1	2	1	4	1	80	16	84
9. DUCKS	3	A	1	1	2	2	4	1	324	80	328
10. SWANS	1	A	0	0	0	5	4	0	20	0	20
									1061	265	1156
5. INTERTIDAL ROCKY											
2. GREENLINGS	1	A	0	0	0	2	0	0	0	0	0
3. HERRING	3	A	2	0	1	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	1	M	0	0	0	3	0	0	0	0	0
5. MISC. CRUSTACEANS	1	M	0	0	0	2	0	0	0	0	0
6. OTHER INVERTEBRATES	1	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	1	A	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	3	A	0	0	0	2	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
2. SMELT	1	A	0	0	0	3	0	0	0	0	0
3. HARDSHELL BIVALVES	1	A	1	1	1	2	0	0	0	0	0
6. CRUSTACEANS	1	A	0	0	0	2	0	0	0	0	0
5. GASTROPODS	1	M	0	0	0	3	0	0	0	0	0
6. SHOREBIRDS	1	A	0	0	0	5	0	0	0	0	0
									0	0	0

TABLE 2-21 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	1	P	0	0	0	3	0	0	0	0	0
4. CHUM SALMON	3	A	2	0	1	2	0	0	0	0	0
5. SOCKEYE SALMON	15	A	3	1	1	2	0	0	0	0	0
6. PINK SALMON	1	A	1	1	1	2	0	0	0	0	0
7. COHO SALMON	1	A	1	1	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	1	A	0	1	0	1	0	0	0	0	0
9. DOLLY VARDEN	1	A	1	1	0	1	0	0	0	0	0
11. ARCTIC GRAYLING	3	A	0	2	1	2	0	0	0	0	0
12. PIKE	3	A	0	2	1	1	0	0	0	0	0
13. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	1	A	0	0	0	3	0	0	0	0	0
15. DUCKS	3	A	1	1	2	2	0	0	0	0	0
16. GEESE	1	A	1	1	2	2	0	0	0	0	0
18. RIVER OTTER	6	A	2	0	1	1	0	0	0	0	0
19. MINK	5	A	2	0	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	0	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	3	A	0	0	0	2	0	0	0	0	0
4. OTHER VEGETATION	3	A	0	0	0	2	1	0	0	0	0
7. WOLVERINE	3	A	1	0	0	1	1	0	0	0	0
8. WOLF	3	A	1	2	0	1	1	0	0	0	0
9. MOOSE	6	A	2	2	3	2	3	0	6	0	6
10. CARIBOU	9	A	1	2	2	2	3	0	6	0	6
16. OTHER MAMMALS	6	A	0	1	1	2	4	0	96	0	96
17. RAPTORS	9	A	0	0	0	3	6	0	126	0	126
18. PTARMIGAN	6	A	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	3	A	0	0	0	2	1	0	6	0	6
									240	0	240
									2062	151	2214

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (161) of the impact score for this case. Tanner crab, reduced to 0 from 18, is the only species which contributed significantly to the change in impact score for this habitat from Case 5.

THE INTERTIDAL SAND/MUD HABITAT contributed 38 percent (809) of the impact score for this case. This habitat's result was the same as Case 5.

THE TERRESTRIAL HABITAT contributed 2 percent (40) of the impact score for this case. The changes in impact score for this habitat from Case 5 were:

Strand Vegetation	increased	to	40	from	10
Other vegetation	reduced	to	0	from	12

CASE 8: WINTER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 1,655

THE PELAGIC HABITAT contributed 16 percent (261)

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (116) and the TERRESTRIAL HABITAT contributed 14 percent (228) of the impact score for this case. With minor exceptions, this habitat's result was the same as Case 6.

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (192) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 6 is accounted for by the following species:

Sculpins	reduced	to	12	from	48
Other Flatfish	reduced	to	18	from	72
Other Marine Invertebrates	reduced	to	77	from	164

THE INTERTIDAL SAND/MUD HABITAT contributed 52 percent (858) of the impact score for this case. With minor exceptions, ducks reduced to 153 from 328 in this habitat from Case 6, accounted for the decreased impact score.

CASE 9: WINTER, BUNKER-C, 10,000 BBLS - IMPACT SCORE 1,344

THE PELAGIC HABITAT contributed 10 percent (135) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 8 is accounted for by the following species:

Phytoplankton	reduced	to 9 from 36
Seabirds	reduced	to 60 from 136

THE SUBTIDAL SAND/MUD HABITAT contributed 21 percent (277) of the impact score for this case. With minor exceptions, the other marine invertebrates increased to 164 from 77 accounted for the increased habitat impact score from Case 8.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (109) of the impact score for this case. Five species had minor impact decreases and along with the increase of 82 from 38 of other marine invertebrates, account for the change from Case 8.

THE INTERTIDAL SAND/MUD HABITAT contributed 56 percent (757) of the impact score for this case. With minor exceptions, shorebirds reduced to 64 from 137 accounted for the increased habitat impact score from Case 8.

THE TERRESTRIAL HABITAT contributed 5 percent (66) of the impact score for this case. The decrease in impact score for this habitat from Case 8 is accounted for by the following species:

Other Mammals	reduced	to	24	from 96
Raptors	reduced	to	30	from 120

CASE 10: WINTER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 1,304

THE PELAGIC HABITAT contributed 14 percent of the impact score for this case. With minor exceptions, phytoplankton increased to 36 from 9 accounted for the change in habitat impact score from Case 9.

THE SUBTIDAL SAND/MUD HABITAT contributed 24 percent (315) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 9 is accounted for by the following species:

Sculpins	increased	to	48	from 12
Other Flatfish	increased	to	72	from 18
Other Marine Invertebrates	reduced	to	77	from 164

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 6 percent (76) of the impact score for this case. With minor exceptions, other marine invertebrates reduced to 36 from 82 accounted for the change in impact score for this habitat from Case 9.

THE INTERTIDAL SAND/MUD HABITAT contributed 51 percent (662) of the impact score for this case. With minor exceptions, invertebrate infauna reduced to 77 from 164 accounted for the change in impact score for this habitation from Case 9.

THE TERRESTRIAL HABITAT contributed 6 percent (72) of the impact score for this case. With a minor exception, this habitat's score was the same as Case 9.

CASE 11: WINTER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 1,048

THE PELAGIC HABITAT contributed 15 percent (160) of the impact score for this case. With minor exceptions, smelt reduced to 5 from 20 accounted for the change in impact score for this habitat from Case 10.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (149) of the impact score for this case. While all species were reduced in impact score in this habitat, the larger decreases from Case 10 were for the following species:

Sculpins	reduced	to	12	from	48
Other Flatfish	reduced	to	18	from	72

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (78) and the TERRESTRIAL HABITAT contributed 6 percent (60) of the impact score for this case. With minor exceptions, these habitats' scores were the same as for Case 10.

THE INTERTIDAL SAND/MUD HABITAT contributed 57 percent (601) of the impact score for this case. With minor exception, the decrease in impact score for this habitat from Case 10 is accounted for by the following species:

Geese	reduced	to	15	from	60
Ducks	reduced	to	5	from	20

CASE 12: SUMMER, GASOLINE, 10,000 BBLS - IMPACT SCORE 948

THE PELAGIC HABITAT contributed 43 percent (409) of the impact score for this case. With minor exceptions, the change in impact score from Case 7 is accounted for by the following species:

Pacific Sandlance	increased	to	72	from	0
Crab Larvae	reduced	to	0	from	48
Chum Salmon	reduced	to	15	from	60
Sockeye Salmon	reduced	to	105	from	420
Seabirds	reduced	to	0	from	50

THE SUBTIDAL SAND/MUD HABITAT contributed 18 percent (174) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 7 is accounted for by the following species:

Starry Flounder	reduced	to	0	from	20
Other Flatfish	reduced	to	0	from	30
Razor Clam	reduced	to	9	from	36
Other Bivalves	reduced	to	6	from	24

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 9 percent (87) of the impact score for this case. While all species were reduced in impact score in this habitat, the largest decrease from Case 7 were for chum salmon reduced to 15 from 60.

THE INTERTIDAL SAND/MUD HABITAT contributed 27 percent (259) of the impact score for this case. The decrease in impact score for this habitat from Case 7 is accounted for by the following species:

Razor Clams	reduced	to	21	from	84
Shorebirds	reduced	to	50	from	213
Geese	reduced	to	0	from	120
Ducks	reduced	to	0	from	144
Swans	reduced	to	0	from	60

THE TERRESTRIAL HABITAT contributed 2 percent (22) of the impact score for this case. The change in impact score for this habitat from Case 7 is accounted for by the following species:

Strand Vegetation	reduced	to	10	from 40
Other Vegetation	increased	to	12	from 0

CASE 13: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 785

THE PELAGIC HABITAT contributed 77 percent (603) of the impact score for this case. With minor exceptions, the change in impact score for the habitat from Case 12 is accounted for by the following species:

Pacific Sandlance	reduced	to	0	from 72
Herring	reduced	to	30	from 120
Sockeye Salmon	increased	to	420	from 105
Seabirds	increased	to	50	from 0

THE SUBTIDAL SAND/MUD HABITAT contributed 6 percent (51) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 12 is accounted for by other marine invertebrates, reduced to 30 from 120.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 4 percent (33) of the impact score for this case. The decrease in impact score for this habitat from Case 12 is accounted for by other marine invertebrates, reduced to 18 from 72.

THE INTERTIDAL SAND/MUD HABITAT contributed 12 percent (98) of the impact score for this case. The decrease in impact score for this habitat from case 12 is accounted for by the following species:

Razor Clam	reduced	to	0	from 21
Softshell Bivalves	reduced	to	0	from 50
Invertebrate Infauna	reduced	to	30	from 120

THE TERRESTRIAL HABITAT did not contribute to the impact score for this case.

CASE 14: WINTER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 636

THE PELAGIC HABITAT contributed 7 percent (43) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 11 is accounted for by the following species:

Phytoplankton	reduced	to	9	from 36
Herring	reduced	to	9	from 36
Seabirds	reduced	to	15	from 60

THE SUBTIDAL SAND/MUD HABITAT contributed 15 percent (95) of the impact score for this case. While most species were reduced in impact score in this habitat the largest decrease from Case 11 was for other flatfish reduced to 0 from 18.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 10 percent (65) of the impact score for this case. With minor exceptions, this habitat's score was the same as for Case 11.

THE INTERTIDAL SAND/MUD HABITAT contributed 60 percent (379) of the impact score for this case. With a minor exception, the decrease in impact score for this habitat from Case 11 is accounted for by the following species:

Razor Clam	reduced	to	21	from	84
Softshell Bivalves	reduced	to	50	from	200

THE TERRESTRIAL HABITAT contributed 8 percent (54) of the impact for this case. With a minor exception, this habitat's result is the same as for Case 11.

CASE 15: SUMMER, BUNKER-C, 100 BBLS - IMPACT SCORE 412

THE PELAGIC HABITAT contributed 37 percent (152) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 13 is accounted for by the following species:

Phytoplankton	reduced	to	0	from	18
Zooplankton	reduced	to	0	from	18
Smelt	reduced	to	0	from	18
Chum Salmon	reduced	to	0	from	15
Sockeye Salmon	reduced	to	105	from	420
Seabirds	reduced	to	0	from	50

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (45) of the impact score for this case. With minor changes in species scores, this habitat's result was the same as Case 13.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (33) of the impact score for this case. This habitat's result was the same as for Case 13.

THE INTERTIDAL SAND/MUD HABITAT contributed 44 percent (182) of the impact score for this case. The change in impact score for this habitat from Case 13 is accounted for by the following species:

Pacific Sandlance	reduced	to	0 from	18
Razor Clam	increased	to	21 from	0
Geese	increased	to	30 from	0
Ducks	increased	to	36 from	0
Swans	increased	to	15 from	0

CASE 16: SUMMER, CRUDE OIL, 100 BBLS - IMPACT SCORE 378

THE PELAGIC HABITAT contributed 52 percent (196) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 15 is accounted for by the following species:

Smelt	increased	to	18 from	0
Chum Salmon	increased	to	15 from	0

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (51) of the impact score for this case. With minor changes in species scores, this habitat's result was the same as Case 15.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 9 percent (23) of the impact score for this case. This habitat's result was the same as Case 15.

THE INTERTIDAL SAND/MUD HABITAT contributed 26 percent (98) of the impact score for this case. The change in impact score for this habitat from Case 15 is accounted for by the following species:

Pacific Sandlance	increased	to	18	from	0
Razor Clam	reduced	to	0	from	21
Geese	reduced	to	0	from	30
Ducks	reduced	to	0	from	36
Swans	reduced	to	0	from	15

CASE 17: WINTER, GASOLINE, 10,000 BBLS - IMPACT SCORE 363

THE PELAGIC HABITAT contributed 20 percent (73) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 14 is accounted for by the following species:

Pacific Sandlance	increased	to	12	from	0
Herring	increased	to	36	from	9
Seabirds	reduced	to	0	from	15

THE SUBTIDAL SAND/MUD HABITAT contributed 28 percent (102) of the impact score for this case. With minor changes in species scores, this habitat's result was the same as Case 14.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 10 percent (36) of the impact score for this case. All seven of the species in this habitat had minor reductions in impact scores from Case 14, reducing the habitat to 36 from 65.

THE INTERTIDAL SAND/MUD HABITAT contributed 40 percent (146) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 14 is accounted for by the following species:

Shorebirds	reduced	to 0 from	64
Geese	reduced	to 0 from	15
Ducks	reduced	to 0 from	144

The impact scores for Cases 18 through 24 range from 178 down to 18. The spill sizes for these cases are 1,000 barrels of gasoline for both Winter and Summer, and 100 barrels of all other spills. The array of scores for these cases is:

	SPILL SIZE BY SEASON			
	1,000 BBLS		100 BBLS	
SPILL TYPE	SUMMER	WINTER	SUMMER	WINTER
Diesel-2	See Case 3	See Case 10	See Case 13	124
Crude Oil	See Case 5	See Case 11	See Case 16	178
Bunker-C	See Case 7	See Case 14	See Case 15	71
Gasoline	171	79	30	18

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(10) ST. MATTHEW ISLAND

St. Matthew Island lies about 230 miles west of the mainland of Alaska in the Bering Sea. It is about 32 miles long and 3.5 miles wide.[62] The nighest elevation on the island is near Cape Upright at 1,505 ft. The spill location was chosen about 10 miles northeast of the island at 60°31.0'N latitude, 172°30.0'W longitude (Fig. 2-61).

(a) PHYSICAL CHARACTERISTICS

St. Matthew Island is relatively isolated in the midst of the Bering Sea. It is located in the Transitional Climatic Zone.

TEMPERATURES

Summer temperatures are moderated by the maritime influence of the Bering Sea. The temperatures are expected to range between 30°F and 51°F.[4] In Winter, colder temperatures can result as the Bering Sea ices up. The Winter temperatures typically range from -2°F to 39°F.[4] Record high and low temperatures are 65°F and -19°F.[4]

Dates of freezeup and breakup are not specifically given in the *COAST PILOT*[8] for St. Matthew Island. Based on other Bering Sea data,[8] St. Matthew Island should be typically icebound from late November to mid-May.

SURFACE WINDS

General wind flow at St. Matthew is southerly during the Summer and northerly for the remainder of the year.[2] The Bering Sea is a secondary track for cyclonic storms.[3] This is reflected in the high Winter wind velocities which average between 15 and 22 knots. Representative winds

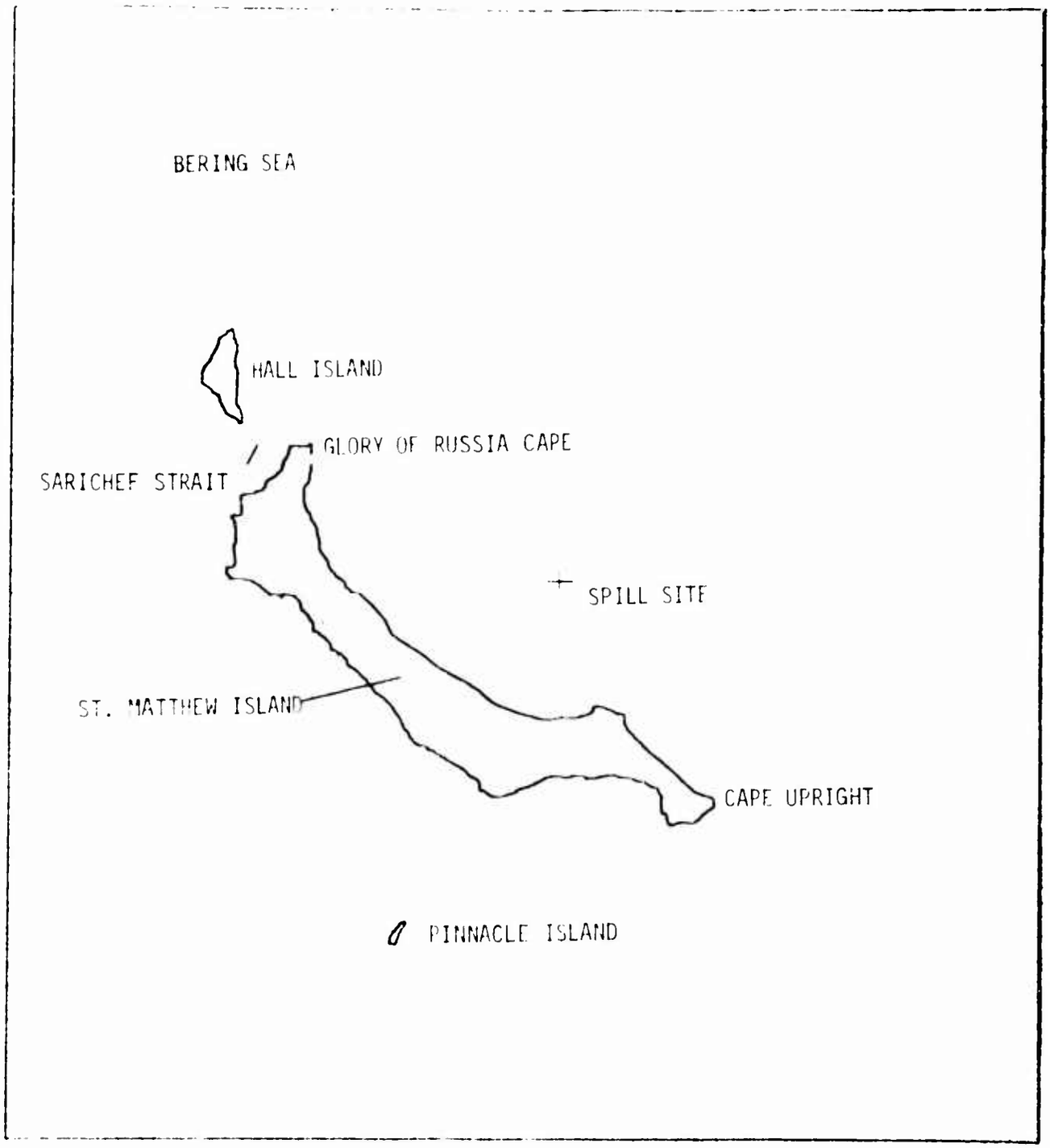


FIGURE 2-61. THE ST. MATTHEW ISLAND LOCATION AND SPILL SITE

NOTE: Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

for the ice-free period were chosen as southwest at 6.0 knots in Summer and north-northwest at 11.0 knots in Fall.

SURFACE CURRENTS

Very little information was located on sea currents in the St. Matthew Island vicinity. The *TIDAL CURRENT TABLES*[9] gave the following information:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Southwest Coast of St. Matthew Island	1.0 K (120°)	1.2 K (290°)

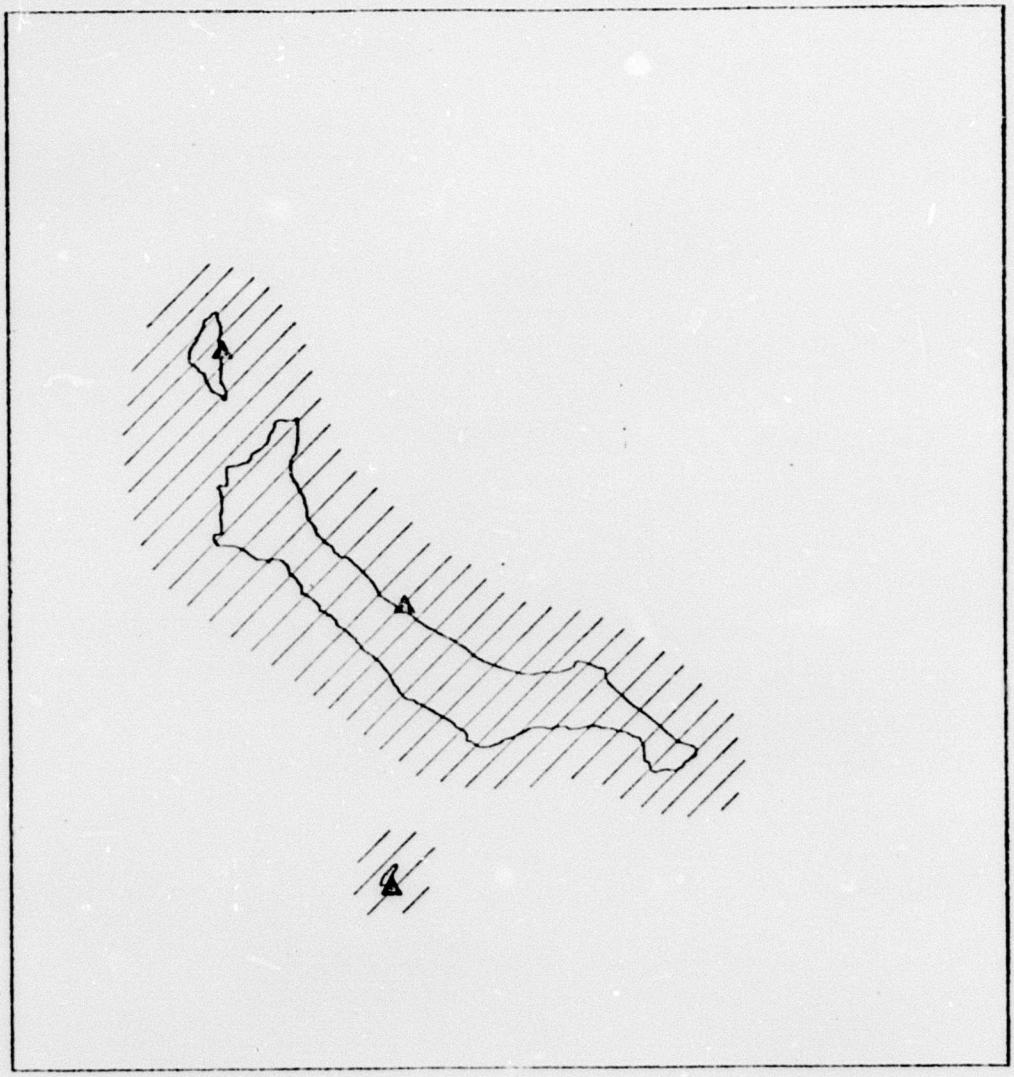
The *COAST PILOT*[8] indicated the diurnal tide range of St. Matthew Island is 2.1 ft, and that tidal currents and tide rips were not found to be strong in a 1951 survey. National Ocean Survey (formerly Coast and Geodetic Survey) charts indicate strong currents in Sarichef Strait.

The current pattern used by MSNW for the oil dispersion modelling duplicated that given by the *TIDAL CURRENT TABLES*[9] for all areas at St. Matthew Island.

(b) BIOLOGICAL CHARACTERISTICS

St. Matthew Island (particularly the adjacent marine waters and shoreline) required the greatest deal of speculation on fauna and flora of any of the marine sites in this study. The area has not been extensively studied. The Island is the topic of the *WILDERNESS STUDY REPORT*.[49] St. Matthew Island, along with nearby Hall Island and Pinnacle Islet, form (in 1909) the Bering Sea Wildlife Refuge.

Resource summaries are shown in Figure 2-62.



Waterfowl and Seabirds

Wintering Area

Seabird Colony

FIGURE 2-62. ST. MATTHEW ISLAND CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

FISHES

SALMONIDS required speculation as to their abundance and distribution in the St. Matthew Island vicinity. A conservative speculation is that there are salmon of one or more species in this vicinity most of the year (with the possible exception of the late November to mid-May ice-bound period). Bristol Bay sockeye and Yukon, Norton Sound and Kotzebue Sound salmon stocks would be expected in this general area as part of their high seas migrations. See the location descriptions for these other locations for further information on these salmon species.

The salmon species are not felt to be very vulnerable to oil products in an open-seas spill situation since these salmon are highly mobile and would seem to be able, in some degree, to move away from oil-polluted areas at least in the one-spill-only cases being evaluated. Extremely large and chronic oil spills in this area could possibly impact food organisms or migration patterns and be more detrimental to these salmon.

No salmon spawning is reported on St. Matthew Island.[49] However, this source[49] reported that Dolly Varden are abundant in the larger freshwater drainages of this island and that their movement to sea may only occur during storms due to gravel beach barriers. This species would be expected to be in shallow nearshore waters while in salt water.

PACIFIC HALIBUT are, in some years, taken in substantial numbers close inshore around the Island in September and October. Few juvenile halibut were reportedly taken.

OTHER FLATFISHES include the flathead sole, yellowfin sole, rock sole, and Alaska plaice in the vicinity of St. Matthew Island.

PACIFIC COD are present in the St. Matthew Island vicinity.

PACIFIC HERRING form what is considered to be the most important commercial fishery in the Island vicinity. Herring concentrate in this part of the Bering Sea along the sea ice edge from November through March (depending on the position of the sea ice) and support a large foreign fleet and reportedly some domestic fishery for herring roe.

MISCELLANEOUS MARINE FISHES include sculpins.

SHELLFISHES

KING CRAB are present and assumed to be in moderate numbers. These are presumed to be the "northern" or "blue" species (*Paralithodes platypus*), whereas the southern species is *P. camtschatica*.

TANNER CRAB are present and assumed to be in low to moderate numbers, As for king crab, no quantitative data were located.

SHRIMP information was not located for St. Matthew Island. Pink shrimp are present, but not in commercial abundance near the Pribilof Islands[44] (south of St. Matthew). Pink shrimp are assumed present during the Summer months in the St. Matthew Island vicinity.

OTHER SHELLFISH probably include other species of crab and bivalve mollusks.

WATERFOWL

Waterfowl have been observed here for many years, but only in the Summer.[49] Seabirds are probably the dominant waterfowl. Ducks are also abundant here. The entire area around St. Matthew Island and the Island's lowlands is waterfowl wintering habitat.[17]

DUCKS include mallard, pintail, green-winged teal, oldsquaw, harlequin, common and king eiders, and red-breasted merganser.[49] Two other eider species migrate through the area.[49] The most abundant nesting ducks are common eiders and oldsquaws.[49]

GEESE are not specified in the [redacted],[49] but they were assumed to migrate through this vicinity.[18]

SWANS are indicated as being whistling swans at St. Matthew Island.[49] They were assumed to be in low numbers and migratory in this vicinity.[18]

SEABIRDS are very numerous on St. Matthew Island. Extensive marine escarpments on this and other exposed islands and islets provide nesting areas for countless numbers of seabirds.[49] Seabirds include pelagic and red-faced cormorants, fulmars, glaucous-winged gulls, black-legged kittiwakes, common and thick-billed murres, pigeon guillemots, parakeet, crested and least auklets, and both horned and tufted puffins.[49] A 1957 survey[62] indicated the following nesting seabirds on St. Matthew Island as most abundant: California murre (1,300), kittiwake (1,200), horned puffin (550), tufted puffin (450), and pigeon guillemot (400). Other species are known to visit this vicinity.[49]

Seabird colonies are shown on the west shore of Hall Island, west mid-shore of St. Matthew Island, and the south "shore" of Pinnacle Island.[17]

SHOREBIRDS were assumed to be in low abundance. Shorebirds here include: American golden plover, European turnstones, wandering tattlers, rock, Baird's and least sandpipers, and dunlins.[49] A 1957 survey[62] indicated red-backed sandpipers (350--nesting) and Aleutian sandpiper (110--nesting) as the most abundant shorebirds.

MARINE MAMMALS

POLAR BEARS are felt to be few in number on and near the pack ice in the St. Matthew Island vicinity. The *WILDERNESS STUDY REPORT*[49] indicated that polar bear were abundant prior to hunting in the late 1800's, but no bears have been observed at St. Matthew since. Because some of the oil spills hypothesized are offshore, MSNW assumed a few polar bear could be present on and around pack ice in the vicinity of St. Matthew Island.

WALRUS herds pass to the north and south of St. Matthew Island during migrations and are assumed to be relatively abundant at this location, particularly in the Summer. Past records indicate walrus hauling out on the northwest cape of St. Matthew (1955), and carcasses have been found on St. Matthew (1957).[49,62] Walrus are known to frequent Hall Island, especially during late Fall and early Winter prior to sea ice formation.[17] St. Matthew Island has several suspected hauling grounds.[17]

SEA LIONS are present in surrounding waters.[49] A 1957 survey[62] located three sea lion carcasses on St. Matthew and about 350 sea lions were observed at a rookery two miles south of Elephant Rock on nearby Hall Island.

HARBOR SEALS occur in moderate numbers around St. Matthew Island. They may number several hundred.[49,62] The harbor (or spotted) seal is associated with the ice only in late Fall and spring.[17] During March through April, they are concentrated along the southern margin of the seasonal sea ice where they bear their pups, breed, and begin their annual molt.[17] As the sea ice recedes northward, some seals disperse along coasts going to the mouths of bays, rivers, and isolated beaches including St. Matthew Island.[17] Other seals follow the receding ice through the Bering Strait and occupy

nearshore areas as far east as Prudhoe Bay.[17] As Winter approaches, these northern groups move south again with the advancing ice and are joined by non-migratory harbor seals to concentrate again at the southern perimeter of the sea ice.

RIBBON SEALS are estimated to be relatively abundant in St. Matthew Island vicinity. These seals are associated with sea ice during late Winter and early spring, and in late Spring when ice recedes these seals stay in the open sea and most remain in the Bering Sea.

BEARDED SEALS are estimated to be moderately abundant in the St. Matthew Island vicinity. These seals, like walrus and ringed seals, remain mostly within sea ice throughout the year.[17] They are most similar to walrus, preferring drifting sea ice where currents and winds are producing openings between ice floes.[17] During late Winter and early Spring, most of these seals are in the Bering Sea, and they retreat with the sea ice through the Chukchi Sea in the Summer.[17] By late August, most sea ice is gone and these seals are distributed along the margin of the polar ice pack over suitable bottom. The migration south begins with new sea ice formation, usually in early October.

RINGED SEALS are estimated to occur in moderate numbers in the St. Matthew Island vicinity. These seals move with the ice much as bearded seals but do not come as far south into open waters; rather, in the Bering Sea they occupy the narrow fringes of land-fast ice.[17] The young are numerous just off the edge of the land-fast ice.[17] Combined with their numbers, this shore-inhabiting behavior makes them a very available and important marine mammal resource to northern Alaska coastal residents.

During receding ice in Spring, the ringed seal moves back north close to shore.[17] By August, they are distributed all along the edge of the polar ice pack.[17]

NORTHERN FUR SEALS occur only as rare transients and would be in very small numbers in this vicinity. See the Unimak Pass location description for more information on this seal species.

WHALES AND PORPOISES occur in the Bering Sea and number 16 species in Game Unit 18, which includes St. Matthew Island. Most of the whales and porpoises occur primarily in open ice-free waters. As a result, these species generally move with respect to the advance and retreat of sea ice.[17] Some of the species move in association with drifting seasonal ice (bowhead, beluga and narwhal).[17] The whales and porpoises may all, at one time, visit the St. Matthew Island vicinity. Documented beached whales on St. Matthew were identified in a 1920 study as bowhead, humpback, blue, beaked, and killer whales.[49] Gray whales were observed feeding northeast of St. Matthew Island in 1957.[49]

POLAR FOX are another marine mammal living on pack ice and beaches. Populations vacillate from common in abundance to uncommon. These animals forage on pack ice and on adjacent land beaches. They also den in beach areas. At this location, they were included with "other mammals" in the evaluation matrix, and they were assumed to be in moderate numbers at St. Matthew.

The impact of ice on the marine mammals of the Bering Sea is discussed in more detail.[50]

TERRESTRIAL MAMMALS

REINDEER (DOMESTICATED CARIBOU) are the largest land mammals on St. Matthew Island. They were introduced in 1944 (29 animals).[49] This population exploded to 6,000 animals and about February 1964 a "crash die-off" occurred.[49] In 1966, 42 animals were observed and the future of the herd is not known.[49] Recovery is dependent on whether the forage can ever recover to support larger reindeer herds.

MISCELLANEOUS MAMMALS includes one rodent--the meadow vole--which is probably a relict dating to the Bering Land Bridge.[49]

FLORA

Terrestrial vegetation is not expected to be affected by the oil spill specified at this area. This area is near the northern limit of most Beringian-Eastern North American strand species, probably giving the vegetation a more Arctic composition.[80] Practically no work has been done on the marine vegetation of this area.[81] Eelgrass could occur on as much as 15 percent of the shallow subtidal shoreline based on the assumed physical shoreline data, but it is not known whether the species occurs here.[70] The Arctic marine algal vegetation is present in the intertidal on about 57 percent of the shoreline in Summer but is probably completely removed by Winter ice-scouring. Shallow subtidal vegetation occurs on about 57 percent of the bottom in Summer and probably 28 percent in Winter. Floating kelp species are absent.[76]

For further physical and biological information on this location, see Appendix D .

(c) RESULTS

Oil spills in the Summer moved away from the island and in the Winter moved toward the island and impacted the beaches. Only the pelagic habitat was impacted in Summer scenarios. Seven habitats were impacted in the Winter scenarios.

Diesel-2 impact scores were greater in Summer, but crude oil, bunker C, and gasoline had greater impact scores in Winter. For these cases, lower impact scores for each species reflected seasonal changes in abundance. These reduced scores were offset by the increased number of species impacted.

The largest impact scores were contributed by herring. Significant contributions were also generated by phytoplankton, zooplankton, and seabirds. In general, the impact scores were low.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were considered at St. Matthew Island. The first scenario, based upon most probable Summer conditions, resulted in a spill trajectory in a north-northeast direction from the spill location (Fig. 2-63) into the Bering Sea away from the Island. The second scenario, for Winter conditions, resulted in oil movement in a southerly direction (Fig. 2-64) reaching the north shore of the Island in approximately 18 hours following the spill. The smaller spills (100 and 1,000 bbls) were intercepted by the Island. A portion of the larger spills (10,000 and 50,000 bbls) was found carried around the southeastern end of the Island into the open sea by wind and current action. The physical impacts of the various products were assessed as has been described earlier in the discussion of spills at Yakutat. Of particular note at this site is that the trajectories of the spill do not allow a simple subtractive analysis. The Summer trajectory is into very deep waters, and it is assumed that the spills will not reach the bottom in a form which would be harmful to flora and fauna. On the other hand, the Winter trajectory into the shallower waters around St. Matthew Island affects six habitats in addition to the pelagic habitat impacted in the Summer.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-22 presents the results of the oil spill scenarios examined at St. Matthew Island without cleanup.

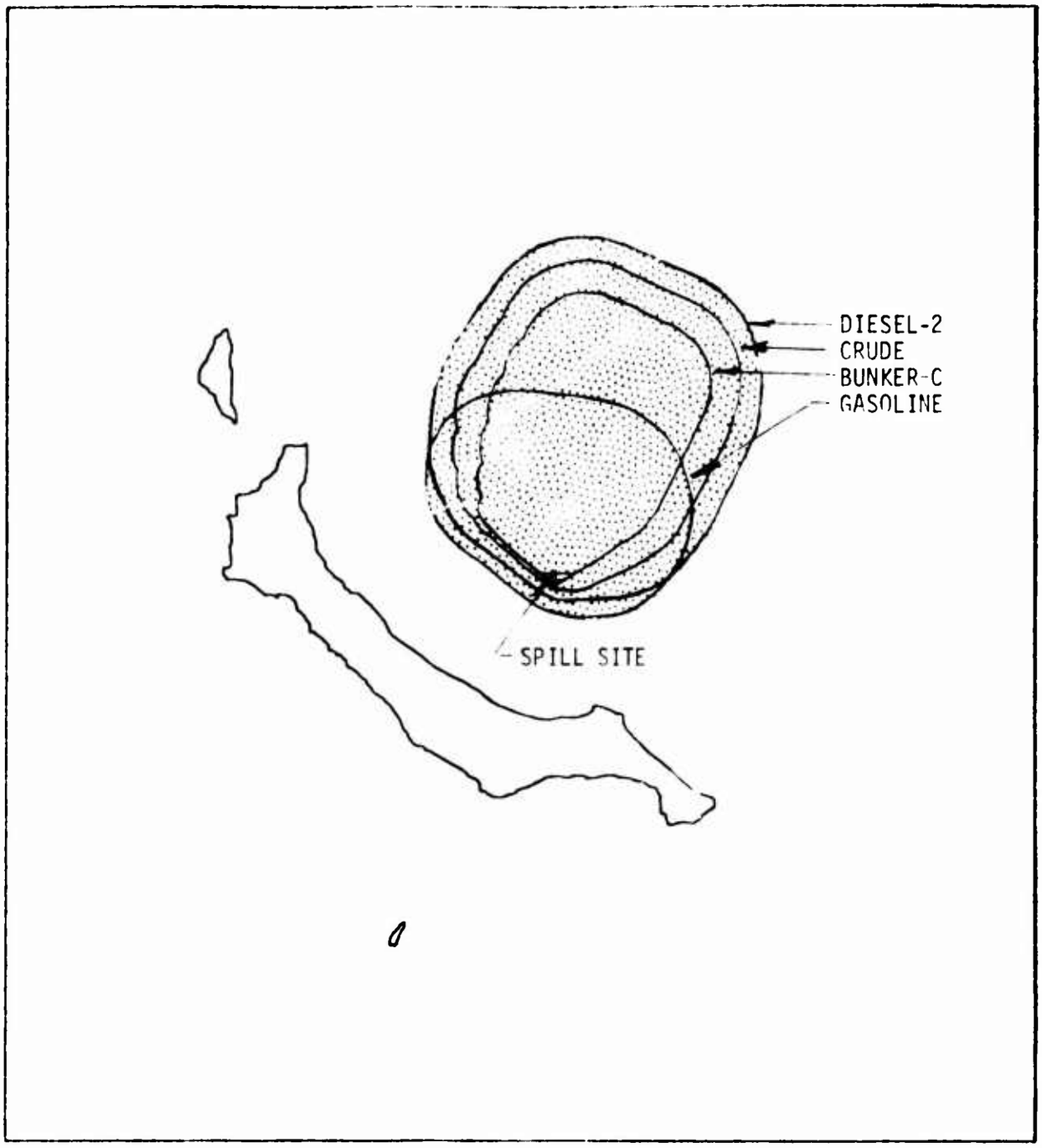


FIGURE 2-63. ST. MATTHEW SUMMER 10,000 BBL SPILL ENVELOPES

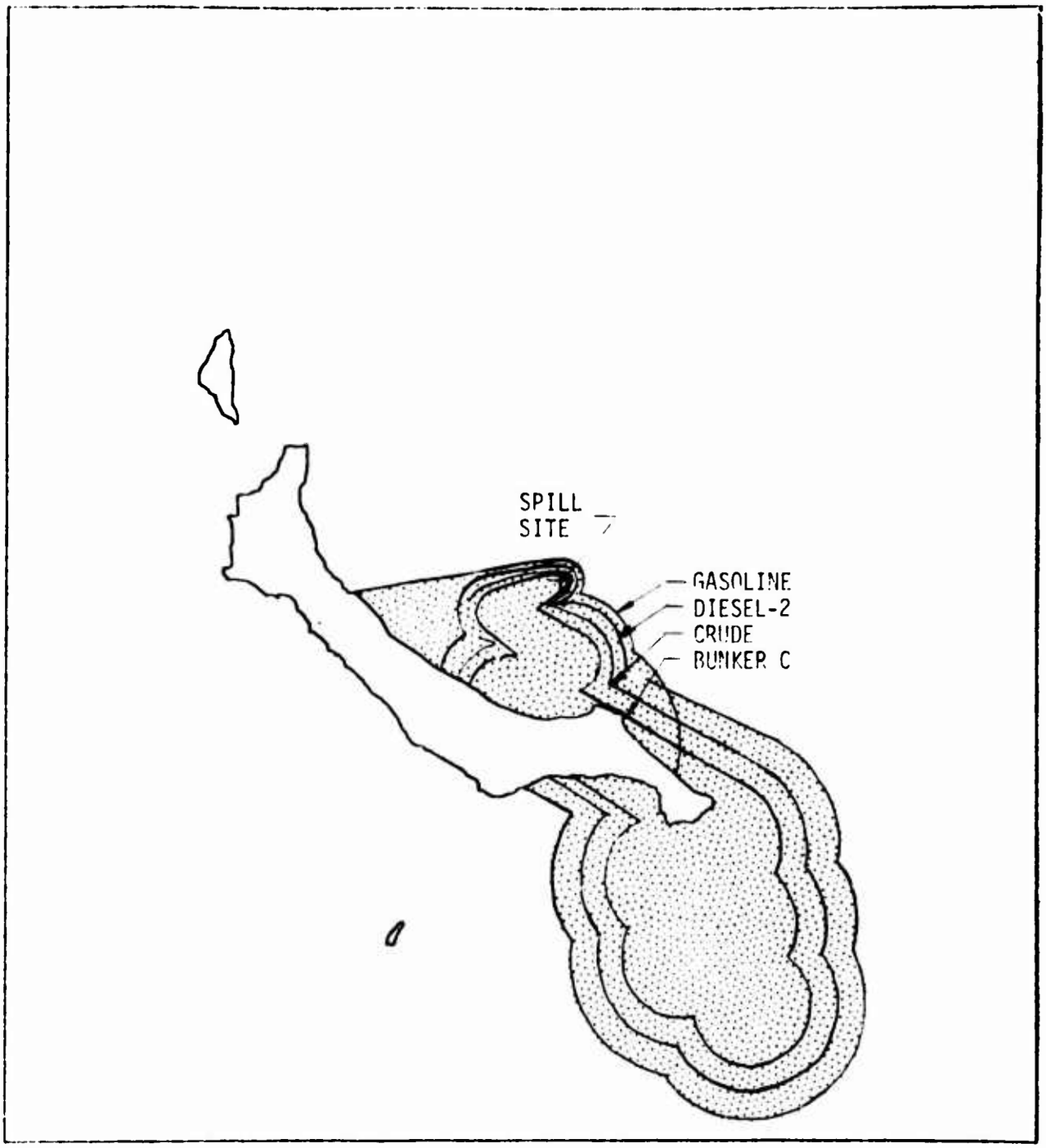


FIGURE 2-64. ST. MATTHEW AUTUMN 10,000 BBL SPILL ENVELOPES

TABLE 2-22. ST. MATTHEW ISLAND CASE RESULTS, NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000	100
SUMMER	Diesel-2	-	3,119 [1](1)	1,534 [8]	256 [19]
	Crude Oil	2,728 [3]	1,759 [6]	684 [13]	147 [22]
	Bunker-C	-	906 [11]	655 [14]	138 [23]
	Gasoline	-	582 [16]	120 [24]	18 [26]
WINTER	Diesel-2	-	2,377 [4]	1,386 [9]	325 [17]
	Crude Oil	3,050 [2]	1,740 [7]	1,154 [10]	261 [18]
	Bunker-C	-	1,868 [5]	889 [12]	175 [20]
	Gasoline	-	616 [15]	166 [21]	100 [23]

(1) Numbers in brackets are the case numbers that follow.

CASE 1: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 3,119

THE PELAGIC HABITAT contributed the entire impact score for this case. The species which were the main contributors to the total were herring (1,450), phytoplankton (273), zooplankton (273), and seabirds (273). Herring were judged to be important commercially and, like the other major contributors to the impact score, were generally the most abundant in the region. Table 2-23, following, presents the full results of this case. No other habitat contributes to the score in this case or any other Summer scenario as described above.

CASE 2: WINTER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 3,050

THE PELAGIC HABITAT contributed 33 percent (994) of the impact score for this case. Only herring (580), which were judged to be the most sensi-

TABLE 2-23. MATRIX RESULTS--CASE 1

AREA	ST. MATTHEW ISLAND
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	10	H	0	0	0	3	9	1	279	30	273
2. ZOOPLANKTON	10	H	0	0	0	3	9	1	279	30	273
3. ICHTHYOPLANKTON	6	E	0	0	0	2	9	1	108	12	109
5. GREENLINGS	3	A	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	3	A	0	0	0	3	9	1	81	9	82
7. HERRING	15	A	3	0	0	3	9	0	810	720	1450
8. SMELT	3	A	0	0	0	3	9	8	81	72	145
9. CRAB LARVAE	6	A	0	0	0	2	9	8	108	96	193
10. KING SALMON	1	E	2	0	0	2	9	1	36	4	36
11. CHUM SALMON	1	E	3	0	0	2	9	1	45	5	46
12. SOCKEYE SALMON	1	E	2	0	0	2	9	1	36	4	36
13. PINK SALMON	1	E	3	0	0	2	9	1	45	5	46
14. COHO SALMON	1	E	2	0	0	2	9	1	36	4	36
15. DOLLY VARDEN	6	A	0	0	0	1	9	8	54	48	97
17. NORTHERN FUR SEAL	1	A	2	0	1	5	0	0	0	0	0
18. RINGED SEAL	3	A	2	0	1	5	0	0	0	0	0
19. RIBBON SEAL	15	A	2	0	1	5	0	0	0	0	0
20. BEARDED SEAL	3	A	2	0	1	5	0	0	0	0	0
21. HARBOR SEAL	6	A	2	0	1	5	0	0	0	0	0
23. WALRUS	10	A	2	0	2	5	0	0	0	0	0
24. WHALES	3	A	0	0	0	5	0	0	0	0	0
26. POLAR BEAR	1	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	3	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	6	A	0	0	0	5	9	1	271	33	274
									2274	1069	3149
2. SUBTIDAL SAND-MUD											
1. CODS	6	A	2	0	0	2	0	0	0	0	0
2. SCULPINS	10	A	0	0	0	2	0	0	0	0	0
3. STARRY FLOUNDER	3	A	0	0	0	2	0	0	0	0	0
4. OTHER FLATFISH	10	A	2	0	0	2	0	0	0	0	0

TABLE 2-23. (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
5. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
6. MISC. MARINE FISH	6	A	1	0	0	2	0	0	0	0	0
8. SHRIMP	6	E	0	0	0	3	0	0	0	0	0
10. OTHER BIVALVES	3	M	0	0	0	1	0	0	0	0	0
11. OTHER MARINE INVERTEBRATES	3	M	0	0	0	3	0	0	0	0	0
									0	0	0
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL GEARED	10	A	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	1	M	3	0	0	2	0	0	0	0	0
4. PACIFIC HALIBUT	6	A	2	0	0	2	0	0	0	0	0
5. OTHER FLATFISH	3	A	0	0	0	2	0	0	0	0	0
6. GREENLINGS	3	A	0	0	0	2	0	0	0	0	0
7. ROCKFISH	3	E	2	0	0	2	0	0	0	0	0
8. WALLEYE POLLOCK	10	A	0	0	0	2	0	0	0	0	0
9. OTHER MARINE FISH	6	A	1	0	0	2	0	0	0	0	0
10. KING CRAB	6	A	2	0	0	2	0	0	0	0	0
11. TANNER CRAB	6	A	1	0	0	2	0	0	0	0	0
12. SCALLOPS	1	A	0	0	0	2	0	0	0	0	0
13. OTHER MARINE INVERTEBRATES	10	M	0	0	0	2	0	0	0	0	0
									0	0	0
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
4. SOFTSHELL BIVALVES	3	A	0	0	0	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	3	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	A	0	0	0	5	0	0	0	0	0
8. GEESE	3	A	0	0	1	1	0	0	0	0	0
9. DUCKS	6	A	0	0	1	2	0	0	0	0	0
10. SWANS	1	A	0	0	1	5	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SPAWNERS	10	A	0	0	0	3	0	0	0	0	0
2. GREENLINGS	6	A	0	0	0	2	0	0	0	0	0
3. HERRING	15	A	2	0	1	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	6	M	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	6	M	0	0	0	2	0	0	0	0	0

TABLE 2-23. (CONT'D)

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HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RELT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	6	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	1	A	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	6	A	0	0	0	2	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	6	A	0	0	0	3	0	0	0	0	0
2. SMELT	3	A	0	0	0	2	0	0	0	0	0
3. HARDSHELL BIVALVES	1	M	0	0	0	2	0		0	0	0
4. CRUSTACEANS	1	M	0	0	0	2	0		0	0	0
5. GASTROPODS	1	M	0	0	0	2	0		0	0	0
6. SHOREBIRDS	1	M	0	0	0	5	0		0	0	0
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	M	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	3	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	E	0	0	0	2	0	0	0	0	0
4. CHUM SALMON	1	E	0	0	0	2	0	0	0	0	0
5. SOCKEYE SALMON	1	E	0	0	0	2	0	0	0	0	0
6. PINK SALMON	1	E	0	0	0	2	0	0	0	0	0
7. COHO SALMON	1	E	0	0	0	2	0	0	0	0	0
9. DOLLY VARDEN	10	A	0	0	0	2	0	0	0	0	0
13. STICKLEBACKS	3	A	0	0	0	3	0	0	0	0	0
15. DUCKS	6	A	0	0	1	2	0	0	0	0	0
16. GEESE	6	A	0	0	1	2	0	0	0	0	0
17. SWANS	3	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	1	A	0	0	0	1	0	0	0	0	0
19. MINK	1	A	0	0	0	1	0	0	0	0	0
20. MUSKRAT	1	A	0	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	1	A	0	0	0	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	6	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	3	A	0	0	0	2	0	0	0	0	0
3. STRAND VEGETATION	6	M	0	0	0	1	0	0	0	0	0
4. OTHER VEGETATION	3	A	0	0	0	2	0	0	0	0	0

TABLE 2-23. (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	CUM.	REG.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
A. TERRESTRIAL											
16. CARIBOU	15	A	0	0	1	3	0	0	0	0	0
15. OTHER MAMMALS	6	A	0	0	0	2	0	0	0	0	0
17. RAPTORS	6	A	0	0	0	5	0	0	0	0	0
18. PTARMIGAN	6	A	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	3	A	0	0	0	2	0	0	0	0	0
									0	0	0
									2274	1069	7119

THE FRESHWATER RIVER HABITAT did not contribute to the impact score as it was judged that the spill would not reach this habitat from a marine origin.

THE TERRESTRIAL HABITAT contributed 1 percent (29) of the impact score for this case. No single species contributed more than the 15 of raptors in this habitat. Table 2-24, following, presents the complete results of this case.

CASE 3: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 2,728

THE PELAGIC HABITAT contributed the entire impact score for this case. Case 3 is the same as Case 1 with the following exceptions. Phytoplankton and zooplankton each reduced to 128 from 273; ichthyoplankton reduced to 51 from 109; smelt reduced to 82 from 145; and the five seal species increased from 0 to a total of 216.

CASE 4: WINTER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 2,377

THE PELAGIC HABITAT contributed 29 percent (691) of the impact score for this case. This habitat's result was the same as for Case 2, with the following exceptions:

Herring	reduced to 328 from 580
Pacific sandlance	reduced to 38 from 82
Dolly Varden	reduced to 9 from 16

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (484) of the impact score for this case. This habitat's result was the same as for Case 1.

TABLE 2-24. MATRIX RESULTS--CASE 2

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	ST. MATTHEW ISLAND
SEASON	WINTER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	3	M	0	0	0	3	9	1	81	9	82
2. ZOOPLANKTON	3	M	0	0	0	3	9	1	81	9	82
3. ICHTHYOPLANKTON	3	E	0	0	0	2	9	1	54	6	55
5. GREENLINGS	3	A	0	0	0	2	9	0	24	0	24
6. PACIFIC SANDLANCE	3	A	0	0	0	3	9	1	81	9	82
7. HERRING	6	A	3	0	0	3	9	8	324	288	580
9. SMELT	1	A	0	0	0	3	9	1	27	3	27
16. DOLLY VARDEN	1	A	0	0	0	1	9	8	9	8	16
17. NORTHERN FUR SEAL	1	A	2	0	1	5	0	0	0	0	0
18. RINGED SEAL	6	A	2	0	1	5	0	0	0	0	0
19. RIBBON SEAL	15	A	2	0	1	5	0	0	0	0	0
20. BEARDED SEAL	13	A	2	0	1	5	0	0	0	0	0
21. HARBOR SEAL	6	A	2	0	1	5	0	0	0	0	0
23. WALRUS	6	A	2	0	2	5	0	0	0	0	0
24. WHALES	1	A	0	0	0	5	0	0	0	0	0
26. POLAR BEAR	1	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	1	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	1	A	0	0	0	5	9	1	45	5	46
									726	337	994
2. SUBTIDAL SAND-MUD											
1. CODS	3	A	2	0	0	2	6	1	48	12	51
2. SCULPINS	6	A	0	0	0	2	6	0	48	0	48
3. STARRY FLOUNDER	3	A	0	0	0	2	6	1	24	6	26
4. OTHER FLATFISH	6	A	2	0	0	2	6	1	96	24	102
5. PACIFIC SANDLANCE	3	A	0	0	0	3	6	1	36	9	36
6. MISC. MARINE FISH	6	A	1	0	0	2	6	0	72	0	72
8. SHRIMP	3	E	0	0	0	3	6	1	36	9	39
10. OTHER BIVALVES	3	M	0	0	0	1	9	1	27	3	27
11. OTHER MARINE INVERTEBRATES	3	M	0	0	0	3	9	1	81	9	82
									468	72	484

TABLE 2-24 (CONT'D).

U.S. EAST COAST OIL SPILL PREDICTION STUDY
ECOLOGICAL MATRIX

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HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL CRABS	3	A	3	0	0	2	1	0	6	0	6
4. PACIFIC HALIBUT	3	A	2	0	0	2	4	1	48	12	51
5. OTHER FLATFISH	1	A	0	0	0	2	4	1	8	2	9
6. GREENLINGS	3	A	0	0	0	2	4	1	24	6	26
7. ROCKFISH	1	A	2	0	0	2	4	1	16	4	17
8. WALLEYE POLLOCK	1	A	0	0	0	2	4	1	8	2	9
9. OTHER MARINE FISH	3	A	1	0	0	2	4	1	36	9	38
10. KING CRAB	3	A	2	0	0	2	4	1	108	12	109
11. TANNER CRAB	3	A	1	0	0	2	9	1	81	9	82
12. SCALLOPS	1	A	0	0	0	2	9	1	18	2	18
13. OTHER MARINE INVERTEBRATES	6	M	0	0	0	3	9	1	162	18	164
									515	76	529
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	4	1	36	9	38
4. SOFTSHELL BIVALVES	3	A	0	0	0	2	9	1	54	6	55
5. INVERTEBRATE INFAUNA	1	M	0	0	0	3	9	1	27	3	27
9. DUCKS	3	A	0	0	1	2	4	1	36	4	38
									153	27	158
5. INTERTIDAL ROCKY											
2. GREENLINGS	3	A	0	0	0	2	9	1	54	6	55
3. HERRING	6	A	3	0	1	2	9	8	324	288	580
4. SESSILE MARINE INVERTEBRATES	6	M	0	0	0	1	9	1	54	6	55
5. MISC. CRUSTACEANS	3	M	0	0	0	2	4	1	24	6	26
6. OTHER INVERTEBRATES	3	M	0	0	0	3	4	1	36	9	38
8. SEA DUCKS	3	A	0	0	0	2	4	1	24	6	26
									516	321	780
6. INTERTIDAL COBBLE-GRAVEL											
2. SMELT	1	A	0	0	0	3	4	1	12	3	13
3. HARDSHELL BIVALVES	1	M	0	0	0	2	9	1	18	2	18
4. CRUSTACEANS	1	M	0	0	0	2	9	1	18	2	18
5. GASTROPODS	1	M	0	0	0	3	9	1	27	3	27
									75	10	76

TABLE 2-24. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	1	M	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	1	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	E	0	0	0	2	0	0	0	0	0
4. CHUM SALMON	1	E	0	0	0	2	0	0	0	0	0
5. SOCKEYE SALMON	1	E	0	0	0	2	0	0	0	0	0
6. PINK SALMON	1	E	0	0	0	2	0	0	0	0	0
7. COHO SALMON	1	E	0	0	0	2	0	0	0	0	0
9. DOLLY VARDEN	3	A	0	0	0	2	0	0	0	0	0
13. STICKLEBACKS	1	A	0	0	0	3	0	0	0	0	0
14. RIVER OTTER	1	A	0	0	0	1	0	0	0	0	0
15. MINK	1	A	0	0	0	1	0	0	0	0	0
23. MUSKRAT	1	A	0	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	1	A	0	0	0	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	6	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	1	A	0	0	0	2	0	0	0	0	0
4. OTHER VEGETATION	1	A	0	0	0	2	1	0	2	0	2
10. CARIBOU	15	A	0	0	1	2	0	0	0	0	0
16. OTHER MAMMALS	6	M	0	0	0	2	1	0	12	0	12
17. RAPTORS	3	A	0	0	0	5	1	0	15	0	15
18. PTARMIGAN	6	A	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	1	A	0	0	0	2	0	0	0	0	0
									29	0	29
									2482	843	3050

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 22 percent (514) of the impact score for this case. This habitat's result was the same as for Case 1, with the following exceptions:

Subtidal seaweed	reduced to 0 from 6
Walleye pollock	reduced to 2 from 9
Other marine fish	reduced to 36 from 38

THE INTERTIDAL SAND/MUD HABITAT contributed 7 percent (158) of the impact score for this case. This habitat's result was the same as for Case 1.

THE INTERTIDAL ROCKY HABITAT contributed 20 percent (468) of the impact score for this case. This habitat's result was the same as for Case 1, with the following exceptions:

Herring	reduced to 328 from 580
Greenlings	reduced to 24 from 55
Sessile marine invertebrate	reduced to 26 from 55

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 1 percent (33) of the impact score for this case. All species groups within this habitat were reduced from the Case 1 results; the changes are:

Smelt	reduced to 3 from 13
Hardshell bivalve	reduced to 9 from 18
Crustaceans	reduced to 8 from 18
Gastropods	reduced to 13 from 27

THE FRESHWATER RIVER HABITAT did not contribute to the impact score as it was judged that the spill would not reach this habitat from a marine origin.

THE TERRESTRIAL HABITAT contributed 1 percent (29) of the impact score for this case. This habitat's result was the same as for Case 2.

CASE 5: WINTER, BUNKER-C, 10,000 BBLS - IMPACT SCORE 1,868

THE PELAGIC HABITAT contributed 34 percent (631) of the impact score for this case. All impacted species within this habitat were judged to have different scores in this case than in Case 4. The changes were:

Phytoplankton	reduced	to	38	from 82
Zooplankton	reduced	to	38	from 82
Ichthyoplankton	reduced	to	26	from 55
Greenlings	reduced	to	0	from 24
Pacific sandlance	reduced	to	36	from 38
Herring	reduced	to	153	from 328
Smelt	reduced	to	12	from 27
Dolly Varden	reduced	to	4	from 9
Northern Fur seal	increased	to	8	from 0
Ringed seal	increased	to	48	from 0
Ribbon seal	increased	to	120	from 0
Bearded seal	increased	to	80	from 0
Harbor seal	increased	to	48	from 0

THE SUBTIDAL SAND/MUD HABITAT contributed 22 percent (411) of the impact score for this case. This habitat's result, with minor differences

of from 2 to 6 for some species, was the same as for Case 4, with the following exceptions:

Other bivalves	reduced to 13 from 27
Other marine invertebrates	reduced to 38 from 82

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 18 percent (330) of the impact score for this case. This habitat's result, with minor differences of from 2 to 9 for some species, was the same as for Case 4, with the following exceptions:

King crab	reduced to 51 from 109
Tanner crab	reduced to 38 from 82
Other marine invertebrates	reduced to 77 from 164

THE INTERTIDAL SAND/MUD HABITAT contributed 6 percent (113) of the impact score for this case. The case result reduced the impact score for three of the four species within this habitat relative to Case 4. The changes were:

Pacific sandlance	reduced to 36 from 38
Softshell bivalves	reduced to 26 from 55
Invertebrate infauna	reduced to 13 from 27

THE INTERTIDAL ROCKY HABITAT contributed 15 percent (287) of the impact score for this case. This habitat's result, with minor differences

of 2 for all species except one, was the same as for Case 4, with the following exception:

Herring	reduced to 153 from 328

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 4 percent (67) of the total impact score for this case. Each of the species in this habitat received higher scores in this case than in Case 4. These scores were:

Smelt	increased to	13	from	3
Hardshell bivalve	increased to	18	from	9
Crustaceans	increased to	9	from	8
Gastropods	increased to	27	from	13

THE FRESHWATER RIVER HABITAT did not contribute to the impact score as it was judged that the spill would not reach this habitat from a marine origin.

THE TERRESTRIAL HABITAT contributed 2 percent (29) of the total impact score for this case. This habitat's score was the same as for Case 4.

CASE 6: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 1,759

THE PELAGIC HABITAT contributed the entire impact score for this case. With the exception of five species groups, there were only minor reductions of from 1 to 8 in this case relative to Case 3. The five exceptions are:

Herring	reduced to	820	from	1,450
Smelt	reduced to	38	from	82
Crab larvae	reduced to	109	from	193

Dolly Varden	reduced to	55	from 97
Seabirds	reduced to	128	from 273

CASE 7: WINTER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 1,740

THE PELAGIC HABITAT contributed 20 percent (355) of the impact score for this case. This habitat's score has some significant differences from the score of Case 5; these are:

Greenlings	increased to	24	from 0
Northern fur seal	reduced to	0	from 8
Ring seal	reduced to	0	from 48
Ribbon seal	reduced to	0	from 120
Bearded seal	reduced to	0	from 80
Harbor seal	reduced to	0	from 48

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (411) of the impact score for this case. This habitat's result was the same as for Case 5.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 19 percent (329) of the impact score for this case. This habitat's result was almost the same (329 vs. 330) as for Case 5.

THE INTERTIDAL SAND/MUD HABITAT contributed 6 percent (113) of the impact score for this case. This habitat's result was the same as for Case 5.

THE INTERTIDAL ROCKY HABITAT contributed 27 percent (470) of the impact score for this case. With a single exception, herring, which increased to 328 from 158, there are only minor differences of 2 in the other species groups compared to Case 5.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 2 percent of the impact score for this case. The change from Case 5 varies from no change for crustaceans to 13 (from 27) for gastropods.

THE FRESHWATER RIVER HABITAT did not contribute to the impact score for this case.

THE TERRESTRIAL HABITAT contributed 2 percent (29) of the impact score for this case. This habitat's score is the same as for Case 5.

CASE 8: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 1,534

THE PELAGIC HABITAT contributed the entire impact score for this case. With minor differences of from 1 to 8, the species within this habitat are scored the same as in Case 6, with the following exceptions:

Pacific sandlance	increased to	36	from 9
Crab larvae	reduced to	51	from 109
Ringed seal	reduced to	0	from 24
Ribbon seal	reduced to	0	from 120
Bearded seal	reduced to	0	from 24
Harbor seal	reduced to	0	from 48

CASE 9: WINTER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 1,386

THE PELAGIC HABITAT contributed 25 percent (353) of the impact score for this case. This habitat's score is almost (353 vs. 355) the same as for Case 7.

THE SUBTIDAL SAND/MUD HABITAT contributed 23 percent (321) of the impact score for this case. This habitat's score is the same as for Case 7, with the following exceptions:

Sculpins	reduced to	12	from 48
Miscellaneous marine fish	reduced to	18	from 72

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 22 percent (309) of the impact score for this case. This habitat's score is almost the same (309 vs. 329), with minor species differences which account for the change from Case 7.

THE INTERTIDAL SAND/MUD HABITAT contributed 8 percent (111) of the impact score for this case. This habitat's score is almost (111 vs. 113) the same as for Case 7.

THE INTERTIDAL ROCKY HABITAT contributed 19 percent (267) of the impact score for this case. This habitat's score, with minor species differences of 2, is the same as in Case 7, with the following exceptions:

Greenlings	reduced to	6	from 26
Herring	reduced to	153	from 328

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 2 percent (25) of the impact score for this case. The species scores within this habitat were all reduced from their levels in Case 7, with the maximum reduction for any one specie being 9 for smelt.

THE FRESHWATER RIVER HABITAT did not contribute to the impact score for this case.

THE TERRESTRIAL HABITAT did not contribute to the impact score for this case. This represents the following changes from Case 7:

Other vegetation	reduced to	0 from	2
Other mammals	reduced to	0 from	12
Raptors	reduced to	0 from	15

CASE 10: WINTER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 1,154

THE PELAGIC HABITAT contributed 28 percent (318) of the impact score for this case. All impacted species contributed to the lower score for this habitat when compared to Case 9. None of the changes exceeded 18, which was the reduction for greenling (24 vs. 6).

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (138) of the impact for this case. The following species had significantly different scores in this case than in Case 9:

Cods	reduced to	12 from	48
Starry flounder	reduced to	6 from	24
Other flatfish	reduced to	24 from	96
Pacific sandlance	reduced to	9 from	36
Shrimp	reduced to	9 from	36

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 25 percent (292) of the impact score for this case. There is an overall minor reduction (292 vs. 309) in this impact score when compared to Case 9.

THE INTERTIDAL SAND/MUD HABITAT contributed 9 percent (108) of the impact score for this case. There is an overall minor reduction (108 vs. 111) in this impact score when compared to Case 9.

THE INTERTIDAL ROCKY HABITAT contributed 23 percent (267) of the impact score for this case. This score is unchanged from Case 9.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 3 percent (31) of the impact score for this case. There is an overall minor increase (31 vs. 25) in the impact score when compared to Case 9.

THE FRESHWATER RIVER AND TERRESTRIAL HABITATS did not contribute to the impact score for this case.

CASE 11: SUMMER, BUNKER-C, 10,000 BBLS - IMPACT SCORE 906

THE PELAGIC HABITAT contributed the entire impact score for this case. The significant changes to Case 11 from Case 9 are:

Phytoplankton	reduced to	30	from 128
Zooplankton	reduced to	30	from 128
Ichthyoplankton	reduced to	12	from 51
Pacific sandlance	reduced to	0	from 36
Herring	reduced to	360	from 820
Dolly Varden	reduced to	24	from 55
Ringed seal	increased to	24	from 0
Ribbon seal	increased to	120	from 0
Bearded seal	increased to	24	from 0
Harbor seal	increased to	48	from 0

CASE 12: WINTER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 889

THE PELAGIC HABITAT contributed 29 percent (261) of the impact score for this case. When compared to Case 10, the impact score for this case

is somewhat lower (261 vs. 318); this reduction is accounted for by the following species:

Greenling	reduced to	0 from	6
Pacific sandlance	reduced to	9 from	36
Smelt	reduced to	3 from	12
Seabirds	reduced to	5 from	20

THE SUBTIDAL SAND/MUD HABITAT contributed 16 percent (138) of the impact score for this case. This habitat's result is the same as for Case 10.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 34 percent (298) of the impact score for this case. There is an overall minor increase (298 vs. 292) in the impact score when compared to Case 10.

THE INTERTIDAL SAND/MUD HABITAT contributed 9 percent (81) of the impact score for this case. A reduction in the score for Pacific sandlance from 36 to 9 accounts for the change from Case 10.

THE INTERTIDAL ROCK HABITAT contributed 8 percent (69) of the impact score for this case. The reduction from Case 10 is accounted for by the following species:

Herring	reduced to	36 from	153
Sessile marine invertebrates	reduced to	6 from	24
Miscellaneous crustaceans	reduced to	6 from	24
Other invertebrates	reduced to	9 from	36
Sea ducks	reduced to	6 from	24

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 5 percent (42) of the impact score for this case. There is an overall minor increase (42 vs. 31) in the impact score when compared to Case 10.

THE FRESHWATER RIVER AND TERRESTRIAL HABITATS did not contribute to the impact score for this case.

CASE 13: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 684

THE PELAGIC HABITAT contributed the entire impact score for this case. The reduction in this score when compared to Case 11 is accounted for by the five seal species not being affected by crude oil.

CASE 14: SUMMER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 655

THE PELAGIC HABITAT contributed the entire impact score for this case. The minor reduction from the impact score of Case 13 is accounted for by smelt (9 vs. 36) and Dolly Varden (24 vs. 26).

CASE 15: WINTER, GASOLINE, 10,000 BBLS - IMPACT SCORE 616

THE PELAGIC HABITAT contributed 32 percent (199) of the impact score for this case. With minor exceptions, the reduction from Case 12 is accounted for by the following species:

Phytoplankton	reduced to	9 from 36
Zooplankton	reduced to	9 from 36
Ichthyoplankton	reduced to	6 from 24

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 22 percent (136) of the impact score for this case. With minor exceptions, the reduction from the impact score of Case 12 is accounted for by the following species:

Pacific halibut	reduced to	12	from 48
Other marine fish	reduced to	9	from 36
King crab	reduced to	12	from 48
Tanner Crab	reduced to	9	from 36

THE INTERTIDAL SAND/MUD HABITAT contributed 7 percent (45) of the impact score for this case. The reduction in this score from Case 12 is accounted for by ducks (0 vs. 36).

THE INTERTIDAL ROCKY HABITAT did not contribute to the impact score for this case. This is a reduction of 69 in the impact score from Case 12.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 6 percent (40) of the impact score for this case. There is an overall minor reduction (40 vs. 42) in the impact score when compared to Case 12.

THE FRESHWATER RIVER HABITAT did not contribute to the impact score for this case.

THE TERRESTRIAL HABITAT contributed 5 percent (31) of the impact score for this case. This score represents an increase of 31 from Case 12, with four species--other vegetation, other mammals, raptors, and other birds--being judged to have minor impacts from the larger spill of gasoline.

CASE 16: SUMMER, GASOLINE, 10,000 BBLS - IMPACT SCORE 582

THE PELAGIC HABITAT contributed the entire impact score for this case. The significant changes to Case 16 from Case 14 are:

Greenlings	increased to	6	from 0
Pacific sandlance	increased to	9	from 0

Smelt	increased to 36	from 9
Seabirds	reduced to 0	from 120

The impact scores for Cases 17 through 26 range from 325 down to 18. The spill sizes for these cases are 1,000 barrels at all spills for both seasons. The array of these scores is:

	SPILL TYPE AND SEASON	SPILL SIZE 1,000	100
SUMMER	Diesel-2	See Case 8	256
	Crude Oil	See Case 13	147
	Bunker-C	See Case 14	138
	Gasoline	120	18
WINTER	Diesel-2	See Case 9	325
	Crude Oil	See Case 10	261
	Bunker-C	See Case 12	175
	Gasoline	156	100

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(11) NOME

Nome is located on the Seward Peninsula on the northern shore of Norton Sound. The spill site is about 2.5 miles south of the City where the depth reaches 60 feet at 64°27.22' N latitude, 165°25' W longitude (Fig. 2-65).

(a) PHYSICAL CHARACTERISTICS

Nome is in the Transitional Climatic Zone. The coast line is low and swampy, with foothills rising 1,000 to 2,000 ft in elevation about 4 to 8 miles inland. Further inland, the Kigluiak and Bendeleben Mountains rise to between 2,000 and 4,000 ft in elevation and shield Nome from the Artic Climatic Zone.

TEMPERATURES

Temperatures in the Summer vary between 29°F and 55°F.[1,4] Winter temperatures vary between -3°F and 35°F.[1,4] Ice typically begins to form in Norton Sound in late October with November 12th the average date of freezeup.[8] Ice breakup occurs around May 29th on the average.[8] Ice impedes navigation usually from early December to early June.[4] Sea temperatures range from 31°F to 64°F in the Summer and below 29°F in Winter.[4]

SURFACE WINDS

Winds generally come from southwesterly directions in the Summer and from east and north the remainder of the year.[2] Wind velocities average highest in the Winter from the east and east-northeast at about 14.1 knots. Representative winds for the ice-free period were chosen as southwest at 9.5 knots for Summer and north-northeast at 10.0 knots for Fall.

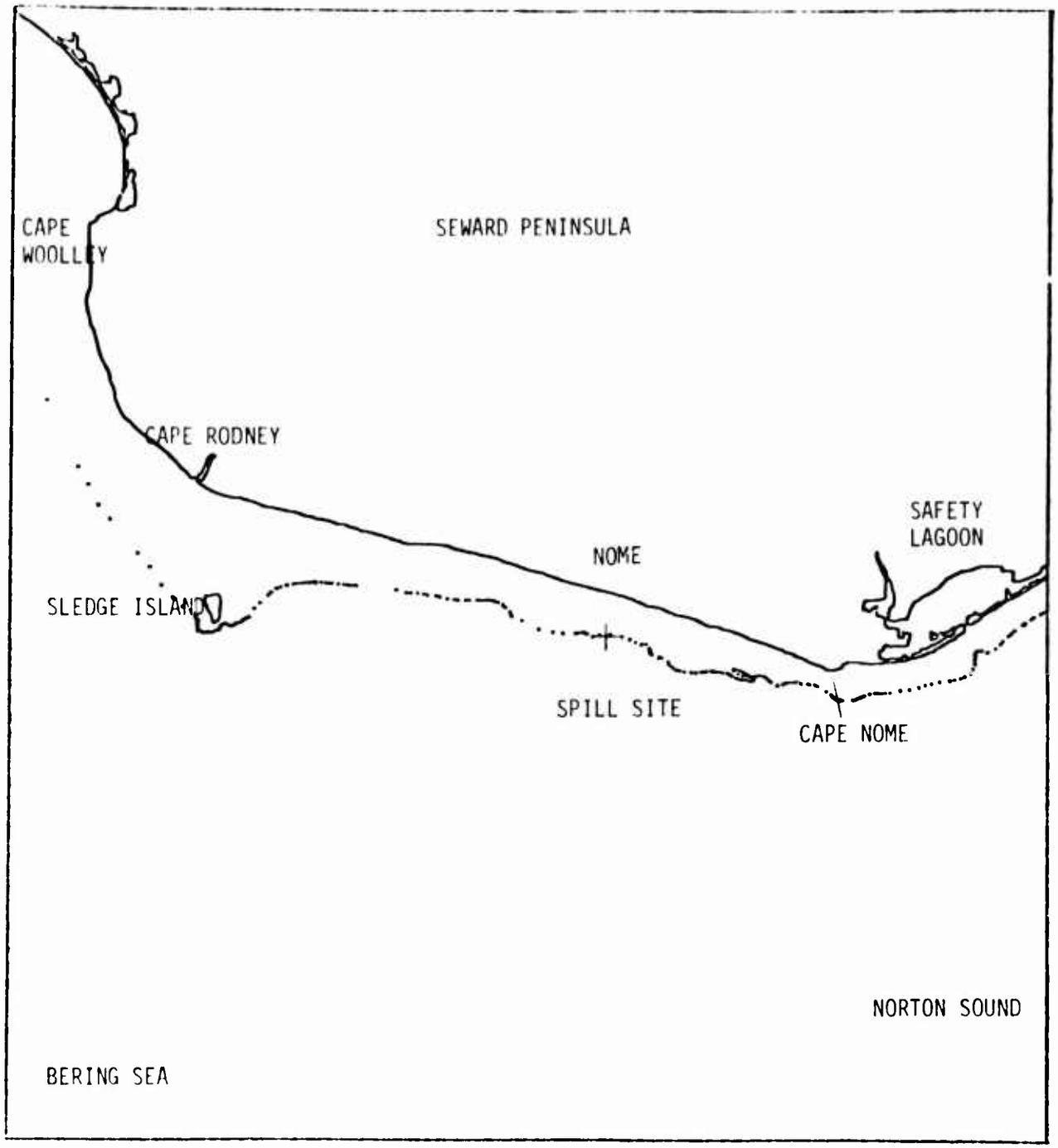


FIGURE 2-65. THE NOME LOCATION AND SPILL SITE

NOTE: The broken line is the 10 fathom (60 feet) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

SURFACE CURRENTS

The *COAST PILOT*[8] gave the following information for the Nome vicinity:

AREA	COMMENT
Cape Nome Two miles off Nome	Diurnal tide range is about 2 feet. Tidal current averages about 1 knot at times of strength. It is chiefly diurnal with the flood set eastward and the ebb northwestward.
Nome	Diurnal tide range 1.6 feet.
Between Sledge Island and Mainland	Tidal current is diurnal, with an average velocity at strength of northwestward current of 1 knot and average velocity at strength of southeastward current of 0.5 knot. Maximum current observed was 1.5 knots setting northwestward.

The *TIDAL CURRENT TABLES*[9] had information for Sledge Island (west of Nome) as follows:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY)	
	EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Two miles north of Sledge Island	0.5 K (120^{o})	1.0 K (305^{o})

Another source[51] indicated that Nome has an extreme tide range of 7.5 ft and that water levels around Nome are more influenced by wind than tide. An extreme example is the recent November, 1974 storm driven by 70-mph winds at Nome. Tidal currents would also be influenced by wind.

The following are the surface current regions used in the oil dispersion modelling by MSNW:

AREA	EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Both sides - Sledge Island	0.5 K (120^{0})	1.0 K (305^{0})
Nearshore - Nome vicinity	0.5 K (100^{0})	1.0 K (280^{0})
Nearshore - East of Nome	0.5 K (065^{0})	1.0 K (245^{0})
Offshore - above areas	0.3 K (090^{0})	1.0 K (270^{0})

(b) BIOLOGICAL CHARACTERISTICS

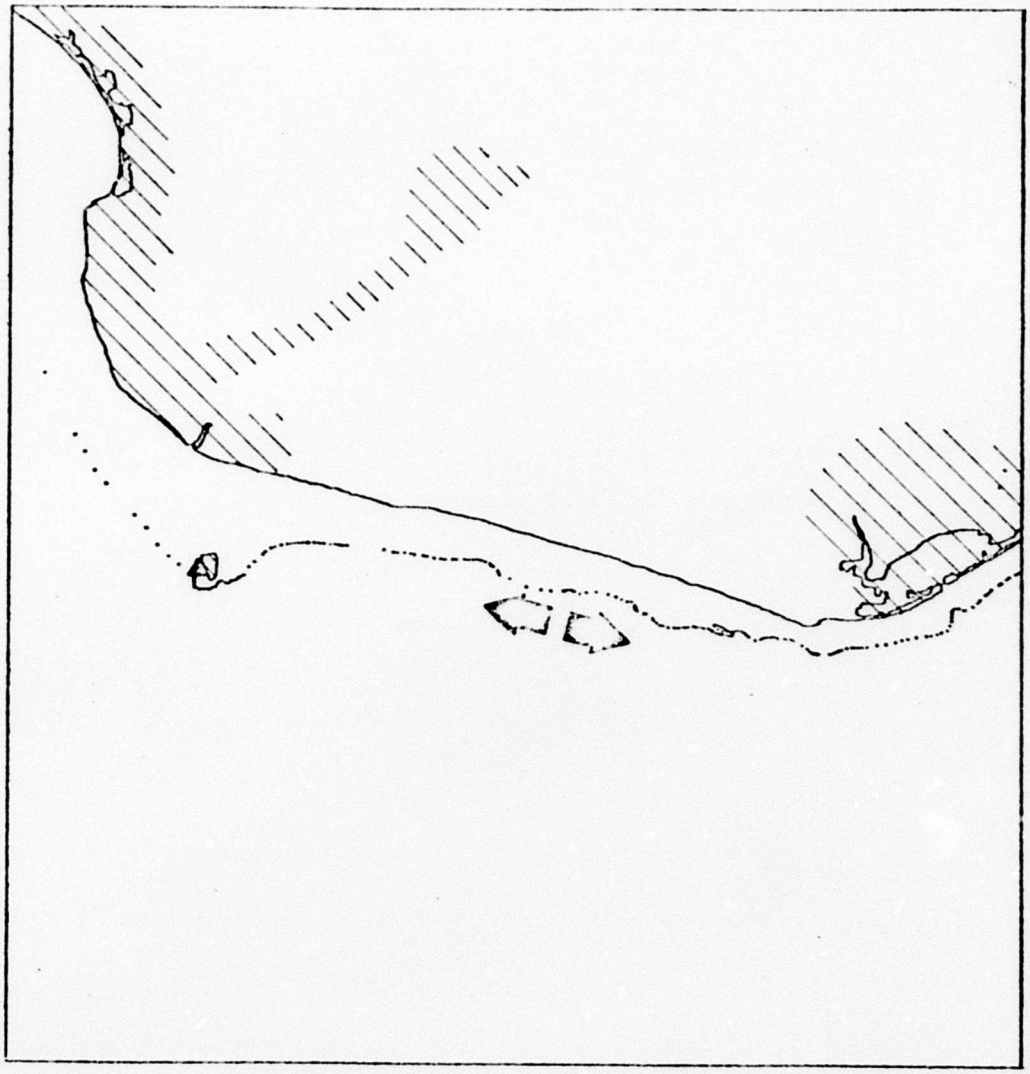
Salmon and marine mammals are important resources because of their utility to the local inhabitants. Waterfowl are abundant in the Nome (Seward Peninsula) area. Resource summaries are shown in Figures 2-66 and 2-67.

FISHES

SALMONIDS include all five North American species of Pacific salmon, Arctic char, and steelhead trout.[51]

Chum salmon are the most abundant in commercial catches in the area from Cape Douglas to Stuart (nearly all of Norton Sound). The average commercial catch (1965-1971) of salmon is as follows:

SALMON	MEAN	(RANGE)
King	1,800	(1,000 - 2,600)
Sockeye	10	(0 - 10)
Coho	4,500	(2,000 - 6,900)
Pink	38,500	(200 - 86,900)
Chum	75,000	(36,900 - 141,400)



Waterfowl and Seabirds

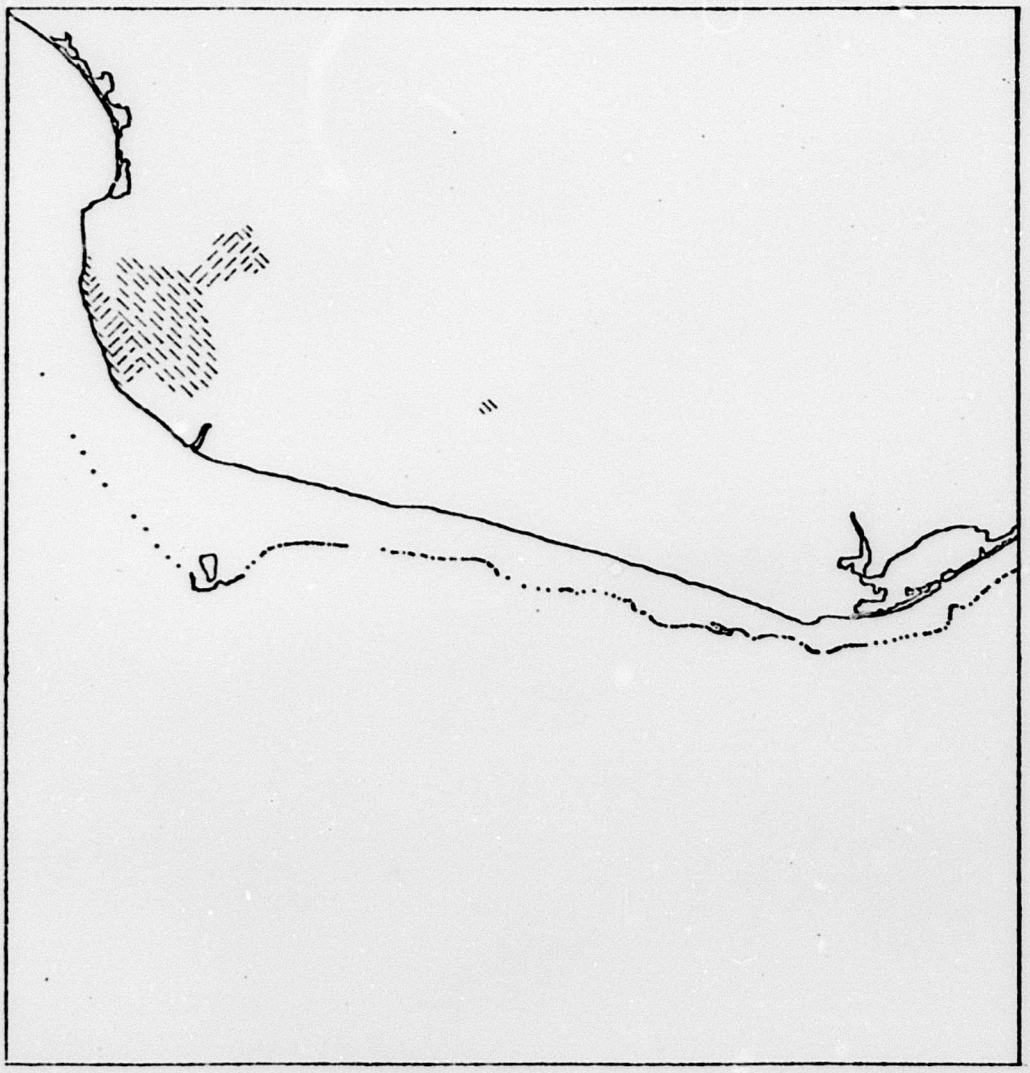
Nesting-Molting Area

Seabird Colonies

Major Migration Routes

FIGURE 2-66. NOME CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.



Musk Ox

Winter Range

Summer Range

FIGURE 2- 67. NOME CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

A substantial subsistence fishery also exists on these salmon in Norton Sound (excludes Yukon District). Average subsistence catches (1963-19[illegible]) are as follows:

SALMON	MEAN	(RANGE)
King	500	(10 - 1,000)
Coho	2,700	(100 - 4,800)
Pink	18,800	(9,200 - 36,900)
Chum	19,700	(12,500 - 30,800)

The timing of the adult salmon runs (the four significant fisheries) estimated for weekly catch data is as follows:

SALMON	TOTAL RUN	PEAK
King	Late May - Late August	Late June
Coho	Mid-July - Mid-September	Mid-August
Pink	Mid-June - Early July	Mid-June
Chum	Late May - Late September	July-August

The timing of juvenile salmon entrance into the sea was not indicated but they probably leave fresh water later than Bristol Bay fish due to colder water temperatures and late ice breakup. The pink and chum salmon fry would probably remain in the Norton Sound area through August, close to shore in estuarine conditions for early feeding and growth and would be vulnerable to oil spills in such locations.

CODS at this location include the blue (Arctic) cod, saffron cod,[51] and Pacific cod. The saffron cod (navaga) is known to approach shallow, pebbly

bottom of Norton Sound in Winter for spawning and in Summer migrates into deeper (30 to 60 m) of water to feed. Cods were assumed moderately abundant here.

FLATFISHES, in terms of species, dominate the shallow marine waters in the Nome vicinity. Species involved include Arctic flounder, flathead sole, Bering flounder, yellowfin sole, longhead dab, and starry flounder. One source reported Arctic flounder as spawning in Winter (like saffron cod) from January through March. Spawning takes place near shore under the ice (at 5 to 10m) and at temperatures of -1°C. No quantitative information was located. These flatfish were assumed in moderate numbers at this location.

MISCELLANEOUS FISHES in marine and fresh waters include smelt, herring, capelin, grayling, whitefish, and northern pike.[51] Sculpins are also present at this location. Miscellaneous marine and freshwater fishes are assumed to be in average numbers at this location. The resident fishes of the Snake River (drains through Nome's harbor) are primarily composed of grayling, Arctic char, and whitefish, with only the latter expected to be in the harbor to any extent.

SHELLFISHES

KING CRAB are known to be present in the Nome vicinity as they are taken in shallow offshore waters by subsistence fishermen.[51] No information on their abundance was located. They are assumed to be in low to moderate numbers.

SHRIMP (coonstripe) are present in the Nome vicinity, but are not notably used for commercial or subsistence purposes.[51] Shrimp were assumed in low numbers at this location.

WATERFOWL

Waterfowl inhabit nesting/molting areas east - Safety Lagoon vicinity, and west - Sledge Island offshore, and in the Cape Rodney vicinity and inland of the Nome location.[17] Major waterfowl migration routes parallel the coast in the Nome vicinity.[17] An estimate of the seabirds in the proposed Bering Sea National Wildlife Refuge (Game Units 3 - 7, Cape of Wales into Norton Sound, is 902,000 birds in designated lands).[52]

DUCKS are very abundant on the tundra and coastal lowlands of the Seward Peninsula (average population of 60 ducks per square mile of habitat).[51] The most common sea duck is the greater scaup, and the pintail is the most common in freshwater areas.[17] Ducks, therefore, were assumed to be very abundant at this location.

GEESE are in low numbers at this location, with small populations of emperor and white-fronted geese and black brant.[52] Nome is in a major waterfowl migration area. Coastal lagoons (including Safety Lagoon, east of Nome) contain stands of eelgrass important to geese and other waterfowl. Isolated stands of eelgrass are located near Nome.[51] Native hunting is suspected to have reduced the populations of geese to present levels.[18]

SEABIRDS are in high numbers east and west of the Nome spill site. West of Nome (about 25 miles) lies Sledge Island with a designated seabird colony[17] where some 35 species were recorded in one month (June, 1950) and undoubtedly more would be found year-round.[52] At this island (designated Game Unit 5 in this source),[52] black-legged kittiwakes and thick-billed and common murres are the most abundant species (estimated 2,000 breeding pairs each), and pigeon guillemots, cormorants, and parakeet and least auklets are common cliff nesters. The common eider nests along beaches.[52]

On Bluff Unit 6,[52] about 40 miles east of Nome, seabirds nest along 3.5 miles of cliff area. The principal species are thick-billed and common murres (estimate 80,000 combined) and black-legged kittiwakes (estimate 10,000). Puffins, gulls, cormorant, and guillemots are listed to be in lower abundance.[52]

SHOREBIRDS were assumed to be moderately abundant, although no specific data were located for this bird group in the Nome vicinity.

MARINE MAMMALS

Marine mammal distribution in the Bering Sea was discussed in detail in the St. Matthew Island location description. For the most part, the polar bear, seals, walrus, sea lions, and whale/porpoise movements are affected by the existence of the ice pack of the Bering Sea. One source[51] indicated that the most common marine mammals in Norton Sound are the walrus, bearded seal, ringed seal, beluga whale, and bowhead whale. With this information and additional information located in Appendix D , MSNW assumed that ringed seals, ribbon seals, walrus, and whales were very abundant; bearded seals and harbor seals were assumed abundant. Polar bear, sea lions, and northern fur seals were assumed few in number at this location.

TERRESTRIAL MAMMALS

MUSKOX rank high at this location only because it is the only location near any of these animals. These animals occupy beaches and nearshore tundra area in the Cape Rodney vicinity. These were introduced in 1970 (36 animals), and 24 animals are now known in the area.[17]

CARIBOU are present in low numbers, but they are difficult to separate from local reindeer.[18] They occupy nearshore tundra areas.

MOOSE are shown as present in the entire Nome vicinity but are in low abundance, and no areas of seasonal concentration are known.[17] They principally occupy willow flats along streams.

BROWN BEARS are assumed to be in sparce abundance in the area, although little data are available.[15] Minor concentrations would be expected on streams with returning salmon.

WOLVES AND WOLVERINES are present throughout this region but both are low in abundance.[17] The wolverine population is thought to be increasing, and the wolf population possibly holding the same or being reduced as they are "controlled" here related to reindeer herding.

OTHER MAMMALS in the area in the Nome vicinity include Arctic fox, red fox, Arctic hare, mice, voles, and lemmings.[51] Low population of these mammals is assumed.

AQUATIC FURBEARERS include mink, muskrat, and weasel,[51] and, as for other mammals, are assumed to be in low abundance in the Nome vicinity.

FLORA

Terrestrial vegetation is not expected to be affected by the oil spills hypothesized at Nome. The comments on strand vegetation for St. Matthew also apply in this area. About 97 percent of the shoreline could be occupied by strand vegetation in Summer according to the digitized physical shoreline substrate data. Eelgrass is probably lacking on the exposed coast, but according to two sources,[70,79] a very large amount of this species occurs in Safety Lagoon to the east. Isolated stands of eelgrass are reported

near Nome.[51] Because of the lack of suitable rocky substrate, marine algae could occupy no more than 2 to 3 percent of the shallow subtidal bottom in Summer. It is likely that there is no intertidal algal vegetation. Floating kelp species are absent.[76]

For further physical and biological information on the Nome location, see Appendix D.

(c) RESULTS

Four habitats were impacted by spills at this location. The pelagic and intertidal sand/mud habitats generally contributed the majority of the impact scores for the cases.

Spills of all four products were assumed. Only crude oil was spilled in the 50,000-bbl volume. For similar spill sizes, diesel-2 had the largest impact scores, followed by crude oil, bunker C, and gasoline.

The largest species contributors were herring, Dolly Varden, eelgrass, seabirds, and shorebirds. The impact on eelgrass in Simpson Lagoon was considered to be the greatest impact because of its ecological importance and the estimated retention of oil in the lagoon and resulting long-term effect.

PHYSICAL FATE OF SPILLS

Three oil spill scenarios were examined at Nome. The first scenario, using most probable Summer conditions, resulted in oil moving in an easterly direction for 6 hours to the shoreline near Nome. For the remaining 66 hours the oil is estimated to slosh back and forth with the tide along the shoreline to the east and west at Nome. The larger spills (10,000 and 50,000 bbls) were judged to reach Simpson Lagoon east of Nome. (See Fig. 68) The second scenario, using most probable Fall/Winter conditions, resulted in oil moving in a south-easterly direction from the spill location into Norton Sound. This scenario is not discussed here as the impacts would be generally without meaning due to ice formation during this time of year. A spill under the ice would follow a different trajectory as the oil would not be affected by wind as is the case in this scenario. Further, subsurface currents are not known to any extent in Norton Sound and therefore any most probable conditions would at best be a guess and could provide misleading results. (See Cape Blossom for a complete examination of the possible results of a Winter scenario such as this.) The third scenario assumes the ice pack has moved into Norton Sound and that the oil is spilled on top of the ice. This scenario results in a puddle of oil on the ice surface approximately 500 m in radius and 1-cm thick. There would be minimal environmental impact from this spill, provided the oil was removed prior to breakup. Therefore, this scenario is discussed only under the cleanup portion of this section.

See Page 2-27 for discussion of spill enveloping process.

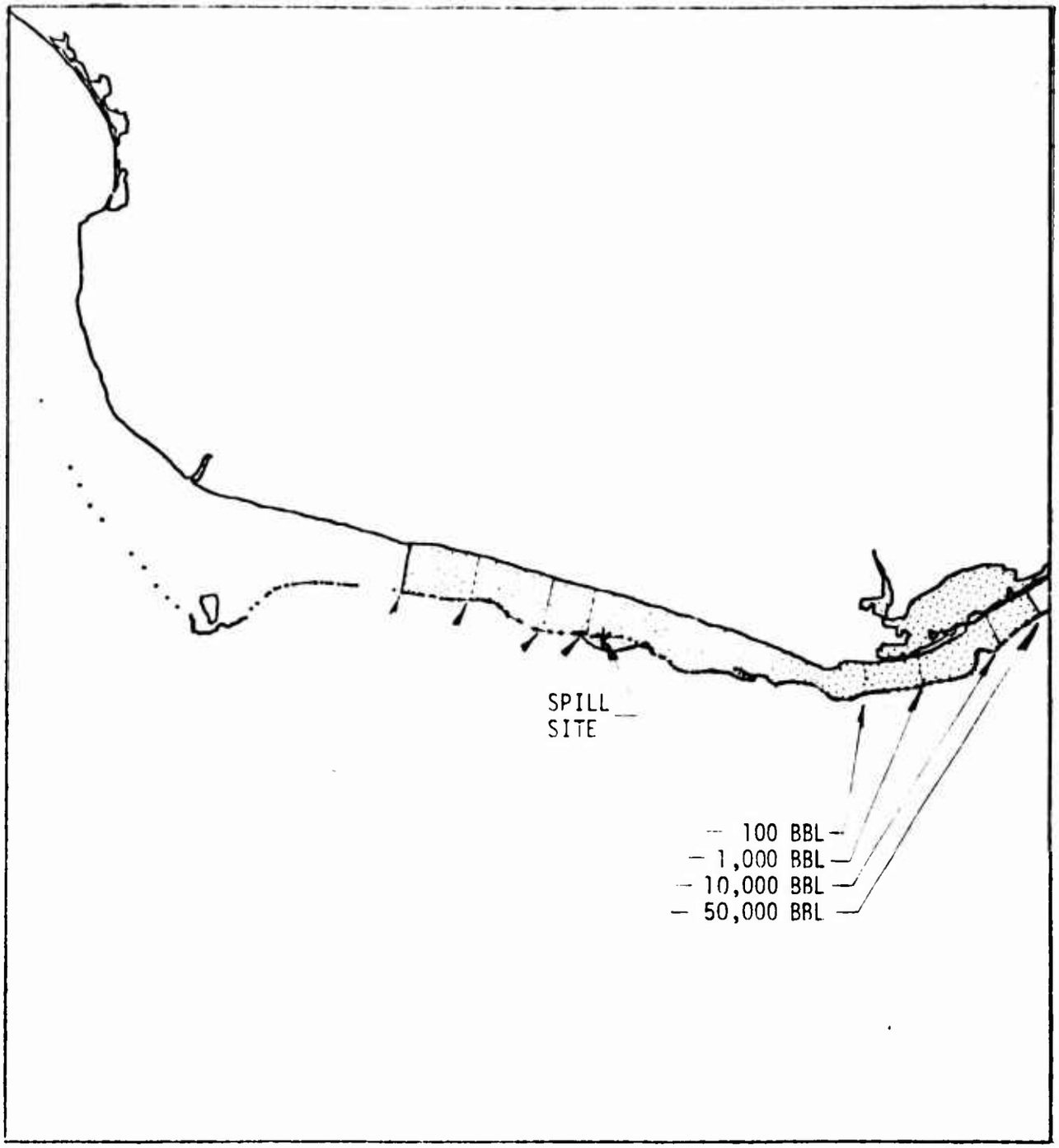


FIGURE 2-68 NOME SUMMER CRUDE OIL SPILL ENVELOPES

CASE DISCUSSION

Table 2-25 presents the results at the Summer oil spill scenarios examined at Nome without cleanup.

TABLE 2-25. NOME CASE RESULTS NO CLEANUP

SPILL TYPE	SPILL SIZE 50,000	10,000	1,000	100
Diesel-2	-	4,693 [2]	2,402 [2]	429 [9]
Crude Oil	5,905 [1](1)	3,285 [3]	1,752 [6]	347 [10]
Bunker-C	-	2,956 [4]	1,402 [7]	276 [11]
Gasoline	-	807 [8]	217 [12]	21 [13]

(1) Numbers in brackets are case numbers that follow.

All summer spill cases impacted only four habitats.

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 5,905

THE PELAGIC HABITAT contributed 39 percent (2,314) of the impact score in this case. The main contributing species to this score in this habitat were herring (387), smelt (219), crab larvae (193), chum salmon (102), Dolly Varden (387), and seabirds (547). The herring, smelt, crab larvae, Dolly Varden, and seabirds were among the most abundant species in this habitat. The salmon and seabirds were rated as major in commercial importance. The salmon were rated as minor in recreational importance. The salmon were rated major, the seabirds and Dolly Varden moderate, and smelt minor in subsistence importance. With the exception of the salmon, all of these species were judged to be the most sensitive to a crude oil spill in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 10 percent (562) of the impact score for this case. Only other flatfish (153) contributed significantly to the impact score for this case. The flatfish were one of the most abundant species in this habitat. They were rated as of minor commercial and recreational importance and of moderate subsistence importance.

THE INTERTIDAL SAND/MUD HABITAT contributed 41 percent (2,422) of the impact score for this case. The main contributing species to this impact score for this habitat were eelgrass (1,620), invertebrate infauna (145), shorebirds (328), and ducks (128). The eelgrass, ducks, and shorebirds were the most abundant species in this habitat. Shorebirds were rated minor and ducks major in subsistence importance. The eelgrass, infauna, and shorebirds were judged to be among the most sensitive to a crude oil spill in this habitat.

THE TERRESTRIAL HABITAT contributed 10 percent (607) of the impact score for this case. Tundra (128) and raptors (200) were the only species which contributed significantly to the impact score in this habitat. Both species were among the most abundant in this habitat. Rapters were classified as protected. Table 2-26 presents the full results of Case 1.

CASE 2: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 4,693

THE PELAGIC HABITAT contributed 58 percent (2,705) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 1 is accounted for by the following species:

Phytoplankton	increased	to	82	from 38
Zooplankton	increased	to	164	from 77

TABLE 2-26. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	NOME
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	3	H	0	0	0	3	4	1	36	9	38
2. ZOOPLANKTON	6	H	0	0	0	3	4	1	72	18	77
3. ICHTHYOPLANKTON	3	H	0	0	0	2	4	1	24	6	26
5. GREENLINGS	1	E	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	3	E	0	0	0	3	1	0	9	0	9
7. HERRING	6	A	0	0	1	3	9	8	216	192	287
8. SMELT	6	A	0	0	1	3	9	1	216	24	219
9. CRAB LARVAE	6	A	0	0	0	2	9	8	108	96	104
10. KING SALMON	1	A	2	1	2	2	4	1	28	7	30
11. CHUM SALMON	3	A	3	0	3	2	4	1	96	24	102
12. SOCKEYE SALMON	1	A	1	0	2	2	4	1	20	5	21
13. PINK SALMON	1	A	3	1	3	2	4	1	36	9	38
14. COHO SALMON	1	A	2	1	0	2	4	1	20	5	21
16. DOLLY VARDEN	6	A	0	1	2	1	9	8	216	192	287
17. NORTHERN FUR SEAL	1	A	0	0	2	5	1	0	7	0	7
18. RINGED SEAL	10	A	0	0	3	5	1	0	80	0	80
19. RIBBON SEAL	10	A	0	0	1	5	1	0	60	0	60
20. BEARDED SEAL	6	A	0	0	1	5	1	0	36	0	36
21. HARBOR SEAL	6	A	0	0	1	5	1	0	36	0	36
23. WALRUS	10	A	0	0	1	5	1	0	36	0	36
24. WHALES	10	A	0	0	3	5	0	0	0	0	0
26. POLAR BEAR	1	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	6	A	3	0	2	5	9	1	540	60	547
									1856	647	2314
2. SUBTIDAL SAND-MUD											
1. CODS	6	A	0	0	1	2	4	1	72	18	77
2. SCULPINS	6	A	0	0	0	2	4	1	48	12	51
3. STARRY FLOUNDER	3	A	0	0	0	2	4	1	24	6	26
4. OTHER FLATFISH	6	A	1	1	2	2	4	1	144	36	153

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TABLE 2-26 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
5. PACIFIC SANDLANCE	3	E	0	0	0	3	4	1	36	9	78
6. MISC. MARINE FISH	3	H	0	0	0	2	4	1	24	6	26
8. SHRIMP	3	E	0	0	0	3	9	1	81	9	82
10. OTHER BIVALVES	3	H	0	0	0	1	9	1	27	3	27
11. OTHER MARINE INVERTEBRATES	3	E	0	0	0	3	9	1	81	9	82
									537	108	562
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	1	E	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	3	A	0	0	3	2	0	0	0	0	0
5. OTHER FLATFISH	3	A	0	0	0	2	0	0	0	0	0
6. GREENLINGS	1	E	0	0	0	2	0	0	0	0	0
8. WALLEYE POLLOCK	3	E	0	0	0	2	0	0	0	0	0
9. OTHER MARINE FISH	3	E	0	0	0	2	0	0	0	0	0
10. KING CRAB	3	E	0	0	2	2	0	0	0	0	0
11. TANNER CRAB	3	E	0	0	1	2	0	0	0	0	0
12. SCALLOPS	3	E	0	0	0	2	0	0	0	0	0
13. OTHER MARINE INVERTEBRATES	6	E	0	0	0	3	0	0	0	0	0
									0	0	0
4. INTERTIDAL SAND-MUD											
1. EELGRASS	6	A	0	0	0	3	0	27	162	486	1620
2. PACIFIC SANDLANCE	3	E	0	0	0	3	4	1	36	9	78
3. RAZOR CLAM	3	H	0	0	0	2	9	3	54	48	97
4. SOFTSHELL BIVALVES	1	H	0	0	0	2	9	3	18	16	32
5. INVERTEBRATE INFAUNA	3	E	0	0	0	3	9	3	81	72	145
7. SHOREBIRDS	6	A	0	0	1	5	9	1	324	36	328
8. GEESE	1	A	0	0	2	1	4	1	12	3	13
9. DUCKS	6	A	0	0	3	2	4	1	120	30	429
10. SWANS	1	A	0	0	0	5	4	1	20	5	21
									827	765	2422
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	0	0	0	0	0
2. GREENLINGS	3	E	0	0	0	2	0	0	0	0	0
3. HERRING	6	A	0	0	1	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	1	H	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	3	H	0	0	0	2	0	0	0	0	0

TABLE 2-26 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	3	M	0	0	1	1	0	0	0	0	0
7. SHOREBIRDS	1	A	0	0	1	5	0	0	0	0	0
8. SEA DUCKS	3	A	0	0	3	2	0	0	0	0	0
9. MARINE MAMMAL ROOKERIES	1	A	0	0	0	5	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	E	0	0	1	3	0	0	0	0	0
2. SMELT	6	A	0	0	1	1	0	0	0	0	0
3. HARDSHELL BIVALVES	1	M	0	0	0	2	0	0	0	0	0
4. CRUSTACEANS	3	M	0	0	0	2	0	0	0	0	0
5. GASTROPODS	1	M	0	0	0	3	0	0	0	0	0
6. SHOREBIRDS	6	A	0	0	1	5	0	0	0	0	0
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	E	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	3	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	1	2	2	0	0	0	0	0
4. CHUM SALMON	3	A	0	0	3	2	0	0	0	0	0
5. SOCKEYE SALMON	1	A	0	0	2	2	0	0	0	0	0
6. PINK SALMON	1	A	0	1	1	2	0	0	0	0	0
7. COHO SALMON	1	A	0	1	0	2	0	0	0	0	0
9. DOLLY VARDEN	6	A	0	1	1	1	0	0	0	0	0
10. WHITEFISH	10	A	1	2	3	1	0	0	0	0	0
11. ARCTIC GRAYLING	6	A	0	1	2	2	0	0	0	0	0
12. PIKE	6	A	0	1	1	1	0	0	0	0	0
13. STICKLEBACKS	3	M	0	0	0	3	0	0	0	0	0
14. OTHER FISH	3	E	0	0	0	3	0	0	0	0	0
15. DUCKS	10	A	0	0	3	2	0	0	0	0	0
16. GEESE	6	A	0	0	2	2	0	0	0	0	0
17. SWANS	3	A	0	0	0	5	0	0	0	0	0
19. MINK	3	A	0	0	2	1	0	0	0	0	0
20. MUSKRAT	3	A	0	0	2	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	0	0	2	1	0	0	0	0	0
									0	0	0

TABLE 2-26 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	4	1	120	30	150
2. RIPARIAN VEGETATION	6	E	0	0	0	2	4	1	48	12	51
3. STRAND VEGETATION	15	A	0	0	0	1	4	1	60	15	64
4. OTHER VEGETATION	1	M	0	0	0	2	4	0	8	0	8
5. BROWN BEAR	1	A	1	1	1	2	0	0	0	0	0
7. WOLVERINE	3	A	1	0	0	1	4	0	24	0	24
8. WOLF	3	A	1	0	0	1	4	0	24	0	24
9. MOOSE	1	A	0	1	2	2	0	0	0	0	0
10. CARIBOU	3	A	0	1	2	2	0	0	0	0	0
13. MUSKOX	15	A	0	0	0	5	0	0	0	0	0
16. OTHER MAMMALS	3	A	0	1	2	2	4	0	60	0	60
17. RAPTORS	10	A	0	0	0	5	4	0	200	0	200
18. PTARMIGAN	6	A	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	6	A	0	0	0	2	4	0	45	0	45
									592	57	607
									3812	1517	5905

Ichtyoplankton	increased	to	55	from	26
Pacific Sandlance	increased	to	38	from	9
Smelt	increased	to	387	from	219
King Salmon	increased	to	64	from	30
Chum Salmon	increased	to	219	from	102
Sockeye Salmon	increased	to	46	from	21
Pink Salmon	increased	to	82	from	38
Coho Salmon	increased	to	46	from	21
Ringed Seal	reduced	to	0	from	80
Ribbon Seal	reduced	to	0	from	60
Bearded Seal	reduced	to	0	from	36
Harbor Seal	reduced	to	0	from	36

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (543) of the impact score in this case. With minor exceptions, this habitat's result was the same as for Case 1.

THE INTERTIDAL SAND/MUD HABITAT contributed 18 percent (847) of the impact score in this case. With minor exceptions, the decrease in impact score for this habitat from Case 1 is accounted for by the following species:

Eelgrass	reduced	to	164	from	1,620
Razor Clam	reduced	to	55	from	97
Invertebrate Infauna	reduced	to	82	from	145

THE TERRESTRIAL HABITAT contributed 13 percent (598) of the impact score for this case. With minor exceptions, this habitat's result was the same for Case 1.

CASE 3: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 3,285

THE PELAGIC HABITAT contributed 46 percent (1,464) of the impact score for this case. Most species impact scores were substantially changed from results of Case 2 in this habitat. The significant changes were as follows:

Ringed Seal	increased	to	80	from	0
Ribbon Seal	increased	to	60	from	0
Bearded Seal	increased	to	36	from	0
Harbor Seal	increased	to	36	from	0
Phytoplankton	reduced	to	36	from	82
Zooplankton	reduced	to	72	from	164
Ichtyoplankton	reduced	to	24	from	55
Pacific Sandlance	reduced	to	9	from	38
Herring	reduced	to	219	from	337
Smelt	reduced	to	102	from	387
Crab Larvae	reduced	to	109	from	193
King Salmon	reduced	to	28	from	14
Chum Salmon	reduced	to	96	from	219
Sockeye Salmon	reduced	to	20	from	46
Pink Salmon	reduced	to	36	from	82
Coho Salmon	reduced	to	20	from	46
Dolly Varden	reduced	to	219	from	387
Seabirds	reduced	to	255	from	547

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (437) of the impact score for this case. With minor exceptions, the decrease in impact score for this habitat from Case 2 is accounted for by the following species:

Shrimp	reduced	to	38	from 82
Other Marine Invertebrates	reduced	to	38	from 82

THE INTERTIDAL SAND/MUD HABITAT contributed 26 percent (847) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 2 is accounted for by the following species:

Eelgrass	increased	to	290	from 164
Shorebirds	reduced	to	153	from 328

THE TERRESTRIAL HABITAT contributed 18 percent (598) of the impact score for this case. This habitat's result was the same as for Case 2.

CASE 4: SUMMER, BUNKER C, 10,000 BBLS - IMPACT SCORE 2,956

THE PELAGIC HABITAT contributed 31 percent (902) of the impact score for this case. With minor exceptions, the decrease in impact score in this habitat from Case 3 is accounted for by the following species:

Phytoplankton	reduced	to	9	from 36
Zooplankton	reduced	to	18	from 72
Ichtyoplankton	reduced	to	6	from 24
Herring	reduced	to	102	from 219
Crab Larvae	reduced	to	51	from 109
King Salmon	reduced	to	7	from 28
Chum Salmon	reduced	to	24	from 96
Pink Salmon	reduced	to	9	from 36
Dolly Varden	reduced	to	96	from 219

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (408) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 3 is accounted for by the following species:

Shrimp	increased	to	82	from	38
Other Bivalves	increased	to	60	from	13
Sculpins	reduced	to	12	from	48
Other Flatfish	reduced	to	72	from	144

THE INTERTIDAL SAND/MUD HABITAT contributed 33 percent (973) of the impact score for this case. Only shorebirds, increased to 328 from 153, contributed significantly to the change in impact score for this habitat from Case 3.

THE TERRESTRIAL HABITAT contributed 23 percent (673) of the impact score for this case. Only strand vegetation, increased to 137 from 64, contributed significantly to the change in impact score for this habitat from Case 3.

CASE 5: SUMMER, DIESEL-2, 1,000 BBLS - ESTIMATED SCORE 2,402

THE PELAGIC HABITAT contributed 58 percent (1,384) of the score for this case. The main contributing species to this impact score for this habitat were judged to be herring, smelt, crab larvae, chum salmon, Dolly Varden, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 12 percent (278) of the score for this case. Only other flatfish were judged to contribute significantly to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 18 percent (434) of the score for this case. Only eelgrass and shorebirds were judged to congribute significantly to the score in this habitat.

THE TERRESTRIAL HARITAT contributed 13 percent (306) of the score for this case. Only raptors were judged to contribute significantly to the score in this habitat.

CASE 6: SUMMER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 1,752

THE PELAGIC HABITAT contributed 46 percent (781) of the score for this case. The main contributing species to the score in this habitat were judged to be herring, Dolly Varden, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (233) of the score for this case. Only other flatfish were judged to contribute significantly to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 24 percent (419) of the score for this case. Eelgrass and shorebirds were judged to contribute significantly to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 18 percent (320) of the score for this case. Tundra and raptors were judged to contribute significantly to the score in this habitat.

CASE 7: SUMMER, BUNKER-C, 1,000 BBLS - ESTIMATED SCORE 1,402

THE PELAGIC HABITAT contributed 31 percent (428) of the score for this case. Seabirds were judged to contribute significantly to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (194) of the score for this case.

THE INTERTIDAL SAND/MUD HABITAT contributed 33 percent (461) of the score for this case. Eelgrass and shorebirds were judged to contribute significantly to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 23 percent (319) of the score for this case. Tundra, strand vegetation, and raptors were judged to contribute significantly to the score in this habitat.

CASE 8: SUMMER, GASOLINE, 10,000 BBLS - IMPACT SCORE 807

THE PELAGIC HABITAT contributed 56 percent (451) of the impact score for this case. Herring (96), smelt (96), and Dolly Varden (96) were the species which contributed significantly to the impact score for this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (162) of the impact score for this case. No individual species contributed more than 36 to the impact score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 18 percent (149) of the impact score for this case. Eelgrass (72) is the only species which contributed significantly to the impact score for this habitat.

THE TERRESTRIAL HABITAT contributed 6 percent (45) of the impact score for this case.

The estimated scores for cases 9 through 13 range from 429 down to 21. The spill sizes for these cases are 1,000 bbls for gasoline and 100 bbls for all products.

The array of these scores is:

SPILL TYPE	SPILL SIZE 1,000 BBLS	100 BBLS
Diesel-2	See Case 5	429
Crude Oil	See Case 6	347
Bunker-C	See Case 7	276
Gasoline	217	21

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(12) CAPE BLOSSOM

Cape Blossom is located on Baldwin Peninsula on the northeastern shore of Kotzebue Sound. It lies about 11 miles south of Kotzebue. The spill location was taken at about 15 miles west of Cape Blossom at 66°45'N latitude, 163°0'W longitude (Fig. 2-69).

(a) PHYSICAL CHARACTERISTICS

Cape Blossom is located in the Arctic Climatic Zone. Baldwin Peninsula and much of the coastal plain is low rolling tundra with numerous flowing streams and open lakes in Summer.

TEMPERATURES

Temperatures exhibit a maritime influence in Summer and early Fall when winds blow onshore, and a continental influence when winds blow offshore. Winter temperatures typically range from -14°F to 7°F.[1,4] Summer temperatures range from 37°F to 59°F.[1,4] Record high and low temperatures are 85°F and -48°F at Kotzebue.[1,4]

Sea temperatures range between 29°F and 44°F in May and June and between 29°F and 60°F in July through September.[4] Average date of freezeup is October 23rd and breakup is May 31st.[8]

SURFACE WINDS

Winds predominate from westerly directions in Summer, easterly directions during September through March, and mixed east and west during April and May at Kotzebue.[2] The surrounding terrain has little influence on the wind. Representative winds at the spill site were chosen as west at 12.0 knots during Summer and east at 14.5 knots during Fall.

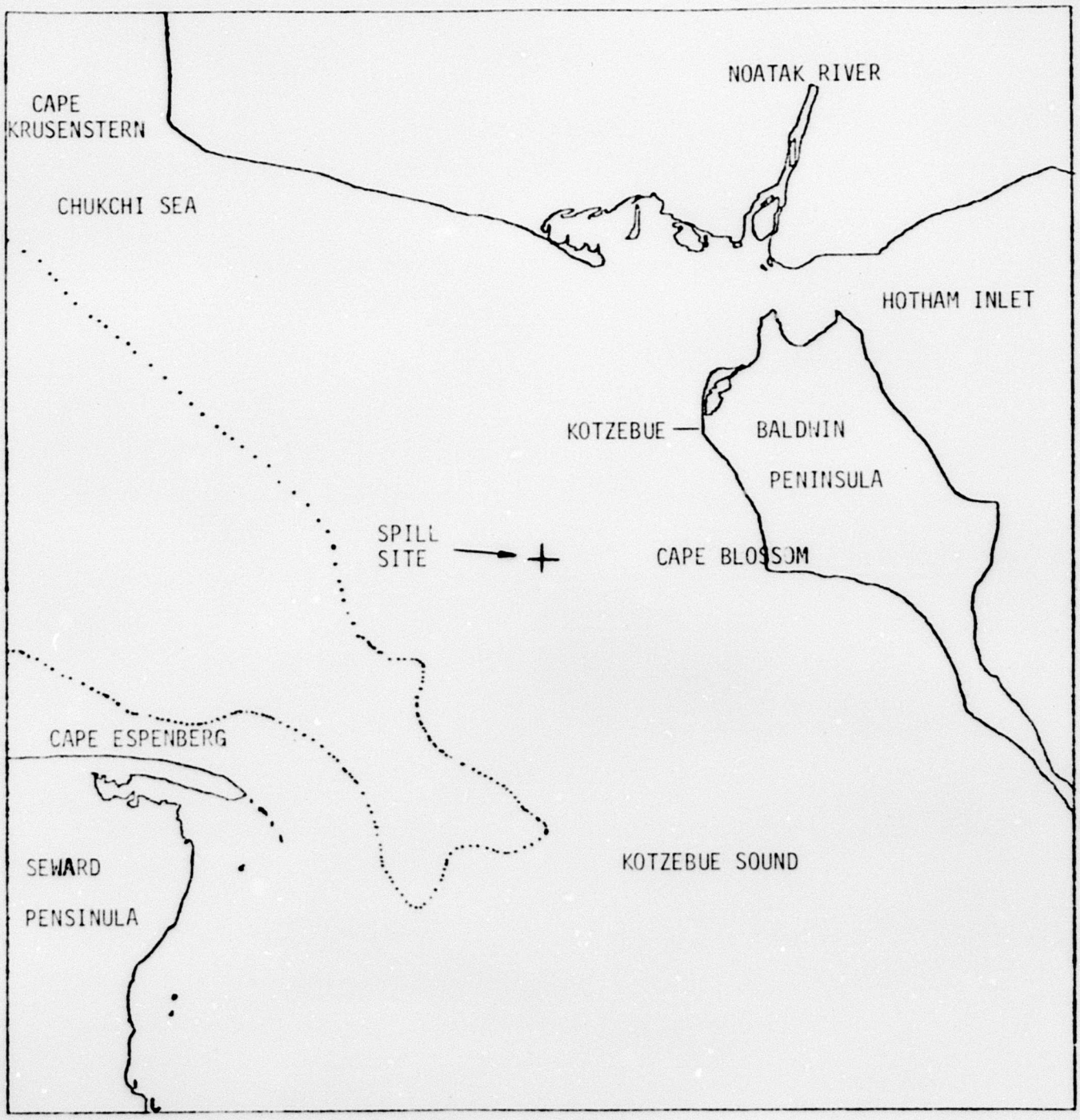


FIGURE 2-69. THE CAPE BLOSSOM LOCATION AND SPILL SITE.

NOTE: The broken line is the 10 fathom (60 ft.) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

SURFACE CURRENTS

Little data were found for the surface currents at this location. No information was available from the *TIDAL CURRENT TABLES*.[9] The *COAST PILOT*[8] contained the following:

AREA	COMMENT
Kiwalitz (south Kotzebue Sound)	Diurnal tide range is 2.7 feet.
Southwest of Cape Blossom (3-6 miles)	Average tidal current velocity is 0.5 knot. Flood sets southeastward; ebb sets northwestward. A non-tidal flow set northwestward of varying velocity has been observed for days at a time (maximum velocities of 1-2 knots at times of tidal currents ebb strength.
Hotham Inlet	Waters are little influenced by tides and are mostly fresh because of the near absence of any eastward current; prolonged southeast winds lower the level of Inlet waters.

Based upon these limited data, MSNW assumed the following tidal influence areas for oil dispersion modelling at the Cape Blossom site:

AREA	MAXIMUM CURRENTS (AVERAGE VELOCITY) EBB VELOCITY(DIRECTION)	FLOOD VELOCITY(DIRECTION)
Upper Kotzebue Sound	0.6 K (310°)	0.4 K (130°)
Southeastern Kotzebue Sound	0.9 K (340°)	0.6 K (160°)
South-southeastern Kotzebue Sound	0.9 K (060°)	0.6 K (240°)
South-southwestern Kotzebue Sound	0.9 K (090°)	0.6 K (180°)
Southwestern Kotzebue Sound	0.9 K (150°)	0.6 K (330°)
West Entrance Kotzebue Sound	0.9 K (090°)	0.6 K (270°)
Northeast Entrance Kotzebue Sound	0.9 K (280°)	0.6 K (100°)
Outlet vicinity Hotham Inlet	0.9 K (270°)	0.6 K (090°)

(b) BIOLOGICAL CHARACTERISTICS

The major biological resources in the Kotzebue Sound area would be waterfowl and marine mammals. The Chamisso National Wildlife Refuge, established in 1912 as a preserve and breeding ground for birds,[53] is located in the southeast corner of Kotzebue Sound.

Resource summaries are shown in Figure 2-70.

FISHES

A list of the freshwater and anadromous fishes of the Seward Peninsula is given in Table 2-27.

SALMONIDS are not numerous here compared to some other locations, but they are a vital resource utilized by man. The only major commercial salmon fishery is on chum salmon (mean annual catch for 1965-1971 is 72,000 fish). The Noatak and Kobuk River north and east (into Hotham Inlet), respectively, are the major producers. There is also substantial subsistence fisheries in these two rivers (harvest--20,000 to 70,000 chums annually). Smolt and juvenile chum salmon would be in the Sound vicinity throughout the Summer.

Subsistence fisheries also harvest approximately 10,000 to 30,000 sheefish annually. These fish are anadromous like salmon the are present in Hotham Inlet in the early Spring. They then move into the rivers in late Summer to spawn.

Other salmonids in the vicinity are coho, king, and pink salmon, Arctic char, Arctic grayling, and several whitefish species.[54] Dolly Varden also are reported north of Kotzebue Sound (Point Hope area).[55]

The marine fish communities of Kotzebue Sound have not been systematically surveyed. An extensive survey was made to the northwest in the

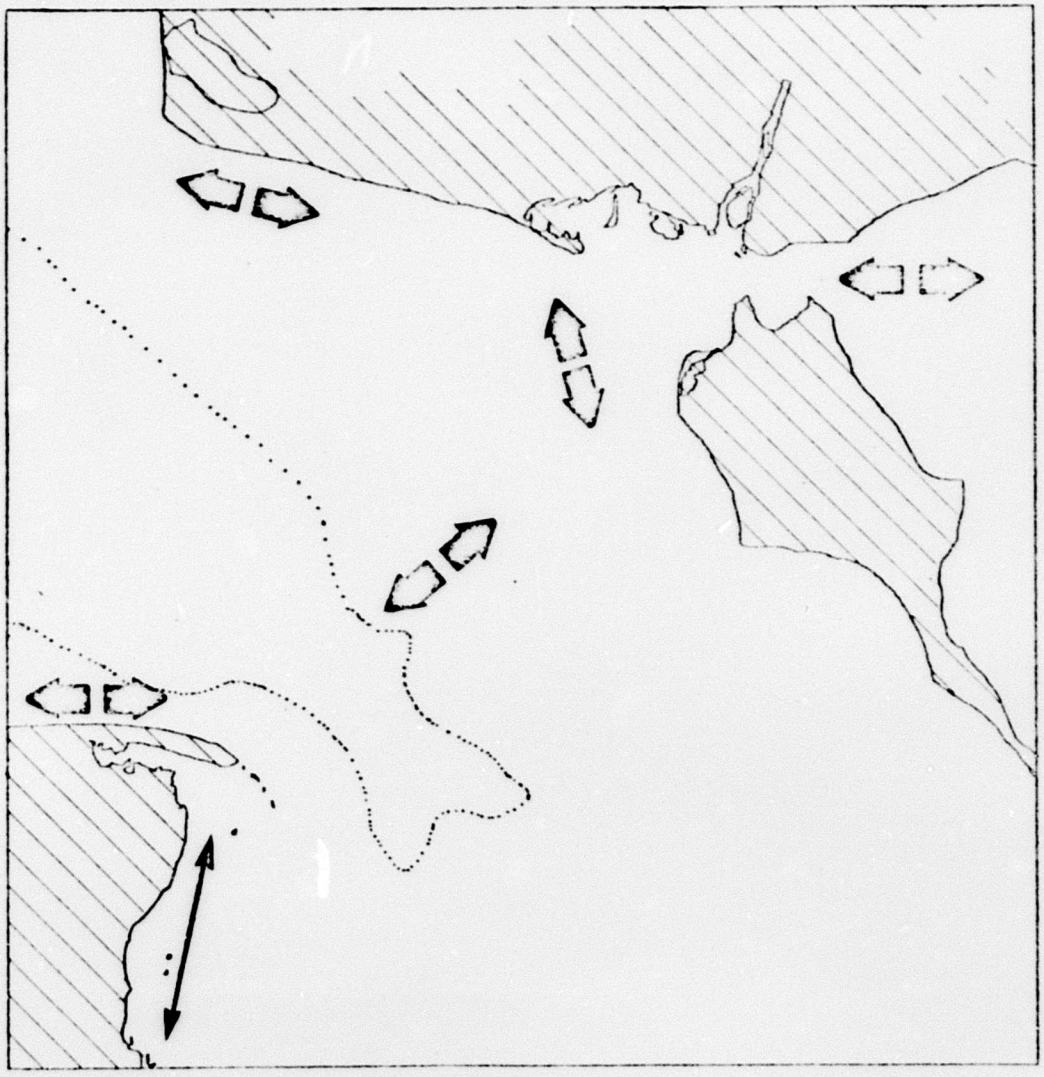


FIGURE 2-70. CAPE BLOSSOM CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

TABLE 2-27. CHECKLIST OF THE FRESHWATER AND ANADROMOUS FISHES OF THE SEWARD PENINSULA

Species		Seward Peninsula	
Common Name	Scientific Name	Bering Sea Drainage	Chukchi Sea Drainage
Sheefish (inconnu)	Stenodus leucichthys	x	x
Humpback Whitefish	Coregonus pidschian	x	x
Least Cisco	C. sardinella	x	x
Bering Cisco	C. laurettae	x	x
Round Whitefish	Prosopium cylindraceum	x	x
Arctic Grayling	Thymallus arcticus	x	x
Arctic Char	Salvelinus alpinus	x	x
Sockeye Salmon	Oncorhynchos nerka	x	x
Coho Salmon	O. Kisutch	x	x
Chinook Salmon	O. tshawytscha	x	x
Chum Salmon	O. keta	x	x
Pink Salmon	O. gorbuscha	x	x
Boreal Smelt	Osmerus eperlamus	x	x
Pond Smelt	Hypomesus olidus	x	x
Northern Pike	Esox lucius	x	x
Blackfish	Dallia pectoralis		x
Longnose Sucker	Catostomus catostomus	x	x
Burbot	Lota lota	x	x
Ninespine Stickleback	Pungitius pungitius	x	x
Threespine Stickleback	Gasterosteus aculeatus	x	
Deepwater Sculpin	Myexocephalus quadricornis	x	
Slimy Sculpin	Cottus cognatus	x	x

Source: Alaska Planning Group, *ENVIRONMENTAL STATEMENT--PROPOSED CHUKCHI-IMURUK NATIONAL WILDLANDS, ALASKA*, National Park Service, U.S. Department of the Interior, DES 73 93, December 1973, Draft.

Chukchi Sea off Cape Thompson,[55] and information from that study is used in the following descriptions. Another source[54] indicated that the saltwater fish important in the southern part of Kotzebue Sound are tom cod, flounder, herring, and mud shark.

PACIFIC HERRING were captured in large numbers in the Cape Thompson investigations[55] and are assumed to be abundant in the Kotzebue Sound vicinity.

SMELT were captured frequently and may, at times, appear in large quantities;[55] they were assumed to be abundant at this location. Eulachon and capelin are numerous smelt species in Arctic Alaska.[60]

CODS include Arctic cod and saffron cod at this location. These were assumed to be of average abundance at this location.

FLATFISHES including Bering flounder, arrowtooth flounder, yellowfin sole, Alaska plaice, Arctic flounder, and starry flounder were taken in the Cape Thompson study, but were in low densities (and small size).[55] These fish were assumed to be in low to average abundance at this location.

OTHER MARINE FISHES include numerous sculpin species, tom cod and mud shark. One sculpin species, the hamecon, is utilized by native fishermen.

SHELLFISHES

KING CRAB were taken in a few hauls in the Chukchi Sea,[55] and a few were assumed to be in Kotzebue Sound.

TANNER CRAB were taken and were abundant in the Chukchi Sea survey,[55] and some were assumed to be in Kotzebue Sound.

SHRIMP (cragonid, hippolytid, and pandalid) were abundant in the Chukchi Sea survey[55] and were assumed to be also in Kotzebue Sound.

SCALLOPS were relatively numerous in waters off Point Hope[55] and were assumed to also be in Kotzebue Sound.

WATERFOWL

Waterfowl (including seabirds) are present on the shore and land areas on the east and west sides of Kotzebue Sound.[17] These same areas are also nesting and molting areas.[17] Major migration routes are shown across the entrance of Kotzebue, and minor migration routes occur at the south end of the Sound.[17] Chamisso National Wildlife Refuge is located on Chamisso Island in the southeast corner of the Sound and has large seabird colonies.[53]

DUCKS are very abundant in Kotzebue Sound. This location lies in a Game Management Unit (23) and is one of the highest waterfowl production areas in the State--44 breeding ducks per square mile. Mean average production by 234,000 ducks was estimated at 187,000 young.[53] The principal species reported on the Seward Peninsula were pintail, scaup, oldsquaw, and scoters.[54] Surf scoters were reported to number 150 in one observation (July) off Chamisso Island.[53]

GEESE are known to include Canada and white-fronted geese.[17] Emperor geese may occur in the Kotzebue vicinity.[54] Geese and other waterfowl have been depleted in local areas in this vicinity by illegal Spring shooting and Summer bird "drives."[17]

SWANS were not reported by one source[17] but are thought to possibly be in the area because they are described as inhabiting the outer Seward Peninsula (southwest of Cape Blossom).[54]

SEABIRDS are numerous at this area with three seabird colonies described in the southern part of Kotzebue Sound. These refuges are at Chamisso Island (National Wildlife Refuge), Cape Deceit - Toawlevic Point, and Sullivan Bluffs.[17] The seabirds occupying these colonies include black-legged kittiwakes, glaucous-winged gulls, horned puffins, thick-billed murres, and common murres.[17] Chamisso Island has large cliff colonies of horned puffins, thick-billed murres, and black-legged kittiwakes. These appear to be the most numerous seabird species.[53] Relative to other locations, the Cape Blossom vicinity was felt to have an average abundance of seabirds.

SHOREBIRDS were assumed to be in average abundance at this location even though no quantitative information was located. Sandpipers and snipe were reported for Chamisso Island.[53]

MARINE MAMMALS

Information on marine mammal movements in the Bering Sea, Chukchi Sea, and Beaufort Sea is discussed in the St. Matthew Island location description. These mammals are generally involved in migrations related to the advance and retreat of sea ice. Marine mammals would be expected to be concentrated in this general vicinity in the Spring as sea ice is retreating before Summer and in late Fall with the advance of sea ice before Winter. From information[17,18] at hand, MSNW assumed the following abundances: ringed seals, walrus, and whales--very abundant; ribbon seal--abundant; bearded seal, harbor seal, and polar bear--low abundance; and northern fur seal--few, if any, present at this location.

TERRESTRIAL MAMMALS

BROWN BEAR numbers are thought to be sparse to medium in the Cape Blossom vicinity, although no precise estimates exist.[17]

CARIBOU in this area are part of the large Arctic herd (estimated to number 242,000).[17] Just what proportion of this herd might inhabit the Cape Blossom vicinity at any given time is not clear, but MSNW assumed this species was quite abundant at this location.

MOOSE are found in low numbers throughout this vicinity although the population is expanding.[17] This animal is a locally important source of meat in the Fall.[17]

MUSKOX were planted at Cape Thompson (north of Kotzebue Sound) in 1970.[17] Lone animals have been reported as far east as the Noatak River,[17] and a few muskox were assumed to be in the northern part of the Cape Blossom vicinity.

WOLVES AND WOLVERINES are present in this general vicinity.[17] This source[17] indicated that they are in moderate numbers in Game Management Unit 23, in which Cape Blossom is located.

OTHER SMALL MAMMALS in the area include Arctic hare and Arctic fox.

FLORA

Terrestrial vegetation is not expected to be affected by the hypothetical oil spills at Cape Blossom. At this location, many Beringian-Eastern North American strand (beach) species reach their northernmost distribution. According to one source,[55] based on a study of Cape Thompson to the west, the gravelly beaches do not favor the formation of strand vegetation. However, species such as *Elymus mollis*, *Senecio pseudo-arnica*,

Lathyrus japonicus, and others can be found, mainly on the leeward side of barrier beaches and at creek mouths.[54] Sea-ice scouring destroys the vegetation in Winter. About 86 percent of the shore at Cape Blossom is potentially available for strand species. Saline meadows of sedge-grass mats are minor in extent on wet alluvium near creek mouths and submerged sometimes by onshore storms.[55] Eelgrass does not occur this far north in Alaska.[74] The marine algae collected at Cape Thompson[55] show an Arctic character, but because the specimens were all collected in the drift, little can be said about the algal vegetation of the area. Only about 12 percent of the shallow subtidal bottom would be potentially available for growth of marine algae at Cape Blossom. Intertidal algal vegetation is probably very limited in area or lacking. Floating kelp species do not occur in this area.

For further physical and biological information on this location, see Appendix D.

(c) RESULTS

Five habitats were impacted by spills at this location. The pelagic and intertidal rock habitats contributed the majority of the impact scores for the cases.

Spills of all four products were assumed, but only crude oil was spilled in the 50,000-bbl volume. For similar spill sizes, diesel-2 spills had the highest scores. Scores for crude oil and bunker C were about equal. Gasoline had the smallest impact scores.

The largest species contributions were for herring, smelt, Dolly Varden, and shorebirds. Seasonal differences in scores reflect differences in species

abundance and a major change in oil slick trajectory. Summer scores were higher than Winter scores. The impact scores for crude oil--50,000 barrels and diesel-2--10,000 barrels were about equal in both seasons.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Cape Blossom. The first scenario, using most probable Summer conditions, resulted in oil moving in an easterly direction toward Cape Blossom (Fig. 2-71). The trajectory of the spill carried the oil to the western shore of the Baldwin Peninsula, between Cape Blossom and Kotzebue, approximately 36 hours after a spill. The second scenario, using most probable Winter conditions, resulted in oil moving in a westerly direction north of Cape Espenberg through Kotzebue Sound (Fig. 2-72). Of particular note at this site is that the trajectories of the spill do not allow a simple subtractive analysis. The Summer trajectory onshore impacts five of the habitats used in evaluation of impact. The Winter trajectory only impacts two of these five, plus one additional habitat. The scenario described as Winter at this location is more accurately described as being late Fall, or just prior to the formation of the icepack in Kotzebue Sound.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-28 presents the results of the oil spill scenarios examined at Cape Blossom without cleanup.

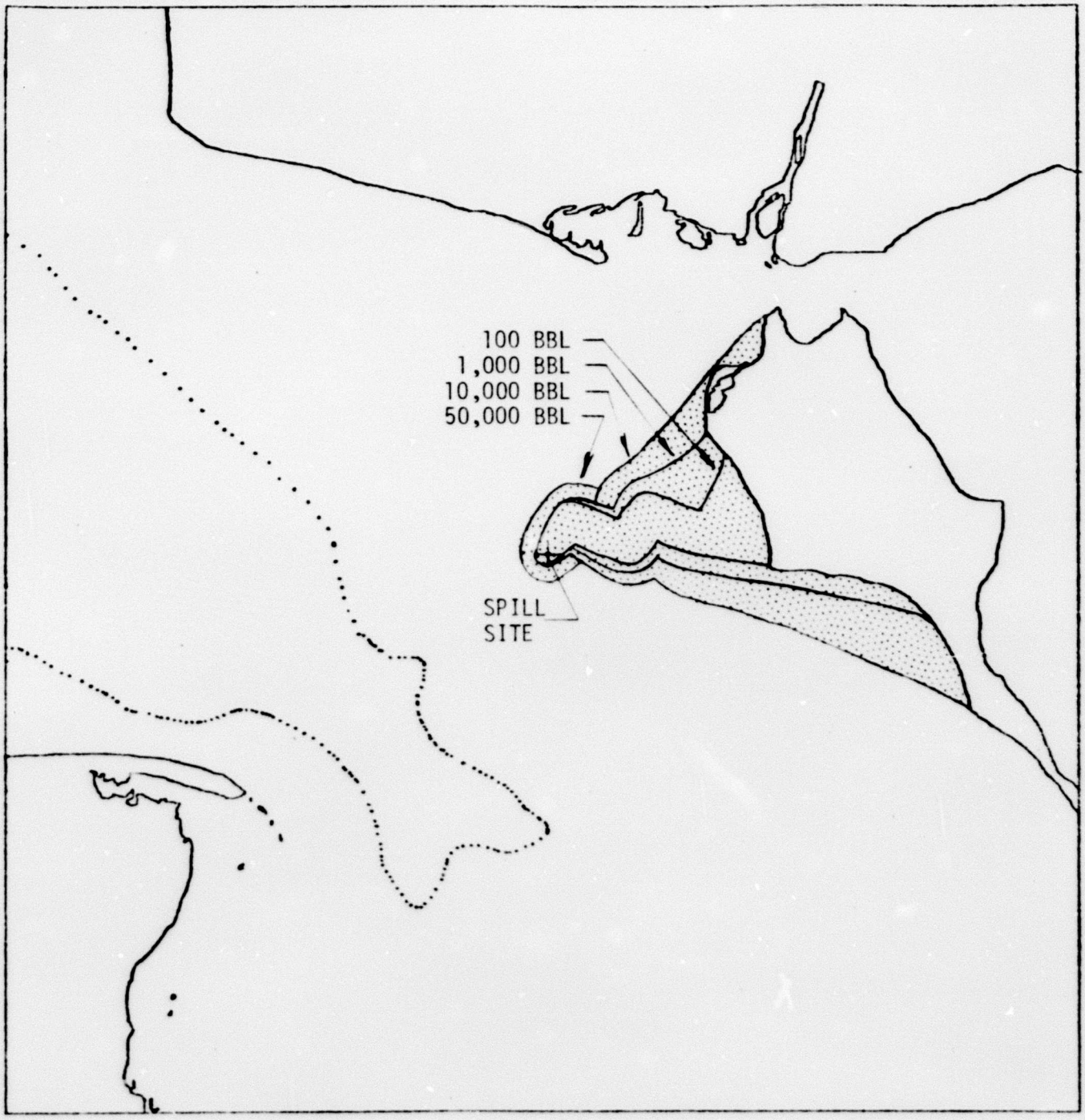


FIGURE 2-71. CAPE BLOSSOM SUMMER CRUDE OIL SPILL ENVELOPES

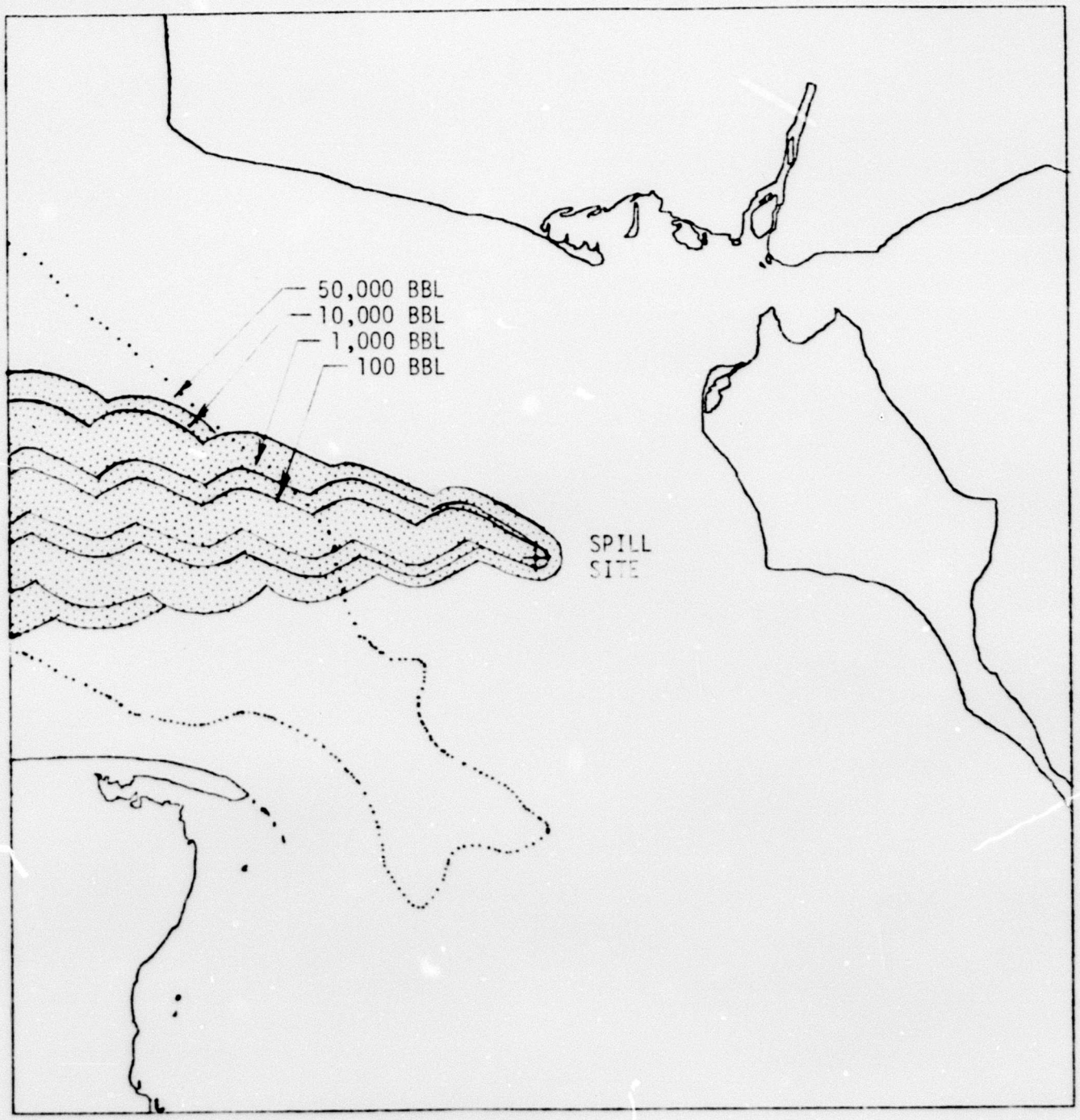


FIGURE 2-72. CAPE BLOSSOM AUTUMN CRUDE OIL SPILL ENVELOPES

TABLE 2-28 . CAPE BLOSSOM CASE RESULTS, NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000	100
SUMMER	Diesel-2	-	4,432 [2]	2,268 [5]	405 [16]
	Crude Oil	5,144 [1](1)	2,783 [4]	1,484 [8]	294 [18]
	Bunker-C	-	2,807 [3]	1,331 [9]	262 [19]
	Gasoline	-	453 [14]	122 [22]	12 [26]
WINTER	Diesel-2	-	1,709 [6]	989 [10]	158 [20]
	Crude Oil	1,630 [7]	807 [12]	585 [13]	133 [21]
	Bunker-C	-	923 [11]	419 [15]	76 [24]
	Gasoline		381 [17]	86 [23]	73 [25]

(1) Numbers in brackets are the case numbers that follow.

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 5,144

Three habitats did not contribute to the impact score for this case. These habitats, subtidal sand/mud, intertidal sand/mud, and freshwater river, do not contribute to any Summer scenario cases.

THE PELAGIC HABITAT contributed 39 percent (2,014) of the impact score for this case. The species which were the main contributors to this impact score were herring (644), smelt (483), Dolly Varden (387), and seabirds (273). All of these species were among the most abundant in this habitat, and were judged to be among the most sensitive to crude oil spills.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contribut[illegible] 9 percent (499) of the impact score for this case. While all species within the habitat were impacted, those which were major contributors to the impact score were chum

salmon (82), tanner crab (97), scallops (97), and other marine invertebrates (82). With the exception of chum salmon, these species were among the most abundant in this habitat. Chum salmon were rated high in importance for commercial and subsistence fishing. All four species were judged to be among the most sensitive in this habitat to crude oil spills.

THE INTERTIDAL ROCK HABITAT contributed 31 percent (1,588) of the impact score for this case. While all species within this habitat were impacted, those which were major contributors to the impact score were herring (483), miscellaneous crustaceans (193), other invertebrates (290), shorebirds (273), and seaducks (273). These five species were the most abundant in this habitat and were judged to be among the most sensitive to crude oil spills. Shorebirds were classified as protected, and seaducks were rated as having a high subsistence importance.

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 17 percent (892) of the impact score for this case. While all species within this habitat were impacted, those species which were major contributors to the impact score were smelt (483) and shorebirds (273). These two species were the most abundant in this habitat and were judged to be among the most sensitive to crude oil spills. Shorebirds were classified as protected.

THE TERRESTRIAL HABITAT contributed 3 percent (151) of the impact score for this case. While no individual specie was impacted in more than a moderate way, the major contributors to the impact score were strand vegetation (43), other vegetation (48), and raptors (30). These species were the most abundant of those impacted. Raptors were classified as protected.

Table 2-29 following presents the full results of Case 1.

TABLE 2-29. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	CAPE BLOSSOM
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RELT.
1. PELAGIC											
1. PHYTOPLANKTON	7	E	0	0	0	3	6	1	24	0	24
2. ZOOPLANKTON	6	A	0	0	0	3	6	1	72	44	77
3. ICHTHYOPLANKTON	3	E	0	0	0	3	6	1	24	6	26
5. SAPLINGS	1	E	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	7	A	0	0	0	3	1	0	3	0	3
7. HERRING	10	A	0	0	1	7	9	0	168	329	646
8. SMELT	10	A	0	0	0	7	9	1	279	28	272
9. CRAB LARVA	3	C	0	0	0	2	9	0	54	43	97
11. CHUM SALMON	1	A	7	1	3	2	6	1	24	0	39
16. DOLLY VARDEN	6	A	0	1	2	1	9	0	216	192	347
17. NORTHERN FUR SEAL	1	A	0	0	2	5	1	0	7	0	7
18. RINGED SEAL	10	P	0	0	2	5	1	0	72	0	70
19. KIDDON SEAL	6	P	0	0	1	5	1	0	36	0	36
20. BEARDED SEAL	7	P	0	0	1	5	1	0	14	0	14
21. HARBOR SEAL	3	P	0	0	2	5	1	0	21	0	21
23. WALRUS	10	P	0	0	2	5	0	0	0	0	0
24. WHALES	10	A	0	0	2	5	0	0	0	0	0
26. POLAR BEAR	3	A	0	0	0	1	0	0	0	0	0
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	6	A	0	0	0	5	9	1	270	72	273
									1497	662	2016
2. SUBTIDAL SAND-MUD											
1. COD	6	A	0	0	2	2	0	0	0	0	0
2. SCULPIN	3	A	0	0	0	2	0	0	0	0	0
3. STARRY FLOUNDER	3	A	0	0	0	2	0	0	0	0	0
4. OTHER FLATFISH	6	A	0	0	1	2	0	0	0	0	0
5. PACIFIC SANDLANCE	7	A	0	0	0	3	0	0	0	0	0
6. MISC. MARINE FISH	6	A	0	0	0	2	0	0	0	0	0
9. SHRIMP	3	A	0	0	0	2	0	0	0	0	0
10. OTHER BIVALVES	6	A	0	0	0	1	0	0	0	0	0

TABLE 2-29. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
11. OTHER MARINE INVERTEBRATES	6	A	0	0	0	3	0	0	0	0	0
									0	0	0
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	3	E	0	0	0	2	4	0	24	0	24
3. CHUM SALMON	1	A	0	1	3	2	9	1	81	9	82
5. OTHER FLATFISH	3	A	0	0	0	2	4	1	24	6	25
6. GREENLINGS	3	E	0	0	0	2	4	1	24	6	25
9. WALLEYE POLLOCK	3	A	0	0	0	2	4	1	24	6	25
9. OTHER MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
10. KING CRAB	1	A	0	0	0	2	9	8	18	16	32
11. TANNER CRAB	3	A	0	0	0	2	9	8	54	48	97
12. SCALLOPS	3	E	0	0	0	2	9	8	54	48	97
13. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	9	1	81	9	82
									392	144	499
4. INTERTIDAL SAND-MUD											
1. EELGRASS	1	E	0	0	0	3	0	0	0	0	0
2. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
4. SOFTSHELL BIVALVES	6	E	0	0	0	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	6	A	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	H	0	0	0	5	0	0	0	0	0
8. GEESE	3	A	0	0	3	1	0	0	0	0	0
9. DUCKS	10	A	0	0	3	2	0	0	0	0	0
10. SWANS	1	A	0	0	0	5	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	4	0	36	0	36
2. GREENLINGS	3	E	0	0	0	2	4	0	24	0	24
3. HERRING	10	A	0	0	1	2	9	8	270	240	489
4. SESSILE MARINE INVERTEBRATES	1	A	0	0	0	1	9	8	9	8	16
5. MISC. CRUSTACEANS	6	A	0	0	0	2	9	8	108	96	193
6. OTHER INVERTEBRATES	6	A	0	0	0	3	9	8	162	144	290
7. SHOREBIRDS	6	H	0	0	0	5	9	1	270	30	273
8. SEA DUCKS	6	A	0	0	3	2	9	1	270	30	273
									1149	548	1588

TABLE 2-29. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	1	4	0	36	0	36
2. SMELT	10	A	0	0	0	1	9	8	270	240	483
3. HARDSHELL BIVALVES	1	A	0	0	0	2	9	1	18	2	19
4. CRUSTACEANS	3	M	0	0	0	2	9	1	54	6	55
5. GASTROPODS	1	A	0	0	0	3	9	1	27	3	27
6. SHOREBIRDS	6	M	0	0	0	5	9	1	270	30	273
									675	281	893
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	M	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	3	M	0	0	0	3	0	0	0	0	0
9. CHUM SALMON	1	A	0	1	3	2	0	0	0	0	0
10. WHITEFISH	10	A	0	1	2	1	0	0	0	0	0
11. ARCTIC GRAYLING	6	A	0	2	2	2	0	0	0	0	0
12. PIKE	6	A	0	2	2	1	0	0	0	0	0
13. STICKLEBACKS	3	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	10	A	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	0	0	3	2	0	0	0	0	0
16. GEESE	10	A	0	0	3	2	0	0	0	0	0
17. SWANS	3	A	0	0	1	5	0	0	0	0	0
18. RIVER OTTER	3	A	0	0	1	1	0	0	0	0	0
19. MINK	3	A	0	0	1	1	0	0	0	0	0
20. MUSKRAT	3	A	0	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	0	0	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	15	P	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	10	M	0	0	0	2	0	0	0	0	0
3. STRAND VEGETATION	10	E	0	0	0	1	4	1	40	10	43
4. OTHER VEGETATION	6	M	0	0	0	2	4	0	48	0	48
5. BROWN BEAR	3	A	1	1	2	2	0	0	0	0	0
7. WOLVERINE	3	A	2	1	0	1	1	0	12	0	12
8. WOLF	3	A	2	1	0	1	0	0	0	0	0
9. MOOSE	1	A	0	1	3	2	0	0	0	0	0
10. CARIBOU	10	A	1	1	3	2	0	0	0	0	0
13. MUSKOX	3	A	0	0	0	3	0	0	0	0	0
16. OTHER MAMMALS	3	A	0	0	2	2	1	0	12	0	12
17. RAPTORS	6	A	0	0	0	5	1	0	30	0	30

TABLE 2-29. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	PSLT.
a. TERRESTRIAL											
1a. PTARMIGAN	6	A	0	0	1	2	0	0	0	0	0
1b. OTHER BIRDS	7	A	0	0	0	2	1	0	6	-	6
									148	10	151
									3867	1645	5144

CASE 2: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 4,432

THE PELAGIC HABITAT contributed 54 percent (2,376) of the impact score for this case. The change in impact score for this habitat compared with Case 1 is accounted for, with minor exceptions, by the following species:

Phytoplankton	increased	to	82	from	38
Zooplankton	increased	to	164	from	77
Ichthyoplankton	increased	to	55	from	26
Pacific Sandlance	increased	to	38	from	9
Smelt	increased	to	438	from	273
Chum Salmon	increased	to	145	from	38
Ringed Seal	reduced	to	0	from	70
Ribbon Seal	reduced	to	0	from	36
Bearded Seal	reduced	to	0	from	18
Harbor Seal	reduced	to	0	from	21

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (360) of the impact score for this case. The decrease in impact score for this habitat compared with Case 1 is accounted for, with minor exceptions, by the following species:

Tanner Crabs	reduced	to	55	from	97
Scallops	reduced	to	55	from	97

THE INTERTIDAL ROCKY HABITAT contributed 25 percent (1,054) of the impact score for this case. The decrease in impact score for this habitat compared with Case 1 is accounted for, with minor exceptions, by the following species:

Intertidal Seaweeds	reduced	to 9	from 36
Miscellaneous Crustaceans	reduced	to 109	from 193
Other Invertebrates	reduced	to 164	from 290
Shorebirds	reduced	to 128	from 273
Sea Ducks	reduced	to 128	from 273

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 12 percent (524) of the impact score for this case. The decrease in impact score for this habitat compared with Case 1 is accounted for, with minor exceptions, by the following species:

Intertidal Seaweeds	reduced	to 9	from 36
Smelt	reduced	to 273	from 483
Shorebirds	reduced	to 128	from 273

THE TERRESTRIAL HABITAT contributed 3 percent (118) of the impact score for this case. Only other vegetation (12 vs. 48) contributed substantially to the reduced impact score compared to Case 1 in this habitat.

CASE 3: SUMMER, BUNKER-C, 10,000 BBLS - IMPACT SCORE 2807

THE PELAGIC HABITAT contributed 26 percent (740) of the impact score for this case. The change in impact score for this habitat compared with Case 2 is accounted for, with minor exceptions, by the following species:

Phytoplankton	reduced	to	9	from	82
Zooplankton	reduced	to	18	from	164
Ichthyoplankton	reduced	to	6	from	55
Pacific Sandlance	reduced	to	0	from	38
Herring	reduced	to	170	from	644
Smelt	reduced	to	120	from	483
Crab Larvae	reduced	to	26	from	97
Chum Salmon	reduced	to	9	from	145
Dolly Varden	reduced	to	102	from	387
Seabirds	reduced	to	128	from	273
Ringed Seal	increased	to	70	from	0
Ribbon Seal	increased	to	36	from	0
Bearded Seal	increased	to	18	from	0
Harbor Seal	increased	to	21	from	0

THE SUBTIDAL ROCK/COBBLE GRAVEL HABITAT contributed 8 percent (234) of the impact score for this case. The change in impact score for this habitat compared with Case 2 is accounted for, with minor exceptions, by the following species:

Chum Salmon	reduced	to	9	from	82
Tanner Crab	reduced	to	26	from	82
Other Marine Invertebrates	reduced	to	38	from	82
Scallops	increased	to	120	from	55

THE INTERTIDAL ROCKY HABITAT contributed 33 percent (930) of the impact score for this case. The change in impact score for this habitat

compared with Case 2 is accounted for, with minor exceptions, by the following species:

Herring	reduced	to 128	from 483
Miscellaneous Crustaceans	reduced	to 12	from 109
Other Invertebrates	reduced	to 18	from 164
Shorebirds	increased	to 600	from 128

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 28 percent of the impact score for this case. The change in impact score for this habitat compared with Case 2 is accounted for, with minor exceptions, by the following species:

Smelt	reduced	to 120	from 273
Hardshell Bivalves	reduced	to 9	from 32
Crustaceans	reduced	to 26	from 55
Gastropods	reduced	to 3	from 27
Shorebirds	increased	to 600	from 128

THE TERRESTRIAL HABITAT contributed 5 percent of the impact score for this case. This habitat's result was the same, with minor exceptions, as in Case 2 (127 vs. 118).

CASE 4: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 2,783

THE PELAGIC HABITAT contributed 44 percent (1,223) of the impact score for this case. The increase in impact score for this habitat compared to Case 3 is accounted for, with minor exceptions, by the following species:

Phytoplankton	increased	to	36	from 9
Zooplankton	increased	to	72	from 18
Herring	increased	to	364	from 170
Crab Larvae	increased	to	55	from 26
Chum Salmon	increased	to	36	from 9
Dolly Varden	increased	to	219	from 102

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (316) of the impact score for this case. The change in impact score for this habitat compared to Case 3 is accounted for, with minor exceptions, by the following species:

Chum Salmon	increased	to	38	from 9
Tanner Crab	increased	to	55	from 26
Other Marine Invertebrates	increased	to	82	from 38
Scallops	reduced	to	55	from 120

THE INTERTIDAL ROCKY HABITAT contributed 22 percent (610) of the impact score for this case. The change in impact score for this habitat compared to Case 3 is accounted for, with minor exceptions, by the following species:

Miscellaneous Crustaceans	increased	to	109	from 12
Other Invertebrates	increased	to	164	from 18
Shorebirds	reduced	to	128	from 600
Sea Ducks	reduced	to	30	from 128

THE TERRESTRIAL HABITAT contributed 4 percent (106) of the impact score for this case. This habitat's result was the same, with some minor exceptions, as in Case 3 (106 vs. 127).

CASE 5: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 2,268

THE PELAGIC HABITAT contributed 48 percent (1,082) of the impact score for this case. The change in impact score for this habitat compared to Case 3 is accounted for, with minor exceptions, by the following species:

Pacific Sandlance	increased	to	36	from	9
Crab Larvae	reduced	to	26	from	55
Ring Seal	reduced	to	0	from	70
Ribbon Seal	reduced	to	0	from	36
Bearded Seal	reduced	to	0	from	18
Harbor Seal	reduced	to	0	from	21

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (157) of the impact score for this case. The decrease in impact score in this habitat from Case 4 is accounted for, with minor exceptions, by the following species:

Tanner Crab	reduced	to	26	from	55
Scallops	reduced	to	26	from	55
Other Marine Invertebrates	reduced	to	38	from	82

THE INTERTIDAL ROCKY HABITAT contributed 29 percent (66) of the impact score for this case. The change in impact score for this habitat from Case 4 is accounted for, with minor exceptions, by the following species:

Intertidal Seaweeds	reduced	to	9	from 36
Miscellaneous Crustaceans	reduced	to	51	from 109
Other Invertebrates	reduced	to	77	from 164
Herring	increased	to	273	from 128
Sea Ducks	increased	to	120	from 30

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 13 percent (305) of the impact score for this case. The change in impact score for this habitat from Case 4 is accounted for, with minor exceptions, by the following species:

Intertidal Seaweed	reduced	to	0	from 36
Smelt	reduced	to	128	from 273
Crustaceans	reduced	to	26	from 55

THE TERRESTRIAL HABITAT contributed 3 percent (64) of the impact score for this case. Strand vegetation, reduced to 10 from 40, accounts for the change in impact score for this habitat from Case 4, with minor exceptions.

CASE 6: WINTER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 1,709

Only three habitats contribute to this first winter scenario case. Only these three habitats will be examined for all Winter cases at Cape Blossom.

THE PELAGIC HABITAT contributed 69 percent (1,187) of the impact score for this case. The species which were the main contributors to this impact score were herring (387), smelt (290), and seabirds (273). These species were the most abundant of those impacted in this habitat and were among those judged the most sensitive to a diesel-2 spill.

THE SUBTIDAL SAND/MUD HABITAT contributed 22 percent (383) of the impact score for this case. The species which were the main contributors to this impact score were cods (102), other bivalves (55), and other marine invertebrates (82). These three species were among the most abundant in this habitat. Cods were judged to have a moderate subsistence importance. The bivalves and marine invertebrates were among the species judged most sensitive to a diesel-2 spill.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (139) of the impact score for this case. The only species which contributed substantially to this impact score were scallops (55) and other marine invertebrates (27). Scallops were the most abundant species in this habitat. Marine invertebrates were judged to have high ecological importance in this habitat. Both species were judged to be among the most sensitive to a diesel-2 spill. Table 2-30 following presents the full results of Case 6.

CASE 7: WINTER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 1,630

THE PELAGIC HABITAT contributed 68 percent (1,105) of the impact score for this case. The change in impact score for this habitat from Case 6 is accounted for by the following species:

Pacific Sandlance	increased to 82 from 38
Smelt	reduced to 164 from 290

THE SUBTIDAL SAND/MUD HABITAT contributed 23 percent of the impact score for this case. Shrimp, reduced to 13 from 27, accounted for the change in impact score for this habitat from Case 6.

TABLE 2-30. MATRIX RESULTS--CASE 6

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	CAPE BLOSSOM
SEASON	WINTER
SPILL SIZE	11,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	1	E	0	0	0	3	9	1	27	9	27
2. ZOOPLANKTON	3	A	0	0	0	3	9	1	81	9	82
3. ICHTHYOPLANKTON	1	C	0	0	0	2	9	1	18	9	18
5. COPEPODS	1	E	0	0	0	2	4	0	8	0	8
6. PACIFIC SANDLANCE	3	A	0	0	0	3	4	1	36	9	36
7. HERRING	6	A	0	0	1	3	9	4	216	180	787
8. SMELT	6	A	0	0	0	3	9	4	162	144	709
16. DOLLY VARDEN	1	A	0	1	0	1	0	0	36	36	64
17. NORTHERN FUR SEAL	1	A	0	0	0	5	0	0	0	0	0
18. RINGED SEAL	10	P	0	0	0	5	0	0	0	0	0
19. HARBOR SEAL	7	P	0	0	1	5	0	0	0	0	0
20. BEARDED SEAL	6	P	0	0	1	5	0	0	0	0	0
21. HARBOR SEAL	1	P	0	0	2	5	0	0	0	0	0
23. WALRUS	6	P	0	0	2	5	0	0	0	0	0
24. WHALES	3	A	0	0	0	5	0	0	0	0	0
25. POLAR BEAR	6	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	3	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	6	A	0	1	0	5	9	1	270	81	277
									856	471	1167
2. SUBTIDAL SAND-MUD											
1. CODS	6	A	0	0	2	3	4	1	36	24	101
2. SCULPINS	3	A	0	0	0	2	4	0	24	0	24
3. STARRY FLOUNDER	1	A	0	0	0	0	4	1	4	1	4
4. OTHER FLATFISH	3	A	0	0	1	0	4	1	24	9	24
5. PACIFIC SANDLANCE	3	A	0	0	0	3	4	1	36	9	36
6. MISC. MARINE FISH	1	A	0	0	0	2	4	0	8	0	8
8. SMELT	1	A	0	0	0	3	9	4	27	9	27
10. OTHER BIVALVES	6	A	0	0	0	1	9	4	54	36	55
11. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	9	1	81	9	82
									295	97	361

TABLE 2-30. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	1	E	0	0	0	2	0	0	0	0	0
5. OTHER FLATFISH	1	A	0	0	0	2	4	1	8	2	8
6. GROUNDFISH	1	E	0	0	0	2	1	0	2	0	2
8. WALLEYE POLLOCK	1	A	0	0	0	2	1	0	2	0	2
9. OTHER MARINE FISH	1	A	0	0	0	2	4	0	8	0	8
10. KING CRAB	1	A	0	0	0	2	0	1	10	2	10
11. TANNER CRAB	1	A	0	0	0	2	0	1	10	2	10
12. SCALLOPS	3	E	0	0	0	2	0	1	54	4	54
13. OTHER MARINE INVERTEBRATES	1	A	0	0	0	2	0	1	27	3	27
									137	15	170
4. INTERTIDAL SAND-MUD											
1. EELGRASS	1	E	0	0	0	3	0	0	0	0	0
2. PACIFIC SANDLANCE	3	A	0	0	0	2	0	0	0	0	0
4. SOFTSHELL BIVALVES	6	E	0	0	0	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	3	A	0	0	0	3	0	0	0	0	0
9. DUCKS	1	A	0	0	0	2	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
2. GREENLINGS	1	E	0	0	0	2	0	0	0	0	0
3. HERRING	6	A	0	0	1	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	1	A	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	3	A	0	0	0	2	0	0	0	0	0
6. OTHER INVERTEBRATES	3	A	0	0	0	2	0	0	0	0	0
7. SEA DUCKS	1	A	0	0	3	2	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
2. SMELT	6	A	0	0	0	3	0	0	0	0	0
3. HARDSHELL BIVALVES	1	A	0	0	0	2	0	0	0	0	0
4. CRUSTACEANS	1	M	0	0	0	2	0	0	0	0	0
5. GASTROPODS	1	A	0	0	0	2	0	0	0	0	0
									0	0	0

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TABLE 2-30. (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	1	H	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	1	H	0	0	0	3	0	0	0	0	0
4. CHUM SALMON	1	A	0	0	2	2	0	0	0	0	0
10. WHITEFISH	6	A	0	1	2	1	0	0	0	0	0
11. ARCTIC GRAYLING	3	A	0	2	2	2	0	0	0	0	0
12. PIKE	3	A	0	2	2	1	0	0	0	0	0
13. STICKLEBACKS	1	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	A	0	0	0	3	0	0	0	0	0
18. RIVER OTTER	3	A	0	0	1	1	0	0	0	0	0
19. MINK	3	A	0	0	1	1	0	0	0	0	0
20. MUSKRAT	3	A	0	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	0	0	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	15	P	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	6	H	0	0	0	2	0	0	0	0	0
4. OTHER VEGETATION	3	H	0	0	0	2	0	0	0	0	0
7. WOLVERINE	1	A	2	1	0	1	0	0	0	0	0
8. WOLF	3	A	2	1	0	1	0	0	0	0	0
9. MOOSE	3	A	0	1	3	2	0	0	0	0	0
10. CARIBOU	6	A	1	1	1	2	0	0	0	0	0
13. MUSKOX	1	A	0	0	0	3	0	0	0	0	0
16. OTHER MAMMALS	3	A	0	0	2	2	0	0	0	0	0
17. RAPTORS	3	A	0	0	0	5	0	0	0	0	0
18. PTARMIGAN	6	A	0	0	1	2	0	0	0	0	0
19. OTHER BIRDS	3	A	0	0	0	5	0	0	0	0	0
									0	0	0
									1361	498	1709

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 10 percent (156) of the impact score for this case. Minor increases, of less than 8, for four species account for the change in impact score for this habitat compared to Case 6.

CASE 8: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 1,484

THE PELAGIC HABITAT contributed 38 percent (568) of the impact score for this case. The decrease in impact score for this habitat compared with Case 5 is accounted for, with minor exceptions, by the following species:

Phytoplankton	reduced	to	9	from	38
Zooplankton	reduced	to	18	from	77
Ichthyoplanktor	reduced	to	6	from	26
Pacific Sandlance	reduced	to	0	from	36
Herring	reduced	to	160	from	364
Chum Salmon	reduced	to	9	from	38
Dolly Varden	reduced	to	102	from	219

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 11 percent (161) of the impact score for this case. This habitat's result, with only minor differences, was the same as for Case 5 (161 vs. 157).

THE INTERTIDAL ROCKY HABITAT contributed 26 percent (387) of the impact score for this case. The decrease in impact score for this habitat from Case 5 is accounted for by the following species:

Herring	reduced	to	120	from	273
Sea Ducks	reduced	to	0	from	120

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 20 percent (304) and THE TERRESTRIAL HABITAT contributed 4 percent (64) of the impact score for this case. These habitats' scores were the same, with minor exception in Intertidal, as for Case 5.

CASE 9: SUMMER, BUNKER C, 1,000 BBLS - IMPACT SCORE 1,331

THE PELAGIC HABITAT contributed 35 percent (472) of the impact score for this case. Smelt, reduced to 30 from 120, accounted for the change in impact score for this habitat from Case 8, with one minor exception.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 10 percent (132) of the impact score for this case. Chum salmon, reduced to 9 from 36, accounted for the change in impact score for this habitat from Case 8, with one minor exception.

THE INTERTIDAL ROCKY HABITAT contributed 32 percent (425) of the impact score for this case. The change in impact score for this habitat from Case 8 is accounted for, with minor exceptions, by the following species:

Miscellaneous Crustaceans	reduced	to	12	from	51
Other Invertebrates	reduced	to	18	from	77
Sea Ducks	increased	to	128	from	0

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 15 percent (202) of the impact score for this case. Smelt, reduced to 30 from 128, accounted for the change in impact score for this habitat from Case 8, with minor exceptions.

THE TERRESTRIAL HABITAT contributed 8 percent (100) of the impact score for this case. Strand vegetation, increased to 40 from 10, accounted for the change in impact score for this habitat from Case 8, with minor exceptions.

CASE 10: WINTER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 989

THE PELAGIC HABITAT contributed 66 percent (651) of the impact score for this case. The decrease in impact score for this habitat from Case 7 is accounted for, with minor exceptions, by the following species:

Zooplankton	reduced	to	38	from	82
Pacific Sandlance	reduced	to	36	from	82
Herring	reduced	to	319	from	387
Dolly Varden	reduced	to	36	from	64
Seabirds	reduced	to	128	from	273

THE SUBTIDAL SAND/MUD HABITAT contributed 26 percent (261) of the impact score for this case. The decrease in impact score for this habitat from Case 7 is accounted for, with minor exceptions, by the following species:

Other Bivalves	reduced	to	26	from	55
Other Marine Invertebrates	reduced	to	38	from	82

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (77) of the impact score for this case. While all species were reduced to some extent from the result of Case 7 in this habitat, only scallops reduced to 26 from 55 contributed significantly to the reduction.

THE PELAGIC HABITAT contributed 59 percent (545) of the impact score for this case. The change in impact score for this habitat from Case 10 is accounted for, with minor exceptions, by the following species:

Herring	reduced	to	102	from	219
Smelt	reduced	to	72	from	16
Ringed Seal	increased	to	70	from	0
Ribbon Seal	increased	to	18	from	0
Bearded Seal	increased	to	36	from	0

THE SUBTIDAL SAND/MUD HABITAT contributed 31 percent (284) of the impact score for this case. Sculpins, increased to 24 from 6, accounted for the change in impact score for this habitat from Case 10, with minor exceptions.

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 10 percent (94) of the impact score for this case. This habitat's result, with only minor differences, was the same as for Case 10 (94 vs. 77).

CASE 12: WINTER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 807

THE PELAGIC HABITAT contributed 53 percent (437) of the impact score for this case. The change in impact score for this habitat from Case 11 is accounted for, with minor exceptions, by the following species:

Ringed Seal	reduced	to	0	from	70
Ribbon Seal	reduced	to	0	from	18
Bearded Seal	reduced	to	0	from	36

THE SUBTIDAL SAND/MUD HABITAT contributed 35 percent (284) and the SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 12 percent (93) of the impact score for this case. These habitats' results were the same as for Case 11.

CASE 13: WINTER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 585

THE PELAGIC HABITAT contributed 68 percent (398) of the impact score for this case. This habitat's result, with only minor differences, was the same as for Case 12 (398 vs. 437).

THE SUBTIDAL SAND/MUD HABITAT contributed 20 percent (115) of the impact score for this case. The decrease in impact score for this habitat from Case 12 is accounted for, with only minor exceptions, by the following species:

Cods	reduced	to	24	from	96
Other Flatfish	reduced	to	9	from	36
Pacific Sandlance	reduced	to	9	from	36

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 12 percent (72) of the impact score for this case. This habitat's result, with only minor differences, was the same as for Case 12 (72 vs. 93).

CASE 14: SUMMER, GASOLINE, 10,000 BBLS - IMPACT SCORE 453

THE PELAGIC HABITAT contributed 68 percent (309) of the impact score for this case. The decrease in impact score for this habitat from Case 9 is accounted for, with minor exception, by the following species:

Dolly Varden	reduced	to	24	from 96
Seabirds	reduced	to	0	from 120

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 7 percent (32) of the impact score for this case. The decrease in impact score for this habitat from Case 9 is accounted for, with minor exceptions, by the following species:

Tanner Crab	reduced	to	0	from 26
Scallops	reduced	to	6	from 26
Other Marine Invertebrates	reduced	to	9	from 36

THE INTERTIDAL ROCKY HABITAT contributed 14 percent (64) of the impact score for this case. The decrease in impact score for this habitat from Case 9 is accounted for, with minor exceptions, by the following species:

Herring	reduced	to	30	from 120
Shorebirds	reduced	to	0	from 128
Seaducks	reduced	to	0	from 128

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 8 percent (38) of the impact score for this case. Shorebirds, reduced to 0 from 128, accounted for the decreased impact score in this habitat from Case 9, with only minor exceptions.

THE TERRESTRIAL HABITAT contributed 2 percent (10) of the impact score for this case. The decrease in impact score for this habitat from Case 9 is accounted for, with minor exceptions, by the following species:

Strand Vegetation	reduced	to	10	from 40
Raptors	reduced	to	0	from 30

CASE 15: WINTER, BUNKER C, 1,000 BBLS - IMPACT SCORE 419

THE PELAGIC HABITAT contributed 54 percent (226) of the impact score for this case. The decrease in impact score for this habitat from Case 13 is accounted for, with minor exceptions, by the following species:

Pacific Sandlance	reduced	to	9	from	36
Smelt	reduced	to	18	from	72
Seabirds	reduced	to	30	from	120

THE SUBTIDAL SAND/MUD HABITAT contributed 27 percent (117) and the SUBTIDAL ROCK/GRAVEL HABITAT contributed 19 percent (78) of the impact score for this case. With only minor exceptions, these scores were the same as for Case 13.

CASE 16: SUMMER, DIESEL-1-2, 100 BBLS - IMPACT SCORE 405

THE PELAGIC HABITAT contributed 45 percent (181) of the impact score for this case. The change in impact score for this habitat from Case 14 is accounted for, with minor exceptions, by the following species:

Herring	reduced	to	40	from	160
Seabirds	increased	to	30	from	0

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 8 percent (32) of the impact score for this case. This habitat's result was the same as for Case 14.

THE INTERTIDAL ROCKY HABITAT contributed 30 percent (121) of the impact score for this case. The increase in impact score for this habitat from Case 14 is accounted for, with minor exceptions, by the following species:

Shorebirds	increased	to	30	from	0
Seaducks	increased	to	30	from	0

THE INTERTIDAL COBBLE/GRAVEL HABITAT contributed 18 percent (71) of the impact score for this case. Shorebirds, increased to 30 from 0, accounted for the increased impact score for this habitat from Case 14, with only minor exceptions.

THE TERRESTRIAL HABITAT did not contribute to the impact score in this case.

CASE 17: WINTER, GASOLINE, 10,000 BBLS - IMPACT SCORE 381

THE PELAGIC HABITAT contributed 55 percent (209) of the impact score for this case. The change in impact score for this habitat from Case 15 is accounted for, with minor exceptions, by the following species:

Zooplankton	reduced	to	9	from	36
Seabirds	reduced	to	0	from	30
Smelt	increased	to	72	from	18

THE SUBTIDAL SAND/MUD HABITAT contributed 33 percent (124) of the impact score for this case. With only a minor exception, this habitat's score was the same as for Case 15 (124 vs. 115).

THE SUBTIDAL ROCK/COBBLE/GRAVEL HABITAT contributed 13 percent (48) of the impact score for this case. The decrease in impact score for this habitat from Case 15 is accounted for by greenlings, walleye pollock, other marine fish, king crab and tanner crab, all being reduced to 2 from 8.

The impact scores for Cases 18 through 26 range from 294 down to 18. The spill sizes for these cases are 1,000 barrels of gasoline for both Summer and Winter and 100 barrels for all other cases. The array of these scores is:

	SPILL SIZE BY SEASON			
	1,000 BBLS		100 BBLS	
SPILL TYPE	SUMMER	WINTER	SUMMER	WINTER
Diesel-2	See Case 5	See Case 10	See Case 16	158
Crude Oil	See Case 8	See Case 13	294	133
Bunker-C	See Case 9	See Case 15	262	76
Gasoline	122	86	12	73

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(13) OFFSHORE PRUDHOE BAY

Prudhoe Bay is located on the Beaufort Sea coast approximately midway between Point Barrow and the Canadian border. The continental shelf in this region is gently sloping. The Midway Islands form part of a barrier island chain approximately 8 to 10 miles from the mainland shore. The 10-fathom line occurs about 6 miles beyond the barrier islands about 12 to 16 miles offshore. The spill site was chosen at the 10-fathom curve north of the Midway Islands at 70°33.06'N latitude, 148°25.14'W longitude (Fig. 2-73).

(a) PHYSICAL CHARACTERISTICS

Prudhoe Bay is located in the Arctic Climatic Zone. The climate is characterized by cold temperatures, some maritime influence in the Summer, little annual precipitation, and persistent winds. The Arctic coastal plain is gently rolling, poorly drained tundra.

TEMPERATURES

Temperatures during the Winter range from -33°F to -7°F.[1,4] Temperatures in Summer range from 32°F to 52°F.[1,4] Record high and low temperatures of 75°F and -59°F have been recorded at Prudhoe and Barter Island.[1,4]

Coastal freezeup generally occurs in late September. Breakup begins in May or June with inland snow melt. River meltwater flows over lagoon and bay bottom-fast ice, eventually breaking through the sea ice and flowing seaward under it.[30]

SURFACE WINDS

Arctic winds are highly persistent with calms reported less than 6 percent of the time.[2] Winds are generally easterly or westerly.[2]

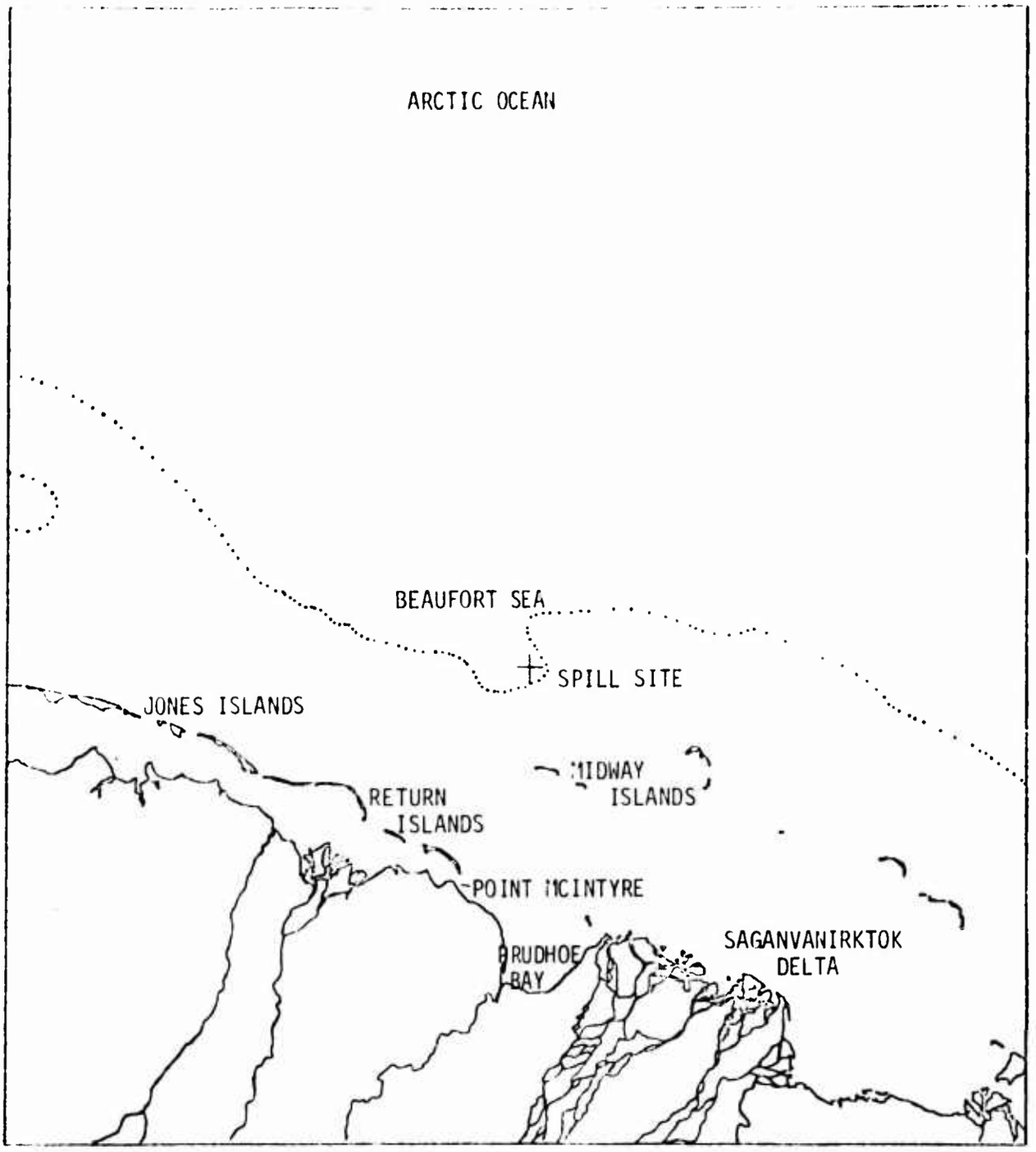


FIGURE 2-73. THE PRUDHOE BAY LOCATION AND THE OFFSHORE SPILL SITE.

NOTE: The broken line is the 10 fathom (60 ft.) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

Representative wind for Summer was chosen as east by east-northeast at 11.5 knots.

SURFACE CURRENTS

Information on the surface currents of this location was not located in either the *COAST PILOT*[8] or the *TIDAL CURRENT TABLES*[9] or in the *ALASKAN ARCTIC COAST* study.[56] The *COAST PILOT*[8] did indicate that the diurnal tide range at Point Barrow is 0.5 ft, and a May-August 1945 current survey estimated a current strength of 3 to 4 knots in a northeasterly direction northwest of the point at Barrow and a current of 1 knot in a northwesterly direction along the northeast side of the point. The shallowness of the Prudhoe Bay vicinity would also influence tidal and wind-driven currents. The Bay has depths of 6 to 9 ft, with an access route 4 ft deep.[8]

Average offshore currents in the Beaufort Sea and to the west are less than 0.1 knot, because of the large clockwise gyre in the Amerasian Basin of the Arctic Ocean.[57] Non-tidal current components (wind and pressure fields) are unusually dominant here with storm surges able to cause 5-ft sea level changes over a period of a few days.[57] There also are steric effects which can seasonally change the level of the sea.[57] Such sea level changes are quite important on a coastline where water depth may only be 10 ft deep 10 miles offshore.

Studies[57] conducted by the University of Alaska Institute of Marine Sciences were utilized as they conducted oceanographic investigations in the nearshore waters of Harrison Bay, with the following preliminary results:

(1) Currents are far from steady-state due to the strong influence of local winds.

(2) Dominant longshore components, either east or west, were observed, but average to the west because of the predominance of winds from the east.

(3) A current/wind direction relationship was established as:

Wind (direction in degrees) = 233^{0} - 0.58 x current (direction in degrees).

(4) A current/wind velocity relationship was established as: current velocity (cm per second) = 10.1 + 0.78 x windspeed (miles per hour).

MSNW utilized these formulae with the assumed most-probable wind directions and velocities to provide a current component in the oil spill dispersion modelling at this location.

(b) BIOLOGICAL CHARACTERISTICS

The Offshore Prudhoe area is dominated by marine mammals and waterfowl seasonally, while marine fish and shellfish appear sparse compared to the sourthern marine study locations. The adjacent Beaufort Sea has low biological productivity relative to more temperate waters, but productivity rises sharply during the Summer when the area is ice-free and light intensities rise.[63] While individuals of a single species may be extremely high in an Arctic population, the number of species is low.[63]

Resource summaries are shown in Figure 2- 74.

FISHES

SALMONIDS - There is no commercial fishery for salmonids in the Beaufort Sea, and the subsistence usage in the area is limited. Sport fishing is only a potential at this time.

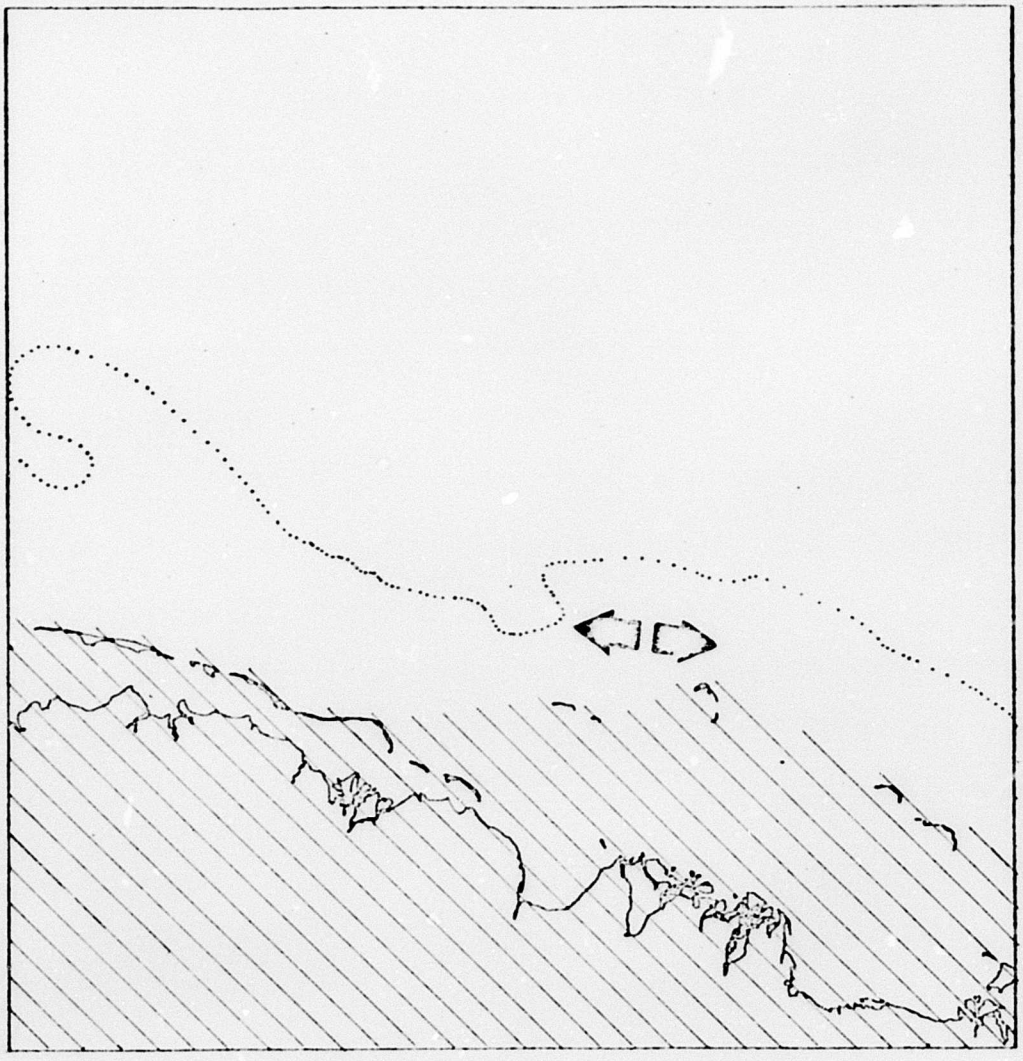


FIGURE 2-74. PRUDHOE BAY CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

Only stray pink and chum salmon have been located in the Prudhoe vicinity, while small runs of chum salmon are known to occur in the Colville River to the west.[58] This would indicate that a few pink and chum salmon are in the offshore waters. These salmon would enter rivers in the Fall (lower Sagavanirktok River, August 27, 1971[58]) and spawn, and juveniles would probably out-migrate in June when the area is free from ice.

The most abundant species in the Sagavanirktok River are the Arctic char, Arctic Grayling, and round whitefish.[58] The Arctic char is anadromous and would be expected in nearshore marine waters from May 25th to September 10th, based upon the tabulated life history in Table 2-31.

Other than occasional salmon and these char, few, if any, of the other Sagavanirktok fishes are anadromous and go to sea.[59] The Sagavanirktok River also supports numerous Arctic grayling and round whitefish, and smaller numbers of lake trout.[59] Rarely caught are broad whitefish, humpback whitefish, least cisco, and Arctic cisco.[59]

OTHER FRESH WATER FISHES included rainbow smelt, slimy sculpin, burbot, and nine-spine stickleback.[59]

OTHER MARINE FISHES have been the subject of only recent investigations and, therefore, the fishes of the Beaufort Sea are little understood. Comments in the *ALASKA ARCTIC COAST* study[5] on marine fishes are mostly drawn from the Chukchi Sea studies at Cape Thompson,[55] and comments on these results are with the Cape Blossom location description. Marine fish that are thought to breed locally are saffron cod, sandlance, capelin, and some flounders.[56] Another source indicated that Arctic cod, Arctic flounder, and sandlance breed locally. Resident spawners have a tendency

TABLE 2-31. MOVEMENT PATTERNS OF ANADROMOUS ARCTIC CHAR IN THE PIPELINE CORRIDOR OF THE SAGAVANIRKTOK RIVER

Time Period	Direction of Migration	Age or Maturity Group; General Remarks
May 25 to June 15 1)	Downstream	Mature, spawned out adults; migrating from eastern tributaries or other wintering zones to the sea.
	Downstream	Immature, older age classes (3-6); migrating from eastern tributaries or other wintering zones to the sea.
	Upstream and Downstream	Fry-of-the year and other young age classes (1-3); migrating into diverse zones of tributaries and main Sagavanirktok River from spawning and wintering zones in the eastern tributaries.
July 15 to August 25 2)	Upstream	Mature adults; migrating from the sea to eastern tributary spawning grounds.
	Upstream	Immature, older age classes (3-6); migrating from the sea to eastern tributaries or other wintering zones.
August 25 to September 10	Upstream and Downstream	Immature, younger age classes (1-3); migrating from diverse and scattered summer feeding zones to eastern tributaries or other wintering zones.

NOTES: 1. Including usual breakup flood period of May 25 to June 1.
2. Usually peaking August 12 to 18.

SOURCE: Alyeska Pipeline Service Company, *BIOLOGICAL DOCUMENTATION OF THE TRANS ALASKA PIPELINE SYSTEM*, Appendix E-3.1014, April 1974, Summary Report.

to lay large eggs in shallow water which move into pelagic waters for the Summer and then sink to deeper waters to mature. [56]

Arctic flounder, starry flounder, and four-horn sculpin are in low salinity estuaries and river mouths.[56,57] The bulk of these marine fish are benthic (or bottom) forms. Exceptions include the Arctic char (when at sea), Pacific herring, smelt species, sandlance, and salmon, among others.

The general abundance of Beaufort Sea fish species is sparse as a result of the harshness of the environment, although localized abundances of some Arctic marine fishes occur in Summer. [56] Examples given by this source [56] are Arctic cod and sandlance which play an important food-web role for pelagic fishes and other animals, including seabirds. Arctic cod are the most important food item of birds, while sandlance are the second most important.[56]

MSNW assumed the following abundances of marine fish in the Prudhoe Bay vicinity: cods--abundant; sculpins, char, smelt--average abundance; herring, flatfish, miscellaneous fish--moderate abundance; and other species--low abundance.

SHELLFISHES

SHRIMP are present [56] and presumed to be in low numbers.

MISCELLANEOUS INVERTEBRATES include benthic infaunal organisms which are abundant in the Beaufort Sea, particularly at depths of 700 m.[56] Densities decline as one moves to shallower water, but the organisms are still present in nearshore waters.[56] Annelids are the most abundant, followed by mollusks and arthropods of about the same abundance.[56]

No economically important invertebrate species in commercial quantities are known for the Beaufort Sea.

WATERFOWL

Waterfowl (including seabirds) are present in the entire Prudhoe Bay vicinity and out to the nearshore islands.[17] These same areas are also nesting/molting areas.[17] A major waterfowl, seabird migration route (east/west) is shown outside the nearshore islands off Prudhoe Bay. Most waterfowl are Summer visitors to this area (exceptions are black guillemots and several gull species). The key waterfowl aspect is that the Prudhoe Bay vicinity is the only significant breeding area for snow geese in Alaska (see Figure 2-75).[56] Waterfowl densities in inshore waters (within 5 miles of the coast) of the Beaufort Sea exceed adjacent mainland densities. Table 2-32 summarizes bird population estimates for the Arctic Coastal region.

DUCKS are very numerous at this location. Average densities of 16 breeding ducks per square mile were indicated.[17] Sea ducks (king and common eider, oldsquaws) dominate the area. The heaviest concentration of these ducks and other waterfowl (brant, gulls, and shorebirds) migrate along the Alaska Arctic coast from the Canadian Arctic islands in the Fall of the year (August-November). One study indicated that over 1 million adult and juvenile eiders use the Beaufort Sea migration route.[17] Oldsquaws are the other dominant duck in these migrations. Pintail ducks are also numerous. Ducks were assumed to be quite abundant in marine areas. Immigration of ducks is usually before Spring breakup (about May).

GEESE are a critical resource in one key area on the delta and mouth of the Sagavanirktok River draining into Prudhoe Bay (see Figure 2-75). This is the only significant breeding area for snow geese in Alaska.[56] Black brant are also involved in the westward Fall migrations from the Canadian Arctic islands.[17] White-fronted geese are produced in this vicinity.

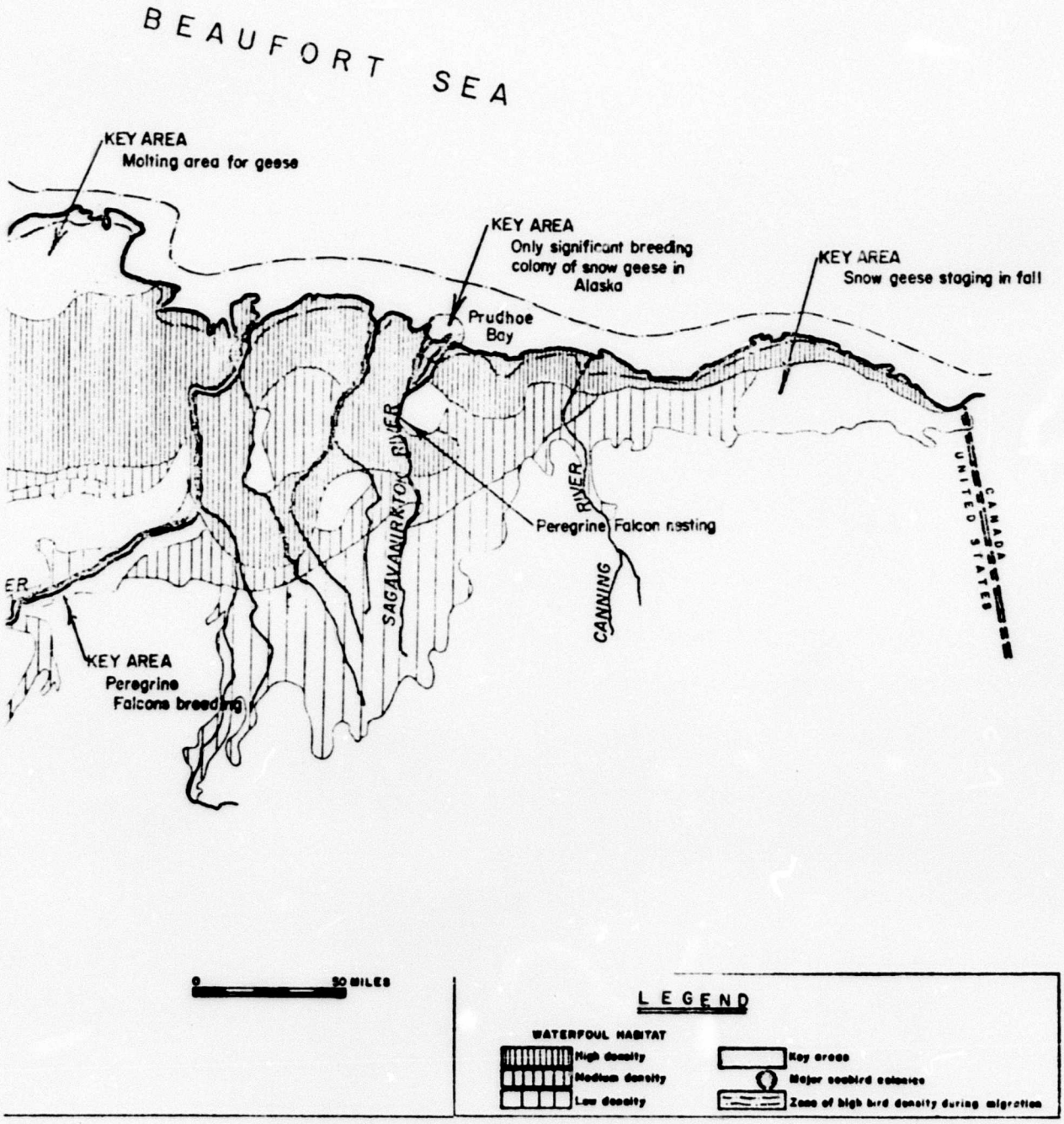


FIGURE 2-75. WATERFOWL HABITAT AND KEY AREAS ON THE ARCTIC COAST OF ALASKA.

SOURCE: The Arctic Institute of North America, *THE ALASKAN ARCTIC COAST - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, Contract No. DACW85-74-C-0029, June 1974.

TABLE 2-32. ESTIMATED BIRD POPULATION'S FOR THE ARCTIC COASTAL REGION.

whistling swans	3,000 to 5,000	
geese	170,000	
white-fronted geese, Canada geese, black brant 1/ snow geese.		
dabbling ducks	200,000 to 500,000	
pintails, widgeon, green-winged teal, mallards, shovelers		
diving ducks	875,000	
oldsquaws, eiders, scaup, scoters		
sea birds (nesting)	1,000,000 to 2,000,000	
murres, kittiwakes, puffins glaucous gulls, cormorants, guillemots		
ptarmigan	240,000	(vary considerably)
shorebirds	5,500,000	
jaegers	200,000	
gulls	75,000	
terns	150,000	
raptors	14,000	
passerine birds	2,750,000	

1/ Black brant fluctuate considerably in numbers.

SOURCE: The Arctic Institute of North America, *THE ALASKAN ARCTIC COAST - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, Contract No. DACW85-74-C-0029, June 1974.

This Game Management Unit (26) has Fall migrations of an estimated 175,000 to 200,000 geese.[17] Canada geese are also present.[56]

SWANS are estimated at 10,000 whistling swans in the Game Management Unit (26) including this location. Concentrations exist on the Colville River Delta and in the Teshekpuk Lake area.[17]

SEABIRDS are very numerous in the general Arctic coastal region. These include murres, kittiwakes, puffins, glaucous-winged gulls, cormorants, and guillemots.[56]

SHOREBIRDS are very abundant in the Arctic coastal region.

MARINE MAMMALS

Marine mammals include polar bear, and several seal species, and whale species.[56] Marine mammals in the Bering Sea and their migrations to the Chukchi and Beaufort Seas are generally discussed in the St. Matthew Island location description.

POLAR BEAR distribution and denning areas are shown in Figure 2-76. This species was judged to be very abundant at this location.

WALRUS distribution and migrations are shown in Figures 2-77 and 2-78. Walrus were assumed abundant at this location.

SEAL (ringed and bearded) distributions and migrations are shown in Figures 2-77 and 2-78. The harbor (spotted) seals migrate into the vicinity in the Summer to inhabit the ice-free coast and replace the ringed seal in the nearshore environment.[56] Ringed seals were assumed to be in great abundance with harbor and bearded seals in lesser abundance.

WHALES include bowhead, beluga, gray, humpback, finback, sei, and killer whales in the Beaufort Sea.[56] The above group is generally associated

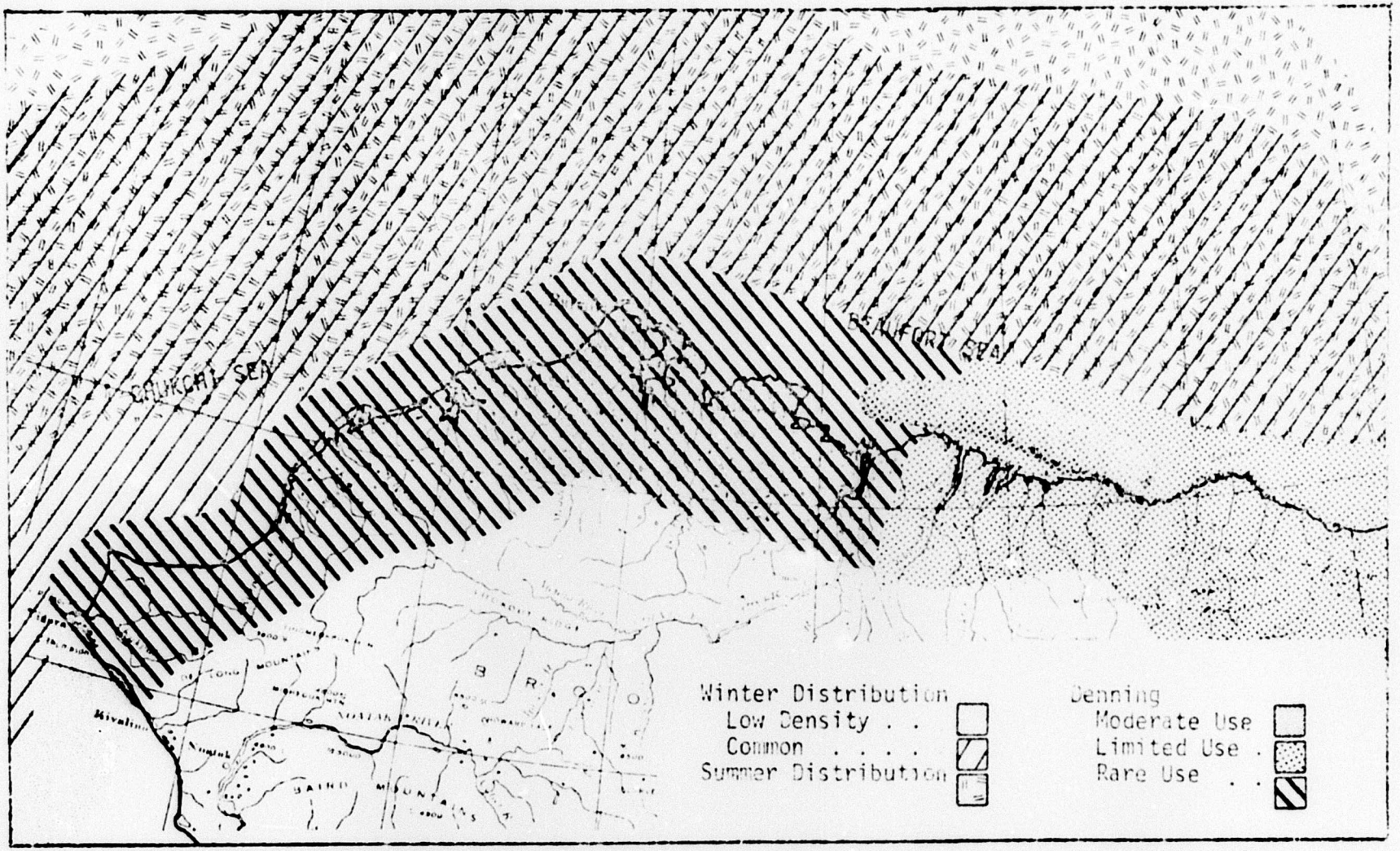


FIGURE 2-76. Polar bear distribution during summer and winter and denning areas, in arctic Alaska.

SOURCE: The Arctic Institute of North America, *THE ALASKAN ARCTIC COAST - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, Contract No. DACW85-74-C-0029, June 1974.

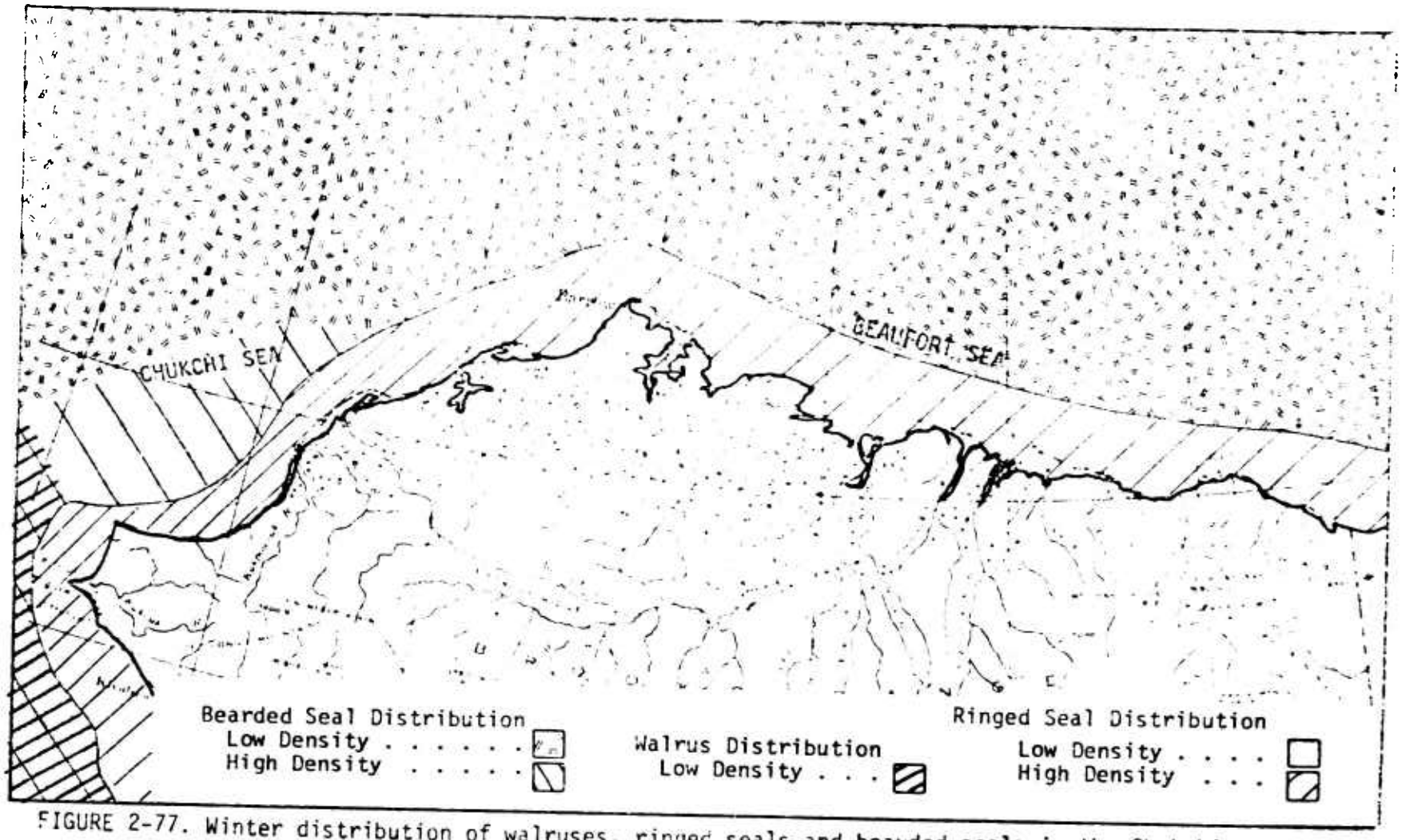


FIGURE 2-77. Winter distribution of walruses, ringed seals and bearded seals in the Chukchi and Beaufort Seas.

SOURCE: The Arctic Institute of North America, *THE ALASKAN ARCTIC COAST - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, Contract No. DACW85-74-C-0029, June 1974.

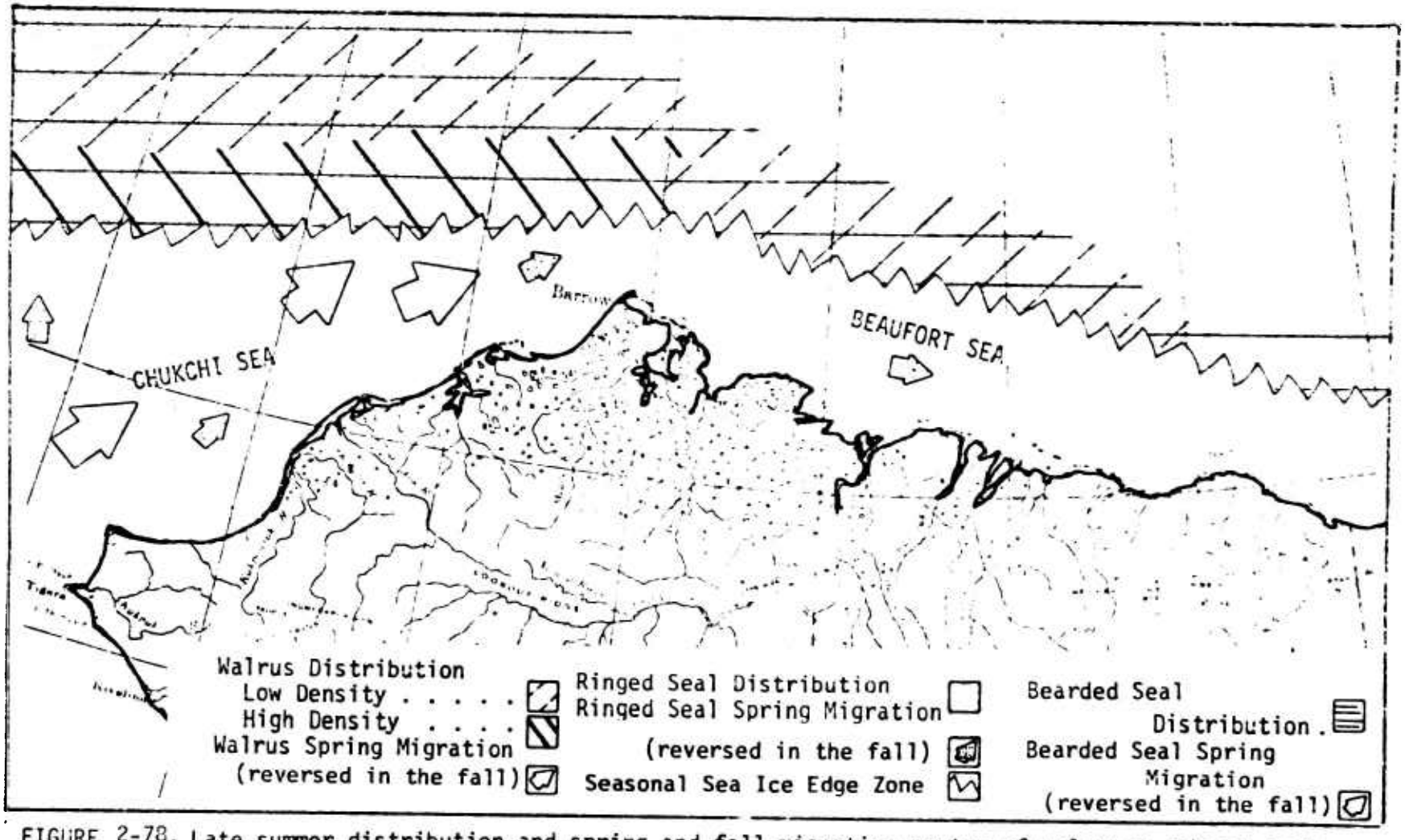


FIGURE 2-78. Late summer distribution and spring and fall migration routes of walruses, ringed seals and bearded seals in the Chukchi and Beaufort Seas.

SOURCE: The Arctic Institute of North America, *THE ALASKAN ARCTIC COAST - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, Contract No. DACW85-74-C-0029, June 1974.

with ice, except for the sei whale, which is intolerant of ice.[56] Bowhead whales inhabit the Beaufort Sea from late April to mid-October.[56] This source[56] gave additional details on these whales. Whales were assumed abundant in this area.

OTHER MARINE MAMMALS include narwhal, and piked whale--low abundances.

TERRESTRIAL MAMMALS

BROWN BEAR are indicated as present throughout the Prudhoe Bay vicinity but only sparse populations exist.[17] The bears here are likely to be concentrated along the Sagavanirktok River.[59]

MOOSE are indicated as distributed throughout this vicinity, but no concentration areas are shown.[59] They are in low abundance here. The low numbers of moose in this vicinity are likely to be concentrated along the Sagavanirktok River.[59] The few expected near the coast would be during May to August.[56]

CARIBOU utilize the Prudhoe Bay vicinity as Summer range.[17] The pipeline corridor lies approximately between Alaska's two largest caribou herds.[58] Their distribution and movements are detailed in Figure 2-79. One source[59] implied low abundances of caribou in the Prudhoe vicinity in Summer, while larger numbers are expected to migrate northward along the pipeline corridor from March 15th to June 1st and southward from early August to early December.[59]

WOLVES AND WOLVERINES are indicated as present throughout the Prudhoe Bay vicinity.[17] Both are thought to be in low to moderate numbers in the Prudhoe Bay vicinity.

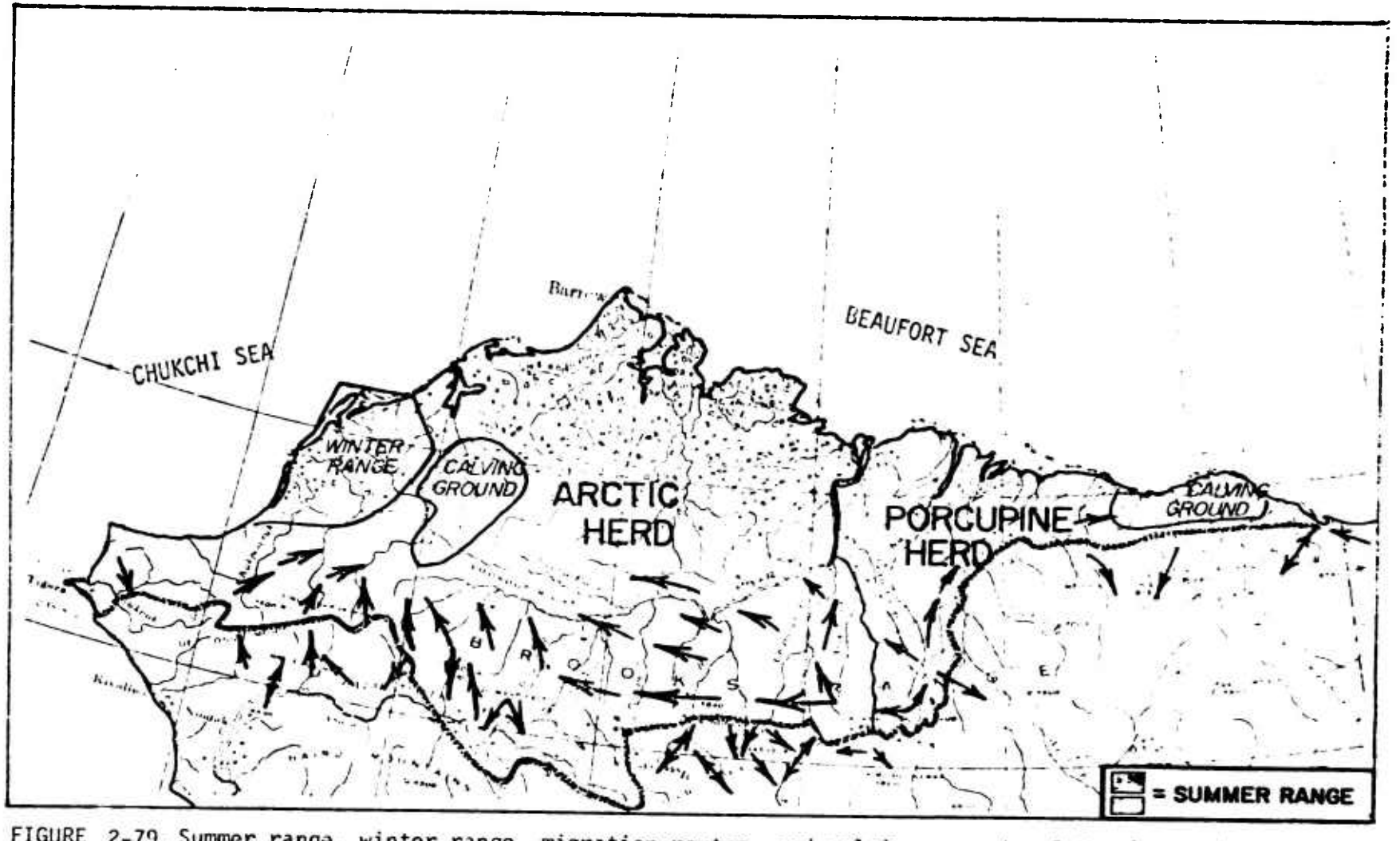


FIGURE 2-79. Summer range, winter range, migration routes, and calving grounds of the Arctic herd and Porcupine herd of the barren ground caribou in arctic Alaska.

SOURCE: The Arctic Institute of North America, *THE ALASKAN ARCTIC COAST - A BACKGROUND STUDY OF AVAILABLE KNOWLEDGE*, Contract No. DACW85-74-C-0029, June 1974.

AQUATIC FURBEARERS, such as mink and river otter, are not generally distributed this far north and west (restricted to areas east of Colville River).[56]

OTHER TERRESTRIAL MAMMALS include red fox, Arctic ground squirrel, lemmings, shrews, and voles.[56] The Arctic fox, an inhabitant of both the terrestrial area and the pack ice, is very abundant at this location.

FLORA

Terrestrial vegetation is not expected to be affected by the oil spill hypothesized at this location. The strand (beach) vegetation is relatively poorly developed in this area because of the Winter ice-scouring and Summer storms. Where plants are established, they are ephemeral and do not last very long.[82] On the wider beaches, prostrate mats of such species as *Cerastium beeringianum*, *Stellaria humifusa*, etc., may form. *Lathyrus maritimus* is common on sandy shores.[82] *Saxifraga rivularis* and *Cochlearia officianalis* are found on bluff faces. According to the physical shoreline substrate data assumed by MSNW, 100 percent of the shoreline at this area could be colonized by strand species.

Because of the lack of suitable substrate, there is probably very little or no subtidal margine algal vegetation at this area. Intertidal algal vegetation is almost certainly lacking. Neither eelgrass nor floating kelp species occur in this area.[70,76]

For further physical and biological information on this location, see Appendix D .

(c) RESULTS

Only four habitats were impacted by spills at this location. Rocky and cobble/gravel habitats were not present, and the spills did not reach freshwater river habitats. The pelagic habitat contributed the most to the impact scores for diesel-2 spills. The intertidal sand/mud habitat contributed the most for bunker C spills.

Spills of all four oil products were assumed, but only crude oil was spilled in the 50,000-bbl volume. The 10,000-bbl diesel spill score (4,438) was nearly equal to the 50,000-bbl crude oil spill score (4,760) in Summer. For similar spill sizes, the ranking of product impact scores was diesel-2, bunker C, crude oil, and gasoline.

The largest species contributions were for seabirds, shorebirds, and smelt. Fish were sensitive to chemical effects,and birds were sensitive to physical contact with the oil.

PHYSICAL FATE OF SPILLS

Three spill scenarios were examined at Offshore Prudhoe. The first scenario, based upon most probable Summer conditions, resulted in oil moving in a west-southwest direction from the spill location toward the shore of the Beaufort Sea (see Fig 2-80). This scenario reaches the Jones Islands in approximately 24 hours and the mainland in approximately 30 hours. The second and third scenarios were based upon most probable Winter conditions. In the second scenario the spill was assumed to take place under the ice. A spill under the ice would follow a different trajectory than on water, as the wind would not affect the direction or distance traveled. The sub-surface currents at this site are not well enough understood to provide a reasonably probable scenario for complete evaluation. (See Cape Blossom for a complete examination of the possible results of a Winter scenario such as this.) The third scenario assumes the oil is spilled on the ice surface. This scenario results in a puddle of oil on the ice surface approximately 500 m in radius and 1 cm thick for a 50,000-barrel crude spill. There would be minimal environmental impact from this spill, unless the oil is not removed prior to the ice pack retreating from shore. Therefore, this scenario is discussed only under the cleanup portion of this section. The Summer scenarios to be discussed impact only four habitats.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-33 presents the results of the Summer scenarios at Offshore Prudhoe without cleanup.

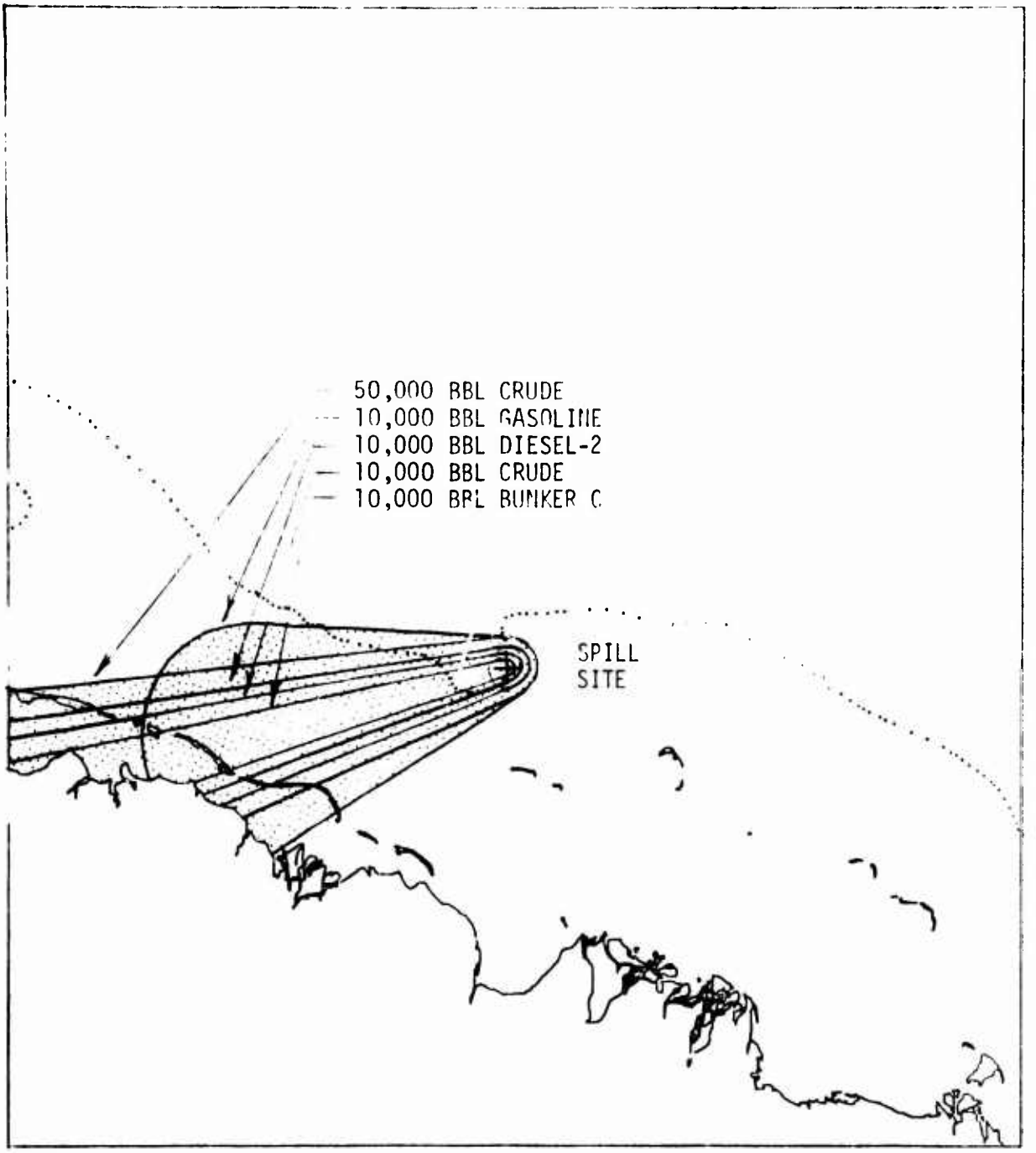


FIGURE 2-80. OFFSHORE PRUDHOE BAY SUMMER SPILL ENVELOPES

TABLE 2-33. OFFSHORE PRUDHOE BAY CASE RESULTS NO CLEANUP

SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000[1]	100[1]
Diesel-2	--	4,438 [2]	2,271 [5]	406 [9]
Crude Oil	4,760 [1][2]	2,868 [4]	1,529 [7]	303 [11]
Bunker-C	--	3,582 [3]	1,698 [6]	334 [10]
Gasoline	--	635 [8]	171 [12]	17 [13]

[1]Results for 1,000 and 100-barrel spills are estimated scores.
[2]Numbers in brackets are the case numbers that follow.

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 4,760

THE PELAGIC HABITAT contributed 49 percent (2,317) of the impact score for this case. The main contributing species to this impact score in this habitat were herring (145), smelt (273), Dolly Varden (290), ringed seal (280), harbor seal (144), and seabirds (820). Ringed seal and seabirds were among the most abundant species in this habitat. Dolly Varden were rated minor in recreational importance. Smelt and seals were rated moderate and Dolly Varden and seabirds minor in subsistence importance. Herring, smelt, Dolly Varden, and seabirds were among the species judged to be most sensitive to a crude oil spill in this habitat. The seals and seabirds were classified as protected.

THE SUBTIDAL SAND/MUD HABITAT contributed 15 percent (701) of the impact score for this case. Cods (255) and shrimp (193) were the species which contributed substantially to this score in this habitat. Cods were the most abundant specie in this habitat, and were rated at minor commercial importance. Shrimp were rated minor and cods major in subsistence importance. Shrimp were among the species judged to be most sensitive to a crude oil spill in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 19 percent (921) of the impact score for this case. Shorebirds (328), geese (128) and swans (255) were substantial contributors to the impact score in this habitat. These species were the most abundant in this habitat. Geese and ducks were rated of minor recreational importance. Shorebirds were rated minor, and geese and ducks major in subsistence importance. Shorebirds were classified as protected.

THE TERRESTRIAL HABITAT contributed 17 percent (821) of the impact score for this case. Strand vegetation (137) and raptors (264) were substantial contributors to the impact score in this habitat. Strand vegetation was one of the most abundant species in this habitat and was judged to be the most sensitive to a crude oil spill. Raptors were rated at minor commercial importance, and classified as endangered because of the possible presence of the endangered species of perrigrine falcon.

Table 2-34 presents the complete results for Case 1.

CASE 2: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 4,438

THE PELAGIC HABITAT contributed 49 percent (2,175) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 1 is accounted for by the following species:

TABLE 2-34. MATRIX RESULT--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	OFFSHORE PRUDHOE
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. MYSIDACEAN	3	M	3	0	0	3	4	1	36	9	36
2. ZOOPLANKTON	8	A	3	0	0	3	4	1	72	18	77
3. ICHTHYOPLANKTON	2	A	0	0	1	2	4	1	8	2	9
4. PACIFIC HERRING	2	A	0	0	0	3	1	0	3	0	3
5. HERRING	3	A	0	0	0	3	9	8	81	72	149
6. SMELT	8	A	0	0	2	3	9	1	270	30	273
7. CRAB LARVAE	1	E	0	0	0	2	9	8	16	16	32
8. CHUM SALMON	1	M	0	0	2	2	4	1	16	4	17
9. PINK SALMON	1	A	0	0	2	2	4	1	16	4	17
10. SOCKEYE SALMON	3	M	0	1	1	1	9	8	162	144	290
11. NORTHERN FUR SEAL	1	M	0	0	2	3	4	0	28	0	28
12. HARBOR SEAL	10	A	0	0	2	3	4	0	280	0	280
13. RIBBON SEAL	3	I	0	0	1	3	4	0	72	0	72
14. BEARDED SEAL	3	A	0	0	1	3	4	0	72	0	72
15. HARBOR SEAL	3	A	0	0	1	3	4	0	144	0	144
16. WALRUS	10	A	0	0	2	3	0	0	0	0	0
17. WHALES	0	I	0	0	3	3	0	0	0	0	0
18. POLAR BEAR	15	A	0	0	1	3	0	0	0	0	0
19. OTHER MARINE MAMMALS	0	A	3	0	3	2	0	0	0	0	0
20. SEABIRDS	15	A	0	0	1	3	9	4	810	90	820
									2088	389	2317
2. SUBTIDAL BOTTOM-MUD											
1. COD	10	A	2	0	3	2	4	1	240	60	255
2. SCULPINS	6	A	0	0	0	2	4	0	48	0	48
3. STARRY FLOUNDER	3	A	0	0	3	2	4	1	24	6	26
4. OTHER FLATFISH	3	A	0	0	1	2	4	1	36	9	38
5. PACIFIC HERRING	1	A	0	0	0	3	1	0	3	0	3
6. MISC. TAKING FISH	3	A	0	0	0	2	4	0	24	0	24
8. SHRIMP	3	A	0	0	1	3	9	8	108	96	193
10. OTHER BIVALVES	1	A	0	0	1	1	9	8	16	16	32

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TABLE 2-34 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	COMP.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
11. OTHER MARINE INVERTEBRATES	5	A	0	0	0	3	9	1	81	9	82
									582	196	701
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
									3	0	0
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	1	E	0	0	3	3	1	6	3	0	3
4. SOFTSHELL CLAMS	1	E	0	0	1	2	9	9	27	24	45
5. INVERTEBRATE INFAUNA	5	A	0	0	0	3	9	1	81	9	82
7. SHOREBIRDS	3	A	0	0	1	5	9	1	324	36	328
8. GEESE	0	A	0	1	3	1	4	1	128	30	128
9. DUCKS	13	A	0	1	3	2	4	1	240	60	255
10. CRABS	3	A	0	0	1	3	4	1	72	18	77
									667	177	921
5. INTERTIDAL ROCK											
									3	0	3
6. INTERTIDAL COBBLE-GRAVEL											
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	A	0	0	3	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	3	A	0	0	3	3	0	0	0	0	0
4. CHUM SALMON	1	A	0	0	2	2	0	0	0	0	0
6. PINK SALMON	1	A	0	0	2	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	1	2	1	0	0	0	0	0
9. COHO SALMON	0	A	0	1	2	1	0	0	0	0	0
10. WHITEFISH	10	A	0	1	3	1	0	0	0	0	0
11. ARCTIC GRAYLING	0	A	0	1	3	2	0	0	0	0	0
13. STICKLEBACKS	3	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	1	A	0	0	0	3	0	0	0	0	0
15. DUCKS	15	A	0	1	3	2	0	0	0	0	0

TABLE 2-34 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	Lev.	Comp.	Dom.	Rec.	Sub.	Ecol.	S.Trm	L.Trm	S.TRM	L.TRM	RSLT.
7. FRESHWATER RIVER											
16. GEESE	1>	A	0	1	3	2	0	0	0	0	0
17. SWANS	1>	A	0	0	1	2	0	0	0	0	0
18. MINK	3	A	1	0	1	1	0	0	0	0	0
20. MUSKRAT	3	A	1	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	1	0	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	1>	A	0	0	0	3	1	0	45	0	45
2. RIPARIAN VEGETATION	0	E	0	0	0	2	1	0	12	0	12
3. STRAND VEGETATION	1>	A	0	0	0	1	3	1	135	15	137
4. OTHER VEGETATION	5	A	0	0	0	2	4	1	48	12	51
5. GROUND SQUIRREL	3	A	1	1	1	2	0	0	0	0	0
7. WOLVERINE	3	A	2	1	1	1	4	0	60	0	60
8. WOLF	3	A	2	1	1	1	4	0	60	0	60
9. MOOSE	1	A	0	1	1	2	0	0	0	0	0
10. CARIBOU	3	A	1	2	3	2	1	0	48	0	48
16. OTHER MAMMALS	0	A	0	0	2	2	4	0	96	0	96
17. RAPTORS	3	A	0	0	1	4	4	0	264	0	264
18. PTARMIGAN	0	A	0	0	1	2	0	0	0	0	0
19. OTHER BIRDS	3	A	0	0	0	2	4	0	48	0	48
									810	27	821
									4353	789	4760

Phytoplankton	increased	to	82	from	38
Zooplankton	increased	to	164	from	77
Smelt	increased	to	483	from	273
Chum Salmon	increased	to	64	from	17
Pink Salmon	increased	to	64	from	17
Northern Fur Seal	reduced	to	0	from	28
Ringed Seal	reduced	to	0	from	280
Ribbon Seal	reduced	to	0	from	72
Bearded Seal	reduced	to	0	from	72
Harbor Seal	reduced	to	0	from	144

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (594) of the impact score for this case. With minor exceptions, shrimp reduced to 109 from 193, accounted for the change in impact score for this habitat from Case 1.

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (924) of the impact score for this case. The change in impact score for this habitat from Case 1 is accounted for by the following species:

Pacific Sandlance	increased	to	27	from	3
Softshell Bivalves	reduced	to	27	from	48

THE TERRESTRIAL HABITAT contributed 17 percent (745) of the impact score for this case. With minor exceptions, strand vegetation reduced to 64 from 137, accounted for the decrease in impact score for this habitat from Case 1.

CASE 3: SUMMER, BUNKER-C, 10,000 BBLS - IMPACT SCORE 3,582

THE PELAGIC HABITAT contributed 23 percent (813) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 2 is accounted for by the following species:

Ringed Seal	increased	to	70	from	0
Harbor Seal	increased	to	36	from	0
Phytoplankton	reduced	to	9	from	82
Zooplankton	reduced	to	18	from	164
Herring	reduced	to	38	from	145
Smelt	reduced	to	120	from	483
Crab Larvae	reduced	to	9	from	32
Chum Salmon	reduced	to	4	from	64
Pink Salmon	reduced	to	4	from	64
Dolly Varden	reduced	to	77	from	290
Seabirds	reduced	to	383	from	820

THE SUBTIDAL SAND/MUD HABITAT contributed 18 percent (682) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 2 is accounted for by the following species:

Shrimp	increased	to	240	from	109
Other Bivalves	increased	to	40	from	18
Sculpins	reduced	to	12	from	48
Other Marine Invertebrates	reduced	to	38	from	82

THE INTERTIDAL SAND/MUD HABITAT contributed 36 percent (1,291) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 2 is accounted for by the following species.

Softshell Bivalves	increased	to	60	from	27
Shorebirds	increased	to	720	from	328
Invertebrate Infauna	reduced	to	38	from	82

THE TERRESTRIAL HABITAT contributed 23 percent (821) of the impact scpre for this case. With a minor exception, strand vegetation increased to 137 from 64 accounted for the increase in impact score for this habitat from Case 2.

CASE 4: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 2,868

THE PELAGIC HABITAT contributed 37 percent (1,075) of the impact score for this case. With minor exceptions, the increase in impact score for this habitat from Case 3 is accounted for by the following species:

Phytoplankton	increased	to	36	from 9
Zooplankton	increased	to	72	from 18
Herring	increased	to	82	from 38
Dolly Varden	increased	to	164	from 77

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (323) of the impact score for this case. With minor exceptions, the change in impact score for this habitat from Case 3 is accounted for by the following species:

Other Marine Invertebrates	increased	to	82	from 38
Cods	reduced	to	60	from 240
Other Flatfish	reduced	to	9	from 36
Shrimp	reduced	to	109	from 240

THE INTERTIDAL SAND/MUD HABITAT contributed 25 percent (725) of the impact score for this case. With a minor exception, the change in impact score for this habitat from Case 3 is accounted for by the following species:

Invertebrate Infauna	increased	to	82	from 38
Softshell Bivalves	reduced	to	27	from 60
Shorebirds	reduced	to	152	from 720

THE TERRESTRIAL HABITAT contributed 26 percent (745) of the impact score for this case. With a minor exception, strand vegetation reduced to 64 from 137 accounted for the decrease in impact score for this habitat from Case 3.

CASE 5: SUMMER, DIESEL-2, 1,000 BBLS - ESTIMATED SCORE 2,271

THE PELAGIC HABITAT contributed 49 percent (1,113) of the score for this case. The main contributing species to this score in this habitat were judged to be zooplankton, smelt, Dolly Varden, and seabirds.

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (304) of the score for this case. Only cods were judged to contribute significantly to the score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (473) of the score for this case. Shorebirds and ducks were judged to contribute significantly to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 17 percent (381) of the score in this case. Raptors were judged to contribute significantly to the score in this habitat.

CASE 6: SUMMER, BUNKER-C, 1,000 BBLS - ESTIMATED SCORE 1,698

THE PELAGIC HABITAT contributed 23 percent (385) of the score in this case. Seabirds were judged to contribute significantly to the score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 18 percent (311) of the score in this case. Cods and shrimp were judged to contribute significantly to the score in this case.

THE INTERTIDAL SAND/MUD HABITAT contributed 36 percent (612) of the score in this case. Shorebirds and ducks were judged to contribute significantly to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 23 percent (389) of the score for this case. Raptors were judged to contribute significantly to the score in this habitat.

CASE 7: SUMMER, CRUDE OIL, 1,000 BBLS - ESTIMATED SCORE 1,529

THE PELAGIC HABITAT contributed 37 percent (573) of the score in this case. Dolly Varden and Seabirds were judged to contribute significantly to this score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 11 percent (172) of the score for this case. No species were judged to contribute significantly.

THE INTERTIDAL SAND/MUD HABITAT contributed 25 percent (387) of the score for this case. Shorebirds and ducks were judged to contribute significantly to the score in this habitat.

THE TERRESTRIAL HABITAT contributed 26 percent (397) of the score for this case. Raptors were judged to contribute significantly to the score in this habitat.

CASE 8: SUMMER, GASOLINE, 10,000 BBLS - IMPACT SCORE 635

THE PELAGIC HABITAT contributed 22 percent (138) of the impact score for this case. No species contributed more than 36 to this impact score in this habitat.

THE SUBTIDAL SAND/MUD HABITAT contributed 29 percent (182) of the impact score for this case. Cods (60) were the largest contributor to the impact score in this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 29 percent (186) of the impact score for this case. Ducks (60) were the largest contributor to this impact score in this habitat.

THE TERRESTRIAL HABITAT contributed 20 percent (129) of the impact score for this case. Raptors (66) were the largest contributor to the impact score in this habitat.

The estimated scores for Cases 9 through 13 range from 406 down to 17. The spill sizes for these cases are 1,000 barrels for gasoline and 100 barrels for all spill types. The array of these scores is:

	SPILL SIZE	
SPILL TYPE	1,000 BBLS	100 BBLS
Diesel-2	See Case 5	406
Crude Oil	See Case 7	303
Bunker-C	See Case 6	334
Gasoline	171	17

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(14) ONSHORE PRUDHOE

Prudhoe Bay is located next to the mouth of the Sagavanirktok River on the Beaufort Sea coast. The spill site was chosen about 12 miles upstream on the western bank of the Sagavanirktok near the Deadhorse landing area at 70°12.78'N latitude, 148°25.14'W longitude (Fig. 2-81).

(a) PHYSICAL CHARACTERISTICS

The spill site is located on the North Slope Beaufort Sea coast. The region is flat, gently rolling tundra, underlain by thick permafrost.[4] The surface shows ice polygon patterns caused by the cyclical freeze/thaw stress.

Freezing temperatures occur in the Prudhoe Bay area during nine months of the year.[1] Freezeup, the transitional[8] period between Summer and Winter, usually begins around September 6th. Air temperature during the Winter is around -10°F to -20°F, often dropping to -45°F;[1,4] in Summer, the temperature may rise to +70°F but is more often between 40°F and 50°F.[1,4] Winds, usually easterly, occur persistently all year-round.[2,4] Mean annual precipitation is about 10 in., and snow may fall during any month of the year, although precipitation in July and August is usually in the form of rain.[4]

The thaw season usually begins around June 22nd, lasting on the average of 70 to 80 days.[8,30] Thaw begins inland with snow melt and river flow.

The North Slope coastal area is very flat. Altitude gains average about 5 ft per mile in the first 20 miles from the shoreline. At the spill

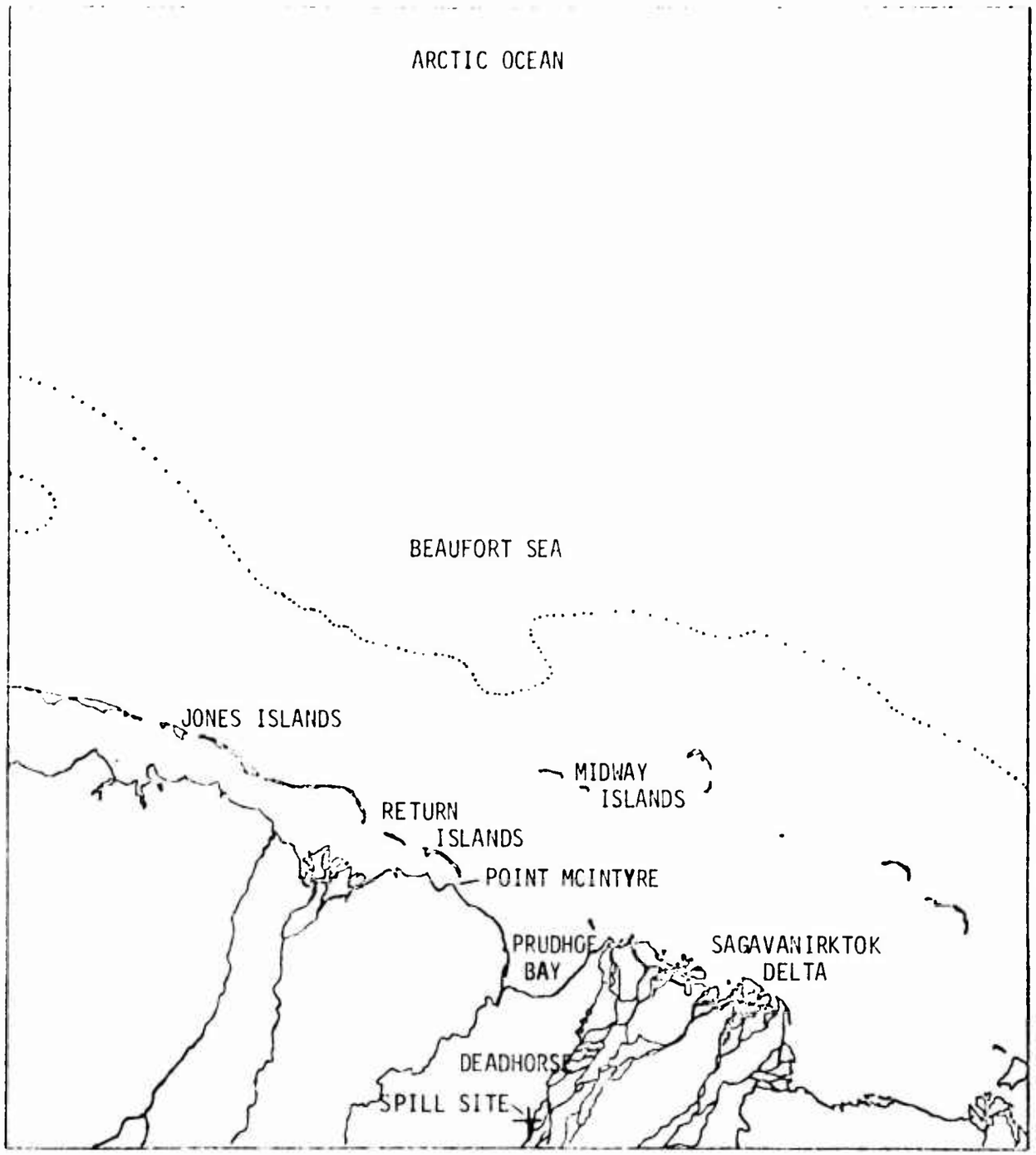


FIGURE 2-81. THE PRUDHOE BAY LOCATION AND ONSHORE SPILL SITE.

NOTE: The broken line is the 10 fathom (60 ft.) contour. Scale can be determined from an axis of the spill site cross (equals about 2 miles or 3.3 km).

site, the flow in the Sagavanirktok River averages about 4.6 ft per second, with peak velocities of about 13.5 ft per second during breakup.[5]

The Arctic Coastal Plain is poorly drained and thus is marshy in spite of the scanty precipitation. Soils along the Sagavanirktok River are ice-rich silt and fine sand overlying sand and gravel. Vegetation is wet-sedge-meadow tundra.

SPILL SCENARIO

The spill site chosen lies close to the westernmost branch of the Sagavanirktok River. It is presumed that within a short period of time following the incident, oil flows into the river.

The average river flow estimated for this portion of the river was used to calculate transit times downstream. Peak runoff conditions should yield a lesser impact of oil in the river itself due to the scouring action of the volume of water and associated ice and debris.

Using the estimated flow velocity of 4.6 ft per second,[5] the oil slick reaches the western delta coastline in an elapsed time of 5 hours. From there it is transported according to the coastal current of the Beaufort Sea which is strongly influenced by the wind.[57] For a steady wind out of the east by east-northeast (78.75°), at 11.5 knots, a current of 0.4 knot (0.454 mph) flowing to the west (266°) is estimated.[57]

Under these conditions, oil reaching the mouth of the Sagavanirktok River would spread westward along the coastline. The shoreline of Prudhoe Bay would be impacted between 6 and 20 hours after the incident. At about 28 to 30 hours, the leading edge of the slick could reach Point McIntyre and Stump Island. Within 40 hours, the edge of the slick could be midway

into the Return Islands and could be reaching the mouth of the Kuparuk River. Outflow from the Kuparuk should keep the oil from reaching the delta unless forced onshore by strong winds.

In Winter, the oil spill would not flow far on the frozen Sagavanirktok River.

(b) BIOLOGICAL CHARACTERISTICS

The biological characteristics for the Offshore Prudhoe location included freshwater and terrestrial characterizations that applied to this spill location. See the Offshore Prudhoe location description for this information. Under ice-free conditions, the crude oil spills will reach the sea via the Sagavanirktok River, so that marine characteristics are also required.

One biological characteristic not discussed in the Offshore Prudhoe location is the terrestrial and aquatic vegetation that could be impacted in the Onshore Prudhoe Bay crude oil spill scenarios. The terrestrial vegetation in this coastal plain of northern Alaska in the vicinity of the spill site is a wet-sedge-meadow tundra.[56] This source[56] described this plant community as follows:

> About half of the coastal plain and from 10 to 20 percent of the foothills are vegetated by wet sedge meadows. Wet meadow vegetation occupies poorly drained lowlands, the margins of floodplains, and the borders of lakes and streams. Low or slightly depressed areas may also contain this vegetative type. Wet sedge meadows usually grow on peaty soils that thaw one or two feet by late Summer. The peaty soil is usually saturated, and standing water is found on the surface during the thaw period. Wet sedge meadows appear commonly in association with frost polygons.

Carex is usually the dominant genus in wet sedge meadows. However, any of several species of sedge may dominate in a given part of a wet sedge meadow. Many moss species are present. Lichens usually are not found growing in the wet meadows.

Carex aquatilis is the dominant sedge found growing in the wet meadows. This water sedge has a wide range of habitats in which it will grow, including floodplains, wet meadows, and lake margins. The plants may reach 18 in. (46 cm) in the foothills but generally grow no higher than 6 in. (15 cm) in the Barrow area. Other important sedges are *Carex chordorrhiza*, *C. membranacea*, *C. rariflora*, and *C. rotundata*. Along the Arctic coast, the grass *Dupontia fischeri* and *Eriophorum scheuchzeri* are locally dominant. Grasses, sedges, rushes, small heath shrubs, small willows, herbs, and horsetail are also fairly common in wet sedge meadows. Some of these plants are typically found on the flat, wet areas of the meadow, while others, especially shrubs, are found along the drier ridges which separate the polygonal depressions.

Aquatic vegetation in the lower Sagavanirktok River is not well defined and is presumed absent or scarce. One source[14] mentioned sedges " ... along small streams and drainage lines which are completely choked with vegetation." Another source[56] indicated that nearly all the aquatic vegetation of the Arctic Slope occurs in lakes, however, the remainder is never described. It was assumed that the lower Sagavanirktok River (spill site and downstream) was generally barren as a result of salinity changes with tides, the silt load carried by the stream, and ice formation--breakup in the lower river. Aquatic vegetation was therefore assumed sparse.

Comments indicated that general river primary production (by phytoplankton) is low in the Colville River to the west.

See Appendix D for additional physical and biological information on this location.

(c) RESULTS

Only five of the eight habitats were impacted by spills at this location. Rocky and cobble/gravel habitats were not present on the Beaufort Sea coast. The freshwater river habitat usually contributed the most to each impact score, varying around 30 to 40 percent of each total score.

Spills were postulated for all four oil products, but only crude oil was assumed spilled in the largest quantities (50,000 and 10,000 barrels). Seasonal differences in scores reflect both species abundance differences between the seasons and modification of impact due to scouring during the Spring breakup. The largest impact score was for the largest crude oil spill in Summer. For similar spill sizes, the ranking on impact scores by highest was diesel-2, bunker C, crude oil, and gasoline.

The largest species contributions were for fish in the river, waterfowl in the river and delta area, and seabirds. The highest scores were for waterfowl and seabirds, reflecting the high relative abundance of these species in Summer.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined for Onshore Prudhoe. The first scenario was based on most probable Summer conditions. The second scenario was based on conditions at "breakup" and would apply to a late Springtime spill or a Winter spill which was not cleaned up.

Average river flow rates estimated for the western channels near the spill site were used to calculate downstream transit times. With these, the slick reached the delta mouth in five to six hours. The easterly wind used for the Offshore Prudhoe scenario was assumed to push the slick westward along the Beaufort Sea coastline. Most of Prudhoe Bay was impacted in 12 hours. In 24 hours the slick began to impact the Return Islands and Point McIntyre. For the 72-hour time frame, a 50,000-bbl spill was estimated to impact the coastline to Milne Point and Pingok Island in the Jones Islands. A 10,000-bbl spill was estimated to impact Beechy Point and Cottle Island. The delta of the Kuparuk River was assumed to be little affected due to the freshwater outflow. These impacts are illustrated in Figure 2-82.

See Page 2-27 for discussion of spill enveloping process.

CASE DISCUSSION

Table 2-35 presents the results of the oil spill scenarios examined at Offshore Prudhoe without cleanup.

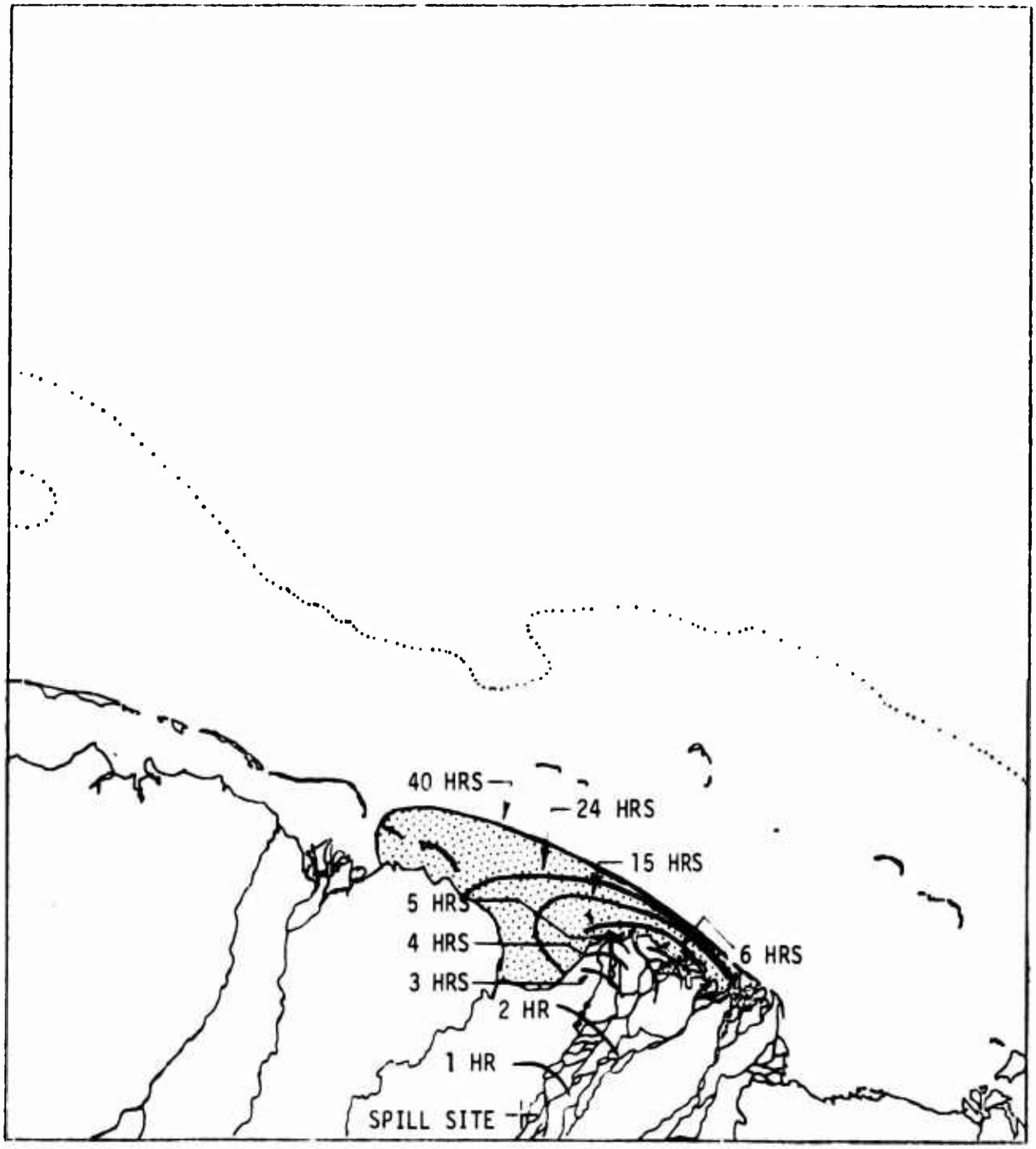


FIGURE 2-82. ONSHORE PRUDHOE 50,000 BBL CRUDE SPILL ISOCHRONES

STREAM VELOCITY = 4.6 FT./SEC.
SLOPE GRADIENT ≈ 5 FT./MILE

TABLE 2-35. ONSHORE PRUDHOE CASE RESULTS - NO CLEANUP

	SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000	100
SUMMER	Diesel-2	-	-	3,670 [3]	745 [9]
	Crude Oil	7,782 [1](1)	4,549 [2]	2,044 [6]	293 [14]
	Bunker-C	-	-	2,107 [5]	310 [13]
	Gasoline	-	-	546 [12]	118 [16]
BREAKUP	Diesel-2	-	-	930 [8]	191 [15]
	Crude Oil	2,269 [4]	1,375 [7]	575 [11]	45 [19]
	Bunker-C	-	-	728 [10]	96 [18]
	Gasoline	-	-	101 [17]	20 [20]

(1) Numbers in brackets are case numbers that follow.

Three habitats were not impacted in the above cases; the subtidal rock/gravel, intertidal rocky, and intertidal cobble/gravel habitats. The case discussion will address the five impacted habitats.

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 7,782

THE PELAGIC HABITAT contributed 19 percent (1,453) of the impact score for this case. The species which were the main contributors to this impact score were zooplankton (72), smelt (120), Dolly Varden (164), and seabirds (820). Seabirds were the most abundant impacted species. Dolly Varden were judged to have recreational and subsistence importance. Smelt, salmon and the seal species were judged to have subsistence importance. Phytoplankton, zooplankton, Pacific sandlance, herring, and smelt were judged to be ecologically important, and all the pelagic mammal species were

categorized as protected. Dolly Varden and seabirds were judged to be the most sensitive species in the habitat to crude oil entering the sea at the delta mouth.

THE SUBTIDAL SAND/MUD HABITAT contributed 5 percent (419) of the impact score for this case. The species which were the main contributors were cods (240), shrimp (51), and other marine invertebrates (38). Cods were the most relatively abundant species and had commercial subsistence and ecological importance. Pacific sandlance, shrimp, and other marine invertebrates had ecological importance.

THE INTERTIDAL SAND/MUD HABITAT contributed 12 percent (921) of the impact score for this case. The species which were the main contributors were shorebirds (328), geese (128), and ducks (255). These bird species were the most relatively abundant in the habitat. Geese and ducks had recreational importance and the highest subsistence importance values. Shorebirds and swans included species categorized as protected.

THE FRESHWATER RIVER HABITAT contributed 49 percent (3,804) of the impact score for this case. The species which were the main contributors were Dolly Varden (480), whitefish (213), ducks (1,800), geese (383), and swans (383). Ducks, geese and swans were judged the most relatively abundant species in the habitat. The mammal species were given some commercial importance. Rainbow trout, Dolly Varden, whitefish, Arctic grayling, ducks, and geese, all had recreational importance. All these species, plus salmon, had subsistence importance. Swans were categorized as protected. Salmon, Dolly Varden, and ducks were judged to be the most sensitive species to the effect of the spill.

THE TERRESTRIAL HABITAT contributed the final 15 percent (1,185) of the impact score for this case. The species which were the main contributors were tundra (191), strand vegetation (137), caribou (192), and raptors (281). Tundra and strand were the most relatively abundant species in the habitat. Wolverine and wolf had the highest commercial importance values and caribou had the highest recreation and subsistence importance values. Tundra was judged the most ecologically importan[illegible]nd [illegible]ptors included an endangered species of peregrine falcon.

Table 2-36 presents the complete results of Case 1.

CASE 2: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 4,549

THE PELAGIC HABITAT contributed 20 percent (924) of the impact score for this case. The decrease in impact score for this case compared to Case 1 is mainly accounted for by the following species:

Dolly Varden	reduced	to 77 from 164
Seabirds	reduced	to 383 from 820

THE SUBTIDAL SAND/MUD HABITAT contributed 9 percent (425) of the impact score for this case. The minor decrease in score for this habitat from Case 1 is accounted for by minor decreases in impacts on shrimp and other marine invertebrates.

THE INTERTIDAL SAND/MUD HABITAT contributed 15 percent (653) of the impact score for this case. The decrease in score for this habitat from Case 1 is mainly accounted for by shorebirds (reduced to 153 from 328).

THE FRESHWATER RIVER HABITAT contributed 39 percent (1,778) of the impact score for this case. The decrease in score for this habitat from Case 1 is mainly accounted for by the following species:

TABLE 2-36. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	ONSHORE PRUDHOE
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	PIPELINE BREAK
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT				
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	3	M	0	0	0	1	4	0	36	0	36
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	1	M	0	0	0	2	4	0	8	0	8
6. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
7. HERRING	3	A	0	0	0	3	4	1	36	0	36
8. SMELT	6	A	0	0	0	3	4	0	120	0	120
9. CRAB LARVAE	1	E	0	0	0	2	4	1	8	1	9
11. CHUM SALMON	1	A	0	0	0	2	4	1	14	4	17
13. PINK SALMON	1	A	0	0	0	2	4	1	15	4	17
14. DOLLY VARDEN	6	A	0	1	1	1	0	1	142	18	164
17. NORTHERN FUR SEAL	1	A	0	0	0	2	1	0	7	0	7
18. RINGED SEAL	10	A	0	0	0	2	1	0	70	0	70
19. RIBBON SEAL	3	A	0	0	0	1	1	0	18	0	18
20. BEARDED SEAL	3	A	0	0	0	1	1	0	18	0	18
21. HARBOR SEAL	6	A	0	0	0	1	1	0	36	0	36
23. WALRUS	10	A	0	0	0	2	0	0	0	0	0
24. WHALES	6	A	0	0	0	1	0	0	0	0	0
26. POLAR BEAR	15	A	0	0	0	1	0	0	0	0	0
27. OTHER MARINE MAMMALS	6	A	3	0	0	2	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	1	5	1	810	90	900
									1436	127	1563
2. SUBTIDAL SAND-MUD											
1. CODS	10	A	1	0	0	2	4	0	240	0	240
2. SCULPINS	6	A	0	0	0	2	1	0	12	0	12
3. STARRY FLOUNDER	3	A	0	0	0	2	4	0	24	0	24
4. OTHER FLATFISH	3	A	0	0	1	2	4	0	36	0	36
5. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
6. MISC. MARINE FISH	3	A	0	0	0	2	1	0	6	0	6
8. SHRIMP	3	A	0	0	1	3	4	1	48	12	71
10. OTHER BIVALVES	1	A	0	0	1	1	4	1	8	2	9

TABLE 2-36 (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
11. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	4	1	96	9	39
									413	27	419
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
									0	0	0
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	1	E	0	0	0	3	1	0	3	0	3
4. SOFTSHELL BIVALVES	1	E	0	0	1	2	0	0	27	24	49
5. INVERTEBRATE INFAUNA	3	A	0	0	0	3	0	1	81	9	90
7. SHOREBIRDS	6	A	0	0	1	5	0	1	324	54	378
8. GEESE	6	A	0	1	3	1	4	1	120	30	150
9. DUCKS	10	A	0	1	3	2	4	1	240	45	285
10. SWANS	3	A	0	0	1	5	4	1	72	18	90
									847	177	985
5. INTERTIDAL ROCKY											
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	A	0	0	0	3	4	1	96	9	39
2. AQUATIC INVERTEBRATES	3	A	0	0	0	3	4	1	96	0	96
4. CHUM SALMON	1	A	0	0	2	2	4	0	16	32	80
6. PINK SALMON	1	A	0	0	2	2	4	0	16	32	80
8. RAINBOW-STEELHEAD TROUT	3	A	0	1	2	1	4	1	48	12	61
9. DOLLY VARDEN	6	A	0	1	2	1	4	0	96	192	480
10. WHITEFISH	10	A	0	1	3	1	4	1	200	50	213
11. ARCTIC GRAYLING	6	A	0	1	3	2	4	1	144	36	153
13. STICKLEBACKS	3	A	0	0	0	3	4	1	96	0	96
14. OTHER FISH	1	A	0	0	0	3	4	1	12	3	13
15. DUCKS	15	A	0	1	3	2	4	0	360	720	1800

TABLE 2-36 (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
7. FRESHWATER RIVER											
16. GEESE	15	A	0	1	3	2	4	1	340	90	353
17. SWANS	15	A	0	0	1	5	4	1	340	90	343
19. MINK	3	A	1	0	1	1	1	1	9	9	18
20. MUSKRAT	3	A	1	0	1	1	1	1	9	9	18
21. OTHER AQUATIC MAMMALS	3	A	1	0	1	1	1	1	0	0	18
									1747	1311	3496
9. TERRESTRIAL											
1. TUNDRA	15	A	0	0	0	3	4	1	180	45	191
2. RIPARIAN VEGETATION	6	E	0	0	0	2	4	1	48	12	51
3. STRAND VEGETATION	15	A	0	0	0	1	0	1	135	15	137
4. OTHER VEGETATION	6	A	0	0	0	2	4	1	48	12	51
5. BROWN BEAR	3	A	1	1	1	2	1	0	15	0	15
7. WOLVERINE	3	A	2	1	1	1	4	0	60	0	60
8. WOLF	3	A	2	1	1	1	4	0	60	0	60
9. MOOSE	1	A	0	1	1	2	0	0	0	0	0
10. CARIBOU	6	A	1	2	3	2	4	0	192	0	192
16. OTHER MAMMALS	6	A	0	0	2	2	4	0	96	0	96
17. RAPTORS	6	A	0	0	1	0	4	1	264	66	281
18. PTARMIGAN	6	A	0	0	1	2	0	0	0	0	0
19. OTHER BIRDS	6	A	0	0	0	2	4	1	48	12	51
									1146	149	1195
									9609	1900	7792

Dolly Varden	reduced	to	102	from	480
Ducks	reduced	to	383	from	1,800

THE TERRESTRIAL HABITAT contributed the remaining 17 percent (769) of the impact score for this case. The decrease in score for this habitat from Case 1 is mainly due to the following species:

Strand Vegetation	reduced	to	64	from	137
Caribou	reduced	to	48	from	192
Other Mammals	reduced	to	24	from	96

CASE 3: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 3,670

THE PELAGIC HABITAT contributed 24 percent (892) of the impact score for this case. With minor exceptions, the change in impact score from Case 1 for this habitat is due to decreased impact scores for the mammal species and seabirds. The major contributing species were smelt (128), Dolly Varden (164), and seabirds (383).

THE SUBTIDAL SAND/MUD HABITAT contributed 13 percent (477) of the impact score for this case. The minor increase in impact score from Case 1 for this habitat is due to sculpin and Pacific sandlance.

THE INTERTIDAL SAND/MUD HABITAT contributed 18 percent (639) of the impact score for this case. The change in impact score from Case 1 for this habitat is primarily due to shorebirds (reduced to 144 from 328).

THE FRESHWATER RIVER HABITAT contributed 38 percent (1,398) to the impact score for this case. The decrease in impact score from Case 1 for this habitat is due primarily to the following species:

Dolly Varden	reduced	to	102 from	480
Whitefish	reduced	to	50 from	213
Arctic Grayling	reduced	to	36 from	153
Ducks	reduced	to	360 from	1,800

THE TERRESTRIAL HABITAT contributed 7 percent (264) of the impact score for this case. The decrease in impact score from Case 1 for this habitat is primarily due to the following species:

Tundra	reduced	to	45 from	191
Strand Vegetation	reduced	to	15 from	137
Caribou	reduced	to	48 from	192
Raptors	reduced	to	66 from	281

CASE 4: BREAKUP, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 2,269

THE PELAGIC HABITAT contributed 16 percent (357) of the impact score for this case. The decrease in score from Case 1 for this habitat is due to decreased species abundance for the breakup period compared to Summer. The major decreases were in the following species:

Smelt	reduced	to	60 from	120
Dolly Varden	reduced	to	27 from	164
Seabirds	reduced	to	164 from	820

THE SUBTIDAL SAND/MUD HABITAT contributed 9 percent of the impact score for this case. The decrease in score from Case 1 is primarily due to the following species:

Cods	reduced	to	144	from	240
Shrimp	reduced	to	17	from	51
Other Marine Invertebrates	reduced	to	17	from	51

THE INTERTIDAL SAND/MUD HABITAT contributed 5 percent (104) of the impact score. The decrease in score from Case 1 is primarily due to the following species:

Shorebirds	reduced	to	0	from	328
Geese	reduced	to	0	from	128
Ducks	reduced	to	26	from	255
Swans	reduced	to	0	from	77

THE FRESHWATER RIVER HABITAT contributed 30 percent (671) of the impac score for this case. The decrease in score from Case 1 for this habitat is mainly due to the following species:

Chum Salmon	reduced	to	0	from	80
Pink Salmon	reduced	to	0	from	80
Dolly Varden	reduced	to	240	from	480
Whitefish	reduced	to	128	from	213
Arctic Grayling	reduced	to	77	from	153
Ducks	reduced	to	120	from	1,800
Geese	reduced	to	0	from	383
Swans	reduced	to	0	from	383

THE TERRESTRIAL HABITAT contributed 10 percent (919) of the impact score for this case. The change in score from Case 1 is due to species

abundance differences of the two seasons. The following species account for the major changes:

Strand Vegetation	reduced	to	0	from	137
Other Vegetation	reduced	to	0	from	51
Raptors	reduced	to	140	from	281
Caribou	increased	to	320	from	192

CASE 5: SUMMER, BUNKER C, 1,000 BBLS - IMPACT SCORE 2,107

THE PELAGIC HABITAT contributed 24 percent (507) of the impact score for this case. The decrease in score from Case 3 for this habitat results from minor decreases in impact on the species due to bunker C compared to diesel. The majority of the decrease is accounted for by the following species:

Zooplankton	reduced	to	18	from	77
Smelt	reduced	to	30	from	123
Dolly Varden	reduced	to	77	from	164

THE SUBTIDAL SAND/MUD HABITAT contributed 5 percent (101) of the impact score for this case. The decrease in score from Case 3 for this habitat resulted from decreases in all impacted species. The following were the largest decreases:

Cods	reduced	to	60	from	240
Sculpins	reduced	to	0	from	48
Shrimp	reduced	to	12	from	51
Other Marine Invertebrates	reduced	to	12	from	51

THE INTERTIDAL SAND/MUD HABITAT contributed 8 percent (165) of the impact score for this case. The major decreases from Case 3 are due to the following species:

Shorebirds	reduced	to	36	from	144
Geese	reduced	to	30	from	120
Ducks	reduced	to	60	from	240
Swans	reduced	to	18	from	72

THE FRESHWATER RIVER HABITAT contributed 40 percent (850) of the impact score for this case. The change from Case 3 for this habitat is pr marily due to the following species:

Geese	reduced	to	90	from	360
Swans	reduced	to	90	from	360
Aquatic Vegetation	increased	to	36	from	9

THE TERRESTRIAL HABITAT contributed 23 percent (484) of the impact score for this case. The increase in score from Case 3 for this habitat is due to the following species:

Tundra	increased	to	180	from	45
Riparian Vegetation	increased	to	48	from	12
Strand Vegetation	increased	to	64	from	15

CASE 6: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 2,044

THE PELAGIC HABITAT contributed 25 percent (510) of the impact score for this case. The decrease in score from Case 2 for this habitat is due to

minor decreases in all species, with smelt (to 30 from 120) and ringed seal (to 0 from 70) the largest decreases.

THE SUBTIDAL SAND/MUD HABITAT contributed 5 percent (101) of the impact score. Decreases from Case 2 were noted for all species, with cods (to 60 from 240) the largest drop in score.

THE INTERTIDAL SAND/MUD HABITAT contributed 15 percent (301) of the impact score. Decreases from Case 2 were noted for all species, with geese (to 30 from 120), and ducks (to 60 from 240), the largest.

THE FRESHWATER RIVER HABITAT contributed 40 percent (823) of the impact score. Scores for most species decreased from Case 2, with the largest the following:

Whitefish	reduced	to	50	from	200
Arctic Grayling	reduced	to	36	from	144
Geese	reduced	to	90	from	360
Swans	reduced	to	90	from	360

THE TERRESTRIAL HABITAT contributed 15 percent (309) of the impact score. The major decreases from Case 2 were for the following species:

Tundra	reduced	to	45	from	180
Raptors	reduced	to	66	from	264

CASE 7: BREAKUP, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 1,375

THE PELAGIC HABITAT contributed 18 percent (255) of the impact score for this case. The decrease in score from Case 4 is mainly due to shorebirds (to 77 from 164).

THE SUBTIDAL SAND/MUD HABITAT contributed 16 percent (215) of the impact score. The decrease from Case 4 is minor.

THE INTERTIDAL SAND/MUD HABITAT contributed 5 percent (67) of the impact score. The decrease from Case 4 is small, with the largest for softshell bivalves (to 27 from 48).

THE FRESHWATER RIVER HABITAT contributed 25 percent (344) of the impact score. The decrease from Case 4 is mainly due to the following species:

Dolly Varden	reduced	to	51 from	240
Ducks	reduced	to	26 from	120

THE TERRESTRIAL HABITAT contributed 36 percent (494) of the impact score. The decrease from Case 4 is mainly due to caribou (to 80 from 320) and other mammals (to 24 from 96).

CASE 8: BREAKUP, DIESEL-2, 1,000 BBLS - IMPACT SCORE 930

The changes in impact scores in comparison with Case 3 are entirely due to species abundance differences for the two different seasons.

THE PELAGIC HABITAT contributed 25 percent (228) of the impact score. The largest decreases from Case 3 were for smelt (to 64 from 128) and Dolly Varden (to 27 from 164).

THE SUBTIDAL SAND/MUD HABITAT contributed 26 percent (245) of the impact score. The major decreases from Case 3 were for cods (to 144 from 240), shrimp (to 17 from 51), and other marine invertebrates (to 17 from 51).

THE INTERTIDAL SAND/MUD HABITAT contributed 7 percent (62) of the impact score. The major decreases from Case 3 were for shorebirds (to 0 from 144), geese (to 0 from 120), ducks (to 24 from 240), and swans (to 0 from 72).

THE FRESHWATER RIVER HABITAT contributed 18 percent (171) of the impact score. This habitat had the greatest decrease from Case 3, with the following species accounting for the majority of the decrease:

Dolly Varden	reduced	to	51	from	102
Ducks	reduced	to	24	from	360
Geese	reduced	to	0	from	360
Swans	reduced	to	0	from	360

THE TERRESTRIAL HABITAT contributed 24 percent (224) of the impact score. The change in score from Case 3 is mainly accounted for by the following species:

Strand Vegetation	reduced	to	0	from	15
Raptors	reduced	to	33	from	66
Caribou	increased	to	80	from	48

CASE 9: SUMMER, DIESEL-2, 100 BBLS - IMPACT SCORE 745

This case is comparable to Case 3 where, because of the lesser spill volume, the impact on each specie is decreased except for three vegetation species in the terrestrial habitat that retain the same level of impact.

THE PELAGIC HABITAT contributed 13 percent (99) of the impact score. The major impact reductions from Case 3 were for smelt (to 30 from 128), Dolly Varden (to 18 from 164), and seabirds (to 90 from 383).

THE SUBTIDAL SAND/MUD HABITAT contributed 14 percent (104) of the impact score. The major impact reductions were for cods (to 60 from 240), sculpins (to 0 from 48), shrimp (to 12 from 51), and other marine invertebrates (to 12 from 51).

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (159) of the impact score. Major impact reductions were for shorebirds (to 36 from 144), geese (to 30 from 120), ducks (to 60 from 240), and swans (to 18 from 72).

THE FRESHWATER RIVER HABITAT contributed 42 percent (311) of the impact score. Major impact reductions were for Dolly Varden (to 24 from 102), whitefish (to 0 from 50), ducks (to 90 from 360), geese (to 90 from 360), and swans (to 90 from 360).

THE TERRESTRIAL HABITAT contributed 10 percent (72) of the impact score. Only tundra (45), riparian vegetation (12), and strand vegetation (15) were given impact scores for this spill size.

CASE 10: BUNKER C, 1,000 BBLS - IMPACT SCORE 728

The change in impact scores for this case compared to Case 5 was entirely due to species abundance differences for the two different seasons.

THE PELAGIC HABITAT contributed 15 percent (111) of the impact score. Major reductions from Case 5 in impact scores were for Dolly Varden (to 13 from 77) and seabirds (to 72 from 360).

THE SUBTIDAL SAND/MUD HABITAT contributed 7 percent (51) of the impact score. The major reduction was for cods (to 36 from 60).

THE INTERTIDAL SAND/MUD HABITAT contributed 3 percent (21) of the impact score. Major reductions were for shorebirds (to 0 from 36), geese (to 0 from 30), ducks (to 6 from 60), and swans (to 0 from 18).

THE FRESHWATER RIVER HABITAT contributed 23 percent (168) of the impact score. Major reductions were for Dolly Varden (to 48 from 96), ducks (to 24 from 360), geese (to 0 from 90), and swans (to 0 from 90).

THE TERRESTRIAL HABITAT contributed 52 percent (377) of the impact score. Major reductions were for strand vegetation (to 0 from 64) and raptors (to 33 from 66). The impact score for caribou increased (to 80 from 48).

CASE 11: BREAKUP, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 575

The change in impact scores for this case compared to Case 6 was entirely due to species abundance differences for the two different seasons.

THE PELAGIC HABITAT contributed 19 percent (110) of the impact score for this case. Major reductions in impact scores from Case 6 were for Dolly Varden (to 12 from 72) and seabirds (to 72 from 360).

THE SUBTIDAL SAND/MUD HABITAT contributed 9 percent (51) of the impact score. Largest reduction was for cods (to 36 from 60).

THE INTERTIDAL SAND/MUD HABITAT contributed 5 percent (31) of the impact score. Major reductions were for shorebirds (to 0 from 144), geese (to 0 from 30), and ducks (to 6 from 60).

THE FRESHWATER RIVER HABITAT contributed 28 percent (159) of the impact score. Major reductions were for Dolly Varden (to 48 from 96), ducks (to 24 from 360), geese (to 0 from 90), and swans (to 0 from 90).

THE TERRESTRIAL HABITAT contributed 39 percent (224) of the impact score. Major reductions were for strand vegetation (to 0 from 60) and raptors (to 33 from 66). Impact on caribou was increased (to 80 from 48).

CASE 12: SUMMER, GASOLINE, 1,000 BBLS - IMPACT SCORE 546

In comparison to similar spill sizes of the other petroleum types (diesel, crude, and bunker), gasoline was estimated to have a reduced impact in all habitats because of its volatility. In addition to reductions of impact in all other habitats, the SUBTIDAL SAND/MUD HABITAT was assumed

unimpacted for this spill site, since in either breakup or Summer conditions the six-hour time lag to reach the habitat would allow extensive evaporation. This consideration was coupled with the reduced diffusivity of gasoline into water compared with the other petroleum types. Since this is the first spill discussed, the major contributing species are listed.

THE PELAGIC HABITAT contributed 11 percent (61) of the impact score. Largest specie impacts were smelt (30) and Dolly Varden (18).

THE INTERTIDAL SAND/MUD HABITAT contributed 21 percent (111) of the impact score. Largest impacts were geese (30) and ducks (60).

THE FRESHWATER RIVER HABITAT contributed 55 percent (302) of the impact score. Largest impacts were ducks (90), geese (90), and swans (90).

THE TERRESTRIAL HABITAT contributed 13 percent (72) of the score. Only vegetation was given impact; tundra (45), riparian (12), and strand (15).

The impact scores for Cases 13 through 20 range from 310 down to 20. The spill sizes of these cases are 100 bbls except for a 1,000-bbl breakup season gasoline spill. The array of scores for these cases is:

	SPILL SIZE AND SEASON		
SPILL TYPE	1,000 BBLS BREAKUP	100 BBLS SUMMER	100 BBLS BREAKUP
Diesel-2	See Case 8	See Case 9	191
Crude Oil	See Case 11	293	45
Bunker C	See Case 10	310	96
Gasoline	101	118	20

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(15) UMIAT

Umiat lies alongside the Colville River about 80 miles from the Arctic coast at the northern edge of the foothills of the Brooks Range. The spill location was chosen at the base of Uluksrak Bluff about 300 ft from the river and about 18 miles downstream of Umiat at 69°28.33'N latitude, 151°30'W longitude (Fig. 2-83).

(a) PHYSICAL CHARACTERISTICS

The spill site is located about 80 miles upstream from the mouth of the Colville River at an elevation of about 200-ft mean sea level (MSL) in the river floodplain. The Colville River floodplain in this area is surrounded by gently rolling hills rising to elevations between 500 to 1,000 ft MSL.

Umiat lies in the Arctic Climatic Zone. Winter temperatures typically range between -37.5°F and -7°F.[1,4] Summer temperatures are typically between 34°F and 63°F.[1,4] Recorded extremes are 85°F and -78°F.[1,4] The growing season is about 10 weeks long, about 2 weeks longer than the Beaufort Sea coast.[30] The area is underlain by extensive permafrost and the active layer is 6 to 18 in. deep, depending on soil type.[4,30]

Annual precipitation is low, between 4 and 8 in.,[4] but runoff is retarded by thick vegetation cover and accumulated organic material.[1,30] Maximum precipitation occurs in August.[1,4] Snow cover forms in mid-September and builds to depths around 15 to 20 in.[1,4] Snow cover is usually gone around mid-June.[4]

The Colville River usually breaks up around May 24th.[8] River surveys taken about 85 miles downstream of Umiat show stream velocity of about 2.8 ft per sec and flow estimated at 16,000 cubic ft per sec on July

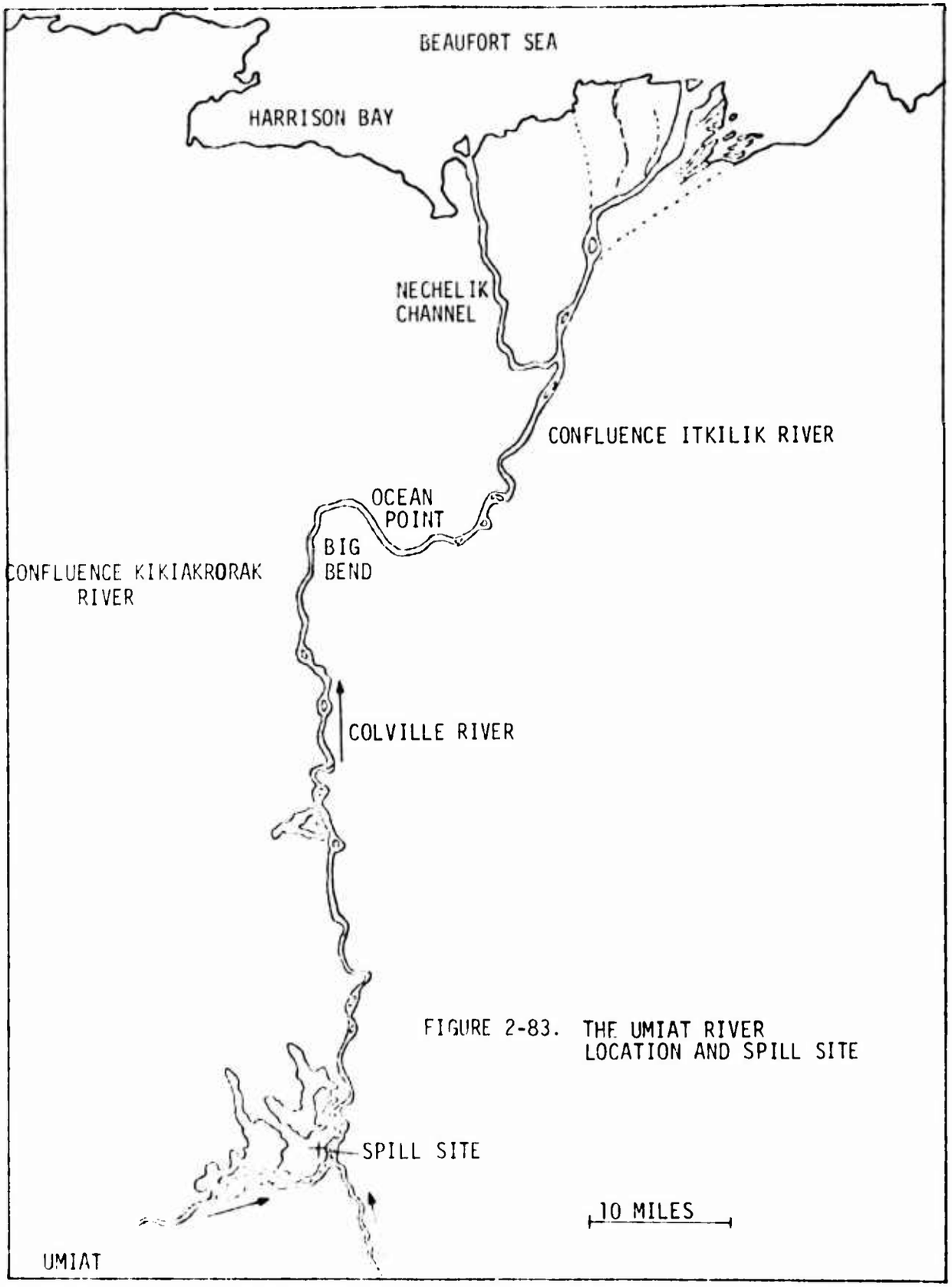


FIGURE 2-83. THE UMIAT RIVER LOCATION AND SPILL SITE

1, 1970.[29] The channel width was 600 ft and average depth was 16 ft.[29] Gradient was 4 ft per mile.[29] No data were given on flow during breakup.

From the spill point to about 10 miles above the survey point, the Colville is a braided, fairly swift stream with gravel bottom channels whereupon it changes to a slower, deeper stream in one or two channels with sand or fine gravel bottoms.[29]

Soils near the river are silt, loess, silty sand, and fine sand overlying sand and gravel.[5,29] Vegetation includes wet-sedge-meadow tundra, cottongrass-birch-heath tundra, and streambank-heath-willow-alder shrub.[29] The dense vegetation cover is typically 6 to 12 in. high.[29]

SPILL SCENARIO

The spill site chosen was below the Uluksrak Bluff, within 300 ft of the river. Within a short period of time, oil would flow into the river.

From there, downstream transport was assumed to occur with the river flow. River flow from the spill site down to Ocean Point (Big Bend) was estimated at 5 ft per second. From here to the delta mouth (about 50 miles), a flow velocity of 2.8 ft per second was assumed in keeping with reported information.

The lead edge of the oil would travel about 15 km in the first 6 hours. In about 12 hours, the lead edge would reach the confluence of the Kikiakrorak River with the Colville just upstream of the start of the Big Bend. In about 16 hours, the slick would reach the slower portion of the river. In about 24 to 25 hours, the slick would reach the confluence of the Itkillik River with the Colville. In 30 to 36 hours, the slick would reach the delta and in about 40 to 48 hours, the slick would reach

the Beaufort Sea. The oil slick would probably spread through all the channels of the delta. Once reaching the sea, the predominant east-west winds would move the oil along the coast.

In the Winter, the oil would not move far on the frozen ground and river.

(b) BIOLOGICAL CHARACTERISTICS

The spill site selected on the Colville River below Umiat will allow crude oil to reach the sea via the river delta under ice-free conditions in a manner similar although longer in time than the Onshore Prudhoe spill location. The Colville River lies about 60 miles to the west of the Sagavanirktok River and the Onshore Prudhoe spill site.

Although this distance is great, it is felt that most of the Prudhoe Bay vicinity comments (Offshore Prudhoe Bay location description) are basically applicable here also. The following comments are meant to modify the Prudhoe Bay vicinity comments (Offshore and Onshore) to better define the Umiat (Colville River) location.

Resource summaries are shown in Figures 2-84 and 2-85.

FISHES

The somewhat closer proximity of the Colville marine areas to the Chukchi Sea may result in greater numbers of marine and anadromous species originating in the Chukchi Sea to be in this vicinity as compared with the Prudhoe Bay vicinity. However, there are not felt to be great differences between these two drainages. Therefore, the fishes assumed in the marine and freshwater environments are felt to be similar with several exceptions.

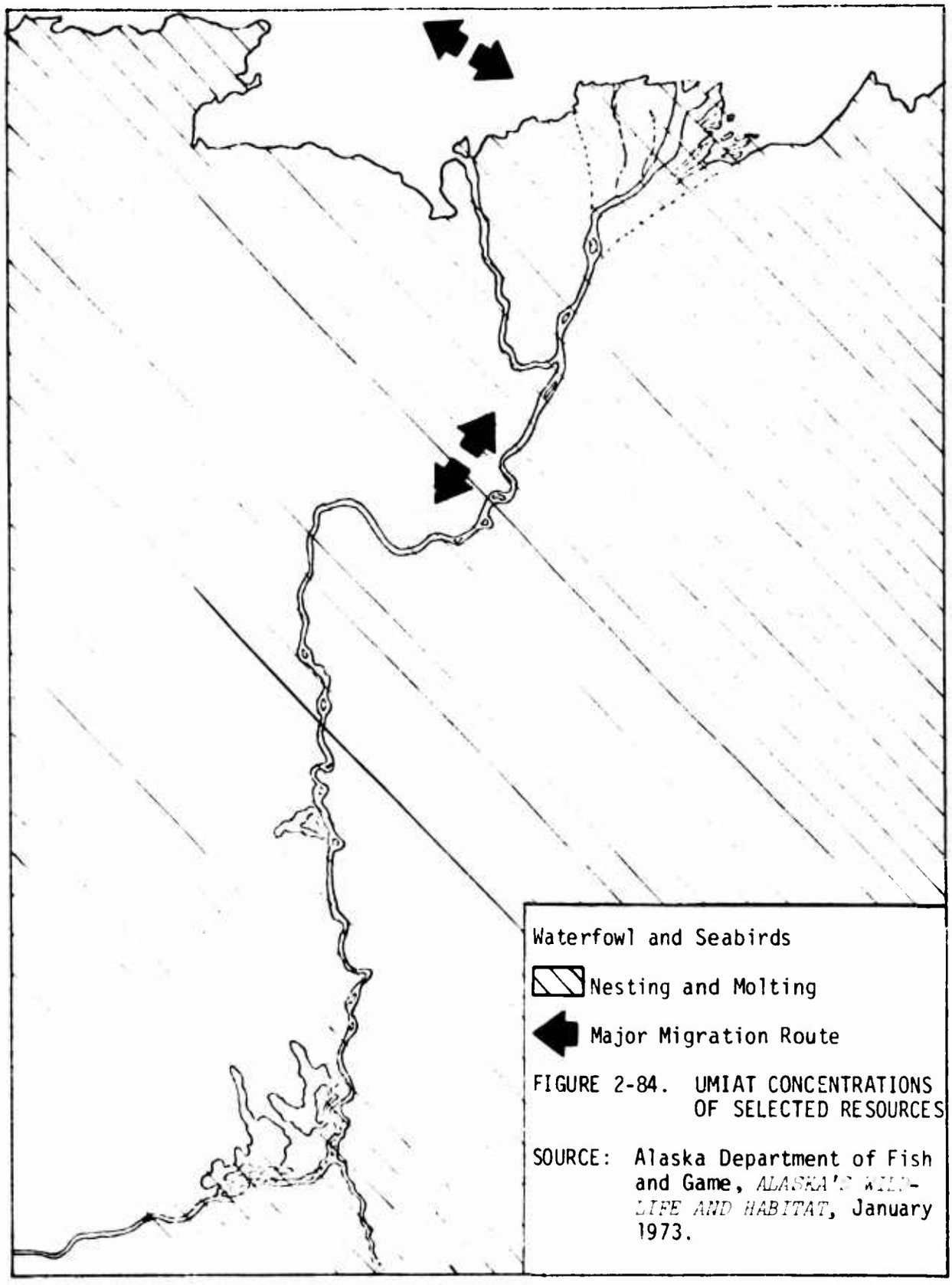


FIGURE 2-84. UMIAT CONCENTRATIONS OF SELECTED RESOURCES

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

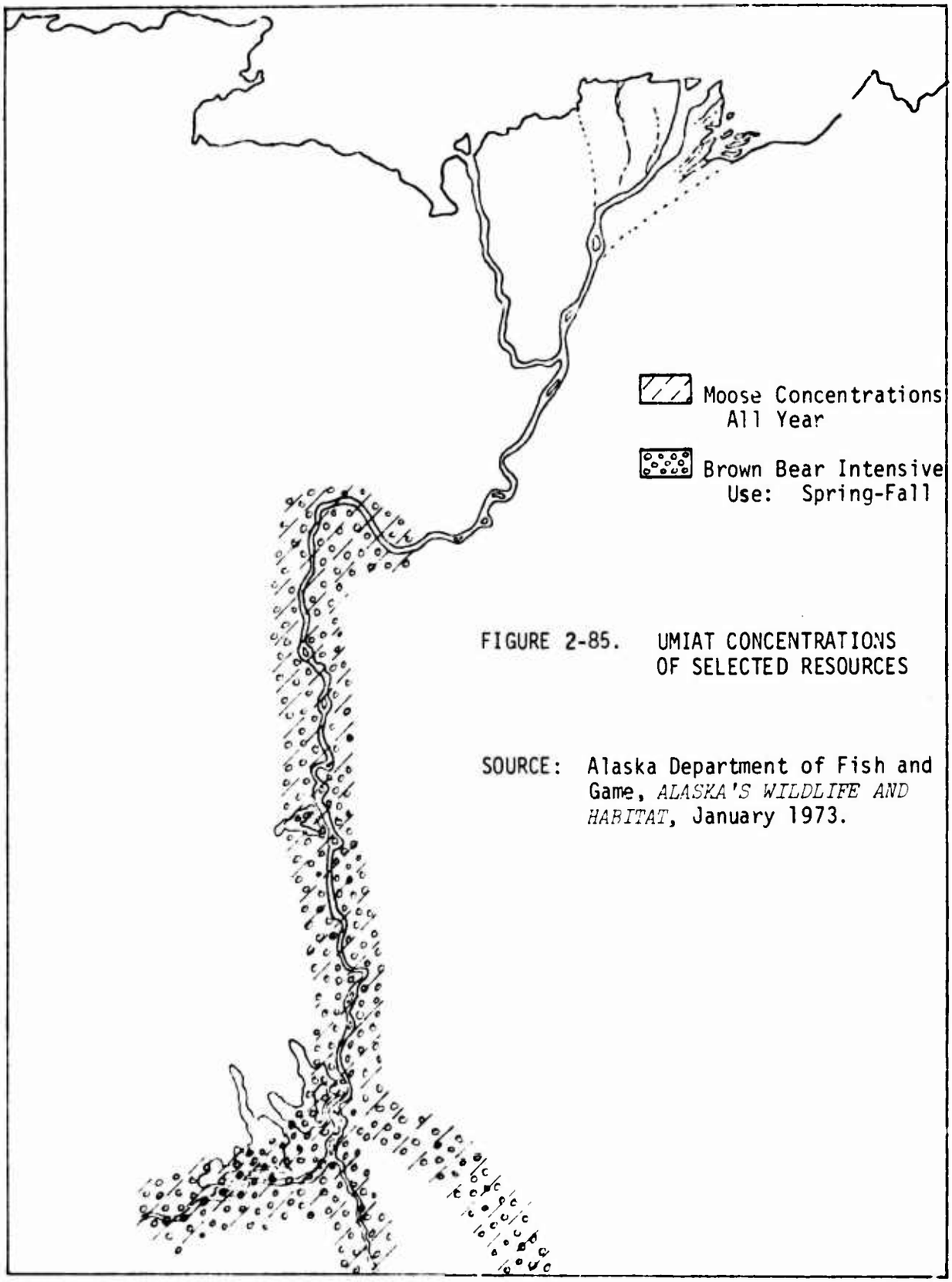


FIGURE 2-85. UMIAT CONCENTRATIONS OF SELECTED RESOURCES

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

SALMONIDS are known to differ somewhat in the Colville River compared to the Sagavanirktok. Small runs of chum salmon are known to occur in the Colville River[28] compared to the few chum and pink salmon "strays" located in the Sagavanirktok River.

A Colville Delta survey in 1970-1971[64] located additional salmonids as follows: broad whitefish, Arctic cisco, least cisco, round whitefish, grayling, lake trout, and Arctic char. The Colville Delta is also an important rearing area for migratory whitefish.[64] The upper river survey located the same salmonids.[64]

OTHER FISHES located were the longnose sucker, Rainbow smelt, four-horn sculpin, and Arctic flounder in the Delta, and the burbot, slimy sculpin, and suckers in the River over 40 river miles upstream from the sea.[64]

WATERFOWL

As Figure 2-74 in the Offshore Prudhoe location description indicates, there is more high-density waterfowl habitat on land at the Colville location as compared to the Prudhoe location. There also is a large goose molting area west of the Colville Delta. Unlike the Sagavanirktok Delta, there is no significant breeding colony of snow geese at the Colville Delta.

The large Fall migration of waterfowl past the Prudhoe Bay vicinity would also pass the Colville vicinity and is not expected to be markedly different in species makeup or abundance.

MARINE MAMMALS

These animals are expected at the Colville vicinity as described for the Offshore Prudhoe Bay location.

TERRESTRIAL MAMMALS

BROWN BEAR are [illegible] as found at the Prudhoe Bay location except that there is a region of Spring-Fall intensive use noted along the Colville River down as far as the major oxbow above the Delta (about 20 miles from the coast).[17] Brown bear are probably more numerous along the Colville River in this location as compared to the Sagavanirktok River.

MOOSE, as with the brown bear, concentrate along the Colville River (in the same areas) during all seasons of the year.[17] Moose would also be more abundant here compared to the Prudhoe Bay location.

CARIBOU are possibly more numerous than at the Prudhoe Bay location, because the Colville vicinity is closer to the larger of the two coastal caribou herds (the Arctic herd). As at the Prudhoe Bay location, the entire land area is coded as Summer range.[17] The variations in abundance in either area are expressed by Figures 2-86 through 2-89 , which show major caribou activities in both areas from 1969 to 1973. Caribou are extremely abundant here.

FLORA

See the Prudhoe Bay (Offshore and Onshore) location descriptions.

For further physical and biological information, see Appendix D.

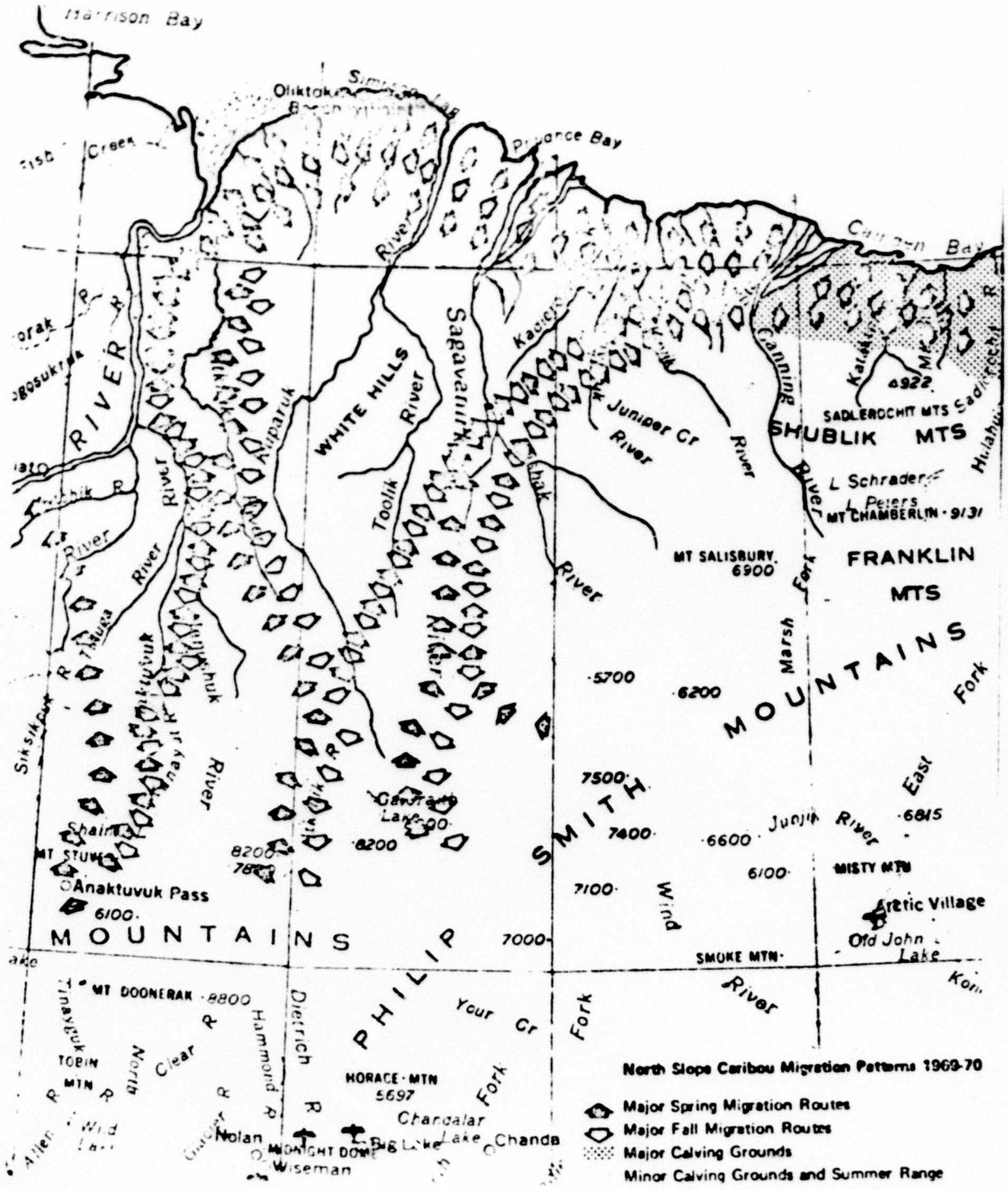


FIGURE 2-86. NORTH SLOPE CARIBOU MIGRATION PATTERNS, 1969-1970.

SOURCE: Alyeska Pipeline Service Comapny, *BIOLOGICAL DOCUMENTATION OF THE TRANS ALASKA PIPELINE SYSTEM*, Appendix E-3.1014, April 1974, Summary Report.

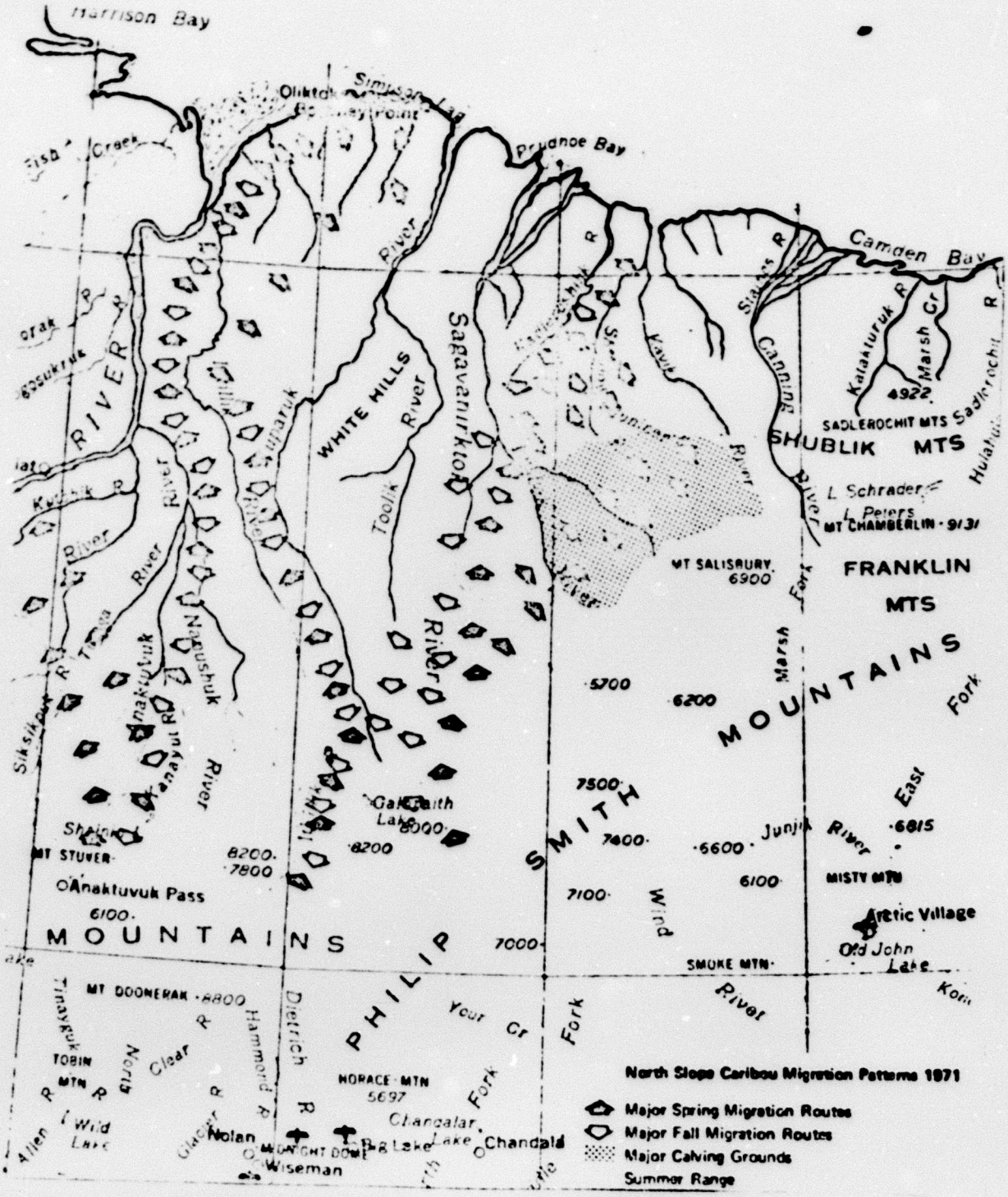


FIGURE 2-87. NORTH SLOPE CARIBOU MIGRATION PATTERNS, 1971

SOURCE: Alyeska Pipeline Service Company, *BIOLGOICAL DOCUMENTATION OF THE TRANS ALASKA PIPELINE SYSTEM*, Appendix E-3.1014, April 1974, Summary Report.

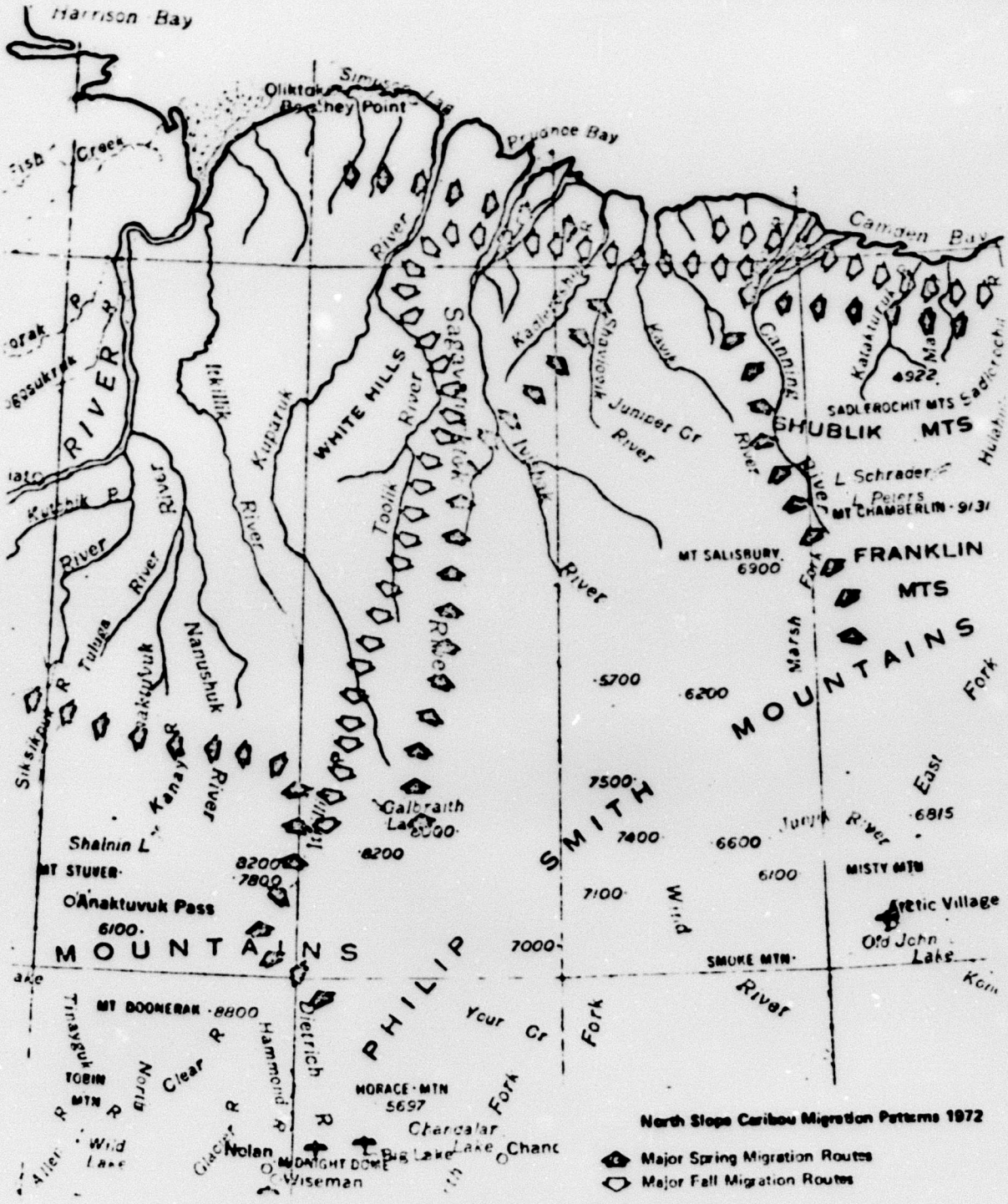


FIGURE 2-88. NORTH SLOPE CARIBOU MIGRATION PATTERNS, 1972.

SOURCE: Alyeska Pipeline Service Company, *BIOLOGICAL DOCUMENTATION OF THE TRANS ALASKA PIPELINE SYSTEM*, Appendix E-3.1014, April 1974, Summary Report.

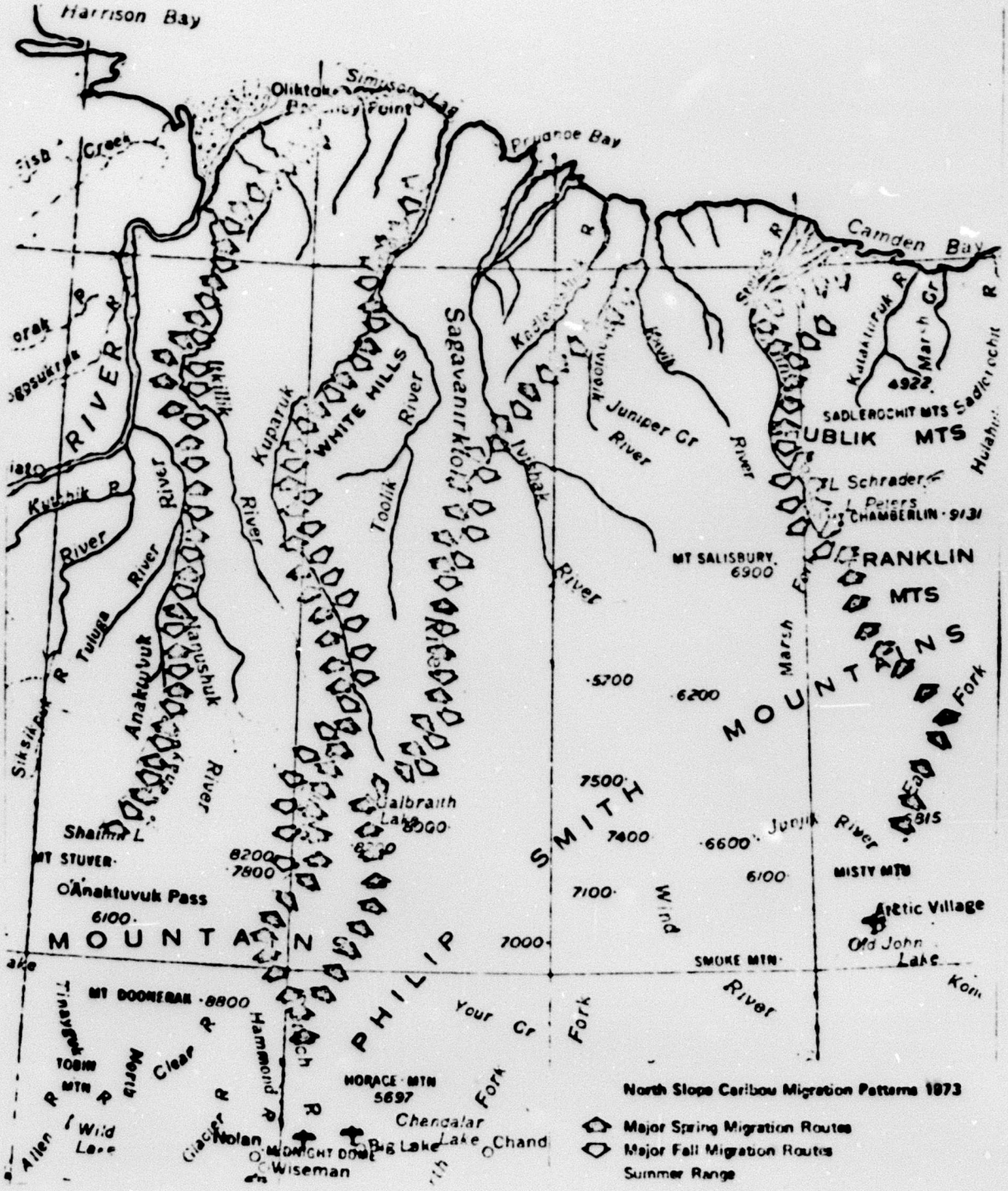


FIGURE 2-89. NORTH SLOPE CARIBOU MIGRATION PATTERNS, 1973.

SOURCE: Alyeska Pipeline Service Company, *BIOLOGICAL DOCUMENTATION OF THE TRANS ALASKA PIPELINE SYSTEM*, Appendix E-3.1014, April 1974, Summary Report.

(c) RESULTS

Five habitats were impacted by spills on the Colville River. Rocky and cobble/gravel habitats were not present on the Beaufort Sea coast. The freshwater river and terrestrial habitats contributed the majority of each impact score.

Spills were postulated for all four products, but only crude oil was presumed spilled in large quantities (10,000 barrels) from pipeline breaks. The largest impact score was derived for the largest crude oil spill in Summer.

The largest species contributions were for fish in the Colville River and waterfowl in the river, the delta area, and the near shoreline. Fish were judged sensitive to chemical toxicity, waterfowl were sensitive to physical contact, and raptors were judged sensitive through ingestion of oil-contaminated fish and waterfowl.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined for the Colville River. These scenarios were similar to the time-frames of those at Onshore Prudhoe, i.e., most probable Summer conditions and the late-Spring breakup period. Winter spills not cleaned up were postulated to resemble a "breakup" spill.

River flow rate measured in Summer below the Big Bend was used for the lower river current speed and an estimate of 5 ft/sec was used for the upper river current speed to calculate spill transport times. A more complete discussion of these details was given earlier in the spill scenario section.

These assumptions resulted in the lead edge of the slick reaching the Big Bend in about 12-14 hours, the Itkillik River junction in about 24 hours, the upper portions of the delta in about 30-36 hours, the lower portions of the delta in about 36-40 hours, and the delta mouth in about 40-45 hours. Predominant easterly winds would push the remaining oil westward along the Beaufort Sea coastline, potentially as far as Atigaru Point in 72 hours. These impacts are illustrated in Fig. 2-90.

CASE DISCUSSION

Table 2-37 presents the results of the oil spill scenarios examined at Umiat without cleanup.

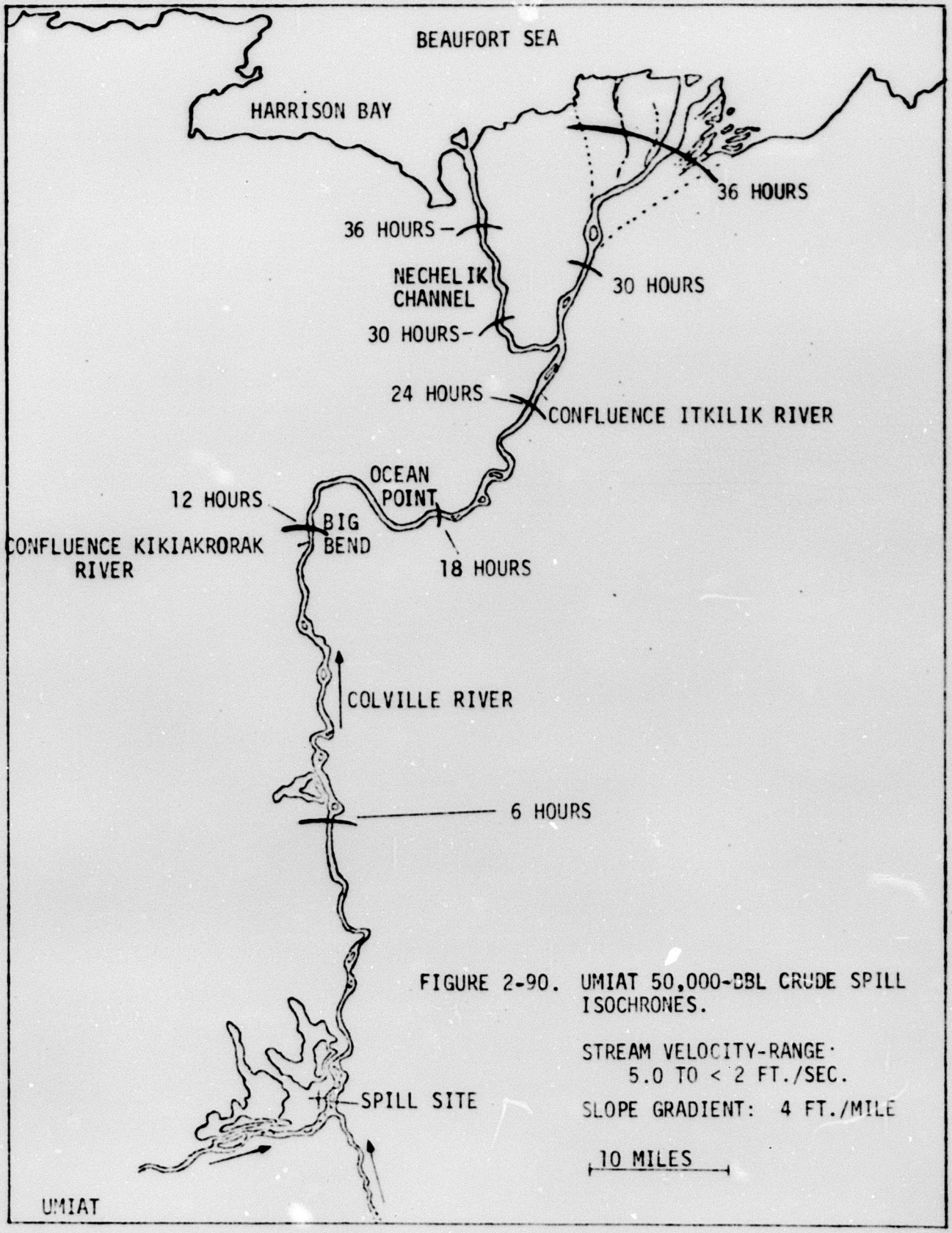


FIGURE 2-90. UMIAT 50,000-BBL CRUDE SPILL ISOCHRONES.

TABLE 2- 37 . UMIAT CASE RESULTS NO CLEANUP

SPILL TYPE AND SEASON	SPILL SIZE 10,000	1,000	100
Diesel-2	--	2,397 [2]	527 [9]
Crude Oil	4,457 [1](1)	2,036 [4]	408 [12]
Bunker-C	--	2,242 [3]	517 [10]
Gasoline	--	460 [11]	99 [16]
Diesel-2	--	693 [6]	162 [13]
Crude Oil	1,219 [5]	591 [8]	88 [17]
Bunker-C	--	650 [7]	114 [14]
Gasoline	--	103 [15]	9 [18]

(1) Numbers in brackets are the case numbers that follow.

Three habitats were not impacted by the spills; the subtidal rock/gravel, intertidal rocky, and intertidal cobble/gravel. Gasoline only impacted the freshwater river and terrestrial habitats. The subtidal sand/mud habitat was not impacted by crude oil and bunker-C spills of 1,000 barrels or less.

CASE 1: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 4,457

THE PELAGIC HABITAT contributed 17 percent (741) of the impact score for this case. The species which were the main contributors to this score were zooplankton (72), Dolly Varden (82), ringed seal (70), and seabirds (383). Seabirds were the most relatively abundant species. Dolly Varden were judged to have recreational and subsistence importance. All the mammal species had subsistence importance and were classified as protected. Plankton, sand-lance, herring and smelt were deemed ecologically important. Dolly Varden and

seabirds were judged to be the most sensitive species in the habitat to crude oil coming from the river delta.

THE SUBTIDAL SAND/MUD HABITAT contributed 2 percent (94) of the impact score. Largest impacts were for cods (18) and other marine invertebrates (36). No species was deemed abundant. Cods had commercial, subsistence, and ecological importance. Marine invertebrates were judged ecologically important.

THE INTERTIDAL SAND/MUD HABITAT contributed 15 percent (691) of the impact score. Largest impact scores were for shorebirds (128), geese (120), ducks (240), and swans (144). Ducks were judged abundant, with shorebirds, geese, and swans moderately abundant. Softshell bivalves were judged the most sensitive species, but were not very abundant. The bird species were judged the next most sensitive. Geese and ducks had recreational importance and high subsistence importance values. Shorebirds and swans were classified as protected.

THE FRESHWATER RIVER HABITAT contributed 42 percent (1,881) of the impact score. The species which were the main contributors were Dolly Varden (82), whitefish (102), Arctic grayling (128), ducks (820), geese (255), and swans (255). Ducks, geese, and swans were judged the most relatively abundant. Dolly Varden, whitefish, Arctic grayling, pike, ducks, and geese had recreational importance. All these species had subsistence importance also. Swans were classified as protected. Dolly Varden and ducks were judged to be the most sensitive species to the spill.

THE TERRESTRIAL HABITAT contributed 24 percent (1,050) of the impact score. The species which were the main contributors were tundra (180), raptors (281), and other birds (200). Tundra was the most relatively abundant

species. Wolverine (60) and wolf (60) had commercial importance values. The large mammal species had recreational and subsistence values. Raptors included an endangered species of peregrine falcon and other birds were classified as protected.

Table 2-38 presents the complete results for Case 1.

CASE 2: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 2,397

The decrease in impact score compared to Case 1 is basically attributable to the fact that the spill size is only 1/10 of the former.

THE PELAGIC HABITAT contributed 7 percent (165) of the impact score. All species impacts were reduced from Case 1, with the main reductions in the following:

Dolly Varden	reduced to 38 from 82
Pinged Seal	reduced to 0 from 70
Seabirds	reduced to 90 from 383

THE SUBTIDAL SAND/MUD HABITAT contributed 4 percent (99) of the impact score. The change in score for this habitat from Case 1 was minor.

THE INTERTIDAL SAND/MUD HABITAT contributed 11 percent (263) of the impact score. The decrease in score from Case 1 is due to the following species, with minor exceptions:

Shorebirds	reduced to 30 from 127
Geese	reduced to 30 from 120
Ducks	reduced to 120 from 240
Swans	reduced to 36 from 144

THE FRESHWATER RIVER HABITAT contributed 58 percent (1,403) of the impact score. The only major reduction in impact from Case 1 was for ducks (reduced to 383 from 820).

TABLE 2-38. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	UMIAT
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	PIPELINE BREAK
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	1	A	0	0	0	3	4	0	12	0	12
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	1	A	0	0	0	2	4	0	8	0	8
6. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
7. HERRING	1	A	0	0	0	3	4	0	12	0	12
8. SMELT	1	A	0	0	0	3	4	0	12	0	12
9. CRAB LARVAE	1	E	0	0	0	2	4	0	8	0	8
16. DOLLY VARDEN	3	A	0	1	1	1	9	1	81	9	82
17. NORTHERN FUR SEAL	1	A	0	0	2	5	1	0	7	0	7
18. RINGED SEAL	10	A	0	0	2	5	1	0	70	0	70
19. RIBBON SEAL	3	A	0	0	1	5	1	0	18	0	18
20. BEARDED SEAL	3	A	0	0	1	5	1	0	18	0	18
21. HARBOR SEAL	6	A	0	0	1	5	1	0	36	0	36
23. WALRUS	10	A	0	0	1	5	0	0	0	0	0
24. WHALES	10	A	0	0	2	5	0	0	0	0	0
26. POLAR BEAR	6	A	0	1	2	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	10	A	0	0	1	5	0	0	0	0	0
28. SEABIRDS	15	A	0	3	1	5	6	1	360	90	363
									717	99	741
2. SUBTIDAL SAND-MUD											
1. CODS	3	E	1	0	3	2	1	0	18	0	18
2. SCULPINS	1	A	0	0	0	2	0	0	0	0	0
3. STARRY FLOUNDER	1	A	1	0	1	2	1	0	4	0	4
4. OTHER FLATFISH	3	A	1	0	1	2	1	0	12	0	12
5. PACIFIC SANDLANCE	1	A	0	0	0	3	0	0	0	0	0
6. MISC. MARINE FISH	3	A	0	0	0	2	0	0	0	0	0
8. SHRIMP	1	E	0	0	0	3	4	0	12	0	12
10. OTHER BIVALVES	3	A	0	0	0	1	4	0	12	0	12
11. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	6	0	36	0	36
									96	0	96

TABLE 2-38 (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
									0	0	0
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
4. SOFTSHELL BIVALVES	1	A	0	0	0	2	9	1	18	2	18
5. INVERTEBRATE INFAUNA	3	A	0	0	0	3	4	1	36	9	36
7. SHOREBIRDS	6	A	0	0	0	5	4	1	120	30	120
8. GEESE	6	A	0	1	3	1	4	4	120	0	120
9. DUCKS	10	A	0	1	3	2	4	4	240	0	240
10. SWANS	6	A	0	0	1	5	4	0	144	0	144
									681	41	691
5. INTERTIDAL ROCKY											
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	E	0	0	0	3	4	1	36	9	36
2. AQUATIC INVERTEBRATES	3	A	0	0	0	3	4	1	36	9	36
9. DOLLY VARDEN	3	A	0	1	1	1	9	1	81	9	82
10. WHITEFISH	6	A	0	1	2	1	4	1	96	24	102
11. ARCTIC GRAYLING	6	A	0	1	2	2	4	1	120	30	126
12. PIKE	3	A	0	1	2	1	4	1	48	12	51
13. STICKLEBACKS	3	A	0	0	0	3	4	1	36	9	38
14. OTHER FISH	3	A	0	0	0	3	4	1	36	9	38
15. DUCKS	15	A	0	1	3	2	9	1	810	90	820
16. GEESE	10	A	0	1	3	2	4	1	240	60	255
17. SWANS	10	A	0	0	1	5	4	1	240	60	255
19. MINK	6	A	0	0	0	1	1	1	6	6	12
20. MUSKRAT	6	A	0	0	0	1	1	1	6	6	12
21. OTHER AQUATIC MAMMALS	6	A	0	0	0	1	1	1	6	6	12
									1797	333	1881

TABLE 2-38 (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT				
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
1. TUNDRA	15	A	0	0	0	3	4	0	180		180
2. RIPARIAN VEGETATION	6	A	0	0	0	2	4	0	48	0	48
3. STRAND VEGETATION	10	E	0	0	0	1	4	1	40	40	43
4. OTHER VEGETATION	1	M	0	0	0	2	4	0	8	0	8
5. BROWN BEAR	3	-	0	1	1	2	1	0	12	0	12
6. BLACK BEAR	3	A	0	1	1	2	1	0	12	0	12
7. WOLVERINE	10	A	2	0	3	1	1	0	60	0	60
8. WOLF	10	A	2	1	2	1	1	0	60	0	60
9. MOOSE	3	A	0	1	2	2	0	0	0	0	0
10. CARIBOU	10	A	0	1	3	2	1	0	60	0	60
11. MUSKOX	6	A	0	0	0	3	1	0	18	0	18
12. OTHER MAMMALS	6	A	0	0	1	2	1	0	18	0	18
17. RAPTORS	6	A	0	0	1	4	4	1	264	66	281
18. PTARMIGAN	10	P	0	1	2	2	1	0	50	0	50
19. OTHER BIRDS	10	P	0	0	0	5	4	0	200	0	200
									1030	74	1050
									4319	555	4457

THE TERRESTRIAL HABITAT contributed 20 percent (467) of the impact score. The major reductions from Case 1 were for tundra (to 45 from 180), raptors (to 132 from 281), and other birds (to 50 from 200).

CASE 3: SUMMER, BUNKER-C, 1,000 BBLS - IMPACT SCORE 2,242

THE PELAGIC HABITAT contributed 10 percent (216) of the impact score. The change in score from Case 2 was due to decreases in the minor impacts on all the fish and invertebrate species and a larger increase in the impact on seabirds (to 180 from 90).

THE SUBTIDAL SAND/MUD HABITAT impact was reduced to zero.

THE INTERTIDAL SAND/MUD HABITAT contributed 10 percent (233) of the impact score. The decrease in score from Case 2 for this habitat was minor.

THE FRESHWATER RIVER HABITAT contributed 56 percent (1,266) of the impact score. The change from Case 2 was minor. The largest change in score was a decrease for Dolly Varden (to 38 from 82).

THE TERRESTRIAL HABITAT contributed 24 percent (527) of the impact score. The major changes from Case 2 are listed below:

Caribou	reduced	to	0	from 60
Raptors	reduced	to	66	from 132
Tundra	increased	to	180	from 45

CASE 4: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 2,036

THE PELAGIC HABITAT contributed 8 percent (159) of the impact score. Changes from Case 3 for this habitat included the addition of minor impacts on several fish and invertebrate species and a large decrease in impact score for seabirds (to 90 from 180).

THE INTERTIDAL SAND/MUD HABITAT contributed 5 percent (107) of the impact score. The decrease from Case 3 was due to geese (to 0 from 30), ducks (to 60 from 120), and swans (to 0 from 36).

THE FRESHWATER RIVER HABITAT contributed 63 percent (1,291) of the impact score. The change in score from Case 3 was minor.

THE TERRESTRIAL HABITAT contributed 24 percent (479) of the impact score. The change in score from Case 3 was mainly due to the following species:

Tundra	reduced	to	45	from 180
Riparian Vegetation	reduced	to	12	from 48
Caribou	increased	to	60	from 0
Raptors	increased	to	132	from 66

CASE 5: BREAKUP, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 1,219

For all habitats, the change in impact score from Case 1 was due to species abundance differences between the two seasons.

THE PELAGIC HABITAT contributed 10 percent (117) of the impact score. The largest decrease from Case 1 was for seabirds (to 0 from 383).

THE SUBTIDAL SAND/MUD HABITAT contributed 3 percent (36) of the impact score. The reductions from Case 1 were minor as was the score for this habitat.

THE INTERTIDAL SAND/MUD HABITAT contributed 6 percent (72) of the impact score. Major score reductions were for shorebirds (to 0 from 127), geese (to 0 from 120), ducks (to 72 from 240), and swans (to 0 from 144).

THE FRESHWATER RIVER HABITAT contributed 23 percent (284) of the impact score. Major reductions from Case 1 are listed below:

Arctic Grayling	reduced to 64 from 127
Ducks	reduced to 55 from 820
Geese	reduced to 0 from 255
Swans	reduced to 0 from 255

THE TERRESTRIAL HABITAT contributed 58 percent (710) of the impact score. The major reductions from Case 1 were for raptors (to 140 from 281) and other birds (to 120 from 200).

CASE 6: BREAKUP, DIESEL-2, 1,000 BBLS - IMPACT SCORE 693

The change in impact score for this case compared to Case 2 was due entirely to species abundance changes between the two seasons.

THE PELAGIC HABITAT contributed 3 percent (21) of the impact score. The major reduction from Case 2 was for seabirds (to 0 from 90).

THE SUBTIDAL SAND/MUD HABITAT contributed 6 percent (38) of the impact score. Reductions from Case 2 were minor.

THE INTERTIDAL SAND/MUD HABITAT contributed 5 percent (36) of the impact score. Reductions from Case 2 included invertebrate infauna (to 0 from 36), shorebirds (to 0 from 30), geese (to 0 from 30), ducks (to 36 from 120), and swans (to 0 from 36).

THE FRESHWATER RIVER HABITAT contributed 34 percent (235) of the impact score. Reductions from Case 2 included Dolly Varden (to 27 from 82), whitefish (to 48 from 96), Arctic grayling (to 60 from 120), ducks (to 26 from 383), geese (to 0 from 255), and swans (to 0 from 255).

THE TERRESTRIAL HABITAT contributed 52 percent (363) of the impact score. Major reduction from Case 2 was for raptors (to 66 from 132).

ASE 7: BREAKUP, BUNKER-C, 1,000 BBLS - IMPACT SCORE 650

The change in impact score for this case compared to Case 3 was due to pecies abundance changes between the two seasons.

THE PELAGIC HABITAT contributed 2 percent (12) of the impact score. eductions from Case 3 were for Dolly Varden (to 12 from 36) and seabirds (to) from 180).

THE INTERTIDAL SAND/MUD HABITAT contributed 6 percent (36) of the impact score. Major reductions from Case 3 were for shorebirds (to 0 from 30), geese (to 0 from 30), ducks (to 36 from 120), and swans (to 0 from 36).

THE FRESHWATER RIVER HABITAT contributed 30 percent (197) of the impact score. Major reductions were for whitefish (to 48 from 96), Arctic grayling (to 60 from 120), ducks (to 26 from 383), geese (to 0 from 240), and swans (to 0 from 240).

THE TERRESTRIAL HABITAT contributed 62 percent of the impact score. Largest reductions from Case 3 were for strand vegetation (to 0 from 43) and raptor (to 33 from 66).

CASE 8: BREAKUP, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 591

The change in impact score for this case compared to Case 4 was due to species abundance changes between the two seasons.

THE PELAGIC HABITAT contributed 4 percent (21) of the impact score. The major reduction from Case 4 was for seabirds (to 0 from 90).

THE INTERTIDAL SAND/MUD HABITAT contributed 3 percent (18) of the impact score. The reductions from Case 4 were minor; including shorebirds (to 0 from 30) and ducks (to 18 from 60).

THE FRESHWATER RIVER HABITAT contributed 35 percent (207) of the impact score. Major reductions were for whitefish (to 48 from 96), Arctic grayling (to 60 from 120), ducks (to 25 from 383), geese (to 0 from 240), and swans (to 0 from 240).

THE TERRESTRIAL HABITAT contributed 58 percent (345) of the impact score. Major reductions from Case 4 were for strand vegetation (to 0 from 40), raptors (to 66 from 132), and other birds (to 30 from 50).

CASE 9: SUMMER, DIESEL-2, 100 BBLS - IMPACT SCORE 527

The decrease in scores for all habitats from Case 2 was due to the reduced impact associated with the smaller spill size.

THE PELAGIC HABITAT contributed 2 percent (12) of the impact score. Reductions from Case 2 were made for all species, the largest being for seabirds (to 0 from 90).

THE SUBTIDAL SAND/MUD HABITAT contributed 2 percent (12) of the impact score. Minor reductions were made for all species.

THE INTERTIDAL SAND/MUD HABITAT contributed 14 percent (71) of the score. Reductions were made for all species, with shorebirds (to 0 from 30), geese (to 0 from 30), ducks (to 60 from 120), and swans (to 0 from 36) the largest.

THE FRESHWATER RIVER HABITAT contributed 59 percent (309) of the score. Reductions were made for all species, with Arctic grayling (to 30 from 120), whitefish (to 24 from 96), ducks (to 95 from 383), geese (to 60 from 255), and swans (to 60 from 255) the largest.

THE TERRESTRIAL HABITAT contributed 23 percent (123) of the score. The largest reductions were for wolverine (to 0 from 60), wolf (to 0 from 60), caribou (to 0 from 60), and raptors (to 66 from 132).

CASE 10: SUMMER, BUNKER-C, 100 BBLS - IMPACT SCORE 517

The decrease in scores for all habitats from Case 3 was due to the reduced impact associated with the smaller spill size.

THE PELAGIC HABITAT contributed 19 percent (99) of the impact score. Major reduction from Case 3 was for shorebirds (to 90 from 180).

THE INTERTIDAL SAND/MUD HABITAT contributed 12 percent (60) of the impact score. Major reductions were for shorebirds (to 0 from 30), geese (to 0 from 30), ducks (to 60 from 120), and swans (to 0 from 36).

THE FRESHWATER RIVER HABITAT contributed 56 percent (291) of the score. Major reductions from Case 3 were for whitefish (to 24 from 96), Arctic grayling (to 30 from 120), ducks (to 90 from 383), geese (to 60 from 240), and swans (to 60 from 240).

THE TERRESTRIAL HABITAT contributed 13 percent (67) of the impact score. Major reductions were for tundra (to 45 from 180), wolverine (to 0 from 60), and wolf (to 0 from 60).

CASE 11: SUMMER, GASOLINE, 1,000 BBLS - IMPACT SCORE 460

As this case is not comparable to any of the other petroleum types previously discussed, it is discussed mainly on its own. Species abundance and importance discussed in Case 1 holds for this case also.

Because of the higher volatility of gasoline, only the two habitats associated with the river above Big Bend were impacted. These two are discussed below.

THE FRESHWATER RIVER HABITAT contributed 85 percent (393) of the impact score. Species impacted were Dolly Varden (9), whitefish (24), Arctic grayling (30), pike (12), sticklebacks (9), other fishes (9), ducks (180), geese (60), and swans (60).

THE TERRESTRIAL HABITAT contributed the remaining 15 percent (67) of the impact score. The primary impact was to vegetation. Impact on the large fauna of the habitat was felt to be minimal. Impacts were scored for tundra (45), riparian vegetation (12), and strand vegetation (10).

CASE 12: SUMMER, CRUDE OIL, 100 BBLS - IMPACT SCORE 408

The decrease in scores for all habitats from Case 4 was due to the reduced impact associated with the smaller spill size.

THE PELAGIC HABITAT contributed 2 percent (9) of the impact score. The major reductions from Case 4 were for Dolly Varden (to 9 from 38) and seabirds (to 0 from 90).

THE INTERTIDAL SAND/MUD HABITAT only contributed 1/2 percent (2) of the impact score. The only species judged affected was softshell bivalves.

THE FRESHWATER RIVER HABITAT contributed 79 percent (321) of the impact score. Major reductions from Case 4 were for whitefish (to 24 from 96), Arctic grayling (to 30 from 120), ducks (to 90 from 383), geese (to 60 from 240), and swans (to 60 from 240).

THE TERRESTRIAL HABITAT contributed 19 percent (76) of the impact score. Major reductions were for wolverine (to 0 from 60), wolf (to 0 from 60), caribou (to 0 from 60), raptors (to 66 from 132), and other birds (to 0 from 50).

The impact scores for Cases 13 through 18 range from 162 down to 9. The spill sizes are all 100 barrels except for a 1,000-barrel gasoline breakup period spill. The array of scores for these cases is:

	SPILL SIZE AND SEASON			
	1,000		100	
	BREAKUP		SUMMER	BREAKUP
Diesel - 2	See Case 6		See Case 9	162
Crude Oil	See Case 8		See Case 12	88
Bunker-C	See Case 7		See Case 10	114
Gasoline	103		99	9

The relatively low scores for these cases and the minor differences between cases make case-by-case comparison of this site have little meaning. These cases were judged to be in the minimum impact range and cleanup scenarios are not addressed to these smaller spills.

(16) YUKON RIVER CROSSING

The Trans-Alaska Pipeline System (TAPS) crosses the Yukon River just downstream from the confluence of Woodcamp Creek. The confluence of the Tanana and Yukon Rivers lies downstream about 90 miles to the southwest. The spill site was chosen on the northern bank of the river at the pipeline crossing at 65°52.5'N latitude, 149°47.9'W longitude (Fig. 2-91).

(a) PHYSICAL CHARACTERISTICS

The Yukon River Crossing lies in the Rampart Trough, a gently rolling region of tundra, thaw lakes, and permafrost.[14] The location is in the Continental Climatic Zone with generally cold Winters and warm Summers. Temperatures range between -35°F and -1°F during Winter and 43°F and 76°F in Summer.[1,4] Extreme temperatures are -80°F and 97°F.[4]

The annual mean precipitation totals about 10 in.--most occurs in late Summer and Fall.[1,4] Total seasonal snowfall is around 60 in.[14] Average dates of freezeup for the Yukon River at Tanana and Rampart are around November 4th to 6th.[8] Average dates of breakup are around May 14th to 16th.[8]

The terrain of the region is gently rolling topography varying between 300 to 500-ft MSL in altitude. The Fort Hamlin Hills rise to 3,150 ft about 12 miles north of the crossing. A ridge separating Isom and Hess Creeks rises to 2,300 ft about 10 to 12 miles south of the crossing. The Yukon River is quite flat in terrain profile in this region. From Stevens Village to Tanana, a distance of 146 miles by river, the river drops 100 ft in elevation, a grade of about 0.013 percent. Stream flows estimated for the Yukon at the crossing and downstream are 7.0 ft per sec mean annual

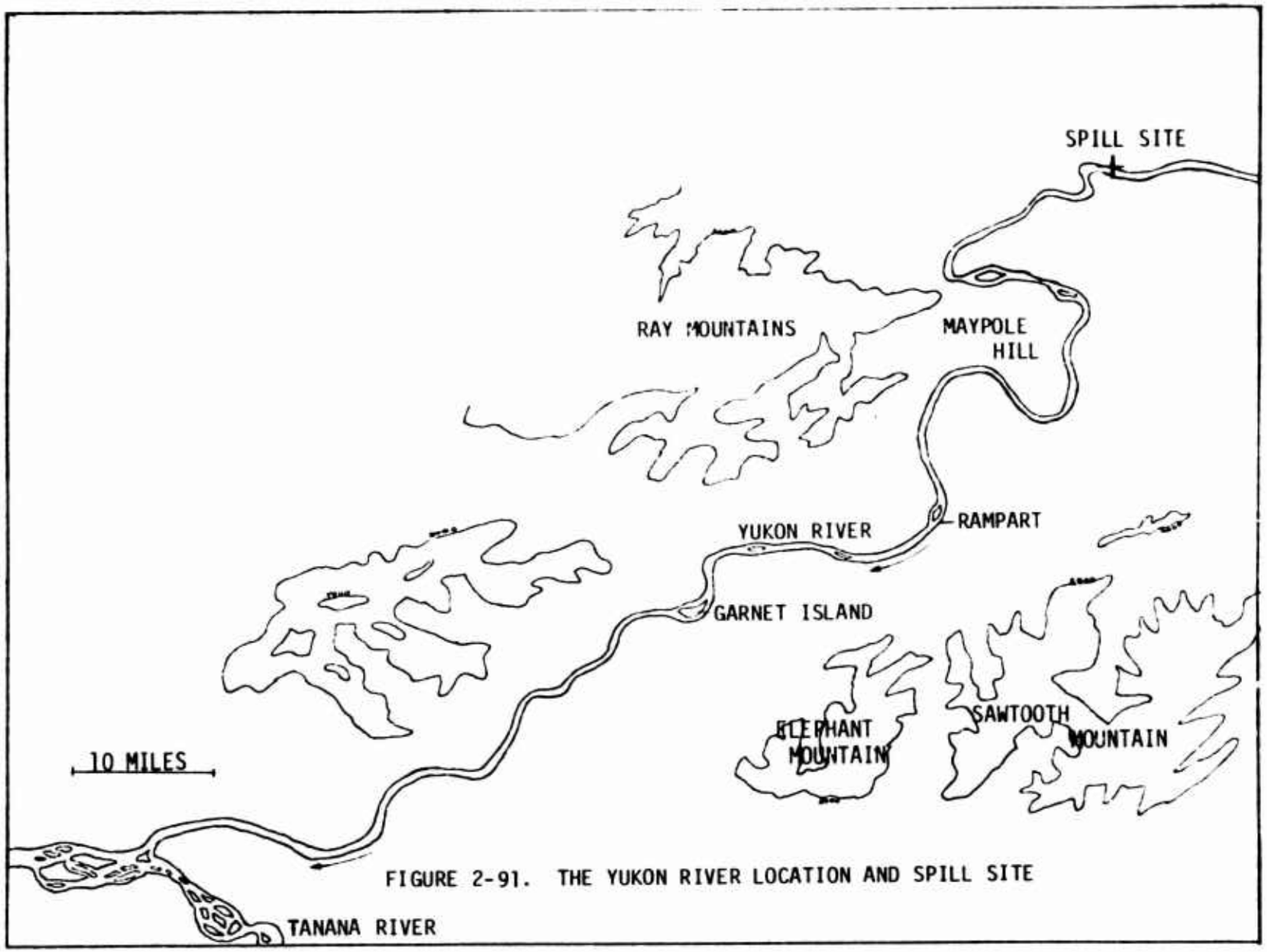


FIGURE 2-91. THE YUKON RIVER LOCATION AND SPILL SITE

velocity, 7.5 ft per sec peak 50-year velocity, 812,000 cubic ft per sec mean annual flow rate, and 968,000 cubic ft per sec peak flow rate.[5]

Soils in this area include frozen colluvial silts, sand, rock fragments, stream gravel, and ice-rich reworked wind-blown silt.[14]

SPILL SCENARIO

The spill site was chosen at the pipeline crossing of the river. It is assumed that oil would enter the river as it is spilled. Transport downstream would occur by the river currents at the time of the spill. The estimated annual average flow velocity of 7.0 ft per sec was chosen, and this flow rate was assumed to hold downstream to the confluence of the Tanana River with the Yukon.

Given these assumptions, the leading edge of the slick would reach Maypole Hill and Hess Creek in about 6 hours, and Rampart in about 11 to 12 hours. Garnet Island would be reached in about 15 hours, and the Rapids by Senatis Mountain would be reached in about 18 hours. In about 24 hours, the slick would reach the confluence of the Tanana and Yukon Rivers. These estimated time isochrons are illustrated in Figure 2-92.

(b) BIOLOGICAL CHARACTERISTICS

The Yukon River crossing area downstream to the confluence with the Tanana River is the assumed major impact area and is the vicinity under discussion at this study location. The spill scenarios involve four volumes of crude oil coming from the TAPS pipeline (under construction) with a break on the north shore of the Yukon River. Little terrestrial vegetation is involved in any direct impacts of the oil spill alone.

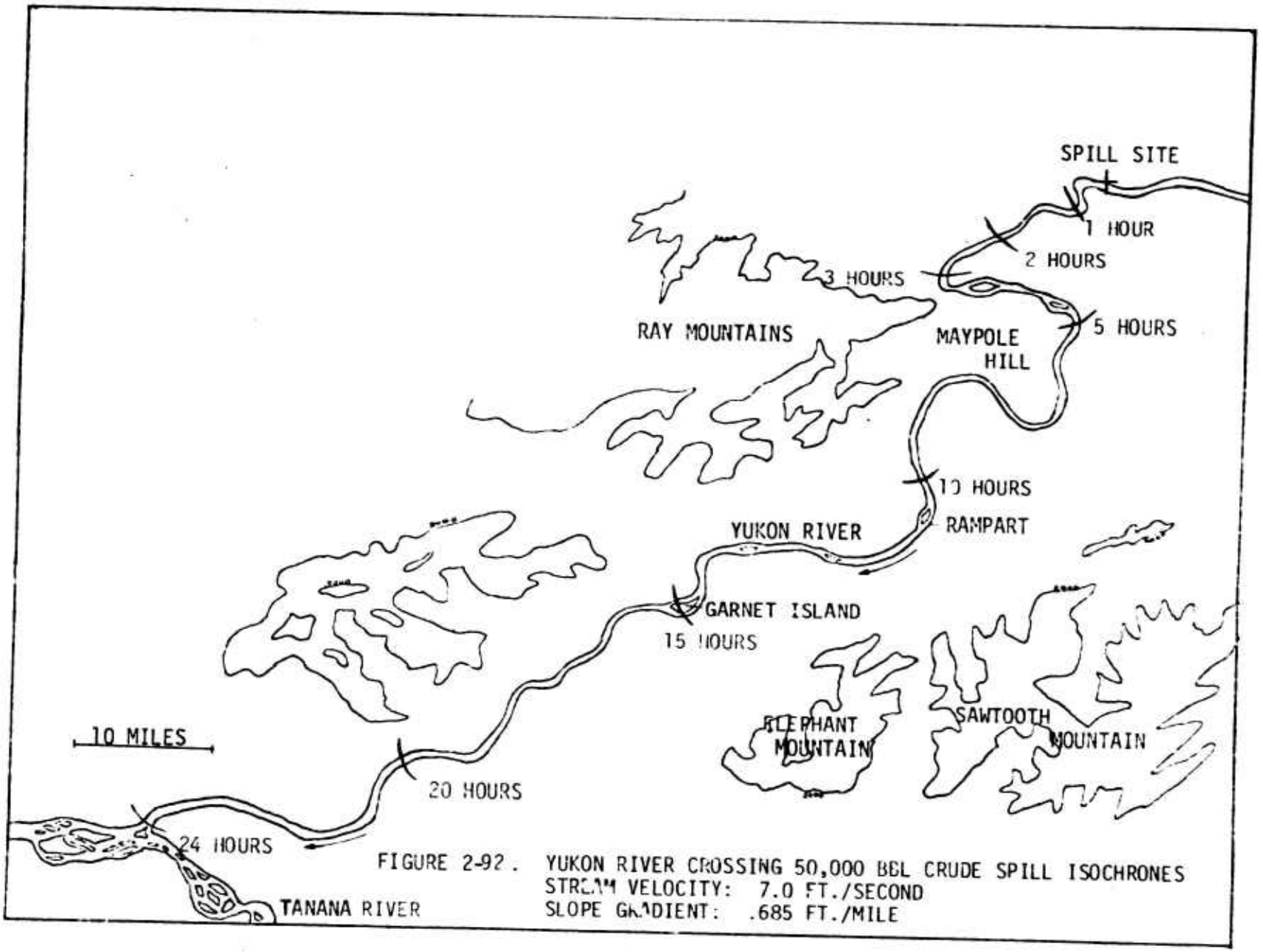


FIGURE 2-92. YUKON RIVER CROSSING 50,000 BBL CRUDE SPILL ISOCHRONES
STREAM VELOCITY: 7.0 FT./SECOND
SLOPE GRADIENT: .685 FT./MILE

The major resources in the Yukon Crossing vicinity are salmon, waterfowl, and terrestrial mammals.

Resource summaries are shown in Figure 2-93.

FISHES

The Yukon River Crossing is the area of the most important fish resources crossed by the TAPS pipeline.[58] The Yukon River is an important "highway" for fishes migrating from as far west as the Bering Sea and as far east and south as the Yukon Territory and British Columbia.

SALMONIDS are the abundant and important fish resource of the Yukon River. Although all five species of North American salmon enter the river at Norton Sound in the Bering Sea, only chum, king, and coho travel the several hundred miles to the location of the crossing.[58] Pink and sockeye salmon are reported in insignificant numbers. Total Yukon salmon run estimates (including commercial and subsistence catches and escapement) range up to 2 million chum and 600,000 king salmon.[58] Based upon studies related to the Rampart Dam project (downstream of the crossing), the estimated salmon runs past the Yukon Crossing vicinity were 200,000 chum, 50,000 coho, and 20,000 king salmon.[58]

Timing of adult salmon runs range from June 25th to October 30th, with the following breakdown by species:[58]

SALMON	TOTAL RUN
King	June 25th to July 31st
Coho	August 20th to October 30th
Spring-Summer chum	July 1st to September 30th

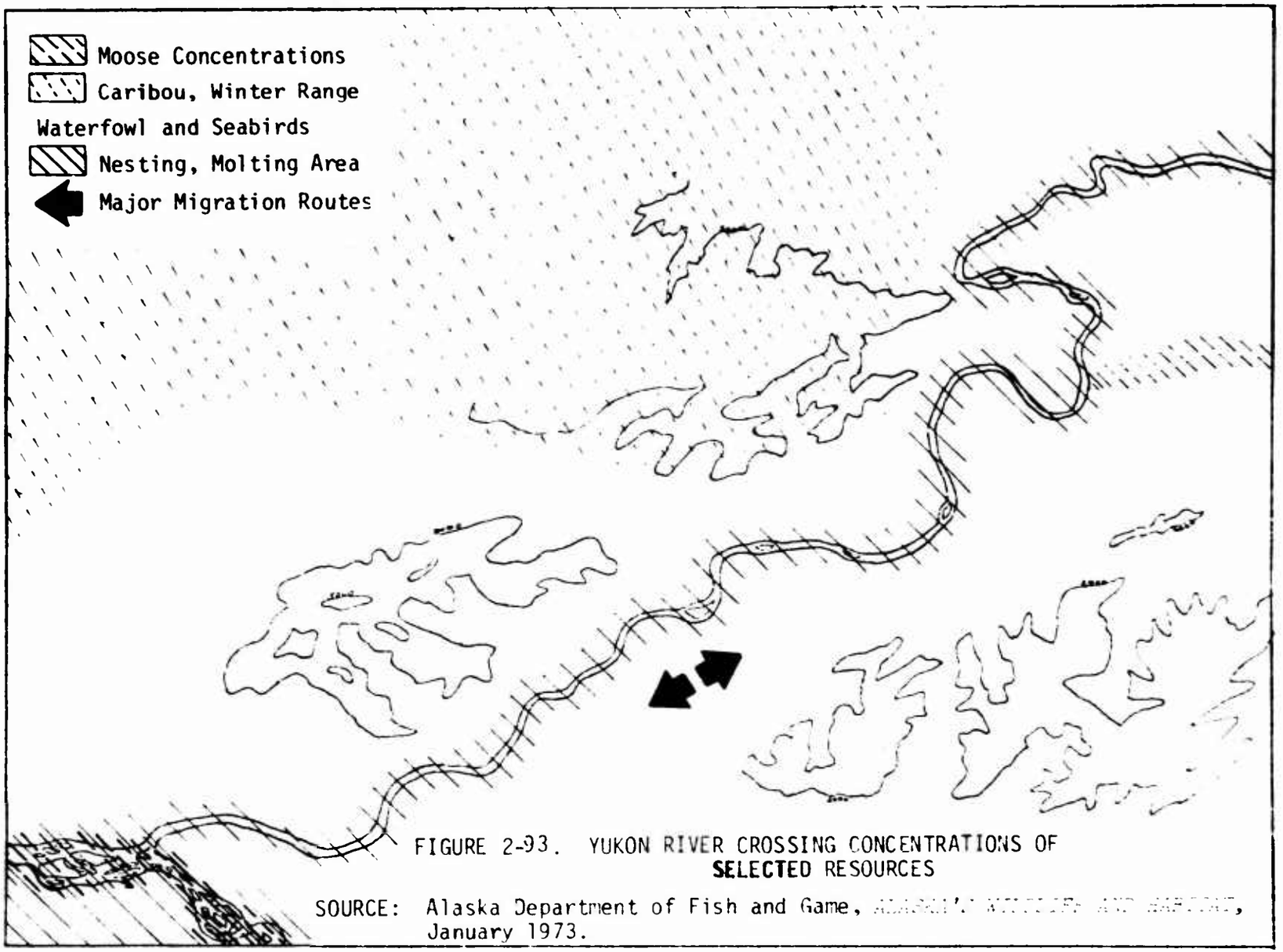


FIGURE 2-93. YUKON RIVER CROSSING CONCENTRATIONS OF SELECTED RESOURCES

SOURCE: Alaska Department of Fish and Game, [illegible], January 1973.

The commercial and subsistence salmon fisheries are used by local residents along the entire Yukon and are very important to their welfare. Estimates of the king salmon run to commercial and subsistence fishermen is $1 million to $1.5 million annually. Commercial coho catches are worth about $20,000 annually. Commercial chum salmon catches are worth about $250,000 annually, but increased harvest in the future could produce a potential catch worth about $1 million annually. Chum salmon subsistence catches have an estimated value of about $300,000.

Mean commercial salmon catches in the Alaskan Yukon (1965-1973) are as follows:

SALMON	MEAN	(RANGE)
King	95,500	(79,300 - 118,000)
Coho	16,000	(700 - 36,600)
Chum	205,100	(23,200 - 517,900)

Mean subsistence catches for the Alaskan Yukon (1965-1973) are as follows:

SALMON	MEAN	(RANGE)
King	16,100	(11,600 - 22,500)
Other (mostly chum)	227,000	(133,100 - 448,900)

Mean commercial catches for the Yukon Territory (1965-1973) are as follows:

SALMON	MEAN	(RANGE)
King	2,200	(1,600 - 3,200)
Chum	2,300	(400 - 3,330)

Mean subsistence catches for the Yukon Territory (1965-1973) are as follows:

SALMON	MEAN	RANGE
King	2,400	(1,000 - 3,000)
Other (mostly chum)	10,400	(1,200 - 14,000)

No salmon spawning is known to exist in the Yukon Crossing vicinity.[59]

Long-term trends (1918-1970) have shown increasing commercial fisheries and decreasing subsistence fisheries; beginning in 1968 and following years, commercial catches have exceeded subsistence catches.[58]

Other resident salmonids in the Yukon Crossing vicinity are sheefish, Arctic grayling, whitefish, and cisco.[58]

Sheefish run up as far as the Yukon Crossing; those in the pipeline corridor are believed to remain locally in the river rather than go to sea throughout the winter period.[58] These fish are known to spawn locally (June and July) each year in the Ray and Dall Rivers.[58] Grayling and whitefish probably migrate up and down the river seasonally at the Crossing, but little is known about these movements.

Recreational fisheries are also an important utilization of some of these salmonids with an extensive sport fishery for grayling and char in the Yukon drainage. The Chena River alone accounts for 25,000 man-days annually.

OTHER FISHES in the Yukon drainage include anadromous lampreys and smelt, neither of which migrate to the Crossing vicinity.[58] Resident fishes of the Yukon Crossing vicinity also include northern pike, long-nosed sucker, burbot, lake chub, trout perch, and sculpin.

WATERFOWL

Waterfowl nest in moderate numbers along the narrow floodplain in the vicinity of the Crossing.[58] The entire section of the Yukon (Crossing to entrance of Tanana River) is indicated as nesting and molting areas for waterfowl.[17] A major north-south migration lies just east of the Crossing, and a major northeast-southwest waterfowl migration route is indicated along this section of the Yukon River.[17] Larger waterfowl nesting and molting land areas are also noted south and west of the Yukon and Tanana junction.[17]

DUCKS are assumed to be very abundant at the Crossing with high densities of ducks upstream at the Yukon Flats and a moderate density of nesting along the Yukon River floodplain. Waterfowl nesting is indicated as extensive throughout the Yukon River and tributary floodplain zones during May and June.[59]

Ducks indicated as present[17] in Game Unit 20, as well as Game Units 12 and 19, are the following: lesser scaup, pintails, widgeons, mallards, green-winged teal, white-winged scoters, buffleheads, American goldeneyes, canvasbacks, and shovelers.[17] For the above Game Units, the breeding

density is 67 ducks per square mile, with an estimated population of 621,000 ducks producing an estimated 1,244,000 birds.[17]

Ducks are of small consequence to subsistence utilization today, but sport hunting is an important use of this resource.

GEESE are said to be found in fairly substantial numbers in the Game Units including the Crossing vicinity. Canada geese and white-fronted geese are the principal species of interest.

SWANS (trumpeters) are indicated on other Yukon drainage systems but not in the Crossing to Tanana junction. A few swans may be present in this vicinity.

SHOREBIRDS, including little brown cranes, are indicated in the Game Unit including the Crossing.

TERRESTRIAL MAMMALS

MOOSE occur in the Crossing vicinity, with Winter concentrations downstream on the Hess Creek drainage and at and below the Yukon-Tanana junction. The latter region is also indicated as providing Spring and Summer calving[17] and feeding areas for thousands of moose.[17] Moose tend to congregate on river flats, islands, and bars in mid to late Winter, particularly in years of deep snow. Moose are an important sport and subsistence resource in the area.

CARIBOU are present in low numbers in the area, but a wintering area exists upstream and west of the Crossing.[17] One source[58] indicated that neither the Steese-Fortymile nor Arctic caribou herds are known to migrate to this vicinity. Another source[59] indicated that the Steese-Fortymile herd is seldom found as far northwest as the south bank of the Yukon. A few

caribou were assumed to be in the Crossing vicinity.

BROWN BEAR are indicated as present north and south of the Yukon area[17] and were assumed to be in low to moderate abundance here.

BLACK BEAR are shown as present in the entire area around this vicinity[17] and were assumed in moderate numbers.[18]

WOLVES AND WOLVERINES are indicated in the Crossing vicinity. Populations are highly variable and are assumed moderate. Wolves and wolverines are not known to concentrate in the Crossing vicinity in any season.[58]

AQUATIC FURBEARERS in this vicinity would include beaver, river otter, and mink, and are assumed to be abundant.[18]

FLORA

The hypothetical spill of crude oil at the Yukon River Crossing is on the north shore of the River where the highway bridge-pipeline crosses the River. The scenario would cause little or no oil to directly impact the terrestrial vegetation but would contact any aquatic vegetation present.

The lower slopes and broad valley flats are generally forested with black spruce and associated heath and dwarf birch.[14] Moss and peat layers are characteristic of floors of mature forests that have not been severely burned in perhaps the last 50 to 200 years.[14]

One source[61] indicated that both sides of the Yukon River in the pipeline vicinity (coded 16S/2) are commercial forest land estimated to contain more than 20 percent trees of 9-in. minimum DBH (diameter breast height) and 12-ft minimum height, capable of producing 20 cu ft or more wood per acre per year.

Floodplains next to larger streams (assumed to include the Yukon River) have riparian vegetation which includes willows, alder, aspen, and balsam poplar.[14] These plants are small and scrubby in form, in places, reflecting young age from recent establishment following severe flooding.

Smaller streams north of the Yukon River are indicated as having herbaceous aquatic plants (pondweeds, sedges, and grass) in quiet water areas produced by oxbows and beaver dams.[14] Slower water areas on the Yukon River would be expected to be similar. The bulk of the river is assumed to be devoid of much aquatic vegetation as a result of fast-flowing water, silt carried by the river, and ice in Winter and ice-souring during breakup.

For further physical and biological information on the Yukon Crossing, see Appendix D.

(c) RESULTS

Only two habitats were present at this location, freshwater river and terrestrial. The freshwater habitat accounted for 80 to 90 percent of the impact score for each case. Only crude oil was spilled from the pipeline. Major impact scores resulted for 50,000-bbl spills in both seasons and 10,000-bbl spills in Summer. Summer scores were higher than those for similar spill sizes during breakup, reflecting the influence of greater species abundance in Summer.

Fish were impacted by the chemical toxicity of the spills. Major contributors to the scores were salmon, Dolly Varden, whitefish, and grayling. Waterfowl were sensitive to physical contact. Ducks, geese, and swans were the major contributors. Wolverine and raptors were judged to be sensitive through ingestion of oil-contaminated fish and waterfowl.

YSICAL FATE OF SPILLS

Three scenarios were examined for the Yukon River. The scenarios ırrespond to the three basic states of the river: free-flowing (Summer and ırly Fall), frozen (Winter and early Spring), and breakup (late Spring).

The scenario for Summer is based on the average flow of the river. ›r a pipeline break at the river, it was estimated that 50,000 barrels of l could flow out of the pipe into the river in less than 1 hour. Down-:ream transport was assumed to occur at the speed of the average river 'rrent with deposition of oil on the river banks, evaporation, weathering, ffusion into the water column, and mixing into the river bed continually, ducing the amount of oil in the slick (see Figure 2-92). Primary impacts re associated with three transit periods as listed below:

0 - 12 hours	chemical effects
12 - 24 hours	physical effects
24+ hours	aesthetic effects

re chemical effects were associated with the volatile, lighter fractions the oil, physical effects included shoreline deposition, smothering, mixing into the river bottom; and aesthetic effects included shoreline ›sition of the residue of the spill. The slick was estimated to reach Tanana River confluence in 24 hours.

For the late-Spring breakup scenario, it was assumed that the oil was l.d just before or at peak flow. Flow estimated in the literature[5] gave ity and volume values about 10 percent greater than the average flow used for Summer. While both scenarios impact the same two habitats,

species abundance was different and it was assumed that the impacts were reduced due to the greater water volume and sediment scouring.

The Winter scenario with the river frozen assumed that the oil formed a pool about 1-cm thick at the spill site. For 50,000 barrels the calculated radius of the pool at that thickness was about 500 m. It was also assumed that cleanup would remove nearly 100 percent of the oil and contaminated snow on the river ice. However, if not removed, the oil was assumed to remain quiescent until breakup, when the impact was scored analogous to the late-Spring or breakup scenario.

CASE DISCUSSION

Table 2-39 presents the results of the oil spill scenarios examined at the Yukon River without cleanup.

TABLE 2-39. YUKON PIVER CASE RESULTS NO CLEANUP

SPILL TYPE AND SEASON	SPILL SIZE 50,000	10,000	1,000	100
Summer Crude Oil	15,650 [1](1)	9,362 [3]	3,320 [5]	1,017 [7]
Breakup Crude Oil	9,816 [2]	5,928 [4]	2,040 [6]	600 [8]

(1) Numbers in brackets are the case numbers that follow.

Only the Freshwater River and Terrestrial Habitats were impacted in the scenarios.

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 15,650

THE FRESHWATER RIVER HABITAT contributed about 91 percent (14,175) of the impact score for this case. All species present contributed significantly

to the impact score. The larger contributions were from king salmon (2,175), chum salmon (2,175), coho salmon (870), Dolly Varden (1,450), whitefish (820), Arctic grayling (820), other fishes (547), ducks (1,692), geese (547), and swans (683). All species were judged to be abundant in this habitat except for coho salmon, pike, and sticklebacks, which were moderately abundant. Sockeye and pink salmon and rainbow/streaked trout were not present. The salmon and mammal species were commercially important. Swans were classified as protected. All salmon species and Dolly Varden were judged to be the most sensitive to the chemical impact of the oil.

THE TERRESTRIAL HABITAT contributed the remaining 9 percent (1,475) to the impact score in this case. The species which were the main contributors were wolverine (319), wolf (150), raptors (255), other birds (255), and other mammals (128). Wolverine and wolves were the most relatively abundant species in this habitat. Raptors were assumed to include the endangered species of peregrine falcon.

Table 2-40 presents the complete results for Case 1.

CASE 2: SPRING BREAKUP, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 9,816

THE FRESHWATER RIVER HABITAT contributed 88 percent (8,668) of the impact score for this case. The only substantial contributions were from fish species. The following species contributed the majority of the impact score

King salmon	2,175
Coho salmon	870
Chum salmon	2,175
Dolly Varden	967
Whitefish	547

TABLE 2-40. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX .

AREA	YUKON RIVER
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	PIPELINE BREAK
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS									RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM		S.TRM	L.TRM	RSLT.
1. PELAGIC												
										0	0	0
2. SUBTIDAL SAND-MUD												
										0	0	0
3. SUBTIDAL ROCK-COBBLE-GRAVEL												
										0	0	0
4. INTERTIDAL SAND-MUD												
										0	0	0
5. INTERTIDAL ROCKY												
										0	0	0
6. INTERTIDAL COBBLE-GRAVEL												
										0	0	0
7. FRESHWATER RIVER												
1. AQUATIC VEGETATION	15	A		0	0	0	3	9	1	405	45	410
2. AQUATIC INVERTEBRATES	10	A		0	0	0	3	9	1	270	30	273
3. KING SALMON	15	A		3	1	3	2	9	8	1215	1350	2175

1

TABLE 2-40 (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	COMP.	COM.	MEG.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
7. FRESHWATER RIVER											
6. CHUM SALMON	15	A	3	1	3	2	9	0	1215	1085	2175
7. COHO SALMON	6	A	3	1	3	2	9	0	486	432	870
9. DOLLY VARDEN	15	A	0	3	2	1	9	0	810	720	1450
10. WHITEFISH	15	A	1	2	2	1	9	1	810	90	820
11. ARCTIC GRAYLING	15	A	0	2	2	2	9	1	810	90	820
12. PIKE	6	A	0	2	2	1	9	1	270	30	273
13. STICKLEBACKS	6	A	0	0	0	3	9	1	162	18	164
14. OTHER FISH	10	A	0	2	1	3	9	1	540	60	547
15. DUCKS	15	A	0	3	2	2	9	0	945	840	1692
16. GEESE	10	A	0	2	2	2	9	1	540	60	547
17. SWANS	15	A	0	0	0	5	9	1	675	75	683
18. RIVER OTTER	15	P	3	0	1	1	4	1	300	75	319
19. MINK	15	P	3	0	1	1	4	1	300	75	319
20. MUSKRAT	15	P	3	0	1	1	4	1	300	75	319
21. OTHER AQUATIC MAMMALS	15	P	3	0	1	1	4	1	300	75	319
									10353	4950	14175
8. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	1	0	30	0	30
2. RIPARIAN VEGETATION	15	A	0	0	0	2	1	0	30	0	30
4. OTHER VEGETATION	10	A	1	0	0	2	1	1	30	30	60
5. BROWN BEAR	3	A	1	1	1	2	1	1	15	15	30
6. BLACK BEAR	3	A	0	1	1	2	1	1	12	12	24
7. WOLVERINE	15	A	2	1	1	1	4	1	300	75	319
8. WOLF	15	A	2	1	1	1	1	1	75	75	150
9. MOOSE	6	A	1	3	3	2	1	0	54	0	54
10. CARIBOU	10	A	1	3	3	2	1	0	90	0	90
12. BISON	10	A	0	0	0	3	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	1	2	2	4	1	120	30	120
17. RAPTORS	6	A	0	0	0	5	4	1	240	60	255
18. PTARMIGAN	10	A	0	2	1	2	1	0	50	0	50
19. OTHER BIRDS	10	A	0	0	1	5	4	1	240	60	255
									1286	357	1475
									11639	5307	15650

Arctic grayling	547
Other fishes	328

THE TERRESTRIAL HABITAT contributed the remaining 12 percent (1,148) of the impact score. The most significant contributing species were wolverine (319), wolf (150), other mammals (128), and raptors (178). Raptors included a species of peregrine falcon listed as endangered.

CASE 3: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 9,362

THE FRESHWATER RIVER HABITAT contributed 86 percent (8,046) of the impact score. The decrease in impact score for this habitat from Case 1 is accounted for primarily by the following species:

King salmon	reduced to 1,230 from 2,175
Coho salmon	reduced to 492 from 870
Chum salmon	reduced to 1,230 from 2,175
Dolly Varden	reduced to 820 from 1,450
Whitefish	reduced to 383 from 820
Arctic grayling	reduced to 383 from 820
Other fishes	reduced to 255 from 547
Ducks	reduced to 957 from 1,692
Swans	reduced to 319 from 683

THE TERRESTRIAL HABITAT contributed the remaining 14 percent (1,316) to the impact score. This amounted to only an 11 percent reduction from Case 1 for this habitat. This was due to reduced estimated long-term impacts in four species which resulted in minor decreases.

CASE 4: SPRING BREAKUP, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 5,928

THE FRESHWATER RIVER HABITAT contributed 83 percent of the impact score for this case. As in Case 5, fish was the species group most affected. The majority of the decrease in score from Case 2 for this habitat is due to the following:

King salmon	reduced to	1,230	from	2,175
Coho salmon	reduced to	492	from	870
Chum salmon	reduced to	1,230	from	2,175
Dolly Varden	reduced to	546	from	967
Whitefish	reduced to	255	from	547
Arctic grayling	reduced to	255	from	547
Other fishes	reduced to	153	from	328

THE TERRESTRIAL HABITAT contributed the remaining 17 percent (1,033) of the impact score for this case. Only minor decreases were noted from Case 2. Minor decreases occurred in the following species:

Wolverine	reduced to	300	from	319
Wolf	reduced to	75	from	150
Other Mammals	reduced to	120	from	128
Raptors	reduced to	170	from	178
Other birds	reduced to	72	from	77

CASE 5: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 3,320

THE FRESHWATER RIVER HABITAT contributed 92 percent (3,065) of the impact score for this case. The decrease in impact score for this habitat is accounted for primarily by the following species:

King salmon	reduced to	540	from	1,230
Coho salmon	reduced to	216	from	492
Chum salmon	reduced to	540	from	1,230
Dolly Varden	reduced to	360	from	820
Whitefish	reduced to	90	from	383
Arctic grayling	reduced to	90	from	383
Other fishes	reduced to	60	from	255
Ducks	reduced to	446	from	957
Geese	reduced to	120	from	255
Swans	reduced to	150	from	319
River otter	reduced to	75	from	300
Mink	reduced to	75	from	300
Muskrat	reduced to	75	from	300
Other aquatic mammals	reduced to	75	from	300

The decrease resulted from various reductions in short-term and long-term impacts on the habitat's species.

THE TERRESTRIAL HABITAT contributed the remaining 8 percent (255) of the impact score for this case. The decrease in impact score for this habitat from Case 2 resulted from decreases for all species in the habitat. The majority of the decrease is accounted for by the following species:

Wolverine	reduced to	75	from	300
Caribou	reduced to	0	from	90
Wolf	reduced to	0	from	75
Other mammals	reduced to	30	from	120

Raptors	reduced to	60 from	240
Other birds	reduced to	60 from	240

CASE 6: SPRING BREAKUP, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 2,040

THE FRESHWATER RIVER HABITAT accounted for 93 percent (1,887) of the impact score for this case. The decrease in impact score from Case 6 is accounted for by the following species, with minor exceptions:

King salmon	reduced to	540 from	1,230
Coho salmon	reduced to	216 from	492
Chum salmon	reduced to	540 from	1,230
Dolly Varden	reduced to	240 from	546
Whitefish	reduced to	60 from	255
Arctic grayling	reduced to	60 from	255
Other fishes	reduced to	36 from	153
River otter	reduced to	30 from	120
Mink	reduced to	30 from	120
Muskrat	reduced to	30 from	120
Other aquatic mammals	reduced to	30 from	120

THE TERRESTRIAL HABITAT contributed the remaining 7 percent (153) of the impact score for this case. The decrease from Case 4 is due to decreases in all species present in this habitat. Only four species were deemed impacted--other vegetation (18), wolverine (75), other mammals (30), and raptors (30).

CASE 7: SUMMER, CRUDE OIL, 100 BBLS - IMPACT SCORE 1,017

THE FRESHWATER RIVER HABITAT contributed 100 percent (1,017) of the impact score for this case. The impact on the Terrestrial Habitat was judged to be negligible for this spill size and was given no impact score. The decrease in impact score from Case 5 is accounted for by the decreases for the following species, with minor exceptions:

King salmon	reduced to	135	from	540
Coho salmon	reduced to	54	from	216
Chum salmon	reduced to	135	from	540
Dolly Varden	reduced to	90	from	360
Ducks	reduced to	105	from	446

CASE 8: SPRING BREAKUP, CRUDE OIL, 100 BBLS - IMPACT SCORE 600

THE FRESHWATER RIVER HABITAT contributed 100 percent (600) of the impact score for this case. Significant reductions in impact scores from Case 6 were only noted for fish species. Fish species account for the majority of the impact score, with the bulk of the contribution due to king salmon (135), chum salmon (135), Dolly Varden (60), whitefish (60), and Arctic grayling (60).

(17) DENALI FAULT CROSSING (DELTA RIVER)

The Trans-Alaska Pipeline System (TAPS) crosses the Denali Fault alongside the Delta River at the Canwell and Castner Glacier moraines below Mount Silvertip and Triangle Peak in the Alaska Range about 25 miles north of Paxson. The spill site is alongside Castner Creek in the Castner Glacier moraine on the Hines Creek strand of Denali Fault about one-half mile from the Delta River at $63^{o}24.22'$ N latitude, $145^{o}43.18'$ W longitude (Fig. 2-94).

(a) PHYSICAL CHARACTERISTICS

The pipeline traverses the Alaska Range along the floodplain of the Delta River and Phelan Creek to Summit Lake. From Fort Greely to Donnelly, the Delta River gains about 460 ft in elevation in 25 miles. From Donnelly to Trims Creek near the spill site, the river gains 670 ft in 19.2 miles. Elevation at the spill site is about 2,440-ft MSL. On all sides of the Delta River, the Alaska Range rises to typical heights of 4,000 to 6,000-ft MSL, with peaks of 8,000 to 10,000-ft MSL. Paxson is at 2,800-ft MSL, with the pass near Summit Lake at about 3,260-ft MSL.

The site is located in the Continental Climatic Zone. Local climatic variations are observed due to the topographical influence of the Alaska Range.[14] Climatic data for Paxson indicated a typical Winter temperature range of $-20^{o}F$ to $+16^{o}F$, and a Summer temperature range of $36\text{-}63^{o}F$.[1,14] Extreme temperatures recorded are $-59^{o}F$ and $85^{o}F$.[1,4,14]

The spatial distribution of precipitation shows a pronounced topographical influence [4,14] Precipitation at Trims Creek near the spill site is about 40 in. per year; at Paxson about 20 in. per year and at Gulkana

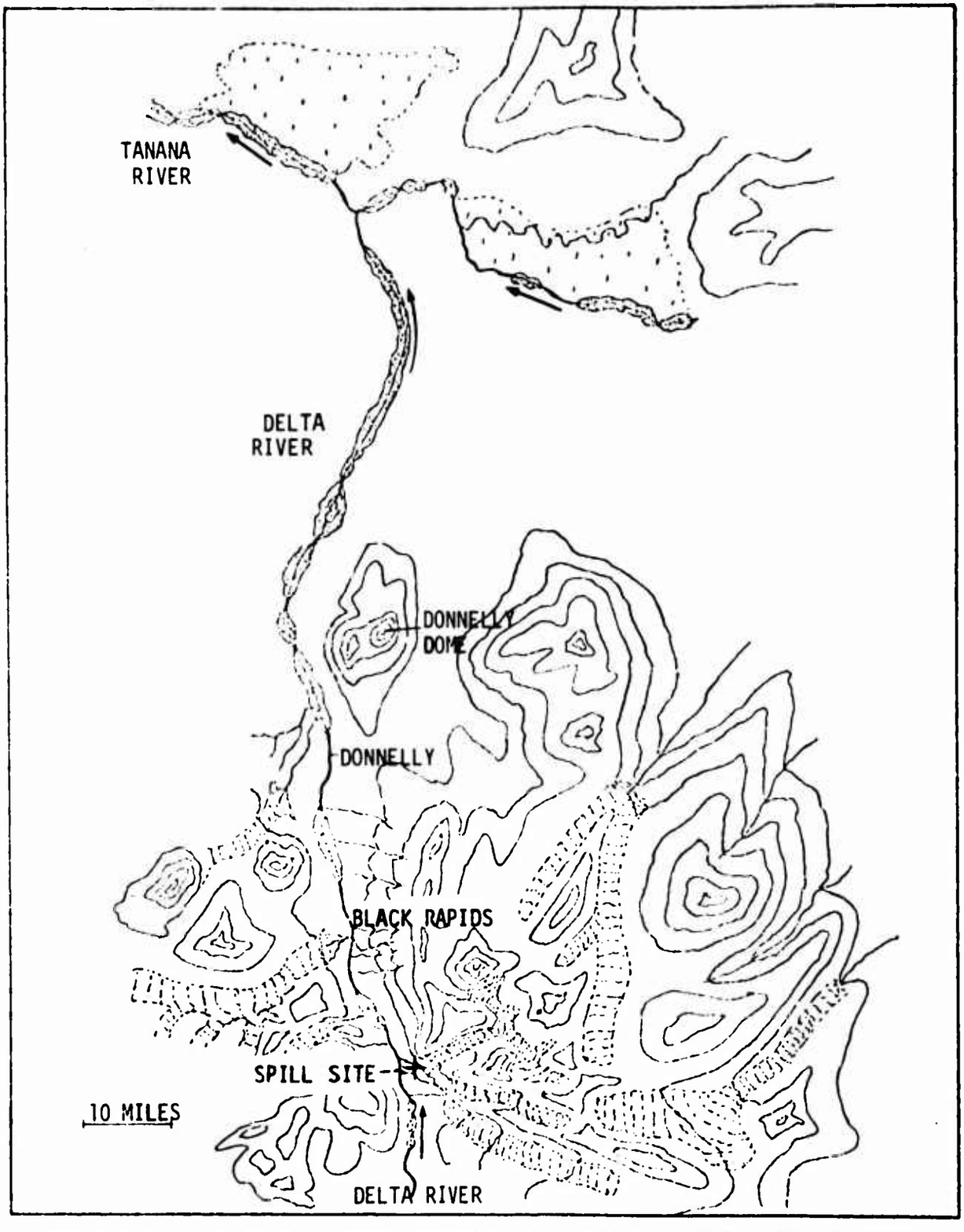


FIGURE 2-94. THE DELTA RIVER LOCATION AND THE DENALI FAULT SPILL SITE

(275 miles south of spill site) about 11 in. per year.[4] Snowfall shows a similar distribution. Snowfall at Trims Creek is about 274 in. per year and at Paxson is about 110 in. per year.

Thaw typically begins in the first part of June, and freezeup begins around mid-August.[4] Spring floods caused by ice jams occur in the Delta River.[4,14] Mean annual flow rate near the spill site has been estimated at about 10,000 cubic ft per sec with a velocity of about 4.4 ft per sec. Peak flow is estimated at 20,000 cubic ft per sec and 5.8 ft per sec.[5]

Soils along the Delta river include floodplain sands and gravel and dense glacial fill over bedrock.[14] Permafrost is discontinuous in this area.[14]

SPILL SCENARIO

The spill site was chosen about one-half mile from the Delta River alongside Castner Creek. It is assumed that oil would take about 1 hour to flow down the glacial moraine to the Delta River. Further transport would occur with the flow of the Delta River. Average flow velocities were chosen. These velocities were estimated at 4.4 ft per sec for about 15 km downstream and 3.7 ft per sec below that. With no further data, we assumed the 3.7-ft per sec velocity would extend to the confluence with the Tanana River.

Given these assumptions, the leading edge of the slick would reach Black Rapids in about 4 hours and Darling Creek in about 6 hours. Donnelly would be reached in about 9 hours and Donnelly Dome would be passed in about 12 hours. The slick would reach Delta Junction in about 19 to 20 hours and it would reach the confluence with the Tanana River in about 23 hours. These time isochrons are illustrated in Figure 2-95.

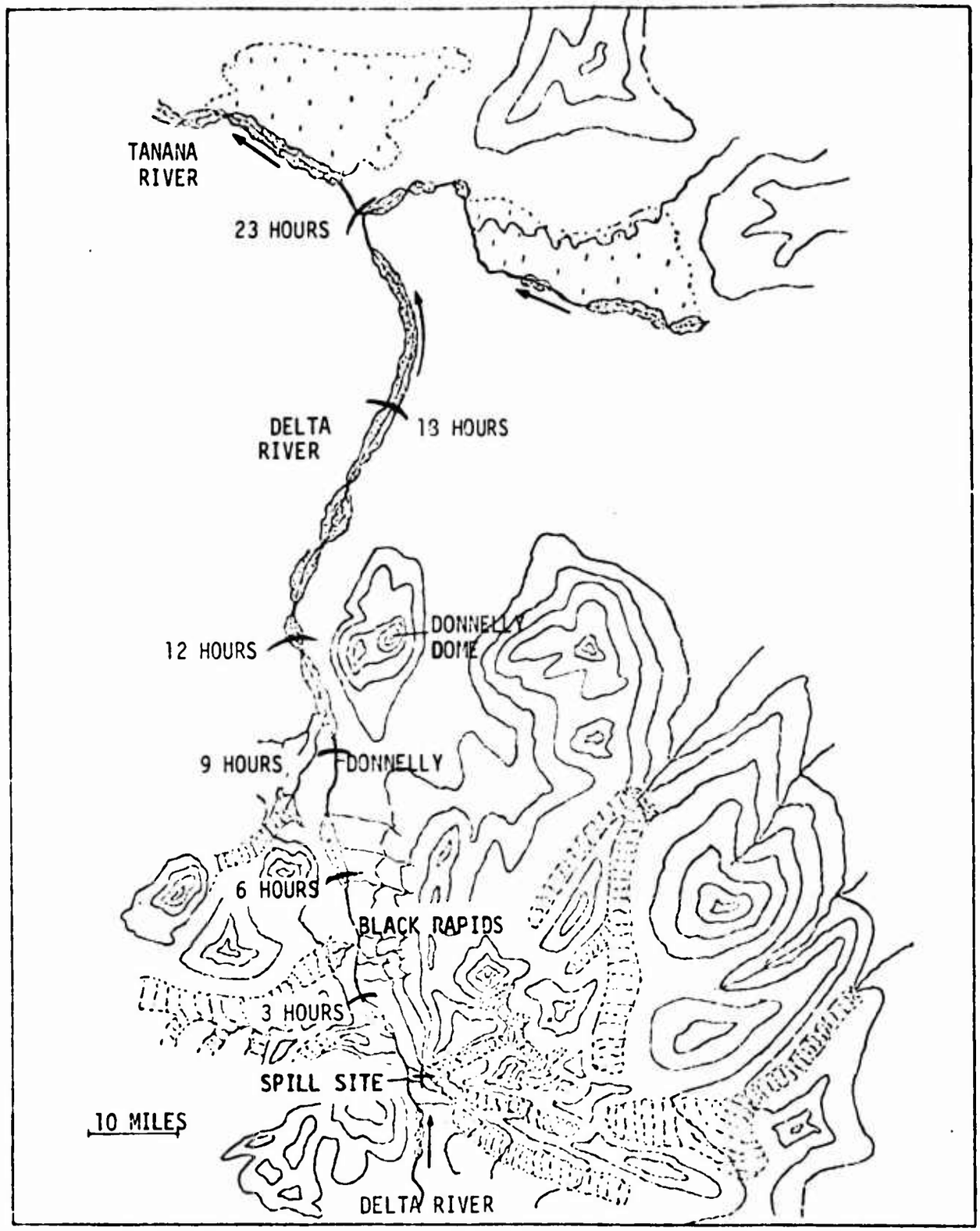


FIGURE 2-95. DENALI FAULT 10,000 BBL CRUDE SPILL ISOCHRONES

STREAM VELOCITY: 4.4 TO 3.7 FT./SECOND

STREAM GRADIENT: VARIABLE

(b) BIOLOGICAL CHARACTERISTICS

This section characterizes the vicinity of the Denali Fault (Hines Creek Strand) crossing the TAPS pipeline, Castner Creek into which a spill would drain, Delta River (into which Castner Creek drains)--from this junction downstream to the vicinity of the junction of the Delta and Tanana Rivers.

The important biological resources in the Denali Fault vicinity and downstream would be waterfowl, several terrestrial mammals, and one salmon species. Resource summaries are shown in Figures 2-96 through 2-99.

FISHES

SALMONIDS present in this "vicinity" are lower in abundance than in the Yukon Crossing location; however, salmon spawning exists in potential impact areas which was not the case at the Yukon River.

Castner Creek is indicated as a steep glacial runoff stream which contains no fisheries resources.[59] The Delta River is a state-designated anadromous fish stream (January 1974); however, the only anadromous species are chum salmon which use the first mile of river above the junction with the Tanana River.[59]

Salmon utilize the following areas[58] near this location: the lower mile of the Delta River, the south bank floodplain of the Tanana River and the Delta-Clearwater River (east of TAPS pipeline corridor). Summer-type (second run of the Yukon) chum salmon dominate, with coho salmon a significant second species, at the Delta-Clearwater River.[58]

Adult salmon time of arrival and spawning is the same for both species of salmon--September 1st to November 30th.[58]

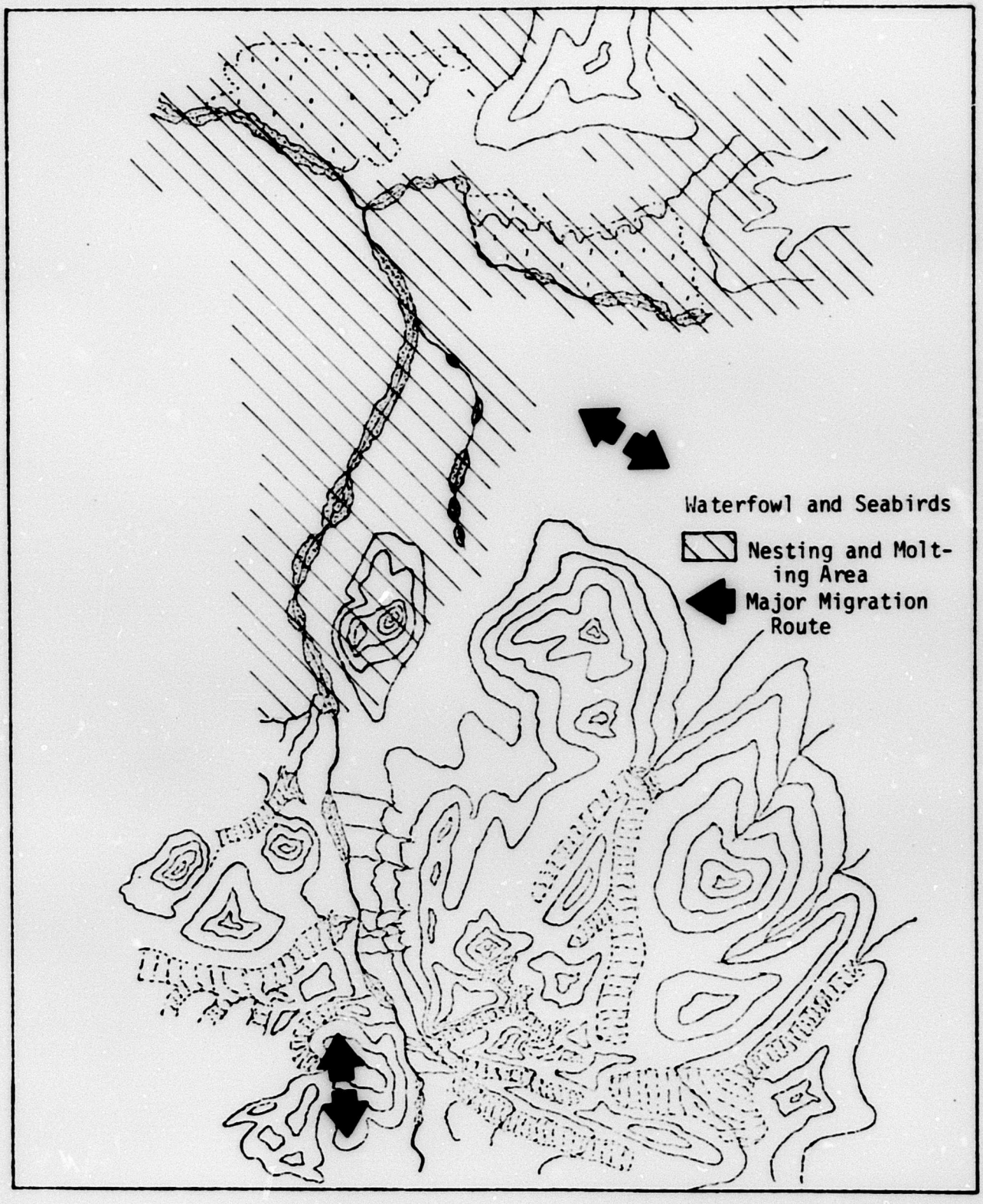


FIGURE 2-96. DENALI FAULT CROSSING CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

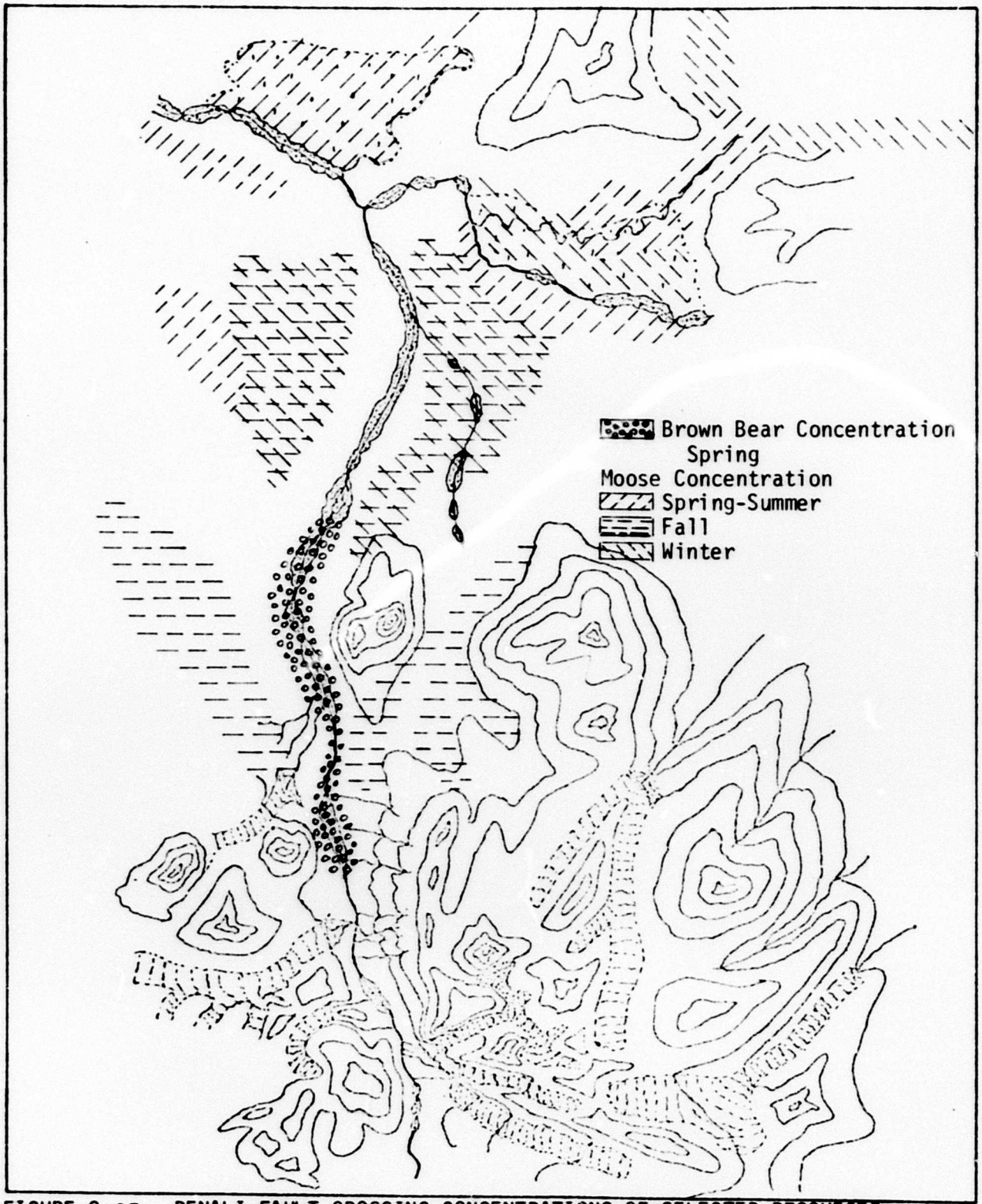


FIGURE 2-97. DENALI FAULT CROSSING CONCENTRATIONS OF SELECTED RESOURCES

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

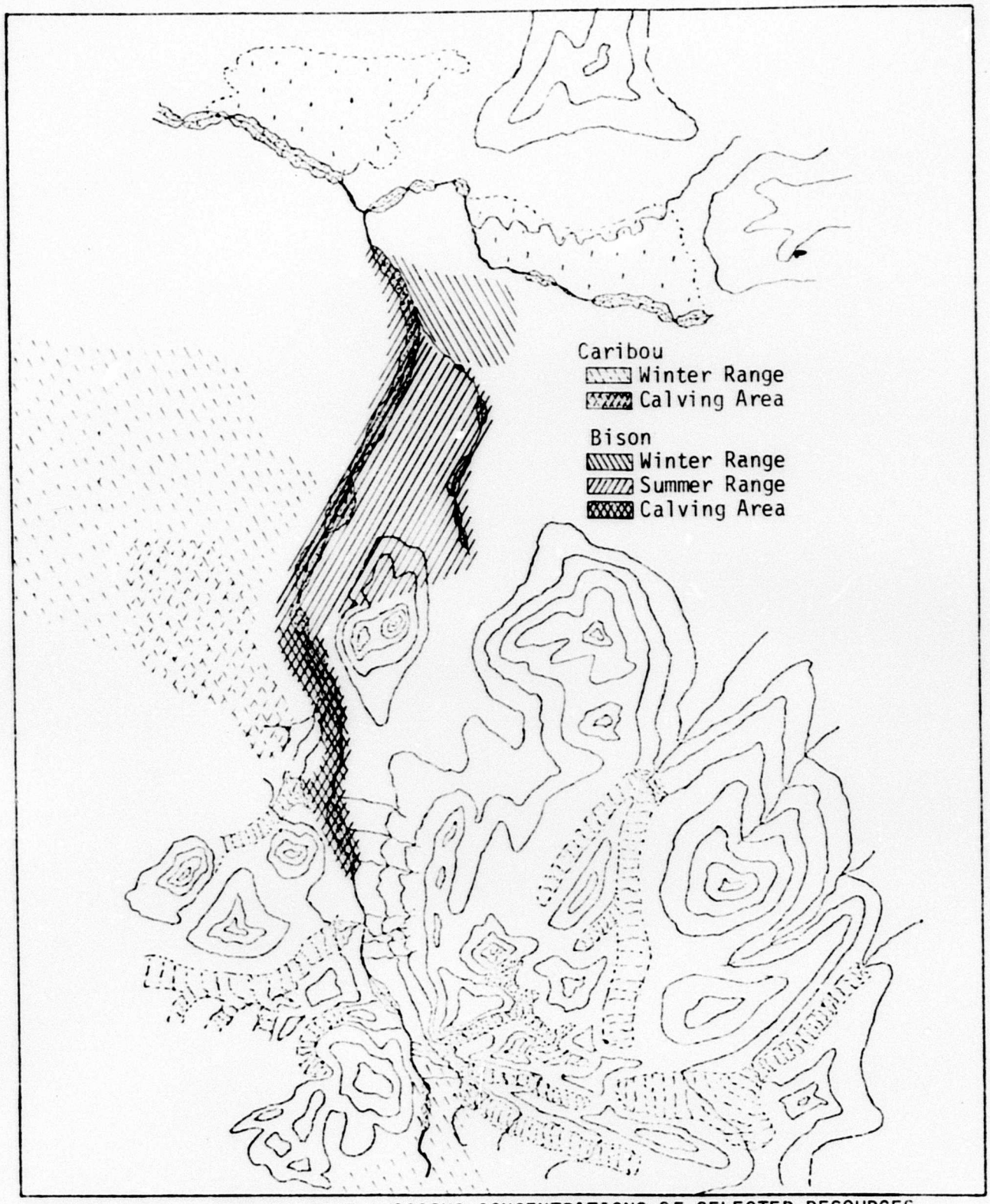


FIGURE 2-98. DENALI FAULT CROSSING CONCENTRATIONS OF SELECTED RESOURCES.

SOURCE: Alaska Department of Fish and Game, *ALASKA'S WILDLIFE AND HABITAT*, January 1973.

The chum salmon in the lower Delta River is the largest documented spawning concentration of Fall chums known in the interior of Alaska.[66] These fish make extensive use of ground-water spring areas (warm) when ice forms in this river.

Other salmonids in the lower Delta and adjacent Tanana Rivers include Arctic grayling and whitefish.[58] Lakes that should not be contacted by oil in this lower Delta River vicinity contain native whitefish, lake trout, Arctic grayling, and planted rainbow trout and landlocked coho salmon.[58]

The upper Delta River is indicated as having no fish resources.[59] This section of the river carries a heavy natural silt load during much of the open-water period and goes dry during the freezeup --October through April.[59]

OTHER FISH in this vicinity include burbot in the lower Delta and adjacent Tanana Rivers.[58] Burbot and suckers are also in the above-mentioned lakes.[58]

WATERFOWL

Waterfowl are indicated as having major north/south migration routes in the vicinity of the Delta River, while molting/nesting areas occur above the spill site just south of Eureka Creek and below the spill site just north of Donnelly. Waterfowl are thought to be less abundant here than in the Yukon Crossing vicinity.

DUCKS are thought to include the same species as described in the Yukon Crossing vicinity as both locations are partially in the same Game Management Unit (20).[17] An important nesting/molting area lies downstream on the Delta River north of Donnelly. Ducks are involved in subsistence and

sport hunting utilization. This is a heavily used Spring/Fall migration area for ducks.

GEESE would also be similar in species to those described for the Yukon Crossing. The area downstream is nesting/molting habitat. Major migrations of geese pass through this area.[17]

SWANS (trumpeter) are common nesters in the Tanana Flats area downstream on the Tanana River from the Delta River junction. They are expected to be in the northern end of the study location vicinity.

SHOREBIRDS are present and this is a migration route for them. Important breeding population exists north of Black Rapids Glacier.

TERRESTRIAL MAMMALS

MOOSE are found along the entire Delta River; but, only in Fall and Winter are concentrations of moose found on the lower Delta River floodplain.[17] Marked movements of moose are expected down the upper Delta River each Fall with reverse movements each Spring.[58] Riparian vegetation is heavily utilized by moose in Winter.[18]

CARIBOU utilize areas as Winter range south as far north as Castner Creek on the Delta and on the Delta north of the Donnelly vicinity. Calving areas are denoted in this latter area also.[17] Another source[58] indicated that the upper Delta (Nelchina caribou) herd was seen this far north only when the herd was larger and that the small Delta herd (5,000) occasionally moves into the Delta lowlands in Summer. Caribou were considered in low abundance in the general Denali Fault Crossing vicinity.

DALL SHEEP are indicated as present in the low mountains (and higher) on each side of the upper Delta River.[17] They are indicated as abundant.[58] Lambing is from early May to mid-June at elevations above 2,500 ft.[58]

BROWN BEAR are in low numbers in the vicinity, with intensive Spring use of the lower Delta from Black Rapids south to the Fort Greely area (west of Donnelly Dome).[17] No denning or concentrations on fish streams are noted on the Delta downstream of Castner Creek (spill site). From November through April, the animals are in hibernation.

BLACK BEAR are present throughout this vicinity.[17] This species is thought to be in moderate numbers here and important in sport hunting.[18] Black bear are in hibernation from November through April.

BISON are indicated as having Summer range along and east of the Delta River north of Black Rapids.[17] This is indicated from April until September.[58] Calving areas are noted along the braided Delta River from north of Black Rapids to the Donnelly Dome vicinity.[17] This is indicated from April 15th to July 15th.[58] Movement of the Delta herd to and from the Tanana wintering zones (north and northeast) is also noted.[58] The northern wintering area is on the Delta River in the Delta Junction area.[17]

WOLVES AND WOLVERINES are indicated as present throughout the vicinity.[17] Both are indicated as abundant in the river valley in this vicinity. Trapped wolverine number 75 annually,[17] while wolf are important sport and fur (as well as ecologically important) animals.

AQUATIC FURBRERERS include mink, muskrat, beaver, and river otter, and are estimated to be in low abundance here.[18]

FLORA

The hypothesized crude oil spills on the Hines Creek Strand of the Denali Fault are assumed to pass over a small amount of land once covered by Castner Glacier and flow into Castner Creek and then into the Delta River.

The area between the Hines Strand and the Delta River (coded 8S/2) is indicated as commercial forest land estimated at more than 20 percent stock of trees, 9-in. minimum DBH and 12-ft minimum height, capable of producing 20 cubic ft or more wood per acre per year. The better drained uplands underlain by loess (fine soil) are indicated as forested with white spruce, white birch, aspen, and locally black spruce, singly or in combination.[14] In flat poorly-drained areas, (presumed also to be the Delta riverbed vicinity), black spruce and larch are small and scattered with a predominance of heath, dwarf birch, and willow shrubs.[14] Sedges and scattered herbaceous plants are also prominent[14] (presumably associated with the stream). No mention is made of true aquatic plants. Silt loads, lack of river flow in Winter, and ice would seem to limit the abundance of aquatic vegetation. The braided nature of the lower Delta River would seem to provide suitable areas for aquatic plants in the Spring-Fall of the year.

For further physical and biological information, see Appendix D .

(c) RESULTS

Only two habitats were present at this spill location--freshwater river and terrestrial. Spill sizes of crude oil ranged up to 10,000 barrels. Summer cases scored higher than breakup (Winter or Spring) cases for similar spill sizes, reflecting the influence of greater species abundance.

Fish were impacted by the chemical toxicity of the spill. Major contributors to the scores were salmon, whitefish, grayling, pike, and Dolly Varden. Waterfowl were impacted by physical contact. Major contributors were geese, ducks, and swans. Raptors were judged sensitive through ingestion of oil-contaminated fish and waterfowl.

The impact scores were smaller than those at the Yukon location for similar spill sizes and seasons.

PHYSICAL FATE OF SPILLS

Two oil spill scenarios were examined at Denali. The first scenario was based on average Summer conditions. The second scenario was based on Springtime conditions typical of the period of breakup of the Delta river. It was assumed that a Wintertime spill, if not cleaned up, would remain quiescent until breakup and was therefore treated the same as a spill that occurred just prior to or during the breakup period.

The spill point was chosen in the Castner Glacier moraine, next to Castner creek, about one-half mile from the Delta river. Even assuming a rapid discharge of oil from the pipe break, flow down the Castner creek bed would result in oil retention in the moraine and a much slower, more continual discharge into the Delta river. The largest spill size was smaller than the Yukon river scenarios, but the average flow of the Delta river is about 1/80 the volume of the Yukon. The deposition of oil in the moraine tended to reduce the estimated impact scores for species associated with the Delta river, but this was offset by the increased impact resulting from the lesser flushing volume of water.

After spillage, the oil was assumed to require one hour to flow down Castner creek and begin flowing into the Delta river. This is equivalent to a flow rate of about 0.7 ft/sec. Once reaching the river, the oil was assumed transported downstream by the river currents. This river transport was discussed earlier in the paragraphs on SPILL SCENARIO. The leading edge of the slick was estimated to reach the confluence of the Delta with the Tanana river in about 23 to 24 hours. The majority of impact due to chemical toxicity and physical smothering was assumed to occur in the Delta river (see Figure 2-95).

CASE DISCUSSION

Table 2-41 presents the results of the oil spill scenarios at Denali without cleanup.

TABLE 2-41. DENALI CASE RESULTS - NO CLEANUP

		SPILL SIZE (BBLS)			
SEASON	SPILL TYPE	10,000	4,000	1,000	100
		(2)			
Summer	Crude Oil	5,414 [1]	3,458 [2]	2,068 [4]	519 [7]
Breakup (1)	Crude Oil	2,575 [3]	1,469 [5]	968 [6]	253 [8]

(1) Includes either Spring or Winter with no cleanup.

(2) Numbers in brackets are the case numbers that follow.

Freshwater river and terrestrial habitats were impacted.

CASE 1: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 5,414

THE FRESHWATER RIVER HABITAT contributed 81 percent (4,408) of the impact score for this case. The species which were the main contributors to this score were king salmon (191), chum salmon (383), coho salmon (191), Dolly Varden (273), whitefish (328), Arctic grayling (328), pike (273), other fishes (273), ducks (494), geese (456), and swans (456). Whitefish, the salmon species, and the mammals had commercial importance. Dolly Varden, whitefish, Arctic grayling, pike, ducks, and geese had the highest recreational importance values. The salmon species had the highest subsistence values. Swans were classified as protected. Fish were judged to be most sensitive to the chemical toxicity of the of the crude oil and waterfowl were judged the most sensitive to physical contact with the oil.

THE TERRESTRIAL HABITAT contributed the remaining 19 percent (1,006) of the impact score for this case. The species which contributed significantly to

TABLE 2-42. MATRIX RESULTS--CASE 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	DENALI FAULT
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	PIPELINE BREAK
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	NO

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC									0	0	0
2. SUBTIDAL SAND-MUD									0	0	0
3. SUBTIDAL ROCK-COBBLE-GRAVEL									0	0	0
4. INTERTIDAL SAND-MUD									0	0	0
5. INTERTIDAL ROCKY									0	0	0
6. INTERTIDAL COBBLE-GRAVEL									0	0	0
7. FRESHWATER RIVER									0	0	0
1. AQUATIC VEGETATION	6	A	0	0	0	3	9	1	162	18	180
2. AQUATIC INVERTEBRATES	3	M	0	0	0	3	9	1	81	9	82
3. KING SALMON	3	A	1	1	3	2	9	1	189	21	191

1

TABLE 2-42 (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TERM	L.TERM	S.TERM	L.TERM	RESIL.
7. FRESHWATER RIVER											
6. CHUM SALMON	6	A	1	1	3	2	9	1	378	42	383
7. COHO SALMON	3	A	1	1	3	2	9	1	189	21	191
9. DOLLY VARDEN	6	A	0	2	2	1	9	1	270	30	273
10. WHITEFISH	6	A	1	2	2	1	9	1	324	36	328
11. ARCTIC GRAYLING	6	A	0	2	2	2	9	1	324	36	328
12. PIKE	6	A	0	2	2	1	9	1	270	30	273
14. OTHER FISH	6	A	0	1	1	3	9	1	270	30	273
15. DUCKS	18	A	0	2	1	2	9	0	432	48	436
16. GEESE	10	A	0	2	1	2	9	1	450	50	456
17. SWANS	18	A	0	0	0	5	9	1	450	50	456
18. RIVER OTTER	6	P	1	0	0	1	4	1	48	12	51
19. MINK	6	P	1	0	0	1	4	1	48	12	51
20. MUSKRAT	6	P	1	0	0	1	4	1	48	12	51
21. OTHER AQUATIC MAMMALS	6	P	1	0	0	1	4	1	48	12	51
									3699	822	4066
8. TERRESTRIAL											
1. TUNDRA	6	A	0	0	0	3	1	0	18	3	18
2. RIPARIAN VEGETATION	15	A	0	0	0	2	1	1	30	30	60
4. OTHER VEGETATION	10	A	2	0	0	2	1	1	40	40	80
5. BROWN BEAR	3	A	1	1	0	2	1	1	12	12	24
6. BLACK BEAR	3	A	0	2	1	2	1	1	15	15	30
7. WOLVERINE	6	A	2	1	0	1	4	1	96	24	102
8. WOLF	6	A	2	1	0	1	1	1	24	24	48
9. MOOSE	6	A	0	2	2	2	1	0	30	0	30
10. CARIBOU	6	A	0	1	1	2	1	0	24	0	24
12. BISON	10	A	0	3	0	3	1	0	60	0	60
14. SHEEP	10	A	0	2	1	1	1	0	40	0	40
16. OTHER MAMMALS	6	P	0	0	0	2	4	1	48	12	51
17. RAPTORS	6	A	0	0	0	0	4	1	24	6	25
18. PTARMIGAN	10	A	0	2	1	2	1	0	50	0	50
19. OTHER BIRDS	6	P	0	0	0	5	4	1	120	30	124
									953	247	1006
									4652	1068	5014

the score were wolverine (102), raptors (255), and other birds (128). Raptors and wolverine were judged to be most sensitive. Raptors were assumed to include an endangered species of peregrine falcon.

Table 2-42 presents the complete results for Case 1.

CASE 2: SUMMER, CRUDE OIL, 4,000 BBLS - IMPACT SCORE 3,458

THE FRESHWATER RIVER HABITAT contributed 79 percent (2,722) of the impact score for this case. The decrease in impact score for this habitat from Case 1 is primarily accounted for by the following species:

King Salmon	reduced	to 89 from 191
Chum Salmon	reduced	to 179 from 383
Coho Salmon	reduced	to 89 from 191
Dolly Varden	reduced	to 128 from 273
Whitefish	reduced	to 153 from 328
Arctic Grayling	reduced	to 153 from 328
Pike	reduced	to 128 from 273
Other Fishes	reduced	to 128 from 273

THE TERRESTRIAL HABITAT contributed the remaining 21 percent (736) of the impact score for this case. The major decrease in score was for wolverine (to 48 from 102) and minor decreases occured for seven other species in this habitat.

CASE 3: BREAKUP, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 2,575

THE FRESHWATER RIVER HABITAT contributed 68 percent (5,162) of the impact score for this case. The decrease in impact score for this habitat compared to Case 1 stemmed from reduced species populations estimated for Winter and Spring. Some fish species had reduced populations and waterfowl were not present. Aquatic mammal populations were judged relatively the same for the different seasons. The decrease in impact score was accounted for by the following species, with minor exceptions:

Dolly Varden	reduced	to 137	from 273
Whitefish	reduced	to 164	from 328
Arctic Grayling	reduced	to 164	from 328
Pike	reduced	to 137	from 273
Other Fishes	reduced	to 137	from 273
Ducks	reduced	to 0	from 494
Geese	reduced	to 0	from 456
Swans	reduced	to 0	from 456

THE TERRESTRIAL HABITAT contributed the remaining 32 percent (813) to the impact score for this case. The changes in impact score compared to Case 1 again were due to differing populations for the species in the habitat for the different seasons. With minor variations, the change in impact score from Case 1 for this habitat is accounted for by the following species:

Wolverine	increased	to	170	from	102
Wolf	increased	to	80	from	48
Moose	increased	to	60	from	36
Other Vegetation	reduced	to	48	from	80
Brown Bear	reduced	to	0	from	24
Black Bear	reduced	to	0	from	30
Raptors	reduced	to	128	from	255
Other Birds	reduced	to	64	from	128

CASE 4: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 2,068

THE FRESHWATER RIVER HABITAT contributed 85 percent (1,761) to the impact score for this case. The decrease in impact score from Case 2 for this habitat is accounted for by the following species, with minor exceptions:

Ducks	reduced	to	213	from	456
Geese	reduced	to	213	from	456
Swans	reduced	to	213	from	456

THE TERRESTRIAL HABITAT contributed the remaining 15 percent (307) of the impact score for this case. The decrease in impact score from Case 2 is primarily accounted for by the following species:

Raptors	reduced	to	120	from	255
Other Birds	reduced	to	30	from	120

CASE 5: BREAKUP, CRUDE OIL, 4,000 BBLS - IMPACT SCORE 1,469

THE FRESHWATER RIVER HABITAT contributed 63 percent (921) of this impact score for this case. The majority of the decrease from Case 3

for this habitat is due to reduced impacts on the following fish species:

King Salmon	reduced	to 89	from 191
Chum Salmon	reduced	to 179	from 383
Coho Salmon	reduced	to 89	from 191
Dolly Varden	reduced	to 64	from 137
Whitefish	reduced	to 77	from 164
Arctic Grayling	reduced	to 77	from 164
Pike	reduced	to 64	from 137
Other Fishes	reduced	to 64	from 137

THE TERRESTRIAL HABITAT contributed the remaining 37 percent (548) of the impact score for this case. The largest decrease in impact score from Case 3 for this habitat was for wolverine (to 80 from 170), with minor decreased scores for six other species.

CASE 6: BREAKUP, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 968

THE FRESHWATER RIVER HABITAT contributed 78 percent (757) of this impact score for this case. The decrease in impact score from Case 5 for this habitat was due to minor decreases in scores for vegetation, invertebrates, and mammals.

THE TERRESTRIAL HABITAT contributed the remaining 22 percent (211) of the impact score for this case. The decrease in impact score from Case 5 for this habitat was due to minor decreases in scores for nine species with the following species accounting for the majority:

Wolverine	reduced	to	40	from	80
Moose	reduced	to	40	from	60
Sheep	reduced	to	0	from	40
Raptors	reduced	to	60	from	128

CASE 7: SUMMER, CRUDE OIL, 100 BBLS - IMPACT SCORE 519

THE FRESHWATER RIVER HABITAT contributed 82 percent (423) of the impact score for this case. The decrease in impact score from Case 4 for this habitat is primarily due to decreases for the following species:

Chum Salmon	reduced	to	42	from	179
Dolly Varden	reduced	to	30	from	128
Whitefish	reduced	to	36	from	153
Arctic Grayling	reduced	to	36	from	153
Pike	reduced	to	30	from	128
Other Fishes	reduced	to	30	from	128
Ducks	reduced	to	50	from	213
Geese	reduced	to	50	from	213
Swans	reduced	to	50	from	213

THE TERRESTRIAL HABITAT contributed the remaining 18 percent (96) of the impact score for this case. The decrease in impact score from Case 4 for this habitat is accounted for by the following species:

Riparian Vegetation	reduced	to	0	from	30
Other Vegetation	reduced	to	0	from	40
Brown Bear	reduced	to	0	from	12
Black Bear	reduced	to	0	from	15
Wolf	reduced	to	0	from	24
Raptors	reduced	to	60	from	120
Other Birds	reduced	to	0	from	30

CASE 8: BREAKUP, CRUDE OIL, 100 BBLS - IMPACT SCORE 253

THE FRESHWATER RIVER HABITAT contributed 68 percent (171) of the impact score for this case. The decrease in impact score from Case 6 for this habitat is primarily due to the following species:

King Salmon	reduced	to	21	from	89
Chum Salmon	reduced	to	42	from	179
Coho Salmon	reduced	to	21	from	89
Dolly Varden	reduced	to	15	from	64
Whitefish	reduced	to	18	from	77
Arctic Grayling	reduced	to	18	from	77
Pike	reduced	to	15	from	64
Other Fishes	reduced	to	15	from	64

THE TERRESTRIAL HABITAT contributed the remaining 32 percent (82) of the impact score for this case. The decrease in impact score from Case 6 for this habitat is due to decreases in the following species:

Riparian Vegetation	reduced	to	0	from	20
Other Vegetation	reduced	to	0	from	24
Wolf	reduced	to	0	from	40
Raptors	reduced	to	30	from	60
Other Birds	reduced	to	0	from	15

B. RESULTS AT SELECTED LOCATIONS WITH CLEANUP

INTRODUCTION

This subsection addresses the impact of selected oil spill cases with cleanup. This evaluation raised and lowered the "without cleanup" impact scores of different spill cases (subsection 2A) as a result of modified impacts estimated to result from the hypothesized cleanup scenarios.

The physical and biological characteristics of the 17 locations investigated are reported in the preceding subsection (2A) and are not repeated here.

Table 2-43 presents a summary of the generic cleanup methods available, their applicability, the response times, and assumptions made for the 17 study locations. General comments on oil spill cleanup methodolgy is contained in Section 6 with specific comments on cautions in the evaluation of the available methods (subsection H).

The times to respond to a specific postulated spill with containment and/or cleanup countermeasures were estimated based on the draft final report "Logistic Requirements and Capabilities for Response to Oil Pollution in Alaska" to USCG by Battelle Memorial Institute under USCG Contract DOT-CG-23223-A, dated November 1974. Table 2-43 reflects airlift response times for cleanup and containment personnel, as well as for equipment to be used in a manual cleanup mode. Whereas it is possible that containment booms and certain other mechanical containment/cleanup equipment would also be airlifted to any specific spill site, this possibility was not taken into account for establishing the response times for barrier and mechanical cleanup implementation in Table 2-43.

TABLE 2-43. CLEANUP METHODS, APPLICABILITY, RESPONSE TIMES, AND ASSUMPTIONS FOR 17 ALASKA LOCATIONS BY SEASONS.

CLEANUP METHOD	SITE AND SEASON (S = Summer W = Winter) (Response Times in Hours)							
	Yakutat (1)		Valdez Harbor[1] (2)		Valdez Narrows[1] (3)		Drift River (4)	
	S	W	S	W	S	W	S	W
WATER								
Barriers	23.0[3]	23.0[2]	5.0[5]	5.0[5]	10.0[4]	16.0[4]	7.5[4]	BI
Skimming Devices	23.0[3]	23.0[2]	5.0[5]	5.0[5]	10.0[4]	16.0[4]	7.5[4]	BI
Dispersants [11]	5.3[5]	5.3[5]	I	I	I	I	I	I
Sorbents	23.0[3]	23.0[3]	5.0[5]	5.0[5]	10.0[4]	16.0[4]	7.5[4]	BI
Sinking Agents	I	I	I	I	I	I	I	I
Gelling	NSA	NSA	NSA	NSA	NSA	NSA	NSA	NSA
Magnetic Separation	NSA	NSA	NSA	NSA	NSA	NSA	NSA	NSA
Burning	23.0[2]	23.0[1]	PS	PS	PS	PS	PS	PS
Manual Removal	23.0[1]	23.0[0]	10.0[4]	10.0[3]	10.0[2]	10.0[2]	7.5[2]	BI
BEACH/LAND								
Emulsification	23.0[1]	-	10.0[1]	10.0[1]	10.0[1]	16.0[1]	7.5[1]	SI
Hydraulic Dispersion	23.0[1]	-	10.0[1]	10.0[1]	10.0[1]	16.0[1]	7.5[1]	SI
Steam Cleaning	NA	-	[0]	[0]	[0]	16.0[3]	23.5[3]	SI
Sand Blasting	NA	-	[0]	[0]	[0]	16.0[3]	23.5[3]	SI
Mechanical/Manual Mixing	23.0[1]	-	10.0[1]	10.0[1]	10.0[1]	16.0[1]	8.0[1]	SI
Burning	NA	-	PS	PS	PS	PS	PS	PS
Mechanical/Manual Removal [10]	23.0[5]	-	10.0[5]	10.0[5]	10.0[5]	16.0[5]	2.8[5]	2.8[3]
On-Site Sand Cleaning [7]	23.0[4]	-	10.0[4]	10.0[4]	16.0[4]	24.0[3]	23.5[4]	SI
Natural Dispersion	0.0[1]	-	0.0[1]	0.0[1]	0.0[1]	0.0[3]	0.0[2]	0.0[1]
ICE								
Burning [2]	IF	IF	IF	IF	IF	IF	IF	4.3[2]
Mechanical/Manual Removal [2]	IF	IF	IF	IF	IF	IF	IF	3.8[3]

LEGEND

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SI = Assumes solid ice
SS = Spill sizes too small for cleanup method
- = Scenario tested did not impact
BI = Assumes broken or brash ice, no appreciable free water

EFFECTIVENESS OF CLEANUP

0 = Ineffective
1
2
3 = Moderately effective
4
5 = Highly effective

See also footnotes at end of table.

TABLE 2-43. (CONT'D)

CLEANUP METHOD	SITE AND SEASON (S = Summer W = Winter) (Response Times in Hours) Port Graham (5) S	W	Kamishak[7] (6) S	W	Unimak (7) S	W	Port Moller (8) S	W
WATER								
Barriers	9.2[4]	9.2[3]	9.2[4]	9.2[3]	NA	NA	36.7[3]	36.7[2]
Skimming Devices	9.2[4]	9.2[3]	9.2[4]	9.2[3]	NA	NA	36.7[3]	36.7[2]
Dispersants [11]	I	I	I	I	I	I	I	I
Sorbents	9.2[4]	9.2[3]	9.2[4]	9.2[3]	NA	NA	36.7[3]	36.7[2]
Sinking Agents	I	I	I	I	I	I	I	I
Gelling	NSA	NSA	NSA	NSA	NSA	NSA	NSA	NSA
Magnetic Separation	NSA	NSA	NSA	NSA	NSA	NSA	NSA	NSA
Burning	PS	PS	SS	SS	28.0[2]	28.0[1]	36.7[0]	36.7[0]
Manual Removal	9.2[2]	9.2[2]	9.2[2]	9.2[2]	28.0[1]	28.0[1]	36.7[2]	36.7[2]
BEACH/LAND								
Emulsification	9.2[1]	9.2[1]	9.2[1]	9.2[1]	28.0[1]	28.0[1]	36.7[1]	36.7[1]
Hydraulic Dispersion	9.2[1]	9.2[1]	9.2[1]	9.2[1]	28.0[1]	28.0[1]	36.7[1]	36.7[1]
Steam Cleaning	15.7[3]	15.7[3]	23.5[3]	23.5[3]	58.7[3]	58.7[3]	78.2[3]	78.2[3]
Sand Blasting	15.7[3]	15.7[3]	23.5[3]	23.5[3]	58.7[3]	58.7[3]	78.2[3]	78.2[3]
Mechanical/Manual Mixing	9.7[1]	9.7[1]	5.0[1]	9.7[1]	58.7[1]	58.7[1]	36.7[1]	36.7[1]
Burning	PS	3.0[2]	SS	SS	8.0[4]	8.0[4]	6.0[4]	6.0[4]
Mechanical/Manual Removal [10]	3.0[5]	3.0[5]	3.0[5]	3.0[5]	8.0[5]	8.0[5]	6.0[5]	6.0[5]
On-Site Sand Cleaning [7]	15.7[4]	15.7[3]	23.5[4]	23.5[3]	58.7[3]	58.7[2]	78.2[4]	78.2[3]
Natural Dispersion	0.0[1]	0.0[3]	0.0[1]	0.0[1]	0.0[4]	0.0[4]	0.0[2]	0.0[2]
ICE								
Burning [2]	IF	IF	IF	IF	IF	IF	IF	IF
Mechanical/Manual Removal [2]	IF	IF	IF	IF	IF	IF	IF	IF

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TABLE 2-43. (CONT'D)

CLEANUP METHOD	SITE AND SEASON (S = Summer W = Winter) (Response Times in Hours) Kvichak (9) S	Kvichak (9) W	St. Matthew[4] (10) S	St. Matthew[4] (10) W	Nome (11) S	Nome (11) W
WATER						
Barriers	45.2[1]	SI	66.0[1]	SI	55.6[1]	SI
Skimming Devices	45.2[1]	SI	66.0[1]	SI	55.6[1]	SI
Dispersants [11]	I	I	7.2[5]	I	I	I
Sorbents	45.2[1]	SI	66.0[1]	SI	55.6[1]	SI
Sinking Agents	I	I	I	I	I	I
Gelling	NSA	NSA	NSA	NSA	NSA	NSA
Magnetic Separation	NSA	NSA	NSA	NSA	NSA	NSA
Burning	45.2[0]	SI	66.0[0]	SI	55.6[0]	SI
Manual Removal	45.2[3]	SI	66.0[1]	SI	55.6[2]	SI
BEACH/LAND						
Emulsification	45.2[1]	SI	66.0[1]	SI	55.6[1]	SI
Hydraulic Dispersion	45.2[1]	SI	66.0[1]	SI	55.6[1]	SI
Steam Cleaning	97.8[3]	SI	145.0[3]	SI	121.2[3]	SI
Sand Blasting	97.8[3]	SI	145.0[3]	SI	121.2[3]	SI
Mechanical/Manual Mixing	97.8[1]	SI	145.0[1]	SI	121.2[1]	SI
Burning	4.6[4]	4.6[4]	7.2[4]	7.2[4]	6.0[4]	6.0[4]
Mechanical/Manual Removal [10]	4.6[5]	4.6[5]	7.2[5]	7.2[5]	6.0[5]	6.0[5]
On-Site Sand Cleaning [7]	97.8[4]	SI	145.0[3]	SI	121.2[4]	SI
Natural Dispersion	0.0[2]	0.0[2]	0.0[3]	0.0[3]	0.0[2]	0.0[2]
ICE						
Burning [2]	IF	4.6[5]	IF	7.2[5]	IF	6.0[5]
Mechanical/Manual Removal [2]	IF	4.6[4]	IF	7.2[4]	IF	6.0[4]

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EFFECTIVENESS OF CLEANUP

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See also footnotes at end of table.

TABLE 2-43. (CONT'D)

CLEANUP METHOD	SITE AND SEASON (S = Summer W = Winter) (Response Times in Hours) Cape Blossom[4] (12) S	W	Offshore Prudhoe[3] (13) S	W	Onshore Prudhoe[3] (14) S	W
WATER						
Barriers	66.0[1]	SI	7.0[3]	SI	5.0[3]	SI
Skimming Devices	66.0[1]	SI	7.0[3]	SI	5.0[3]	SI
Dispersants [11]	I	I	7.0[5]	I	I	I
Sorbents	66.0[1]	SI	7.0[4]	SI	5.0[4]	SI
Sinking Agents	I	I	I	I	I	I
Gelling	NSA	NSA	NSA	NSA	NSA	NSA
Magnetic Separation	NSA	NSA	NSA	NSA	NSA	NSA
Burning	66.0[3]	SI	7.0[1]	SI	5.0[0]	SI
Manual Removal	66.0[3]	SI	7.0[2]	SI	5.0[3]	SI
BEACH/LAND						
Emulsification	66.0[1]	SI	7.0[1]	SI	5.0[1]	SI
Hydraulic Dispersion	66.0[1]	SI	7.0[1]	SI	5.0[1]	SI
Steam Cleaning	145.0[3]	SI	NA	SI	NA	NA
Sand Blasting	145.0[3]	SI	NA	SI	NA	NA
Mechanical/Manual Mixing	145.0[1]	SI	7.0[1]	SI	5.0[1]	SI
Burning	6.0[4]	6.0[4]	7.0[4]	SI	5.0[4]	5.0[4]
Mechanical/Manual Removal [10]	6.0[5]	6.0[5]	7.0[5]	SI	5.0[5]	5.0[5]
On-Site Sand Cleaning [7]	145.0[4]	SI	7.0[4]	SI	5.0[4]	SI
Natural Dispersion	0.0[1]	0.0[1]	-	-	-	-
ICE						
Burning [2]	IF	6.0[5]	IF	7.0[5]	IF	5.0[5]
Mechanical/Manual Removal [2]	IF	6.0[4]	IF	7.0[4]	IF	5.0[4]

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See also footnotes at end of table.

TABLE 2-43. (CONT'D)

CLEANUP METHOD	SITE AND SEASON (S = Summer W = Winter) (Response Times in Hours) Umiat (15) S	Umiat (15) W	Yukon[5] (16) S	Yukon[5] (16) W	Denali[6] (17) S	Denali[6] (17) W
WATER						
Barriers	6.0[3]	SI	7.0[3]	SI	10.0[3]	SI
Skimming Devices	6.0[3]	SI	7.0[3]	SI	10.0[3]	SI
Dispersants [11]	I	I	I	I	I	I
Sorbents	6.0[4]	SI	7.0[4]	SI	10.0[4]	SI
Sinking Agents	I	I	I	I	I	I
Gelling	NSA	NSA	NSA	NSA	NSA	NSA
Magnetic Separation	NSA	NSA	NSA	NSA	NSA	NSA
Burning	6.0[0]	SI	7.0[0]	SI	10.0[0]	SI
Manual Removal	6.0[3]	SI	7.0[3]	SI	10.0[3]	SI
BEACH/LAND						
Emulsification	6.0[1]	SI	7.0[1]	SI	10.0[1]	SI
Hydraulic Dispersion	6.0[1]	SI	7.0[1]	SI	10.0[1]	SI
Steam Cleaning	NA	NA	NA	NA	NA	NA
Sand Blasting	NA	NA	NA	NA	NA	NA
Mechanical/Manual Mixing	6.0[1]	SI	7.0[1]	SI	10.0[1]	SI
Burning	6.0[4]	6.0[4]	2.7[4]	2.7[4]	3.8[4]	3.8[4]
Mechanical/Manual Removal [10]	6.0[5]	6.0[5]	2.7[5]	2.7[5]	3.8[5]	3.8[5]
On-Site Sand Cleaning [7]	6.0[4]	SI	7.0[4]	SI	10.0[4]	SI
Natural Dispersion	-	-	-	-	-	-
ICE						
Burning [2]	IF	6.0[5]	IF	2.7[5]	IF	3.8[5]
Mechanical/Manual Removal [2]	IF	6.0[4]	IF	2.7[4]	IF	3.8[4]

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TABLE 2-43. FOOTNOTES

[1] Assumes cleanup measures available in Valdez Harbor.

[2] Assumes helicopters could land on beaches near oil spills.

[3] Assumes cleanup measures available at Prudhoe Oil Field.

[4] Transportation times for St. Matthew and Cape Blossom based on Nome and factored up for greater distances.

[5] Assumes cleanup measures available in Fairbanks.

[6] Assumes cleanup measures available in Anchorage.

[7] Assumes transportation time is the largest of either Drift River or Port Graham.

[8] Assumes sand cleaning equipment available to all sites.

[9] May be ineffective due to long response time or safety considerations.

[10] May be aided by use of sorbents.

[11] Dispersants were not legal in depths less than 100 feet prior to the 1975 revision of the National Contingency Plan. Based upon the interpretation of the Revised Plan by MSNW, most locations have the code "I" for dispersants because it was judged their use would not be recommended by an On Site Commander (OSC) (See Section 6.E.1. and p. 2-718).

Deployment of barriers and mechanical cleanup equipment that has been airlifted to a location near a given spill site requires land transportation to shoresite transfer points (for the most part of limited availability in the remote spill locations) and availability of (local) vessels. Another possibility is to transfer equipment by helicopter from the destination airfield to surface vessels on water; however, additional coordination, equipment, and logistics are required. Local vessels to serve as deployment and work platforms would either be USCG vessels in the area (not necessarily guaranteed because of the density required to cover all potential spill locations in a specific geographical area) or local fishing vessels. Presence of fishing vessels does not necessarily guarantee accessibility for spill containment and cleanup activity, since they may be engaged in fish harvest and the operators may elect to remain so engaged. The On-Scene Coordinator does not have authority to commandeer vessels for cleanup duty but must negotiate rental agreements; the fishermen may elect not to participate. In any event, one cannot expect availability of local vessels in remote areas uniformly for all times of the year. In keeping with the philosophy of this study, the study team elected to use realistic but conservative estimates of time to implement spill countermeasures. One further notes that the times estimated by the Battelle report (see above) do not take into account the time necessary for notification of a spill incident. The assumption of immediate notification may not be justified based on past spill incidents since many factors could cause significant time delays before the spill response personnel receive notice of the incident and initiate response.

The use of dispersants and sinking agents is regulated according to the provisions of Annex X of the National Oil and Hazardous Substances

Pollution Contingency Plan entitled "Schedule of Chemicals and Other Additives to Remove Oil and Hazardous Substances Discharges." The provisions of the schedule undergo continuous changes as new information regarding the effects of various chemical agents is developed.

Currently (Annex X as given in *FEDERAL REGISTER*, Vol. 40, Number 28, Part II, Monday, February 10, 1975) the use of sinking agents is not allowed for any spill (Subsection 2007.1-1), whereas previously sinking agents were allowed where water depths exceeded 100 meters.

According to subsection 2003.1-10 of Annex X, dispersing agents may now be used for any major or medium discharge in any place, at any time, and in quantities designated by the On-Scene Commander when, in the judgment of the OSC and EPA, such use will mitigate the effects of the discharge either from the point of view of personnel safety, environmental damage, or interference with designated water uses. Previously, the restriction to use in water depths greater than 100 feet (at the discretion of the OSC) was in effect. Consequently, at some sites (Yakutat and St. Matthew Island) and for some spill scenarios, the use of dispersants was considered to be the most effective countermeasure. Factors considered in this judgment included the time history of the slick movement, the water depths involved, and the biological resources present at the postulated spill site. These factors are dictated by the time of year of the spill and prevailing weather conditions. If the spill occurs over deep water, exhibits relatively slow dispersion and minimal (known) biological resources are present, then use of dispersants is effective. Even though the current regulations allow use of dispersants for any spill site, in the opinion of MSNW, use should be restricted to only deep open-ocean situations, since the synergistic effects of dispersants and oil are unknown

at this time even though the dispersants in and of themselves exhibit (relatively) low toxicity. Furthermore, testing of dispersant toxicity presently covers a limited range of organisms and may not be indicative of potential impacts on all phases of the biological community present at all potential spill sites.

The results for each of the cleanup cases must be examined at the habitat (and in some cases the species) level in order to fully understand the increase or decrease in impact score. The results for cleanup cases are dependent upon the following factors:

- The spill location--the distance and direction from the logistics base for cleanup determine the length and types of habitats crossed. For example, the spills in the marine environment were judged to have no major impacts in the terrestrial habitat at any spill location. The logistics base for cleanup operations was assumed to be on land in many of these cases. Therefore, in some cases the impact in the terrestrial habitat was greater in the cleanup scenario than the no-cleanup scenario.

- The response time--this time includes the time from the staging area to the logistics base and from the logistics base to the spill site. Longer response times were judged to be less efficient in cleaning up the spill than shorter times. Therefore, at spill sites such as Valdez Harbor, where response times were of short duration, the cleanup of all spills except gasoline was judged to be most effective and reduced the impact score.

- The type of oil spilled--the more toxic spills were judged to require a faster response time at any site to be as effective as cleanup of less toxic spills. The spill types were judged to rank from most toxic to least toxic as follows: diesel-2 - most toxic; followed by crude oil, bunker C, and gasoline - least toxic. Gasoline was assumed least toxic as the volatile and toxic fractions evaporate rapidly from the surface of the water.

  For example, the results of cleanup of different spill types at Valdez Narrows were: diesel-2, 50,000 bbls, Summer - Cleanup Impact Score 22,126; crude oil, 50,000 bbls, Summer - Cleanup Impact Score 19,274; and bunker C, 50,000 bbls, Summer - Cleanup Impact Score 13,084. The diesel-2 impact score is a one percent <u>increase</u> from no cleanup; the crude

oil impact score is a 0.8 percent decrease from no cleanup, and the bunker C impact score is a 3.9 percent decrease from no cleanup.

- The cleanup method utilized--some cleanup methods were judged to have greater effects on the biota than others. For example, sand blasting to clean oil from rock would probably destroy any organisms on the rock but may be the most effective method of cleanup. On-site sand cleaning, the most effective method for removing the oil product, requires that the sand and biota be removed to a depth of 6 inches or more and results in all biota being destroyed.

This subsection is organized to present a location-by-location description of the following: the methods judged appropriate from Table 2-43; the postulated cleanup scenario; and the evaluation matrix xcores.

(1) YAKUTAT - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective cleanup methods in the open sea were judged to be barriers, skimmers, and sorbents. All three were rated as moderately effective. The most effective cleanup methods onshore were judged to be burning and mechanical/manual removal.

WINTER: Yakutat remains relatively ice-free and the Summer cleanup methods were similarly applicable for all seasons, with a decrease in effectiveness of open-sea methods due to ice presence.

If one assumes that (approved) dispersants are available at Yakutat, and suitable surface vessels (equipped for dispersant application) are available, then application of dispersant to those parts of the slick which are over deep water will prove an effective countermeasure. Effectiveness of this method is somewhat enhanced for Winter spills, since the slick remains offshore.

POSTULATED SCENARIO

The summer spill scenarios were assumed governed by calm winds. Under these conditions, oil was postulated to reach the beaches southwest of Yakutat by about 36 hours (crude oil) to 48 hours (bunker C). Minimum response times of 24 hours for open-sea cleanup were judged to be somewhat effective. Some manual cleanup of impacted beaches was assumed.

In Winter, the oil spill stayed offshore. Open-sea cleanup methods were assumed somewhat hampered by adverse weather conditions, and no change in Winter impact was postulated.

MATRIX RESULTS

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 11,206

The impacts on the pelagic, subtidal sand/mud, and subtidal rock/cobble/gravel habitats were not affected by the cleanup. The intertidal sand/mud habitat impact was reduced from 773 to 660. The intertidal rocky habitat was decreased from 167 to 111. The terrestrial habitat impact was increased to 405 from 162. Table 2-44 presents the complete results for [illegible] e l.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-44. MATRIX RESULTS -- CASE 1

AREA	YAKUTAT
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	M	0	0	0	3	9	1	162	18	164
2. ZOOPLANKTON	6	M	0	0	0	3	9	1	162	18	164
3. ICHTHYOPLANKTON	10	E	0	0	0	2	9	1	180	20	182
4. FLOATING SEAWEED	3	M	3	0	0	2	1	0	6	0	6
5. GREENLINGS	3	E	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	6	E	0	0	0	3	9	1	162	18	164
7. HERRING	3	E	1	0	0	3	9	8	108	96	193
8. SMELT	3	A	0	0	1	3	9	8	108	96	193
9. CRAB LARVAE	6	E	0	0	0	2	9	8	108	96	193
10. KING SALMON	1	A	1	1	1	2	9	8	45	40	81
11. CHUM SALMON	1	A	1	1	1	2	9	8	45	40	81
12. SOCKEYE SALMON	3	A	2	1	1	2	9	8	162	144	290
13. PINK SALMON	1	A	1	1	1	2	9	8	45	40	81
14. COHO SALMON	15	A	2	1	1	2	9	8	810	720	1450
15. RAINBOW-STEELHEAD TROUT	1	E	0	1	1	1	9	8	27	24	48
16. DOLLY VARDEN	3	E	0	0	1	1	9	8	54	48	97
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	15	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	3	A	0	0	0	5	0	0	0	0	0
24. WHALES	6	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	1	A	0	0	0	5	4	0	20	0	20
27. OTHER MARINE MAMMALS	1	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	5	9	8	675	600	1208
									2903	2618	4639
2. SUBTIDAL SAND-MUD											
1. CODS	6	A	2	1	1	2	1	0	36	0	36
2. SCULPINS	6	A	3	0	0	2	4	1	48	12	51
3. STARRY FLOUNDER	6	A	1	0	0	2	1	0	18	0	18
4. OTHER FLATFISH	6	A	1	0	0	2	1	0	18	0	18
5. PACIFIC SANDLANCE	6	E	0	0	0	3	4	1	72	18	77

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-44. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	6	A	0	0	0	2	4	0	48	0	48
7. DUNGENESS CRAB	6	A	1	0	1	2	9	8	216	192	387
8. SHRIMP	6	A	2	0	0	3	9	27	270	810	2700
9. RAZOR CLAM	6	A	0	0	0	2	9	1	108	12	109
10. OTHER BIVALVES	3	M	0	0	1	1	9	1	54	6	55
11. OTHER MARINE INVERTEBRATES	6	M	0	0	0	3	9	1	162	18	164
									1050	1668	3663
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	3	M	0	0	0	2	1	0	6	0	6
2. SUBTIDAL SEAWEED	3	M	0	0	0	2	1	0	6	0	6
3. CHUM SALMON	1	A	1	1	1	2	9	1	45	5	46
4. PACIFIC HALIBUT	6	A	2	1	1	2	4	0	144	0	144
5. OTHER FLATFISH	3	A	1	0	0	2	4	0	36	0	36
6. GREENLINGS	1	M	0	0	0	2	4	0	8	0	8
7. ROCKFISH	3	M	1	0	1	2	4	0	48	0	48
8. WALLEYE POLLOCK	6	A	2	1	1	2	4	0	144	0	144
9. OTHER MARINE FISH	3	M	0	0	0	2	4	0	24	0	24
10. KING CRAB	1	A	1	0	1	2	9	1	36	4	36
11. TANNER CRAB	6	A	1	0	1	2	9	1	216	24	219
12. SCALLOPS	10	A	1	0	1	2	9	1	360	40	364
13. OTHER MARINE INVERTEBRATES	6	M	0	0	0	3	9	1	162	18	164
									1235	91	1245
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	6	E	0	0	0	3	4	1	72	18	77
3. RAZOR CLAM	6	A	0	1	2	2	4	0	120	0	120
4. SOFTSHELL BIVALVES	6	M	0	1	0	2	4	0	72	0	72
5. INVERTEBRATE INFAUNA	6	M	0	0	0	3	4	0	72	0	72
7. SHOREBIRDS	15	P	0	0	0	5	4	1	300	75	319
8. GEESE	6	A	1	2	0	1	0	0	0	0	0
9. DUCKS	6	A	1	2	0	2	0	0	0	0	0
10. SWANS	6	A	0	0	0	*	0	0	0	0	0
									636	93	660
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	M	0	0	0	3	1	0	9	0	9
3. HERRING	3	E	1	0	0	2	4	0	36	0	36

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-44. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
4. SESSILE MARINE INVERTEBRATES	3	M	0	0	0	1	1	0	3	0	3
5. MISC. CRUSTACEANS	3	M	0	0	0	2	1	0	6	0	6
6. OTHER INVERTEBRATES	3	M	0	0	0	3	1	0	9	0	9
7. SHOREBIRDS	6	P	0	0	0	5	1	0	30	0	30
8. SEA DUCKS	6	A	0	0	1	2	1	0	18	0	18
9. MARINE MAMMAL ROOKERIES	3	A	0	0	0	5	0	0	0	0	0
									111	0	111
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	M	0	0	0	3	1	0	9	0	9
2. SMELT	3	A	0	0	1	3	9	1	108	12	109
3. HARDSHELL BIVALVES	3	M	0	1	1	2	9	1	108	12	109
4. CRUSTACEANS	3	M	0	0	0	2	9	1	54	6	55
5. GASTROPODS	3	M	0	0	0	3	9	0	81	0	81
6. SHOREBIRDS	6	P	0	0	0	5	4	0	120	0	120
									480	30	483
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	1	E	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	1	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	1	1	1	2	0	0	0	0	0
4. CHUM SALMON	1	A	1	1	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	2	1	1	2	0	0	0	0	0
6. PINK SALMON	1	A	1	1	1	2	0	0	0	0	0
7. COHO SALMON	15	A	2	1	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	1	E	0	1	1	1	0	0	0	0	0
9. DOLLY VARDEN	1	E	0	0	1	1	0	0	0	0	0
12. PIKE	1	E	0	0	0	1	0	0	0	0	0
13. STICKLEBACKS	1	E	0	0	0	3	0	0	0	0	0
14. OTHER FISH	1	M	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	0	2	1	2	0	0	0	0	0
16. GEESE	15	A	0	2	1	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	*	0	0	0	0	0
18. RIVER OTTER	3	P	2	0	0	1	0	0	0	0	0
19. MINK	3	P	2	0	0	1	0	0	0	0	0
20. MUSKRAT	3	P	2	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	P	2	0	0	1	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-44. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
2. RIPARIAN VEGETATION	3	M	0	0	0	2	0	0	4	0	0
3. STRAND VEGETATION	1	M	0	0	0	1	4	0	4	0	4
4. OTHER VEGETATION	10	A	2	0	0	2	4	0	160	0	160
5. BROWN BEAR	6	A	1	1	0	2	1	0	24	0	24
6. BLACK BEAR	6	A	2	2	0	5	1	0	54	0	54
7. WOLVERINE	6	A	0	0	0	1	1	0	6	0	6
8. WOLF	6	A	0	0	0	1	0	0	0	0	0
9. MOOSE	6	A	0	3	2	2	0	0	0	0	0
11. DEER	3	A	0	2	2	2	0	0	0	0	0
15. GOATS	1	A	0	1	0	1	1	0	2	0	2
16. OTHER MAMMALS	10	A	0	0	0	2	1	1	20	20	40
17. RAPTORS	15	A	0	0	0	5	1	0	75	0	75
18. PTARMIGAN	6	A	0	1	0	2	0	0	0	0	0
19. OTHER BIRDS	10	A	0	0	0	2	1	1	20	20	40
									365	40	405
									6780	3346	11206

(2) VALDEZ HARBOR - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective harbor cleanup methods were judged to be barriers, skimmers, and sorbents. The most effective cleanup method for impacted beaches at this site was judged to be mechanical/manual removal. The next most effective method was judged to be on-site sand cleaning.

WINTER: The above summer methods apply. In addition, for beach impacts, sand blasting and steam cleaning were judged to be moderately effective.

POSTULATED SCENARIO

SUMMER: MSNW assumed that sorbents, oil cleanup equipment, and personnel were available at Valdez at the time of the spill based on the findings of Swift, et al.[67]

On this basis, a rapid response was postulated such that booms were deployed to prevent the spill from spreading throughout the harbor. Skimmers were deployed and the impacted beach near the spill (inside the boomed area) was cleaned with sorbents plus mechanical/manual removal. It was assumed that between 30 percent and 60 percent of the spilled oil was removed, that beach impact was reduced, and that little change was made on the amount of soluble aromatics entering the water column.

WINTER: Little modification of the scenario was postulated for Winter regarding applicable methods and response to a spill. The Winter spill scenario (Section 2-A, Site 2) moves the oil onto land sooner, but the general impact was similar and cleanup methods were judged to be about as effective as during Summer.

MATRIX RESULT

CASE 1: SUMMER, CRUDE OIL, 1,000 BBLS - IMPACT SCORE 4,968

The impact on the pelagic habitat reduced from 1,651 to 1,336 from the non-cleanup scenario. The impact on the subtidal sand/mud habitat reduced from 1,219 to 842, and the subtidal rock/cobble/gravel habitat reduced from 924 to 814. The intertidal sand/mud habitat reduced from 3,571 to 726 due to the lower impact on the northern shorelines. The intertidal rocky and freshwater habitats remained at zero impact. The intertidal cobble/gravel habitat reduced from 2,580 to 636. The terrestrial habitat increased from 585 to 614.

The total impact score was 4,968, substantially lower than the non-cleanup score. Table 2-45 presents the complete results for Case 1.

Similar results were postulated for the Winter scenario.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-45. MATRIX RESULTS -- CASE 1

AREA	VALDEZ HARBOR
SEASON	SUMMER
SPILL SIZE	1,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	6	A	0	0	0	2	1	0	12	0	12
4. FLOATING SEAWEED	10	H	0	0	0	2	1	0	20	0	20
5. GREENLINGS	3	H	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	3	H	0	0	0	3	1	0	9	0	9
7. HERRING	10	A	3	0	0	3	1	0	60	0	60
8. SMELT	3	A	1	1	1	3	4	1	72	18	77
9. CRAB LARVAE	6	E	0	0	0	2	4	0	48	0	48
10. KING SALMON	1	A	1	2	1	2	1	0	6	0	6
11. CHUM SALMON	6	A	2	2	1	2	4	0	168	0	168
12. SOCKEYE SALMON	3	A	2	2	1	2	1	0	21	0	21
13. PINK SALMON	15	A	3	2	1	2	4	0	480	0	480
14. COHO SALMON	6	A	3	2	1	2	1	0	48	0	48
15. RAINBOW-STEELHEAD TROUT	6	H	0	1	0	1	4	0	48	0	48
16. DOLLY VARDEN	10	H	0	2	0	1	4	0	120	0	120
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	10	A	0	0	0	5	0	0	0	0	0
24. WHALES	10	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	0	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	5	1	0	75	0	75
									1331	18	1336
2. SUBTIDAL SAND-MUD											
1. CODS	10	A	2	1	1	2	1	0	60	0	60
2. SCULPINS	6	H	0	0	0	2	1	0	12	0	12
3. STARRY FLOUNDER	6	A	2	0	0	2	1	0	24	0	24
4. OTHER FLATFISH	10	A	2	0	0	2	1	0	40	0	40
5. PACIFIC SANDLANCE	3	H	0	0	0	3	1	0	9	0	9

TABLE 2-45. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	10	H	0	0	0	2	1	0	20	0	20
7. DUNGENESS CRAB	6	A	1	0	1	2	4	1	96	24	102
8. SHRIMP	10	A	3	2	2	3	4	0	400	0	400
9. RAZOR CLAM	3	H	0	0	0	2	1	1	6	6	12
10. OTHER BIVALVES	10	A	0	0	0	1	4	1	40	10	43
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	4	0	120	0	120
									827	40	842
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	15	H	0	0	0	2	1	0	30	0	30
2. SUBTIDAL SEAWEED	15	H	0	0	0	2	1	0	30	0	30
3. CHUM SALMON	6	A	2	1	1	2	4	0	144	0	144
4. PACIFIC HALIBUT	6	A	3	1	0	2	1	0	36	0	36
5. OTHER FLATFISH	10	A	2	0	0	2	1	0	40	0	40
6. GREENLINGS	6	A	0	1	0	2	1	0	18	0	18
7. ROCKFISH	10	A	3	1	0	2	1	0	60	0	60
8. WALLEYE POLLOCK	10	A	2	0	0	2	1	0	40	0	40
9. OTHER MARINE FISH	10	A	0	0	0	2	1	0	20	0	20
10. KING CRAB	6	A	2	1	1	2	4	0	144	0	144
11. TANNER CRAB	10	A	1	1	1	2	0	0	0	0	0
12. SCALLOPS	6	A	1	0	0	2	4	0	72	0	72
13. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	4	0	180	0	180
									814	0	814
4. INTERTIDAL SAND-MUD											
1. EELGRASS	1	H	0	0	0	3	1	0	3	0	3
2. PACIFIC SANDLANCE	3	H	0	0	0	3	1	0	9	0	9
3. RAZOR CLAM	3	A	0	2	2	2	4	1	72	18	77
4. SOFTSHELL BIVALVES	15	A	0	3	1	2	4	1	360	90	383
5. INVERTEBRATE INFAUNA	15	A	0	0	0	3	1	1	45	45	90
6. MARINE MAMMAL ROOKERIES	6	A	0	0	0	5	0	0	0	0	0
7. SHOREBIRDS	10	P	0	0	0	5	1	0	50	0	50
8. GEESE	6	A	1	2	0	1	1	0	24	0	24
9. DUCKS	6	A	1	2	0	2	1	0	30	0	30
10. SWANS	6	A	0	0	0	*	1	0	60	0	60
									653	153	726

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
VALUATION MATRIX

TABLE 2-45. (CONT'D.)

HABITAT.SPECIES	FACTORS: ABUNDANCE INV.	ABUNDANCE CONF.	IMPORTANCE COM.	IMPORTANCE REC.	IMPORTANCE SUB.	IMPORTANCE ECOL.	IMPACT S.TRM	IMPACT L.TRM	RESULTS: IMPACT S.TRM	IMPACT L.TRM	RSLT.
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	15	M	0	0	0	3	0	0	0	0	0
2. GREENLINGS	3	A	0	1	0	2	0	0	0	0	0
3. HERRING	10	A	3	0	0	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	15	A	0	0	0	3	0	0	0	0	0
5. MISC. CRUSTACEANS	6	A	0	1	1	2	0	0	0	0	0
6. OTHER INVERTEBRATES	10	A	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	P	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	3	A	1	2	0	2	0	0	0	0	0
9. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	M	0	0	0	3	1	0	30	0	30
2. SMELT	3	A	1	1	1	3	4	0	72	0	72
3. HARDSHELL BIVALVES	15	A	0	2	1	2	4	1	300	75	319
4. CRUSTACEANS	10	A	0	0	0	2	4	0	80	0	80
5. GASTROPODS	10	A	0	0	0	3	4	0	120	0	120
6. SHOREBIRDS	3	P	0	0	0	5	1	0	15	0	15
									617	75	636
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	M	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	2	1	2	0	0	0	0	0
4. CHUM SALMON	6	A	0	3	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	2	1	2	0	0	0	0	0
6. PINK SALMON	15	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	6	A	0	2	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	M	0	2	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	M	0	2	1	1	0	0	0	0	0
13. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	M	0	0	0	2	0	0	0	0	0
15. DUCKS	6	A	1	2	0	2	0	0	0	0	0
16. GEESE	10	A	1	2	0	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	4	0	0	0	0	0
18. RIVER OTTER	6	A	2	0	1	1	0	0	0	0	0
19. MINK	6	A	2	0	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	0	1	1	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-45. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
a. TERRESTRIAL											
1. TUNDRA	1	M	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	10	M	0	0	0	2	1	0	20	0	20
3. STRAND VEGETATION	6	M	0	0	0	1	9	0	54	0	54
4. OTHER VEGETATION	10	A	2	2	1	2	4	1	280	70	298
5. BROWN BEAR	3	A	2	1	0	2	1	0	15	0	15
6. BLACK BEAR	6	A	1	3	1	5	1	0	60	0	60
7. WOLVERINE	3	A	1	0	0	1	1	0	6	0	6
8. WOLF	3	A	1	0	0	1	1	0	6	0	6
9. MOOSE	1	A	0	1	1	2	0	0	0	0	0
11. DEER	6	A	1	1	1	2	0	0	0	0	0
15. GOATS	6	A	1	2	1	1	0	0	0	0	0
16. OTHER MAMMALS	6	A	2	0	1	2	1	1	30	30	60
17. RAPTORS	15	A	0	0	0	5	1	0	75	0	75
18. PTARMIGAN	6	P	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	1	0	20	0	20
									566	100	614
									4808	386	4968

(3) VALDEZ NARROWS - CLEANUP

APPROPRIATE CLEANUP METHODS

For both Summer and Winter, the most effective open-sea methods were judged to be barriers, skimming devices, and sorbents--all highly effective. For beach cleanup, mechanical/manual removal was judged to be the most effective method.

POSTULATED SCENARIO

Both Winter and Summer non-cleanup scenarios were based on oil moving south-southwesterly into Prince William Sound. MSNW assumed that logistics support for cleanup was available at Valdez.

The estimated response time for cleanup vessels (skimmers) and placement of barriers was about 10 hours.[67] Deployment of this equipment was postulated. Cleanup was postulated to reclaim 20 to 30 percent of the spilled oil through skimming and beach contaminant removal. Difficult beach access in the Narrows was assumed.

MATRIX RESULTS

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 22,126

The impact on the pelagic habitat remained the same as the non-cleanup case. The subtidal sand/mud habitat impact was slightly decreased, as were the subtidal rock/cobble/gravel habitat and intertidal sand/mud habitat impacts. The intertidal rocky habitat impact was increased from 2,157 to 2,302. The intertidal cobble/gravel impact remained the same. No impact of the freshwater river habitat occurred. The terrestrial habitat impact was

increased slightly from 959 to 1,093. Table 2-46 presents the complete results for Case 1. Similar results were postulated for Winter.

CASE 2: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 19,274

The impact on the pelagic habitat from the non-cleanup case decreased from 4,008 to 3,129 and that for the subtidal sand/mud habitat decreased from 2,565 to 2,359. The impact decrease on the subtidal rock/cobble/gravel habitat was minor (from 3,564 to 3,501). The intertidal sand/mud impact remained the same (4,016). The intertidal rocky habitat impact increased to 3,089 from 2,621. The intertidal cobble/gravel habitat impact remained the same (1,685). The freshwater river habitat was not imapcted. The terrestrial habitat impact increased from 978 to 1,495. Table 2-47 presents the complete results for Case 2.

CASE 3: SUMMER, BUNKER C, 50,000 BBLS - IMPACT SCORE 13,084

The impact on the pelagic habitat decreased from the non-cleanup case from 1,236 to 1,188. The subtidal sand/mud habitat score decreased from 1,604 to 1,541, and the subtidal rock/cobble/gravel impact decreased from 2,855 to 1,131. The intertidal sand/mud habitat score remained the same. The intertidal rocky habitat score increased from 1,198 to 1,894. The intertidal cobble/gravel habitat score remained the same (934), as did the freshwater river habitat score (0). The terrestrial habitat score increased from 585 to 1,199. Table 2-48 presents the complete results for Case 3.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-46. MATRIX RESULTS -- CASE 1

AREA	VALDEZ NARROWS
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT. SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	9	1	162	18	164
2. ZOOPLANKTON	6	A	0	0	0	3	9	1	162	18	164
3. ICHTHYOPLANKTON	6	A	0	0	0	2	9	1	108	12	109
4. FLOATING SEAWEED	10	H	0	0	0	2	1	0	20	0	20
5. GREENLINGS	3	H	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	3	H	0	0	0	3	9	1	81	9	82
7. HERRING	10	A	3	0	0	3	9	8	540	480	967
8. SMELT	3	A	1	1	1	3	9	8	162	144	290
9. CRAB LARVAE	6	E	0	0	0	2	9	8	108	96	193
10. KING SALMON	1	A	1	2	1	2	9	8	54	48	97
11. CHUM SALMON	6	A	2	2	1	2	9	8	378	336	677
12. SOCKEYE SALMON	3	A	2	2	1	2	9	8	189	168	338
13. PINK SALMON	10	A	3	2	1	2	9	8	720	640	1289
14. COHO SALMON	6	A	3	2	1	2	9	8	432	384	773
15. RAINBOW-STEELHEAD TROUT	6	H	0	1	0	1	9	8	108	96	193
16. DOLLY VARDEN	10	H	0	2	0	1	9	8	270	240	483
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	10	A	0	0	0	5	0	0	0	0	0
24. WHALES	10	A	0	0	0	*	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	4	0	120	0	120
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	5	9	8	675	600	1208
									4313	3289	7191
2. SUBTIDAL SAND-MUD											
1. CODS	10	A	2	1	1	2	1	0	60	0	60
2. SCULPINS	6	H	0	0	0	2	4	0	48	0	48
3. STARRY FLOUNDER	10	A	2	0	0	2	1	0	40	0	40
4. OTHER FLATFISH	10	A	2	0	0	2	1	0	40	0	40
5. PACIFIC SANDLANCE	3	H	0	0	0	3	4	0	36	0	36

TABLE 2-46. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	10	M	0	0	0	2	4	0	80	0	80
7. DUNGENESS CRAB	6	A	1	0	1	2	9	8	216	192	387
8. SHRIMP	10	A	3	2	2	3	9	8	900	804	1611
9. RAZOR CLAM	3	M	0	0	0	2	9	1	54	6	55
10. OTHER BIVALVES	10	A	0	0	0	1	9	1	90	10	91
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	9	1	270	30	273
									1834	1038	2721
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	15	M	0	0	0	2	1	0	30	0	30
2. SUBTIDAL SEAWEED	15	M	0	0	0	2	1	0	30	0	30
3. CHUM SALMON	6	A	2	1	1	2	9	0	324	0	324
4. PACIFIC HALIBUT	6	A	3	1	0	2	4	0	144	0	144
5. OTHER FLATFISH	10	A	2	0	0	2	4	0	160	0	160
6. GREENLINGS	6	A	0	1	0	2	4	0	72	0	72
7. ROCKFISH	10	A	3	1	0	2	4	0	240	0	240
8. WALLEYE POLLOCK	10	A	2	0	0	2	4	0	160	0	160
9. OTHER MARINE FISH	10	A	0	0	0	2	4	0	80	0	80
10. KING CRAB	6	A	2	1	1	2	9	1	324	36	328
11. TANNER CRAB	10	A	1	1	1	2	9	0	450	0	450
12. SCALLOPS	6	A	1	0	0	2	9	0	162	0	162
13. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	9	0	405	0	405
									2581	36	2585
4. INTERTIDAL SAND-MUD											
1. EELGRASS	1	M	0	0	0	3	4	0	12	0	12
2. PACIFIC SANDLANCE	3	M	0	0	0	3	9	8	81	72	145
3. RAZOR CLAM	3	A	0	2	2	2	9	8	162	144	290
4. SOFTSHELL BIVALVES	15	A	0	3	1	2	9	8	810	720	1450
5. INVERTEBRATE INFAUNA	15	A	0	0	0	3	9	8	405	360	725
6. MARINE MAMMAL ROOKERIES	6	A	0	0	0	5	0	0	0	0	0
7. SHOREBIRDS	10	P	0	0	0	5	9	8	450	400	806
8. GEESE	6	A	1	2	0	1	4	0	96	0	96
9. DUCKS	6	A	1	2	0	2	4	0	120	0	120
10. SWANS	6	A	0	0	0	*	4	0	240	0	240
									2376	1696	3884

TABLE 2-46 (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	15	M	0	0	0	3	4	0	180	0	180
2. GREENLINGS	3	A	0	1	0	2	4	0	36	0	36
3. HERRING	10	A	3	0	0	2	9	6	450	400	806
4. SESSILE MARINE INVERTEBRATES	15	A	0	0	0	1	9	1	135	15	137
5. MISC. CRUSTACEANS	6	A	0	1	1	2	9	1	216	24	219
6. OTHER INVERTEBRATES	10	A	0	0	0	3	9	1	270	30	273
7. SHOREBIRDS	3	P	0	0	0	5	9	1	135	15	137
8. SEA DUCKS	3	A	1	2	0	2	4	1	60	15	64
9. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	9	0	450	0	450
									1932	499	2302
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	M	0	0	0	3	4	0	120	0	120
2. SMELT	3	A	1	1	1	3	9	8	162	144	290
3. HARDSHELL BIVALVES	15	A	0	2	1	2	9	8	675	600	1200
4. CRUSTACEANS	10	A	0	0	0	2	9	8	180	160	322
5. GASTROPODS	10	A	0	0	0	3	9	1	270	30	273
6. SHOREBIRDS	3	P	0	0	0	5	9	1	135	15	137
									1542	949	2350
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	M	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	2	1	2	0	0	0	0	0
4. CHUM SALMON	6	A	0	3	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	2	1	2	0	0	0	0	0
6. PINK SALMON	15	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	6	A	0	2	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	M	0	2	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	M	0	2	1	1	0	0	0	0	0
13. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	M	0	0	0	2	0	0	0	0	0
15. DUCKS	6	A	1	2	0	2	0	0	0	0	0
16. GEESE	10	A	1	2	0	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	*	0	0	0	0	0
18. RIVER OTTER	3	A	2	0	1	1	0	0	0	0	0
19. MINK	6	A	2	0	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	0	1	1	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-46. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
8. TERRESTRIAL											
1. TUNDRA	1	M	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	10	M	0	0	0	2	4	0	80	0	80
3. STRAND VEGETATION	6	M	0	0	0	1	9	1	54	6	55
4. OTHER VEGETATION	10	A	2	2	1	2	4	1	280	70	298
5. BROWN BEAR	3	A	2	1	0	2	1	0	15	0	15
6. BLACK BEAR	6	A	1	3	1	5	1	0	60	0	60
7. WOLVERINE	3	A	1	0	0	1	4	1	24	6	26
8. WOLF	3	A	1	0	0	1	1	1	6	6	12
9. MOOSE	1	A	0	1	1	2	1	0	4	0	4
10. DEER	6	A	1	1	1	2	1	0	30	0	30
11. GOATS	6	A	1	2	1	1	0	0	0	0	0
16. OTHER MAMMALS	6	A	2	0	1	2	4	1	120	30	128
17. RAPTORS	15	A	0	0	0	5	4	0	300	0	300
18. PTARMIGAN	6	P	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	4	1	80	20	85
									1053	138	1093
									15631	7645	22126

TABLE 2-47. MATRIX RESULTS-- CASE 2

AREA	VALDEZ NARROWS
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	6	A	0	0	0	2	4	0	48	0	48
4. FLOATING SEAWEED	10	M	0	0	0	2	4	0	80	0	80
5. GREENLINGS	3	M	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	3	M	0	0	0	3	1	0	9	0	9
7. HERRING	10	A	3	0	0	3	9	1	540	60	547
8. SMELT	3	A	1	1	1	3	9	0	162	0	162
9. CRAB LARVAE	6	E	0	0	0	2	9	1	108	12	109
10. KING SALMON	1	A	1	2	1	2	4	0	24	0	24
11. CHUM SALMON	6	A	2	2	1	2	4	0	168	0	168
12. SOCKEYE SALMON	3	A	2	2	1	2	4	0	84	0	84
13. PINK SALMON	10	A	3	2	1	2	4	0	320	0	320
14. COHO SALMON	6	A	3	2	1	2	4	0	192	0	192
15. RAINBOW-STEELHEAD TROUT	6	M	0	1	0	1	9	1	108	12	109
16. DOLLY VARDEN	10	M	0	2	0	1	9	1	270	30	273
17. NORTHERN FUR SEAL	3	A	0	0	0	5	1	0	15	0	15
21. HARBOR SEAL	10	A	0	0	0	5	1	0	50	0	50
22. SEA LIONS	10	A	0	0	0	5	0	0	0	0	0
24. WHALES	10	A	0	0	0	*	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	4	0	120	0	120
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	5	9	0	675	0	675
									3117	114	3129
2. SUBTIDAL SAND-MUD											
1. CODS	10	A	2	1	1	2	4	0	240	0	240
2. SCULPINS	6	M	0	0	0	2	9	0	108	0	108
3. STARRY FLOUNDER	10	A	2	0	0	2	1	0	40	0	40
4. OTHER FLATFISH	10	A	2	0	0	2	4	0	160	0	160
5. PACIFIC SANDLANCE	3	M	0	0	0	3	9	0	81	0	81

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-47. (CONT'D.)

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	10	M	0	0	0	2	4	0	80	0	80
7. DUNGENESS CRAB	6	A	1	0	1	2	9	1	216	24	240
8. SHRIMP	10	A	3	2	2	3	9	0	900	0	900
9. RAZOR CLAM	3	M	0	0	0	2	9	8	54	43	97
10. OTHER BIVALVES	10	A	0	0	0	1	9	8	90	80	161
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	9	1	[illegible]	30	273
									2236	182	2359
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	15	M	0	0	0	2	4	0	120	0	120
2. SUBTIDAL SEAWEED	15	M	0	0	0	2	4	0	120	0	120
3. CHUM SALMON	6	A	2	1	1	2	9	0	324	0	324
4. PACIFIC HALIBUT	6	A	3	1	0	2	4	0	144	0	144
5. OTHER FLATFISH	10	A	2	0	0	2	4	0	160	0	160
6. GREENLINGS	6	A	0	1	0	2	4	0	72	0	72
7. ROCKFISH	10	A	3	1	0	2	4	0	240	0	240
8. WALLEYE POLLOCK	10	A	2	0	0	2	4	0	160	0	160
9. OTHER MARINE FISH	10	A	0	0	0	2	4	0	80	0	80
10. KING CRAB	6	A	2	1	1	2	9	8	324	288	580
11. TANNER CRAB	10	A	1	1	1	2	9	8	450	400	800
12. SCALLOPS	6	A	1	0	0	2	9	8	162	144	290
13. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	9	0	405	0	405
									2761	832	3501
4. INTERTIDAL SAND-MUD											
1. EELGRASS	1	M	0	0	0	3	4	1	12	3	13
2. PACIFIC SANDLANCE	3	M	0	0	0	3	9	8	81	72	145
3. RAZOR CLAM	3	A	0	2	2	2	9	8	162	144	290
4. SOFTSHELL BIVALVES	15	A	0	3	1	2	9	8	810	720	1450
5. INVERTEBRATE INFAUNA	15	A	0	0	0	3	9	1	405	45	410
6. MARINE MAMMAL ROOKERIES	6	A	0	0	0	5	4	0	120	0	120
7. SHOREBIRDS	10	P	0	0	0	5	9	1	450	50	456
8. GEESE	6	A	1	2	0	1	4	1	96	24	102
9. DUCKS	6	A	1	2	0	2	9	8	270	240	483
10. SWANS	6	A	0	0	0	5	9	1	540	60	547
									2946	1358	4016

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-47. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	15	H	0	0	0	3	9	0	405	0	405
2. GREENLINGS	3	A	0	1	0	2	4	0	36	0	36
3. HERRING	10	A	3	0	0	2	9	8	450	400	806
4. SESSILE MARINE INVERTEBRATES	15	A	0	0	0	1	9	8	135	120	242
5. MISC. CRUSTACEANS	6	A	0	1	1	2	9	8	216	192	387
6. OTHER INVERTEBRATES	10	A	0	0	0	3	9	8	270	240	483
7. SHOREBIRDS	3	P	0	0	0	5	9	1	135	15	137
8. SEA DUCKS	3	A	1	2	0	2	9	1	135	15	137
9. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	9	1	450	50	450
									2232	1032	3089
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	H	0	0	0	3	4	0	120	0	120
2. SMELT	3	A	1	1	1	3	9	8	162	144	290
3. HARDSHELL BIVALVES	15	A	0	2	1	2	9	1	675	75	693
4. CRUSTACEANS	10	A	0	0	0	2	9	1	180	20	182
5. GASTROPODS	10	A	0	0	0	3	9	1	270	30	273
6. SHOREBIRDS	3	P	0	0	0	5	9	1	135	15	137
									1542	284	1665
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	H	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	H	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	2	1	2	0	0	0	0	0
4. CHUM SALMON	6	A	0	3	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	2	1	2	0	0	0	0	0
6. PINK SALMON	15	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	6	A	0	2	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	H	0	2	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	H	0	2	1	1	0	0	0	0	0
13. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	H	0	0	0	2	0	0	0	0	0
15. DUCKS	6	A	1	2	0	2	0	0	0	0	0
16. GEESE	10	A	1	2	0	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	1	0	0	0	0	0
19. RIVER OTTER	6	A	2	0	1	1	0	0	0	0	0
19. MINK	6	A	2	0	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	0	1	1	0	0	0	0	0
									0	0	0

TABLE 2-47. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
1. TUNDRA	1	M	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	10	M	0	0	0	2	1	1	20	20	40
3. STRAND VEGETATION	6	M	0	0	0	1	9	8	54	48	97
4. OTHER VEGETATION	18	A	2	2	1	2	9	1	630	70	638
5. BROWN BEAR	3	A	2	1	0	2	1	1	15	15	30
6. BLACK BEAR	6	A	1	3	1	5	1	1	60	60	120
7. WOLVERINE	3	A	1	0	0	1	4	1	24	6	26
8. WOLF	3	A	1	0	0	1	1	1	6	6	12
9. MOOSE	1	A	0	1	1	2	0	0	0	0	0
11. DEER	6	A	1	1	1	2	0	0	0	0	0
15. GOATS	6	A	1	2	1	1	0	0	0	0	0
16. OTHER MAMMALS	6	A	2	0	1	2	4	1	120	30	124
17. RAPTORS	15	A	0	0	0	5	4	1	300	75	319
18. PTARMIGAN	6	P	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	4	1	80	20	82
									1389	350	1495
									16106	6152	19274

TABLE 2-43 MATRIX RESULTS--
CASE 3

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	VALDEZ NARROWS
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	BUNKER C
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	1	0	18	0	18
2. ZOOPLANKTON	6	A	0	0	0	3	1	0	18	0	18
3. ICHTHYOPLANKTON	6	A	0	0	0	2	1	0	12	0	12
4. FLOATING SEAWEED	10	M	0	0	0	2	1	0	20	0	20
5. OFFSPRINGS	3	M	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	3	M	0	0	0	3	0	0	0	0	0
7. HERRING	10	A	3	0	0	3	4	0	240	0	240
8. SMELT	3	A	1	1	1	3	4	0	72	0	72
9. CRAB LARVAE	6	E	0	0	0	2	4	0	48	0	48
10. KING SALMON	1	A	1	2	1	2	1	0	6	0	6
11. CHUM SALMON	6	A	2	2	1	2	1	0*	42	0	42
12. SOCKEYE SALMON	3	A	2	2	1	2	1	0	21	0	21
13. PINK SALMON	10	A	3	2	1	2	1	0	60	0	60
14. COHO SALMON	6	A	3	2	1	2	1	0	48	0	48
15. RAINBOW-STEELHEAD TROUT	6	M	0	1	0	1	4	0	48	0	48
16. DOLLY VARDEN	10	M	0	2	0	1	4	0	120	0	120
17. NORTHERN FUR SEAL	3	A	0	0	0	5	1	0	15	0	15
21. HARBOR SEAL	10	A	0	0	0	5	1	0	50	0	50
22. SEA LIONS	10	A	0	0	0	5	0	0	0	0	0
24. WHALES	10	A	0	0	0	4	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	1	0	30	0	30
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	5	4	0	300	0	300
									1188	0	1188
2. SUBTIDAL SAND-MUD											
1. CODS	10	A	2	1	1	2	0	0	0	0	0
2. SCULPINS	6	M	0	0	0	2	4	0	48	0	48
3. STARRY FLOUNDER	10	A	2	0	0	2	1	0	40	0	40
4. OTHER FLATFISH	10	A	2	0	0	2	1	0	40	0	40
5. PACIFIC SANDLANCE	3	M	3	0	0	3	4	0	36	0	36

TABLE 2-48. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	10	M	0	0	0	2	1	0	20	0	20
7. DUNGENESS CRAB	6	A	1	0	1	2	9	0	216	0	216
8. SHRIMP	10	A	3	2	2	3	4	0	400	0	400
9. RAZOR CLAM	3	M	0	0	0	2	9	0	54	43	97
10. OTHER BIVALVES	10	A	0	0	0	1	9	0	90	80	161
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	9	0	270	240	483
									1214	368	1541
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	15	M	0	0	0	2	4	0	120	0	120
2. SUBTIDAL SEAWEED	15	M	0	0	0	2	1	0	30	0	30
3. CHUM SALMON	6	A	2	1	1	2	4	0	144	0	144
4. PACIFIC HALIBUT	6	A	3	1	0	2	1	0	36	0	36
5. OTHER FLATFISH	10	A	2	0	0	2	1	0	40	0	40
6. GREENLINGS	6	A	0	1	0	2	1	0	18	0	18
7. ROCKFISH	10	A	3	1	0	2	1	0	60	0	60
8. WALLEYE POLLOCK	10	A	2	0	0	2	1	0	40	0	40
9. OTHER MARINE FISH	10	A	0	0	0	2	1	0	20	0	20
10. KING CRAB	6	A	2	1	1	2	4	1	144	30	153
11. TANNER CRAB	10	A	1	1	1	2	4	1	200	50	213
12. SCALLOPS	6	A	1	0	0	2	4	1	72	18	77
13. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	4	0	180	0	180
									1104	204	1131
4. INTERTIDAL SAND-MUD											
1. EELGRASS	1	M	0	0	0	3	4	1	12	3	13
2. PACIFIC SANDLANCE	3	M	0	0	0	3	4	1	36	9	38
3. RAZOR CLAM	3	A	0	2	2	2	9	27	162	486	1620
4. SOFT-SHELL BIVALVES	15	A	0	3	1	2	9	8	810	720	1458
5. INVERTEBRATE INFAUNA	15	A	0	0	0	3	9	8	405	360	729
6. MARINE MAMMAL ROOKERIES	6	A	0	0	0	5	1	1	30	30	60
7. SHOREBIRDS	10	P	0	6	0	5	9	8	450	360	806
8. GEESE	6	A	1	2	0	1	4	1	96	24	102
9. DUCKS	6	A	1	2	0	2	4	1	120	30	128
10. SWANS	6	A	0	0	0	*	4	1	240	60	255
									2301	2124	5197

U.S. COAST GUARD OIL SPILL PREDICTION STUDY

TABLE 2-48. (CONT'D.)

EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	15	M	0	0	0	3	9	1	405	45	410
2. GREENLINGS	3	A	0	1	0	2	1	0	9	0	9
3. HERRING	10	A	3	0	0	2	4	1	200	50	213
4. SESSILE MARINE INVERTEBRATES	15	A	0	0	0	1	9	8	135	120	242
5. MISC. CRUSTACEANS	6	A	0	1	1	2	4	0	96	0	96
6. OTHER INVERTEBRATES	10	A	0	0	0	3	9	1	270	30	273
7. SHOREBIRDS	3	P	0	0	0	5	9	0	135	0	135
8. SEA DUCKS	3	A	1	2	0	2	4	0	60	0	60
9. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	9	1	450	50	456
									1760	295	1894
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	M	0	0	0	3	4	1	120	30	124
2. SMELT	3	A	1	1	1	3	4	0	72	0	72
3. HARDSHELL CLAMS	15	A	0	2	1	2	4	1	300	75	319
4. CRUSTACEANS	10	A	0	0	0	2	4	1	80	20	85
5. GASTROPODS	10	A	0	0	0	3	1	0	30	0	30
6. SHOREBIRDS	3	P	0	0	0	5	4	8	60	120	300
									662	245	934
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	M	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	2	1	2	0	0	0	0	0
4. CHUM SALMON	6	A	0	3	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	2	1	2	0	0	0	0	0
6. PINK SALMON	15	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	6	A	0	2	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	M	0	2	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	M	0	2	1	1	0	0	0	0	0
13. STICKLEBACK	6	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	M	0	0	0	2	0	0	0	0	0
15. DUCKS	6	A	1	2	0	2	0	0	0	0	0
16. GEESE	10	A	1	2	0	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	*	0	0	0	0	0
18. RIVER OTTER	6	A	2	0	1	1	0	0	0	0	0
19. MINK	6	A	2	0	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	0	1	1	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-48. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
1. TUNDRA	1	M	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	10	M	0	0	0	2	1	1	20	20	40
3. STRAND VEGETATION	6	M	0	0	0	1	9	8	54	43	97
4. OTHER VEGETATION	10	A	2	2	1	2	9	1	630	70	638
5. BROWN BEAR	3	A	2	1	0	2	1	1	15	15	30
6. BLACK BEAR	6	A	1	3	1	5	1	1	60	60	120
7. WOLVERINE	3	A	1	0	0	1	1	1	6	6	12
8. WOLF	3	A	1	0	0	1	1	1	6	6	12
9. MOOSE	1	A	0	1	1	2	0	0	0	0	0
11. DEER	6	A	1	1	1	2	0	0	0	0	0
15. GOATS	6	A	1	2	1	1	0	0	0	0	0
16. OTHER MAMMALS	6	A	2	0	1	2	1	1	30	30	60
17. RAPTORS	15	A	0	0	0	5	1	1	75	75	150
18. PTARMIGAN	6	P	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	1	1	20	20	40
									916	356	1199
									9205	3484	13084

(4) DRIFT RIVER - CLEANUP

APPROPRIATE CLEANUP METHODS

In Summer, the open-water cleanup methods judged most effective were barriers, skimmers, and sorbents. The most applicable beach cleanup method was judged to be mechanical/manual removal. The next most effective methods were on-site sand cleaning, steam cleaning, and sand blasting.

For Winter, the Drift River site presents formidable problems. The broken moving ice (with little if any clear water) precludes effective use of mechanical oil pickup devices and prevents oil concentration pools from forming except under slack tide conditions. Furthermore, the movement of the ice rubble will disperse oil over and under the more cohesive ice segments to make it physically inaccessible. Thus, except for very large spills, any cleanup activity will prove ineffective. In the event of very large spills, selective mechanical/manual cleanup effort during quiescent ice movement periods may serve to remove some oil concentrations.

POSTULATED SCENARIO

SUMMER: The oil basically moved north and east and impacted the northern half of Kalgin Island in about 8 hours, and the western shore of Cook Inlet in about 12 hours. Minimum response times were around 3 hours for personnel to reach the spill site, and 7 to 8 hours for cleanup equipment and material. It was assumed that skimmers and beach cleanup would remove about 15 to 20 percent of the oil.

WINTER: In late Fall, before freezeup, the oil spill scenario had the spill moving southward, impacting lower Kalgin Island and the western shoreline of Cook Inlet about 18 hours after the spill. Mechanical/manual removal

was considered still effective for impacted beaches, but skimmers were felt to be hampered by drifting ice. After freezeups, some selective manual removal may be possible, with minimal response times of about 4 to 6 hours. Any normal operations will be dictated by personnel safety and exposure limitations.

MATRIX RESULTS

The primary analyses were for Summer, 50,000 barrels, diesel-2 and crude oil. These two cases are discussed as follows:

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 18,284

Since some oil was postulated cleaned up by skimmers, the impact score for the pelagic habitat decreased slightly (from 6,671 to 6,666) compared to the non-cleanup cases. The subtidal sand/mud habitat also decreased slightly (1,451 to 1,437), as did the subtidal rock/cobble/gravel habitat (598 to 594). The score for the intertidal sand/mud habitat remained the same (5,763), as did the freshwater river habitat (0). Impact scores increased for intertidal rocky (805 to 931), intertidal cobble/gravel (2,250 to 2,340), and terrestrial (382 to 553) habitats. Table 2-49 presents the complete results for Case 1.

CASE 2: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 15,746

The impact scores decreased for the following habitats compared to the non-cleanup case:

Pelagic	from 3,516 to 3,453
Subtidal sand/mud	from 1,974 to 1,959
Subtidal rock/cobble/ gravel	from 753 to 739
Intertidal sand/mud	from 5,779 to 5,768

The scores for intertidal rocky (1,118) and freshwater river (0) habitats remained the same. The scores increased for the intertidal cobble/gravel (from 2,140 to 2,203) and terrestrial (335 to 506) habitats. Table 2-50 presents the complete results for Case 2.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-49. MATRIX RESULTS--
CASE 1

AREA	DRIFT RIVER
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	9	0	162	0	162
2. ZOOPLANKTON	3	A	0	0	0	3	9	0	81	0	81
3. ICHTHYOPLANKTON	3	A	0	0	0	2	9	0	54	0	54
6. PACIFIC SANDLANCE	3	A	0	0	0	3	9	0	81	0	81
7. HERRING	6	A	3	0	0	3	9	8	324	208	580
8. SMELT	10	A	1	1	3	3	9	8	720	640	1269
9. CRAB LARVAE	3	A	0	0	0	2	9	8	54	46	97
10. KING SALMON	3	A	3	1	1	2	9	8	189	168	336
11. CHUM SALMON	3	A	3	1	1	2	9	8	189	168	338
12. SOCKEYE SALMON	6	A	3	1	1	2	9	8	378	336	677
13. PINK SALMON	3	A	3	1	1	2	9	8	189	168	338
14. COHO SALMON	10	A	3	1	1	2	9	8	630	560	1128
15. RAINBOW-STEELHEAD TROUT	6	A	0	1	2	1	9	8	216	192	387
16. DOLLY VARDEN	6	A	0	1	1	1	9	8	162	144	290
17. NORTHERN FUR SEAL	1	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	6	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	3	A	0	0	0	5	0	0	0	0	0
24. WHALES	6	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	1	A	0	0	0	5	4	0	20	0	20
27. OTHER MARINE MAMMALS	6	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	9	8	450	400	806
									3099	3112	6666
2. SUBTIDAL SAND-MUD											
1. CODS	1	A	1	1	1	2	1	0	5	0	5
2. SCULPINS	3	A	3	0	0	2	4	0	24	0	24
3. STARRY FLOUNDER	6	A	0	1	0	2	1	0	18	0	18
4. OTHER FLATFISH	6	A	1	1	1	2	1	0	30	0	30
5. PACIFIC SANDLANCE	3	A	0	0	0	3	4	0	36	0	36
6. MISC. MARINE FISH	3	A	0	1	0	2	4	0	36	0	36
7. DUNGENESS CRAB	3	A	1	1	1	2	9	8	135	120	242

TABLE 2-49. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
8. SHRIMP	3	A	1	1	1	3	9	8	162	144	290
9. RAZOR CLAM	15	A	2	0	0	2	9	0	540	0	540
10. OTHER BIVALVES	6	A	0	0	0	1	9	0	54	0	54
11. OTHER MARINE INVERTEBRATES	6	A	0	0	0	3	9	0	162	0	162
									1202	264	1437
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	3	A	0	0	0	2	1	0	6	0	6
3. CHUM SALMON	3	A	3	1	1	2	9	0	189	0	189
4. PACIFIC HALIBUT	3	A	1	2	1	2	4	0	72	0	72
5. OTHER FLATFISH	3	A	0	1	0	2	4	0	36	0	36
6. GREENLINGS	1	A	0	0	0	2	4	0	8	0	8
8. WALLEYE POLLOCK	1	A	1	0	1	2	4	0	16	0	16
9. OTHER MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
10. KING CRAB	3	A	1	0	1	2	9	0	108	0	108
11. TANNER CRAB	1	A	1	0	1	2	9	0	36	0	36
12. SCALLOPS	1	A	0	0	0	2	9	0	18	0	18
13. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	9	0	81	0	81
									594	0	594
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	9	8	81	72	145
3. RAZOR CLAM	15	A	2	3	3	2	9	8	1350	1[illegible]0	2417
4. SOFTSHELL BIVALVES	10	A	0	2	1	2	9	8	450	400	806
5. INVERTEBRATE INFAUNA	10	A	0	0	0	3	9	8	270	240	483
6. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	4	0	200	0	200
7. SHOREBIRDS	15	A	0	0	0	5	9	8	675	600	1208
8. GEESE	6	A	1	3	0	1	4	8	126	[illegible]	120
9. DUCKS	6	A	1	3	0	2	4	0	144	0	144
10. SWANS	6	A	0	0	0	*	4	0	240	0	240
									3536	2512	5763
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	A	0	0	0	3	1	0	9	0	9
2. GREENLINGS	1	A	0	0	0	2	4	0	8	0	8
3. HERRING	6	A	3	0	0	2	9	8	270	240	483
4. SESSILE MARINE INVERTEBRATES	3	E	0	0	0	1	9	8	27	24	48
5. MISC. CRUSTACEANS	3	A	0	0	0	2	9	8	54	48	97

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 9. (CONT'D.)

HAB I. SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	3	A	0	0	0	3	9	0	81	72	145
7. SHOREBIRDS	3	A	0	0	0	5	4	1	60	15	64
8. SEA DUCKS	3	A	1	3	0	2	4	1	72	18	77
									581	417	931
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	A	0	0	0	3	4	0	36	0	36
2. SMELT	10	A	1	3	3	3	9	8	900	800	1611
3. HARDSHELL BIVALVES	6	A	0	1	1	2	9	8	216	192	387
4. CRUSTACEAN	3	A	0	0	0	2	9	8	54	48	97
5. GASTROPODS	3	E	0	0	0	3	9	8	81	72	145
6. SHOREBIRDS	3	A	0	0	0	5	4	1	60	15	64
									1347	1147	2340
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	3	A	2	2	2	2	0	0	0	0	0
4. CHUM SALMON	3	A	2	0	0	2	0	0	0	0	0
5. SOCKEYE SALMON	6	A	2	2	2	2	0	0	0	0	0
6. PINK SALMON	3	A	2	2	2	2	0	0	0	0	0
7. COHO SALMON	10	A	2	2	2	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	3	2	1	0	0	0	0	0
9. DOLLY VARDEN	3	A	0	3	2	1	0	0	0	0	0
13. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	A	0	0	0	2	0	0	0	0	0
15. DUCKS	10	A	1	3	0	2	0	0	0	0	0
16. GEESE	10	A	1	3	0	2	0	0	0	0	0
17. SWANS	10	A	0	0	0	*	0	0	0	0	0
18. RIVER OTTER	6	A	2	1	1	1	0	0	0	0	0
19. MINK	6	A	2	1	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	1	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	1	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	1	A	0	0	0	3	4	1	12	3	13
2. RIPARIAN VEGETATION	10	A	0	0	0	2	1	0	20	0	20

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TABLE 2-49. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
8. TERRESTRIAL											
3. STRAND VEGETATION	10	A	0	0	0	1	9	0	90	0	90
4. OTHER VEGETATION	10	A	2	0	0	2	4	0	160	0	160
5. BROWN BEAR	6	A	2	2	0	2	1	0	36	0	36
6. BLACK BEAR	6	A	1	2	1	2	1	0	36	0	36
7. WOLVERINE	3	A	1	2	1	1	1	0	15	0	15
8. WOLF	3	A	1	2	1	1	1	0	15	0	15
9. MOOSE	15	A	3	2	3	2	0	0	0	0	0
10. CARIBOU	3	A	0	2	1	2	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	0	0	2	4	0	48	0	48
17. RAPTORS	10	A	0	0	0	5	1	0	50	0	50
18. PTARMIGAN	6	A	0	2	1	2	1	0	30	0	30
19. OTHER BIRDS	10	A	0	1	1	2	1	0	40	0	40
									552	3	553
									11705	7435	16284

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-50. MATRIX RESULTS-- CASE 2

AREA	DRIFT RIVER
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE INV.	CONF.	IMPORTANCE COM.	REC.	SUB.	ECOL.	IMPACT S.TRM	L.TRM	S.TRM	IMPACT L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
2. ZOOPLANKTON	3	A	0	0	0	3	4	0	36	0	36
3. ICHTHYOPLANKTON	3	A	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	3	A	0	0	0	3	4	0	36	0	36
7. HERRING	6	A	3	0	0	3	9	0	324	285	580
8. SMELT	10	A	1	1	3	3	9	0	720	0	720
9. CRAB LARVAE	3	A	0	0	0	2	9	0	54	48	97
10. KING SALMON	3	A	3	1	1	2	4	0	84	0	84
11. CHUM SALMON	3	A	3	1	1	2	4	0	84	0	84
12. SOCKEYE SALMON	6	A	3	1	1	2	4	0	168	0	168
13. PINK SALMON	3	A	3	1	1	2	4	0	84	0	84
14. COHO SALMON	10	A	3	1	1	2	4	0	280	0	280
15. RAINBOW-STEELHEAD TROUT	6	A	0	1	2	1	9	8	216	192	387
16. DOLLY VARDEN	6	A	0	1	1	1	9	8	162	144	290
17. NORTHERN FUR SEAL	1	A	0	0	0	5	1	0	5	0	5
21. HARBOR SEAL	6	A	0	0	0	5	1	0	30	0	30
22. SEA LIONS	3	A	0	0	0	5	0	0	0	0	0
24. WHALES	6	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	1	A	0	0	0	5	4	0	20	0	20
27. OTHER MARINE MAMMALS	6	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	9	1	450	50	456
									2849	722	3453
2. SUBTIDAL SAND-MUD											
1. CODS	1	A	1	1	1	2	4	0	20	0	20
2. SCULPINS	3	A	0	0	0	2	9	0	54	0	54
3. STARRY FLOUNDER	6	A	0	1	0	2	1	0	18	0	18
4. OTHER FLATFISH	6	A	1	1	1	2	4	0	120	0	120
5. PACIFIC SANDLANCE	3	A	0	0	0	3	9	0	81	0	81
6. MISC. MARINE FISH	3	A	0	1	0	2	4	0	36	0	36
7. DUNGENESS CRAB	3	A	1	1	1	2	9	8	135	120	242

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-50. (CONT'D.)

HABITAT. SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
8. SHRIMP	3	A	1	1	1	3	9	0	162	0	162
9. RAZOR CLAM	15	A	2	0	0	2	9	8	540	480	967
10. OTHER BIVALVES	6	A	0	0	0	1	9	8	54	48	97
11. OTHER MARINE INVERTEBRATES	6	A	0	0	0	3	9	0	162	0	162
									1382	648	1959
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	3	A	0	0	0	2	4	0	24	0	24
3. CHUM SALMON	3	A	3	1	1	2	9	0	189	0	189
4. PACIFIC HALIBUT	3	A	1	2	1	2	4	0	72	0	72
5. OTHER FLATFISH	3	A	3	1	0	2	4	0	36	0	36
6. GREENLINGS	1	A	0	0	0	2	4	0	8	0	8
8. WALLEYE POLLOCK	1	A	1	0	1	2	4	0	16	0	16
9. OTHER MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
10. KING CRAB	3	A	1	0	1	2	9	8	108	96	193
11. TANNER CRAB	1	A	1	0	1	2	9	8	36	32	64
12. SCALLOPS	1	A	0	0	0	2	9	8	18	16	32
13. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	9	0	81	0	81
									612	144	739
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	9	8	81	72	145
3. RAZOR CLAM	15	A	2	3	0	2	9	8	1350	1200	2417
4. SOFTSHELL BIVALVES	10	A	0	2	1	2	9	8	540	480	966
5. INVERTEBRATE INFAUNA	10	A	0	0	0	3	9	0	270	0	270
6. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	4	0	200	0	200
7. SHOREBIRDS	15	A	0	0	0	5	9	1	675	75	003
8. GEESE	6	A	1	3	0	1	4	0	120	0	120
9. DUCKS	6	A	1	3	0	2	9	8	324	288	580
10. SWANS	6	A	0	0	0	3	9	1	540	60	547
									4010	2095	5766
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	A	0	0	0	3	4	0	36	0	36
2. GREENLINGS	1	A	0	0	0	2	4	0	8	0	8
3. HERRING	6	A	3	0	0	2	9	8	270	240	503
4. SESSILE MARINE INVERTEBRATES	3	E	0	0	0	1	9	8	27	24	48
5. MISC. CRUSTACEANS	3	A	0	0	0	2	9	8	54	48	97

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-50. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT				
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	3	A	0	0	0	3	9	8	81	72	145
7. SHOREBIRDS	3	A	0	0	0	5	9	1	135	15	137
8. SEA DUCKS	3	A	1	3	0	2	9	1	162	18	164
									773	417	1118
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	A	0	0	0	3	4	0	36	0	36
2. SHELT	10	A	1	3	3	3	9	8	900	800	1611
3. HARDSHELL BIVALVES	6	A	0	1	1	2	9	1	216	24	219
4. CRUSTACEANS	3	A	0	0	0	2	9	1	54	6	55
5. GASTROPODS	3	A	0	0	0	3	9	8	81	72	145
6. SHOREBIRDS	3	A	0	0	0	5	9	1	135	15	137
									1422	917	2203
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	3	A	2	2	2	2	0	0	0	0	0
4. CHUM SALMON	3	A	2	0	0	2	0	0	0	0	0
5. SOCKEYE SALMON	6	A	2	2	2	2	0	0	0	0	0
6. PINK SALMON	3	A	2	2	2	2	0	0	0	0	0
7. COHO SALMON	10	A	2	2	2	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	3	2	1	0	0	0	0	0
9. DOLLY VARDEN	3	A	0	3	2	1	0	0	0	0	0
13. STICKLEBACKS	6	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	A	0	0	0	2	0	0	0	0	0
15. DUCKS	10	A	1	3	0	2	0	0	0	0	0
16. GEESE	10	A	1	3	0	2	0	0	0	0	0
17. SWANS	10	A	0	0	0	*	0	0	0	0	0
18. RIVER OTTER	6	A	2	1	1	1	0	0	0	0	0
19. MINK	6	A	2	1	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	1	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	1	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	1	A	0	0	0	3	4	1	12	3	13
2. RIPARIAN VEGETATION	10	A	0	0	0	2	1	0	20	0	20

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-50. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
8. TERRESTRIAL											
3. STRAND VEGETATION	10	A	0	0	0	1	4	1	40	10	43
4. OTHER VEGETATION	10	A	2	0	0	2	4	0	160	0	160
5. BROWN BEAR	6	A	2	2	0	2	1	0	36	0	36
6. BLACK BEAR	6	A	1	2	1	2	1	0	36	0	36
7. WOLVERINE	3	A	1	2	1	1	1	0	15	0	15
8. WOLF	3	A	1	2		1	1	0	15	0	15
9. MOOSE	15	A	3	2	3	2	0	0	0	0	0
10. CARIBOU	3	A	0	2	1	2	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	0	0	2	4	0	48	0	48
17. RAPTORS	10	A	0	0	0	5	1	0	50	0	50
18. PTARMIGAN	6	A	0	2	1	2	1	0	30	0	30
19. OTHER BIRDS	10	A	0	1	1	2	1	0	40	0	40
									562	13	586
									11550	4956	15746

(5) PORT GRAHAM - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective open-sea methods were judged to be barriers and skimming devices. The next most effective method was judged to be sorbents with mechanical/manual removal. The most effective beach cleanup method was judged to be mechanical/manual removal. The next most effective method was judged to be on-site sand cleaning; steam cleaning and sand blasting followed.

WINTER: The above methods were also the most effective for Winter. Open-sea methods were reduced in effectiveness by the presence of ice.

POSTULATED SCENARIO

The Summer scenario conditions moved the spill southerly to the shore at Port Graham in about 5 hours. The wind and tide then carried much of the remaining slick northerly across the mouth of Kachemak Bay to impact the eastern shore of Cook Inlet near Anchor Point in about 60 hours. Response times of 9 to 10 hours for barriers and skimming devices did not allow reduction of the shoreline impact at Port Graham, but were postulated to reduce the impact on the northern beaches, removing oil in transit across the mouth of the Bay. Mechanical/manual removal was presumed applied on the southerly beaches impacted.

In the Winter scenario, little beach impact was noted as the slick basically moved offshore in a southwesterly direction. Barriers and skimming devices were hampered by ice presence. Manual removal and skimming devices were presumed used with moderate effectiveness.

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 22,450

The impact scores decreased from the non-cleanup case for the following habitats:

Pelagic	from 6,387 to 6,028
Subtidal sand/mud	from 4,722 to 4,671
Intertidal sand/mud	from 12,429 to 2,702

The impact scores for the following habitats increased from the non-cleanup case:

Intertidal rocky	from 2,767 to 3,415
Terrestrial	from 210 to 684

Impact scores remained the same for intertidal cobble/gravel (1,868) and subtidal rock/cobble/gravel (3,082) habitats. Table 2-51 presents the complete results for Case 1.

CASE 2: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 17,549

Impact scores were changed as a result of beach cleanup south of the spill site and reduction of amount of oil reaching beaches north of the spill site. The following shows the changes in habitat scores from the non-cleanup case:

Pelagic	from 3,583 to 3,197
Subtidal sand/mud	from 3,403 to 2,917
Subtidal rock/cobble/ gravel	from 3,412 to 3,272
Intertidal rocky	from 3,550 to 3,713

Terrestrial	from 245 to 684
Intertidal cobble/ gravel	no change (1,667)
Freshwater river	no change (0)
Intertidal sand/mud	from 3,059 to 2,099

Table 2-52 presents the complete results for Case 2.

CASE 3: SUMMER, GASOLINE, 50,000 BBLS - IMPACT SCORE 2,962

No cleanup methods were judged appropriate for gasoline, mainly because of the hazard to personnel. Thus, the spill was presumed dissipated by natural action--exactly as in the non-cleanup case.

Winter impact scores were not calculated as the non-cleanup cases in Winter were much lower than in Summer. The hampered effectiveness of open-sea cleanup methods due to ice would result in minor changes from the non-cleanup scores.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-51. MATRIX RESULTS-- CASE 1

AREA	PORT GRAHAM
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS: ABUNDANCE INV.	ABUNDANCE CONF.	IMPORTANCE COM.	IMPORTANCE REC.	IMPORTANCE SUB.	IMPORTANCE ECOL.	IMPACT S.TRM	IMPACT L.TRM	RESULTS: IMPACT S.TRM	IMPACT L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	10	A	0	0	0	3	9	0	270	0	270
2. ZOOPLANKTON	10	A	0	0	0	3	9	0	270	0	270
3. ICHTHYOPLANKTON	10	H	0	0	0	2	9	0	180	0	180
4. FLOATING SEAWEED	10	E	0	0	0	2	1	0	20	0	20
5. GREENLINGS	3	H	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	3	E	0	0	0	3	9	0	81	0	81
7. HERRING	15	A	3	1	1	3	9	8	1080	960	1933
8. SMELT	6	A	1	0	0	3	9	8	216	192	387
9. CRAB LARVAE	15	A	0	0	0	2	9	8	270	240	483
10. KING SALMON	1	A	0	1	1	2	9	8	36	32	64
11. CHUM SALMON	1	A	1	0	1	2	9	8	36	32	64
12. SOCKEYE SALMON	3	A	1	1	1	2	9	8	135	120	242
13. PINK SALMON	6	A	2	1	1	2	9	8	324	288	580
14. COHO SALMON	1	A	1	1	1	2	9	8	45	40	81
15. RAINBOW-STEELHEAD TROUT	6	A	0	0	2	1	9	8	162	144	290
16. DOLLY VARDEN	10	A	0	0	2	1	9	8	270	240	483
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	6	A	0	0	0	5	0	0	0	0	0
24. WHALES	6	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	4	0	120	0	120
27. OTHER MARINE MAMMALS	6	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	9	1	450	50	456
									3989	2638	6028
2. SUBTIDAL SAND-MUD											
1. CODS	3	H	2	1	1	2	4	0	72	0	72
2. SCULPINS	3	A	0	0	0	2	4	0	24	0	24
3. STARRY FLOUNDER	6	H	1	0	0	2	1	0	18	0	18
4. OTHER FLATFISH	6	A	2	1	1	2	1	0	36	0	36
5. PACIFIC SANDLANCE	3	A	0	0	0	3	4	0	36	0	36

TABLE 2-51. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	6	A	0	0	0	2	4	0	48	0	48
7. DUNGENESS CRAB	10	A	3	3	2	2	9	8	900	800	1611
8. SHRIMP	15	A	3	2	2	3	9	8	1350	1200	2417
9. RAZOR CLAM	10	A	0	0	0	2	4	1	80	40	85
10. OTHER BIVALVES	6	M	0	0	0	1	9	0	54	0	54
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	9	0	270	0	276
									2888	2620	4671
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	10	M	0	0	0	2	1	0	20	0	20
2. SUBTIDAL SEAWEED	10	E	0	0	0	2	1	0	20	0	20
3. CHUM SALMON	1	A	1	0	1	2	9	1	36	4	36
4. PACIFIC HALIBUT	15	A	3	3	2	2	4	0	600	0	600
5. OTHER FLATFISH	6	A	2	0	0	2	4	0	96	0	96
6. GREENLINGS	10	M	0	1	0	2	4	0	120	0	120
7. ROCKFISH	6	M	2	1	1	2	4	0	144	0	144
8. WALLEYE POLLOCK	6	M	2	1	1	2	4	0	144	0	144
9. OTHER MARINE FISH	10	M	0	0	0	2	4	0	80	0	80
10. KING CRAB	10	A	3	2	0	2	9	1	630	70	638
11. TANNER CRAB	10	A	3	1	1	2	9	1	630	70	638
12. SCALLOPS	10	A	0	0	0	2	9	1	180	20	182
13. OTHER MARINE INVERTEBRATES	10	A	1	0	0	3	9	1	360	40	364
									3060	204	3082
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	9	8	81	72	145
3. RAZOR CLAM	10	A	0	3	1	2	9	8	540	480	967
4. SOFTSHELL BIVALVES	6	E	1	1	1	2	9	8	270	240	483
5. INVERTEBRATE INFAUNA	10	E	0	0	0	3	9	8	270	240	483
6. MARINE MAMMAL ROOKERIES	3	A	0	0	0	5	1	0	15	0	15
7. SHOREBIRDS	6	P	0	0	0	5	9	1	270	33	273
8. GEESE	6	P	1	2	0	1	4	0	96	0	96
9. DUCKS	6	A	1	2	0	2	4	0	120	0	120
10. SWANS	6	A	0	0	0	5	4	0	120	0	120
									1782	1662	2702
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	10	E	0	0	0	3	1	0	30	0	30

U.S. COAST GUARD OIL SPILL PREDICTION STUDY

TABLE 2-51. (CONT'D.) EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
2. GREENLINGS	10	M	0	1	0	2	4	0	120	0	120
3. HERRING	15	A	3	1	1	2	9	8	945	840	1692
4. SESSILE MARINE INVERTEBRATES	10	E	0	0	0	1	9	8	90	80	161
5. MISC. CRUSTACEANS	10	E	0	0	0	2	9	8	180	160	322
6. OTHER INVERTEBRATES	15	E	0	0	0	3	9	8	405	360	725
7. SHOREBIRDS	3	P	0	0	0	5	9	1	135	15	137
8. SEA DUCKS	6	A	1	2	0	2	4	1	120	30	120
9. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	1	1	50	50	100
									2875	1535	3415
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	E	0	0	0	3	1	0	30	0	30
2. SMELT	6	A	1	3	1	3	9	8	432	384	773
3. HARDSHELL BIVALVES	10	E	1	1	0	2	9	8	360	320	644
4. CRUSTACEANS	6	E	0	0	0	2	9	8	108	96	193
5. GASTROPODS	6	E	0	0	0	3	9	1	162	18	164
6. SHOREBIRDS	3	P	0	0	0	5	4	1	60	15	64
									1152	833	1868
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	3	2	2	0	0	0	0	0
4. CHUM SALMON	1	A	0	0	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	0	1	2	0	0	0	0	0
6. PINK SALMON	6	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	1	A	0	0	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	A	0	3	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	A	0	2	2	1	0	0	0	0	0
13. STICKLEBACKS	10	M	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	M	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	1	2	0	2	0	0	0	0	0
16. GEESE	6	P	1	2	0	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	6	P	1	1	1	1	0	0	0	0	0
19. MINK	6	P	1	1	1	1	0	0	0	0	0
20. MUSKRAT	6	P	1	1	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	P	1	1	1	1	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-51. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	CON.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.T	RSLT.
8. TERRESTRIAL											
1. TUNDRA	1	P	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	6	P	0	0	0	2	4	0	48	0	48
3. STRAND VEGETATION	10	E	0	0	0	1	9	1	90	10	91
4. OTHER VEGETATION	10	P	1	0	0	2	9	6	270	0	270
5. BROWN BEAR	3	A	1	2	0	2	1	0	15	0	15
6. BLACK BEAR	10	A	1	3	1	2	1	0	70	0	70
7. WOLVERINE	3	A	1	0	0	1	1	0	6	0	6
8. WOLF	3	A	1	0	0	1	1	0	6	0	6
9. MOOSE	3	A	1	1	1	2	0	0	0	0	0
14. SHEEP	6	M	1	1	0	1	0	0	0	0	0
15. GOATS	6	M	1	1	0	1	0	0	0	0	0
16. OTHER MAMMALS	6	M	0	0	0	2	4	0	48	0	48
17. RAPTORS	10	P	0	0	0	5	1	0	50	0	50
18. PTARMIGAN	10	P	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	4	0	80	0	80
									683	10	684
									15629	8002	22450

TABLE 2-52. MATRIX RESULTS-- CASE 2

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

AREA	PORT GRAHAM
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	10	A	0	0	0	3	4	0	120	0	120
2. ZOOPLANKTON	10	A	0	0	0	3	4	0	120	0	120
3. ICHTHYOPLANKTON	10	H	0	0	0	2	4	0	80	0	80
4. FLOATING SEAWEED	10	E	0	0	0	2	1	0	20	0	20
5. GREENLINGS	3	H	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	3	E	0	0	0	3	1	0	9	0	9
7. HERRING	15	A	3	1	1	3	0	1	1080	120	1093
8. SMELT	6	A	1	0	0	3	0	1	216	24	219
9. CRAB LARVAE	15	A	0	0	0	2	0	1	270	30	273
10. KING SALMON	1	A	0	1	1	2	4	0	16	0	16
11. CHUM SALMON	1	A	1	0	1	2	4	0	14	0	14
12. SOCKEYE SALMON	3	A	1	1	1	2	4	0	60	0	60
13. PINK SALMON	6	A	2	1	1	2	4	0	144	0	144
14. COHO SALMON	1	A	1	1	1	2	4	0	20	0	20
15. RAINBOW-STEELHEAD TROUT	6	A	0	0	2	1	0	1	162	18	164
16. DOLLY VARDEN	10	A	0	0	2	1	0	1	270	30	273
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	6	A	0	0	0	5	0	0	0	0	0
24. WHALES	6	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	4	0	120	0	120
27. OTHER MARINE MAMMALS	6	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	0	0	450	0	450
									3173	222	3197
2. SUBTIDAL SAND-MUD											
1. CODS	3	H	2	1	1	2	4	0	72	0	72
2. SCULPINS	3	A	0	0	0	2	0	0	54	0	54
3. STARRY FLOUNDER	6	H	1	0	0	2	1	0	18	0	18
4. OTHER FLATFISH	5	A	2	1	1	2	4	0	144	0	144
5. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	81	0	81

TABLE 2-52 (CONT'D) U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TPM	L.TPM	S.TPM	L.TPM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	6	A	0	0	0	2	4	0	48	0	48
7. DUNGENESS CRAB	10	A	3	3	2	2	9	1	900	100	911
8. SHRIMP	15	A	3	2	2	3	9	0	1350	0	1350
9. RAZOR CLAM	10	A	0	0	0	2	4	1	80	20	85
10. OTHER BIVALVES	6	H	0	0	0	1	4	1	24	6	26
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	4	1	120	30	122
									2891	156	2917
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	10	H	0	0	0	2	4	0	80	0	80
2. SUBTIDAL SEAWEED	10	E	0	0	0	2	4	0	80	0	80
3. CHUM SALMON	1	A	1	0	1	2	9	1	36	4	34
4. PACIFIC HALIBUT	15	A	3	3	2	2	4	1	600	150	638
5. OTHER FLATFISH	6	A	2	0	0	2	4	1	96	24	102
6. GREENLINGS	10	H	0	1	0	2	4	1	120	30	128
7. ROCKFISH	6	H	2	1	1	2	4	1	144	36	153
8. WALLEYE POLLOCK	6	H	2	1	1	2	4	1	144	36	153
9. OTHER MARINE FISH	10	H	0	0	0	2	4	0	80	0	80
10. KING CRAB	10	A	3	2	0	2	9	1	630	70	638
11. TANNER CRAB	10	A	3	1	1	2	9	1	630	70	638
12. SCALLOPS	10	A	0	0	0	2	9	1	180	20	182
13. OTHER MARINE INVERTEBRATES	10	A	1	0	0	3	9	1	360	40	364
									3180	480	3272
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	9	1	81	9	82
3. RAZOR CLAM	10	A	0	3	1	2	9	1	540	60	547
4. SOFTSHELL BIVALVES	6	E	1	1	1	2	9	1	270	30	273
5. INVERTEBRATE INFAUNA	10	E	0	0	0	3	9	1	270	30	273
6. MARINE MAMMAL ROOKERIES	3	A	0	0	0	5	1	0	15	0	15
7. SHOREBIRDS	6	P	0	0	0	5	9	0	270	0	270
8. GEESE	6	P	1	2	0	1	4	0	96	0	96
9. DUCKS	6	A	1	2	0	2	9	1	270	30	273
10. SWANS	6	A	0	0	0	5	9	0	270	0	270
									2082	159	2099
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	10	E	0	0	0	3	4	1	120	30	129

TABLE 2-52 (CONT'D) U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
2. GREENLINGS	10	H	0	1	0	2	4	0	120	0	120
3. HERRING	15	A	3	1	1	2	9	9	945	840	1692
4. SESSILE MARINE INVERTEBRATES	10	E	0	0	0	1	9	9	90	80	161
5. MISC. CRUSTACEANS	10	E	0	0	0	2	9	9	180	160	322
6. OTHER INVERTEBRATES	15	E	0	0	0	3	9	9	405	360	725
7. SHOREBIRDS	3	P	0	0	0	5	9	9	135	120	242
8. SEA DUCKS	6	A	1	2	0	2	9	1	270	30	273
9. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	1	0	50	0	50
									2315	1620	3713
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	10	E	0	0	0	3	4	0	120	0	120
2. SMELT	6	A	1	3	1	3	9	9	432	396	773
3. HARDSHELL BIVALVES	10	E	1	1	0	2	9	1	360	40	364
4. CRUSTACEANS	6	E	0	0	0	2	9	1	108	12	109
5. GASTROPODS	6	E	0	0	0	3	9	1	162	18	164
6. SHOREBIRDS	3	P	0	0	0	5	9	1	135	15	137
									1317	469	1667
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	10	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	10	H	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	3	2	2	0	0	0	0	0
4. CHUM SALMON	1	A	0	0	1	2	0	0	0	0	0
5. SOCKEYE SALMON	3	A	0	0	1	2	0	0	0	0	0
6. PINK SALMON	6	A	0	3	1	2	0	0	0	0	0
7. COHO SALMON	1	A	0	3	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	A	0	3	1	1	0	0	0	0	0
9. DOLLY VARDEN	10	A	0	2	2	1	0	0	0	0	0
13. STICKLEBACKS	10	H	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	H	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	1	2	0	2	0	0	0	0	0
16. GEESE	6	P	1	2	0	2	0	0	0	0	0
17. SWANS	15	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	6	P	1	1	1	1	0	0	0	0	0
19. MINK	6	P	1	1	1	1	0	0	0	0	0
20. MUSKRAT	6	P	1	1	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	P	1	1	1	1	0	0	0	0	0
									0	0	0

TABLE 2-52 (CONT'D)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
1. TUNDRA	1	P	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	6	P	0	0	0	2	4	0	48	0	48
3. STRAND VEGETATION	10	E	0	0	0	1	9	1	90	10	91
4. OTHER VEGETATION	10	P	1	0	0	2	9	0	270	0	270
5. BROWN BEAR	3	A	1	2	0	2	1	0	15	0	15
6. BLACK BEAR	10	A	1	3	1	2	1	0	70	0	70
7. WOLVERINE	3	A	1	0	0	1	1	0	6	0	6
8. WOLF	3	A	1	0	0	1	1	0	6	0	6
9. MOOSE	3	A	1	1	1	2	0	0	0	0	0
14. SHEEP	6	H	1	1	0	1	0	0	0	0	0
15. GOATS	6	H	1	1	0	1	0	0	0	0	0
16. OTHER MAMMALS	6	H	0	0	0	2	4	0	48	0	48
17. RAPTORS	10	P	0	0	0	5	1	0	50	0	50
19. PTARMIGAN	10	P	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	4	0	80	0	80
									693	10	694
									15641	3116	17549

(6) KAMISHAK - CLEANUP

APPROPRIATE CLEANUP METHODS

The most effective open-sea methods in Summer were judged to be barriers, skimming devices, and sorbents. The most effective Summer beach cleanup method was judged to be mechanical/manual removal. On-site sand cleaning, steam cleaning, and sand blasting were judged to be the next most effective.

In Winter, Kamishak does not usually freeze over and the above methods were still the most effective. Open-sea methods were reduced in effectiveness by ice presence.

POSTULATED SCENARIO

The Summer spill scenario had oil moving northward to impact Augustine Island after about 18 hours. Response times for barriers and skimmers were estimated at 9 to 10 hours based on logistics information.[67] These were assumed deployed with resultant lower impact on Augustine. Beach cleanup was assumed deployed.

The Winter spill scenario assumed limited effectiveness of open-sea methods. Cleanup of the southern impacted beaches was assumed with moderate effectiveness at removing oil.

MATRIX RESULTS

CASE 1: SUMMER, DIESEL-2, 1,000 BBLS - IMPACT SCORE 8,309

Beach cleanup was presumed to generally increase the short-term impact scores for the intertidal and terrestrial habitats. Long-term impacts

for the other habitats were generally reduced from the non-cleanup scenario, reflecting the removal of some of the oil. The changes in habitat scores from the non-cleanup case are shown below:

Subtidal sand/mud	decreased from 1,094 to 1,085
Subtidal rock/cobble/ gravel	decreased from 1,781 to 1,119
Freshwater river	no change (0)
Intertidal sand/mud	no change (0)
Pelagic	increased from 2,694 to 3,002
Intertidal rocky	increased from 1,301 to 1,469
Intertidal cobble/ gravel	increased from 984 to 1,278
Terrestrial	increased from 314 to 356

Table 2-53 presents the complete results for Case 1. Due to the low scores, no other cleanup cases were run.

TABLE 2-53. MATRIX RESULTS--CASE 1

AREA	KAMISHAK
SEASON	SUMMER
SPILL SIZE	1,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	H	0	0	0	3	4	0	72	0	72
2. ZOOPLANKTON	6	H	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	6	A	0	0	0	2	4	0	48	0	48
4. FLOATING SEAWEED	6	H	0	0	0	2	1	0	12	0	12
5. GREENLINGS	1	H	0	0	0	2	1	0	2	0	2
6. PACIFIC SANDLANCE	3	A	0	0	0	3	4	0	36	0	36
7. HERRING	10	A	3	1	1	3	9	0	720	0	720
8. SMELT	6	A	1	0	0	3	4	0	96	0	96
9. CRAB LARVAE	10	E	0	0	0	2	4	0	80	0	80
10. KING SALMON	3	C	0	1	1	2	4	0	48	0	48
11. CHUM SALMON	1	A	1	0	1	2	4	0	16	0	16
12. SOCKEYE SALMON	1	A	1	1	1	2	4	0	20	0	20
13. PINK SALMON	3	A	2	1	1	2	4	0	72	0	72
14. COHO SALMON	1	A	1	1	1	2	4	0	20	0	20
15. RAINBOW-STEELHEAD TROUT	6	E	0	0	2	1	9	0	162	0	162
16. DOLLY VARDEN	10	E	0	0	2	1	9	0	270	0	270
17. NORTHERN FUR SEAL	3	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	10	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	6	A	0	0	0	5	0	0	0	0	0
24. WHALES	3	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	10	A	0	0	0	5	9	8	450	400	886
27. OTHER MARINE MAMMALS	3	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	A	0	0	0	5	9	0	450	0	450
									2646	400	3002
2. SUBTIDAL SAND-MUD											
1. CODS	3	A	2	1	1	2	1	0	18	0	18
2. SCULPINS	3	A	0	0	0	2	1	0	6	0	6
3. STARRY FLOUNDER	10	A	2	0	0	2	1	0	40	0	40
4. OTHER FLATFISH	10	A	2	1	1	2	1	0	60	0	60
5. PACIFIC SANDLANCE	3	A	0	0	0	3	1	0	9	0	9

TABLE 2-53. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	6	H	0	0	0	2	1	0	12	0	12
7. DUNGENESS CRAB	6	A	3	2	2	2	9	0	486	0	486
8. SHRIMP	10	E	0	0	0	3	9	0	270	0	270
9. RAZOR CLAM	3	H	0	0	0	2	4	0	24	0	24
10. OTHER BIVALVES	10	H	0	0	0	1	4	0	40	0	40
11. OTHER MARINE INVERTEBRATES	10	A	0	0	0	3	4	0	120	0	120
									1085	0	1085
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	6	H	0	0	0	2	0	0	0	0	0
2. SUBTIDAL SEAWEED	6	H	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	1	A	1	0	1	2	4	0	16	0	16
4. PACIFIC HALIBUT	10	A	3	3	2	2	1	0	100	0	100
5. OTHER FLATFISH	6	A	2	0	0	2	1	0	24	0	24
6. GREENLINGS	6	A	0	1	0	2	1	0	18	0	18
7. ROCKFISH	3	A	2	1	1	2	1	0	18	0	18
8. WALLEYE POLLOCK	1	A	1	1	1	2	1	0	15	0	15
9. OTHER MARINE FISH	6	H	0	0	0	2	1	0	12	0	12
10. KING CRAB	10	A	3	2	0	2	4	0	280	0	280
11. TANNER CRAB	15	A	3	1	1	2	4	0	420	0	420
12. SCALLOPS	10	A	1	0	0	2	4	0	120	0	120
13. OTHER MARINE INVERTEBRATES	6	H	1	0	0	3	4	0	96	0	96
									1119	0	1119
4. INTERTIDAL SAND-MUD											
1. EELGRASS	6	H	0	0	0	3	0	0	0	0	0
2. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
3. RAZOR CLAM	3	H	0	1	0	2	0	0	0	0	0
4. SOFTSHELL BIVALVES	10	H	1	1	1	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	6	H	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	10	A	0	0	0	5	0	0	0	0	0
8. GEESE	6	A	0	1	0	1	0	0	0	0	0
9. DUCKS	6	A	0	1	0	2	0	0	0	0	0
10. SWANS	6	A	0	0	0	4	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	6	H	0	0	0	3	0	0	0	0	0

TABLE 2-53. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
2. GREENLINGS	6	M	0	1	0	2	4	0	72	0	72
3. HERRING	10	A	3	1	1	2	9	1	630	70	638
4. SESSILE MARINE INVERTEBRATES	6	M	0	0	0	1	9	8	54	48	97
5. MISC. CRUSTACEANS	6	M	0	0	0	2	9	1	108	12	109
6. OTHER INVERTEBRATES	6	M	0	0	0	3	9	8	162	144	290
7. SHOREBIRDS	3	A	0	0	0	5	4	1	60	15	64
8. SEA DUCKS	3	A	1	2	0	2	4	1	60	15	64
9. MARINE MAMMAL ROOKERIES	3	A	0	0	0	5	9	0	135	0	135
									1281	306	1469
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	M	0	0	0	3	0	0	0	0	0
2. SMELT	6	A	1	0	0	3	9	1	216	24	219
3. HARDSHELL BIVALVES	6	M	1	1	0	2	9	8	216	192	387
4. CRUSTACEANS	6	M	0	0	0	2	9	1	108	12	109
5. GASTROPODS	6	M	0	0	0	3	9	8	162	144	290
6. SHOREBIRDS	6	A	0	0	0	5	9	1	270	30	273
									972	402	1276
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	6	M	0	0	0	3	0	0	0		0
2. AQUATIC INVERTEBRATES	15	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	3	A	0	1	1	2	0	0	0	0	0
4. CHUM SALMON	1	A	1	0	1	2	0	0	0	0	0
5. SOCKEYE SALMON	1	A	1	1	1	2	0	0	0	0	0
6. PINK SALMON	3	A	2	1	1	2	0	0	0	0	0
7. COHO SALMON	1	A	1	1	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	6	E	0	1	1	1	0	0	0	0	0
9. DOLLY VARDEN	6	E	0	1	2	1	0	0	0	0	0
13. STICKLEBACKS	6	M	0	0	0	3	0	0	0	0	0
14. OTHER FISH	6	M	0	0	0	2	0	0	0	0	0
15. DUCKS	10	A	0	1	0	2	0	0	0	0	0
16. GEESE	10	A	0	1	0	2	0	0	0	0	0
17. SWANS	10	A	0	0	0	*	0	0	0	0	0
18. RIVER OTTER	6	A	1	1	1	1	0	0	0	0	0
19. MINK	6	A	1	1	1	1	0	0	0	0	0
20. MUSKRAT	6	A	1	1	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	1	1	1	0	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-53. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
8. TERRESTRIAL											
1. TUNDRA	1	A	0	0	0	3	1	0	3	0	3
2. RIPARIAN VEGETATION	3	M	0	0	0	2	0	0	0	0	0
3. STRAND VEGETATION	10	M	0	0	0	1	1	1	10	10	20
4. OTHER VEGETATION	6	M	0	0	0	2	1	1	12	12	24
5. BROWN BEAR	15	A	2	2	2	2	0	0	0	0	0
6. BLACK BEAR	3	A	1	1	0	2	0	0	0	0	0
7. WOLVERINE	6	A	1	1	0	1	0	0	0	0	0
8. WOLF	6	A	1	1	0	1	0	0	0	0	0
9. MOOSE	6	A	2	2	1	2	0	0	0	0	0
10. CARIBOU	3	A	1	1	1	2	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	0	0	2	1	1	12	12	24
17. RAPTORS	10	A	0	0	0	5	4	0	200	0	200
18. PTARMIGAN	10	P	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	10	P	0	0	0	2	4	1	80	20	80
									317	54	356
									7420	1160	8389

(7) UNIMAK PASS - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: No open-sea cleanup methods were judged to be very effective at this location. Burning was judged to be slightly effective. Manual removal was judged to be hardly effective at all. On beaches, the most effective method was judged to be mechanical/manual removal. The next most effective methods were judged to be burning and natural dispersion.

WINTER: The only modification in the judged effectiveness of the above methods was a reduction in the effectiveness of open-water burning.

POSTULATED SCENARIO

The spill scenarios for the two seasons examined had the slick moving northerly through the Pass along the western shoreline of Unimak Island. Beaches on the island were impacted in about 15 hours. Only beach cleanup was postulated. Access was assumed to be by boat only. Cleanup was assumed directed to those spots where oil would tend to pile up.

MATRIX RESULTS

The only case analyzed was for the largest non-cleanup impact score. Similar results are expected for all other cases.

CASE 1: SUMMER, DIESEL-2, 50,000 BBLS - IMPACT SCORE 15,666

In general, the changes from the non-cleanup case were minor. The following were the changes in habitat scores:

Intertidal sand/mud	decreased from 1,830 to 1,814
Intertidal cobble/ gravel	decreased from 836 to 831

Intertidal rocky	increased from	1,902 to 1,911
Terrestrial	increased from	150 to 330

Table 2-54 presents the complete results for Case 1

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-54. MATRIX RESULTS-- CASE 1

AREA	UNIMAK PASS
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	15	A	0	0	0	3	9	0	405	0	405
2. ZOOPLANKTON	15	A	0	0	0	3	9	0	405	0	405
3. ICHTHYOPLANKTON	15	E	0	0	0	2	9	0	270	0	270
4. FLOATING SEAWEED	10	E	0	0	0	2	1	0	20	0	20
5. GREENLINGS	10	A	0	0	0	2	4	0	80	0	80
6. PACIFIC SANDLANCE	10	A	0	0	0	3	9	0	270	0	270
7. HERRING	15	A	2	0	0	3	9	1	675	75	583
8. SMELT	6	A	0	0	0	3	9	1	162	18	164
9. CRAB LARVAE	10	A	0	0	0	2	9	1	180	20	182
10. KING SALMON	6	A	1	1	2	2	9	1	324	36	328
11. CHUM SALMON	10	A	2	0	2	2	9	1	540	60	547
12. SOCKEYE SALMON	10	A	3	1	2	2	9	1	720	80	729
13. PINK SALMON	3	A	1	1	2	2	9	1	162	18	164
14. COHO SALMON	6	A	1	1	2	2	9	1	324	36	328
15. RAINBOW-STEELHEAD TROUT	1	E	0	1	1	1	9	1	27	3	27
16. DOLLY VARDEN	6	A	0	1	1	1	9	1	162	18	164
17. NORTHERN FUR SEAL	10	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	6	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	15	A	0	0	0	5	0	0	0	0	0
24. WHALES	15	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	15	A	0	0	0	5	4	0	300	0	300
27. OTHER MARINE MAMMALS	15	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	0	5	9	1	675	75	683
									5701	439	5749
2. SUBTIDAL SAND-MUD											
1. CODS	10	M	2	0	1	2	1	0	50	0	50
2. SCULPINS	10	A	0	0	0	2	4	0	80	0	80
3. STARRY FLOUNDER	3	A	0	0	0	2	1	0	6	0	6
4. OTHER FLATFISH	10	A	3	0	0	2	1	0	50	0	50
5. PACIFIC SANDLANCE	10	A	0	0	0	3	4	0	120	0	120

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-54. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
6. MISC. MARINE FISH	15	A	0	0	0	2	4	0	120	0	120
7. DUNGENESS CRAB	3	A	1	1	1	2	9	1	135	15	137
8. SHRIMP	6	A	0	0	0	3	9	1	162	18	164
9. RAZOR CLAM	6	A	0	0	0	2	9	0	108	0	108
10. OTHER BIVALVES	3	A	0	0	0	1	9	0	27	0	27
11. OTHER MARINE INVERTEBRATES	6	A	0	0	0	3	9	0	162	0	162
									1020	33	1024
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
1. FLOATING SEAWEED	10	E	0	0	0	2	1	0	20	0	20
2. SUBTIDAL SEAWEED	10	E	0	0	0	2	1	0	20	0	20
3. CHUM SALMON	10	E	2	0	2	2	9	0	540	0	540
4. PACIFIC HALIBUT	10	A	1	0	0	2	4	0	120	0	120
5. OTHER FLATFISH	10	A	3	0	0	2	4	0	200	0	200
6. GREENLINGS	15	A	0	0	0	2	4	0	120	0	120
7. ROCKFISH	10	A	3	0	0	2	4	0	200	0	200
8. WALLEYE POLLOCK	15	A	3	0	0	2	4	0	300	0	300
9. OTHER MARINE FISH	15	A	3	0	0	2	4	0	300	0	300
10. KING CRAB	15	A	3	1	0	2	9	0	810	0	810
11. TANNER CRAB	15	A	3	1	0	2	9	0	810	0	810
12. SCALLOPS	6	A	1	0	0	2	9	0	162	0	162
13. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	9	0	405	0	405
									4057	0	4057
4. INTERTIDAL SAND-MUD											
1. EELGRASS	6	A	0	0	0	3	4	0	72	0	72
2. PACIFIC SANDLANCE	10	A	0	0	0	3	9	0	270	0	270
3. RAZOR CLAM	6	A	0	1	1	2	9	0	216	0	216
4. SOFTSHELL BIVALVES	6	E	0	1	0	2	9	0	162	0	162
5. INVERTEBRATE INFAUNA	6	A	0	0	0	3	9	0	162	0	162
6. MARINE MAMMAL ROOKERIES	10	A	0	0	0	5	1	0	50	0	50
7. SHOREBIRDS	10	A	0	0	0	5	9	0	450	0	450
8. GEESE	6	A	1	1	1	5	4	0	192	0	192
9. DUCKS	6	A	1	1	1	2	4	0	120	0	120
10. SWANS	6	A	0	0	0	5	4	0	120	0	120
									1814	0	1814

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-54. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	10	E	0	0	0	3	4	0	120	0	120
2. GREENLINGS	15	A	0	0	0	2	4	0	120	0	120
3. HERRING	15	A	2	0	0	2	9	1	540	60	547
4. SESSILE MARINE INVERTEBRATES	15	H	0	0	0	1	9	1	135	15	137
5. MISC. CRUSTACEANS	10	H	0	0	0	2	9	1	180	20	182
6. OTHER INVERTEBRATES	15	H	0	0	0	3	9	1	405	45	410
7. SHOREBIRDS	10	A	0	0	0	5	4	0	200	0	200
8. SEA DUCKS	6	A	1	1	1	2	4	0	120	0	120
9. MARINE MAMMAL ROOKERIES	15	A	0	0	0	5	1	0	75	0	75
									1895	140	1911
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	6	E	0	0	0	3	1	0	18	0	18
2. SMELT	6	A	0	0	0	3	9	0	162	0	162
3. HARDSHELL BIVALVES	3	A	0	1	0	2	9	0	81	0	81
4. CRUSTACEANS	10	H	0	0	0	2	9	0	180	0	180
5. GASTROPODS	10	H	0	0	0	3	9	0	270	0	270
6. SHOREBIRDS	6	A	0	0	0	5	4	0	120	0	120
									831	0	831
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	6	E	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	6	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	6	A	2	1	1	2	0	0	0	0	0
4. CHUM SALMON	10	A	2	1	1	2	0	0	0	0	0
5. SOCKEYE SALMON	10	A	2	1	1	2	0	0	0	0	0
6. PINK SALMON	3	A	2	1	1	2	0	0	0	0	0
7. COHO SALMON	6	A	2	1	1	2	0	0	0	0	0
9. DOLLY VARDEN	6	A	0	1	1	1	0	0	0	0	0
13. STICKLEBACKS	3	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	3	A	0	0	0	3	0	0	0	0	0
15. DUCKS	6	A	1	1	1	2	0	0	0	0	0
16. GEESE	10	A	1	1	1	5	0	0	0	0	0
17. SWANS	10	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	3	A	1	0	0	1	0	0	0	0	0
19. MINK	3	A	1	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	1	0	0	1	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-54. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	6	A	0	0	0	2	0	0	0	0	0
3. STRAND VEGETATION	6	E	0	0	0	1	9	1	54	6	55
4. OTHER VEGETATION	6	A	0	0	0	2	4	1	48	12	51
5. BROWN BEAR	10	A	1	0	0	2	0	0	0	0	0
7. WOLVERINE	6	A	0	0	0	1	1	0	6	0	6
8. WOLF	6	A	0	0	0	1	1	0	6	0	6
10. CARIBOU	6	A	1	0	1	2	0	0	0	0	0
16. OTHER MAMMALS	3	M	0	0	0	2	1	1	6	6	12
17. RAPTORS	15	A	0	0	0	*	1	0	150	0	150
18. PTARMIGAN	6	M	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	10	A	0	0	0	5	1	0	50	0	50
									320	24	330
									15588	630	15066

(8) PORT MOLLER

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective open-sea cleanup methods were judged to be barriers, skimming devices, and sorbents. All were felt to be moderately effective. On beaches, mechanical/manual removal was judged to be the most effective method. The next most effective methods were burning and on-site sand cleaning.

WINTER: The above methods were similarly applicable. Open-sea cleanup methods were judged to be less effective, being hampered by the presence of sea ice.

POSTULATED SCENARIO

SUMMER: The spill scenario had the slick move northeasterly, parallel to the shoreline. Beach impact northeast of Port Moller was estimated to occur about 12 hours after the spill. The response times of all open-sea cleanup methods in excess of 36 hours limited their help in reducing the impact of the spill. Beach cleanup was assumed using mechanical/manual removal, some burning, and some sand cleaning.

WINTER: The Winter spill scenario had the slick move basically northeasterly and easterly onto the shoreline at the city of Port Moller, about 9 hours after the spill occurred. Again, the response times for open-water cleanup methods were too long to reduce the beach impact. It was assumed that beach cleanup methods were used and that the results were similar to the Summer situation.

MATRIX RESULTS

CASE 1: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 11,861

The impact scores for six of the eight habitats remained unchanged from the non-cleanup case. The impact scores were increased for the following two habitats:

Intertidal cobble/ gravel	from 563 to 804
Terrestrial	from 131 to 969

Table 2-55 presents the complete results for Case 1.

TABLE 2-55. MATRIX RESULTS-- U.S. COAST GUARD OIL SPILL PREDICTION STUDY
CASE 1
EVALUATION MATRIX

AREA	PORT MOLLER
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	10	A	0	0	0	3	4	0	120	0	120
2. ZOOPLANKTON	10	A	0	0	0	3	4	0	120	0	120
3. ICHTHYOPLANKTON	10	A	0	0	0	2	4	0	80	0	80
5. GREENLINGS	1	A	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	10	A	0	0	0	3	4	0	120	0	120
7. HERRING	10	A	2	0	0	3	9	*	450	400	806
8. SMELT	6	A	0	0	0	3	9	1	162	1*	144
9. CRAB LARVAE	15	A	0	0	0	2	9	*	270	240	483
10. KING SALMON	15	A	1	1	2	2	9	1	810	90	820
11. CHUM SALMON	10	A	2	0	2	2	9	1	540	60	547
12. SOCKEYE SALMON	15	A	3	1	2	2	9	*	1080	960	1933
13. PINK SALMON	10	A	1	1	2	2	9	1	540	60	547
14. COHO SALMON	6	A	1	1	2	2	9	1	324	36	328
16. DOLLY VARDEN	3	A	0	1	1	1	9	*	81	72	145
17. NORTHERN FUR SEAL	6	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	6	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	10	A	0	0	0	5	0	0	0	0	0
23. WALRUS	3	A	0	0	0	5	0	0	0	0	0
24. WHALES	1	A	0	0	0	5	0	0	0	0	0
25. SEA OTTER	6	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	1	P	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	P	0	0	0	5	9	1	450	50	456
									5147	1984	6669
2. SUBTIDAL SAND-MUD											
1. CODS	10	A	2	0	1	2	4	0	200	0	200
2. SCULPINS	15	A	0	0	0	2	4	0	120	0	120
3. STARRY FLOUNDER	6	A	0	0	0	2	4	0	48	0	48
4. OTHER FLATFISH	15	A	2	0	1	2	4	0	300	0	300
5. PACIFIC SANDLANCE	10	A	0	0	0	3	9	1	270	30	273
6. MISC. MARINE FISH	6	A	0	0	0	2	4	0	48	0	48

TABLE 2-55 (CONT'D) U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
7. DUNGENESS CRAB	1	A	1	1	1	2	4	0	20	0	20
8. SHRIMP	1	A	0	0	0	3	9	1	27	3	27
9. RAZOR CLAM	6	A	0	0	0	2	4	1	48	12	51
10. OTHER BIVALVES	6	A	0	0	0	1	4	1	24	6	26
11. OTHER MARINE INVERTEBRATES	15	A	0	0	0	3	9	1	405	45	410
									1510	96	1523
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	3	E	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	10	A	2	0	2	2	9	1	540	60	547
4. PACIFIC HALIBUT	10	A	3	0	0	2	4	0	200	0	200
5. OTHER FLATFISH	6	A	2	0	0	2	4	0	96	0	96
6. GREENLINGS	3	A	0	0	0	2	4	0	24	0	24
8. WALLEYE POLLOCK	3	A	3	0	0	2	4	0	60	0	60
9. OTHER MARINE FISH	6	A	2	0	0	2	4	0	96	0	96
10. KING CRAB	15	A	3	0	1	2	4	0	340	0	340
11. TANNER CRAB	10	A	3	0	1	2	4	0	240	0	240
13. OTHER MARINE INVERTEBRATES	6	A	0	1	1	3	9	1	270	30	273
									1896	90	1896
4. INTERTIDAL SAND-MUD											
1. EELGRASS	10	A	0	0	0	3	0	0	0	0	0
2. PACIFIC SANDLANCE	10	A	0	0	0	3	0	0	0	0	0
3. RAZOR CLAM	6	A	1	2	2	2	0	0	0	0	0
4. SOFTSHELL BIVALVES	6	A	0	1	0	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	10	E	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	6	P	0	0	0	5	0	0	0	0	0
8. GEESE	10	A	1	1	1	1	0	0	0	0	0
9. DUCKS	6	A	1	1	2	2	0	0	0	0	0
10. SWANS	10	A	0	0	0	5	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	1	E	0	0	0	3	0	0	0	0	0
2. GREENLINGS	3	A	0	0	0	2	0	0	0	0	0
3. HERRING	10	A	2	0	0	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	1	H	0	0	0	1	0	0	0	0	0
9. MISC. CRUSTACEANS	3	H	0	0	0	2	0	0	0	0	0

TABLE 2-55 (CONT'D) U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	3	H	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	P	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	3	A	0	0	1	2	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	1	E	0	0	0	3	4	0	12	0	12
2. SMELT	6	A	0	0	0	3	0	1	162	12	164
3. HARDSHELL BIVALVES	3	E	0	1	1	2	0	1	108	12	109
4. CRUSTACEANS	10	H	0	0	0	2	0	1	180	20	182
5. GASTROPODS	10	H	0	0	0	3	0	1	270	30	273
6. SHOREBIRDS	3	P	0	0	0	5	4	1	60	15	64
									732	95	804
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	6	E	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	6	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	15	A	1	1	2	2	0	0	0	0	0
4. CHUM SALMON	10	A	2	0	2	2	0	0	0	0	0
5. SOCKEYE SALMON	15	A	3	1	2	2	0	0	0	0	0
6. PINK SALMON	10	A	1	1	2	2	0	0	0	0	0
7. COHO SALMON	6	A	1	1	2	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	1	1	1	0	0	0	0	0
9. DOLLY VARDEN	3	A	0	1	1	1	0	0	0	0	0
11. ARCTIC GRAYLING	6	E	0	1	0	2	0	0	0	0	0
12. PIKE	3	E	0	1	0	1	0	0	0	0	0
13. STICKLEBACKS	3	E	0	0	0	3	0	0	0	0	0
14. OTHER FISH	3	E	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	1	1	2	2	0	0	0	0	0
16. GEESE	15	A	1	1	1	2	0	0	0	0	0
17. SWANS	10	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	6	P	1	0	0	1	0	0	0	0	0
19. MINK	6	P	1	0	0	1	0	0	0	0	0
20. MUSKRAT	6	P	1	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	P	1	0	0	1	0	0	0	0	0
									0	0	0

TABLE 2-55 (CONT'D) U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
9. TERRESTRIAL											
1. TUNDRA	6	A	0	0	0	3	4	1	72	18	77
2. RIPARIAN VEGETATION	3	E	0	0	0	2	4	0	24	0	24
3. STRAND VEGETATION	10	E	0	0	0	1	4	0	40	0	40
4. OTHER VEGETATION	3	A	0	0	0	2	4	0	24	0	24
5. BROWN BEAR	10	A	3	1	0	2	1	0	60	0	60
7. WOLVERINE	6	A	1	1	0	1	1	0	18	0	18
8. WOLF	6	A	1	1	0	1	1	0	18	0	18
9. MOOSE	10	A	2	1	1	2	1	0	60	0	60
10. CARIBOU	10	A	2	1	1	2	1	0	60	0	60
16. OTHER MAMMALS	10	A	1	1	0	2	4	0	160	0	160
17. RAPTORS	15	A	0	0	0	5	4	0	300	0	300
18. PTARMIGAN	6	E	0	0	0	2	4	0	48	0	48
19. OTHER BIRDS	10	A	0	0	0	2	4	0	80	0	80
									964	18	969
									10299	2285	11841

(9) KVICHAK - CLEANUP

APPROPRIATE CLEANUP METHODS

None of the cleanup procedures was judged to be particularly effective at this site due primarily to the long response time. The minimum time for the movement of equipment from Kodiak to the site was postulated to be about 45 hours; for that reason, the equipment might not arrive in time to contain the spill. In this case, manual removal was thought to be the only effective method of cleanup, provided sufficient personnel were nearby and able to help with the cleanup operation.

For the impacted beaches in the area, burning and mechanical/manual removal were deemed to be the most effective procedures; even though muddy conditions might hamper the movement of men and equipment involved in the cleanup operation. These conditions might cause certain logistic problems along the beaches, especially in the removal of the oily debris.

POSTULATED SCENARIO

Kodiak was assumed to be the nearest support base for a cleanup operation at this site. On this basis, a fairly long response time was postulated. In this case the spills were not contained and the beach areas were still impacted. Thus, sand cleaning was thought to be important.

MATRIX RESULTS

The cleanup operation actually increased the impact scores due to the lead time requirements and the ineffectiveness of the water cleanup, and all of the travel along the beaches in the beach cleanup operation. This was

reflected in the increased impact scores for the intertidal sand/mud and terrestrial habitats. With minor exceptions, both short-term and long-term impact scores were increased or remained unchanged for species in these habitats.

CASE 1: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 8,205

The impact scores generally remained the same as for the non-cleanup case except for the habitats associated with the beaches. These habitats had increased scores reflecting the larger short-term impact from the cleanup operations. The following list shows the habitat scores:

Pelagic	no change (3,729)
Subtidal sand/mud	no change (836)
Subtidal rock/cobble/ gravel	no change (592)
Intertidal cobble/ gravel	no change (0)
Intertidal rocky	no change (0)
Freshwater river	no change (0)
Intertidal sand/mud	increased from 2,070 to 2,568
Terrestrial	increased from 151 to 480

Table 2-56 presents the complete results for Case 1.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-56. MATRIX RESULTS-- CASE 1

AREA	KVICHAK
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

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HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	3	A	0	0	0	2	4	0	24	0	24
5. GREENLINGS	1	A	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	6	A	0	0	0	3	4	0	72	0	72
7. HERRING	6	A	2	0	0	3	9	8	270	240	483
8. SMELT	6	A	0	0	0	3	9	1	162	18	104
9. CRAB LARVAE	6	A	0	0	0	2	9	8	105	96	193
11. CHUM SALMON	3	A	2	0	1	2	9	8	135	120	242
12. SOCKEYE SALMON	15	A	3	1	1	2	9	8	945	840	1692
13. PINK SALMON	1	A	1	1	1	2	9	8	45	40	81
14. COHO SALMON	1	A	1	1	1	2	9	8	45	40	81
16. DOLLY VARDEN	3	A	0	1	0	1	9	8	54	48	97
17. NORTHERN FUR SEAL	1	A	0	0	0	5	0	0	0	0	0
20. BEARDED SEAL	1	A	0	0	0	5	0	0	0	0	0
21. HARBOR SEAL	3	A	0	0	0	5	0	0	0	0	0
22. SEA LIONS	3	A	0	0	0	5	0	0	0	0	0
23. WALRUS	3	P	0	0	0	5	0	0	0	0	0
24. WHALES	6	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	6	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	10	P	0	0	0	5	9	1	450	50	455
									2454	1440	3724
2. SUBTIDAL SAND-MUD											
1. CODS	3	A	1	0	0	2	4	0	36	0	36
2. SCULPINS	6	A	0	0	0	2	4	0	48	0	48
3. STARRY FLOUNDER	11	A	0	0	0	2	4	0	88	0	88
4. OTHER FLATFISH	11	A	1	0	0	2	4	0	11	0	11
5. PACIFIC SANDLANCE	6	A	0	0	0	2	4	1	24	12	36
6. MISC. MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
8. SHRIMP	1	A	0	0	0	3	9	1	27	3	27

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-56. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
9. RAZOR CLAM	3	E	1	0	0	2	4	1	36	9	38
10. OTHER BIVALVES	6	E	0	0	0	1	4	1	24	6	26
11. OTHER MARINE INVERTEBRATES	10	E	0	0	0	3	9	1	270	30	273
									827	60	830
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	1	E	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	3	A	2	0	1	2	9	8	135	120	242
4. PACIFIC HALIBUT	1	A	3	1	1	2	4	0	26	4	26
5. OTHER FLATFISH	3	A	0	0	0	2	4	0	24	3	24
6. GREENLINGS	1	A	0	0	0	2	4	0	8	2	8
9. OTHER MARINE FISH	3	A	1	0	0	2	4	0	36	5	36
10. KING CRAB	3	A	3	0	1	2	1	0	18	4	18
11. TANNER CRAB	3	A	3	0	1	2	4	0	72	4	72
13. OTHER MARINE INVERTEBRATES	6	E	0	0	0	3	9	1	162	18	164
									483	138	592
4. INTERTIDAL SAND-MUD											
1. EELGRASS	3	E	0	0	0	3	4	1	36	9	38
2. PACIFIC SANDLANCE	6	A	0	0	0	3	9	1	162	18	164
3. RAZOR CLAM	3	E	1	2	2	2	9	1	189	21	191
4. SOFTSHELL BIVALVES	10	E	0	1	2	2	9	1	450	50	456
5. INVERTEBRATE INFAUNA	10	A	0	0	0	3	9	1	270	30	273
7. SHOREBIRDS	10	P	0	0	0	5	9	1	450	50	456
8. GEESE	6	P	1	1	2	1	9	1	270	30	273
9. DUCKS	6	A	1	1	2	2	9	8	324	288	580
10. SWANS	3	A	0	0	0	5	9	1	135	15	137
									2286	511	2568
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	0	0	0	0	0
2. GREENLINGS	1	A	0	0	0	2	0	0	0	0	0
3. HERRING	6	A	2	0	0	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	1	M	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	1	M	0	0	0	2	0	0	0	0	0
6. OTHER INVERTEBRATES	1	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	P	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	3	A	0	0	0	2	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-56. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REG.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	0	0	0	0	0
2. SMELT	6	A	0	0	0	3	0	0	0	0	0
3. HARDSHELL BIVALVES	1	A	1	1	1	2	0	0	0	0	0
4. CRUSTACEANS	3	A	0	0	0	2	0	0	0	0	0
5. GASTROPODS	3	H	0	0	0	3	0	0	0	0	0
6. SHOREBIRDS	6	P	0	0	0	5	0	0	0	0	0
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	6	P	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	6	P	0	0	0	3	0	0	0	0	0
4. CHUM SALMON	3	A	2	0	1	2	0	0	0	0	0
5. SOCKEYE SALMON	15	A	3	1	1	2	0	0	0	0	0
6. PINK SALMON	1	A	1	1	1	2	0	0	0	0	0
7. COHO SALMON	1	A	1	1	1	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	1	0	1	0	0	0	0	0
9. DOLLY VARDEN	3	A	0	1	0	1	0	0	0	0	0
11. ARCTIC GRAYLING	6	A	0	2	1	2	0	0	0	0	0
12. PIKE	6	A	0	2	1	1	0	0	0	0	0
13. STICKLEBACKS	10	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	3	A	0	0	0	2	0	0	0	0	0
15. DUCKS	10	A	1	1	2	2	0	0	0	0	0
16. GEESE	15	A	1	1	2	2	0	0	0	0	0
17. SWANS	6	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	6	A	2	0	1	1	0	0	0	0	0
19. MINK	6	A	2	0	1	1	0	0	0	0	0
20. MUSKRAT	6	A	2	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	6	A	2	0	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	4	1	120	30	120
2. RIPARIAN VEGETATION	6	A	0	0	0	2	4	0	48	0	48
3. STRAND VEGETATION	10	E	0	0	0	1	4	1	40	10	43
4. OTHER VEGETATION	6	A	0	0	0	2	1	1	12	12	24
5. BROWN BEAR	3	A	2	1	0	2	1	0	15	0	15
7. WOLVERINE	3	A	1	0	0	1	1	0	6	0	6
8. WOLF	3	A	1	0	0	1	1	0	6	0	6
9. MOOSE	6	A	2	2	3	2	0	0	0	0	0

TABLE 2-56. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS: ABUNDANCE INV.	ABUNDANCE CONF.	IMPORTANCE COM.	IMPORTANCE REC.	IMPORTANCE SUB.	IMPORTANCE ECOL.	IMPACT S.TRM	IMPACT L.TRM	RESULTS: IMPACT S.TRM	IMPACT L.TRM	RSLT.
B. TERRESTRIAL											
13. CARIBOU	6	A	1	2	2	2	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	1	1	2	1	1	24	24	48
17. RAPTORS	15	A	0	0	0	5	1	1	75	75	150
18. PTARMIGAN	6	A	0	1	1	2	0	0	0	0	0
19. OTHER BIRDS	6	A	0	0	0	2	1	0	12	0	12
									358	151	480
									6408	2358	8285

(10) ST. MATTHEW ISLAND - CLEANUP

APPROPRIATE CLEANUP METHODS

The long travel times from the support base of Kodiak reduced the effectiveness of most of the readily accepted open-sea cleanup procedures, such as the use of skimmers, barriers, and sorbents. The minimum response time was assumed to be about 66 hours, or almost three days; hence, these procedures were not expected to be able to contain the spill to any degree. Use of sinking agents was not considered even though these procedures might reduce the visibility of the spill, because federal legislation prohibits the use of these procedures due to their highly toxic and negative effect upon the aquatic environment.

For the cases where beach areas were impacted, burning and mechanical/manual removal were the only applicable and thus effective procedures provided; of course, men and equipment were airlifted to the spill site.

POSTULATED SCENARIO

Given the fairly long response time from the support base, any spill was expected to spread to its physical limits before the cleanup team arrived at the site. Hence, whatever response was generated was not expected to significantly reduce the impact of the spill in the open sea. The cleanup operation was therefore directed toward removal of the oil from the nearshore habitats for Winter spills. Summer spills did not impact the shoreline as the predominant winds moved the oil away from the island. Logistic operations on the island were postulated to impact the terrestrial habitat.

MATRIX RESULTS

The cleanup response was not sufficient to reduce the open-sea impact of the spill; consequently, the impact scores were not affected by the cleanup operations. The logistics operations would affect the nearshore environment. Impact scores for both short term and long term were increased for the terrestrial habitat as a result. The impact scores for the pelagic habitat were not changed because of the long response time.

The case analysis was directed to the largest diesel Summer spill, as it had the highest score of the non-cleanup scenarios.

CASE 1: SUMMER, DIESEL-2, 10,000 BBLS - IMPACT SCORE 3,346

The spill scenario had the oil slick moving northward away from the island. The only change estimated for the cleanup case was for the terrestrial habitat impact (increased from 0 to 227). Table 2-57 presents the complete results for Case 1. No other cleanup cases were given impact scores due to the low scores of the comparable non-cleanup cases.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-57. MATRIX RESULTS-- CASE 1

AREA	ST. MATTHEW ISLAND
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	NO. 2 DIESEL OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	10	H	0	0	0	3	9	1	270	30	273
2. ZOOPLANKTON	10	H	0	0	0	3	9	1	270	30	273
3. ICHTHYOPLANKTON	6	E	0	0	0	2	9	1	108	12	109
5. GREENLINGS	3	A	0	0	0	2	4	0	24	0	24
6. PACIFIC SANDLANCE	3	A	0	0	0	3	9	1	81	9	82
7. HERRING	15	A	3	0	0	3	9	8	810	720	1090
8. SMELT	3	A	0	0	0	3	9	8	81	72	145
9. CRAB LARVAE	6	A	0	0	0	2	9	8	108	96	193
10. KING SALMON	1	E	2	0	0	2	9	1	36	4	36
11. CHUM SALMON	1	E	3	0	0	2	9	1	45	5	45
12. SOCKEYE SALMON	1	E	2	0	0	2	9	1	36	4	36
13. PINK SALMON	1	E	3	0	0	2	9	1	45	5	45
14. COHO SALMON	1	E	2	0	0	2	9	1	36	4	36
16. DOLLY VARDEN	6	A	0	0	0	1	9	8	54	48	97
17. NORTHERN FUR SEAL	1	A	2	0	1	5	0	0	0	0	0
18. RINGED SEAL	3	A	2	0	1	5	0	0	0	0	0
19. RIBBON SEAL	15	A	2	0	1	5	0	0	0	0	0
20. BEARDED SEAL	3	A	2	0	1	5	0	0	0	0	0
21. HARBOR SEAL	6	A	2	0	1	5	0	0	0	0	0
23. WALRUS	10	A	2	0	2	5	0	0	0	0	0
24. WHALES	3	A	0	0	0	5	0	0	0	0	0
26. POLAR BEAR	1	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	3	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	6	A	0	0	0	5	9	1	270	30	273
									2274	1669	3119
2. SUBTIDAL SAND-MUD											
1. CODS	6	A	2	0	0	2	0	0	0	0	0
2. SCULPINS	10	A	0	0	0	2	0	0	0	0	0
3. STARRY FLOUNDER	3	A	0	0	0	2	0	0	0	0	0
4. OTHER FLATFISH	10	A	2	0	0	2	0	0	0	0	0

TABLE 2-57. (CONT'D.)

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
5. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
6. MISC. MARINE FISH	6	A	1	0	0	2	0	0	0	0	0
8. SHRIMP	6	E	3	0	0	3	0	0	0	0	0
10. OTHER BIVALVES	3	H	0	0	0	1	0	0	0	0	0
11. OTHER MARINE INVERTEBRATES	3	H	0	0	0	3	0	0	0	0	0
									0	0	0
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	10	A	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	1	H	3	0	0	2	0	0	0	0	0
4. PACIFIC HALIBUT	6	A	2	0	0	2	0	0	0	0	0
5. OTHER FLATFISH	3	A	0	0	0	2	0	0	0	0	0
6. GREENLINGS	3	A	0	0	0	2	0	0	0	0	0
7. ROCKFISH	3	E	2	0	0	2	0	0	0	0	0
8. WALLEYE POLLOCK	10	A	0	0	0	2	0	0	0	0	0
9. OTHER MARINE FISH	6	A	1	0	0	2	0	0	0	0	0
10. KING CRAB	6	A	2	0	0	2	0	0	0	0	0
11. TANNER CRAB	6	A	1	0	0	2	0	0	0	0	0
12. SCALLOPS	1	A	0	0	0	2	0	0	0	0	0
13. OTHER MARINE INVERTEBRATES	10	H	0	0	0	3	0	0	0	0	0
									0	0	0
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
4. SOFTSHELL BIVALVES	3	A	0	0	0	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	3	H	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	A	0	0	0	5	0	0	0	0	0
8. GEESE	3	A	0	0	1	1	0	0	0	0	0
9. DUCKS	6	A	0	0	1	2	0	0	0	0	0
10. SWANS	1	A	0	0	1	5	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	10	A	0	0	0	3	0	0	0	0	0
2. GREENLINGS	6	A	0	0	0	2	0	0	0	0	0
3. HERRING	15	A	3	0	1	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	6	H	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	6	H	0	0	0	2	0	0	0	0	0

TABLE 2-57. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	6	M	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	1	A	0	0	0	5	0	0	0	0	0
8. SEA DUCKS	6	A	0	0	0	2	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	6	A	0	0	0	3	0	0	0	0	0
2. SMELT	3	A	0	0	0	2	0	0	0	0	0
3. MARUSHELL BIVALVES	1	M	0	0	0	2	0	0	0	0	0
4. CRUSTACEANS	1	M	0	0	0	2	0	0	0	0	0
5. GASTROPODS	1	M	0	0	0	3	0	0	0	0	0
6. SHOREBIRDS	1	M	0	0	0	5	0	0	0	0	0
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	M	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	3	M	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	E	0	0	0	2	0	0	0	0	0
4. CHUM SALMON	1	E	0	0	0	2	0	0	0	0	0
5. SOCKEYE SALMON	1	E	0	0	0	2	0	0	0	0	0
6. PINK SALMON	1	E	0	0	0	2	0	0	0	0	0
7. COHO SALMON	1	E	0	0	0	2	0	0	0	0	0
9. DOLLY VARDEN	10	A	0	0	0	2	0	0	0	0	0
13. STICKLEBACKS	3	A	0	0	0	3	0	0	0	0	0
15. DUCKS	6	A	0	0	1	2	0	0	0	0	0
16. GEESE	6	A	0	0	1	2	0	0	0	0	0
17. SWANS	3	A	0	0	0	5	0	0	0	0	0
18. RIVER OTTER	1	A	0	0	0	1	0	0	0	0	0
19. MINK	1	A	0	0	0	1	0	0	0	0	0
20. MUSKRAT	1	A	0	0	0	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	1	A	0	0	0	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	6	A	0	0	0	3	4	1	72	18	77
2. RIPARIAN VEGETATION	3	A	0	0	0	2	4	0	24	0	24
3. STRAND VEGETATION	6	M	0	0	0	1	4	0	24	0	24
4. OTHER VEGETATION	3	A	0	0	0	2	4	0	24	0	24

U.S. COAST GUARD OIL SPILL PREDICTION STUDY

TABLE 2-57 (CONT'D)

EVALUATION MATRIX

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
8. TERRESTRIAL											
15. CARIBOU	15	A	0	0	1	3	1	0	60	0	60
16. OTHER MAMMALS	6	A	0	0	0	2	1	0	12	0	12
17. RAPTORS	6	A	0	0	0	5	0	0	0	0	0
18. PTARMIGAN	6	A	0	0	0	2	0	0	0	0	0
19. OTHER BIRDS	3	A	0	0	0	2	1	0	6	0	6
									222	18	227
									2496	1687	3346

(11) NOME - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective open-sea cleanup method was judged to be manual removal. Barriers and skimming devices were judged to be hardly effective at all. All other methods were judged to be ineffective, illegal, or not state-of-art. The most effective beach cleanup method was judged to be mechanical/manual removal. The next most effective methods were judged to be burning and on-site sand cleaning.

WINTER: Solid ice was presumed present and no open-water methods were applicable. On beaches, mechanical/manual removal was judged most effective, followed by burning. On ice, the reverse held.

POSTULATED SCENARIO

The oil spill scenario for Summer had the slick impacting the beach near Nome within 6 hours. Due to the long response times (about 50 to 60 hours) for open-sea cleanup methods, none was presumed employed. The entire cleanup effort was presumed to be directed to the impacted beaches.

For Winter, the scenarios had oil moving away from the beaches with the ice or spilled on top of the pack ice. In the case of moving with or under the ice, cleanup was assumed to be of little utility due to long response time and difficulty of reaching the oil and removing it. In the case of oil spilled on the pack ice, it was assumed that cleanup was made by burning, with limited manual operations because of the hazard on the ice pack.

MATRIX RESULTS

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 6,239

Because the oil beached rapidly, no oil was assumed removed before beach impact. Thus, cleanup would only affect the habitats associated with the beach. Six habitat scores remained the same from the non-cleanup case: pelagic (2,314), subtidal sand/mud (562), subtidal rock/cobble/gravel (0), intertidal rocky (0), intertidal cobble/gravel (0), and freshwater river (0). The two habitats changed at Nome and the changed scores are listed below:

Intertidal sand/mud	decreased from 2,422 to 2,357
Terrestrial	increased from 607 to 1,006

Table 2-58 presents the complete results of Case 1.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-58. MATRIX RESULTS--
CASE 1

AREA	NOME
SEASON	SUMMER
SPILL SIZE	90,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	3	H	0	0	0	3	4	1	36	9	39
2. ZOOPLANKTON	6	H	0	0	0	3	4	1	72	18	77
3. ICHTHYOPLANKTON	3	H	0	0	0	2	4	1	24	6	26
5. GREENLINGS	1	E	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	3	E	0	0	0	3	1	0	9	0	9
7. HERRING	6	A	0	0	1	3	9	8	216	192	387
8. SMELT	6	A	0	0	1	3	9	1	216	24	219
9. CRAB LARVAE	6	A	0	0	0	2	9	8	108	96	193
10. KING SALMON	1	A	2	1	2	2	4	1	28	7	30
11. CHUM SALMON	3	A	3	0	3	2	4	1	96	24	102
12. SOCKEYE SALMON	1	A	1	0	2	2	4	1	20	5	21
13. PINK SALMON	1	A	3	1	3	2	4	1	36	9	39
14. COHO SALMON	1	A	2	1	0	2	4	1	20	5	21
16. DOLLY VARDEN	6	A	0	1	2	1	9	8	216	192	387
17. NORTHERN FUR SEAL	1	A	0	0	2	5	1	0	7	0	7
18. RINGED SEAL	10	A	0	0	3	5	1	0	80	0	80
19. RIBBON SEAL	10	A	0	0	1	5	1	0	60	0	60
20. BEARDED SEAL	6	A	0	0	1	5	1	0	36	0	36
21. HARBOR SEAL	6	A	0	0	1	5	1	0	36	0	36
23. WALRUS	10	A	0	0	3	5	0	0	0	0	0
24. WHALES	10	A	0	0	3	4	0	0	0	0	0
26. POLAR BEAR	1	A	0	0	0	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	6	A	3	0	2	5	9	1	540	60	547
									1856	647	2314
2. SUBTIDAL SAND-MUD											
1. CODS	6	A	0	0	1	2	4	1	72	18	77
2. SCULPINS	6	A	0	0	0	2	4	1	48	12	51
3. STARRY FLOUNDER	3	A	0	0	0	2	4	1	24	6	26
4. OTHER FLATFISH	6	A	1	1	2	2	4	1	144	36	153

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-58 (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
5. PACIFIC SANDLANCE	3	E	0	0	0	3	4	1	36	9	36
6. MISC. MARINE FISH	3	H	0	0	0	2	4	1	24	4	26
8. SHRIMP	3	E	0	0	0	3	9	1	81	9	82
10. OTHER BIVALVES	3	H	0	0	0	1	9	1	27	3	27
11. OTHER MARINE INVERTEBRATES	3	E	0	0	0	3	9	1	81	9	82
									527	108	562
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	1	E	0	0	0	2	0	0	0	0	0
3. CHUM SALMON	3	A	3	0	3	2	0	0	0	0	0
5. OTHER FLATFISH	3	A	0	0	0	2	0	0	0	0	0
6. GREENLINGS	1	E	0	0	0	2	0	0	0	0	0
8. WALLEYE POLLOCK	3	E	0	0	0	2	0	0	0	0	0
9. OTHER MARINE FISH	3	E	0	0	0	2	0	0	0	0	0
10. KING CRAB	3	E	0	0	2	2	0	0	0	0	0
11. TANNER CRAB	3	E	0	0	1	2	0	0	0	0	0
12. SCALLOPS	3	E	0	0	0	2	0	0	0	0	0
13. OTHER MARINE INVERTEBRATES	6	E	0	0	0	3	0	0	0	0	0
									0	0	0
4. INTERTIDAL SAND-MUD											
1. EELGRASS	6	A	0	0	0	3	9	27	162	486	1620
2. PACIFIC SANDLANCE	3	E	0	0	0	3	4	0	36	0	36
3. RAZOR CLAM	3	H	0	0	0	2	9	8	54	48	97
4. SOFTSHELL BIVALVES	1	H	0	0	0	2	9	8	18	16	32
5. INVERTEBRATE INFAUNA	3	E	0	0	0	3	9	1	81	9	82
7. SHOREBIRDS	6	A	0	0	1	5	9	1	324	36	328
8. GEESE	1	A	0	0	2	1	4	1	12	4	13
9. DUCKS	6	A	0	0	3	2	4	1	120	30	124
10. SWANS	1	A	0	0	0	5	4	1	20	5	21
									827	633	2357
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	0	0	0	0	0
2. GREENLINGS	3	E	0	0	0	2	0	0	0	0	0
3. HERRING	6	A	0	0	1	2	0	0	0	0	0
4. SESSILE MARINE INVERTEBRATES	1	H	0	0	0	1	0	0	0	0	0
5. MISC. CRUSTACEANS	3	H	0	0	0	2	0	0	0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-58 (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
5. INTERTIDAL ROCKY											
6. OTHER INVERTEBRATES	3	H	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	A	0	0	1	5	0	0	0	0	0
8. SEA DUCKS	3	A	0	0	3	2	0	0	0	0	0
9. MARINE MAMMAL ROOKERIES	1	A	0	0	0	5	0	0	0	0	0
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	0	0	0	0	0
2. SMELT	6	A	0	0	1	3	0	0	0	0	0
3. HARDSHELL BIVALVES	1	H	0	0	0	2	0	0	0	0	0
4. CRUSTACEANS	3	H	0	0	0	2	0	0	0	0	0
5. GASTROPODS	1	H	0	0	0	3	0	0	0	0	0
6. SHOREBIRDS	6	A	0	0	1	5	0	0	0	0	0
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	E	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	3	E	0	0	0	3	0	0	0	0	0
3. KING SALMON	1	A	0	1	2	2	0	0	0	0	0
4. CHUM SALMON	3	A	0	0	3	2	0	0	0	0	0
5. SOCKEYE SALMON	1	A	0	0	2	2	0	0	0	0	0
6. PINK SALMON	1	A	0	1	3	2	0	0	0	0	0
7. COHO SALMON	1	A	0	1	0	2	0	0	0	0	0
9. DOLLY VARDEN	6	A	0	1	1	1	0	0	0	0	0
10. WHITEFISH	10	A	1	2	3	1	0	0	0	0	0
11. ARCTIC GRAYLING	6	A	0	1	2	2	0	0	0	0	0
12. PIKE	6	A	0	1	1	1	0	0	0	0	0
13. STICKLEBACKS	3	H	0	0	0	3	0	0	0	0	0
14. OTHER FISH	3	E	0	0	0	3	0	0	0	0	0
15. DUCKS	10	A	0	0	3	2	0	0	0	0	0
16. GEESE	6	A	0	0	2	2	0	0	0	0	0
17. SWANS	3	A	0	0	0	5	0	0	0	0	0
19. MINK	3	A	0	0	2	1	0	0	0	0	0
20. MUSKRAT	3	A	0	0	2	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	0	0	2	1	0	0	0	0	0
									0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-58 (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
9. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	9	8	270	240	483
2. RIPARIAN VEGETATION	6	E	0	0	0	2	4	1	48	12	51
3. STRAND VEGETATION	15	A	0	0	0	1	4	1	60	15	64
4. OTHER VEGETATION	1	H	0	0	0	2	4	0	8	0	8
5. BROWN BEAR	1	A	1	1	1	2	0	0	0	0	0
7. WOLVERINE	3	A	1	0	0	1	4	0	24	0	24
8. WOLF	3	A	1	0	0	1	4	0	24	0	24
9. MOOSE	1	A	0	1	2	2	0	0	0	0	0
10. CARIBOU	3	A	0	1	2	2	0	0	0	0	0
13. MUSKOX	15	A	0	0	0	5	0	0	0	0	0
16. OTHER MAMMALS	3	A	0	1	2	2	4	1	60	15	64
17. RAPTORS	10	A	0	0	0	5	4	1	200	50	213
18. PTARMIGAN	6	A	0	1	1	2	1	0	24	0	24
19. OTHER BIRDS	6	A	0	0	0	2	4	1	48	12	51
									766	344	1006
									3986	1732	6239

(12) CAPE BLOSSOM - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective open-sea methods were judged to be burning and manual removal. On beaches, the most effective method was judged to be mechanical/manual removal. Burning and on-site sand cleaning were judged the next most effective.

WINTER: Solid ice was assumed present. The most effective cleanup method was judged to be burning on ice and mechanical/manual removal on land. The next most effective methods were mechanical/manual removal on ice and burning on land.

POSTULATED SCENARIO

The Summer spill scenario had the oil slick impacting the Baldwin Peninsula between Cape Blossom and Kotzebue after about 36 hours. The response times were too long (66+ hours) for all open-water methods to be of much use. Cleanup of the impacted beaches was assumed via mechanical/manual removal, burning, and on-site sand cleaning.

In Winter, it was assumed that the spill was on solid ice, and could be worked on for longer times. Highly effective mechanical/manual removal and burning were postulated.

MATRIX RESULTS

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 5,960

Given the long response time, the cleanup procedures were not expected to significantly reduce the effects of any spill at this location.

The cleanup procedures postulated, such as burning and manual removal of oil from the aquatic environment, were expected to further impact the shoreline and land habitats. This was reflected in increased short-term and long-term impact scores or no changes for all species in the intertidal rocky, intertidal cobble/gravel, and terrestrial habitats.

The impact score increased some 18 percent from 5,144 to 5,960 in the "cleanup" case. Table 2-59 presents the complete results for Case 1.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-59. MATRIX RESULTS--
CASE 1

AREA	CAPE BLOSSOM
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT			IMPACT	
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	PSLT.
1. PELAGIC											
1. PHYTOPLANKTON	3	E	0	0	0	3	4	1	36	0	36
2. ZOOPLANKTON	6	A	0	0	0	3	4	1	72	18	72
3. ICHTHYOPLANKTON	3	E	0	0	0	2	4	1	24	6	26
5. GREENLINGS	1	E	0	0	0	2	0	0	0	0	0
6. PACIFIC SANDLANCE	3	A	0	0	0	3	1	0	9	0	9
7. HERRING	10	A	0	0	1	3	9	8	360	320	644
8. SMELT	10	A	0	0	0	3	9	1	270	30	273
9. CRAB LARVAE	3	E	0	0	0	2	9	8	54	48	97
11. CHUM SALMON	1	A	3	1	3	7	4	1	36	0	38
16. DOLLY VARDEN	6	A	0	1	9	1	9	8	216	192	387
17. NORTHERN FUR SEAL	1	A	0	0	2	5	1	0	7	0	7
18. RINGED SEAL	10	P	0	0	2	5	1	0	70	0	70
19. RIBBON SEAL	6	P	0	0	1	5	1	0	36	0	36
20. BEARDED SEAL	3	P	0	0	1	5	1	0	18	0	18
21. HARBOR SEAL	3	P	0	0	2	5	1	0	21	0	21
23. WALRUS	10	P	0	0	2	5	0	0	0	0	0
24. WHALES	10	A	0	0	2	5	0	0	0	0	0
26. POLAR BEAR	3	A	0	0	0	3	0	0	0	0	0
27. OTHER MARINE MAMMALS	10	A	0	0	0	5	0	0	0	0	0
28. SEABIRDS	6	A	0	0	0	5	9	1	270	30	273
									1499	667	2014
2. SUBTIDAL SAND-MUD											
1. CODS	6	A	0	0	2	2	0	0	0	0	0
2. SCULPINS	3	A	0	0	0	2	0	0	0	0	0
3. STARRY FLOUNDER	3	A	0	0	0	2	0	0	0	0	0
4. OTHER FLATFISH	6	A	0	0	1	2	0	0	0	0	0
5. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
6. MISC. MARINE FISH	6	A	0	0	0	2	0	0	0	0	0
8. SHRIMP	3	A	0	0	0	3	0	0	0	0	0
10. OTHER BIVALVES	6	A	0	0	0	1	0	0	0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-59 (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
11. OTHER MARINE INVERTEBRATES	6	A	0	0	0	3	0	0	0	0	0
									0	0	0
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
2. SUBTIDAL SEAWEED	3	E	0	0	0	2	4	0	24	0	24
3. CHUM SALMON	1	A	3	1	3	2	9	1	81	9	82
5. OTHER FLATFISH	3	A	0	0	0	2	4	1	24	6	26
6. GREENLINGS	1	E	0	0	0	2	4	1	8	2	9
8. WALLEYE POLLOCK	3	A	0	0	0	2	4	1	24	6	26
9. OTHER MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
10. KING CRAB	1	A	0	0	0	2	9	8	18	16	32
11. TANNER CRAB	3	A	0	0	0	2	9	8	54	48	97
12. SCALLOPS	3	E	0	0	0	2	9	8	54	48	97
13. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	9	1	81	9	82
									392	144	499
4. INTERTIDAL SAND-MUD											
1. EELGRASS	1	E	0	0	0	3	0	0	0	0	0
2. PACIFIC SANDLANCE	3	A	0	0	0	3	0	0	0	0	0
4. SOFTSHELL BIVALVES	6	E	0	0	0	2	0	0	0	0	0
5. INVERTEBRATE INFAUNA	6	A	0	0	0	3	0	0	0	0	0
7. SHOREBIRDS	3	H	0	0	0	5	0	0	0	0	0
8. GEESE	3	A	0	0	3	1	0	0	0	0	0
9. DUCKS	10	A	0	0	3	2	0	0	0	0	0
10. SWANS	1	A	0	0	0	5	0	0	0	0	0
									0	0	0
5. INTERTIDAL ROCKY											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	9	1	81	9	82
2. GREENLINGS	3	E	0	0	0	2	4	0	24	0	24
3. HERRING	10	A	0	0	1	2	9	8	270	240	483
4. SESSILE MARINE INVERTEBRATES	1	A	0	0	0	1	9	8	9	8	16
5. MISC. CRUSTACEANS	6	A	0	0	0	2	9	8	108	96	193
6. OTHER INVERTEBRATES	6	A	0	0	0	3	9	8	162	144	290
7. SHOREBIRDS	6	H	0	0	0	5	9	1	270	30	273
8. SEA DUCKS	6	A	0	0	3	2	9	1	270	30	273
									1194	557	1634

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-59 (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
6. INTERTIDAL COBBLE-GRAVEL											
1. INTERTIDAL SEAWEEDS	3	E	0	0	0	3	9	1	81	9	82
2. SMELT	10	A	0	0	0	3	9	8	270	240	493
3. HARDSHELL BIVALVES	1	A	0	0	0	2	9	8	18	14	32
4. CRUSTACEANS	3	H	0	0	0	2	9	8	54	43	97
5. GASTROPODS	1	A	0	0	0	3	9	8	27	24	48
6. SHOREBIRDS	6	H	0	0	0	5	9	1	270	30	279
									720	347	1015
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	H	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	3	H	0	0	0	3	0	0	0	0	0
4. CHUM SALMON	1	A	0	1	3	2	0	0	0	0	0
10. WHITEFISH	10	A	0	1	2	1	0	0	0	0	0
11. ARCTIC GRAYLING	6	A	0	2	2	2	0	0	0	0	0
12. PIKE	6	A	0	2	2	1	0	0	0	0	0
13. STICKLEBACKS	3	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	10	A	0	0	0	2	0	0	0	0	0
15. DUCKS	15	A	0	0	3	2	0	0	0	0	0
16. GEESE	10	A	0	0	3	2	0	0	0	0	0
17. SWANS	3	A	0	0	1	5	0	0	0	0	0
18. RIVER OTTER	3	A	0	0	1	1	0	0	0	0	0
19. MINK	3	A	0	0	1	1	0	0	0	0	0
20. MUSKRAT	3	A	0	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	0	0	1	1	0	0	0	0	0
									0	0	0
8. TERRESTRIAL											
1. TUNDRA	15	P	0	0	0	3	4	1	180	45	191
2. RIPARIAN VEGETATION	10	H	0	0	0	2	4	0	80	0	80
3. STRAND VEGETATION	10	E	0	0	0	1	9	1	90	10	91
4. OTHER VEGETATION	6	H	0	0	0	2	9	0	108	0	108
5. BROWN BEAR	3	A	1	1	2	2	1	0	18	0	18
7. WOLVERINE	3	A	2	1	0	1	1	0	12	0	12
8. WOLF	3	A	2	1	0	1	1	0	12	0	12
9. MOOSE	1	A	0	1	3	2	1	0	6	0	6
10. CARIBOU	10	A	1	1	3	2	1	0	70	0	70
13. MUSKOX	3	A	0	0	0	3	0	0	0	0	0
16. OTHER MAMMALS	3	A	0	0	2	2	4	0	48	0	48
17. RAPTORS	6	A	0	0	0	5	4	0	120	0	120

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-59 (CONT'D)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
9. TERRESTRIAL											
19. PTARMIGAN	6	A	0	0	1	2	1	0	19	0	19
19. OTHER BIRDS	3	A	0	0	0	2	4	0	24	0	24
									786	58	798
									4591	1785	5960

(13) OFFSHORE PRUDHOE - CLEANUP

APPROPRIATE CLEANUP METHODS

The most effective Summer open-sea cleanup method was judged to be sorbents. The next most effective methods were judged to be barriers and skimming devices. If the spill is moving offshore and dispersing relatively slowly, use of (approved) dispersants, if applied soon after the spill occurs, is effective. The most effective Summer beach cleanup method was judged to be mechanical/manual removal. The next most effective methods were judged to be burning and on-site sand cleaning.

In Winter, the presence of solid ice was assumed. The most effective method was judged to be burning. The next most effective method was judged to be mechanical/manual removal.

POSTULATED SCENARIO

The spill scenario for Summer had the oil slick moving in a southwesterly direction. The slick reached the Jones Islands in about 24 hours.

It was assumed that cleanup equipment, material, and personnel were available at Prudhoe[67] in conjunction with the petroleum activity. Response times for skimmers, etc. were estimated at about 7 to 8 hours. It was assumed that this deployment reduced the beach impact. Deployment of beach cleanup manpower and material was assumed.

In Winter, two possible scenarios were postulated in the non-cleanup section. The first assumes that oil was spilled under the ice. For this scenario, no cleanup method was easily applicable due to the difficulty of finding the oil. For the second scenario, oil was assumed spilled on top of the ice. For this scenario, it was assumed that burning and mechanical/manual removal was very effective and that most of the oil was removed.

MATRIX RESULTS

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 4,065

The effectiveness of the cleanup operation reduced the impact scores in all of the habitats affected by the spill. The effect of the cleanup procedures was most noticeable in the reduction of the long-term impacts. The long-term impacts were reduced because the oil spill was boomed within a reasonable period of time and thus was not allowed to reach the nearshore and beach habitats at this site.

As a result of the cleanup effort, the long-term impact decreased by some 73 percent, from 789 to 214. This particular case illustrated a perhaps obvious but important point; an early response, within a few hours after a spill occurs, can dramatically reduce both the short- and long-term effects of the spill upon the aquatic environment and at the same time reduce the magnitude of the cleanup operation.

Table 2-60 presents the complete results for Case 1.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-60. MATRIX RESULTS-- CASE 1

AREA	OFFSHORE PRUDHOE
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	TANKER CASUALTY
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	3	M	0	0	0	3	4	0	36	0	36
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	1	M	0	0	0	2	4	0	8	0	8
6. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
7. HERRING	3	A	0	0	0	3	9	1	81	9	82
8. SMELT	6	A	0	0	2	3	9	0	270	0	270
9. CRAB LARVAE	1	E	0	0	0	2	9	1	18	2	18
11. CHUM SALMON	1	A	0	0	2	2	4	0	16	0	16
13. PINK SALMON	1	A	0	0	2	2	4	0	16	0	16
16. DOLLY VARDEN	6	A	0	1	1	1	9	1	162	18	164
17. NORTHERN FUR SEAL	1	A	0	0	2	5	4	0	28	0	28
18. RINGED SEAL	10	A	0	0	2	5	4	0	280	0	280
19. RIBBON SEAL	3	A	0	0	1	5	4	0	72	0	72
20. BEARDED SEAL	3	A	0	0	1	5	4	0	72	0	72
21. HARBOR SEAL	6	A	0	0	1	5	4	0	144	0	144
23. WALRUS	10	A	0	0	2	5	0	0	0	0	0
24. WHALES	6	A	0	0	3	5	0	0	0	0	0
26. POLAR BEAR	15	A	0	0	1	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	6	A	3	0	0	2	0	0	0	0	0
28. SEABIRDS	15	A	0	0	1	5	9	0	810	0	810
									2088	29	2091
2. SUBTIDAL SAND-MUD											
1. CODS	10	A	1	0	3	2	4	0	240	0	240
2. SCULPINS	6	A	0	0	0	2	4	0	48	0	48
3. STARRY FLOUNDER	3	A	0	0	0	2	4	0	24	0	24
4. OTHER FLATFISH	3	A	0	0	1	2	4	0	36	0	36
5. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
6. MISC. MARINE FISH	3	A	0	0	0	2	4	0	24	0	24
8. SHRIMP	3	A	0	0	1	3	9	1	108	12	109
10. OTHER BIVALVES	1	A	0	0	1	1	9	1	18	2	18

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-60. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
2. SUBTIDAL SAND-MUD											
11. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	9	0	81	0	81
									582	14	583
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
									0	0	0
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	1	E	0	0	0	3	0	0	0	0	0
4. SOFTSHELL BIVALVES	1	E	0	0	1	2	9	1	27	3	27
5. INVERTEBRATE INFAUNA	3	A	0	0	0	3	4	1	36	9	38
7. SHOREBIRDS	6	A	0	0	1	5	4	1	144	36	153
8. GEESE	5	A	0	1	3	1	4	1	120	30	128
9. DUCKS	10	A	0	1	3	2	4	1	240	60	255
10. SWANS	3	A	0	0	1	5	4	1	72	18	77
									639	156	678
5. INTERTIDAL ROCKY											
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	A	0	0	0	3	0	0	0	0	0
2. AQUATIC INVERTEBRATES	3	A	0	0	0	3	0	0	0	0	0
4. CHUM SALMON	1	A	0	0	2	2	0	0	0	0	0
6. PINK SALMON	1	A	0	0	2	2	0	0	0	0	0
8. RAINBOW-STEELHEAD TROUT	3	A	0	1	2	1	0	0	0	0	0
9. DOLLY VARDEN	6	A	0	1	2	1	0	0	0	0	0
10. WHITEFISH	10	A	0	1	3	1	0	0	0	0	0
11. ARCTIC GRAYLING	6	A	0	1	3	2	0	0	0	0	0
13. STICKLEBACKS	3	A	0	0	0	3	0	0	0	0	0
14. OTHER FISH	1	A	0	0	0	3	0	0	0	0	0
15. DUCKS	15	A	0	1	3	2	0	0	0	0	0

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-60. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
7. FRESHWATER RIVER											
16. GEESE	15	A	0	1	3	2	0	0	0	0	0
17. SWANS	10	A	0	0	1	5	0	0	0	0	0
19. MINK	3	A	1	0	1	1	0	0	0	0	0
20. MUSKRAT	3	A	1	0	1	1	0	0	0	0	0
21. OTHER AQUATIC MAMMALS	3	A	1	0	1	1	0	0	0	0	0
									0	0	0
6. TERRESTRIAL											
1. TUNDRA	15	A	0	0	0	3	0	0	0	0	0
2. RIPARIAN VEGETATION	6	E	0	0	0	2	0	0	0	0	0
3. STRAND VEGETATION	15	A	0	0	0	1	9	1	135	15	137
4. OTHER VEGETATION	6	A	0	0	0	2	4	0	48	0	48
5. BROWN BEAR	3	A	1	1	1	2	0	0	0	0	0
7. WOLVERINE	3	A	2	1	1	1	4	0	60	0	60
8. WOLF	3	A	2	1	1	1	4	0	60	0	60
9. MOOSE	1	A	0	1	1	2	0	0	0	0	0
10. CARIBOU	6	A	1	2	3	2	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	0	2	2	4	0	96	0	96
17. RAPTORS	6	A	0	0	1	2	4	0	264	0	264
18. PTARMIGAN	6	A	0	0	1	2	0	0	0	0	0
19. OTHER BIRDS	6	A	0	0	0	2	4	0	48	0	48
									711	15	713
									4020	214	4065

(14) ONSHORE PRUDHOE - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective Summer cleanup method was judged to be mechanical/manual removal of the oil. The next most effective methods were judged to be burning and sorbents.

WINTER: For Winter, the most effective cleanup methods on land were deemed to be mechanical/manual removal and burning, with removal being preferred. On ice these same cleanup measures were judged most effective on land, with burning slightly more effective.

POSTULATED SCENARIO

The spill site was close to the Sagavanirktok River. Large spills were postulated to enter the river soon after the spill and the lead edge of the slick was estimated to reach the delta mouth about 5 hours later. (See Site Discussion - Site 14 - No Cleanup.)

It was assumed that off-duty operating personnel associated with the petroleum activity at Prudhoe were available, along with equipment and sorbents, so that a rapid response to the spill was possible. Based on this assumption and logistics information for Prudhoe,[67] it was assumed that land cleanup methods were employed to remove oil that did not enter the river, and beach cleanup methods (sorbents and manual removal) were used to remove oil from heavier downstream concentrations and from shorelines on the seacoast impacted.

In Winter, it was assumed that the oil formed a large puddle that was removed by burning and mechanical/manual removal.

MATRIX RESULTS

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 8,453

Based on the cleanup scenario, adjustments were made to the species impacted in the habitats. In general, short-term effects remained virtually the same, but long-term effects were slightly lowered in response to removal of part of the spilled oil. The effectiveness of the cleanup procedures was most noticeable in the freshwater river habitat, where the cleanup allowed the freshwater mammals to recover in a shorter period of time and thus reduced the effect of the spill in the nearshore habitats of the delta and bay. However, the cleanup procedures were detrimental to the delicate vegetation in this region and thus produced a negative effect in the terrestrial habitat near the river. Given the long recovery time of any vegetation in this region, the impact scores were dramatically increased by the cleanup activity; however, the relative benefits of the cleanup vs. no cleanup were very difficult to measure in this case; therefore, the relative merits of any cleanup activity is simply a trade-off between the up-river environments and the down-river environment of the delta and bay.

Table 2-61 presents the complete results for Case 1.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-61. MATRIX RESULTS--
CASE 1

AREA	ONSHORE PRUDHOE
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	PIPELINE BREAK
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	3	H	0	0	0	3	4	0	36	0	36
2. ZOOPLANKTON	5	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	1	H	0	0	0	2	4	0	8	0	8
6. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
7. HERRING	3	A	0	0	0	3	4	1	36	9	38
8. SMELT	6	A	0	0	2	3	4	0	120	0	120
9. CRAB LARVAE	1	E	0	0	0	2	4	1	8	2	9
11. CHUM SALMON	1	A	0	0	2	2	4	1	16	4	17
13. PINK SALMON	1	A	0	0	2	2	4	1	16	4	17
16. JOLLY VARDEN	6	A	0	1	1	1	9	1	162	18	164
17. NORTHERN FUR SEAL	1	A	0	0	2	5	1	0	7	0	7
18. RINGED SEAL	10	A	0	0	2	5	1	0	70	0	70
19. RIBBON SEAL	3	A	0	0	1	5	1	0	18	0	18
20. BEARDED SEAL	3	A	0	0	1	5	1	0	18	0	18
21. HARBOR SEAL	6	A	0	0	1	5	1	0	36	0	36
23. WALRUS	10	A	0	0	2	5	0	0	0	0	0
24. WHALES	6	A	0	0	3	5	0	0	0	0	0
26. POLAR BEAR	15	A	0	0	1	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	6	A	3	0	0	2	0	0	0	0	0
28. SEABIRDS	15	A	0	0	1	5	9	1	810	90	820
									1436	127	1453
2. SUBTIDAL SAND-MUD											
1. CODS	10	A	1	0	3	2	4	0	240	0	240
2. SCULPINS	6	A	0	0	0	2	1	0	12	0	12
3. STARRY FLOUNDER	3	A	0	0	0	2	4	0	24	0	24
4. OTHER FLATFISH	3	A	0	0	1	2	4	0	36	0	36
5. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
6. MISC. MARINE FISH	3	A	0	0	0	2	1	0	6	0	6
8. SHRIMP	3	A	0	0	1	3	4	1	48	12	51
10. OTHER BIVALVES	1	A	0	0	1	1	4	1	8	2	9

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-61. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.IRM	L.IRM	S.IRM	L.IRM	RSLT.
2. SUBTIDAL SAND-MUD											
11. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	4	1	36	9	38
									413	23	419
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
									0	0	0
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	1	E	0	0	0	3	1	0	3	0	3
4. SOFTSHELL BIVALVES	1	E	0	0	1	2	9	1	27	3	27
5. INVERTEBRATE INFAUNA	3	A	0	0	0	3	9	0	81	0	81
7. SHOREBIRDS	6	A	0	0	1	5	9	0	324	0	324
8. GEESE	6	A	0	1	3	1	4	0	120	0	120
9. DUCKS	10	A	0	1	3	2	4	1	240	60	255
10. SWANS	3	A	0	0	1	5	4	0	72	0	72
									867	63	882
5. INTERTIDAL ROCKS											
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	A	0	0	0	3	4	0	36	0	36
2. AQUATIC INVERTEBRATES	3	A	0	0	0	3	4	0	36	0	36
4. CHUM SALMON	1	A	0	0	2	2	4	1	16	4	17
6. PINK SALMON	1	A	0	0	2	2	4	1	16	4	17
8. RAINBOW-STEELHEAD TROUT	3	A	0	1	2	1	4	0	48	0	48
9. DOLLY VARDEN	3	A	0	1	2	1	4	8	96	192	480
10. WHITEFISH	10	A	0	1	3	1	4	0	200	0	200
11. ARCTIC GRAYLING	6	A	0	1	3	2	4	1	144	36	153
13. STICKLEBACKS	3	A	0	0	0	3	4	0	36	0	36
14. OTHER FISH	1	A	0	0	0	3	4	0	12	0	12
15. DUCKS	15	A	0	1	3	2	4	8	360	720	1800

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-61. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.IRM	L.IRM	S.IRM	L.IRM	RSLI.
7. FRESHWATER RIVER											
16. GEESE	15	A	0	1	3	2	4	1	360	90	383
17. SWANS	15	A	0	0	1	5	4	1	360	90	383
19. MINK	3	A	1	0	1	1	4	1	36	9	38
20. MUSKRAT	3	A	1	0	1	1	4	1	36	9	38
21. OTHER AQUATIC MAMMALS	3	A	1	0	1	1	1	1	9	9	18
									1801	1163	3695
8. TERRESTRIAL											
1. TUNDRA	15	A	0	0	0	3	9	8	405	360	725
2. RIPARIAN VEGETATION	6	E	0	0	0	2	9	1	108	12	109
3. STRAND VEGETATION	15	A	0	0	0	1	9	8	135	120	242
4. OTHER VEGETATION	6	A	0	0	0	2	9	1	108	12	109
5. BROWN BEAR	3	A	1	1	1	2	1	0	15	0	15
7. WOLVERINE	3	A	2	1	1	1	4	0	60	0	60
8. WOLF	3	A	2	1	1	1	4	0	60	0	60
9. MOOSE	1	A	0	1	1	2	0	0	0	0	0
10. CARIBOU	6	A	1	2	3	2	4	0	192	0	192
16. OTHER MAMMALS	6	A	0	3	2	2	4	1	96	24	102
17. RAPTORS	6	A	0	0	1	4	4	1	264	66	281
18. PTARMIGAN	6	A	0	0	1	2	0	0	0	0	0
19. OTHER BIRDS	6	A	0	0	0	2	9	1	108	12	109
									1551	606	2004
									6960	1982	8453

(15) UMIAT - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective cleanup method was judged to be mechanical/manual removal on land. The next most effective methods were judged to be burning and sorbents.

WINTER: For spills on land, the most effective methods were the same as for Summer. For spills on ice, the most effective method was judged to be burning. Mechanical/manual removal was judged to be next most effective on ice.

POSTULATED SCENARIO

The spill site was about 18 miles downstream from Umiat, below Uluksrak Bluff, about 300 ft from the Colville River. Oil was postulated to reach the river within the first hour. Limited personnel and cleanup material support were assumed available at Umiat.[67] The response times were estimated at 12+ hours. In this time, most of the oil would reach the river. Cleanup operations were assumed to remove the remaining oil from the spill site plus some of the oil in slack water areas downriver.

For Winter, it was assumed that the river was frozen. Response time would be measured in days rather than hours, but the spill would remain quiescent. It was assumed that the spill was located prior to being covered by snow and that cleanup was effected over the necessary time, via burning and mechanical/manual removal.

MATRIX RESULTS

CASE 1: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 4,832

In general, short-term impacts were increased in the terrestrial habitat and long-term impacts were slightly decreased in two other habitats, reflecting the removal of some oil. The change in impact scores from the non-cleanup case are shown below:

Intertidal sand/mud	decreased from 690 to 681
Freshwater river	decreased from 1,880 to 1,857
Pelagic	no change (741)
Subtidal sand/mud	no change (94)
Subtidal rock/cobble/ gravel	no change (0)
Intertidal rocky	no change (0)
Intertidal cobble/ gravel	no change (0)
Terrestrial	increased from 1,050 to 1,465

Table 2-62 presents the complete results for Case 1.

It was assumed that a Winter spill would have a minor impact score if cleaned up, but would have an impact score comparable to that for the breakup cases if left alone.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-62. MATRIX RESULTS-- CASE 1

AREA	UMIAT
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	PIPELINE BREAK
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC											
1. PHYTOPLANKTON	1	A	0	0	0	3	4	0	12	0	12
2. ZOOPLANKTON	6	A	0	0	0	3	4	0	72	0	72
3. ICHTHYOPLANKTON	1	A	0	0	0	2	4	0	8	0	8
6. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
7. HERRING	1	A	0	0	0	3	4	0	12	0	12
8. SMELT	1	A	0	0	0	3	4	0	12	0	12
9. CRAB LARVAE	1	E	0	0	0	2	4	0	8	0	8
16. DOLLY VARDEN	3	A	0	1	1	1	9	1	81	9	82
17. NORTHERN FUR SEAL	1	A	0	0	2	5	1	0	7	0	7
18. RINGED SEAL	10	A	0	0	2	5	1	0	70	0	70
19. RIBBON SEAL	3	A	0	0	1	5	1	0	18	0	18
20. BEARDED SEAL	3	A	0	0	1	5	1	0	18	0	18
21. HARBOR SEAL	6	A	0	0	1	5	1	0	36	0	36
23. WALRUS	10	A	0	0	1	5	0	0	0	0	0
24. WHALES	10	A	0	0	2	5	0	0	0	0	0
26. POLAR BEAR	6	A	0	1	2	5	0	0	0	0	0
27. OTHER MARINE MAMMALS	10	A	0	0	1	5	0	0	0	0	0
28. SEABIRDS	15	A	0	0	1	5	4	1	360	99	363
									717	99	741
2. SUBTIDAL SAND-MUD											
1. CODS	3	E	1	0	3	2	1	0	18	0	18
2. SCULPINS	1	A	0	0	0	2	0	0	0	0	0
3. STARRY FLOUNDER	1	A	1	0	1	2	1	0	4	0	4
4. OTHER FLATFISH	3	A	1	0	1	2	1	0	12	0	12
5. PACIFIC SANDLANCE	1	A	0	0	0	3	0	0	0	0	0
6. MISC. MARINE FISH	3	A	0	0	0	2	0	0	0	0	0
8. SHRIMP	1	E	0	0	0	3	4	0	12	0	12
10. OTHER BIVALVES	3	A	0	0	0	1	4	4	12	0	12
11. OTHER MARINE INVERTEBRATES	3	A	0	0	0	3	4	0	36	0	36
									94	0	

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-62. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
3. SUBTIDAL ROCK-COBBLE-GRAVEL											
									0	0	0
4. INTERTIDAL SAND-MUD											
2. PACIFIC SANDLANCE	1	A	0	0	0	3	1	0	3	0	3
4. SOFTSHELL BIVALVES	1	A	0	0	0	2	9	0	18	0	18
5. INVERTEBRATE INFAUNA	3	A	0	0	0	3	4	0	36	0	36
7. SHOREBIRDS	6	A	0	0	0	5	4	0	120	0	120
8. GEESE	6	A	0	1	3	1	4	0	120	0	120
9. DUCKS	10	A	0	1	3	2	4	0	240	0	240
10. SWANS	6	A	0	0	1	5	4	0	144	0	144
									681	0	681
5. INTERTIDAL ROCKY											
									0	0	0
6. INTERTIDAL COBBLE-GRAVEL											
									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	3	E	0	0	0	3	4	0	36	0	36
2. AQUATIC INVERTEBRATES	3	A	0	0	0	3	4	0	36	0	36
9. DOLLY VARDEN	3	A	0	1	1	1	9	0	81	0	81
10. WHITEFISH	6	A	0	1	2	1	4	0	96	0	96
11. ARCTIC GRAYLING	6	A	0	1	2	2	4	0	120	0	120
12. PIKE	3	A	0	1	2	1	4	0	48	0	48
13. STICKLEBACKS	3	A	0	0	0	3	4	0	36	0	36
14. OTHER FISH	3	A	0	0	0	3	4	0	36	0	36
15. DUCKS	15	A	0	1	3	2	9	0	810	0	810
16. GEESE	10	A	0	1	3	2	4	0	240	0	240
17. SWANS	10	A	0	0	1	5	4	0	240	0	240
19. MINK	6	A	0	0	0	1	4	0	24	0	24
20. MUSKRAT	6	A	0	0	0	1	4	0	24	0	24
21. OTHER AQUATIC MAMMALS	6	A	0	0	0	1	4	0	24	0	24
									1851	0	1851

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-62. (CONT'D.)

HABITAT/SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	IND.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
B. TERRESTRIAL											
1. TUNDRA	15	A	0	0	0	3	9	1	405	45	410
2. RIPARIAN VEGETATION	6	A	0	0	0	2	9	0	108	0	108
3. STRAND VEGETATION	10	E	0	0	0	1	9	1	90	10	91
4. OTHER VEGETATION	1	H	0	0	0	2	9	0	18	0	18
5. BROWN BEAR	3	A	0	1	1	2	1	0	12	0	12
6. BLACK BEAR	3	A	0	1	1	2	1	0	12	0	12
7. WOLVERINE	10	A	2	0	3	1	1	0	60	0	60
8. WOLF	10	A	2	1	2	1	1	0	60	0	60
9. MOOSE	3	A	0	1	2	2	0	0	6	0	6
10. CARIBOU	10	A	3	1	3	2	1	0	60	0	60
13. MUSKOX	6	A	0	0	0	3	1	0	18	0	18
16. OTHER MAMMALS	6	A	0	0	1	2	4	0	72	0	72
17. RAPTORS	6	A	0	0	1	4	4	1	264	66	281
18. PTARMIGAN	10	P	0	1	2	2	1	0	50	0	50
19. OTHER BIRDS	10	P	0	0	0	5	4	1	200	50	213
									1429	171	1465
									4772	270	4632

(16) YUKON RIVER - CLEANUP

APPROPRIATE CLEANUP METHODS

SUMMER: The most effective cleanup method was judged to be mechanical/manual removal. The next most effective methods were judged to be burning and sorbents.

WINTER: The most effective cleanup method for spilled oil remaining on land was judged to be mechanical/manual removal. The next most effective method was burning. On the river ice, the most effective method was judged to be burning, with mechanical/manual removal the next most effective method.

POSTULATED SCENARIO

SUMMER: The spill site was postulated at the TAPS crossing, on the northern bank of the Yukon River. Oil would nearly immediately enter the river when spilled. Response times of about 7 hours were estimated for all major cleanup efforts based on the previous logistics study.[67]

It was assumed that cleanup efforts would be directed to the downstream area, using Rampart as a staging base. Also, land methods were assumed used at the spill site. It was assumed that the efforts along the river were marginally effective due to the amount of riverbank affected and the relative inefficiency of manual cleanup methods. It was also assumed that sorbents were applied with manual cleanup methods to those areas of the river that oil would concentrate in.

WINTER: Winter spills were assumed to form a large pool on top of the frozen river. Response times would not be as critical and it was

assumed that nearly all of the oil was effectively removed by burning and mechanical/manual methods.

MATRIX RESULTS

Only two habitats were impacted in the non-cleanup cases, as the Yukon location is far removed from the saltwater habitats. In general, it was felt that long-term impacts would be reduced in the river with oil removal, but some short-term impacts would be increased by the cleanup activity. The changes in the habitat scores from the non-cleanup case are shown below.

CASE 1: SUMMER, CRUDE OIL, 50,000 BBLS - IMPACT SCORE 16,114

The habitat scores are as follows:

Freshwater river	decreased from 14,175 to 14,044
Terrestrial	increased from 1,475 to 2,070

Table 2-63 presents the complete results for Case 1.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-63. MATRIX RESULTS--
CASE 1

AREA	YUKON RIVER
SEASON	SUMMER
SPILL SIZE	50,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	PIPELINE BREAK
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC									0	0	0
2. SUBTIDAL SAND-MUD									0	0	0
3. SUBTIDAL ROCK-COBBLE-GRAVEL									0	0	0
4. INTERTIDAL SAND-MUD									0	0	0
5. INTERTIDAL ROCKY									0	0	0
6. INTERTIDAL COBBLE-GRAVEL									0	0	0
7. FRESHWATER RIVER											
1. AQUATIC VEGETATION	15	A	0	0	0	3	9	0	405	0	405
2. AQUATIC INVERTEBRATES	10	A	0	0	0	3	9	0	270	0	270
3. KING SALMON	15	A	3	1	3	2	9	9	1215	1080	2175

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-63 (CONT'D)

HABITAT.SPECIES	ABUNDANCE INV.	ABUNDANCE CONF.	IMPORTANCE CUM.	IMPORTANCE REC.	IMPORTANCE SUB.	IMPORTANCE ECOL.	IMPACT S.TRM	IMPACT L.TRM	RESULTS IMPACT S.TRM	RESULTS IMPACT L.TRM	RESULTS RSLT.
7. FRESHWATER RIVER											
4. CHUM SALMON	15	A	3	1	3	2	9	8	1215	1080	2175
7. COHO SALMON	6	A	3	1	3	2	9	8	486	432	870
9. DOLLY VARDEN	15	A	0	3	2	1	9	8	810	720	1450
10. WHITEFISH	15	A	1	2	2	1	9	0	810	0	810
11. ARCTIC GRAYLING	15	A	0	2	2	2	9	0	810	0	810
12. PIKE	6	A	0	2	2	1	9	0	270	0	270
13. STICKLEBACKS	6	A	0	0	0	3	9	0	162	0	162
14. OTHER FISH	10	A	0	2	1	3	9	0	540	0	540
15. DUCKS	15	A	0	3	2	2	9	8	945	840	1692
16. GEESE	10	A	0	2	2	2	9	0	540	0	540
17. SWANS	15	A	0	0	0	5	9	0	675	0	675
18. RIVER OTTER	15	P	3	0	1	1	4	0	360	0	300
19. MINK	15	P	3	0	1	1	4	0	300	0	300
20. MUSKRAT	15	P	3	0	1	1	4	0	300	0	300
21. OTHER AQUATIC MAMMALS	15	P	3	0	1	1	4	0	300	0	300
									10353	4152	14044
8. TERRESTRIAL											
1. TUNDRA	10	A	0	0	0	3	1	0	30	0	30
2. RIPARIAN VEGETATION	15	A	0	0	0	2	4	0	120	0	120
4. OTHER VEGETATION	10	A	1	0	0	2	4	1	120	30	128
5. BROWN BEAR	3	A	1	1	1	2	1	1	15	15	30
6. BLACK BEAR	3	A	0	1	1	2	1	1	12	12	24
7. WOLVERINE	15	A	2	1	1	1	4	1	300	75	319
8. WOLF	15	A	2	1	1	1	1	1	75	75	150
9. MOOSE	6	A	1	3	3	2	1	0	54	0	54
10. CARIBOU	10	A	1	3	3	2	1	0	90	0	90
12. BISON	10	A	0	0	0	3	0	0	0	0	0
16. OTHER MAMMALS	6	A	0	1	2	2	9	1	270	30	273
17. RAPTORS	6	A	0	0	0	*	4	1	240	60	255
18. PTARMIGAN	10	A	0	2	1	2	1	0	50	0	50
19. OTHER BIRDS	10	A	0	0	1	5	9	1	540	60	547
									1916	357	2070
									12269	4509	16114

(17) DENALI FAULT - CLEANUP

APPROPRIATE CLEANUP METHODS

The most applicable Summertime cleanup method was judged to be sorbents coupled with manual removal. Barriers and skimming devices were judged to be moderately effective on the lower part of the river, but were deemed ineffective on the upper portion above Donnelly. The most applicable cleanup method on the riverbanks was judged to be mechanical/manual removal, with burning and on-site sand cleaning deemed next most efficient.

In Winter, solid ice was presumed present. The most applicable methods were judged to be mechanical/manual removal on land and burning on ice. The next most effective methods were judged to be burning on land and mechanical/manual removal on ice.

POSTULATED SCENARIO

SUMMER: The spill scenarios had oil moving down Castner Creek in about one hour, reaching the Delta River. Since response times for open-water cleanup were estimated at around 10 hours, these methods would only be effective below Donnelly. It was assumed that riverbank cleanup was deployed as rapidly as possible, but no other cleanup methods were employed.

WINTER: In a winter spill, it was assumed that the oil would form a large splotch on the snow in the Castner Creek bed. It was also assumed to remain quiescent for a sufficient period that mechanical/manual removal would regather nearly all of the oil and oil-contaminated snow.

MATRIX RESULTS

Only two habitats were impacted at Denali in the non-cleanup cases as the location is well removed from salt water. In general, it was felt

that oil removal would reduce long-term impact scores in the river, but some short-term impact scores would increase due to the cleanup activity.

CASE 1: SUMMER, CRUDE OIL, 10,000 BBLS - IMPACT SCORE 5,432

The changes in habitat scores from the non-cleanup case are as follows:

Freshwater river	decreased from 4,096 to 4,029
Terrestrial	increased from 1,006 to 1,403

Table 2-64 presents the complete results for Case 1.

Winter spills, in which nearly all of the oil was removed, were assumed to have a minor impact score. If not cleaned up, they were assumed to have scores comparable to those for the breakup scenarios.

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-64. MATRIX RESULTS--CASE 1

AREA	DENALI FAULT
SEASON	SUMMER
SPILL SIZE	10,000 BBLS.
SPILL TYPE	CRUDE OIL
SPILL MODE	PIPELINE BREAK
RELEASE TYPE	INSTANTANEOUS
SPILL CLEANUP	YES

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
1. PELAGIC									0	0	0
2. SUBTIDAL SAND-MUD									0	0	0
3. SUBTIDAL ROCK-COBBLE-GRAVEL									0	0	0
4. INTERTIDAL SAND-MUD									0	0	0
5. INTERTIDAL ROCKY									0	0	0
6. INTERTIDAL COBBLE-GRAVEL									0	0	0
7. FRESHWATER RIVER									0	0	0
1. AQUATIC VEGETATION	6	A	0	0	0	3	9	0	162	0	162
2. AQUATIC INVERTEBRATES	3	H	3	0	0	3	9	0	81	0	81
3. KING SALMON	3	A	1	1	3	2	9	0	189	0	189

U.S. COAST GUARD OIL SPILL PREDICTION STUDY
EVALUATION MATRIX

TABLE 2-64. (CONT'D.)

HABITAT.SPECIES	FACTORS								RESULTS		
	ABUNDANCE		IMPORTANCE				IMPACT		IMPACT		
	INV.	CONF.	COM.	REC.	SUB.	ECOL.	S.TRM	L.TRM	S.TRM	L.TRM	RSLT.
7. FRESHWATER RIVER											
6. CHUM SALMON	6	A	1	1	3	2	9	0	378	0	378
7. COHO SALMON	3	A	1	1	3	2	9	0	189	0	189
8. DOLLY VARDEN	6	A	0	2	2	1	9	0	270	0	270
10. WHITEFISH	6	A	1	2	2	1	9	0	324	0	324
11. ARCTIC GRAYLING	6	A	0	2	2	2	9	0	324	0	324
12. PIKE	6	A	0	2	2	1	9	0	270	0	270
14. OTHER FISH	6	A	0	1	1	3	9	0	270	0	270
15. DUCKS	10	A	0	2	1	2	9	1	450	50	456
16. GEESE	10	A	0	2	1	2	9	1	450	50	456
17. SWANS	10	A	0	0	0	5	9	1	450	50	456
18. RIVER OTTER	6	P	1	0	0	1	4	1	48	12	51
19. MINK	6	P	1	0	0	1	4	1	48	12	51
20. MUSKRAT	6	P	1	0	0	1	4	1	48	12	51
21. OTHER AQUATIC MAMMALS	6	P	1	0	0	1	4	1	48	12	51
									3999	198	4029
8. TERRESTRIAL											
1. TUNDRA	6	A	0	0	0	3	1	0	18	0	18
2. RIPARIAN VEGETATION	15	A	0	0	0	2	4	1	120	30	126
4. OTHER VEGETATION	10	A	2	0	0	2	4	1	160	40	170
5. BROWN BEAR	3	A	1	1	0	2	1	1	12	12	24
6. BLACK BEAR	3	A	0	2	1	2	1	1	15	15	30
7. WOLVERINE	6	A	2	1	0	1	4	1	96	24	102
8. WOLF	6	A	2	1	0	1	1	1	24	24	48
9. MOOSE	6	A	0	2	2	2	1	1	36	36	72
10. CARIBOU	6	A	0	1	1	2	1	0	24	0	24
12. BISON	10	A	0	3	0	3	1	0	60	0	60
14. SHEEP	10	A	0	2	1	1	1	0	40	0	40
16. OTHER MAMMALS	6	P	0	0	0	2	9	1	108	12	109
17. RAPTORS	6	A	0	0	0	*	4	1	240	60	255
18. PTARMIGAN	10	A	0	2	1	2	1	0	50	0	50
19. OTHER BIRDS	6	P	0	0	0	5	9	1	270	30	273
									1473	283	1493
									5272	481	5432

C. RANKING OF OIL SPILL CASES WITH AND WITHOUT CLEANUP.

This subsection presents a ranking of all evaluated "no-cleanup" and cleanup oil spill cases. A total of 372 "no-cleanup" oil spills were ranked and are listed in Table 2-65.

The cleanup evaluated include:

- The cleanup impact scores for the largest no-cleanup cases at each location--17 cases.
- The cleanup impact scores for the largest no-cleanup cases of bunker C and gasoline not included above--2 cases.
- The cleanup impact scores of any remaining spill cases of largest volume in the highest 10 no-cleanup cases--3 cases.

These cleanup cases are ranked in Table 2-66. Other cleanup cases (Winter season) are generally discussed with each location, parallel with the scored cases. These evaluations establish a trend of impact changes with cleanup as compared to no-cleanup spill cases.

TABLE 2-65

RANK ORDER OF OIL SPILL CASES: NO CLEANUP

KEY:

SUMMER = S	GASOLINE = G	50,000 bbls = 50
WINTER = W	DIESEL-2 = D	10,000 bbls = 10
	CRUDE OIL = C	4,000 bbls = 4
	BUNKER C = B	1,000 bbls = 1
		100 bbls = 0.1

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
1	Port Graham	S	D	50	31,465
2	Port Graham	S	D	10	23,167
3	Valdez Narrows	S	D	50	21,898
4	Valdez Narrows	S	D	10	19,812
5	Valdez Narrows	S	C	50	19,437
6	Port Graham	S	C	50	18,919
7	Drift River	S	D	50	17,920
8	Unimak	S	D	50	15,668
9	Yukon River	S	C	50	15,650
10	Drift River	S	C	50	15,615
11	Unimak	S	C	50	15,427
12	Valdez Narrows	W	C	50	14,338
13	Valdez Narrows	W	D	50	14,018
14	Valdez Narrows	S	B	50	13,609
15	Valdez Narrows	S	C	10	13,479
16	Port Graham	S	B	50	13,443
17	Drift River	S	D	10	13,194
18	Port Graham	S	C	10	13,120
19	Valdez Narrows	W	D	10	12,593
20	Unimak	S	D	10	11,536
21	Valdez Narrows	W	B	50	11,486
22	Yakutat	S	D	50	11,351
23	Drift River	S	B	50	11,031
24	Valdez Narrows	S	B	10	10,972
25	Port Graham	S	B	10	10,838
26	Drift River	S	C	10	10,829
27	Port Graham	S	D	1	10,805
28	Port Muller	S	D	10	10,782
29	Unimak	S	C	10	10,698
30	Valdez Harbor	S	C	1	10,530

TABLE 2-65 (CONT'D.)

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
31	Unimak	W	D	50	10,052
32	Valdez Harbor	S	B	1	10,032
33	Valdez Narrows	W	C	10	9,943
34	Yukon River	W	C	50	9,766
35	Valdez Harbor	S	D	1	9,744
36	Yukon River	S	C	10	9,364
37	Valdez Narrows	W	B	10	9,260
38	Valdez Narrows	S	D	1	8,962
39	Drift River	S	B	10	8,893
40	Unimak	W	C	50	8,841
41	Drift River	W	C	50	8,731
42	Port Moller	S	C	10	8,613
43	Valdez Harbor	W	B	1	8,368
44	Yakutat	S	D	10	8,357
45	Drift River	W	D	50	8,283
46	Valdez Harbor	W	C	1	8,209
47	Port Moller	W	D	10	7,877
48	Onshore Prudhoe	S	C	50	7,782
49	Unimak	W	D	10	7,687
50	Port Graham	W	D	50	7,623
51	Port Graham	W	C	50	7,615
52	Valdez Harbor	W	D	1	7,580
53	Kamishak	S	D	1	7,565
54	Kvichak	S	D	10	7,378
55	Drift River	W	B	50	7,327
56	Drift River	W	D	10	7,202
57	Unimak	S	B	50	6,938
58	Valdez Narrows	S	C	1	6,798
59	Port Graham	W	D	10	6,628
60	Port Graham	S	C	1	6,617
61	Yakutat	S	C	50	6,683
62	Port Moller	S	B	10	6,382
63	Valdez Narrows	W	D	1	6,223
64	Drift River	S	D	1	6,156
65	Valdez Narrows	S	B	1	5,939
66	Nome	S	C	50	5,905
67	Kvichak	S	C	10	5,894
68	Port Moller	W	C	10	5,888
69	Yukon River	W	C	10	5,881
70	Port Graham	S	B	1	5,867

TABLE 2-65. (CONT'D.)

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
71	Unimak	W	C	10	5,799
72	Kamishak	S	C	1	5,722
73	Unimak	S	B	10	5,593
74	Port Moller	S	D	1	5,578
75	Drift River	S	C	1	5,461
76	Denali Fault	S	C	10	5,414
77	Unimak	S	C	1	5,396
78	Unimak	S	D	1	5,382
79	Kamishak	S	B	1	5,319
80	Cape Blossom	S	C	50	5,144
81	Drift River	W	C	10	5,037
82	Valdez Narrows	W	C	1	5,015
83	Valdez Narrows	W	B	1	5,013
84	Drift River	S	B	1	4,814
85	Port Moller	W	B	10	4,782
86	Offshore Prudhoe	S	C	50	4,760
87	Unimak	W	B	50	4,735
88	Nome	S	D	10	4,693
89	Kvichak	S	D	1	4,596
90	Unimak	W	D	1	4,592
91	Yakutat	S	C	10	4,565
92	Onshore Prudhoe	S	C	10	4,554
93	Umiat	S	C	10	4,457
94	Offshore Prudhoe	S	D	10	4,438
95	Cape Blossom	S	D	10	4,432
96	Port Graham	W	C	10	4,393
97	Kvichak	S	B	10	4,367
98	Drift River	W	C	1	4,302
99	Drift River	W	B	10	4,135
100	Port Graham	W	D	1	3,959
101	Yakutat	S	D	1	3,899
102	Onshore Prudhoe	S	D	1	3,657
103	Offshore Prudhoe	S	B	10	3,582
104	Port Moller	S	C	1	3,512
105	Denali Fault	S	C	4	3,458
106	Yukon River	S	C	1	3,320
107	Nome	S	C	10	3,285
108	Kamishak	W	D	1	3,254
109	St. Matthew	S	D	10	3,119
110	Yakutat	W	D	50	3,111

TABLE 2-65. (CONT'D.)

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
111	St. Matthew	W	C	50	3,050
112	Unimak	S	B	1	3,028
113	Port Graham	S	G	50	2,962
114	Nome	S	B	10	2,956
115	Kvichak	S	C	1	2,894
116	Kamishak	W	C	1	2,877
117	Offshore Prudhoe	S	C	10	2,868
118	Cape Blossom	S	B	10	2,807
119	Cape Blossom	S	C	10	2,783
120	Valdez Harbor	S	B	0.1	2,749
121	St. Matthew	S	C	50	2,728
122	Port Graham	W	B	50	2,711
123	Yakutat	W	D	10	2,704
124	Unimak Pass	W	B	10	2,672
125	Kamishak	S	D	0.1	2,661
126	Valdez Harbor	S	C	0.1	2,606
127	Denali Fault	W	C	10	2,575
128	Port Moller	S	B	1	2,561
129	Valdez Narrows	S	G	50	2,554
130	Valdez Harbor	S	G	1	2,500
131	Port Moller	W	D	1	2,420
132	Nome	S	D	1	2,402
133	Umiat	S	D	1	2,397
134	Drift River	W	B	1	2,397
135	St. Matthew	W	D	10	2,377
136	Unimak Pass	S	G	50	2,350
137	Yakutat	S	C	1	2,302
138	Offshore Prudhoe	S	D	1	2,271
139	Cape Blossom	S	D	1	2,268
140	Onshore Prudhoe	W	C	50	2,265
141	Umiat	S	B	1	2,260
142	Unimak Pass	W	C	1	2,216
143	Kvichak	W	D	10	2,214
144	Valdez Harbor	W	C	0.1	2,153
145	Valdez Harbor	W	B	0.1	2,143
146	Onshore Prudhoe	S	B	1	2,112
147	Kvichak	S	B	1	2,118
148	Denali Fault	S	C	1	2,068
149	Yukon River	W	C	1	2,058
150	Yakutat	W	C	50	2,056

TABLE 2-65. (CONT'D.)

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
151	Onshore Prudhoe	S	C	1	2,044
152	Umiat	S	C	1	2,036
153	Port Graham	S	D	0.1	2,020
154	Yakutat	S	B	50	1,950
155	Port Moller	W	C	1	1,945
156	Drift River	W	C	1	1,925
157	St. Matthew	W	B	10	1,913
158	Valdez Harbor	W	G	1	1,882
159	Drift River	S	G	50	1,826
160	St. Matthew	W	C	10	1,795
161	Valdez Harbor	S	D	0.1	1,769
162	St. Matthew	S	C	10	1,759
163	Nome	S	C	1	1,752
164	Cape Blossom	W	D	10	1,709
165	Offshore Prudhoe	S	B	1	1,698
166	Port Graham	W	C	1	1,679
167	Kvichak	W	C	10	1,655
168	Kamishak	W	B	1	1,641
169	Yakutat	W	B	50	1,633
170	Cape Blossom	W	C	50	1,630
171	Port Graham	S	G	10	1,617
172	Yakutat	W	D	1	1,616
173	Kamishak	S	C	0.1	1,593
174	Valdez Narrows	W	G	50	1,593
175	Port Moller	S	G	10	1,587
176	Unimak	W	B	1	1,549
177	St. Matthew	S	D	1	1,534
178	Port Graham	W	B	10	1,530
179	Offshore Prudhoe	S	C	1	1,529
180	Kamishak	S	G	1	1,507
181	Cape Blossom	S	C	1	1,484
182	Denali Fault	W	C	4	1,469
183	Nome	S	B	1	1,402
184	Valdez Narrows	S	G	10	1,394
185	St. Matthew	W	D	1	1,386
186	Onshore Prudhoe	W	C	10	1,381
187	Kvichak	W	B	10	1,344
188	Cape Blossom	S	B	1	1,331
189	Kvichak	W	D	1	1,304
190	Unimak	S	G	10	1,283

TABLE 2-65. (CONT'D.)

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
191	Kamishak	S	B	0.1	1,279
192	Valdez Narrows	S	D	0.1	1,241
193	Valdez Narrows	W	D	0.1	1,234
194	Port Moller	W	G	10	1,188
195	Yakutat	W	C	10	1,186
196	Port Moller	W	B	1	1,180
197	Umiat	W	C	10	1,159
198	St. Matthew	W	C	1	1,154
199	Drift River	S	D	0.1	1,150
200	Port Moller	S	D	0.1	1,138
201	Unimak	W	G	50	1,138
202	Yakutat	S	B	10	1,101
203	Kvichak	W	D	1	1,048
204	Yukon River	S	C	0.1	1,017
205	Unimak	S	D	0.1	1,006
206	Drift River	S	G	10	997
207	Cape Blossom	W	D	1	989
208	Denali Fault	W	C	1	968
209	Kvichak Bay	S	G	10	948
210	Onshore Prudhoe	W	D	1	935
211	Cape Blossom	W	B	10	923
212	Yakutat	W	B	10	922
213	St. Matthews	S	B	10	906
214	St. Matthews	W	B	1	889
215	Port Graham	W	B	1	887
216	Valdez Narrows	W	G	10	870
217	Port Graham	W	G	50	837
218	Onshore Prudhoe	S	D	0.1	817
219	Valdez Narrows	S	C	0.1	812
220	Cape Blossom	W	C	10	807
221	Nome	S	G	10	807
222	Port Graham	S	C	0.1	791
223	Valdez Narrows	W	D	0.1	787
224	Kvichak	S	D	0.1	785
225	Unimak Pass	W	D	0.1	767
226	Onshore Prudhoe	W	B	1	736
227	Yakutat	S	D	0.1	729
228	Drift River	W	D	0.1	718
229	Unimak Pass	W	G	10	717
230	St. Matthews	S	C	1	684

TABLE 2-65. (CONT'D.)

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
231	Umiat	W	D	1	678
232	Port Graham	W	D	0.1	661
233	St. Matthews	S	B	1	655
234	Drift River	W	C	0.1	653
235	Unimak Pass	W	G	10	645
236	Umiat	W	B	1	644
237	Yakutat	S	B	1	638
238	Kvichak	W	B	1	636
239	Offshore Prudhoe	S	G	10	635
240	St. Matthews	W	G	10	616
241	Yukon River	W	C	0.1	600
242	Valdez Narrows	W	C	0.1	599
243	Port Moller	S	B	0.1	597
244	Cape Blossom	W	C	1	585
245	Onshore Prudhoe	W	C	1	583
246	St. Matthews	S	G	10	582
247	Drift River	W	G	50	580
248	Umiat	W	C	1	577
249	Port Moller	S	C	0.1	548
250	Onshore Prudhoe	S	G	1	546
251	Yakutat	S	G	50	535
252	Yakutat	W	B	1	534
253	Umiat	S	D	0.1	527
254	Port Graham	W	G	10	527
255	Denali Fault	S	C	0.1	519
256	Umiat	S	B	0.1	517
257	Drift River	S	B	0.1	505
258	Unimak Pass	W	C	0.1	477
259	Umiat	S	G	1	460
260	Kamishak	W	C	0.1	457
261	Cape Blossom	S	G	10	453
262	Yakutat	W	G	1	453
263	Port Graham	S	G	1	450
264	Valdez Narrows	S	B	0.1	441
265	Port Graham	S	B	0.1	436
266	Nome	S	D	0.1	429
267	Cape Blossom	W	B	1	419
268	Drift River	W	C	0.1	414
269	Kvichak	S	B	0.1	412
270	Umiat	S	C	0.1	408

TABLE 2-65. (CONT'D.)

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
271	Offshore Prudhoe	S	D	0.1	406
272	Cape Blossom	S	D	0.1	405
273	Valdez Harbor	S	G	0.1	404
274	Valdez Narrows	S	G	1	388
275	Cape Blossom	W	G	10	381
276	Kvichak	S	C	0.1	378
277	Valdez Narrows	W	B	0.1	372
278	Kamishak	W	D	0.1	372
279	Kvichak	W	G	10	363
280	Port Graham	W	C	0.1	361
281	Drift River	S	B	0.1	358
282	Unimak Pass	S	G	1	357
283	Nome	S	C	0.1	347
284	Valdez Harbor	W	G	0.1	340
285	Yakutat	S	G	10	337
286	Offshore Prudhoe	S	B	0.1	334
287	Unimak Pass	W	B	0.1	327
288	St. Matthews	W	D	0.1	325
289	Onshore Prudhoe	S	B	0.1	314
290	Offshore Prudhoe	S	C	0.1	303
291	Cape Blossom	S	C	0.1	294
292	Onshore Prudhoe	S	C	0.1	293
293	Port Moller	S	G	1	286
294	Drift River	S	G	1	277
295	Nome	S	B	0.1	276
296	Yakutat	S	C	0.1	275
297	Yakutat	W	D	0.1	270
298	Port Moller	W	C	0.1	264
299	Cape Blossom	S	B	0.1	262
300	St. Matthews	W	C	0.1	261
301	St. Matthews	S	D	0.1	256
302	Kamishak	W	B	0.1	255
303	Denali Fault	W	C	0.1	253
304	Valdez Narrows	W	G	1	242
305	Unimak Pass	S	B	0.1	225
306	Nome	S	G	1	217
307	Port Moller	W	G	1	214
308	Yakutat	W	G	50	200
309	Unimak Pass	W	G	1	193
310	Onshore Prudhoe	W	D	0.1	190

TABLE 2-65. (CONT'D.)

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
311	Port Graham	W	B	0.1	187
312	Port Moller	W	D	0.1	184
313	Kvichak	W	C	0.1	178
314	St. Matthews	W	B	0.1	175
315	Kvichak	S	G	1	171
316	Offshore Prudhoe	S	G	1	171
317	Drift River	W	G	10	167
318	St. Matthews	W	G	1	166
319	Umiat	W	D	0.1	159
320	Cape Blossom	W	D	0.1	158
321	Kamishak	S	G	0.1	154
322	St. Matthews	S	C	0.1	147
323	Port Graham	W	G	1	142
324	St. Matthews	S	B	0.1	138
325	Yakutat	S	B	0.1	134
326	Cape Blossom	W	C	0.1	133
327	Yakutat	W	G	10	126
328	Kvichak	W	D	0.1	124
329	Cape Blossom	S	G	1	122
330	St. Matthews	S	G	1	120
331	Onshore Prudhoe	S	G	0.1	118
332	Umiat	W	B	0.1	114
333	Yakutat	W	B	0.1	113
334	Kamishak	W	G	1	111
335	Port Moller	W	C	0.1	105
336	Umiat	W	G	1	103
337	Onshore Prudhoe	W	G	1	101
338	St. Matthews	W	G	0.1	100
339	Umiat	S	G	0.1	99
340	Yakutat	W	C	0.1	97
341	Onshore Prudhoe	W	B	0.1	96
342	Yakutat	S	G	1	91
343	Umiat	W	C	0.1	88
344	Cape Blossom	W	G	1	86
345	Kvichak	W	G	1	79
346	Cape Blossom	W	B	0.1	76
347	Cape Blossom	W	G	0.1	73
348	Kvichak	W	B	0.1	71
349	Port Moller	S	G	0.1	50
350	Drift River	W	G	1	45

TABLE 2-65. (CONT'D)

RANK (1)	LOCATION (2)	SEASON (3)	SPILLED TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
351	Onshore Prudhoe	W	C	0.1	45
352	Port Graham	S	G	0.1	40
353	Port Moller	W	G	0.1	38
354	Yakutat	W	G	1	34
355	Kamishak	W	G	0.1	33
356	Unimak Pass	S	G	0.1	32
357	Valdez Narrows	S	G	0.1	31
358	Kvichak	S	G	0.1	30
359	Unimak Pass	W	G	0.1	29
360	Drift River	S	G	0.1	25
361	Valdez Narrows	W	G	0.1	22
362	Nome	S	G	0.1	21
363	Port Graham	W	G	0.1	21
364	Onshore Prudhoe	W	G	0.1	20
365	Kvichak	W	G	0.1	18
366	St. Matthews	S	G	0.1	18
367	Offshore Prudhoe	S	G	0.1	17
368	Yakutat	S	G	0.1	13
369	Cape Blossom	S	G	0.1	12
370	Umiat	W	G	0.1	9
371	Drift River	W	G	0.1	7
372	Yakutat	W	G	0.1	5

TABLE 2-66

RANK ORDER OF SELECTED OIL SPILL CASES: CLEANUP

KEY:

SUMMER = S	GASOLINE = G	50,000 bbls = 50
WINTER = W	DIESEL-2 = D	10,000 bbls = 10
	CRUDE OIL = C	4,000 bbls = 4
	BUNKER C = B	1,000 bbls = 1
		100 bbls = 0.1

RANK (1)	LOCATION (2)	SEASON (3)	SPILL TYPE (4)	SPILL SIZE (5)	IMPACT SCORE (6)
1	Port Graham	S	D	50	22,450
2	Valdez Narrows	S	D	50	22,126
3	Valdez Narrows	S	C	50	19,274
4	Drift River	S	D	50	18,284
5	Port Graham	S	C	50	17,549
6	Yukon River	S	C	50	16,114
7	Drift River	S	C	50	15,746
8	Unimak	S	D	50	15,666
9	Valdez Narrows	S	B	50	13,084
10	Port Moller	S	D	10	11,829
11	Yakutat	S	D	50	11,206
12	Onshore Prudhoe	S	C	50	8,453
13	Kamishak	S	D	1	8,309
14	Kvichak	S	D	10	8,205
15	Nome	S	C	50	6,239
16	Cape Blossom	S	C	50	6,081
17	Denali Fault	S	C	10	5,432
18	Valdez Harbor	S	C	1	4,968
19	Umiat	S	C	10	4,832
20	Offshore Prudhoe	S	C	50	4,065
21	St. Matthew	S	D	10	3,346
22	Port Graham	S	G	50	2,962

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