

OCS Study
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**Sea Otter Surveys of Yakutat Bay and Adjacent Gulf of Alaska Coastal
Areas - Cape Hinchinbrook to Cape Spencer 1995-1996**

Funded by: Minerals Management Service
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FINAL REPORT:

**Sea Otter Surveys of Yakutat Bay and Adjacent Gulf of Alaska Coastal Areas - Cape
Hinchinbrook to Cape Spencer 1995-1996**

January 1998

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The opinions, findings, conclusions, or recommendations expressed in this report or product are those of the authors and do not necessarily reflect the views of the Minerals Management Service, nor does mention of trade names or commercial products constitute endorsement or recommendation for use by the Federal Government.

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ABSTRACT

The world-wide sea otter population was drastically reduced by commercial harvesting from the mid-1700's through the 1800's to as few as several hundred animals. The population in Alaska has recovered to near historic numbers and is now estimated to be 100,000-150,000 sea otters. However, the population range is discontinuous and one of the gaps in distribution occurs along the outer Gulf of Alaska coast. Current sea otter distribution and abundance data are needed to address potential management concerns regarding oil and gas development and shell fisheries conflicts within the region. Aerial surveys for sea otters were conducted in August of 1995 and 1996, to determine the distribution of sea otters along the outer Gulf of Alaska coast from Cape Hinchinbrook to Cape Spencer, and to determine the abundance of sea otters within Yakutat Bay. Along the outer Gulf of Alaska coast, sea otters were concentrated in the following areas: 1) Cape Hinchinbrook to Cape Suckling (n=256), 2) Cape Suckling to Kaliakh River (n=15), 3) Ocean Cape to Dangerous River (n=28), 4) Dry Bay to Lituya Bay (n=163), and 5) Icy Point to Cape Spencer (n=32). A minimum count of sea otters in Yakutat Bay was 245 adult sea otters and 8 pups. The number of animals counted in the distribution surveys reflect a minimum count at the time of the survey. No sea otters were observed from Kaliakh River to Point Manby including Icy Bay. An abundance estimate determined by strip transect and intensive search unit methodology yielded an overall sea otter population estimate of 404 for Yakutat and Disenchantment Bays, and Russell and Nunatak Fiords. A further refined estimate of abundance for the high density area of Yakutat Bay was 194. The sea otter population has increased in abundance and expanded in range since the last complete survey of the area in 1987. The population within Yakutat Bay may be increasing due to net population growth and immigration from the translocated population in Southeast or from the Prince William Sound-Controller Bay area.

INTRODUCTION

Prior to the mid-1700's, sea otters (*Enhydra lutris*) could be found in large numbers in coastal areas of Japan, Russia (Kamchatka), the United States (Alaska, Washington, Oregon, and California), Canada (British Columbia), and Mexico (Lensink 1962, Kenyon 1969). Extensive commercial harvesting of sea otters occurred during the mid-1700's through the 1800's which drastically reduced the population (Bancroft 1959, Lensink 1962, Kenyon 1969). Russian vessels harvested an estimated 200,839 sea otter pelts from the northwest coast during the 18th and 19th centuries (Cadwell 1986). Records of actual harvest numbers are often incomplete; many vessels and their harvest of sea otters pelts were lost in the rough seas in the outer Gulf of Alaska coastal areas during the early years of the fur trade (Bancroft 1959, Lensink 1962, Cadwell 1986). Sea otters were eliminated from much of their range which, in north America, was continuous along the Pacific coast from the Aleutian Islands, Alaska, through Baja California, Mexico (Kenyon 1969, Riedman and Estes 1990). The sea otter was subsequently protected by the International Fur Seal Treaty in 1911. In the absence of harvest pressure, the population expanded from 11 remnant groups to recolonize much of the former sea otter range (Figure 1). To aid in the population recovery, Alaska Department of Fish and Game (ADF&G) translocated sea otters from areas with major concentrations (Amchitka Island and Prince William Sound, Alaska) to parts of the historical range where sea otters had been extirpated due to over harvest. Relocation efforts were successful in establishing sea otters in southeast Alaska (Khaz Bay; Yakobi, Biorika, Maurelle Islands, and Cape Spencer), British Columbia, and Washington (Jameson et al. 1982; Riedman and Estes 1990). The current Alaska sea otter population is estimated to be 100,000-150,000 (Calkins and Schneider 1985).

Currently the sea otter population range is discontinuous within Alaska (Figure 1). A gap in sea otter distribution occurs along the Gulf of Alaska coast between Prince William Sound and Yakutat Bay and between Yakutat Bay and Cape Spencer. Sea otters were believed to have been extirpated from Cape Suckling to Cape Spencer including Yakutat Bay by the early 1900's (Figure 2). During August of 1966, 10 sea otters from Montague Island, Prince

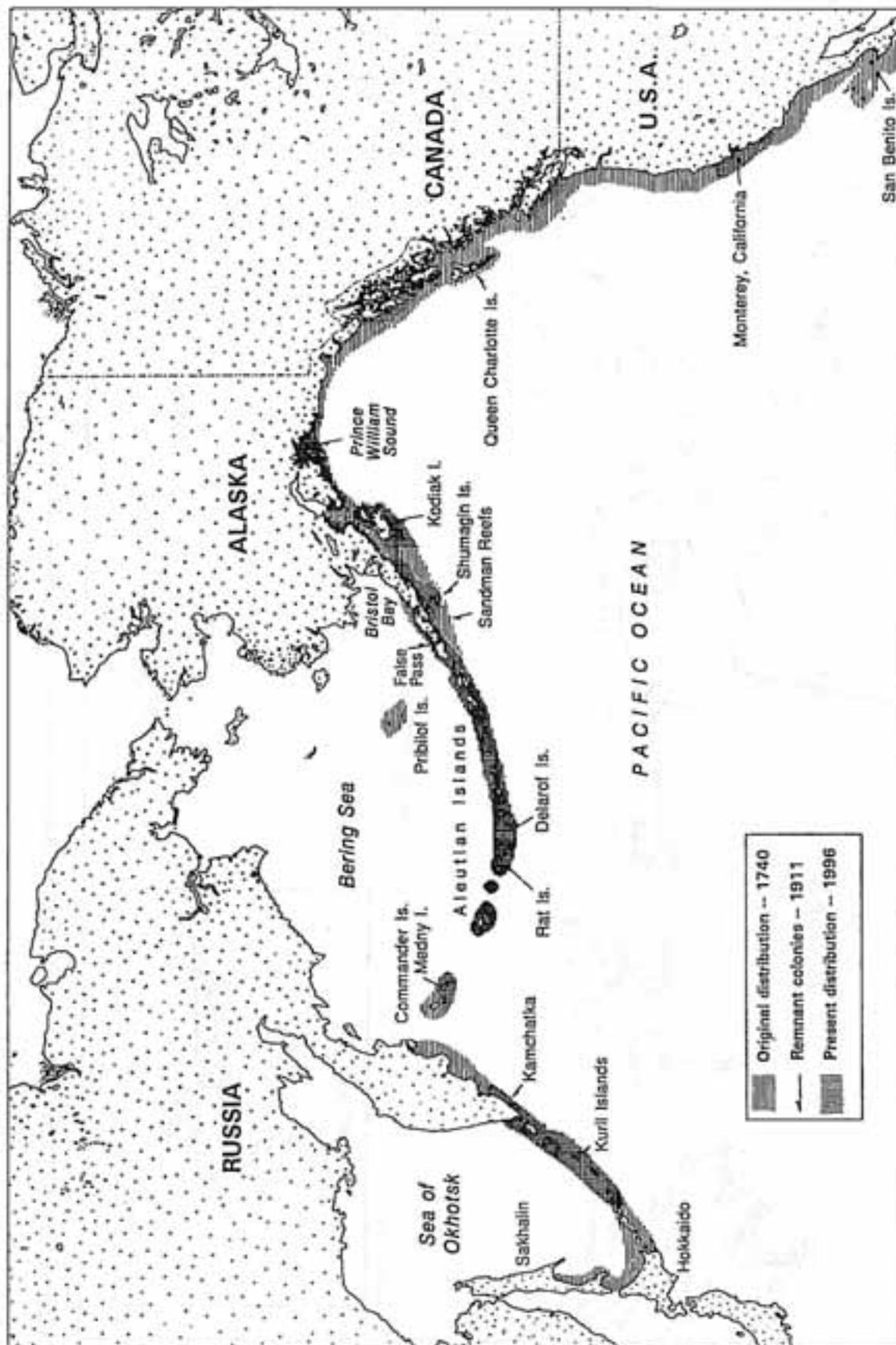


Figure 1. A world population distribution of sea otters (*Enhydra lutris*) including the original distribution prior to commercial exploitation (1740), the locations of remnant populations (1911), and the current distribution (1996). Adapted from Kenyon (1969) and Rotterman and Simon-Jackson (1988).

William Sound were translocated to Yakutat Bay (Calkins and Schneider 1985; K. Schneider pers. comm.). The Yakutat Bay area was monitored after sea otters were translocated in 1966, though sightings were infrequent, a few sea otters were observed along the Gulf of Alaska coast between Icy and Dry Bays. No sea otters were observed between Icy Bay and Cape Suckling during the monitoring period (Calkins et al. 1975). Surveys for sea otters conducted by ADF&G in 1970 recorded 6 sea otters observed between Yakutat and Dry Bays, and 15 within Yakutat Bay (Calkins and Schneider 1985). By 1985, biologists at ADF&G speculated approximately 50 sea otters resided in Yakutat Bay (Calkins and Schneider 1985). The outer Gulf of Alaska coast from Point Martin to Cross Sound, including Yakutat Bay, was surveyed in 1987 to determine the sea otter distribution and relative abundance (Simon-Jackson 1986, Simon-Jackson and Hodges 1987). Sea otters were observed between Point Martin and Cape Suckling and between Cape Spencer and Cross Sound, however, no otters were observed between Cape Suckling and Cape Spencer. The reported Native subsistence harvest of sea otters in Yakutat Bay did not begin until 1993 and thereafter occurred in low levels [average annual reported harvest = 12 (U.S. Fish and Wildlife Service, Unpublished data 1988-1996)].

As sea otters continue to recolonize the Gulf of Alaska coast, potential resource management conflicts may arise. Management concerns include: 1) effects of oil and gas development and transport along the Gulf of Alaska coastline on sea otters and 2) conflicts between commercial and Native subsistence shellfisheries and sea otters. The first step in addressing these management concerns is to determine the current sea otter distribution along the Gulf of Alaska coast and to develop an estimate of population abundance for the Yakutat Bay area where sea otters are aggregated.

We present the results of two distribution surveys for sea otters (and other marine mammals) for the outer Gulf of Alaska coast from Cape Hinchinbrook to Cape Suckling (1996) and from Cape Suckling to Cape Spencer (1995). The 1996 sea otter distribution replicates the methodology of a survey conducted during 1986 (Simon-Jackson). An abundance survey for sea otters was conducted in Yakutat Bay during August 1995 which followed the aerial survey

methodology developed by Bodkin and Udevitz (1996). The survey method was replicated to improve precision in the population estimate.

METHODS

Distribution Surveys

1 A distribution survey was conducted from Cape Suckling to Cape Spencer during 8-9 August 1995 (Figure 2). The distribution survey platform was a Grumman Goose flying at an altitude of 152 m with an airspeed of 153 kph. There were four observers, two seated on each side of the aircraft. The survey strip was approximately 400 m both shoreward and seaward from the flight path of the aircraft. The coastline from Cape Suckling to Cape Spencer was surveyed, including Icy and Dry bays but not Yakutat Bay. Survey conditions were excellent; high overcast skies and very little wind.

2 A second distribution survey was conducted from Cape Hinchinbrook to Cape Suckling during 19-23 August 1996. The survey platform was a 206 Cessna aircraft flying at an altitude of 152 m with an airspeed of 153 kph. There were two observers, one seated on each side of the aircraft. The survey area extended approximately one kilometer seaward from the shoreline, including barrier islands. The shoreline was surveyed at approximately low tide and during the mid-day hours following the methods of Simon-Jackson (1986). Additionally, a portion of the shallow water area (< 91 m) was surveyed by systematic transects which covered approximately 10% of the shallow water area (Figure 3). Survey viewing conditions were variable from moderate to marginal and winds were a brisk 15-20 knots from the east.

In both distribution surveys, the aircraft maintained altitude and distance from shore. If observers needed to verify species or counts, the plane circled the area until verification was obtained (where feasible). Date, time, weather conditions, marine mammal species and number observed, and coordinates were recorded for each observation. Location coordinates of all marine mammals observed were recorded on a data sheet in latitude and longitude

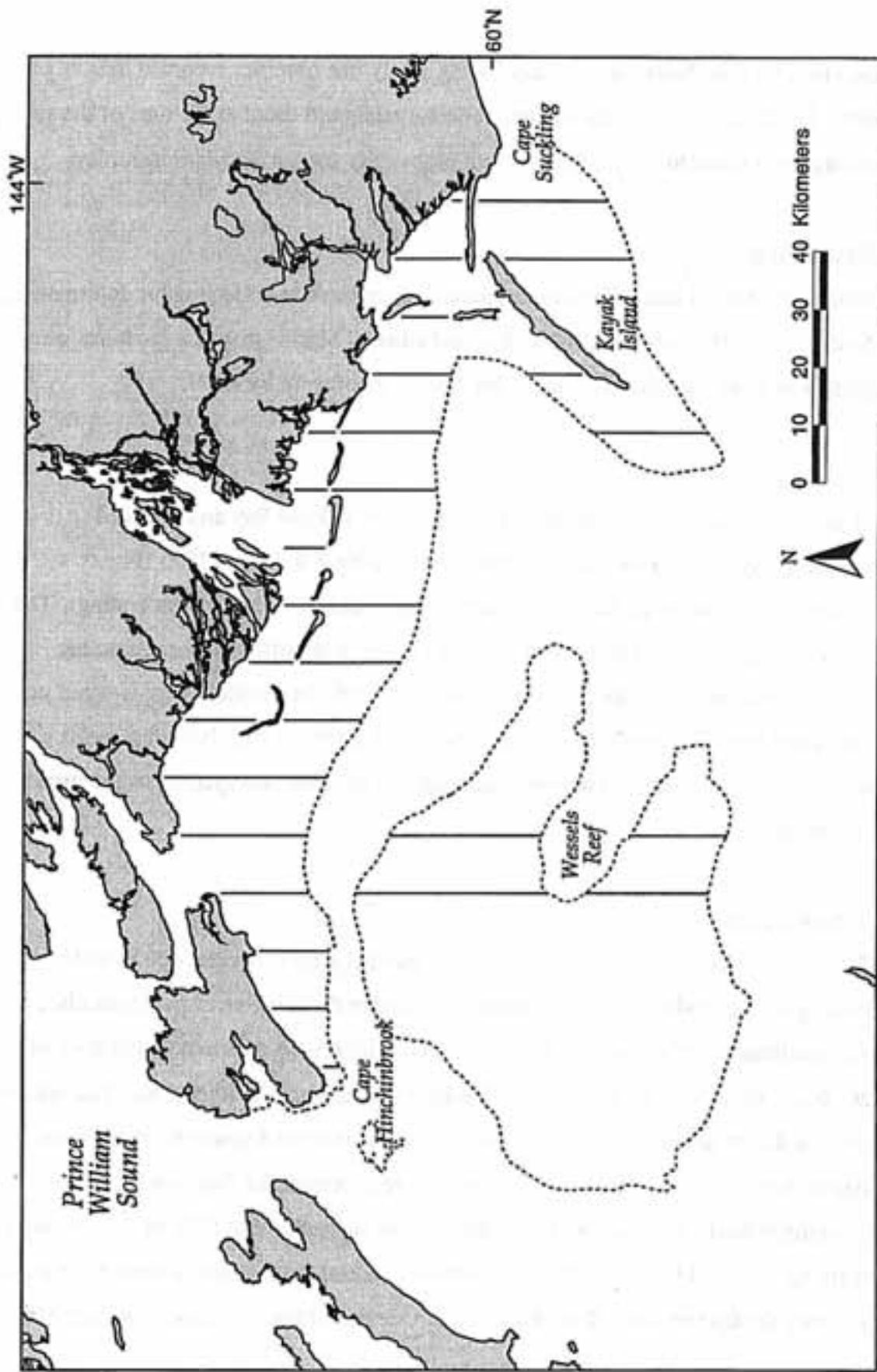


Figure 3. Location of offshore transects surveyed from Cape Hinchinbrook to Cape Suckling, August 1996 for sea otter (*Enhydra lutris*) distribution. Dotted line represents 50-fathom isobath.

determined by a Global Positioning System (GPS). Only one observer recorded data at a given time. The number of animals counted reflect a minimum count at the time of the survey and no attempt was made to develop a detection probability for the distribution survey.

Data Analysis

Data were entered into a Paradox database and exported to a Geographic Information System (GIS) after being error-checked and edited. Marine mammal locations were plotted to make distribution maps using ArcView software by ESRI.

Abundance survey

An aerial survey of sea otter abundance was conducted in Yakutat Bay and included Disenchantment Bay and Russell and Nunatak Fiords during 7-9 August 1995 (Figure 4). The survey platform was a Scout (a fixed-wing, single engine aircraft with tandem seating). The survey methodology followed Bodkin and Udevitz (1996); a stratified random sampling procedure developed to assess sea otter abundance. In brief, the methodology is based on strip transect and intensive search unit (ISU) counts of sea otters. Population estimates are developed from sea otter density estimates and detection probabilities specific to the survey and the observer.

Survey Design

The sampling frame consisted of a series of parallel strip transects, 400 m wide overlaying the study area and oriented to maximize their degree of perpendicularity to the coastline. In trial surveys, Bodkin and Udevitz (1996) determined that 86% of the sea otters were detected at distances less than 400 m from the flight line. The criterion used to define the sample area was based on the maximum known sea otter forage depths (approximately 100 m) and sea otter's requirement for frequent access to foraging habitat. Information from trial surveys suggested that 85% of the sea otters were encountered in only 32% of the sample area and that sea otters were concentrated in water depths less than 40 m (Bodkin and Udevitz 1996). To allocate survey effort

proportionately to the expected abundance, the survey area was separated into two strata, a high and a low density stratum. The high density stratum extended from shore to 400 m seaward or to the 40 m depth contour, whichever was greatest. The low density stratum boundary began at the seaward high density stratum boundary and extended to 2 km offshore or to the 100 m depth contour, whichever was greater. Bays and inlets less than 6 km wide were considered high density strata regardless of water depth. Survey effort was allocated proportionally between high and low density strata and reflected the expected sea otter abundance in each strata (Figure 4). Transects were surveyed every 1.2 km (every third transect) in the high density stratum and every 8.0 km (every twentieth transect) in the low density stratum.

The minimum distance between survey transects was determined to be 1.2 km in the high density stratum (Bodkin and Udevitz 1996). Therefore, three systematic samples were possible from the initial overlay of 400 m wide transects. In the high density stratum every third transect was sampled and, therefore, sample 1 (S1) began on transect 1, sample 2 (S2) began on transect 2, and sample 3 (S3) began on transect 3. Low density transects for each sample were determined by a random selection of the initial transect and every 20th transect thereafter. Because we anticipated an overall low density of sea otters in the survey area, replicate surveys were used to increase the sample size and obtain a more precise population estimate (Figure 5). Random selections (with replacement) of the three possible systematic samples determined the specific transects which were surveyed in each replication of the abundance survey.

Unadjusted population estimates were developed from the survey strata by the following equations:

$$\hat{Y}_{(un)j} = \frac{\sum_{i=1}^{n_j} y_{ij}}{\sum_{i=1}^{n_j} a_{ij}} A_j$$

$$\text{var}(\hat{Y}_{(un)j}) = \frac{A_j^2 (1-f_j) n_j}{\left(\sum_{i=1}^{n_j} a_{ij}\right)^2 (n_j-1)} \sum_{i=1}^{n_j} \left(y_{ij} - \frac{a_{ij} \sum_{i=1}^{n_j} y_{ij}}{\sum_{i=1}^{n_j} a_{ij}} \right)^2$$

where

A_j = total area of stratum j,

n_j = number of surveyed transects in stratum j,

y_{ij} = number of otters detected in strip count on transect i in stratum j,
 $i=1, \dots, n_j$,

a_{ij} = area of transect i in stratum j, and

f_j = the sampling fraction, approximated by

$$f_j = \frac{1}{A_j} \sum_{i=1}^{n_j} a_{ij} .$$

Intensive search units consist of 5 concentric 400 m diameter circles flown within the 400 m survey strip. Intensive search units were initiated by the sighting of a group (one or more sea otters). The pilot used a stopwatch to guide the circumference of each circle (48 seconds to complete an ISU circle) and to time the minimum 1 minute

spacing between successive ISUs. For each group observed, the following information was recorded 1) ISU location, 2) whether animals were detected on the strip count or on the subsequent circles within the ISU, and 3) the behavior of each animal (e.g. diving or nondiving). Sea otters in the initiating group and those that swam into the ISU were not included in the calculation of the correction factor.

A correction factor was developed for each survey for the observer by the following equation:

$$\hat{p}_k = \frac{\sum_{i=1}^{t_k} c_i}{\sum_{i=1}^{t_k} s_i}$$

$$\text{var}(\hat{p}_k) = \frac{t_k \sum_{i=1}^{t_k} (c_i - \hat{p}_k s_i)^2}{(t_k - 1) \left(\sum_{i=1}^{t_k} s_i \right)^2}$$

where

- s_i = number of otters detected in strip count of ISU i , $i=1, \dots, t_k$, and
- c_i = total number of otters detected after intensive search of ISU i .

A total of five replications of the sea otter abundance survey were conducted; the first was the survey of all high and low density transects in Yakutat and Disenchantment Bays, and Russell and Nunatak Fiords (referred to as the complete survey in the following text), and four additional replications of a subset of the high density area

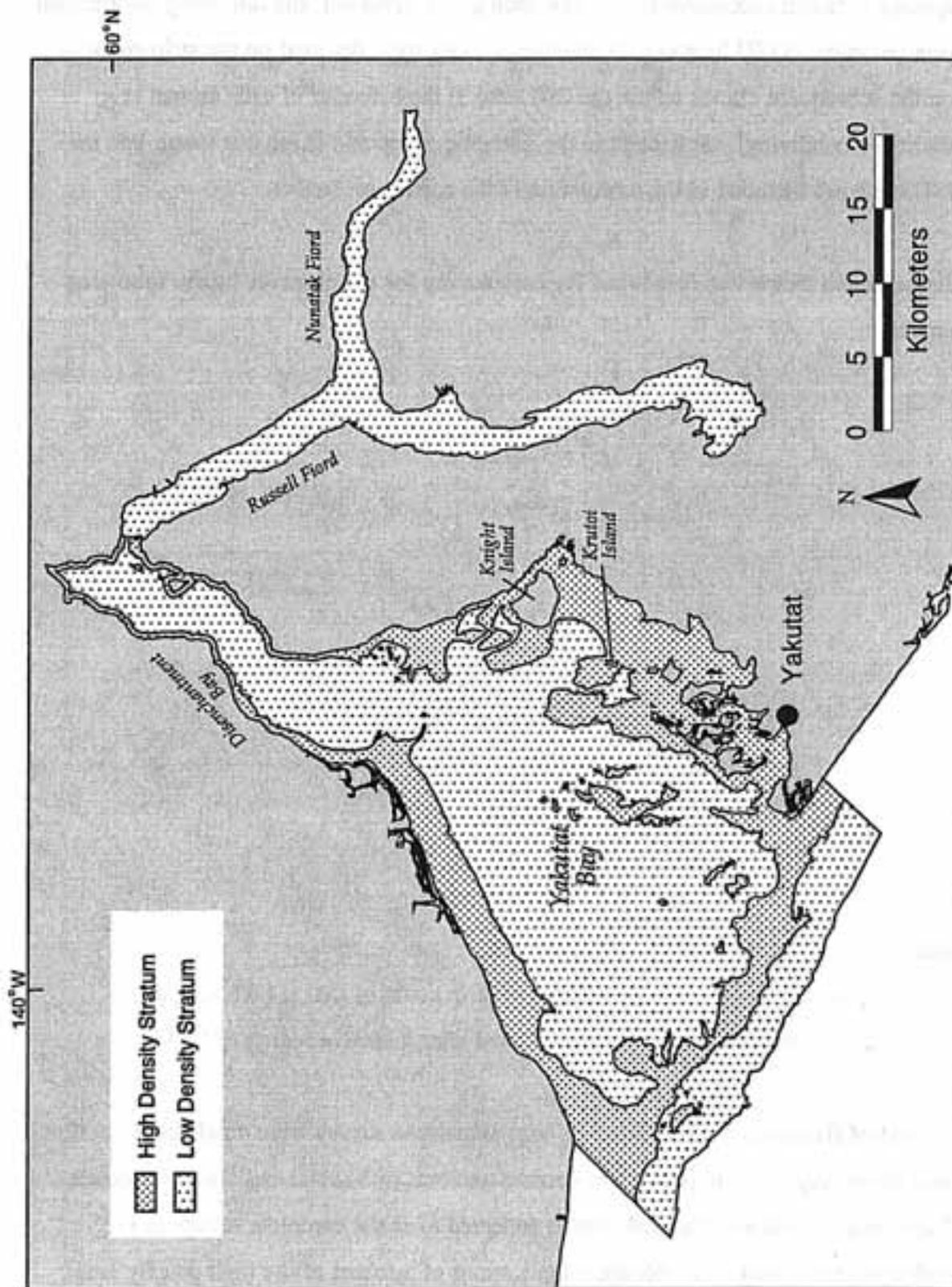


Figure 4. The study area for a sea otter (*Enhydra lutris*) abundance survey in Yakutat Bay, Alaska, 7-9 August 1995.

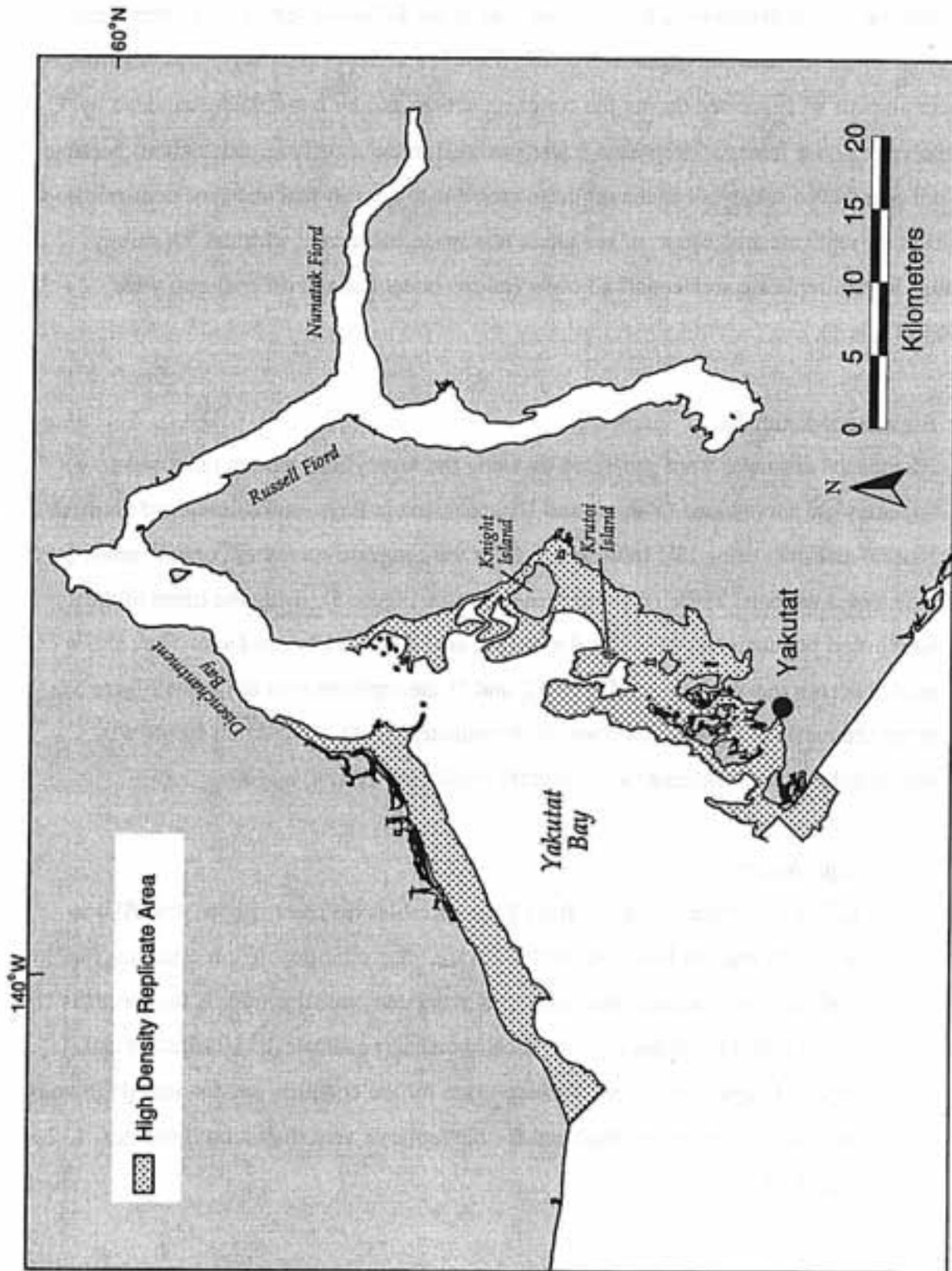


Figure 5. The study area for sea otter (*Enhydra lutris*) replicate surveys to determine an abundance estimate for Yakutat Bay, Alaska, 7-9 August 1995.

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within Yakutat Bay (referred to as the replicate area in the following text) (see Figure 5 and Table 1). The survey area of replicates 2-5 (S2, S3, S3, and S2, respectively) was determined by where animals were located during the complete survey and by information provided by local Native sea otter hunters. Replicate 3 was not used in the abundance calculations because it was not possible to survey all of the replicate area due to aircraft fuel and time constraints. In addition, a 'replicate area count' of sea otters was made concurrent with the 5th survey replicate. In the 'replicate area count' all observed sea otters (on and off transect) were recorded (Table 1).

Abundance Estimates

Abundance estimates were generated by using the survey information three ways: 1) the complete survey area (Yakutat and Disenchantment Bays, and Russell and Nunatak Fiords) and only using ISU information from the complete survey to correct counts for undetected animals; 2) the replicate area only (see Figure 5), using the mean of the unadjusted population estimates and applying an overall correction factor from ISU's pooled across replicates (1, 2, 4, and 5); and 3) the replicate area only (see Figure 5), using the mean of the adjusted population estimates where a correction factor was developed for each replicate independently (replicates 1, 2, 4, and 5).

Data Analysis

Edited data were converted from Paradox tables (transect, flight, and ISU) to SAS data sets via DBMS/COPY software. Sea otter population estimates for Yakutat Bay were obtained with SAS programs (see Appendix A for formulas used in the calculation of population abundance estimates). Unadjusted and adjusted population estimates were made for the complete survey area (high and low density survey stratum) and for the replicate area (based on replicates 1, 2, 4, and 5).

Table 1. Structure of the aerial survey replications for sea otter (*Enhydra lutris*) abundance in the Yakutat Bay area 7-9 August 1995.

Survey Number	Survey Date	High/Low		Survey Design	Complete Survey	Replicate Area	Comments
		Density	Flown				
1	8/7/95	163	27	S2	Y	Y	105 high density transects were selected in the replicate area
2	8/8/95	102	2	S2	N	Y	
3	8/8/95	45	4	S3	N	N	Replicate area incomplete
4	8/9/95	105	5	S3	N	Y	
5	8/9/95	99	3	S2	N	Y	An 'replicate area count' was conducted concurrently with this replicate

RESULTS

Distribution Surveys

Minimum counts of sea otters, harbor seals (*Phoca vitulina*), harbor porpoise (*Phocoena phocoena*), Steller's sea lion (*Eumetopias jubatus*) and unidentified marine mammals were obtained for the near shore area between Cape Hinchinbrook and Cape Spencer (not including Yakutat Bay). Minimum counts and distribution information on harbor seals, harbor porpoise, and Steller sea lions are presented in Appendix B.

In the 1995 distribution survey, sea otters were concentrated in localized areas along the outer Gulf of Alaska coast. The median group size was 2 (range 1-21); the total count was 238 (Figure 6). The four main areas where sea otters were observed were: 1) Cape Suckling to Kaliakh River (n=15), 2) Ocean Cape to Dangerous River (n=28), 3) Dry Bay to Lituya Bay (n=163), and 4) Icy Point to Cape Spencer (n=32). In Yakutat Bay, a count of the replicate high density area was 245 adult sea otters and 8 pups. The majority of these animals were concentrated in a large, loosely aggregated group between Knight and Krutoi Islands. The distribution of sea otters in Yakutat Bay is shown in Figures 7-11. No sea otters were observed in Disenchantment Bay and Russell and Nunatak Fiords. No sea otters were observed from Kaliakh River to Point Manby including Icy Bay.

low density?

In the 1996 distribution survey, sea otters were fairly uniformly distributed between Cape Hinchinbrook and Cape Suckling. The total number of sea otters counted was 256; the median group size was 1 (range 1-30). Sea otters were observed on 26% of 31 off shore transects surveyed and accounted for 7.8% (n=20) of the total number of sea otters observed between Cape Hinchinbrook and Cape Suckling. The greatest distance sea otters were observed from shore (land areas not covered by storm high tide) was 20 km, these observations were close to mud flats exposed at mean low tide.

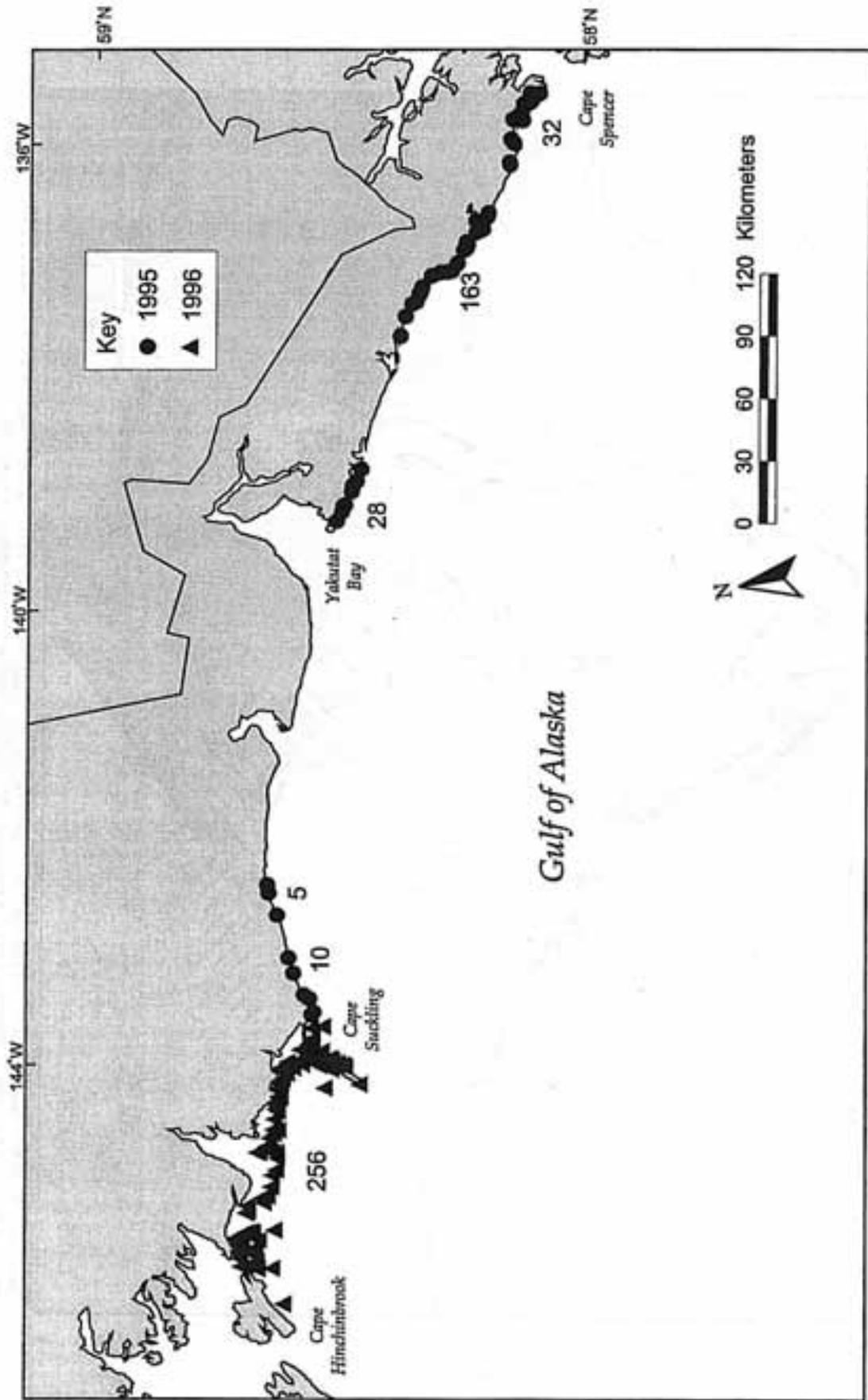


Figure 6. The distribution and minimum counts of sea otters (*Enhydra lutris*) observed from Cape Hinchinbrook to Cape Spencer, Alaska, during aerial surveys conducted in 1995 and 1996. Each marker represents a sighting of one or more sea otters.

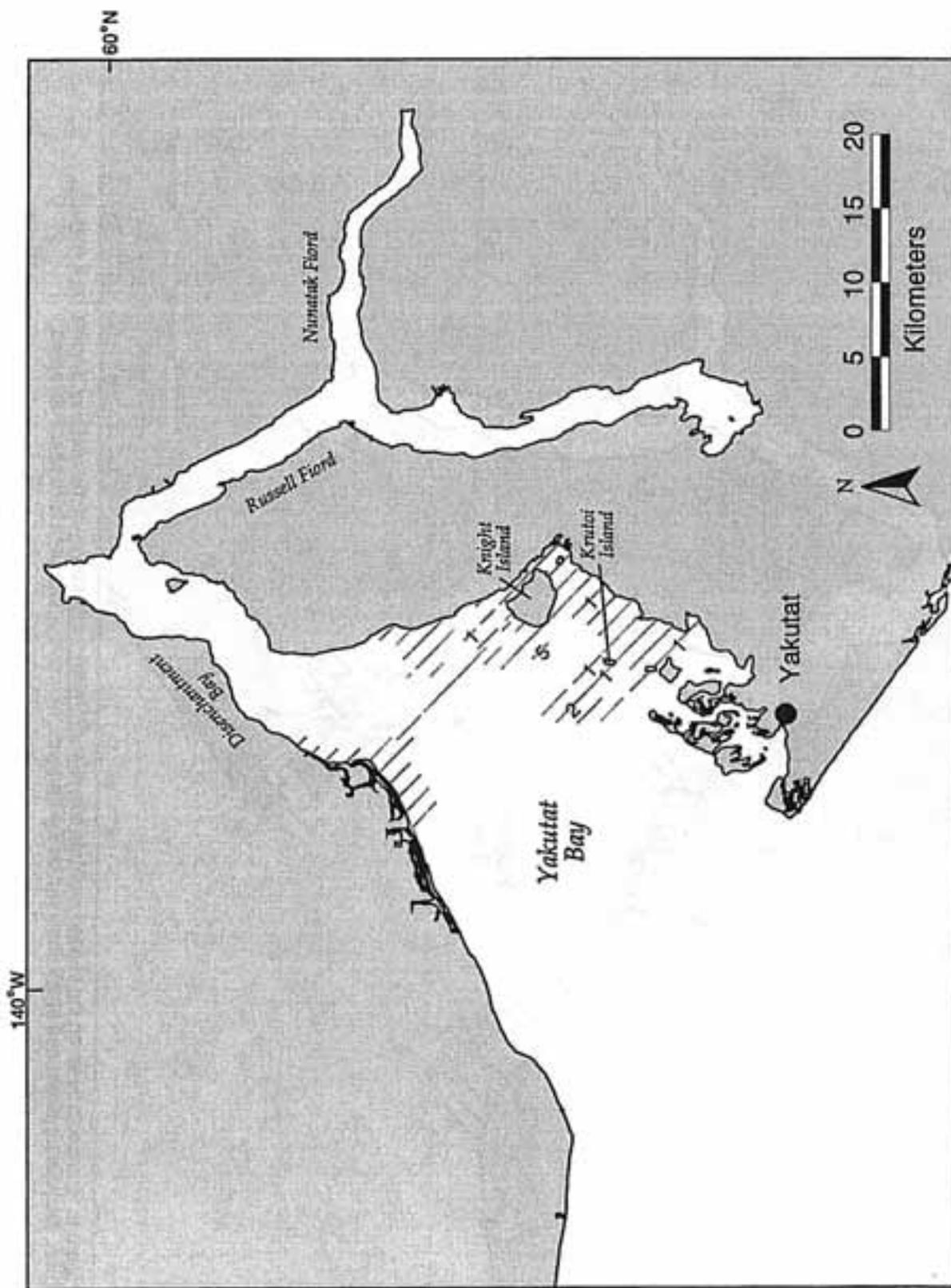


Figure 9. Transects flown on the third replicate sea otter (*Enhydra lutris*) survey of Yakutat Bay, Alaska, on 8 August 1995. Numbers indicate sea otters observed on the transect. No number indicates zero otters observed.

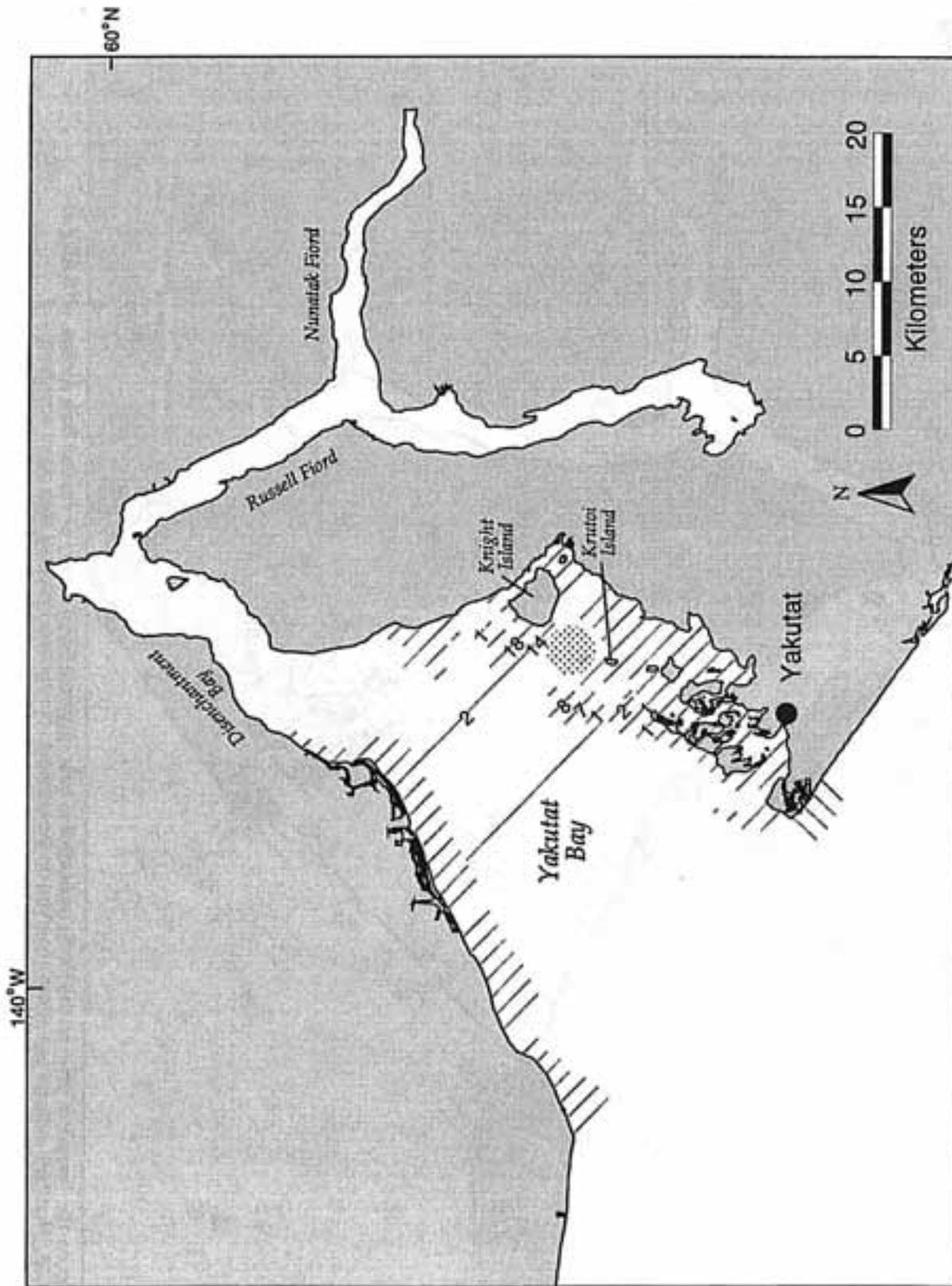


Figure 11. Transects flown on the fifth replicate sea otter (*Enhydra lutris*) survey of Yakutat Bay, Alaska, on 9 August 1995. Numbers indicate sea otters observed on the transect. No number indicates zero otters observed. Shaded area indicates large group of otters sighted off-transect.

Abundance Survey

The complete survey area abundance estimate for sea otters area is presented in Table 2. Unadjusted population estimates with standard errors were obtained for each strata (high and low density) separately. The ISU data was pooled across strata and applied to both high and low population stratum estimates; the correction factor was 2.63. The overall sea otter population abundance estimate was 404 (95%CI=136-672) for Yakutat and Disenchantment Bays, and Russell and Nunatak Fiords.

Sea otter population estimates for the replicate survey area (shaded area of Figure 5) were generated based on replicates 1, 2, 4, and 5 and are presented in Table 3. Unadjusted and adjusted population estimates were developed for each replicate, resulting in four independent estimations of population abundance. The combined correction factor applied to the unadjusted population mean of the replicates resulted in a corrected population estimate of 193 (95%CI=16-402). There was considerable variation in the sea otter density estimated among surveys. An alternative method to assessing population abundance using the replicate data is to take the mean of the adjusted population estimates. This accounts for the variability in the detection probabilities among replicate surveys. The correction factors ranged from 1.0 to 3.5 among survey replicates. The mean of the adjusted population estimates was 194 (95%CI=28-360) sea otters in the replicate area in Yakutat Bay.

Table 2. Sea otter (*Enhydra lutris*) aerial survey results from the Yakutat Bay area (including Disenchantment Bay and Russell and Nunatak Fiords) conducted 7-9 August 1995.

Survey Stratum	Number of Transects	Number of Otters Counted	Density (Otters/km ²)	Correction Factor	Unadjusted Population Size	Adjusted Population Size	Adjusted Population Standard Error
High	163	33	0.25	2.63	112	294	112.9
Low	27	2	0.04	2.63	42	110	77.4
All						404	136.9

Table 3. Sea otter (*Enhydra lutris*) replicate aerial survey results from the Yakutat Bay area (high density survey strata) conducted 7-9 August 1995.

Replicate Number	Number of Transects	Number of Otters Counted	Density (Otters/km ²)	Correction Factor	Unadjusted Population Size	Adjusted Population Size	Adjusted Population Standard Error
1	105	33	0.34	2.63	107	280	107.0
2	102	14	0.14	3.50	45	158	95.2
4	105	20	0.20	1.00	62	62	18.5
5	99	53	0.57	1.55	179	276	115.3
All				1.96	98	193	65.8

120

1000 245

DISCUSSION

Historically, the habitat in the Gulf of Alaska coastal area supported a large number of sea otters. In the Yakutat Bay area there were reports of Russian expeditions which harvested as many as 2,000 sea otters. Approximately 2,800 sea otters were also harvested in the Lituya Bay area by Russian and French fur traders (Cadwell 1986, Bancroft 1959). La Perouse (1797) speculated in his ship log during an exploration of the Gulf of Alaska coast that a factory could collect 10,000 sea otter skins annually from this region (Cadwell 1986, La Perouse 1797- as referenced by Simon-Jackson and Hodges 1987). However, by 1832, the Russian-American Company discontinued harvesting sea otters in the Lituya Bay region because their hunting efforts were unsuccessful (Bancroft 1959, Cadwell 1986).

Sea otters are returning and beginning to re-occupy the coastal habitat along the Gulf of Alaska, but the population is nowhere near the historic densities reported by the fur trade. The current sea otter distribution has changed since the last complete survey in 1986-87 (Simon-Jackson 1986, Simon-Jackson and Hodges 1987). There were no sea otters observed in the 1987 survey of the outer Gulf Coast between Cape Suckling and Cape Spencer; though there were several sea otter sightings reported between Yakataga and Icy Bay and within Yakutat Bay from other sources. Nine years later, we observed 206 sea otters on the outer Gulf Coast (from Cape Suckling to Cape Spencer) and a minimum count of 245 within Yakutat Bay.

→ dist'n survey

Seasonal differences in the sea otter distribution or differences in survey methodology may account for some of the observed differences between surveys. However, it seems likely that population range expansion from the Prince William Sound-Controller Bay area or the southeast population are contributing to the observed changes in sea otter distribution between Cape Suckling and Cape Spencer.

The minimum counts of sea otters have been variable in the Controller Bay area; 185 and 48 sea otters were reported in 1986 and 1987, respectively (Simon-Jackson 1986, Simon-Jackson and Hodges 1987). In our 1996 distribution survey, we observed 96 sea otters in the Controller Bay area. Simon-Jackson observed a median group size of 2 (range 2-124) with the largest group occurring in Controller Bay. Our median group size was also small and the largest group we observed in the Controller Bay area was 14 sea otters.

The distribution surveys are useful for minimum count data and provide a picture of sea otter population expansion in the Gulf of Alaska coastal area. However, they only provide a 'snapshot' in time that may be affected by factors such as season, tidal state and survey conditions. The distribution and the minimum count data for other marine mammal species are presented in Appendix B.

The abundance survey provides a means of comparing population abundance over time and is readily repeatable over longer time intervals (e.g. every 5-10 years). The methodology developed by Bodkin and Udevitz (1996) allows for the calculation of observer and survey-specific correction factors in the determination of an abundance estimate. There was considerable variability in the correction factor and the abundance estimates in the replicate surveys. Sea otters are highly mobile and large groups of animals can influence the variation among transects considerably. Some of the observed variation in the population estimates of sea otters is due to the clumped distribution of sea otters within Yakutat Bay (e.g. many transects had zero animals and a few had high counts). There may have also been movement of sea otters in and out of the high density survey area from the outer Gulf of Alaska coast. During the 'replicate area count' of sea otters, a large group of otters ($n=120$) was observed off-transect. We believe most of the otters in a group of that size would have been observed within a transect during at least one of the other replicates (1-4), if present. Variation in the estimated correction factor also affects the adjusted population estimate; there were < 10 ISU's per replicate (range 2-7) which reduced the precision of the estimated correction factors. Of the two methods used to determine population estimates for the replicate area in Yakutat

Bay, averaging the adjusted population estimates is likely most defensible because it adjusts for detectability bias and does not assume a constant correction factor for all replicates.

The sea otter population has increased in abundance and expanded in range since the last complete survey of the area in 1987. The population within Yakutat Bay may be increasing due to immigration from the translocated population in Southeast or from the Prince William Sound-Controller Bay area. Simon-Jackson (1986) reports that the recolonization of Controller Bay was presumably by animals dispersing from the Prince William Sound stock. It is unclear whether sea otters now located in Yakutat Bay dispersed from the Controller Bay area, or from the translocated population of Cape Spencer, or established from the original 10 animals translocated to Yakutat Bay in 1966. Small translocated populations (<25-30 animals) are unlikely to establish themselves in a new area because the reproduction rate will likely be less than the mortality and emigration rates (Jameson et. al 1982). Therefore, it is likely that both the translocation and natural immigration have contributed to the sea otter colonization of Yakutat Bay.

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APPENDIX A: SAS computer programs were developed to determine sea otter population abundance estimates from line transect data (Bodkin and Udevitz 1996) for the Yakutat Bay area, Alaska 1995. The following programs (survey 1a, 2a, 2b, 2c, and 4c) were developed by Douglas Burn, USFWS, Marine Mammals Management in consultation with Mark Udevitz, Biological Resources Division, USGS. Documentation of specific program code occur within the text and are denoted by an asterisk.

APPENDIX B: Marine mammal distribution and minimum counts

Concurrent with the distribution surveys for sea otters, we recorded observations of any other marine mammals encountered in the Gulf of Alaska coast during August 1995 and 1996. The distribution surveys were designed to maximize the opportunity to observe sea otters and therefore were not optimum for detecting other marine mammal species. We likely missed species that inhabit off-shore areas. Haul-out areas and rookeries were not specifically surveyed unless they occurred within the survey boundaries set for sea otters. Interpretation of these incidental sightings is difficult because we did not follow a standardized, species-specific survey protocol. However, the information provides an index to marine mammal numbers in the near-shore areas between Cape Hinchinbrook and Cape Spencer during August of 1995 and 1996.

The following maps show the distribution and minimum counts of: Steller's sea lion (*Eumetopias jubatus*) $n = 575$, harbor seals (*Phoca vitulina*) $n = 246$, harbor porpoise (*Phocoena phocoena*) $n = 84$, and unidentified marine mammals $n = 2$.

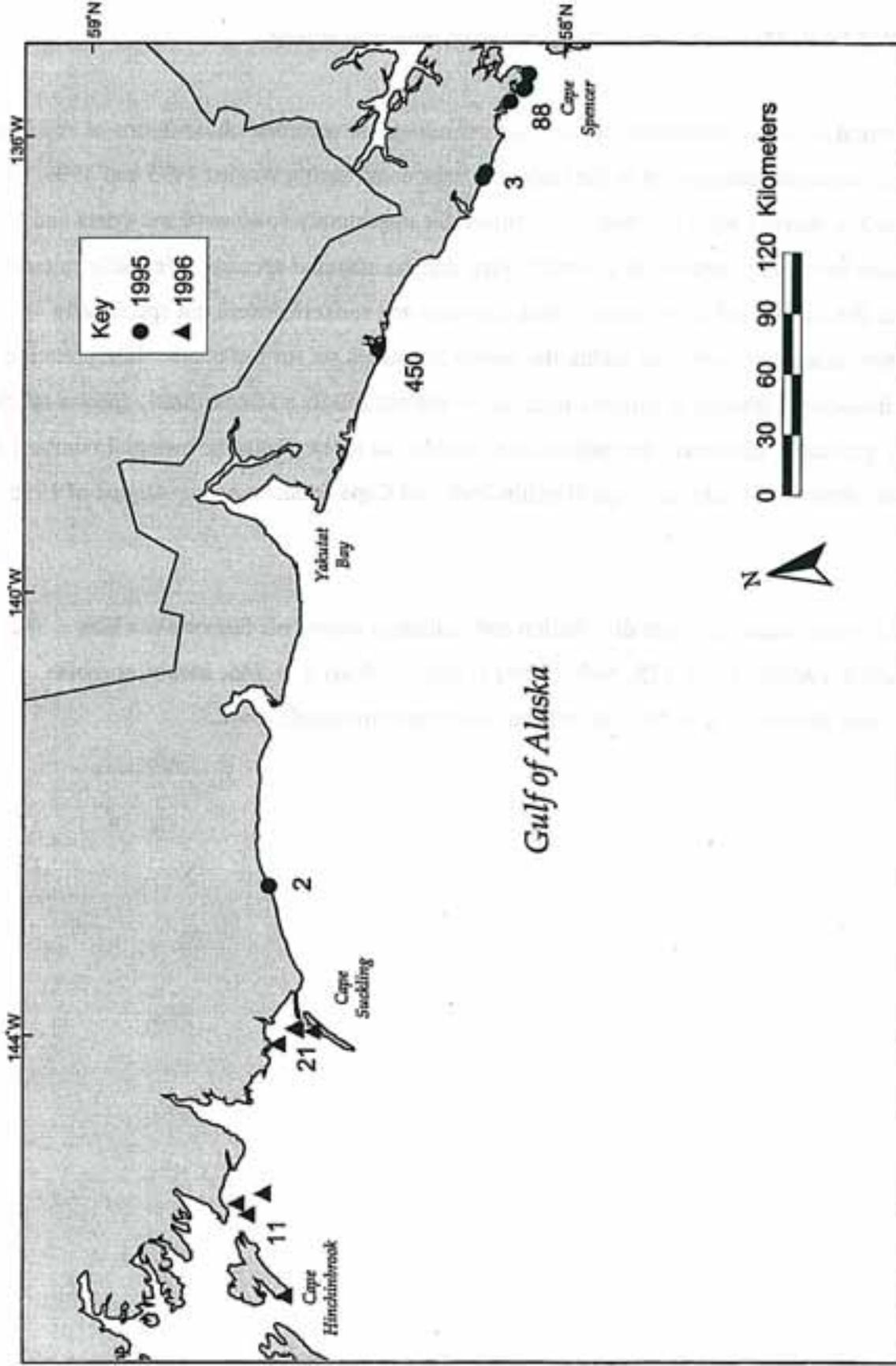


Figure B-1. The distribution and minimum counts of Steller's sea lions (*Eumetopias jubatus*) observed from Cape Hinchinbrook to Cape Spencer, Alaska, during aerial surveys conducted in 1995 and 1996. Each marker represents a sighting of one or more sea lions.

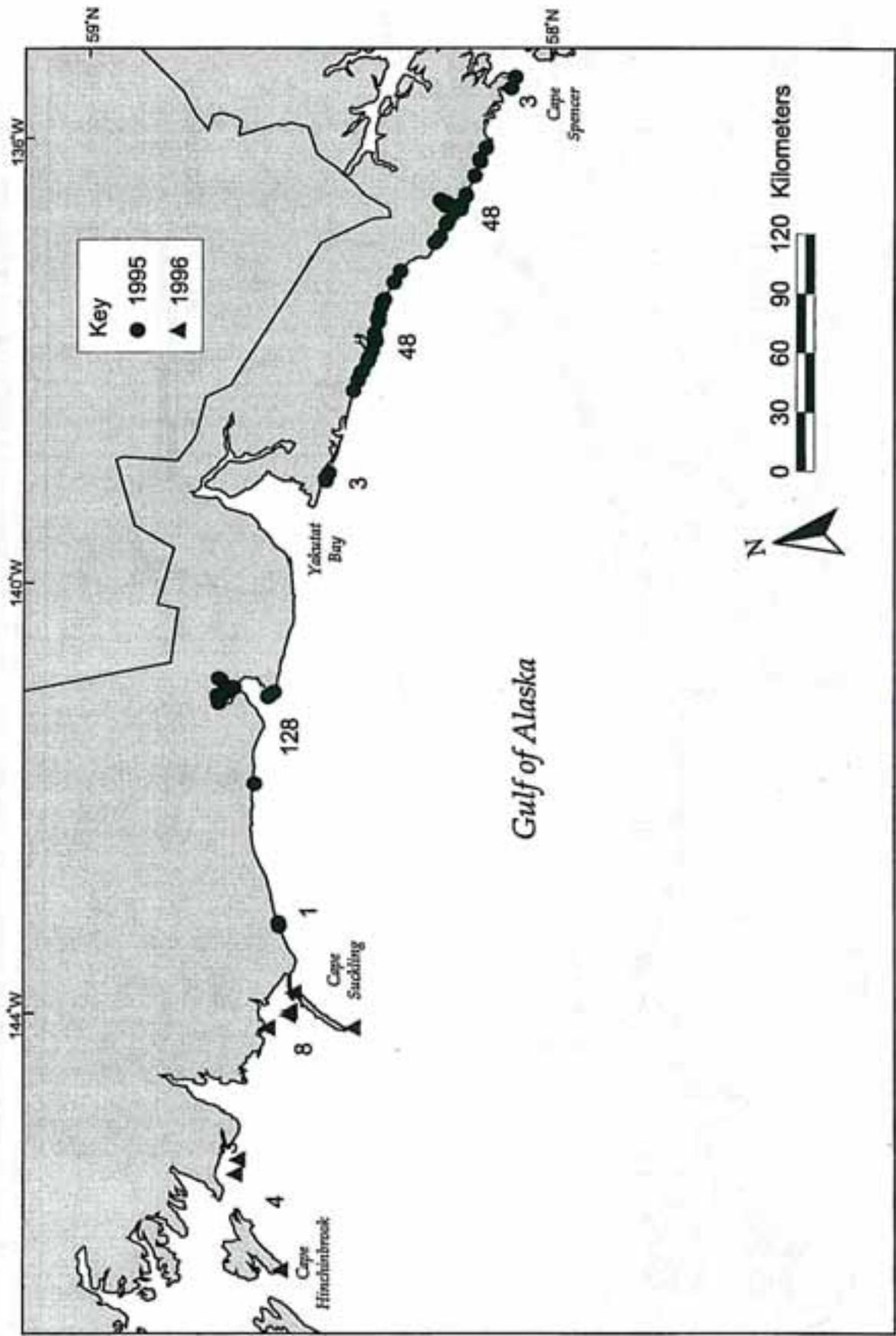


Figure B-2. The distribution and minimum counts of harbor seals (*Phoca vitulina*) observed from Cape Hinchinbrook to Cape Spencer, Alaska, during aerial surveys conducted in 1995 and 1996. Each marker represents a sighting of one or more seals.

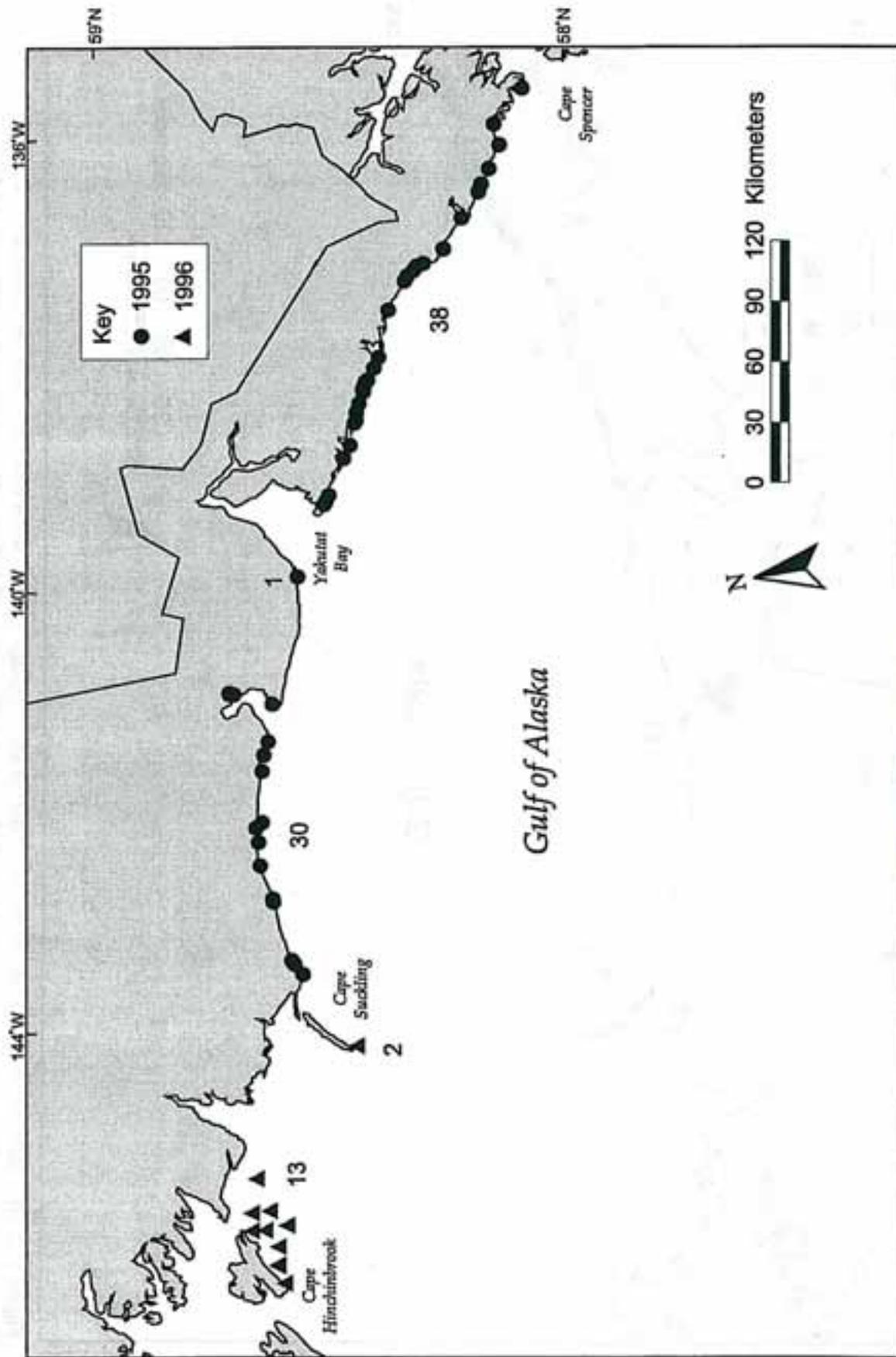


Figure B-3. The distribution and minimum counts of harbor porpoise (*Phocoena phocoena*) observed from Cape Hinchinbrook to Cape Spencer, Alaska, during aerial surveys conducted in 1995 and 1996. Each marker represents a sighting of one or more porpoise.

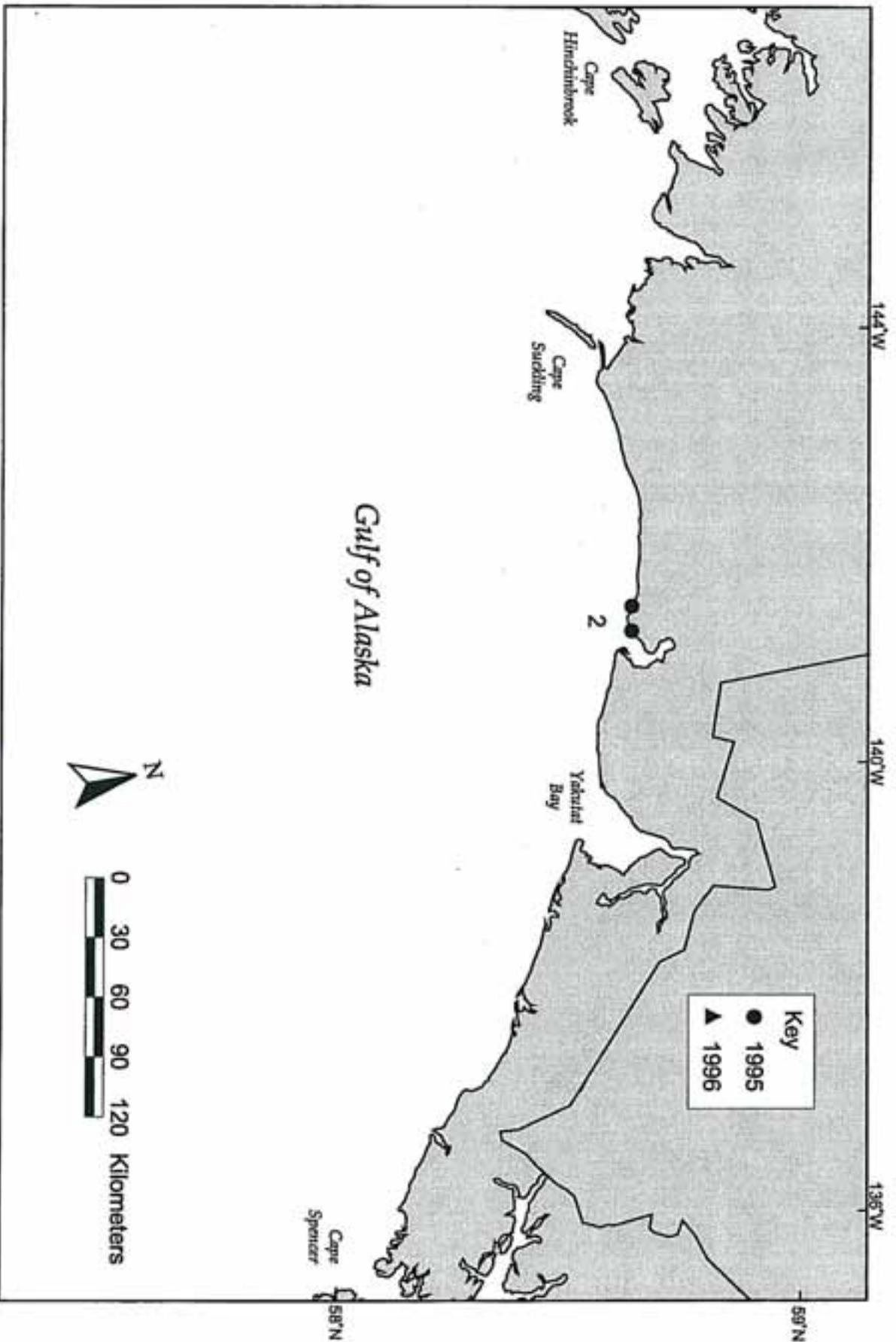


Figure B-4. The distribution and minimum counts of unidentified marine mammals observed from Cape Hinchinbrook to Cape Spencer, Alaska, during aerial surveys conducted in 1995 and 1996. Each marker represents a sighting of one or more animals.



This diagram illustrates the layout of a field or a technical structure. The various shapes and lines represent different components or sections. The overall arrangement suggests a complex system or a detailed plan of a specific area.