Distribution and Relative Abundance of Sea Otters in South-central and Southwestern Alaska Before or at the Time of the T/V *Exxon Valdez* Oil Spill

by

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ABSTRACT.—Surveys of sea otters (*Enhydra lutris*) conducted before, immediately after, or at the time of the T/V *Exxon Valdez* oil spill were used to guide otter capture efforts and assess the immediate effects of the spill. Shoreline counts (by boat) of sea otters in Prince William Sound in 1984 suggested that a minimum of 4,500 sea otters inhabited nearshore waters of Prince William Sound. Areas of highest density within the western portion of Prince William Sound included the Bainbridge Island area, Montague Island, Green Island, and Port Wells. About 1,330 sea otters were counted from helicopters along the coast of the Kenai Peninsula. Highest densities of sea otters were found along the western end of the Kenai Peninsula. At Kodiak Island, about 3,500 sea otters were counted in coastal surveys from helicopters. Highest densities of sea otters were found in Perenosa Bay in northern Afognak Island, and in waters between Afognak, Kodiak, and Raspberry Islands. Along the Alaska Peninsula, about 6,500 sea otters were counted between Kamishak Bay and Unimak Pass. Areas of concentration included the Izembek Lagoon area, False Pass, the Pavlof Islands, Hallo Bay, and Kujulik Bay. Line transect surveys conducted offshore of the coastal strips indicate that at the time of the surveys relatively high densities of sea otters existed offshore at Kodiak Island and along the Alaska Peninsula, but not on the Kenai Peninsula.

At the time of the T/V *Exxon Valdez* oil spill, great concern existed for the safety and health of wildlife in the path of the spill. Sea otters (*Enhydra lutris*) were the source of much of this concern because they are one of the most susceptible marine mammals to contamination from oil (Costa and Kooyman 1982; Siniff et al. 1982; Geraci 1988; Ralls et al. 1988) and they were the most abundant marine mammal in the path of the oil.

The size and distribution of sea otter populations are dynamic, particularly in geographic areas that are in the process of recolonization (Garshelis and Garshelis 1984; Garshelis et al. 1986; Johnson 1987; Estes 1990). Unfortunately, recent data on the number of sea otters in some areas affected by the oil spill did not exist before the spill. Therefore, shortly after the grounding of the tanker, biologists from the U.S. Fish and Wildlife Service initiated aerial surveys of sea otters to identify concentrations of sea otters that might be at risk from the oil, and provide some direction to the oil spill response effort. We summarize data on the relative abundance and distribution of sea otters in the oil spill zone.

Methods

Sea otter surveys in Prince William Sound were conducted from June through August in 1984 and 1985. An 8-m open Boston Whaler was the primary survey vessel. The survey vessel was run parallel to the coast, about 100 m offshore. One observer counted all sea otters between the vessel and shore; another observer counted all sea otters outside the vessel, most of which were within 100 to

200 m from shore. Most surveys were done when wave height was <0.3 m. If large groups of sea otters were spotted in the distance, the survey boat stopped to make accurate counts before the sea otters dispersed at the vessel's approach. For additional details on methodologies for boat surveys in Prince William Sound see Irons et al. (1988).

Sea otter surveys outside Prince William Sound were conducted in early April through late May 1989 from a Bell 206 or Hughes 500 helicopter fitted with either pop-out floats or fixed floats (helicopters with pop-out floats were used preferentially because of unrestricted visibility). Both coastal and offshore line transect counts were conducted. Two observers flew during each survey. The surveys were flown in the direction that placed the forward observer on the coastal side of the helicopter. The helicopters flew parallel to the coastline about 200 m offshore, at a constant speed of 70 knots and an altitude of about 100 m. The shoreside observer in the front seat was responsible for counting all sea otters between the helicopter and shore. The rear observer counted all sea otters beyond 200 m from shore. The pilot pointed out sea otters directly on the flight path that may have been missed by the observer in the rear seat. The helicopter deviated from the coast to survey offshore islands and rocks. Hover counts were conducted on every 20th observation to account for diving animals. During hover counts, the helicopter hovered or circled around the animal or group of animals to obtain the highest total count for that observation. The highest total count included the initial number of sea otters counted plus any additional animals observed while hovering. In some instances, hover counts were conducted at higher altitudes to avoid scaring sea otters. Large groups of sea otters (>20) were circled to obtain the best possible count. Consequently, adjustments due to diving were not made for groups of more than 20 sea otters. Line transect surveys for sea otters were conducted offshore (outside of 400 m) following the guidelines in Burnham et al. (1980). Data from the offshore line transect surveys are not summarized here.

The fact that sea otters dive and escape detection complicates the analysis of sea otter survey data. During boat surveys, the vessel speed was sufficiently slow that many diving seas otters were probably detected; nevertheless, some sea otters were undoubtedly missed. For the helicopter coastal counts, an average correction factor was used to adjust all groups of sea otters with less than 20 animals. Line transect data are not included; therefore, the numbers presented in this report are not population estimates.

For analysis, Prince William Sound was divided into 15 regions of unequal size (see Irons et al. 1988). To estimate sea otter density, the number of sea otters observed in each region was divided by the number of kilometers of shoreline surveyed. For areas outside Prince William Sound, the coastline was divided into segments based primarily on shoreline features such as points of land, bays, and lagoons. Wherever possible, the lengths of the segments were kept approximately equal. Densities of sea otters for areas outside Prince William Sound were calculated by dividing the total adjusted number of sea otters for each segment by the number of kilometers of shoreline in each segment. In this paper, high density refers to more than 2.5 sea otters per kilometer. Moderate densities are between 1.0 and 2.0 sea otters per kilometer.

Results

Within Prince William Sound in 1984–1985, sea otter densities varied from 0.2 to 2.7 sea otters per kilometer of shoreline. High densities of sea otters were found along the northwestern shore of Montague Island, at Green Island, in Port Wells, and in Orca Inlet (Fig. 1). Of those areas, only the Montague–Green Island area was affected by oil from the T/V *Exxon Valdez*. Areas with moderate densities of sea otters that were affected by oil included the Port Bainbridge and the Unakwik Inlet areas, although only a small portion of the latter area was affected. Irons et al. (1988) counted 4,509 sea otters from boats in Prince William Sound in 1984–1985. The number of sea otters counted in 1984–1985 in areas that were oil-affected in some way was 2,500.

Survey techniques used by Irons et al. (1988) were not designed to sample offshore areas that might be occupied by sea otters. In one such area near Cordova, Monnett and Rotterman (1989) counted 3,500 sea otters from fixed-winged aircraft; many of these otters were associated with intertidal haul outs in Orca Inlet.

Densities of sea otters on the Kenai Peninsula, as determined from helicopter surveys at the time of impact of oil from the T/V *Exxon Valdez* oil spill in April 1989, ranged from 0.0 to 4.6 sea otters per kilometer. High densities were found on the western end of the Kenai Peninsula near Seldovia and English Bay (Fig. 2). Those areas received little or no effect from the oil spill. Three areas of moderate

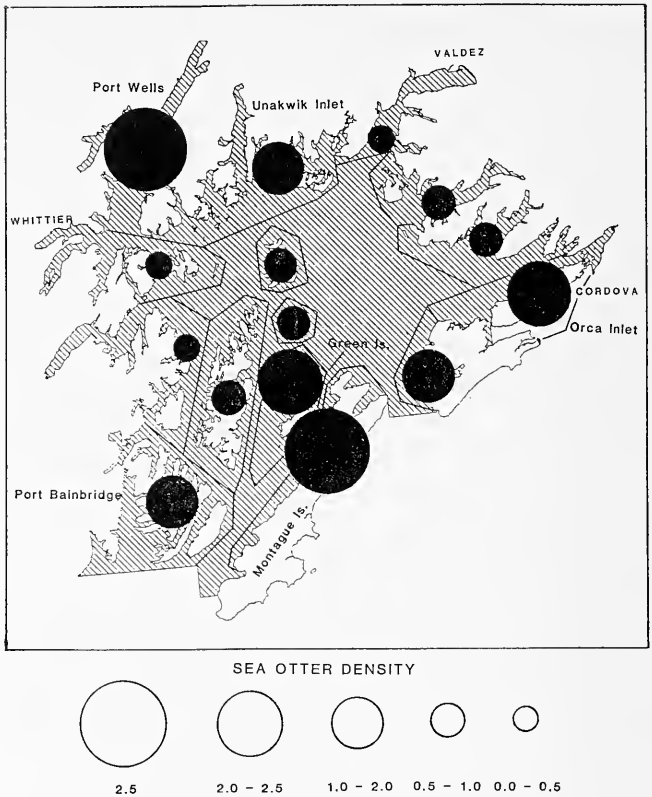

Fig. 1. Densities of sea otters (number per kilometer of coastline) in Prince William Sound in 1984–1985.

sea otter density were identified on the Kenai Peninsula: Whidbey Bay on the eastern end of the Kenai Peninsula, Chugach and Windy bays, and the greater Port Chatham area. While all three areas are considered within the oil spill zone, only the Chugach and Windy bays area was heavily affected by oil. Densities of sea otters for other areas on the Kenai Peninsula ranged from 0.0 to 0.78 sea otters per kilometer. About 1,330 sea otters were counted on the Kenai Peninsula during the spring survey, and all were potentially at risk from oil.

Densities of sea otters in the Kodiak Archipelago ranged from 0.0 to 4.4 sea otters per kilometer. Nine regions had high densities, including Perenosa Bay in Northern Afognak Island, and eight coastal segments in waters between Kodiak, Raspberry, and Afognak islands east to Spruce Island (Fig. 3). Moderate sea otter densities were found on the west side of Afognak Island, and in Seal Bay on northern Afognak, Kazakof Bay on southern Afognak Island, Kizhuyak Bay on northern Kodiak Island, northern Chiniak Bay, and Spiridon Bay in western Kodiak Island. Regions that were hardest hit by oil included Shuyak Island, the western side of Afognak Island, Kupreanof Strait, and the bays on the northwestern part of Kodiak Island (Galt and Payton 1990). About 3,500 sea otters were counted in the Kodiak Archipelago during the spring 1989 survey; all were considered at risk.

On the Alaska Peninsula, high densities (within the range of those observed along the Kenai Peninsula and in the Kodiak Archipelago) were found at Hallo Bay south of Cape Douglas, near Kujulik Bay east of Chignik, north of the Shumagin Islands, in the Pavlof Islands, and in Bechevin Bay north of False Pass (Figs. 4 and 5). The highest densities of sea otters observed during the spring 1989 survey were found along the Alaska Peninsula. Densities were as high as 25.5 sea otters per kilometer. Densities of sea otters in excess of 14.0 per kilometer were found at False Pass, Amak

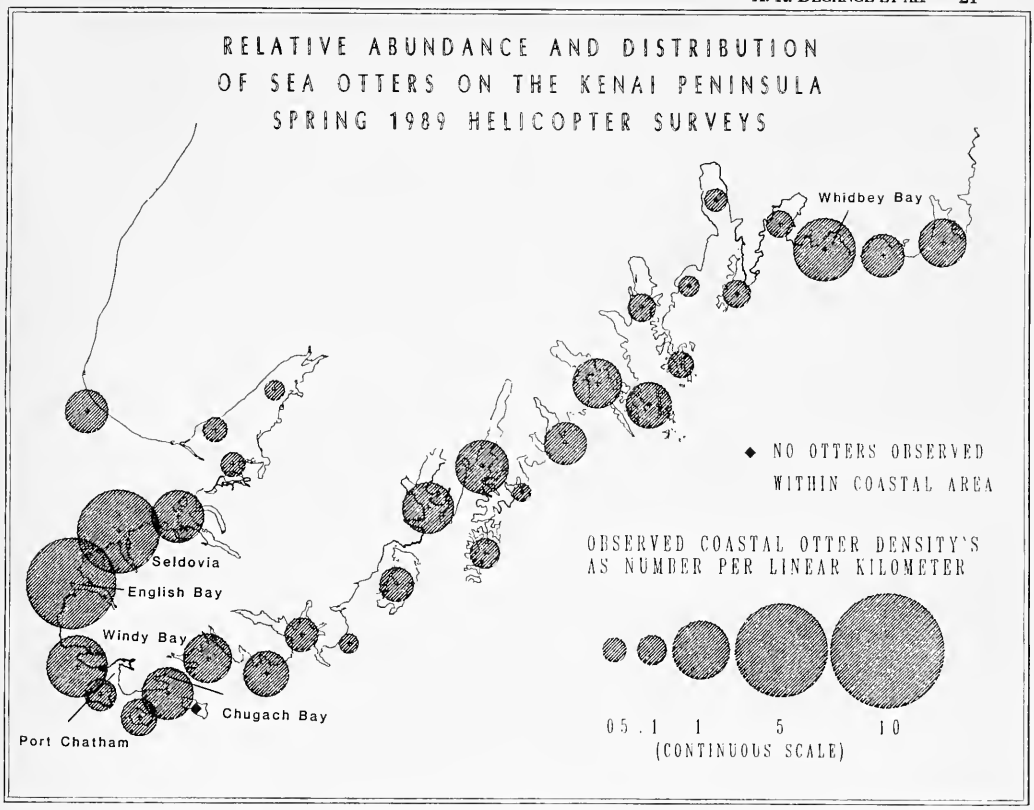

Fig. 2. Densities of sea otters (number per kilometer of coastline) along the Kenai Peninsula in April 1989.

Island, and near Izembek Lagoon (Fig. 5). Oil, in the form of a thick mousse, was found scattered along the coastline of the Alaska Peninsula south to the Chignik area (Galt and Payton 1990). Not one of the beaches southwest of Chignik was oiled. About 6,500 sea otters were counted during the spring 1989 survey along the Alaska Peninsula, including the southern half of Kamishak Bay, all of Unimak Island, and the north side of the Alaska Peninsula to Izembek Lagoon. Within the portion of the Alaska Peninsula that was affected by oil, about 2,500 sea otters were counted that were potentially at risk.

Discussion

The surveys conducted around the time of the T/V *Exxon Valdez* oil spill met the principal objective for which they were intended, that is, to identify concentrations of sea otters to help guide the response effort. About 15,800 sea otters were counted in the survey area during boat and helicopter surveys. As stated earlier, the numbers presented here are not population estimates. They cannot be used as population estimates because it is likely that some sea otters were missed during the surveys and because offshore survey data are not included in the analysis. Strip sampling, which was used in this study, assumes that all animals in the search area were counted. This assumption is rarely fulfilled for most censuses of wildlife populations, particularly diving marine mammals. Although an attempt was made to limit surveys to the best conditions, factors such as weather, sea state, glare, observer capability, avoidance or repulsion of the survey animal, survey craft, and survey speed all resulted in missed animals. No analyses have been completed yet to correct the data for any of these factors. During helicopter surveys, observers

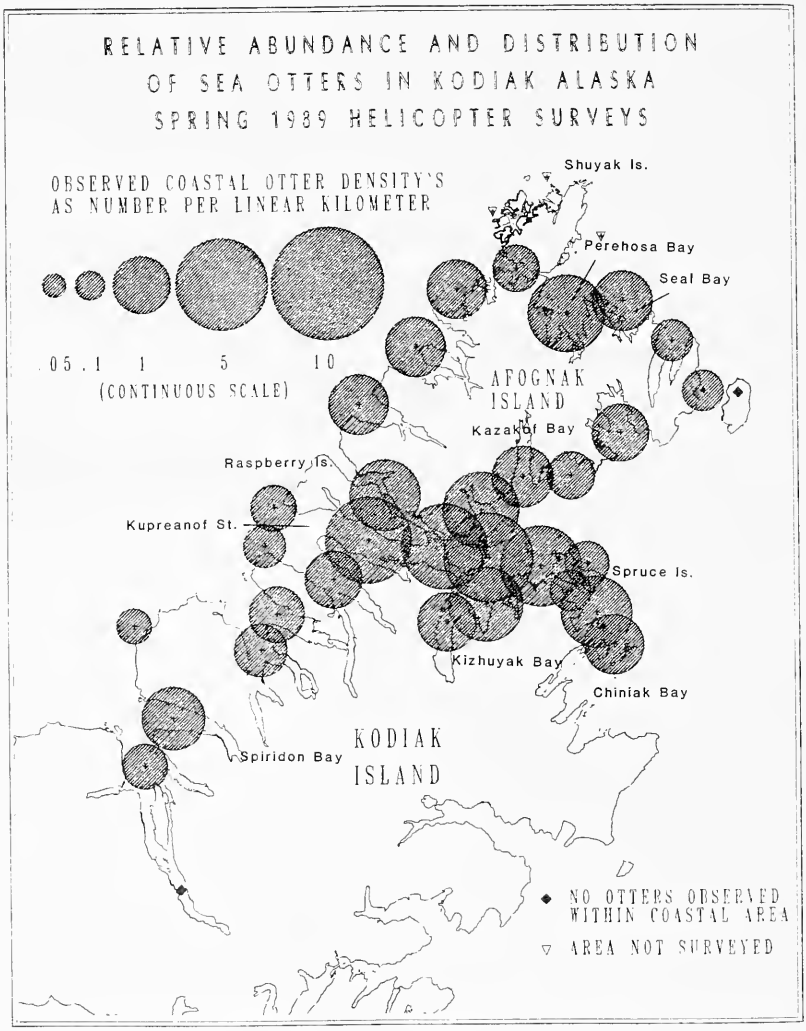

Fig. 3. Densities of sea otters (number per kilometer of coastline) in the northern Kodiak Archipelago in April 1989.

attempted to correct for animals that were diving by conducting periodic hover counts; however, single animals that were underwater were always missed. No attempt was made to correct the boat data for diving sea otters. Although some diving sea otters were missed during boat surveys, the prob-

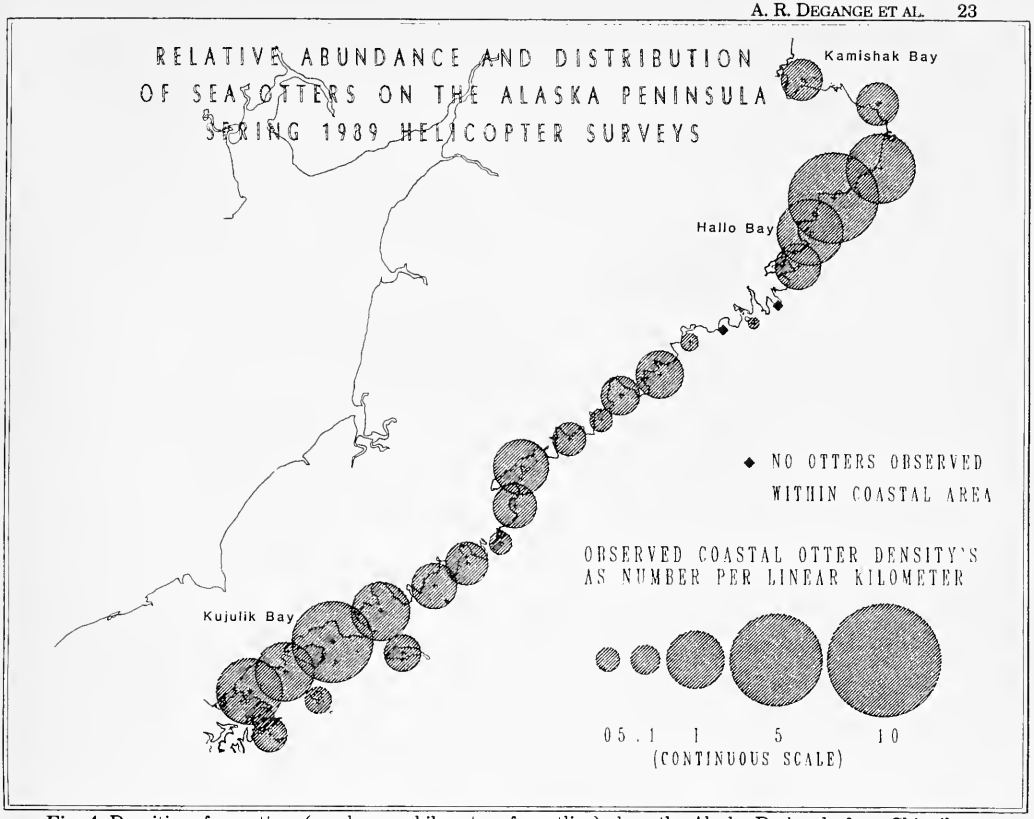

Fig. 4. Densities of sea otters (number per kilometer of coastline) along the Alaska Peninsula from Chignik to Kamishak Bay in spring 1989.

lem of missing diving sea otters was probably not as severe from boats as from helicopters because of the slower survey speeds of boats. Many sea otters inhabit some offshore (>400 m from shore) areas. This is particularly true of broad shallow areas such as the Sandman Reefs near the Shumagin Islands (an area that permits sea otters to feed far offshore) and areas like the Kodiak Archipelago, where large numbers of sea otters are frequently found resting over deep water several kilometers from shore (Drummer et al. 1990, DeGange and Monson, unpublished data). Because offshore areas that may contain even low densities of sea otters are extensive, surveys designed to sample only inshore waters may miss large numbers of sea otters.

Based on the timing of recovery of sea otter carcasses during the oil spill response and the number of carcasses recovered from major geographic locations, it seems that the effects of the T/V *Exxon Valdez* oil spill on sea otters were most acute in Prince William Sound and along the Kenai Peninsula (DeGange and Lensink 1990). Several areas with moderate and high densities of sea otters were affected by the spill. At the time of the spill, these areas were occupied primarily by females, many of which were pregnant or lactating. The Green Island area of Prince William Sound was identified before the oil spill as an important region for pup rearing. Although some high-density habitat was affected by the spill, survey data indicate that the effects of the spill on sea otter populations could have been worse, particularly if the oil had gone to Orca Inlet near Cordova, or if high-density habitat at Kodiak Island and on the Alaska Peninsula had been more severely affected. Populations of sea otters at Kodiak Island and on the Alaska Peninsula were somewhat protected

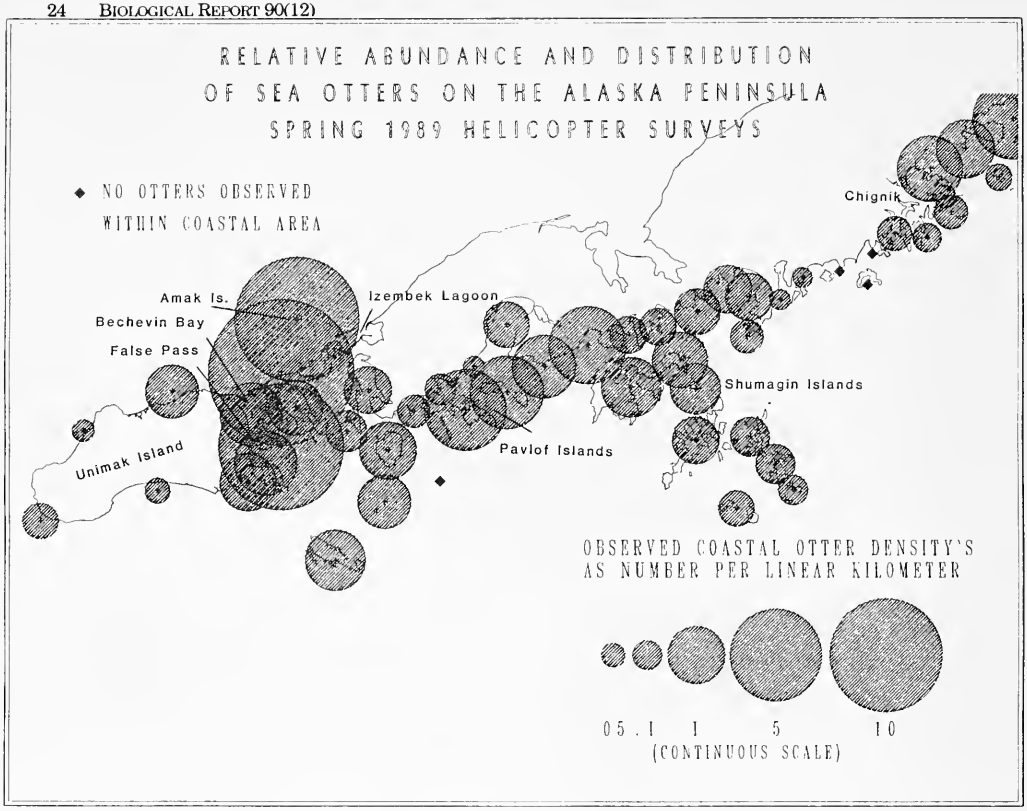

Fig. 5. Densities of sea otters (number per kilometer of coastline) along the Alaska Peninsula from Chignik to Unimak Pass in spring 1989.

from the oil spill by their distance from Bligh Reef (and hence the amount of time it took oil to travel there), and the weathered state of the oil (it seems that weathered oil did not affect sea otters as severely as freshly spilled crude oil; DeGange and Lensink 1990; Galt and Payton 1990).

The T/V *Exxon Valdez* oil spill demonstrated that our knowledge of the number of sea otters in various portions of south-central Alaska that potentially were at risk from oil was inadequate both from the perspective of guiding a response and for assessing damages. The most complete survey information available before the spill for Prince William Sound was 4 to 5 years old. Very little information was available for the Kenai Peninsula, the Kodiak Archipelago, and the Alaska Peninsula. Censusing sea otters is an inexact science. Therefore, as part of future oil spill contingency planning, we recommend that survey designs for sea otters, tailored for specific geographic areas, be in place. The T/V *Exxon Valdez* oil spill also made clear the need to frequently monitor populations of sea otters at greatest risk from oil. Surveys must be done with sufficient frequency and precision to statistically track changes in the distribution and abundance of sea otter populations. A survey of this kind should include the population of sea otters in Prince William Sound and anywhere else that oil-related development and transport occurs within their range.

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