OCS Report
MMS 2007-039

Oil-Spill Risk Analysis: Sivulliq Exploration Project

U.S. Department of the Interior
Minerals Management Service
Environmental Division

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Contents

Page

Figures

Tables

Appendix A

Page

Figures

Appendix B

Tables

Page

Tables

Appendix C

C-1 to C-12. Conditional probabilities (expressed as a percent chance) that an oil spill starting at a particular location in the summer season ……

Introduction

The proposed Shell Offshore, Inc. Beaufort Sea exploration plan (EP) pertains to Outer Continental Shelf (OCS) activities in the Beaufort Sea. This report examines the probabilities (expressed as percent change) of contact by hypothetical large oil spills from Beaufort Sea Leases OCS-Y-1805, 1807, 1808, and 1809—also called the Sivilluq exploration project.

Because oil spills may occur from activities associated with offshore oil exploration, production, and transportation, the Minerals Management Service (MMS) formally assesses the risk of hypothetical oil spills. When accidental oil spills are evaluated, it is important to remember that the occurrence of such spills is fundamentally a matter of probability. The probability that an oil spill will contact a specific environmental resource within a given time of travel from a certain location or spill point is termed a *conditional probability*; the "condition" being that a spill is assumed to have occurred. Also, the winds, ice, and ocean currents that transport oil spills cannot be known for certain. A probabilistic event such as oil-spill contact to an environmentally sensitive area cannot be predicted, only an estimate of its likelihood (its probability) can be quantified.

This report summarizes results of the oil-spill risk analysis (OSRA) conducted for the Sivulliq Exploration Project. The objective of this analysis was to estimate the relative oil-spill contacts associated with oil exploration, production, and transportation from the proposed exploration site. A description of the OSRA model used in this analysis can be found in previous papers (Smith et al., 1982; LaBelle and Anderson, 1985) and on the internet at http://www.mms.gov/eppd/sciences/osmp/index.htm.

Summary of the Proposed Action

The central area of the Sivulliq exploration project is located on leases OCS-Y-1807 and OCS-Y-1808. The OSRA study area extends from latitude 69° N. to 72.5° N. and from longitude 138° W. to 157° W. (see figure 1).

Location of Sivulliq Exploration Project

The proposed Sivulliq exploration project will use a self-contained offshore drilling facility. Figure 1 shows the location of the Sivulliq project, the site where large oil spills, if they were to occur, would originate. The Sivulliq exploration site is centered at 70°20'48" N. and 146°06'17" W.

Framework of the Analysis

The OSRA depends not only on the meteorologic, oceanographic, geographic, and sea-ice conditions of the study area, but also on the environmental resource areas at risk from oil spills.

Environmental Resource Areas

The 62 environmental resource areas analyzed were taken from the OSRA for the Liberty Development and Production Plan (Johnson et al., 2000). Appendix A (see figures A-1 through A-6) shows the locations of these areas. These environmental resource areas were digitized in the same coordinate system, or base map, used for the trajectory simulations. Each environmental resource area that is typically present year-round was treated as being vulnerable to oil all year. This method assumes that the environmental resource area is sensitive to oil-spill effects throughout the entire year rather than seasonally. Each environmental resource area not usually present year-round was treated as vulnerable to contact from oil spills only during the months it is likely to be present. The digitized environmental resource areas, their months of vulnerability, and the illustrations depicting their locations are shown in the list on the following page.

The locations of 20 boundary segments located along the edges of the study area were also digitized in the same coordinate system to quantify spill trajectories that may travel out of the study area (see figure A-7). Each boundary segment was treated as being vulnerable all year.

Also included in the analysis was an additional environmental resource area, land, which comprised the entire study area coastline. Upon contacting land, the trajectory simulation is ended. Land was further analyzed by dividing the Beaufort Sea coastline into 51 land segments, 38 of which are in the study area (see figure 2). Land segments 6 through 19 and 32 through 43 are each approximately 18.64 miles (30 kilometers [km]) long. Land segments 20 through 31 are closest to the Sivulliq project and are each approximately 12.43 miles (20 km) long.

Because the trajectory model simulates an oil spill as a point, each environmental resource area was digitized with an areal extent slightly greater than it actually occupies. For example, the digitized shoreline environmental resource areas extend a short distance offshore. This extension allows the OSRA model to simulate a spill that approaches and partially contacts the environmental resource area (or boundary segment), then withdraws and continues along its path. For this analysis, the model calculated trajectory simulations over two seasons: winter (October-June) and summer (July-September).

Environmental Resource Area	Months Assumed Vulnerable	Figure
Spring Lead 1	April-May	A-1
Spring Lead 2	April-May	A-2
Spring Lead 3	April-May	A-3
Spring Lead 4	April-May	A-1
Spring Lead 5	April-May	A-2
Ice/Sea Segment 6	January-December	A-1
Ice/Sea Segment 7	January-December	A-1
Ice/Sea Segment 8	January-December	A-2
Ice/Sea Segment 9	January-December	A-1
Ice/Sea Segment 10	January-December	A-2
Ice/Sea Segment 11	January-December	A-1
Ice/Sea Segment 12	January-December	A-2
Ice/Sea Segment 13	January-December	A-1
Environmental Resource Area (ERA) 14	May-October	A-2
ERA 15	May-October	A-1
ERA 16	May-October	A-2
ERA 17	May-October	A-1
ERA 18	May-October	A-2
ERA 19	May-October	A-1
ERA 20	May-October	A-2
ERA 21	May-October	A-2
Simpson Lagoon	May-October	A-3
Gwyder Bay	May-October	A-4
ERA 24	May-October	A-2
Prudhoe Bay	May-October	A-3
ERA 26	May-October	A-4
ERA 27	May-October	A-5
ERA 28	May-October	A-3
ERA 29	May-October	A-4
ERA 30	May-October	A-4
ERA 31	January-December	A-3
Water Surface over Boulder Patch I	January-December	A-4
Water Surface over Boulder Patch II	May-October	A-5
ERA 34	May-October	A-3
ERA 35	May-October	A-6
ERA 36	May-October	A-3
ERA 37	May-October	A-4
ERA 38	May-October	A-3
ERA 39	May-October	A-2
ERA 40	May-October	A-3
ERA 41	May-October	A-2
Canning River	May-October	A-3
ERA 42	May-October	A-2
Simpson Cove	May-October	A-3
ERA 45	May-October	A-2
Arey Lagoon, Hula Hula River	May-October	A-3
Whaling Area/Kaktovik	August-October	A-4
Thetis Island	January-December	A-4
Spy Island	January-December	A-5
Leavitt and Pingok Islands	January-December	A-6
Bertoncini, Bodfish, and Cottle Islands	January-December	A-5
Long Island	January-December	A-6
Egg and Stump Islands	January-December	A-5
West Dock	January-December	A-6
Reindeer and Argo Islands	January-December	A-6
Cross and No Name Islands	January-December	A-6
Endicott Causeway	January-December	A-6
Narwhal, Jeanette, and Karluk Islands	January-December	A-1
Tigvariak Island	January-December	A-6
Pole and Belvedere Islands	January-December	A-5
Challenge, Alaska, Duchess, and Northstar Islands	January-December	A-5
Flaxman Island	January-December	A-4

Source: Johnson et al., 2000

Oil-Spill Trajectory Simulations

The trajectory simulation portion of the model consists of many hypothetical oil-spill trajectories that collectively represent the mean surface transport and the variability of the surface transport as a function of time and space. The trajectories represent the Lagrangian motion that a particle on the surface might take under given wind, ice, and ocean current conditions. Multiple trajectories are simulated to give a statistical representation, over time and space, of possible transport under the range of wind, ice, and ocean current conditions that exist in the area.

As the simulated oil spills moved, any contacts with environmental resource areas were recorded. Spill movement continued until the spill contacted land, moved out of the study area, or aged more than 30 days in open water or 360 days in ice conditions.

The trajectories simulated by the model represent hypothetical pathways of oil slicks. They do not directly consider cleanup, dispersion, or weathering processes that could determine the quantity or properties of the oil that might eventually contact environmental resource areas or land segments. An implicit analysis of weathering and decay can be considered by noting the age of simulated trajectories when they contact environmental resource areas. For this analysis, the periods selected were 3, 10, and 30 days (60, 180, and 360 days in ice conditions) to represent implicit measures of oil weathering as well as matters relating to containment and cleanup.

Current and Ice Information From a General Circulation Model

Trajectories are constructed from simulations of wind-driven and density-induced ocean flow fields, and the ice motion field. The basic approach is to simulate these time and spatially dependent currents separately, then to combine them through linear superposition to produce an oil-transport vector. This vector is then used to create a trajectory. Simulations are performed for two seasons, winter (October-June) and summer (July-September). The choice of this seasonal division was based on meteorological, climatological, and biological cycles, as well as consultation with Alaska OCS Region environmental analysts. Hedström et al. (1995), and Hedström (1994) detail the modeling of each ice motion field and ocean current component. Brief summaries of the methods and assumptions follow.

For cases where the ice concentration is below 80 percent, each trajectory is constructed using vector addition of the ocean current field and 3.5 percent of the instantaneous wind field—a method based on work done by Huang and Monastero (1982), Smith et al. (1982), and Stolzenbach et al. (1977). For cases where the ice concentration is 80 percent or greater, the model ice velocity is used to transport the oil. Equations 1 and 2 show the components of motion that are simulated and used to describe the oil transport:

$$U_{oil} = U_{current} + 0.035\ U_{wind} \quad (1)$$

or

$$U_{oil} = U_{ice} \quad (2)$$

where: U_{oil} = oil drift vector
$U_{current}$ = current vector (when ice concentration < 80%)
U_{wind} = wind speed at 10 m above the sea surface
U_{ice} = ice vector (when ice concentration $\geq$ 80%)

The wind drift factor was estimated to be 0.035, with a variable drift angle ranging from 0^o to 25^o clockwise. The drift angle was computed as a function of wind speed according to the formula in Samuels et al. (1982). (The drift angle is inversely related to wind speed.)

For each trajectory simulation, the start time for the first trajectory was the first day of the season (winter or summer) of the first year of wind data (1980) at 6 a.m. Greenwich Mean Time (GMT). The summer season consists of July 1-September 30, and the winter season is October 1-June 30. Each subsequent trajectory was started every 1 day on average, at 6 a.m. GMT. A total of 6,000 trajectories (3,500 in winter, 2,500 in summer) was launched from the Sivulliq exploration site over the 17 years of wind data (1980-1996), and results of these trajectory simulations were combined to represent platform risk.

Offshore: For the Beaufort/Chukchi Sea, the $U_{current}$ and U_{ice} are simulated using a three-dimensional coupled ice-ocean hydrodynamic model (Hedström et al., 1995; Hedström, 1994). This model is based on the ocean model of Haidvogel et al. (1991), and the ice model of Hibler (1979). The location of each trajectory at each time interval is used to select the appropriate ice concentration. Depending on the ice concentration, either the ice or water velocity with wind drift from the stored results of the Haidvogel et al. (1991) coupled ice-ocean model is used (see eq. 1 and 2 above). Surface transport of the oil slick for each spill was simulated as a series of straight-line displacements in 1-hour increments of a point governed by the U_{oil} vectors.

The trajectories age while they are in the water/on the ice. For each day that the hypothetical spill is in the water, the spill ages—up to a total of 30 days. While the spill is in the ice ($\geq$ 80% concentration), the aging process is suspended. The maximum time allowed for the transport of oil in the ice is 360 days after which the trajectory is terminated. The 30-day limit is maintained for spill trajectories in open water.

Summer trajectories are those that start between the beginning of July and the end of September. Therefore, any trajectory contacting an environmental resource area, land segment, or boundary segment beginning at the end of September is considered a summer contact and is counted along with the rest of the contacts from spills launched in the summer.

Nearshore: Inshore of the 20-meter bathymetry contour, $U_{current}$ is simulated using a two-dimensional hydrodynamic model developed by the National Oceanic and Atmospheric Administration (NOAA) (Galt, 1980). This model does not have an ice component. In this

model, an ice mask is applied within the 0-meter and 20-meter water-depth contours to simulate the observed shorefast ice zone (see figure 3) from November 1 to June 15. For the months of November through June 15, U_{ice} is zero, and the ice concentration is greater than or equal to 80 percent. The two-dimensional model incorporated the barrier islands, in addition to the coastline. The model of the shallow water is based on the wind forcing and the continuity equation. The model was originally developed to simulate wind-driven shallow water dynamics in lagoons and shallow coastal areas with a complex shoreline. The solutions are determined by a finite element model where the primary balance is between the wind forcing friction, the pressure gradients, Coriolis accelerations, and the bottom friction. The time dependencies are considered small, and the solution is determined by iteration of the velocity and sea-level equations, until the balanced solution is calculated. The wind is the primary forcing function, and a sea-level boundary condition of no anomaly produced by the particular wind stress is applied far offshore, at the northern boundary of the OSRA domain. An example of the currents simulated by this model for a 10-meter/second wind from the east is shown in figure 4.

The results of the model were compared to current meter data from the Endicott Environmental Monitoring Program to determine if the model was simulating the first order transport and the dominant flow. The model simulation was similar to the current meter velocities during summer. Example time series from 1985 show the current flow at Endicott Station ED1 for the U (east-west) and V (north-south) components, plotted on the same axis with the current derived from the NOAA model for U and V (Der-U and Der-V). The series show many events that coincide in time, and where the currents derived from the NOAA model are generally in good correspondence with the measured currents. Some of the events in the measured currents are not particularly well represented, and that is probably due to forcing of the current by something other than wind, such as low-frequency alongshore wave motions.

Wind Information

The 17-year reanalysis of the wind fields used was provided to us by Rutgers. The analysis of the wind fields are derived from the National Aeronautics and Space Association/NOAA TIROS Operational Vertical Sounder (TOVS) Polar Pathfinder Data Set. These state-of-the-art data are being readied for distribution to the Arctic modeling community as a product of this MMS/Rutgers modeling effort. Available from January 1980 through December 1996, the TOVS Polar Pathfinder Data Set provides observations of areas poleward of latitude 60^{o} N. at a resolution of 100 km x 100 km. Designed to address the particular needs of the polar research community, the data set is centered on the North Pole and has been gridded using an equal-area azimuthal projection, a version of the Equal-Area Scalable Earth-Grid. Variables retrieved from satellite-observed radiances for this product include atmospheric temperature, water vapor, skin surface temperature, total effective cloud fraction, cloud top pressure and temperature, solar zenith elevation, surface pressure, turning angle between geostrophic wind and surface stress over ice, emissivity, boundary layer stratification, and geostrophic draft coefficient. The algorithm used to generate these grids has been validated through comparisons with surface observations from the North Polar drifting meteorological station.

Conditional Probabilities

The probability (expressed as percent chance) that a large oil spill will contact a specific environmental resource area, land segment, or boundary segment within a given time of travel from a certain location or hypothetical spill site is termed a *conditional probability*, the condition being that a large spill is assumed to have occurred. Conditional probabilities of contact for 3, 10, and 30 days (60, 180, and 360 days in ice conditions) were calculated for the Sivulliq exploration site. These conditional probabilities of contact with environmental resource areas and land segments are presented on an annual basis in tables 1 through 12 and, on a seasonal basis in appendices B (winter) and C (summer).

Discussion

Conditional probabilities assume that a large spill has occurred and that the transport of the spilled oil depends only on the winds, ice, and ocean currents in the study area. For Sivulliq, conditional probabilities of contact (expressed as percent chance) were estimated for 3, 10, 30, 60, 180, or 360 days during both winter (see appendix B) and summer (see appendix C). However, if the probability of contact to a land segment is less than 0.5 percent for the entire time interval, the tables are not presented in this report. Winter spills are defined as spills that begin in October through June, melt out of the ice, and contact during the frozen and open-water period. Summer spills are defined as spills that begin in July through September.

Comparisons Through Time

The proposed Sivulliq exploration project is close to shore (16-20 km), and it is understandable that spills have a probability of contact to the adjacent coastline.

3 Days: Large spills originating at the Sivulliq hypothetical spill site on an annual basis have low probabilities of contact (0.5- to 1-percent chance) to land segments within 3 days. Land segments 29 and 30 have a 1-percent chance of contact on an annual basis (see table 7). The environmental resource areas with the chance of contact greater than 1 percent are within a 5-mile radius. Within 3 days, three barrier island groups—Pole and Belvedere Islands; Challenge, Alaska, Duchess, and Northstar Islands; and Flaxman Island—have a 1- to 2-percent chance of contact from large spills originating from the Sivulliq hypothetical spill site (see tables 1 and B-1). Large spills starting during winter from the Sivulliq hypothetical spill site have a less than 0.5-percent chance of contacting any land segment within 3 days (table not presented).

The environmental resource areas with the highest probabilities of contact (5- to 22-percent chance) within 3 days during the summer are located within a 10-mile radius. The three barrier island groups with the highest chances of contact, ranging from 2 to 4 percent, are Pole and Belvedere Islands; Challenge, Alaska, Duchess, and Northstar Islands; and Flaxman Island (see table C-1). Large spills starting during summer from the Sivulliq hypothetical spill site have a chance of contact within 3 days to land segments 27 through 33 ranging from 1- to 2-percent chance (see table C-7). All other land segments have a less than 0.5-percent chance of contact.

10 Days: The environmental resource areas with the higher probabilities of contact (10- to 15-percent chance) from the proposed site, on an annual basis, are within a 25-mile radius (see table 2). Large spills starting during winter from the Sivulliq hypothetical spill site do not have a chance of contact to any land segments greater than 0.5-percent within 10 days (table not presented).

By 10 days, spills starting during summer from the Sivulliq hypothetical spill site have the higher chances of contact to environmental resource areas that are within a 15-mile radius, ranging from 10 to 32 percent (see table C-2). By 10 days, spills starting during the summer from the hypothetical spill site have a chance of contacting additional land segments 22, 25, 26 and 34 ranging from 1 to 2 percent (see table C-8). The highest chance of contact is to land segments 29-34 and range from 2 to 5 percent chance (see table C-8).

30 Days: By 30 days, large spills starting during winter from the Sivulliq hypothetical spill site have the higher probabilities of contact (11- to 13-percent chance) to the environmental resource areas that are within a 10-mile radius (see table B-3). The exceptions to this are Environmental Resource Area 40 and Ice/Sea Segment 11, which are directly adjacent to the Sivulliq hypothetical spill site. Environmental Resource Area 40 has an 11-percent chance and Ice/Sea Segment has a 13-percent chance of contact from spills originating at the Sivulliq. Spills starting during winter from the Sivulliq hypothetical spill site do not have a probability of contact to land segments greater than 0.5 percent within 30 days (table not presented).

By 30 days, the paths of spills starting during summer from the Sivulliq hypothetical spill site extend farther from the hypothetical spill site. The higher probabilities of contact to environmental resource areas are to those located within a 40-mile radius and range from a 14- to 46-percent chance (see table C-3). By 30 days, additional land segments 21, 35 and 39 have a 1-percent chance of contact (see table C-9). The two land segments with the highest chance of contact are 30 and 33, at a 6-percent level (see table C-9).

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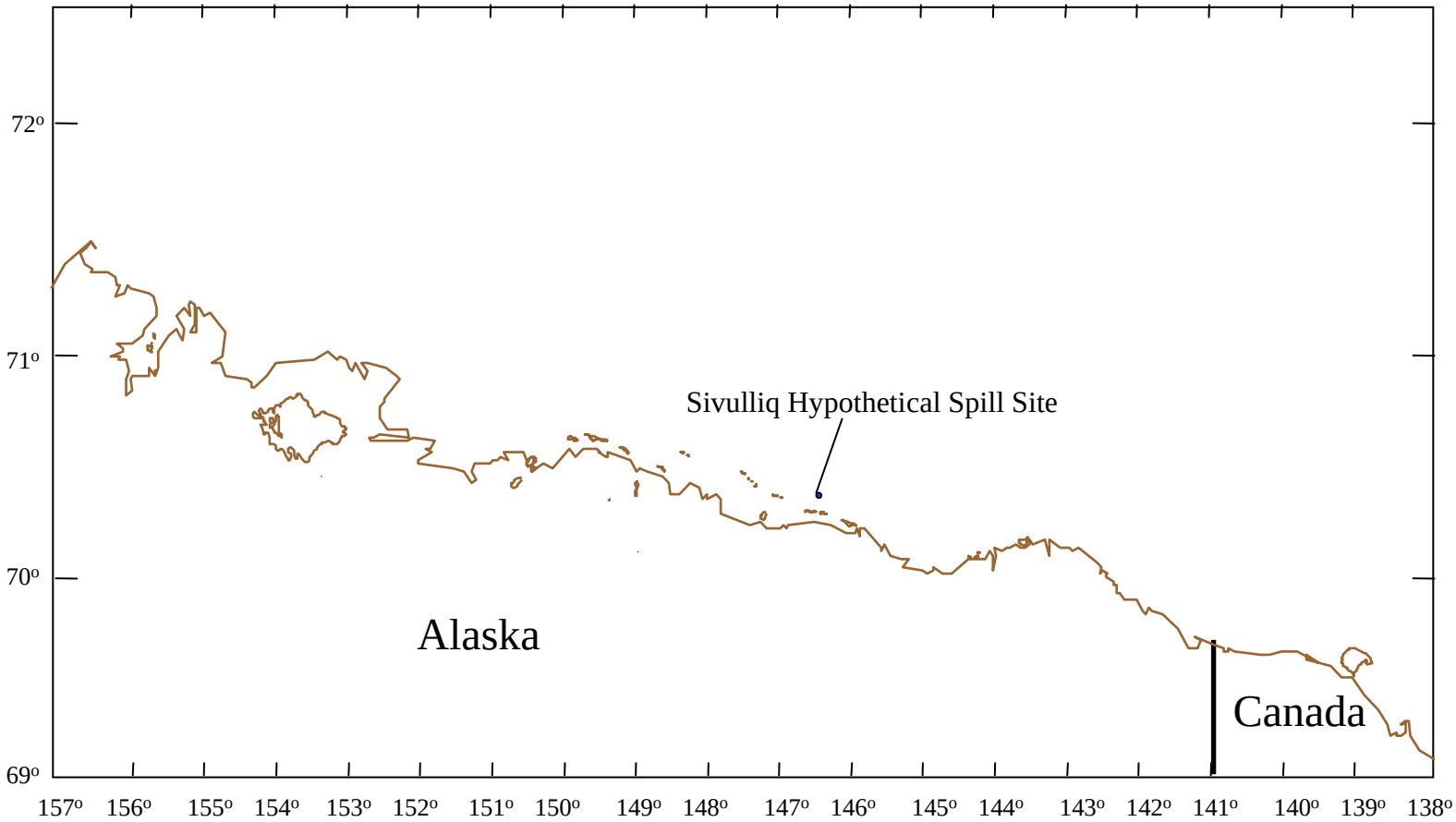

Figure 1. Locations of Study Area and Sivulliq Hypothetical Spill Site.

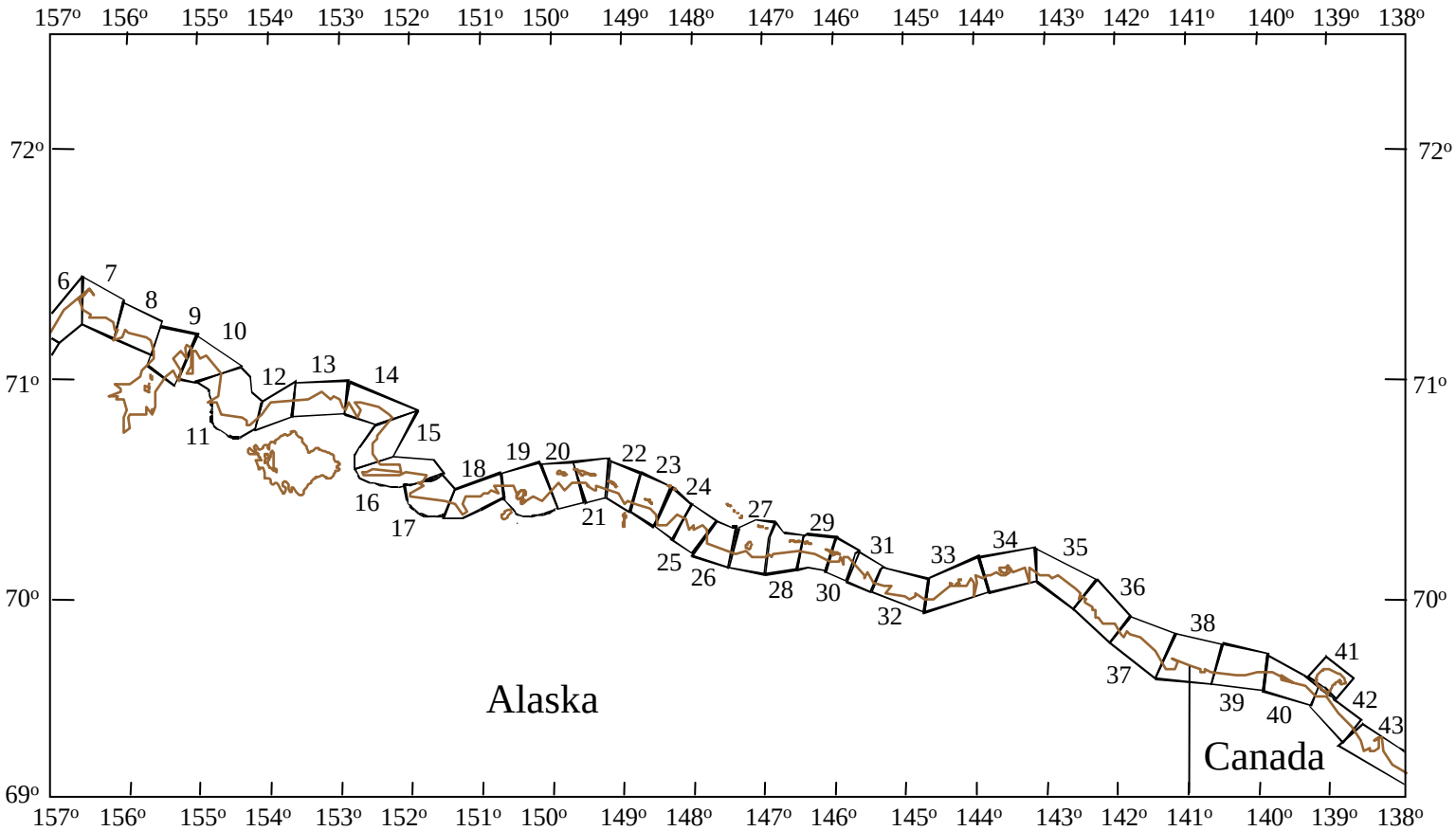

Figure 2. Study Area Coastline Divided into Land Segments, Sivulliq Exploration Project.

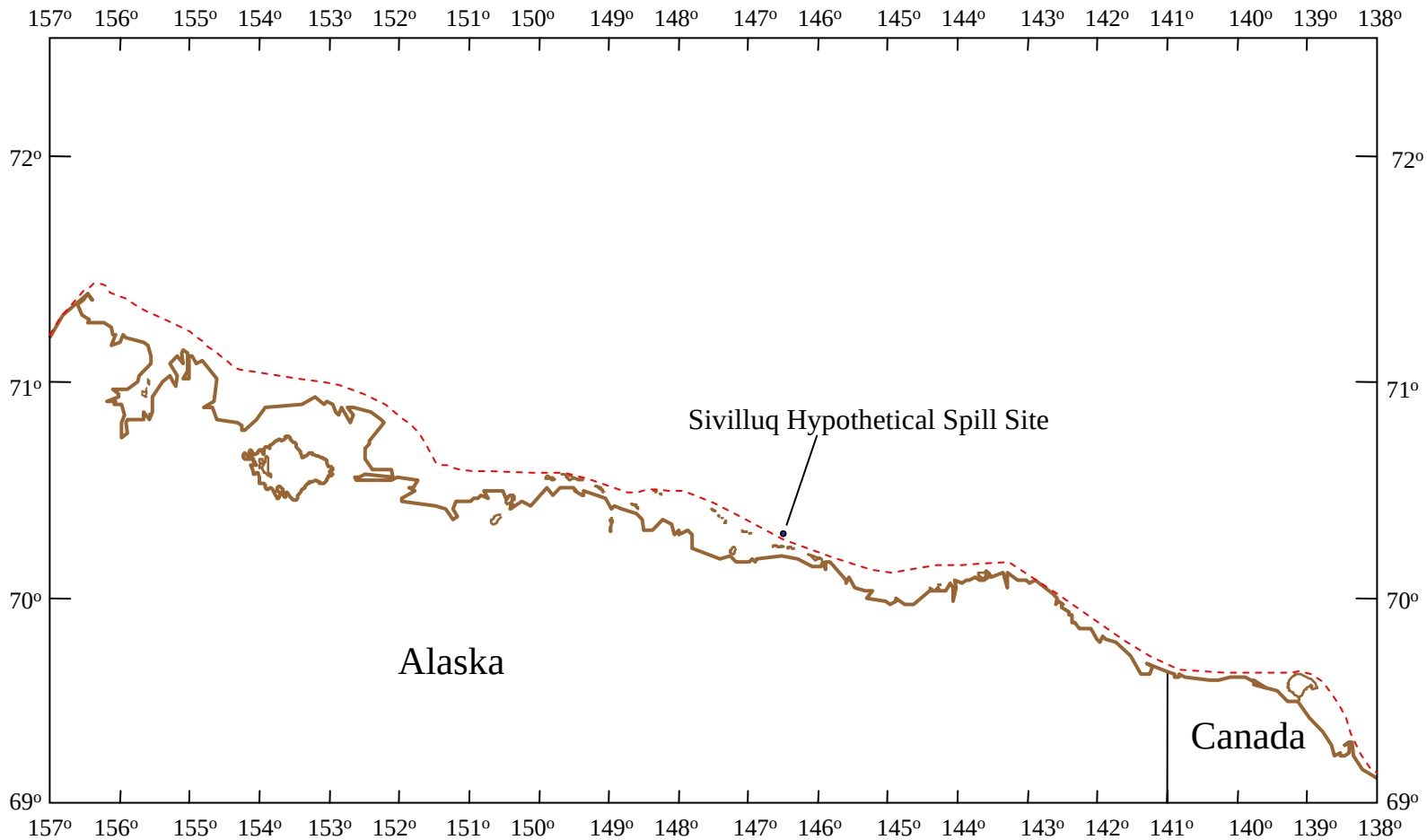

Figure 3. Location of Ice Line.

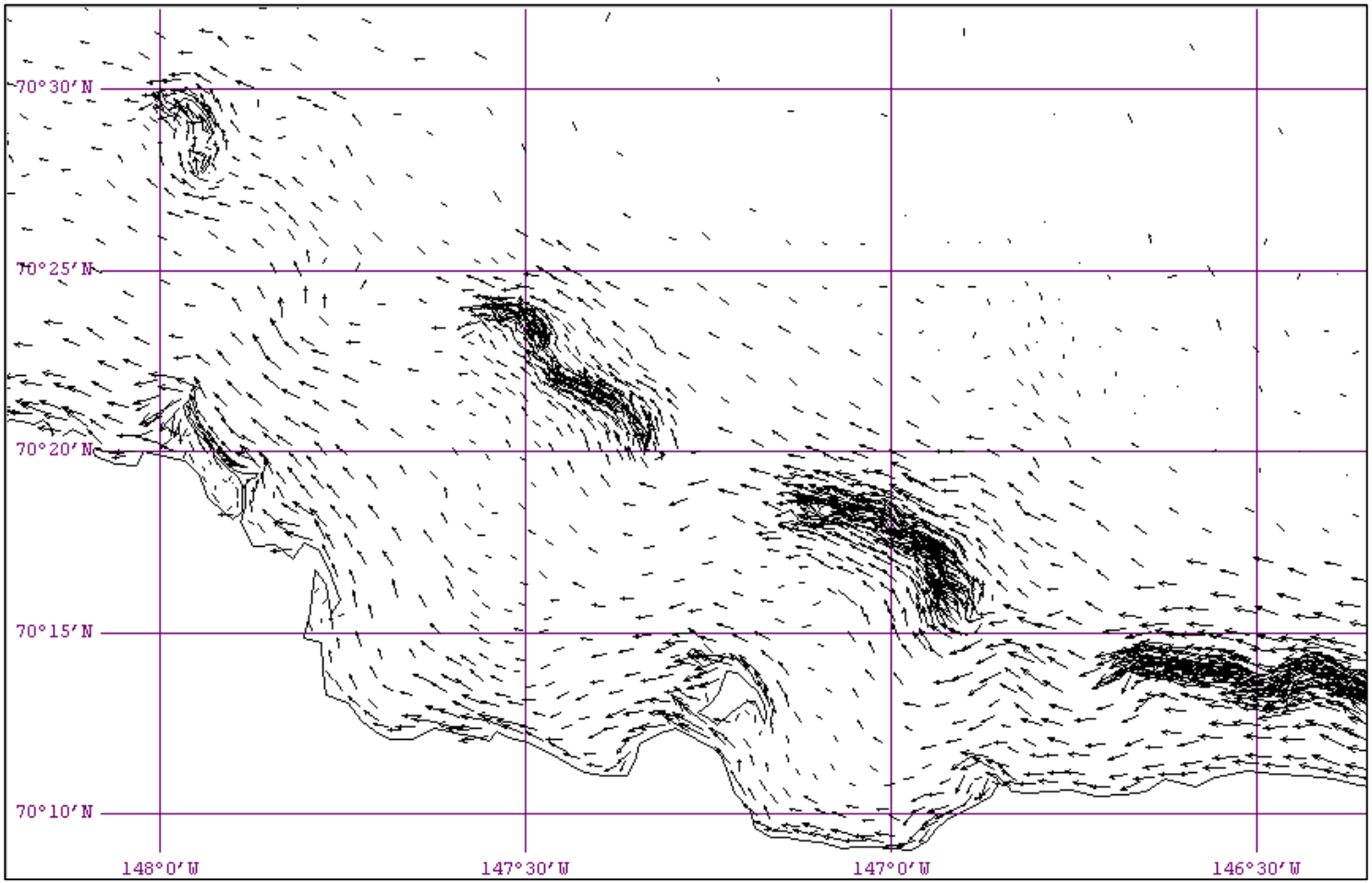

Figure 4. Nearshore Surface Currents Simulated by the NOAA Model for a Wind from the East at 10 meters/second.

Table 1. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain environmental resource within 3 days	
Environmental Resource Area	**Probability**
Land	4
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	n
Ice/Sea Segment 8	n
Ice/Sea Segment 9	n
Ice/Sea Segment 10	2
Ice/Sea Segment 11	9
Ice/Sea Segment 12	n
Ice/Sea Segment 13	n
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	n
Simpson Lagoon	n
Gwyder Bay	n
ERA 24	n
Prudhoe Bay	n
ERA 26	n
ERA 27	n
ERA 28	n
ERA 29	n
ERA 30	1
ERA 31	n
Water Surface over Boulder Patch I	n
Water Surface over Boulder Patch II	n
ERA 34	n
ERA 35	n
ERA 36	n
ERA 37	n
ERA 38	n
ERA 39	2
ERA 40	9
ERA 41	7
ERA 42	1
Canning River	4
Simpson Cove	n
ERA 45	1
Arey Lagoon, Hula Hula River	n
Whaling Area/Kaktovik	n
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	n
Bertoncini, Bodfish, and Cottle Islands	n
Long Island	n
Egg and Stump Islands	n
West Dock	n
Reindeer and Argo Islands	n
Cross and No Name Islands	n
Endicott Causeway	n
Narwhal, Jeanette, and Karluk Islands	n
Tigvariak Island	n
Pole and Belvedere Islands	1
Challenge, Alaska, Duchess, and Northstar Islands	2
Flaxman Island	2
Note: n = Less than 0.5 percent.	

Table 2. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain environmental resource within 10 days

Environmental Resource Area	Probability
Land	11
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	n
Ice/Sea Segment 8	n
Ice/Sea Segment 9	1
Ice/Sea Segment 10	4
Ice/Sea Segment 11	15
Ice/Sea Segment 12	2
Ice/Sea Segment 13	1
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	n
Simpson Lagoon	n
Gwyder Bay	n
ERA 24	1
Prudhoe Bay	n
ERA 26	n
ERA 27	n
ERA 28	1
ERA 29	1
ERA 30	2
ERA 31	1
Water Surface over Boulder Patch I	1
Water Surface over Boulder Patch II	1
ERA 34	n
ERA 35	1
ERA 36	n
ERA 37	1
ERA 38	1
ERA 39	4
ERA 40	15
ERA 41	10
ERA 42	2
Canning River	6
Simpson Cove	1
ERA 45	4
Arey Lagoon, Hula Hula River	1
Whaling Area/Kaktovik	2
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	n
Bertoncini, Bodfish, and Cottle Islands	n
Long Island	n
Egg and Stump Islands	n
West Dock	n
Reindeer and Argo Islands	1
Cross and No Name Islands	1
Endicott Causeway	1
Narwhal, Jeanette, and Karluk Islands	1
Tigvariak Island	1
Pole and Belvedere Islands	2
Challenge, Alaska, Duchess, and Northstar Islands	3
Flaxman Island	3

Note: n = Less than 0.5 percent.

Table 3. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain environmental resource within 30 days	
Environmental Resource Area	**Probability**
Land	19
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	1
Ice/Sea Segment 8	1
Ice/Sea Segment 9	3
Ice/Sea Segment 10	6
Ice/Sea Segment 11	25
Ice/Sea Segment 12	4
Ice/Sea Segment 13	3
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	1
Simpson Lagoon	1
Gwyder Bay	n
ERA 24	2
Prudhoe Bay	n
ERA 26	1
ERA 27	1
ERA 28	1
ERA 29	3
ERA 30	4
ERA 31	2
Water Surface over Boulder Patch I	1
Water Surface over Boulder Patch II	2
ERA 34	n
ERA 35	1
ERA 36	n
ERA 37	1
ERA 38	1
ERA 39	6
ERA 40	26
ERA 41	14
ERA 42	3
Canning River	9
Simpson Cove	1
ERA 45	6
Arey Lagoon, Hula Hula River	2
Whaling Area/Kaktovik	4
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	1
Bertoncini, Bodfish, and Cottle Islands	1
Long Island	1
Egg and Stump Islands	1
West Dock	1
Reindeer and Argo Islands	1
Cross and No Name Islands	2
Endicott Causeway	1
Narwhal, Jeanette, and Karluk Islands	2
Tigvariak Island	1
Pole and Belvedere Islands	2
Challenge, Alaska, Duchess, and Northstar Islands	4
Flaxman Island	4
Note: n = Less than 0.5 percent.	

Table 4. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain environmental resource within 60 days	
Environmental Resource Area	**Probability**
Land	27
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	1
Ice/Sea Segment 7	2
Ice/Sea Segment 8	2
Ice/Sea Segment 9	4
Ice/Sea Segment 10	8
Ice/Sea Segment 11	34
Ice/Sea Segment 12	4
Ice/Sea Segment 13	3
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	1
ERA 21	2
Simpson Lagoon	2
Gwyder Bay	1
ERA 24	3
Prudhoe Bay	1
ERA 26	2
ERA 27	1
ERA 28	2
ERA 29	5
ERA 30	5
ERA 31	3
Water Surface over Boulder Patch I	2
Water Surface over Boulder Patch II	2
ERA 34	n
ERA 35	1
ERA 36	1
ERA 37	1
ERA 38	2
ERA 39	9
ERA 40	38
ERA 41	18
ERA 42	5
Canning River	11
Simpson Cove	1
ERA 45	7
Arey Lagoon, Hula Hula River	3
Whaling Area/Kaktovik	5
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	1
Bertoncini, Bodfish, and Cottle Islands	1
Long Island	1
Egg and Stump Islands	1
West Dock	1
Reindeer and Argo Islands	2
Cross and No Name Islands	3
Endicott Causeway	2
Narwhal, Jeanette, and Karluk Islands	3
Tigvariak Island	1
Pole and Belvedere Islands	2
Challenge, Alaska, Duchess, and Northstar Islands	5
Flaxman Island	5
Note: n = Less than 0.5 percent.	

Table 5. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain environmental resource within 180 days	
Environmental Resource Area	**Probability**
Land	60
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	2
Ice/Sea Segment 7	3
Ice/Sea Segment 8	3
Ice/Sea Segment 9	6
Ice/Sea Segment 10	14
Ice/Sea Segment 11	47
Ice/Sea Segment 12	6
Ice/Sea Segment 13	3
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	1
ERA 18	n
ERA 19	1
ERA 20	2
ERA 21	5
Simpson Lagoon	4
Gwyder Bay	1
ERA 24	7
Prudhoe Bay	3
ERA 26	4
ERA 27	3
ERA 28	5
ERA 29	13
ERA 30	17
ERA 31	10
Water Surface over Boulder Patch I	6
Water Surface over Boulder Patch II	6
ERA 34	1
ERA 35	2
ERA 36	1
ERA 37	4
ERA 38	5
ERA 39	27
ERA 40	55
ERA 41	34
ERA 42	12
Canning River	20
Simpson Cove	3
ERA 45	13
Arey Lagoon, Hula Hula River	6
Whaling Area/Kaktovik	8
Thetis Island	1
Spy Island	1
Leavitt and Pingok Islands	3
Bertoncini, Bodfish, and Cottle Islands	2
Long Island	2
Egg and Stump Islands	2
West Dock	2
Reindeer and Argo Islands	4
Cross and No Name Islands	8
Endicott Causeway	4
Narwhal, Jeanette, and Karluk Islands	9
Tigvariak Island	2
Pole and Belvedere Islands	7
Challenge, Alaska, Duchess, and Northstar Islands	12
Flaxman Island	12
Note: n = Less than 0.5 percent.	

Table 6. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain environmental resource within 360 days	
Environmental Resource Area	**Probability**
Land	90
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	2
Ice/Sea Segment 7	4
Ice/Sea Segment 8	4
Ice/Sea Segment 9	8
Ice/Sea Segment 10	17
Ice/Sea Segment 11	51
Ice/Sea Segment 12	6
Ice/Sea Segment 13	3
ERA 14	n
ERA 15	1
ERA 16	1
ERA 17	2
ERA 18	2
ERA 19	3
ERA 20	6
ERA 21	10
Simpson Lagoon	10
Gwyder Bay	2
ERA 24	14
Prudhoe Bay	4
ERA 26	6
ERA 27	5
ERA 28	9
ERA 29	23
ERA 30	28
ERA 31	18
Water Surface over Boulder Patch I	11
Water Surface over Boulder Patch II	12
ERA 34	2
ERA 35	6
ERA 36	2
ERA 37	8
ERA 38	7
ERA 39	42
ERA 40	66
ERA 41	41
ERA 42	15
Canning River	24
Simpson Cove	4
ERA 45	16
Arey Lagoon, Hula Hula River	7
Whaling Area/Kaktovik	10
Thetis Island	2
Spy Island	3
Leavitt and Pingok Islands	6
Bertoncini, Bodfish, and Cottle Islands	7
Long Island	4
Egg and Stump Islands	4
West Dock	4
Reindeer and Argo Islands	8
Cross and No Name Islands	14
Endicott Causeway	7
Narwhal, Jeanette, and Karluk Islands	16
Tigvariak Island	3
Pole and Belvedere Islands	13
Challenge, Alaska, Duchess, and Northstar Islands	18
Flaxman Island	17
Note: n = Less than 0.5 percent.	

Table 7. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain land segment within 3 days	
Land Segment	**Probability**
29	1
30	1

Table 8. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain land segment within 10 days	
Land Segment	**Probability**
27	1
28	1
29	2
30	2
31	1
32	1
33	2
34	1

Table 9. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain land segment within 30 days	
Land Segment	**Probability**
21	1
22	1
23	1
25	1
27	1
28	1
29	2
30	3
31	2
32	1
33	3
34	1

Table 10. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain land segment within 60 days	
Land Segment	**Probability**
21	1
22	1
23	1
24	1
25	2
26	1
27	2
28	1
29	3
30	3
31	3
32	2
33	4
34	2
39	1

Table 11. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain land segment within 180 days	
Land Segment	**Probability**
17	1
21	2
22	2
23	2
24	2
25	4
26	1
27	3
28	2
29	7
30	7
31	7
32	4
33	7
34	4
39	1

Table 12. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) will contact a certain land segment within 360 days	
Land Segment	**Probability**
17	1
18	1
19	1
20	2
21	5
22	3
23	3
24	4
25	6
26	2
27	5
28	5
29	9
30	10
31	9
32	5
33	9
34	6
35	1
39	2

Appendix A

Locations of Environmental Resource Areas

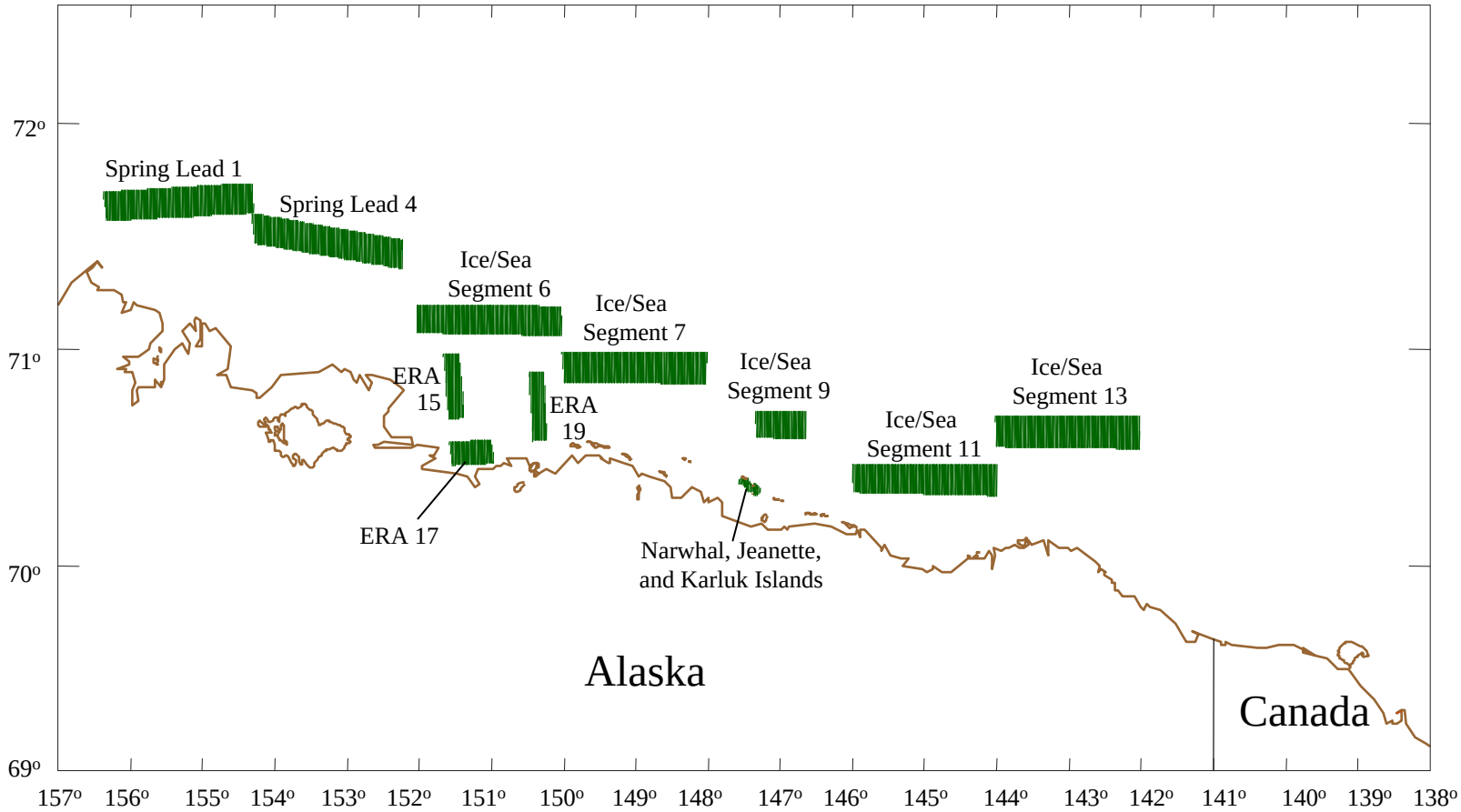

Figure A-1. Locations of Spring Leads 1 and 4; Ice/Sea Segments 6, 7, 9, 11, and 13; Narwhal, Jeanette, and Karluk Islands; and Environmental Resource Areas 15, 17, and 19.

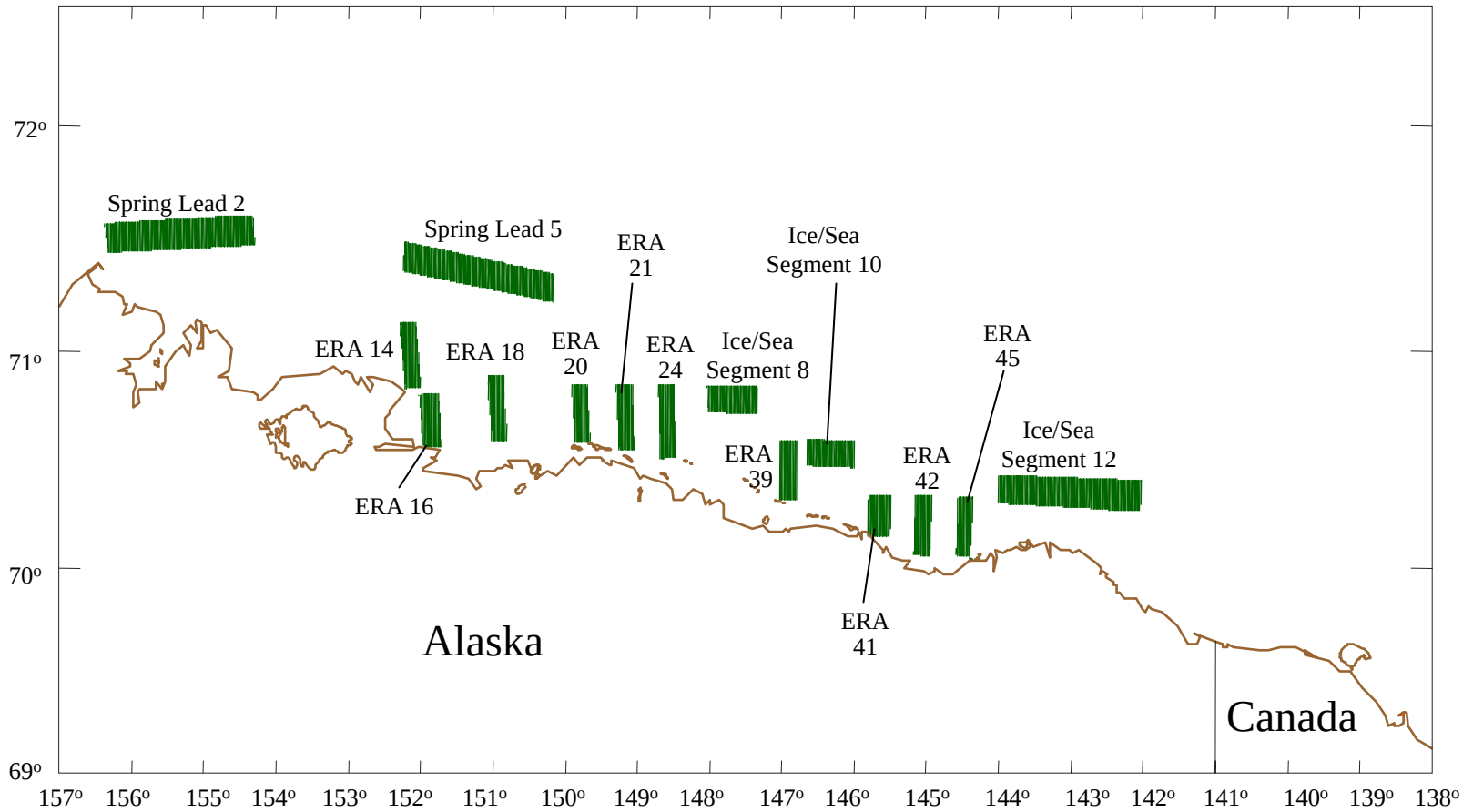

Figure A-2. Locations of Spring Leads 2 and 5; Ice/Sea Segments 8, 10, and 12; and Environmental Resource Areas 14, 16, 18, 20, 21, 24, 39, 41, 42, and 45.

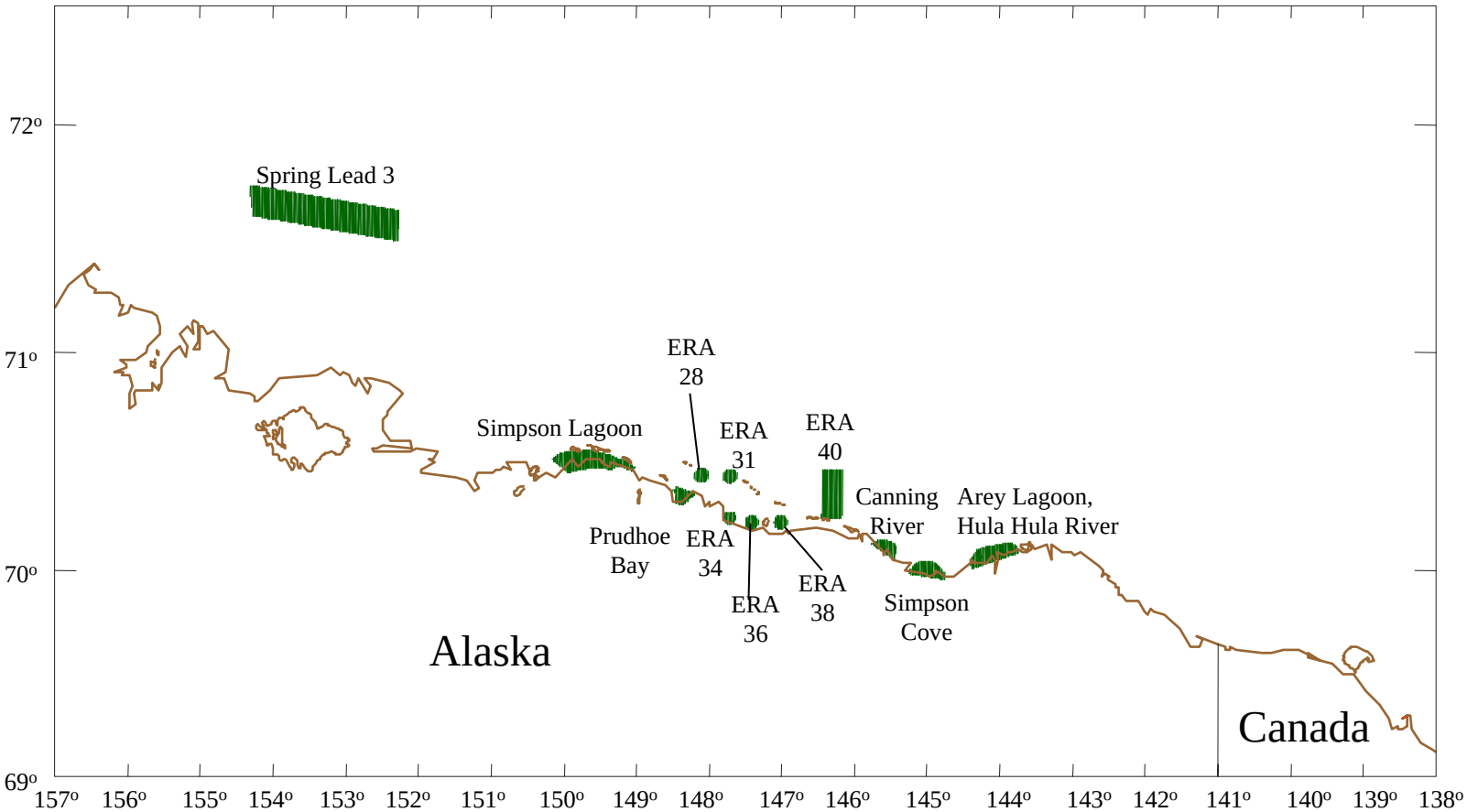

Figure A-3. Locations of Spring Lead 3; Simpson Lagoon; Prudhoe Bay; Environmental Resource Areas 28, 31, 34, 36, 38, and 40; Canning River; Simpson Cove; and Arey Lagoon, Hula Hula River.

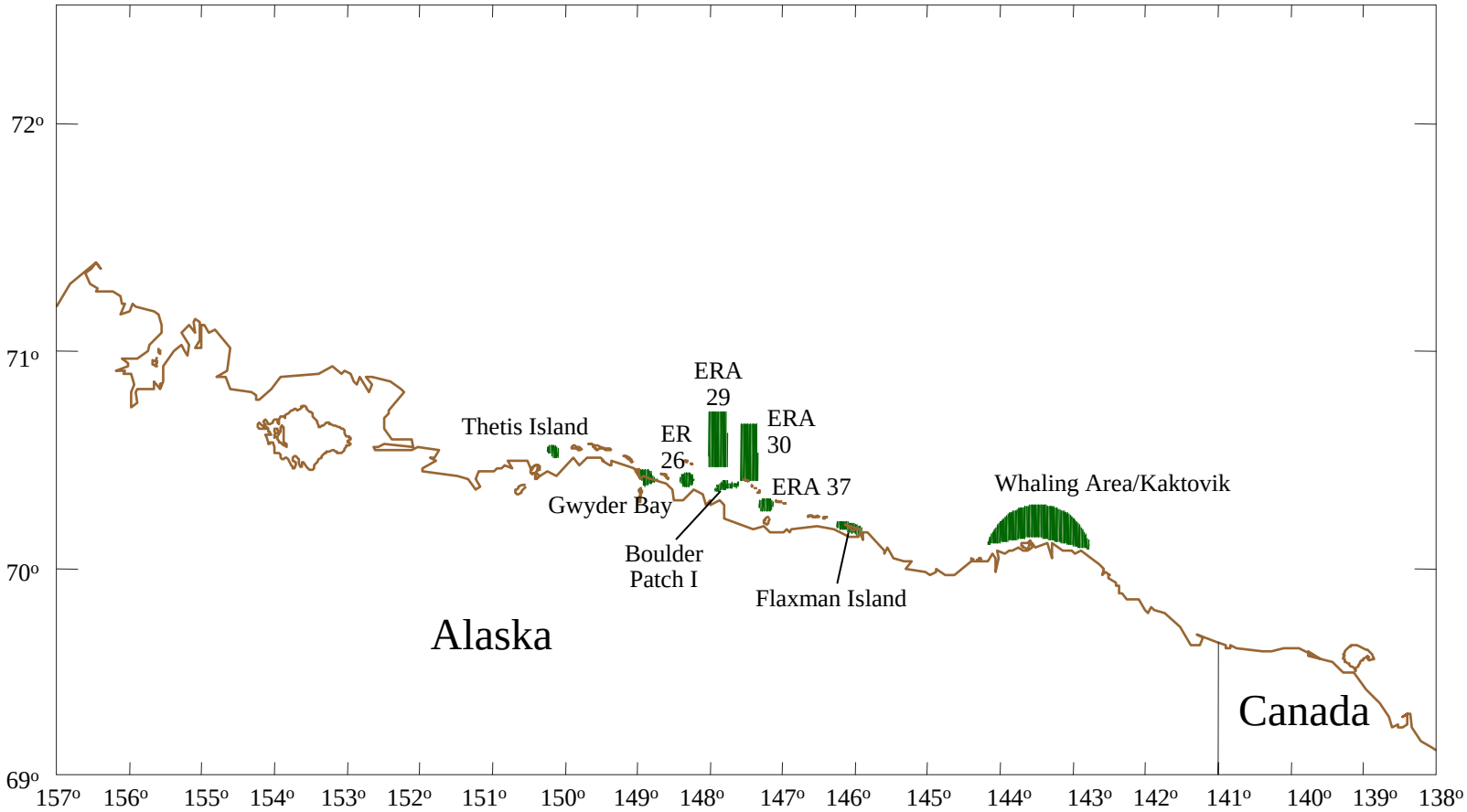

Figure A-4. Locations of Thetis Island; Gwyder Bay; Boulder Patch I; Environmental Resource Areas 26, 29, 30, and 37; Flaxman Island; and Whaling Area/Kaktovik.

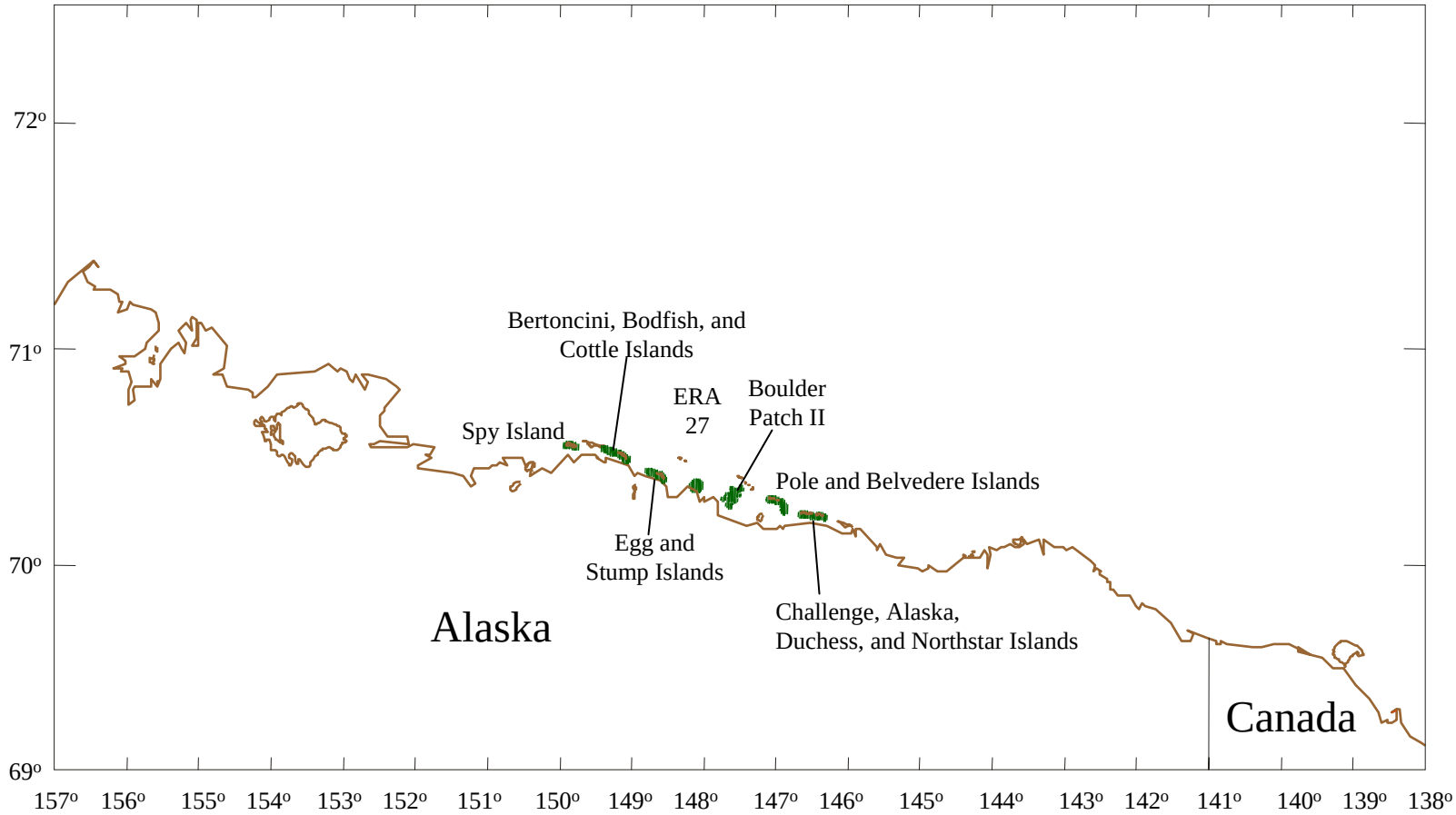

Figure A-5. Locations of Spy Island; Bertoncini, Bodfish, and Cottle Islands; Egg and Stump Islands; Environmental Resource Area 27; Boulder Patch II; Pole and Belvedere Islands; and Challenge, Alaska, Duchess, and Northstar Islands.

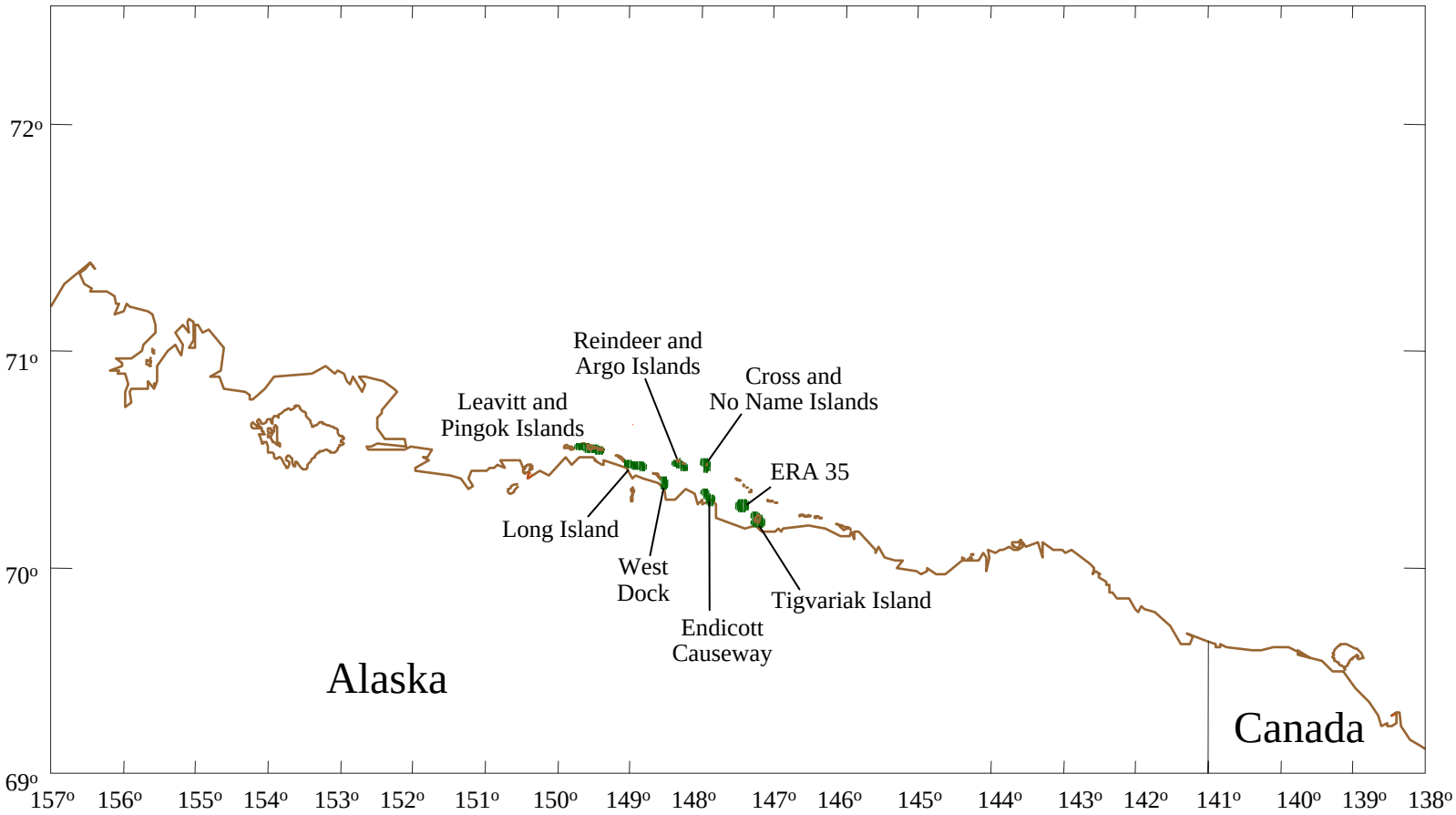

Figure A-6. Locations of Leavitt and Pingok Islands; Long Island; Reindeer and Argo Islands; West Dock; Endicott Causeway; Cross and No Name Islands; Tigvariak Island; and Environmental Resource Area 35.

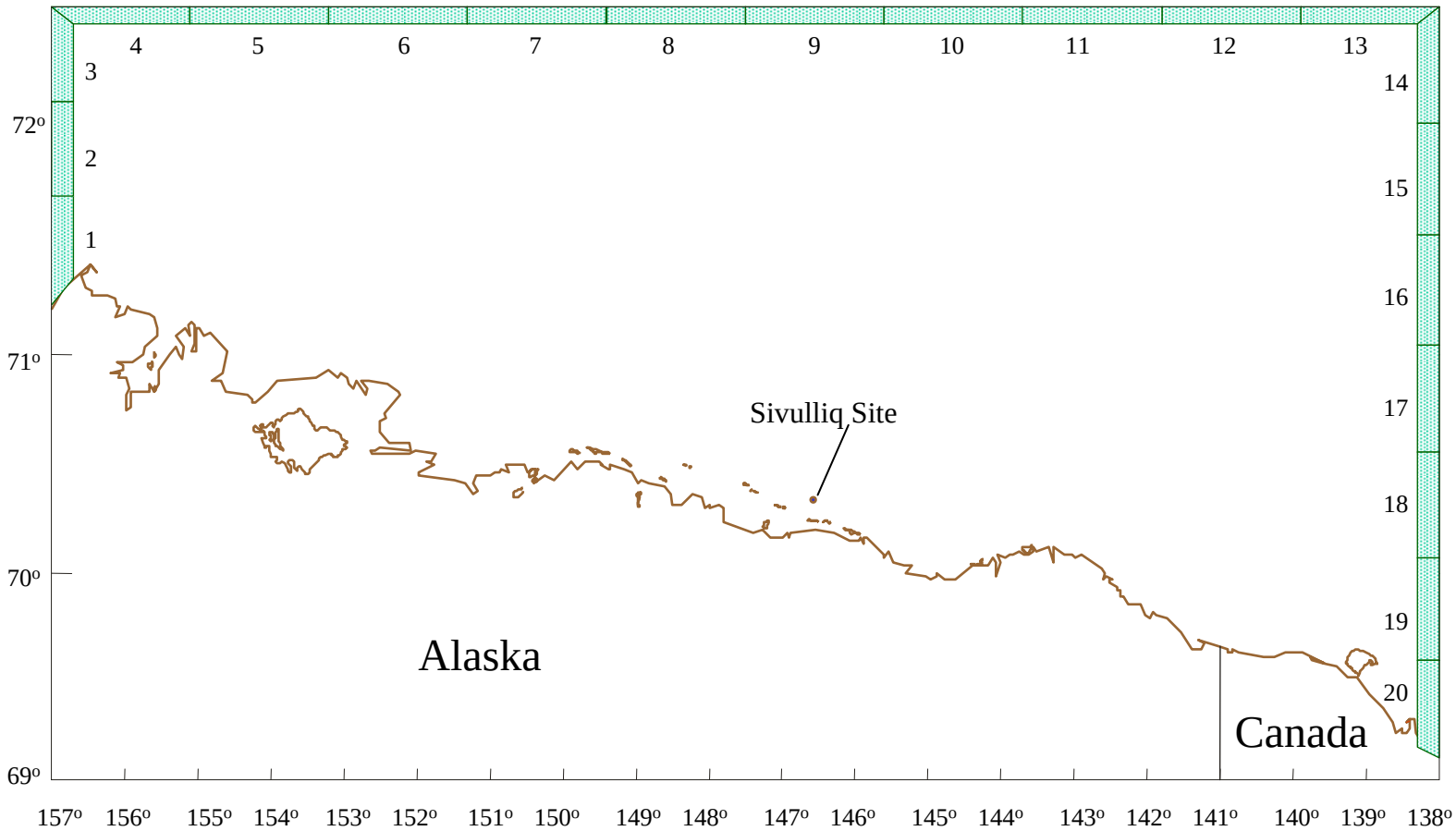

Figure A-7. Locations of Boundary Segments 1-20.

Appendix B

Conditional Probabilities of Contact to Environmental Resource Areas and Land Segments in the Winter Season

Table B-1. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the winter season will contact a certain environmental resource within 3 days	
Environmental Resource Area	**Probability**
Land	n
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	n
Ice/Sea Segment 8	n
Ice/Sea Segment 9	n
Ice/Sea Segment 10	n
Ice/Sea Segment 11	1
Ice/Sea Segment 12	n
Ice/Sea Segment 13	n
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	n
Simpson Lagoon	n
Gwyder Bay	n
ERA 24	n
Prudhoe Bay	n
ERA 26	n
ERA 27	n
ERA 28	n
ERA 29	n
ERA 30	n
ERA 31	n
Water Surface over Boulder Patch I	n
Water Surface over Boulder Patch II	n
ERA 34	n
ERA 35	n
ERA 36	n
ERA 37	n
ERA 38	n
ERA 39	n
ERA 40	n
ERA 41	n
ERA 42	n
Canning River	n
Simpson Cove	n
ERA 45	n
Arey Lagoon, Hula Hula River	n
Whaling Area/Kaktovik	n
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	n
Bertoncini, Bodfish, and Cottle Islands	n
Long Island	n
Egg and Stump Islands	n
West Dock	n
Reindeer and Argo Islands	n
Cross and No Name Islands	n
Endicott Causeway	n
Narwhal, Jeanette, and Karluk Islands	n
Tigvariak Island	n
Pole and Belvedere Islands	n
Challenge, Alaska, and Duchess and Northstar Islands	n
Flaxman Island	n
Note: n = Less than 0.5 percent.	

Table B-2. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the winter season will contact a certain environmental resource within 10 days	
Environmental Resource Area	**Probability**
Land	n
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	n
Ice/Sea Segment 8	n
Ice/Sea Segment 9	n
Ice/Sea Segment 10	n
Ice/Sea Segment 11	5
Ice/Sea Segment 12	n
Ice/Sea Segment 13	n
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	n
Simpson Lagoon	n
Gwyder Bay	n
ERA 24	n
Prudhoe Bay	n
ERA 26	n
ERA 27	n
ERA 28	n
ERA 29	n
ERA 30	n
ERA 31	n
Water Surface over Boulder Patch I	n
Water Surface over Boulder Patch II	n
ERA 34	n
ERA 35	n
ERA 36	n
ERA 37	n
ERA 38	n
ERA 39	n
ERA 40	2
ERA 41	n
ERA 42	n
Canning River	n
Simpson Cove	n
ERA 45	n
Arey Lagoon, Hula Hula River	n
Whaling Area/Kaktovik	n
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	n
Bertoncini, Bodfish, and Cottle Islands	n
Long Island	n
Egg and Stump Islands	n
West Dock	n
Reindeer and Argo Islands	n
Cross and No Name Islands	n
Endicott Causeway	n
Narwhal, Jeanette, and Karluk Islands	n
Tigvariak Island	n
Pole and Belvedere Islands	n
Challenge, Alaska, Duchess, and Northstar Islands	n
Flaxman Island	n
Note: n = Less than 0.5 percent.	

Table B-3. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the winter season will contact a certain environmental resource within 30 days	
Environmental Resource Area	**Probability**
Land	n
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	n
Ice/Sea Segment 8	n
Ice/Sea Segment 9	n
Ice/Sea Segment 10	n
Ice/Sea Segment 11	13
Ice/Sea Segment 12	n
Ice/Sea Segment 13	n
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	n
Simpson Lagoon	n
Gwyder Bay	n
ERA 24	n
Prudhoe Bay	n
ERA 26	n
ERA 27	n
ERA 28	n
ERA 29	n
ERA 30	n
ERA 31	n
Water Surface over Boulder Patch I	n
Water Surface over Boulder Patch II	n
ERA 34	n
ERA 35	n
ERA 36	n
ERA 37	n
ERA 38	n
ERA 39	n
ERA 40	11
ERA 41	n
ERA 42	n
Canning River	n
Simpson Cove	n
ERA 45	n
Arey Lagoon, Hula Hula River	n
Whaling Area/Kaktovik	n
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	n
Bertoncini, Bodfish, and Cottle Islands	n
Long Island	n
Egg and Stump Islands	n
West Dock	n
Reindeer and Argo Islands	n
Cross and No Name Islands	n
Endicott Causeway	n
Narwhal, Jeanette, and Karluk Islands	n
Tigvariak Island	n
Pole and Belvedere Islands	n
Challenge, Alaska, Duchess, and Northstar Islands	n
Flaxman Island	n
Note: n = Less than 0.5 percent.	

Table B-4. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the winter season will contact a certain environmental resource within 60 days	
Environmental Resource Area	**Probability**
Land	n
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	n
Ice/Sea Segment 8	n
Ice/Sea Segment 9	n
Ice/Sea Segment 10	1
Ice/Sea Segment 11	18
Ice/Sea Segment 12	n
Ice/Sea Segment 13	n
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	n
Simpson Lagoon	n
Gwyder Bay	n
ERA 24	n
Prudhoe Bay	n
ERA 26	n
ERA 27	n
ERA 28	n
ERA 29	n
ERA 30	n
ERA 31	n
Water Surface over Boulder Patch I	n
Water Surface over Boulder Patch II	n
ERA 34	n
ERA 35	n
ERA 36	n
ERA 37	n
ERA 38	n
ERA 39	n
ERA 40	27
ERA 41	n
ERA 42	n
Canning River	n
Simpson Cove	n
ERA 45	n
Arey Lagoon, Hula Hula River	n
Whaling Area/Kaktovik	n
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	n
Bertoncini, Bodfish, and Cottle Islands	n
Long Island	n
Egg and Stump Islands	n
West Dock	n
Reindeer and Argo Islands	n
Cross and No Name Islands	n
Endicott Causeway	n
Narwhal, Jeanette, and Karluk Islands	n
Tigvariak Island	n
Pole and Belvedere Islands	n
Challenge, Alaska, Duchess, and Northstar Islands	n
Flaxman Island	n
Note: n = Less than 0.5 percent.	

Table B-5. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the winter season will contact a certain environmental resource within 180 days	
Environmental Resource Area	**Probability**
Land	31
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	1
Ice/Sea Segment 8	2
Ice/Sea Segment 9	3
Ice/Sea Segment 10	10
Ice/Sea Segment 11	41
Ice/Sea Segment 12	2
Ice/Sea Segment 13	n
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	1
ERA 18	n
ERA 19	1
ERA 20	2
ERA 21	5
Simpson Lagoon	4
Gwyder Bay	1
ERA 24	6
Prudhoe Bay	2
ERA 26	3
ERA 27	3
ERA 28	5
ERA 29	14
ERA 30	20
ERA 31	11
Water Surface over Boulder Patch I	6
Water Surface over Boulder Patch II	6
ERA 34	1
ERA 35	2
ERA 36	1
ERA 37	4
ERA 38	5
ERA 39	29
ERA 40	54
ERA 41	25
ERA 42	10
Canning River	14
Simpson Cove	3
ERA 45	8
Arey Lagoon, Hula Hula River	4
Whaling Area/Kaktovik	5
Thetis Island	1
Spy Island	1
Leavitt and Pingok Islands	3
Bertoncini, Bodfish, and Cottle Islands	2
Long Island	1
Egg and Stump Islands	2
West Dock	2
Reindeer and Argo Islands	4
Cross and No Name Islands	8
Endicott Causeway	4
Narwhal, Jeanette, and Karluk Islands	9
Tigvariak Island	1
Pole and Belvedere Islands	7
Challenge, Alaska, Duchess, and Northstar Islands	11
Flaxman Island	11
Note: n = Less than 0.5 percent.	

Table B-6. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the winter season will contact a certain environmental resource within 360 days	
Environmental Resource Area	**Probability**
Land	97
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	3
Ice/Sea Segment 8	3
Ice/Sea Segment 9	8
Ice/Sea Segment 10	16
Ice/Sea Segment 11	48
Ice/Sea Segment 12	3
Ice/Sea Segment 13	1
ERA 14	n
ERA 15	1
ERA 16	1
ERA 17	3
ERA 18	2
ERA 19	4
ERA 20	8
ERA 21	13
Simpson Lagoon	13
Gwyder Bay	3
ERA 24	17
Prudhoe Bay	5
ERA 26	8
ERA 27	7
ERA 28	11
ERA 29	29
ERA 30	37
ERA 31	23
Water Surface over Boulder Patch I	15
Water Surface over Boulder Patch II	15
ERA 34	2
ERA 35	8
ERA 36	3
ERA 37	11
ERA 38	8
ERA 39	53
ERA 40	72
ERA 41	36
ERA 42	15
Canning River	21
Simpson Cove	4
ERA 45	13
Arey Lagoon, Hula Hula Rive	7
Whaling Area/Kaktovik	9
Thetis Island	2
Spy Island	3
Leavitt and Pingok Islands	8
Bertoncini, Bodfish, and Cottle Islands	9
Long Island	5
Egg and Stump Islands	5
West Dock	4
Reindeer and Argo Islands	10
Cross and No Name Islands	18
Endicott Causeway	8
Narwhal, Jeanette, and Karluk Islands	21
Tigvariak Island	4
Pole and Belvedere Islands	18
Challenge, Alaska, Duchess, and Northstar Islands	21
Flaxman Island	19
Note: n = Less than 0.5 percent.	

Table B-7. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the winter season will contact a certain land segment within 180 days	
Land Segment	**Probability**
17	1
20	1
21	2
22	1
23	1
24	2
25	4
26	1
27	3
28	2
29	6
30	6
31	6
32	3
33	6
34	3
39	1

Table B-8. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the winter season will contact a certain land segment within 360 days	
Land Segment	**Probability**
17	2
18	1
19	2
20	2
21	6
22	4
23	3
24	5
25	6
26	2
27	5
28	6
29	9
30	11
31	8
32	5
33	9
34	6
39	2

Appendix C

Conditional Probabilities of Contact to Environmental Resource Areas and Land Segments in the Summer Season

Table C-1. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain environmental resource within 3 days	
Environmental Resource Area	**Probability**
Land	9
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	n
Ice/Sea Segment 8	n
Ice/Sea Segment 9	1
Ice/Sea Segment 10	5
Ice/Sea Segment 11	20
Ice/Sea Segment 12	n
Ice/Sea Segment 13	n
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	n
Simpson Lagoon	n
Gwyder Bay	n
ERA 24	n
Prudhoe Bay	n
ERA 26	n
ERA 27	n
ERA 28	n
ERA 29	n
ERA 30	1
ERA 31	1
Water Surface over Boulder Patch I	n
Water Surface over Boulder Patch II	1
ERA 34	n
ERA 35	1
ERA 36	n
ERA 37	1
ERA 38	1
ERA 39	5
ERA 40	22
ERA 41	18
ERA 42	2
Canning River	9
Simpson Cove	1
ERA 45	3
Arey Lagoon, Hula Hula River	1
Whaling Area/Kaktovik	1
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	n
Bertoncini, Bodfish, and Cottle Islands	n
Long Island	n
Egg and Stump Islands	n
West Dock	n
Reindeer and Argo Islands	n
Cross and No Name Islands	n
Endicott Causeway	n
Narwhal, Jeanette, and Karluk Islands	1
Tigvariak Island	1
Pole and Belvedere Islands	2
Challenge, Alaska, Duchess, and Northstar Islands	4
Flaxman Island	4
Note: n = Less than 0.5 percent.	

Table C-2. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain environmental resource within 10 days	
Environmental Resource Area	**Probability**
Land	26
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	1
Ice/Sea Segment 8	1
Ice/Sea Segment 9	3
Ice/Sea Segment 10	10
Ice/Sea Segment 11	29
Ice/Sea Segment 12	6
Ice/Sea Segment 13	3
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	n
ERA 21	1
Simpson Lagoon	1
Gwyder Bay	n
ERA 24	2
Prudhoe Bay	n
ERA 26	1
ERA 27	1
ERA 28	1
ERA 29	3
ERA 30	6
ERA 31	3
Water Surface over Boulder Patch I	2
Water Surface over Boulder Patch II	3
ERA 34	1
ERA 35	2
ERA 36	1
ERA 37	2
ERA 38	2
ERA 39	10
ERA 40	32
ERA 41	24
ERA 42	4
Canning River	15
Simpson Cove	2
ERA 45	9
Arey Lagoon, Hula Hula River	3
Whaling Area/Kaktovik	6
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	n
Bertoncini, Bodfish, and Cottle Islands	1
Long Island	1
Egg and Stump Islands	1
West Dock	1
Reindeer and Argo Islands	1
Cross and No Name Islands	2
Endicott Causeway	1
Narwhal, Jeanette, and Karluk Islands	3
Tigvariak Island	1
Pole and Belvedere Islands 4	4
Challenge, Alaska, Duchess, and Northstar Islands	7
Flaxman Island	7
Note: n = Less than 0.5 percent.	

Table C-3. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain environmental resource within 30 days	
Environmental Resource Area	**Probability**
Land	47
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	n
Ice/Sea Segment 7	2
Ice/Sea Segment 8	3
Ice/Sea Segment 9	6
Ice/Sea Segment 10	14
Ice/Sea Segment 11	43
Ice/Sea Segment 12	10
Ice/Sea Segment 13	7
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	n
ERA 18	n
ERA 19	n
ERA 20	1
ERA 21	2
Simpson Lagoon	2
Gwyder Bay	1
ERA 24	5
Prudhoe Bay	1
ERA 26	3
ERA 27	2
ERA 28	3
ERA 29	7
ERA 30	9
ERA 31	4
Water Surface over Boulder Patch I	3
Water Surface over Boulder Patch II	4
ERA 34	1
ERA 35	2
ERA 36	1
ERA 37	3
ERA 38	3
ERA 39	15
ERA 40	46
ERA 41	34
ERA 42	8
Canning River	21
Simpson Cove	2
ERA 45	13
Arey Lagoon, Hula Hula River	5
Whaling Area/Kaktovik	9
Thetis Island	n
Spy Island	n
Leavitt and Pingok Islands	1
Bertoncini, Bodfish, and Cottle Islands	2
Long Island	2
Egg and Stump Islands	2
West Dock	2
Reindeer and Argo Islands	3
Cross and No Name Islands	4
Endicott Causeway	3
Narwhal, Jeanette, and Karluk Islands	5
Tigvariak Island	2
Pole and Belvedere Islands	5
Challenge, Alaska, Duchess, and Northstar Islands	9
Flaxman Island	10
Note: n = Less than 0.5 percent.	

Table C-4. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain environmental resource within 60 days	
Environmental Resource Area	**Probability**
Land	66
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	1
Ice/Sea Segment 7	4
Ice/Sea Segment 8	5
Ice/Sea Segment 9	8
Ice/Sea Segment 10	18
Ice/Sea Segment 11	56
Ice/Sea Segment 12	11
Ice/Sea Segment 13	7
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	1
ERA 18	n
ERA 19	n
ERA 20	2
ERA 21	4
Simpson Lagoon	4
Gwyder Bay	1
ERA 24	7
Prudhoe Bay	2
ERA 26	4
ERA 27	2
ERA 28	6
ERA 29	11
ERA 30	13
ERA 31	7
Water Surface over Boulder Patch I	5
Water Surface over Boulder Patch II	6
ERA 34	1
ERA 35	2
ERA 36	1
ERA 37	3
ERA 38	5
ERA 39	22
ERA 40	55
ERA 41	44
ERA 42	13
Canning River	27
Simpson Cove	3
ERA 45	17
Arey Lagoon, Hula Hula River	7
Whaling Area/Kaktovik	11
Thetis Island	1
Spy Island	1
Leavitt and Pingok Islands	2
Bertoncini, Bodfish, and Cottle Islands	2
Long Island	2
Egg and Stump Islands	3
West Dock	2
Reindeer and Argo Islands	4
Cross and No Name Islands	7
Endicott Causeway	4
Narwhal, Jeanette, and Karluk Islands	7
Tigvariak Island	2
Pole and Belvedere Islands	6
Challenge, Alaska, Duchess, and Northstar Islands	13
Flaxman Island	13
Note: n = Less than 0.5 percent.	

Table C-5. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain environmental resource within 180 days	
Environmental Resource Area	**Probability**
Land	75
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	4
Ice/Sea Segment 7	6
Ice/Sea Segment 8	6
Ice/Sea Segment 9	9
Ice/Sea Segment 10	19
Ice/Sea Segment 11	57
Ice/Sea Segment 12	11
Ice/Sea Segment 13	7
ERA 14	n
ERA 15	n
ERA 16	n
ERA 17	1
ERA 18	n
ERA 19	n
ERA 20	2
ERA 21	5
Simpson Lagoon	5
Gwyder Bay	1
ERA 24	8
Prudhoe Bay	3
ERA 26	5
ERA 27	3
ERA 28	6
ERA 29	13
ERA 30	15
ERA 31	8
Water Surface over Boulder Patch I	5
Water Surface over Boulder Patch II	6
ERA 34	1
ERA 35	2
ERA 36	1
ERA 37	3
ERA 38	5
ERA 39	24
ERA 40	57
ERA 41	47
ERA 42	14
Canning River	29
Simpson Cove	3
ERA 45	19
Arey Lagoon, Hula Hula River	8
Whaling Area/Kaktovik	13
Thetis Island	1
Spy Island	1
Leavitt and Pingok Islands	3
Bertoncini, Bodfish, and Cottle Islands	3
Long Island	2
Egg and Stump Islands	3
West Dock	3
Reindeer and Argo Islands	5
Cross and No Name Islands	8
Endicott Causeway	5
Narwhal, Jeanette, and Karluk Islands	8
Tigvariak Island	2
Pole and Belvedere Islands	6
Challenge, Alaska, Duchess, and Northstar Islands	14
Flaxman Island	14
Note: n = Less than 0.5 percent.	

Table C-6. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain environmental resource within 360 days	
Environmental Resource Area	**Probability**
Land	83
Spring Lead 1	n
Spring Lead 2	n
Spring Lead 3	n
Spring Lead 4	n
Spring Lead 5	n
Ice/Sea Segment 6	4
Ice/Sea Segment 7	6
Ice/Sea Segment 8	6
Ice/Sea Segment 9	9
Ice/Sea Segment 10	20
Ice/Sea Segment 11	57
Ice/Sea Segment 12	11
Ice/Sea Segment 13	7
ERA 14	1
ERA 15	1
ERA 16	1
ERA 17	2
ERA 18	2
ERA 19	2
ERA 20	3
ERA 21	7
Simpson Lagoon	6
Gwyder Bay	2
ERA 24	9
Prudhoe Bay	3
ERA 26	5
ERA 27	4
ERA 28	7
ERA 29	15
ERA 30	18
ERA 31	10
Water Surface over Boulder Patch I	7
Water Surface over Boulder Patch II	7
ERA 34	2
ERA 35	3
ERA 36	2
ERA 37	4
ERA 38	6
ERA 39	27
ERA 40	58
ERA 41	48
ERA 42	14
Canning River	29
Simpson Cove	3
ERA 45	19
Arey Lagoon, Hula Hula River	8
Whaling Area/Kaktovik	13
Thetis Island	2
Spy Island	2
Leavitt and Pingok Islands	4
Bertoncini, Bodfish, and Cottle Islands	4
Long Island	3
Egg and Stump Islands	4
West Dock	3
Reindeer and Argo Islands	6
Cross and No Name Islands	10
Endicott Causeway	5
Narwhal, Jeanette and Karluk	9
Tigvariak Island	2
Pole and Belvedere Islands	7
Challenge, Alaska, Duchess, and Northstar Islands	14
Flaxman Island	15
Note: n = Less than 0.5 percent.	

Table C-7. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain land segment within 3 days	
Land Segment	**Probability**
27	1
28	1
29	2
30	2
31	1
32	1
33	1

Table C-8. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain land segment within 10 days	
Land Segment	**Probability**
22	1
25	1
26	1
27	2
28	2
29	4
30	5
31	3
32	2
33	4
34	2

Table C-9. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain land segment within 30 days	
Land Segment	**Probability**
21	1
22	1
23	2
24	1
25	2
26	1
27	3
28	2
29	5
30	6
31	5
32	4
33	6
34	3
35	1
39	1

Table C-10. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain land segment within 60 days	
Land Segment	**Probability**
17	1
21	2
22	2
23	2
24	2
25	4
26	1
27	4
28	3
29	7
30	8
31	8
32	5
33	9
34	5
35	1
39	1

Table C-11. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain environmental resource within 180 days	
Land Segment	**Probability**
17	1
21	3
22	2
23	2
24	3
25	5
26	2
27	4
28	3
29	8
30	9
31	9
32	5
33	10
34	6
35	1
39	2

Table C-12. Conditional probabilities (expressed as percent chance) that an oil spill starting at a particular location (Sivulliq) in the summer season will contact a certain environmental resource within 360 days	
Land Segment	**Probability**
17	1
18	1
19	1
20	1
21	4
22	2
23	3
24	3
25	5
26	2
27	4
28	3
29	8
30	9
31	9
32	5
33	10
34	6
35	1
39	2

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.