Exxon Valdez Oil Spill
Restoration Project Annual Report

Habitat Use, Behavior, and Monitoring of Harbor Seals in Prince William Sound, Alaska

Restoration Project 93046
Annual Report

This annual report has been prepared for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have not been addressed in this annual report.

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in Prince William Sound, Alaska

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Study History: Restoration Project 93046 continues the study effort initiated under Marine Mammal Study Number 5 (Assessment of Injury to Harbor Seals in Prince William Sound, Alaska, and Adjacent Areas) in 1989 through 1991. The project was reclassified as Restoration Study Number 73 (Harbor Seal Restoration Study) in 1992, and continued as 93046 (Habitat Use, Behavior, and Monitoring of Harbor Seals in Prince William Sound, Alaska) in 1993.

Abstract: Aerial surveys of harbor seals (*Phoca vitulina richardsi*) were conducted at 25 trend count sites in Prince William Sound (PWS) during pupping and molting in 1990-1993. Molting period counts at oiled sites were 51% lower than in 1993 than in 1988, compared to 11% lower at unoiled sites. Pupping counts for all sites combined were 23% lower in 1993 than in 1989. Harbor seals in PWS have not recovered since the *Exxon Valdez* oil spill. Satellite-linked time-depth recorders (SLTDRs) were attached to 20 harbor seals in PWS during 1991-1993. SLTDRs provided locations for 76% to 82% of the days they transmitted. Tagged seals moved an average of 5-10 km/day. Seals showed strong site fidelity, hauling out mostly at the locations where they were tagged and sometimes at another nearby location. One juvenile seal traveled to the Copper River delta and the Columbia glacier, then returned to the tagging location. Daily maximum dive depths for seals smaller than 50 kg were usually 100-130 m, compared to 130-150 m for larger seals. For all seals combined, 58% of the dives were less than 50 m.

Key Words: Aerial surveys, Alaska, *Exxon Valdez* oil spill, harbor seal, *Phoca vitulina richardsi*, Prince William Sound, satellite-tagging.

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EXECUTIVE SUMMARY

Harbor seals (*Phoca vitulina richardsi*) are common in Prince William Sound (PWS) throughout the year. Harbor seal habitats in PWS were directly impacted by substantial amounts of oil during the *Exxon Valdez* oil spill (EVOS). Damage assessment studies conducted during and after the EVOS showed that the spill had a measurable impact on harbor seals. It was estimated that 300 harbor seals died in oiled areas of PWS. The impacts of the EVOS on harbor seals are of particular concern since trend count surveys have indicated that the number of harbor seals in PWS declined by over 40% from 1984 to 1988, and similar declines have been noted in other parts of the northern Gulf of Alaska. Because of concerns for harbor seals, a restoration science study was designed to monitor their trend in numbers, and gather data on their habitat use and behavior.

Aerial surveys were conducted in 1990-1993 during pupping and molting periods at 25 trend count haulout sites that have been used for NRDA and other studies. Molting-period trend counts at oiled sites in 1993 were 51% lower than they were in 1988 prior to the EVOS, which compares to 11% lower counts at unoiled sites. This indicates that the harbor seal population has not recovered from damage caused by the EVOS. A comparison of 1993 counts with counts from 1989 indicates that the population is not recovering. Molting-period counts have decreased slightly (4% decline for all sites combined) but the trend was not statistically significant. Pupping-period counts have shown a significant declining trend (counts for all sites in 1993 were 23% lower than in 1989).

Satellite-tagging studies have been conducted since 1991. Four seals were instrumented with satellite-linked time-depth recorders (SLTDRs) during a pilot project in 1991, and 16 others during 1992 and 1993, 10 in the spring and 6 in the fall. In total, 12 were tagged at Seal Island, five at Applegate Rocks, and one each at Herring Bay, Bay of Isles, and Channel Island. SLTDRs deployed in spring were operational for about 60-70 days, and provided locations for 76% to 82% of these days. Tagged seals moved average minimum distances of 5-10 km/day. Seven of 10 seals tagged in spring 1992-1993 hauled out mostly at the tagging location, one hauled out at the tagging site and a nearby location with about equal frequency, and two others hauled out only at other locations. SLTDR sensor data indicated that most seals hauled out progressively more from May to July.

Depth histograms were recorded for over 64,000 dives. For all seals combined, 58% of the dives were less than 50 m, 39% were 50-150 m, and 3% were deeper than 150 m. More deep dives occurred in May than in June or July. Seals smaller than 50 kg made fewer deep dives than did seals larger than 50 kg. The usual maximum depth for small seals was 100-130 m, compared to 130-150 m for larger seals. In the Copper River Delta and near glaciers, most dives were to less than 50 m, whereas in central PWS and the Gulf of Alaska most dives were to greater than 100 m.

It is essential to continue to monitor the trend in abundance of PWS harbor seals through aerial surveys during pupping and molting. These surveys are inexpensive to conduct and provide valuable information about the numbers of pup and non-pup seals. In addition, satellite-tagging studies should be continued to learn more about movements, diving behavior, and haulout use

of harbor seals in PWS. These studies should be complimented by studies of disease, predation, and food availability in order to better understand their potential roles in limiting the recovery of harbor seals following the EVOS.

INTRODUCTION

Harbor seals, *Phoca vitulina richardsi*, are one of the most common marine mammal species in Prince William Sound (PWS), where they occur throughout the year. Harbor seals are seen primarily in the coastal zone where they feed, haul out to rest, give birth, care for their young, and molt (Pitcher and Calkins 1979). Hauling out areas include intertidal reefs, rocky shores, mud bars, floating glacial ice, and gravel and sand beaches. Pups are born at the same general locations that are used as haulouts at other times of year.

The exact number of harbor seals inhabiting PWS is unknown. The Sound has over 4,800 km of coastline, consisting of many fiords, bays, islands, and offshore rocks, and it is not feasible to survey every possible location where harbor seals might haul out. Based on harvest data, Calkins et al. (1975) estimated a minimum population of 13,000 in the early 1970s. Beginning in 1983, the Alaska Department of Fish and Game (ADF&G) began conducting repetitive aerial counts at selected haulouts to monitor population trend. Between 1984 and 1988, for unknown reasons, the number of seals at the 25 trend count sites in eastern and central PWS declined by 40% (Pitcher 1986, 1989).

On 24 March 1989, the T/V *Exxon Valdez* ran aground on Bligh Reef in northeastern PWS, spilling approximately 11 million gallons of crude oil. Some of the largest harbor seal haulouts in PWS, and waters adjacent to these haulouts, were directly impacted by substantial amounts of oil. Oil impacted seal habitat in the Gulf of Alaska at least as far to the southwest as Tugidak Island. Harbor seals were exposed to oil on land and in the water (Lowry et al. in press). In the early weeks of the spill, they swam through oil and inhaled aromatic hydrocarbons as they breathed at the air/water interface. On haulouts in oiled areas, seals crawled through and rested on oiled rocks and algae throughout the spring and summer. Pups were born on haulouts in May and June, when some of the sites still had oil on them, resulting in pups becoming oiled. Many pups nursed on oiled mothers. At haulouts throughout the oiled areas, seals were exposed to increased human activity in the form of air and boat traffic and cleanup activities.

Studies conducted as part of the Natural Resources Damage Assessment (NRDA) program documented a substantial impact of the spill on harbor seals (Frost and Lowry 1993). The decline in seal numbers from 1988 to 1989 was significantly greater at oiled than at unoiled sites, and pup production was reduced at oiled sites in 1989 (Frost et al. in press). Calculations indicated that about 300 seals died due to the spill, and that pup production was about 26% lower than normal.

Because of the decline in harbor seals, which was exacerbated in the area impacted by the EVOS, it is particularly important to try to determine what factors are limiting the population. Because seal numbers were declining before the spill, it cannot be assumed that the number of seals in oiled areas will return naturally to pre-spill levels. Therefore, continued monitoring of the population trend is needed to determine if recovery is occurring.

To facilitate recovery of seals in PWS it will also be necessary to identify and appropriately manage areas of particular biological significance. Most of the information on harbor seals in PWS consists of counts of animals on haulouts during pupping and molting. While those data are useful for monitoring changes in overall abundance, they provide little insight into the causes for the ongoing decline, nor are they adequate for designing conservation and management measures. Information is needed on site fidelity, movements between haulout sites, seasonal changes in hauling out patterns, habitats used for feeding, and feeding behavior.

Recently developed satellite-linked telemetry can be used to gather information on these important aspects of harbor seal biology. Miniature satellite-linked time-depth recorders (SLTDRs) have made it possible to monitor location and diving behavior of marine mammals (Mate 1987, 1989; Hill et al. 1987; Stewart et al. 1989; Lowry et al. 1994). The SLTDRs transmit to a circumpolar satellite-based positioning system that calculates locations from Doppler shifts in received signal frequency. These locations are used to track movements of animals. When combined with appropriate environmental sensors and microprocessor hardware and software, other information about an animal's environment and behavior can be transmitted to the satellite.

OBJECTIVES

The objectives of this restoration study have been:

1) to conduct aerial surveys of harbor seals at 25 trend count sites in PWS during pupping and molting;

2) to compare data from current surveys to data collected following the EVOS to determine whether seals numbers are recovering;

3) to describe hauling out and diving behavior, and by inference, feeding behavior of satellite-tagged seals in PWS relative to date, time of day, and tide;

4) to describe use of and frequency of movements between haulouts; and

5) to determine movement patterns within PWS and between PWS and adjacent areas.

METHODS

Aerial Surveys

Aerial surveys were conducted in PWS along a previously established trend count route (Calkins and Pitcher 1984; Pitcher 1986, 1989). The trend count route covered 25 haulout sites, and included 7 sites that were substantially impacted by the EVOS and 18 unoiled sites that were north, east, and south of the primary area impacted by oil (Table 1, Figure 1).

Survey methods were identical to those used during the NRDA harbor seal study (Frost and Lowry 1993). Surveys were conducted from a single engine fixed-wing aircraft (Cessna 180 or 185). Visual counts of seals were made of seals at altitudes of 150-300 meters, usually with the aid of 7 power binoculars. For larger groups (generally those of 20 or more seals) photographs were taken using a hand-held 35-mm camera with a 70-210 mm zoom lens and high speed film

(ASA 400). Color slides were commercially developed, and seals were counted from images projected on a white surface. During June surveys, separate counts were made of pups and non-pups. Replicate counts (usually 4-10) were made at each site.

Aerial surveys in 1989, 1990, and 1991 were conducted as part of NRDA Marine Mammals Study Number 5. Funding for harbor seal surveys in PWS in 1992 was provided by the National Marine Fisheries Service, National Marine Mammal Laboratory (NMML); the data are included in this report with their permission. Surveys in 1993 were funded as part of this restoration study.

Aerial Survey Data Analysis

Data were analyzed in order to determine whether there was an identifiable trend in the counts of harbor seals in PWS since 1989. For each year, daily surveys were averaged for each site and then sites were summed to produce yearly estimates for the oiled, unoiled, and total trend count areas. The 95% confidence interval was estimated by bootstrapping (Efron and Tibshirani 1993). The bootstrap method resampled with replacement from the actual daily counts at each haul-out site to produce a new data set with the same sample size (number of counts) for each site in each year. This resampling was done 2000 times for each year's data, and then the 2000 bootstrap estimates were ordered. Ordinarily, the 50th and 1950th ordered bootstrap estimates provide a 95% confidence interval, but as recommended by Efron and Tibshirani (1993), we used a bias-corrected version that slightly adjusted the choice of the ordered bootstrap estimates for the confidence interval endpoints.

A linear regression model was fitted to the 1989-1993 yearly estimates at oiled sites, unoiled sites, and for the trend count area as a whole. This was done for both pupping and molting counts. During the pupping period, only the counts of non-pups were used in the analysis. The regression line for each group took the form,

$$Y = \beta_0 + \beta_1(X)$$

where Y is the mean count/site summed for all sites, β_0 is the y intercept of the line, β_1 is the slope, and X is the year. The significance of regression coefficients was tested using analysis of variance (Snedecor and Cochran 1969).

Capture and Tagging of Seals

Before this study, researchers had never live-captured harbor seals in PWS, and efforts in 1991 were therefore focussed on developing the necessary techniques and equipment. SLTDRs were attached to a small number of seals to evaluate tag performance and to determine baseline values for variables such as depth of dive and dive duration. This information was used to program tags appropriately so that they gathered and stored the maximum amount of useful data. More substantial field efforts were conducted in 1992 and 1993.

Field work was conducted during April and September 1991, May 1992, and May and September 1993. Personnel were transported to the study sites aboard chartered vessels from either Valdez or Whittier. The primary area of operations was in central and western PWS.

Seals were caught by entanglement in nets set near their haulouts. Nets were approximately 100 m long and either 3.7 or 7.4 m deep with standard floats and lead lines. The size of openings ranged from 10 to 15 cm (20-30 cm stretch mesh). Nets were set from a 6-m Boston Whaler, as closely as possible to areas where seals were hauled out and where they were likely to become entangled as they went in the water in response to the presence of people and boats. A 5-m Whaler and a 4-m Zodiac raft were used to help set and tend the net. When seals became entangled they were brought into the boats, cut free from the tangle net, and put into hoop nets (large stockings made of 1 cm mesh soft nylon webbing). Seals were usually taken to shore to be worked on, but because of darkness and weather they were sometimes processed on boats.

In some cases seals could be physically restrained during handling and tagging. Larger animals were sedated with a mixture of ketamine and diazepam administered intramuscularly at standard doses (Geraci et al. 1981). Each seal was weighed, measured, and tagged in the hindflippers with individually numbered plastic tags. Approximately 50 cc of blood was drawn from the extradural intervertebral vein. Whiskers of some seals were taken for stable isotope analysis. Skin samples were taken for genetic analysis.

Larger seals were selected for attachment of satellite-linked SLTDRs, which were glued to the mid-dorsal surface of the seal using Devcon quick setting epoxy (Fedak et al. 1984; Stewart et al. 1989). Some seals were also equipped with small VHF radiotags that were either glued on the top of the head or attached to a flipper tag.

The SLTDRs were manufactured by Wildlife Computers (Redmond, WA). Tags used in 1991 were 1.0 watt units that measured 13.5 x 12.5 x 3.8 cm and weighed about 1050 g. In 1992 and 1993 tags produced 0.5 watts, measured 14.8 x 10.0 x 3.8 cm, and weighed about 750 g. Both types of tags were powered by four lithium C cells.

SLTDRs were equipped with conductivity and pressure sensors, and built-in programmable microprocessors that collected and summarized data for periods when animals were diving and stored it for later transmission, as has been done for spotted seals (*Phoca largha*), crabeater seals (*Lobodon carcinophagus*) and Steller sea lions (*Eumetopias jubatus*) (Lowry et al. 1994; Hill et al. 1987; R. Merrick, personal communication). Data were stored in six hour blocks (0300-0900 hrs, 0900-1500 hrs, 1500-2100 hrs, and 2100-0300 hrs local time) and transmitted to the satellite once the six hour period was complete. Data from four periods were stored in memory providing at least a 24-hour window for transmission before the data were lost. Dive data were initially summarized as histograms in depth bins of 4-10 m, 11-50 m, 51-100 m, 101-150 m, 151-200 m, and >200 m, and duration bins of 0-2 minutes, >2-4 minutes, >4-6 minutes, >6-8 minutes, >8-10 minutes and over 10 minutes. Beginning in fall 1991 depth bins were changed to 4-20 m, 21-50 m, 51-100 m, 101-150 m, 151-200 m, and over 200 m. Four of the SLTDRs deployed in September 1993 were equipped with new software that allowed data to be stored in 10 bins. Settings used on those units were: 4-20 m, 21-50 m, 51-75 m, 76-100 m, 101-150 m, 151-200 m, 201-250 m, 251-300 m, 301-350 m, and over 350 m; and 0-2 minutes, >2-4 minutes, >4-6 minutes, >6-8 minutes, >8-10 minutes, >10-12 minutes, >12-14 minutes, >14-16 minutes, >16-18 minutes, and greater than 18 minutes. The new software also collects and reports the amount of time in the six hour periods that the seal spent in each of the specified depth ranges.

Each SLTDR transmitted information to a National Oceanic and Atmospheric Administration polar-orbiting satellite whenever the seal was hauled out or when it surfaced sufficiently long for transmission to occur, and the satellite was positioned such that it could receive the signal. A transmission that is successfully received by the satellite is referred to as an uplink.

Satellite Tag Data Analysis

Data were obtained from Service Argos. The Argos system recorded date and time of each uplink and calculated a location for the SLTDR based on Doppler shift whenever sufficient signals were received during a satellite pass. The accuracy of location calculations varies based in part on the number of uplinks that occur during a satellite pass. Service Argos assigns a quality ranking to location information. This rank is based on predicted accuracy, which suggests that for the best data (assigned quality number 3) predicted locations are expected to be within 150 m of actual locations 68% of the time. Locations that are based on few uplinks or have other potential problems are assigned quality 0. For this study, quality 0 locations were used principally to provide approximate positions of seals on days when no quality 1-3 fixes were obtained. When only one uplink occurred during a satellite pass, sensor data were recorded but no location was calculated. Stewart et al. (1989) and Mate (1987) provide additional description and analysis of the Argos system and its application to marine mammal tracking.

For analysis and presentation of data, dates and times reported by Service Argos were converted to true local time from Greenwich mean time by subtracting 10 hours. The correction we used for true local time is not equivalent to the corrections normally used for Alaska standard time (-9 GMT) or Alaska daylight savings time (-8 GMT). However, the minus 10 correction accounts for the actual position of the sun, and makes mid-day occur at approximately 1200 hours.

Custom computer software was developed for checking, compiling, and analyzing SLTDR data. The first step in analysis of location data was to screen out erroneous locations based on the apparent speed of the seals. To do this, the time, distance, and speed between each sequential pair of fixes were calculated for all location records obtained. A three-stage process was used to flag records that produced improbable movements: 1) apparent speeds of greater than 10 km/hr for a period of greater than 5 minutes (Davis et al. 1985); 2) apparent speeds of greater than 100 km/hr for a period of greater than 1 minute; and 3) apparent speeds of greater than 500 km/hr for any length of time. Flagged records were inspected visually, and the locations that were most distant from adjacent records were removed from the database. When all suspect records had been removed, distances and speeds between adjacent records were recalculated. Numbers of location records referred to in this report include only those records that remained after the screening process.

With each transmission, SLTDRs reported the seals as hauled out or at sea based on the status of conductivity sensors. A datafile was created that indicated the times when sensors indicated that haulouts began and ended. A program was developed to calculate the apparent duration of each haulout and at sea period, and to compile these data for monthly and bi-monthly periods. Seals that were hauled out when a satellite was above the horizon, went into the water and remained there when no satellite was overhead, and hauled out again when a satellite came back into view, would have been classified as hauled out for the entire period. Because of problems with the 1.0 watt SLTDRs, no usable land-sea sensor data were obtained in 1991.

The land-sea sensor data were merged with location records to produce a datafile that included SLTDR number, date, time, latitude, longitude, location quality, and whether sensors indicated that the seal was on land or at sea. A computer program was written that calculated from this datafile the average location of the seal during each haulout bout and the average daily position for at sea locations. The program also calculated the distance between each sequential pair of average positions. Only fixes with location qualities 1-3 were used in this analysis, and the result was saved as an average position datafile.

The all-location and average-position datafiles were used to produce geographic information system (GIS) coverages in ARCINFO, and datasets were selected and displayed using ARCVIEW. Figures shown in this report are from the all-location datafiles, and use only location qualities 1-3 to reduce clutter. Average position datafiles were used to determine the specific locations where seals hauled out. The locations of haulout bouts were displayed on the screen and each was assigned to the nearest known seal haulout site. If a location plotted more than 5 km from any known haulout, or if it was approximately equidistant between haulouts, the location of that haulout bout was categorized as unknown.

Dive data from Wildlife Computers tags were initially extracted using software provided by the manufacturer. An error-checking algorithm was used to validate messages. Histogram messages were sorted by date, period, and type, and duplicate messages were removed. In addition, this software extracted status messages which provided information about battery voltage and maximum depth of dive. Custom software was developed to sum dive information by month, and within months by bin and by period.

Dive count data, in addition to the land-sea data files, were used to estimate the proportion of time a seal hauled out. For each six-hour bin that data were received, the SLTDR reported the total number of dives made by the seal. We considered the seal hauled out if it made five or fewer dives in a period, and estimated the proportion of time hauled out by comparing the number of periods with five or less dives to the total number of periods for which data were received. This method provides a first approximation of the proportion of time hauled out, but the result is undoubtedly an underestimate since seals that hauled out only for partial periods (and therefore made more than five dives) were not included.

Because SLTDRs attached in September 1993 are still operational, it was not possible to completely analyze the data received from them. Results of preliminary analysis of location information received through 31 December 1993 are included in this report. SLTDRs deployed in September 1993 reported histogram data in a different format. The software to extract this modified histogram data has not yet been completed by the manufacturer, and therefore dive data for these SLTDRs are not included in this report.

RESULTS

Aerial Surveys--Molting

Molting period surveys were conducted in 1984 and 1988 (Pitcher 1986, 1989; Appendices A,B), and have been done annually since the EVOS (Table 2; Appendices C-G). The surveys included 25 major haulout sites in eastern, northern, and central PWS. Counts were also made in 1983, but they were not considered by observers to be of the same quality as later surveys (J. Lewis, personal communication) and therefore are not included in this analysis.

For the molting period at all sites combined there was a 41% decline in mean counts from 1984 to 1988, or approximately 12% per year. Molting counts dropped further between 1988 and 1989, especially at the oiled sites (43% at oiled sites and 11% at unoiled sites), and by 1989 the trend area counts were 55% lower than in 1984. Since 1989, the overall decline in counts made during the molting period appears to have stopped and seal numbers appear to have stabilized. However, as of September 1993, counts in the trend count area as a whole were 27% lower than they were in 1988 and 57% lower than in 1984.

The greatest change in seal counts (-43%) occurred from 1988 to 1989 at oiled sites (Table 3). A comparison of 1988 counts with those made in 1993 shows that counts at oiled sites remain 51% lower than they were before the spill, compared with 11% at unoiled sites. Since 1989, counts for the trend count area as a whole have varied from year to year by 1%-24%, but they have not consistently increased or decreased. When 1993 counts are compared to 1989, mean counts at oiled sites were 14% lower, counts at unoiled sites were identical, and counts for the trend count route as a whole were 4% lower.

Regression analysis of counts made during the molt in 1989-1993 indicated no significant trend during this period at either oiled sites ($R^2=0.11$, $P=0.58$), unoiled sites ($R^2=0.01$, $P=0.90$), or all sites combined ($R^2=0.06$, $P=0.68$) (Figure 2).

Aerial Surveys--Pupping

Before 1989, there had been no counts of seals in PWS during pupping. Following the EVOS, ADF&G conducted aerial surveys during pupping in 1989-1993 (Table 4; Appendices H-L). Mean and maximum counts for each site in each year are shown in Table 4.

During 1993, three surveys occurred in early June and three others during the third week in June. By the time of the later surveys, pups were much larger and more difficult to distinguish from adults. In fact, surveys were terminated because of the difficulty in distinguishing pups from non-pups. An examination of pup/non-pup ratios for the early and late surveys indicates a marked difference. Thirty-two pups/100 non-pups were counted during 7-9 June, compared to 27 pups/100 non-pups during 20-22 June. The early June pup counts were considered more representative and were used for annual comparisons of pup production in 1993.

With the exception of 1989, when pup production in the oiled area was less than in the following years, the ratio of pups to non-pups has been relatively stable at 32-37 pups/100 non-pups in the oiled area and 17-21 pups/100 non-pups in the unoiled area (Table 5). During 1990-1993, pup production has ranged from 24-29 pups/100 non-pups for the trend count area as a whole.

Although the proportion of pups at the trend count sites has been relatively stable since 1990, the mean counts of non-pups and pups have declined substantially (Table 5). In the trend count area as a whole, there has been a 23% decline in the number of non-pup seals since 1989 (based on the overall mean for early and late June surveys) and a 20% decline in the number of pups (based on the early June counts). At unoiled sites, the mean counts of non-pups declined steadily from 1989 through 1992 and then increased somewhat in 1993, with 34% fewer non-pup seals at the unoiled sites in 1993 than there were in 1989. In the oiled area, June 1993 counts were approximately 5% lower than in 1989.

Regression analysis of counts made during pupping in 1989-1993 indicated a significant decline in the number of non-pups in the trend count area as a whole ($R^2=0.78$, $P=0.05$) (Figure 3). The decline occurred principally at unoiled sites, but the trend for those sites was not statistically significant ($R^2=0.72$, $P=0.17$). There was no trend in non-pup counts at oiled sites ($R^2=0.25$, $P=0.39$).

During pupping-period aerial surveys in 1992 and 1993, satellite-tagged seals were present in the trend count area. There were four instrumented seals during the surveys in 1992 and six in 1993. For these seals, we examined land/sea sensor data to determine whether the seals were hauled out or at sea during the time the surveys were flown. Because it was not always possible to determine land/sea status at the time of the surveys (satellite coverage is not continuous), land/sea status could be determined for only 44% of the surveys in 1992 and 67% of the surveys in 1993 (Table 6). For the instances when haulout status could be determined, data indicated that satellite-tagged seals were hauled out during 16 of the 31 periods when surveys were conducted (52%).

Capture and Tagging of Seals

Forty-five harbor seals were captured during April and September 1991, May 1992, and May and September 1993 (Table 7). During April 1991 field work, weather was generally cold and windy, with rain and snow, and conditions frequently prevented any seal capture attempts. On 19 April four seals were caught at Seal Island, and the two largest animals were instrumented with SLTDRs and VHF tags. During September 1991 field operations, five seals were captured and two were tagged with SLTDRs.

Because the cold and stormy weather we experienced in April 1991 greatly reduced the amount of time we could work, 1992 capture operations were conducted in mid-May. Two problems were encountered during 1992. First, the pupping period began shortly after we started work, and we sometimes could not set the net because we did not want to capture pups or their mothers. Second, many seals seemed to be able to detect the net and escaped by swimming under the lead line or over the float line. Eight seals were captured. Four were large enough to tag with SLTDRS; all of them were caught in one set at Applegate Rocks on 17 May.

During 1993, procedures were modified somewhat based on experience gained in 1991 and 1992. Spring capture operations were scheduled for early May 1993, which eliminated the problem of encountering newborn pups. New capture nets were constructed using panels of varying colors (light blue, dark blue, light green, and dark green), 30-cm stretch mesh webbing, foam-core float line instead of floats, and lighter lead line. Modifications were also made to the small boats to enable the nets to be set more quickly. These changes enhanced our ability to catch seals. Twenty-eight seals were caught in 1993; six were equipped with SLTDRs in the spring and six in the fall.

The 20 seals to which we attached SLTDRs during 1991-1993 were captured at the following locations: Seal Island-12; Applegate Rocks-5; Herring Bay-1; Bay of Isles-1; and Channel Island-1 (Table 7). Of those, 11 were adult males, 4 were subadult males, 4 were adult females, and 1 was a subadult female. In the remainder of this report, tagged seals will be referred to by the SLTDR number shown in Table 7.

SLTDR Performance

Performance of the 1.0 watt SLTDRs used in 1991 was very erratic (Table 8). Only 14 location fixes were received for 14096 over the 68 day period from 21 April through 25 June. A limited amount of dive depth and duration data was transmitted. Twenty location records were obtained for 14097 during 24-26 April, and no transmissions were received thereafter. It transmitted no dive depth data, and durations were reported for only 31 dives. SLTDR 11466 was operational for only four days after attachment. It transmitted dive data for each day but provided only eight location fixes, all on 12 September. SLTDR 11467 produced the most location information of any unit attached in 1991, with 86 fixes obtained during a 28 day period. However, dive data were received only during 13-15 September.

Because seals 14096 and 14097 were also equipped with VHF radio transmitters it was possible to verify their status and location from aircraft and boats. During the period from late April through late June they were regularly hauled out at Seal Island, especially at low tide (K. Frost, unpublished; S. Rainey, personal communication). With the aid of the VHF transmitters both seals were located and observed from boats on 23 May. At that time the SLTDRs appeared to be attached properly and undamaged (J. Lewis, personal communication).

In 1992 we began using newly developed 0.5 watt SLTDRs, and reliability improved greatly (Table 8). All units provided information on depths and durations of dives. The four units attached in May 1992 operated for an average of 60.2 days, with individual SLTDRs providing 94-247 locations. On average, locations were determined for the seals on 67% of the days the transmitters were operational. In May 1993, tags were attached about 9 days earlier in the season than in 1992, and they lasted on average about 10 days longer (70.7 days). They provided more total location records (mean total per seal of 246 in 1993 versus 158 for 1992), and gave location information for the seals on 82% of the days that the transmitters operated.

The SLTDRs attached in September 1993 were all still operational as of 31 December. As of that time the SLTDRs had been operational for 104-107 days.

Movements of Seals

Two seals tagged in April 1991 (14096 and 14097) and one seal tagged in September 1991 (11466) were almost always located near Seal Island (Figure 4). Seal 14096, which we tracked from 21 April through 20 June, moved from Seal Island to a bay on northeast Knight Island. Seal 11467 was tagged and released in Herring Bay on 12 September 1991, and four location fixes were received from near the tagging location during the morning of 13 September. The next location obtained was on 15 September, at which time the seal was in College Fiord after having travelled a minimum distance of 90 km (Figure 4.). Numerous location fixes were obtained during 15-22 September, all of which indicated the seal was in the upper part of College Fiord, usually near the Yale Glacier. No locations were obtained on 23 September, then on 24 September the seal was again located in Herring Bay. Subsequent location fixes indicated that it remained in Herring Bay until the last transmission was received on 8 October.

The four SLTDRs put on seals in May 1992 provided a total of 632 locations over periods ranging from 52 to 69 days (Figures 5-8). All four seals were captured in central Prince William Sound at Applegate Rocks. The activities of two of the animals (3086 and 3088) were concentrated in the area of capture during May-July (Figures 5 and 7). Seal 3086 made several trips to Bay of Isles, and was also located on the west side of Knight Island. After being tagged, seal 3087 spent most of its time south of Applegate Rocks (Figure 6). During 11-15 June, it was near Little Green Island, and from 19-30 June it was in southern Montague Strait near the south end of Latouche Island. On 7 July, 3087 had moved back northward, and it was near Channel Island until signals stopped on 11 July. Seal 3089 ranged quite widely (Figure 8). It moved northward after being tagged and was near the Columbia Glacier during 21-23 May. It then moved southeastward out of PWS and from 26 May-5 June it was located several times off the Copper River Delta. On 9 June 3089 was in Hinchinbrook Entrance, then from 12 June through 18 July it was again off the Copper River Delta. On 21 July the seal had returned to Seal Island where it remained until the last location on 24 July.

The six SLTDRs attached in May 1993 provided a total of 1,476 locations over periods ranging from 39 to 86 days (Figures 9-14). After seal 2282 was released at Seal Island on 7 May it was next located on 9 May at the head of College Fiord, a minimum swimming distance of 120 km from the tagging site (Figure 9). It remained in College Fiord until 12 May, then moved back to central PWS where it was located near Seal and Naked islands. It then returned to College Fiord and remained there during 1-5 June. After early June, all relocations were in central PWS, until the last location on 28 July at Seal Island. Seal 2283 spent most of its time near where it was tagged on Seal Island (Figure 10). It made one trip to northeastern PWS and was located near the Columbia Glacier during 9-19 May. Seal 2287 did not move out of central PWS, with all locations in the area between Seal Island and Naked Island (Figure 11). Seal 2240 was tagged at Applegate Rocks, and moved between there and Seal Island during 10-22 May (Figure 12). No locations were received from 22 May until 28 May at which time the seal was at Middleton Island, having moved a minimum distance of 140 km (assuming it left PWS through Hinchinbrook Entrance). It was back in PWS on 1 June and remained there until the last location on 1 August at Applegate Rocks. Seal 11040 was near the tagging location at Seal Island during 9-19 May and 5 June-7 July (Figure 13). However, during 20 May-1 June it was located about 120 km south of there in open water of the Gulf of Alaska. Seal 11042 was tagged at Seal Island and never moved far from there during the period from 9 May to 25 July (Figure 14).

As of 31 December 1993, the six SLTDRs attached in September 1993 had produced 2,020 location records (Figures 15-20). Three of the four seals tagged at Seal Island (2280, 2282, and 2287) remained very near the tagging location (Figures 15, 17, and 19). Seal 2282 made occasional short trips to Applegate Rocks. Seal 2284, however, ranged widely (Figure 16). It was at Seal Island after tagging until 20 September, then moved to the Columbia Glacier and stayed there 22-24 September. From 27 September through 11 October it was back at Seal Island, then it again moved to the Columbia Glacier and stayed there through 12 November. After that it alternated periods at the Columbia Glacier (18-29 November, 3-9 December, and 14-28 December) with trips to the southwest as far as Lone and Perry islands (13-16 November, 30 November-2 December, 10-13 December, and 30-31 December). Seal 2283 tagged at Channel Island and seal 5039 tagged at Bay of Isles did not move far from their tagging locations (Figures 18 and 20).

Movements of satellite tagged harbor seals are summarized in Table 9. Eight seals did not move far from the area where they were tagged in central PWS. Two made movements to glaciers at the head of College Fiord and three moved to the Columbia Glacier. Three moved out of PWS, one to the Copper River Delta, one to Middleton Island, and one to the Gulf of Alaska south of Montague Strait. Not counting the six transmitters that were still operating on 31 December 1993, 10 out of 14 seals were at the location where they were tagged when the last transmissions were received, and the other 4 were at haulouts nearby.

The distances that seals moved during the period they were tracked ranged from 288 to 816 km, with average daily rates of 5.4 to 10.6 km/day Table 10). These are minimum distances because they are based on straight line distances between haulout locations and average daily positions at sea. The highest daily rates were for seals that moved to glaciers in northern PWS (2282 and 2283) and to the Copper River Delta (3089).

Haulout Behavior

Seals tagged in May 1992 were all captured at Applegate Rocks. For two of these seals (3086 and 3088), 70-86% of the haulouts for which location was known were at Applegate Rocks. They only occasionally used other nearby haulout sites (Table 11). For the other two seals, there were no haulouts recorded at Applegate Rocks. Seal 3087 hauled out mostly at Danger Island and Channel Island. Seal 3089 ranged widely and apparently did not haul out very frequently.

The single seal tagged at Applegate Rocks in May 1993 (2240) mostly hauled out at that location (Table 12). Two of the seals captured at Seal Island (11040 and 11042) hauled out only at Seal Island. The other three (2282, 2283, and 2287), hauled out 15-56% of the time at other locations. One of the latter seals (2282) hauled out at Agnes Island (near Naked Island) as often as at Seal Island, while another (2287) was at Smith Island on 29% of its known location haulouts.

Using the land-sea sensor data, we estimated that the 10 satellite-tagged seals spent 39% of their time hauled out, for all months combined, with a range among individuals of 22% to 57% (Table 13). Seals spent an average of 22% of the time hauled out in May (range 1%-36%), 43% in June (range 26%-73%), and 54% in July (range 6%-80%). The average proportion of time hauled out was quite similar in 1992 and 1993. Although there was considerable individual variation, all seals except one spent more time hauled out July than in May. This seal was an adult female that we classified as pregnant at the time of tagging. She spent most of her time on land or in very shallow water in late June, suggesting they she may have been attending a pup. It is possible that the 15-day period in early July when no data were received represented a feeding bout following the weaning of her pup.

When we estimated of the proportion of time hauled out based on the number of 6-hour periods with 5 or fewer dives, these bin data indicated that the 10 seals on average were hauled for 31% of the time (Table 14). There was no clear trend for seals to be hauled out more in any one month.

Diving Behavior

Depth of dive histogram information was received summarizing 64,843 dives (20,253 in 1992 and 44,590 in 1993) made by seals during the period from May to August. For the 10 seals combined, 40% of the total dives were to depths of 20 m or less and 58% to depths of 50 m or less. Only 3% of the dives were to depths greater than 150 m (Figure 21). In both 1992 and 1993 most dives were in the 4-20 m depth range, but in 1993 there were more dives to depths greater than 100 m. Three of the four seals tagged in 1992 were small subadults. The six seals tagged in May 1993 were all adults.

In general, the proportions of dives in the different depth bins were similar during May-July (Figure 22). For each of the three months, 56-61% of the total dives were to 50 m or less, 38-39% were 50-150 m, and 1-5% were greater than 150 m. Most (75%) of the dives deeper than 150 m were made in May and the fewest deep dives were made in July (6%). Future analyses will examine individual variability among seals.

The sample size is too small to allow statistically meaningful comparisons by age group and/or by sex. However, it appeared that the three seals smaller than 50 kg did not dive as deep as seals larger than 50 kg. Only 19 of the 18,603 dives (0.1%, range 0-0.4%) recorded for small seals were deeper than 150 m, compared to 1,946 of 46,215 (4%, range 0.5-14.0%) of the dives for seals larger than 50 kg.

Dive data were summarized by four 6-hr periods each day, corresponding approximately to morning (0300-0900 h), mid-day (0900-1500 h), evening (1500-2100 h), and night (2100-0300 h) (Figure 23). The distribution of dives among these four periods was similar for the 10 seals combined, with 22-28% of the dives occurring in each period.

For some seals, it was possible to determine the general location where dive data were collected, and thus to examine the effects of location on dive depths (Table 15). We compared diving behavior of seals when they were near glaciers (Columbia Glacier or College Fiord); near the

Copper River delta; near islands in central PWS; and offshore in the Gulf of Alaska (near Middleton Island or south of Montague Island). Seals near Seal, Smith, and Agnes islands and in the Gulf of Alaska generally made more dives deeper than 100 m. Twenty-six percent (range 5-44%) of the total dives by seals near the islands and over 50% (range 31-59%) of the dives in the Gulf were deeper than 100 m. In contrast, only 6% (range 0-9%) of the dives of seals near glaciers and none in the Copper River delta were deeper than 100 m.

The maximum depth of dive was recorded for each seal for each day that data were received by the satellite (Tables 17, 18). The deepest dive was 404 m by an 87 kg male in College Fiord during early May 1992. Dives to maximum depths of greater than 200 m were also made by the same seal in early June when it was again in College Fiord. All seals instrumented during spring 1993 dove to depths of greater than 200 m on several days, but maximum depths were usually less than 200 m. On 54% of the days for which we received data (n=267 for all seals) maximum dive depths were 130-170 m. For the remaining days, approximately half had maximum depths of greater than 170 m and half of less than 130 m. All of the seals tagged in 1993 were considered to be adults. Maximum dive depths of the three juvenile males tagged in 1992 were markedly different; dives exceeded 130 m on only 12% of the data days (n=105) and 200 m on only one day. Maximum dive depth on most days was 100-130 m (39% of all data days).

DISCUSSION

Trends in Numbers of Seals

In the mid-1970s harbor seals were abundant in PWS and the Gulf of Alaska, and the population was considered healthy (Pitcher and Calkins 1979). Approximately 4,000 seals were counted in PWS during a June 1972 helicopter survey (Pitcher and Vania 1973). A minimum population of 13,000 harbor seals was later estimated based on a reported annual harvest of 2,500, annual recruitment of 20%, and no obvious decline while harvest was occurring at this level (Calkins et al. 1975). No counts that covered the entire PWS were conducted from 1973 until 1991, when molting-period surveys of the trend count route (this study) were conducted simultaneously with surveys in northern and western PWS (Loughlin 1992). A minimum of 2,500 hauled out seals were counted on those surveys combined.

The only other systematic counts that we know of in PWS were conducted during 25 August-10 September 1978 at Channel Island (L. Smith/ADF&G, unpubl.). The mean of 22 counts made at low tide by a ground-based observer was 300 (range 95-667, s.d 163.5). This is not significantly different than the mean count of 283 (range 59-501, s.d. 147.9) for trend count surveys at Channel Island in 1984 ($t=0.273$, $df=28$. $p>0.7$). Between 1984 and 1993, the magnitude of the decline at Channel Island (58%) was similar to the overall decline at the trend count sites (57%). We do not know whether trends in seal abundance at Channel Island and for the trend count as a whole also were similar prior to 1984. If they were, this suggests that seal numbers in PWS may have been relatively stable in the late 1970s and early 1980s, followed by a substantial decline during 1984-1989.

Results of trend count surveys since 1989 suggest different trends for pupping and molting periods (Table 19, Figures 2,3). No trend for either oiled or unoiled sites, or for the trend count area as a whole, is evident during the molting period. In contrast, pupping-period surveys suggest a continuing decline, with 1993 counts of non-pups 23% lower than counts in 1989. The number of pups also has declined by 20%. At this time it is not clear whether counts during molting or pupping provide the most accurate indication of the overall trend in numbers for this area. It is cause for concern, however, that counts during the reproductive period have declined.

Recent declines in harbor seal numbers have also been documented in other parts of the northern Gulf of Alaska (Hoover-Miller 1989; Pitcher 1990, 1991; Loughlin 1993), and harbor seals are now much less numerous than they once were. Although the exact number of seals in the area is not known, trend counts indicate the declines are on the order of 60%-90%.

Habitat Use and Behavior on Land

The SLTDRs we attached to harbor seals in PWS have produced new information about where seals haul out. The general tendency for seals tracked in spring-summer 1992 and 1993 was for them to spend most of their time in central PWS (Table 9). Three of 10 seals moved out of PWS to the south or southwest, but all of them returned. Two seals moved to glaciers in northern PWS. None of the tagged animals spent any time in the large bays and fiords of eastern or western PWS. Seven of the 10 seals hauled out mostly at the location where they were tagged, one used the tagging site and another nearby haulout equally, and two used only other haulout sites (Tables 11 and 12). Preliminary analysis of data from September-December 1993 indicates that seals tracked during fall and winter also tended to remain close to the sites where they were captured. This is similar to the results obtained by Pitcher and McAllister (1981) for harbor seals radio-tagged on Tugidak Island, where individual animals showed considerable fidelity to one or two specific haulout sites.

We used two methods to estimate the proportion of time the tagged seals spent hauled out. A comparison of these estimates, derived from the land/sea sensor data and from the dive count data, revealed that for some seals and in some months the estimates were similar, while for a few they differed by 50%-60% (Table 14). Neither method resulted in consistently higher or lower estimates.

We consider neither of these methods to be satisfactory. When land/sea sensor data were used, the amount of time hauled out was almost certainly overestimated and the time at sea underestimated. This is because the signal from a hauled out seal will almost always be received when a satellite is overhead, whereas a seal in the water may be under water or bobbing at the surface with only its head above water and therefore not transmitting a signal.

At the latitude of PWS, there are only about 10 satellite passes per day by each of the two satellites that ARGOS monitors, and each pass lasts 15 minutes or less. For each satellite, there is a continuous 4-7 hour block daily when no satellites pass over PWS. Although the periods without coverage are offset somewhat, there remains a 3-5 hour period with no satellite coverage. Using the land/sea sensor method described above, whatever the status was just prior to the break in satellite coverage will be assumed to be the status for the entire 3-5 hour period with no coverage.

When dive count bin data are used to estimate time hauled out, different biases may occur. If the seal remains hauled out for more than six hours, the SLTDR will quit transmitting until the seal goes into the water. If it then goes into the water and does not send regular signals, the data for the period when the SLTDR was hauled out and did not transmit may be lost, thus underestimating the amount of time hauled out. This is a particular problem if the seal was hauled out for more than 24 hours, since data are only stored for that long. Similarly, if the seal spends long periods at sea when its back, and therefore the SLTDR, does not break the surface, the time at sea will be underestimated.

With the existing SLTDR software, it is not possible to distinguish periods when the seal has been hauled out for more than 6 hr, and therefore is not transmitting, from periods when it is at sea with its back below the surface and also not transmitting. New software incorporated into four of the SLTDRs deployed in September 1993 will measure and report the amount of time in each period that the pressure sensor indicates a depth of zero. This will provide an actual measure of the amount of time that seals spend at the surface and should help to describe haulout behavior.

It was possible to compare the number of times satellite-tagged seals were hauled out during surveys with the total number of times they could have been hauled out to estimate the proportion of seals hauled out during pupping surveys. Based on sensor data collected during 1992-93 pupping-period surveys, we estimated that 52% of the seals were hauled out where they could be counted during surveys. Although the sample size is small, this is a useful first estimate for PWS of the proportion of seals hauled out during a survey period. If this proportion were extrapolated to the surveys as a whole, it would indicate that the surveys missed 48% of the seals in the area because they were not hauled out, and consequently that there were about twice as many seals as were counted.

Habitat Use and Behavior at Sea

When they are at sea, seals are presumably either moving from one location to another, or feeding. SLTDRs attached to seals provided many locations of seals while they were at sea. In general, at-sea locations were not far from the haulouts the seals were using. The most dramatic exception to this was for seal 11040, which was located several times during 20 May through 1 June 1993 in the Gulf of Alaska more than 30 km from the nearest land (Figure 13). Other at-sea locations show the routes of travel of seals between two centers of activity (e.g., Figures 8 and 9).

Depth of dive data reported by the SLTDRs indicated that seals often travel at least several kilometers away from their haulouts to feed in deeper water offshore, and often dive to the bottom. The maximum dive depth recorded for any seal in this study was 404 m by seal 2282. This dive occurred somewhere in Port Wells while the seal was traveling between central PWS and College Fiord. The maximum depth in this area is 417 m. Near Middleton Island, the maximum depth of dive for seal 2240 was 236 m. A seal would have to swim approximately 15 km east of Middleton to reach water of this depth. Seal 11040 left PWS and swam to an area southwest of Montague Island where it remained for almost two weeks. The area where the seal was diving, and presumably feeding, was substantially deeper (>160 m) than surrounding waters (<130 m). Maximum water depth shown on charts of this area is 216 m, and the deepest recorded dive by the seal was to 212 m. Near the Columbia Glacier the deepest water is about 260-290 m, and seals dove to maximum depths of 264 m. Near Seal Island, maximum water depths range from 160-214 m. The maximum depths of dives for seals in this area generally ranged from 150-212 m.

Although seals dive to similar maximum depths (which seem to reflect bottom depth) in a variety of habitats, the distribution of dives among different depth increments varies considerably by area. Near the Columbia Glacier and in College Fiord, despite maximum water depths of more than 250 m, approximately 70-90% of the dives of the seals using these areas were to depths of less than 50 m. It is unclear whether seals were feeding in the water column over deep water or diving to the bottom in shallow water near shore. Locations provided by the satellite tags are not precise enough to resolve this question at this time. It is interesting to note that in fiords near glaciers the zooplankton layer is closer to the surface than it is in other parts of the sound (Ted Cooney, pers. commun.). The small fishes eaten by seals may be feeding on this near-surface zooplankton layer. Over 90% of the dives of seal 3089 off the Copper River Delta were to less than 50 m. Water in this area is generally less than 50 m and the seal may have been diving to the bottom.

In most other areas, it appeared that many feeding dives were to the bottom. For example, when seal 11040 was in the Gulf where water depth was greater than 150 m, 40% of her dives were deeper than 150 m. Twenty percent of the dives by seal 2240 near Middleton Island were deeper than 150 m, although the area within 15 km of the island is all shallower than 150 m. Near the islands in central PWS, more than 25% of the dives of seals using these areas were deeper than 100 m. Maximum dive depths were less near Applegate Rocks, which is surrounded by shallower water, than at Seal, Smith, or Agnes islands where deeper water occurs within a few kilometers of the haulouts.

Factors Affecting Population Recovery

The mortality caused by the EVOS reduced seal numbers in part of PWS (Frost et al. in press), and will most likely have the effect of increasing the time required for the number of seals to recover, once other factors limiting population growth are controlled. Unfortunately, at the present time there is very little understanding of the factors that may be adversely affecting harbor seals in this area.

The limited data available suggest that disease has not been responsible for the decline in Alaskan harbor seals (Pitcher 1990; Sease 1992). There is no evidence that pollutants, other than those resulting from the EVOS, have had any effect on harbor seals in Alaska.

Several types of human activities may affect harbor seals. PWS supports a large commercial fishery for salmon (*Oncorhynchus* spp.), and other smaller fisheries for shellfish, groundfish, and herring (*Clupea harengus*). These fisheries may interact directly with seals through net entanglement and shooting, or indirectly through effects on prey availability (Sease 1992). Tourism is growing rapidly, bringing with it increased vessel traffic in areas that were once remote and relatively undisturbed habitat. The logging industry has increased greatly, causing habitat changes in nearshore areas that may be important to harbor seals or their prey.

Subsistence hunting by coastal Native residents may have affected harbor seals numbers in PWS, and may affect population recovery. The estimated annual harvest in PWS (Tatitlek and Chenega Bay) during the mid 1980s was 550-700 (Stratton and Chisum 1986; Stratton 1990). The harvest decreased substantially following the EVOS, to a reported annual total of about 110-130 during 1989-1991 (ADF&G Division of Subsistence, unpublished data). During 1992 the reported harvest increased to about 200 for Chenega Bay and Tatitlek (Wolfe 1993).

Without better population estimates for PWS as a whole, it is difficult to estimate the impact of recent subsistence harvests on harbor seals. The reported harvest of 110-130 during 1989-1991 is about 5% of the 2500 seals counted by Loughlin (1992) during 1991. Since that count of 2500 does not include the seals that are present in PWS but not hauled out, we think it is unlikely that harvests of the current magnitude could be the primary cause of a decline in a healthy population. It is possible, however, that the estimated harvest rates in the 1980s were high enough to contribute significantly to the decline that was occurring then. If a population is declining for other reasons, any harvest may exacerbate the decline and/or delay recovery.

Harbor seals are not the only marine species that has declined in the Gulf of Alaska region. Steller sea lion numbers have declined by over 50% since the 1960s (Loughlin et al. 1992) and several species of marine birds have also declined (Springer 1993). It has been postulated that food resources may be limited, therefore causing these declines (Anonymous 1993). It is very difficult to acquire the data necessary to determine whether food is limiting, and if so, what is responsible for the limitation.

Killer whales (*Orcinus orca*) are normally predators of both harbor seals and sea lions. In some parts of Alaska the behavior of killer whales seems to have changed in recent years, perhaps as a response to changes in availability of prey (Frost et al. 1992). It is possible that killer whale predation may have some influence on the ability of a reduced harbor seal population to recover.

CONCLUSIONS

Counts of harbor seals during the molting period appear to have been stable from 1989 through 1993 at both oiled and unoiled trend count sites in PWS. In contrast, pupping period counts in the trend count area as a whole have declined significantly since 1989. At this time it is unknown whether pupping-period or molting-period counts provide a better indicator of population status. In any event, neither series of counts shows any indication of population recovery. In fact, the average number of seals counted at oiled sites in August-September 1993 was 51% lower than in 1988, whereas counts at unoiled sites were only 11% lower. This strongly suggests a continued effect of the EVOS on the number of seals at oiled sites.

Satellite-linked SLTDRs have provided an effective means of monitoring the movements and haulout locations of harbor seals in PWS. SLTDRs deployed during 1991-1993 have demonstrated that the spring and summer movements of harbor seals are mostly confined to within PWS. Seals hauled out predominantly at the location where they were captured, although some also used nearby haulouts. Movements between terrestrial haulouts in central PWS and glaciers in northern PWS were not uncommon. Preliminary analysis of data from seals tagged in September 1993 suggest a similar pattern of behavior during fall and winter. In June 1992 and 1993, tagged seals were hauled out during 52% of the times that aerial survey counts were made.

The SLTDRs attached to seals provided a wealth of data on at-sea behavior. Most areas where seals were diving and probably feeding were within a few kilometers of haulouts. However, one seal spent several days feeding in the Gulf of Alaska south of Montague Strait more than 30 km from the nearest land. The deepest dive recorded by a tagged seal was to 404 m, but most dives were to depths of less than 200 m. The distribution of diving depths was related to the habitats in which seals were feeding, and it appears that on many dives seals were feeding on or near the bottom.

The number of harbor seals in PWS and adjacent parts of the Gulf of Alaska has declined on the order or 60%-90% since the 1970s. A variety of factors in addition to the EVOS may have played a role in this decline, but their relative importance is poorly understood. Continued efforts are needed to monitor the status of harbor seals and to investigate factors that may be causing the population to decline or be limiting population growth.

RECOMMENDATIONS

1. It is essential to continue monitoring the trend in abundance of PWS harbor seals. Recovery, either natural or as a result of restoration efforts, should be monitored through annual counts of index sites. Until it is determined whether pupping-period or molting-period counts are the best indicator of population status, surveys should be conducted during both periods. This information should be shared with subsistence hunters in PWS so that they can make informed decisions about their harvests of harbor seals.

2. Satellite tagging should be continued. To date, SLTDRs have been attached to 15 males and 5 females. Future emphasis should be on catching and tagging as many adult females as possible. Information on movements and diving behavior of juveniles is also needed, but existing 0.5-watt SLTDRs are too large for use on these small seals. In the future some SLTDRs should be attached to seals at locations that have not previously been studied in order to increase our understanding of the behavior seals in other parts of PWS.

3. Studies of the blood chemistry and health status of seals in PWS should be continued in order to examine the possible role of disease in the ongoing declines.

4. Because food limitation may be a factor in the harbor seal decline, it is necessary to conduct studies to better understand the prey base of harbor seals and changes in the availability of prey. These are not simple studies to design. However, as a first step, analysis of stable isotopes and lipids in blood and blubber may provide an indication of general diet, trophic status, and the magnitude of individual (and perhaps seasonal) variation in diet. It may be possible to detect differences between juveniles and adults that will help us to understand how food availability may be limiting.

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Table 1. Prince William Sound harbor seal trend count route.

Site #	Site name	Oiling status
1	Sheep Bay	unoiled
2	Gravina Island	unoiled
3	Gravina Rocks	unoiled
4	Olsen Bay	unoiled
5	Porcupine Point	unoiled
6	Fairmount Island	unoiled
7	Payday	unoiled
8	Olsen Island	unoiled
9	Point Pellew	unoiled
10	Little Axel Lind Island	unoiled
11	Storey Island	oiled
12	Agnes Island	oiled
13	Little Smith Island	oiled
14	Big Smith Island	oiled
15	Seal Island	oiled
16	Applegate Rocks	oiled
17	Green Island	oiled
18	Channel Island	unoiled
19	Little Green Island	unoiled
20	Port Chalmers	unoiled
21	Stockdale Harbor	unoiled
22	Montague Point	unoiled
23	Rocky Bay	unoiled
24	Schooner Rocks	unoiled
25	Canoe Passage	unoiled

Table 2. Number of counts (n), mean (μ), and maximum (max) number of harbor seals counted during aerial surveys in Prince William Sound, August-September 1989-1993. Data for 1992 are from the National Marine Mammmal Laboratory (unpublished). Sites are shown in Figure 1.

Site	1984			1988			1989			1990			1991			1992			1993		
	n	μ	max	n	μ	max	n	μ	max	n	μ	max	n	μ	max	n	μ	max	n	μ	max
1	8	46	90	9	12	31	8	0	0	8	<1	2	9	1	4	10	<1	1	6	4	22
2	8	27	49	9	12	38	5	20	54	8	5	13	10	13	28	10	24	41	4	16	28
3	8	45	66	9	42	65	8	33	50	7	21	37	10	27	38	10	31	42	5	38	44
4	8	150	239	9	80	129	7	43	66	8	69	104	10	80	125	10	41	76	6	73	86
5	8	31	54	9	4	16	7	7	13	8	1	4	10	14	21	9	8	20	7	3	6
6	8	98	133	7	42	74	8	33	53	8	22	43	8	17	26	8	12	17	7	20	26
7	8	12	16	9	2	9	8	2	4	8	4	13	9	5	11	9	<1	1	7	<1	1
8	8	40	54	9	12	20	8	7	13	8	10	17	9	10	16	9	4	8	7	2	8
9	8	23	43	9	20	32	8	24	32	8	23	33	8	23	29	9	13	17	7	10	15
10	8	28	35	9	18	32	8	23	27	8	15	23	8	10	15	9	7	9	7	3	8
11	8	12	20	9	5	14	8	3	10	8	3	10	9	<1	2	9	<1	1	7	<1	2
12	8	83	109	8	39	56	8	35	60	8	36	50	8	39	61	9	45	61	7	22	50
13	8	79	127	9	32	60	7	22	40	8	29	43	10	25	28	9	33	41	7	24	37
14	8	99	162	8	78	98	6	41	52	7	30	40	9	33	42	9	44	53	7	36	48
15	8	115	166	8	70	85	7	36	59	6	39	50	7	63	78	8	52	71	7	41	49
16	8	227	435	6	154	219	4	83	103	7	115	151	9	106	169	8	65	108	5	54	74
17	8	62	105	8	42	66	7	18	32	8	23	47	8	25	40	9	37	49	6	28	52
18	8	283	501	7	83	195	1	116	116	2	41	45	8	105	235	8	78	119	6	118	213
19	8	60	128	5	51	95	3	32	47	5	28	46	8	15	34	8	56	71	5	48	58
20	8	73	143	7	69	98	5	61	78	5	104	131	8	109	152	9	62	83	6	114	127
21	8	35	75	8	46	76	6	44	63	8	49	59	8	47	57	9	42	54	6	14	19
22	8	47	76	8	32	46	7	37	48	8	36	49	9	28	34	9	10	22	6	1	4
23	8	37	53	8	11	24	8	11	19	8	11	18	9	21	28	9	24	30	6	22	34
24	8	72	112	8	67	86	8	59	87	8	43	58	9	56	81	9	57	67	5	61	87
25	8	14	31	8	36	91	9	19	71	8	23	61	8	51	104	10	25	54	5	21	41

Table 3. Mean counts and annual percent change for harbor seals at oiled and unoiled trend count sites in Prince William Sound, August-September 1984-1993. Percent change shown for 1988 is the average annual rate of decline from 1984-1988. Data for 1984 and 1988 are from Pitcher (1986, 1989); data for 1992 are from the National Marine Mammal Laboratory (unpublished).

	Oil Category					
	Oiled (n=7)		Unoiled (n=18)		All (n=25)	
Year	mean	annual % change	mean	annual % change	mean	annual % change
1984	675		1121		1796	
1988	418	-11	639	-13	1057	-12
1989	239	-43	568	-11	807	-24
1990	276	+15	504	-11	780	- 3
1991	290	+ 5	631	+25	921	+18
1992	276	- 5	493	-22	769	-16
1993	206	-25	568	+15	774	+ 1
Overall declines						
1984-1993		-69		-49		-57
1988-1993		-51		-11		-27
1989-1993		-14		0		- 4

Table 4. Number of counts (n) and mean and maximum (max) number of harbor seals and harbor seal pups counted during aerial surveys in Prince William Sound, June 1989-1993. Data for 1992 are from the National Marine Mammal Laboratory (unpublished). Sites are shown in Figure 1.

	1989			1990			1991			1992			1993		
		non-pups/pups			non-pups/pups			non-pups/pups			non-pups/pups			non-pups/pups	
Site	n	mean	max	n	mean	max	n	mean	max	n	mean	max	n	mean	max
1	9	0/ 0	0/ 0	9	2/ 0	4/ 0	9	0/ 0	1/ 0	4	3/ 1	8/ 1	5	10/ 0	19/ 1
2	9	3/ 0	19/ 1	9	11/ 0	18/ 0	10	3/ 0	11/ 1	4	2/ 0	6/ 0	6	6/ 0	14/ 1
3	9	5/ 0	13/ 1	9	5/ 1	9/ 1	10	1/ 0	4/ 1	4	9/ 0	10/ 0	5	9/ 1	16/ 3
4	7	68/16	88/25	8	55/21	69/33	9	23/11	46/15	4	25/ 9	32/17	5	35/9	47/11
5	8	9/ 2	24/ 4	9	2/ 1	3/ 1	9	7/ 2	12/ 4	4	2/ 0	3/ 1	6	3/ 0	9/ 0
6	9	17/ 5	29/ 9	7	10/ 4	17/ 9	8	11/ 4	17/ 6	3	16/ 4	23/ 6	6	14/ 3	25/ 3
7	9	4/ 3	11/10	7	0/ 0	1/ 1	8	4/ 1	8/ 2	3	3/ 0	8/ 1	6	4/ 1	8/ 2
8	8	10/ 2	17/ 4	7	3/ 1	6/ 1	8	3/ 1	7/ 2	3	1/ 1	1/ 1	6	6/ 2	11/ 3
9	8	11/ 3	18/ 5	7	8/ 1	10/ 2	8	3/ 0	8/ 0	3	5/ 0	6/ 1	6	6/ 0	14/ 1
10	8	3/ 0	6/ 1	7	1/ 0	3/ 0	8	3/ 0	7/ 1	3	1/ 0	1/ 0	6	0/ 0	0/ 0
11	9	3/ 0	8/ 1	7	5/ 1	8/ 3	7	1/ 0	1/ 1	3	1/ 0	3/ 0	6	1/ 0	3/ 1
12	8	29/ 9	34/13	8	43/15	54/18	9	40/14	52/17	4	40/13	50/16	6	33/ 9	45/10
13	9	11/ 3	36/ 9	8	19/ 6	25/11	9	14/ 7	19/ 8	4	13/ 5	17/ 6	6	20/ 5	31/ 9
14	8	18/ 7	28/13	8	18/ 5	24/11	9	24/ 5	32/ 7	4	15/ 4	20/ 5	6	12/ 5	16/ 8
15	9	46/14	68/23	8	47/20	54/23	9	71/29	87/39	4	46/22	54/30	6	42/14	49/19
16	6	151/31	199/56	8	137/36	158/43	9	143/45	177/54	4	84/36	104/45	6	108/31	132/46
17	9	22/ 8	32/11	8	28/16	33/22	8	25/11	36/15	4	50/13	61/19	6	48/13	58/18
18	8	91/12	152/20	7	73/ 3	96/ 5	9	61/ 3	94/ 5	4	69/ 8	78/19	6	53/ 1	110/ 2
19	8	88/15	118/30	7	68/ 6	100/ 9	8	45/ 6	62/ 9	4	36/ 7	50/10	6	40/ 6	49/ 8
20	9	75/19	104/23	7	95/24	110/30	9	66/18	94/28	4	38/14	62/24	6	81/18	113/29
21	9	20/ 4	32/ 9	7	28/ 0	37/ 0	9	13/ 0	24/ 0	4	6/ 1	18/ 3	6	1/ 0	3/ 1
22	9	15/ 4	32/ 8	6	23/ 1	28/ 2	9	16/ 1	20/ 2	4	13/ 1	16/ 2	6	5/ 1	9/ 2
23	9	25/ 8	32/11	6	21/ 6	28/ 7	9	19/ 5	27/ 8	4	10/ 3	14/ 6	6	18/ 4	26/ 7
24	9	29/ 6	54/10	8	25/ 3	42/ 5	8	24/ 3	39/ 4	4	30/ 6	38/ 8	6	20/ 4	29/ 5
25	9	0/ 0	1/ 0	8	1/ 1	3/ 2	10	1/ 1	5/ 1	4	0/ 0	1/ 0	6	0/ 0	0/ 0

Table 5. Mean counts of harbor seals and harbor seal pups at oiled and unoiled trend count sites in Prince William Sound, June 1989-1993. Data for 1992 are from the National Marine Mammal Laboratory (unpublished).

	Oiled (n=7)			Unoiled (n=18)			Combined (n=25)		
	non-pups	pups	pups/100 non-pups	non-pups	pups	pups/100 non-pups	non-pups	pups	pups/100 non-pups
1989	279	72	26.0	471	98	20.9	750	170	22.7
1990	296	99	33.6	430	72	16.8	726	171	23.6
1991	317	111	35.0	302	56	18.5	619	167	27.0
1992	248	92	37.2	268	55	20.5	516	147	28.5
1993 early	271	87	32.1	262	49	18.7	533	136	25.5
late	256	68	26.6	359	48	13.4	615	116	18.9
all	264	77	29.2	310	49	15.8	574	126	22.0

Table 6. Land/sea status of satellite-tagged harbor seals during aerial surveys in Prince William Sound, June 1992-1993. Unk means that the land/sea status was unknown; dashes indicate that the transmitter was no longer functional.

1992	SLTDR			
Survey Date	3086	3087	3088	3089
14 June	unk	unk	sea	unk
16 June	land	sea	unk	sea
19 June	land	land	unk	unk
20 June	unk	sea	unk	unk

1993	SLTDR					
Survey Date	11040	11042	2282	2283	2287	2240
7 June	land	unk	sea	sea	land	sea
8 June	land	land	sea	land	land	land
9 June	land	sea	sea	land	land	land
20 June	unk	unk	sea	land	---	sea
21 June	unk	unk	sea	land	---	unk
22 June	unk	unk	sea	unk	---	sea

Table 7. Harbor seals captured and tagged with SLTDRs during field activities conducted in Prince William Sound, 1991-1993.

Capture Date	Capture Location	Sex	Age Class	SLTDR #	Std L (cm)	Ax G (cm)	Wt (kg)
4/19/91	Seal Island	F	subadult	none		86.0	31.8
4/19/91	Seal Island	F	subadult	none		80.0	30.9
4/19/91	Seal Island	F	subadult	14097		87.0	41.8
4/19/91	Seal Island	M	adult	14096		113.0	79.5
9/11/91	Seal Island	M	subadult	none			22.7
9/11/91	Seal Island	M	subadult	none			34.1
9/11/91	Seal Island	M	adult	11466			88.6
9/11/91	Seal Island	F	subadult	none	101.0	74.9	30.5
9/12/91	Herring Bay	F	adult	11467			70.7
5/14/92	Seal Island	M	subadult	none		74.0	25.0
5/14/92	Seal Island	F	subadult	none		82.0	29.5
5/14/92	Seal Island	M	subadult	none	108.0	72.5	29.5
5/17/92	Applegate Rocks	M	subadult	none		87.5	34.1
5/17/92	Applegate Rocks	M	subadult	3089		89.0	38.6
5/17/92	Applegate Rocks	M	subadult	3086		90.0	43.2
5/17/92	Applegate Rocks	F	adult	3088		111.5	61.4
5/17/92	Applegate Rocks	M	subadult	3087		89.0	45.5
5/7/93	Seal Island	M	adult	2287	147.0	105.5	83.5
5/7/93	Seal Island	F	subadult	none	103.0	72.7	28.9
5/7/93	Seal Island	M	adult	2282	138.5	107.5	87.1
5/7/93	Applegate Rocks	M	adult	2283	121.5	102.2	59.4
5/7/93	Applegate Rocks	F	subadult	none	101.0	83.0	31.7
5/8/93	Seal Island	F	subadult	none	107.0	86.0	38.7
5/8/93	Seal Island	F	adult	11040	140.0	103.4	65.0
5/8/93	Applegate Rocks	M	subadult	none	103.0	91.0	37.0
5/8/93	Applegate Rocks	M	adult	2240	135.0	100.1	66.2
5/8/93	Applegate Rocks	M	subadult	none	112.0	76.5	31.9
5/9/93	Seal Island	M	adult	11042	148.5	113.0	87.3
5/9/93	Seal Island	M	subadult	none	107.5	80.5	31.4
5/9/93	Seal Island	F	subadult	none	105.0	84.0	32.4
9/15/93	Seal Island	F	adult	2282	122.0	118.0	84.1
9/15/93	Seal Island	M	subadult	none	117.0	88.5	35.5
9/15/93	Seal Island	M	subadult	none	107.0	87.0	40.0
9/15/93	Seal Island	M	adult	2287	139.0	102.0	65.0
9/15/93	Seal Island	M	subadult	2284	112.0	96.0	47.7
9/15/93	Seal Island	M	subadult	none	114.0	85.0	40.9
9/15/93	Seal Island	M	pup	none	101.0	76.0	25.9
9/15/93	Seal Island	F	pup	none	92.0	74.5	24.1
9/16/93	Bay of Isles	M	adult	5039	134.0	106.5	84.1
9/18/93	Seal Island	M	adult	2280	136.0	96.0	61.4
9/18/93	Seal Island	F	subadult	none	118.0	77.0	34.1
9/18/93	Applegate Rocks	M	pup	none	99.0	73.0	23.6
9/18/93	Channel Island	M	adult	2283	144.0	104.0	81.7
9/18/93	Channel Island	M	subadult	none	108.0	81.0	38.6
9/18/93	Channel Island	F	subadult	none	100.0	84.0	34.1

Table 8. Performance of satellite-linked SLTDRs attached to harbor seals in Prince William Sound, 1991-1993.

SLTDR	Date Attached	Date of Last Transmission	Total Days Operational	No. Days w/ Locations	Total No. Locations
14096	4/19/91	6/25/91	68	9	14
14097	4/19/91	4/26/91	8	4	20
11466	9/11/91	9/14/91	4	1	8
11467	9/11/91	10/8/91	28	22	86
3086	5/17/92	7/7/92	52	45	140
3087	5/17/92	7/11/92	56	46	151
3088	5/17/92	7/19/92	64	40	247
3089	5/17/92	7/24/92	69	31	94
2282	5/7/93	7/28/93	83	78	329
2283	5/7/93	7/21/93	76	72	308
2287	5/7/93	6/14/93	39	38	191
2240	5/8/93	8/1/93	86	54	225
11040	5/8/93	7/8/93	62	44	215
11042	5/9/93	7/25/93	78	63	208
2282	9/15/93	12/31/93[a]	107		
2284	9/15/93	12/31/93[a]	107		
2287	9/15/93	12/31/93[a]	107		
5039	9/16/93	12/31/93[a]	106		
2280	9/18/93	12/31/93[a]	104		
2283	9/18/93	12/31/93[a]	104		

[a] SLTDRs were still operational as of 31 December 1993.

Table 9. Summary of movements of satellite-tagged harbor seals in Prince William Sound, 1991-1993.

SLTDR	Location and Date Tagged	Other Major Areas and Dates of Use	Location/Date of Last Location Fix
14096	Seal Island-4/19/91		NE Knight Isl-6/20/91
14097	Seal Island-4/19/91		Seal Island-4/26/91
11466	Seal Island-9/11/91		Seal Island-9/14/91
11467	Herring Bay-9/11/91	College Fiord-9/15-22	Herring Bay-10/8/91
3086	Applegate Rks-5/17/92	Knight Island Passage-5/24 Bay of Isles-6/14, 25, 28; 7/1-2 Herring Bay-7/5	N Green Island--7/7/92
3087	Applegate Rks-5/17/92	Little Green Island-6/11-15 Danger Island-6/19-30 Channel Island-7/7-11	Channel Island-7/11/92
3088	Applegate Rks-5/17/92		Applegate Rks-7/19/92
3089	Applegate Rks-5/17/92	Columbia Glacier-5/21-23 Copper R. Delta-5/25-6/5; 6/12-7/18 Hinchinbrook Entrance-6/8-9	Seal Island-7/24/92
2282	Seal Island-5/7/93	College Fiord-5/9-12; 6/1-5 Naked Island-5/26-28; 6/10-7/13	Seal Island-7/28/93
2283	Seal Island-5/7/93	Columbia Glacier-5/9-19	Seal Island-7/21/93
2287	Seal Island-5/7/93	Smith Island-5/10-22	Seal Island-6/14/93
2240	Applegate Rks-5/8/93	Middleton Island-5/28 Seal Island-5/10-17	Applegate Rks-8/1/93
11040	Seal Island-5/8/93	Gulf of Alaska-5/20-6/1	Seal Island-7/7/93
11042	Seal Island-5/9/93		Seal Island-7/25/93
2282	Seal Island-9/15/93	Applegate Rocks-9/16; 10/1, 12, 14	12/31/93[a]
2284	Seal Island-9/15/93	Columbia Gl.-9/22-24; 10/14-11/12 11/18-29; 12/3-9; 12/14-28 Lone Island-11/13-16; 11/30-12/2; 12/10-13; 12/30-31	12/31/93[a]
2287	Seal Island-9/15/93		12/31/93[a]
5039	Bay of Isles-9/16/93		12/31/93[a]
2280	Seal Island-9/18/93		12/31/93[a]
2283	Channel Island-9/18/93		12/31/93[a]

[a] SLTDRs were still operational as of 31 December 1993.

Table 10. Distances moved by satellite-tagged harbor seals in Prince William Sound, 1992-1993.

SLTDR#	Dates Tracked[a]	Distance moved (km) Total	per Day
3086	5/19/92-7/7/92	367	7.3
3087	5/26/92-7/11/92	417	8.9
3088	5/18/92-7/19/92	456	7.2
3089	5/19/92-7/24/92	649	9.7
2282	5/7/93-7/28/93	816	9.8
2283	5/9/93-7/21/93	781	10.6
2287	5/7/93-6/14/93	288	7.4
2240	5/9/93-8/1/93	587	6.9
11040	5/8/93-7/7/93	457	7.5
11042	5/10/93-7/25/93	419	5.4

[a] Dates may differ slightly from those in Table 3 because only location qualities 1-3 were included in distance moved calculations.

Table 11. Use of haulout sites by satellite-tagged harbor seals in Prince William Sound, May-July 1992. Numbers indicate the number of haulout bouts that occurred at each site based on location and land-sea sensor data.

Location	SLTDR Number/Tagging Site			
	3086 Applegate	3087 Applegate	3088 Applegate	3089 Applegate
Applegate Rocks	21	--	30	--
Seal Island	--	--	2	2
Bay of Isles	6	--	--	--
W. Green I.	1	--	--	--
N. Green I.	2	--	1	--
Channel Island	--	5	2	--
Port Chalmers	--	1	--	--
Little Green I.	--	3	--	--
W. Montague I.	--	3	--	--
Danger Island	--	9	--	--
Smith Island	--	--	--	1
Bligh Island	--	--	--	--
Hinchinbrook I.	--	--	--	2
Copper R. Delta	--	--	--	2
TOTAL KNOWN	30	21	35	7
Unknown	3	1	6	1
TOTAL	33	22	41	8

Table 12. Use of haulout sites by satellite-tagged harbor seals in Prince William Sound, May-August 1993. Numbers indicate the number of haulout bouts that occurred at each site based on location and land-sea sensor data.

	SLTDR Number/Tagging Site					
Location	2240 Applegate Rks.	2282 Seal Island	2283 Seal Island	2287 Seal Island	11040 Seal Island	11042 Seal Island
Seal Island	3	27	46	21	35	40
Applegate Rks.	33	--	3	--	--	--
Smith Island	--	--	1	9	--	--
Agnes Island	--	27	1	1	--	--
Columbia Gl.	--	--	3	--	--	--
College Fiord	--	7	--	--	--	--
Middleton I.	2	--	--	--	--	--
TOTAL KNOWN	38	61	54	31	35	40
Unknown	6	4	6	5	2	10
TOTAL	44	65	60	36	37	50

Table 13. Percent of time hauled out, based on land-sea data files, for satellite-tagged harbor seals in Prince William Sound, May-July 1992-1993. Standard deviation of mean percentages is shown in parentheses.

SLTDR	1-15 May	16-31 May	1-15 June	16-30 June	1-15 July	16-31 July	Total
1992							
3086	--	28	44	59	49	--	45
3087	--	1	38	52	38	--	33
3088	--	30	21	50	6	--	28
3089	--	30	50	39	82	36	50
1993							
11040	22	6	27	82	80	--	31
11042	26	24	83	64	71	76	59
2240	23	11	27	48	93	68	47
2282	14	23	26	26	41	64	32
2283	2	35	32	52	43	65	38
2287	30	42	39	--	--	--	38
All 1992							
Mean	--	22	38	50	44	--	39
S.D.	--	14.2	12.5	8.3	31.4	--	10.2
All 1993							
Mean	19	24	39	54	66	68	41
S.D.	10.1	13.7	22.1	20.7	22.9	5.4	10.6
1992+1993							
Mean	19	23	39	52	56	62	40
S.D.	10.1	13.1	18.0	15.6	27.6	15.2	9.9

Table 14. Comparison of the percent of time hauled out by ten satellite-tagged harbor seals in Prince William Sound, May-July 1992-1993. The porportion of time hauled out was calculated from land/sea data files (L/S) and from histogram files indicating the number of dives per 6-hr period (bin).

	May		June		July		Total	
SLTDR	L/S	Bin	L/S	Bin	L/S	Bin	L/S	Bin
1992								
3086	28	30	52	24	49	41	45	28
3087	1	22	45	44	38	60	33	42
3088	30	71	26	55	6	67	28	63
3089	30	13	45	25	70	36	50	22
1993								
11040	10	23	41	43	80	24	31	32
11042	25	41	76	13	73	31	59	31
2240	14	45	38	20	80	29	47	30
2282	20	22	26	6	51	18	32	15
2283	24	22	42	34	48	37	38	31
2287	37	18	39	6	--	--	38	14
All 1992								
Mean	22	34	42	37	41	51	39	39
S.D.	14.2	25.6	11.2	15.1	26.7	14.9	10.2	18.2
All 1993								
Mean	22	29	44	20	66	28	41	26
S.D.	9.5	11.4	16.9	15.3	15.7	7.2	10.6	8.5
1992+1993								
Mean	22	31	43	27	55	38	40	31
S.D.	10.8	17.3	14.1	16.7	24.0	16.1	9.9	14.1

Table 15. Depths of dives for satellite-tagged harbor seals at different locations in Prince William Sound and the Gulf of Alaska during May-July 1992-1993.

SLTDR	Location	Dates	Percent of dives in depth bin (m) 4-20	21-50	51-100	101-150	151-200	>200	Total no. of dives
3089	Columbia Gl.	5/21-23	78	16	5	0	0	0	811
	Copper River	5/25-6/5	89	6	5	0	0	0	833
	Copper River	6/12-7/18	69	26	5	0	0	0	1816
	Seal Island	7/21-24	41	36	18	5	0	0	542
2282	College Fiord	5/9-12	53	19	11	9	0	0	855
	Seal Island	5/16-24	25	6	16	52	0	0	625
	Agnes Island	5/26-28	7	4	17	63	0	0	214
	College Fiord	6/1-5	77	12	7	3	0	0	1429
	Agnes Island	6/10-7/13	67	12	11	9	0	0	4546
2283	Columbia Gl.	5/9-19	46	20	29	4	1	0	2914
	Seal Island	5/19-6/14	14	7	34	43	1	0	6792
2287	Smith Island	5/11-22	19	18	26	32	7	0	2772
	Seal Island	5/22-6/14	25	24	21	28	2	0	1400
2240	Seal Island	5/10-17	78	2	2	15	1	0	504
	Middleton I.	5/28-29	49	13	7	11	16	3	382
11040	Seal Island	5/9-19	66	19	10	4	0	0	924
	Gulf of AK.	5/20-6/1	14	11	16	19	29	11	1598
	Seal Island	6/5-7/7	51	12	15	22	1	0	3017
11042	Seal Island	5/8-7/8	26	28	20	20	5	0	7464

Table 16. Depths of dives for satellite-tagged harbor seals in different habitat types in Prince William Sound and the Gulf of Alaska during May-July 1992-1993.

	Depth bin (m)					
Habitat	4-20	21-50	51-100	101-150	151-200	>200
Fiord near glacier						
3089	78	16	5	0	0	0
2282	68	14	9	5	3	1
2282	46	20	29	4	1	0
All	58	17	18	4	2	0
Copper River delta						
3089	75	19	5	0	0	0
Gulf of Alaska						
2240	49	13	7	11	17	3
11040	14	11	16	19	29	11
All	21	12	15	17	26	9
Seal, Smith, Agnes I.						
3089	41	36	18	5	0	0
2282	60	11	12	16	1	0
2283	14	7	34	43	1	0
2287	25	24	21	28	2	0
2240	78	2	2	15	1	0
11040	54	14	14	18	1	0
11042	26	28	20	20	5	0
All	35	17	22	24	2	0

Table 17. Maximum dive depths (m) for four satellite-tagged harbor seals in Prince William Sound during May-July 1992.

	3086			3087			3088			3089		
Day	May	Jun	Jul	May	Jun	Jul	May	Jun	Jul	May	Jun	Jul
1		84	104		-	-		-	8		4	-
2		76	112		128	-		4	8		-	48
3		76	-		-	-		8	8		-	-
4		116	-		132	-		4	8		-	-
5		108	104		136	-		4	-		-	-
6		-	108		-	128		4	-		0	-
7		124	4		-	-		12	-		20	-
8		136			-	120		4	-		56	-
9		112			128	0		4	-		72	-
10		-			76	4		4	-		112	-
11		100			104	-		4	-		84	104
12		96			96	76		8	-		-	116
13		124			4			8	-		-	-
14		-			88			4	-		-	-
15		108			124			-	-		-	-
16		96			-			-	-		-	-
17		-			128			-	-		72	-
18	68	92		100	120		4	-	-	8	76	-
19	88	144		124	240		4	-	0	48	-	-
20	100	-		108	148		12	-		68	-	-
21	104	96		132	148		4	-		56	-	-
22	160	-		-	8		8	-		168	-	128
23	48	128		120	4		4	-		76	-	-
24	80	100		128	4		4	-		100	-	144
25	72	104		124	8		4	-		-	-	4
26	136	108		132	12		4	188		72	-	4
27	88	108		-	4		4	76		24	-	
28	132	124		-	0		4	4		8	-	
29	76	-		128	4		-	136		20	-	
30	80	112		128	8		4	8		-	-	
31	76			128			09			-		

Table 18. Maximum dive depths (m) for six satellite-tagged harbor seals in Prince William Sound during May-July 1993.

	2240			2282			2283			2287		11040			11042		
Day	May	Jun	Jul	May	Jun	Jul	May	Jun	Jul	May	Jun	May	Jun	Jul	May	Jun	Jul
1		-	108		148	112		136	140		172		-	-		-	156
2		236	120		208	120		44	140		140		212	8		-	156
3		164	-		220	148		120	144		168		212	8		-	152
4		-	-		104	136		160	144		-		-	132		-	172
5		-	-		184	124		152	120		164		-	-		176	-
6		160	-		-	152		112	140		184		216	132		168	-
7		156	120		-	148		144	136		136		132	132		212	160
8	4	160	108	4	268	148		136	132	176	148		4	4		-	160
9	4	120	120	404	-	164	184	132	4	216	-	8	4		-	-	140
10	-	160	-	-	172	156	264	148	4	172	-	168	8		-	168	168
11	168	108	-	-	-	164	244	152	-	232	192	136	4		196	-	-
12	4	-	-	240	136	136	-	152	-	156	180	32	8		136	-	-
13	0	132	-	248	148	172	212	-	136	160	156	8	4		-	-	148
14	4	-	-	268	-	172	-	-	-	172	152	36	-		160	-	168
15	144	-	-	-	-	148	148	148	148	140	-	68	-		192	-	144
16	144	-	-	292	196	152	-	144	-	-	-	124	-		180	148	144
17	8	144	-	160	160	144	132	144	140	-	-	-	-		-	-	152
18	8	144	-	-	168	132	208	-	128	172	-	60	-		-	-	168
19	-	-	-	180	100	-	196	148	-	168	-	104	-		184	-	160
20	156	-	116	164	176	148	192	144	-	172	-	-	-		180	-	168
21	164	-	-	140	172	152	232	-	128	176	-	-	-		168	-	168
22	156	132	100	148	116	-	-	136		156	-	-	-		168	160	-
23	164	-	96	132	-	-	240	152		228	-	-	-		164	168	-
24	-	-	116	144	84	140	108	140		-	-	-	-		196	-	180
25	-	-	120	132	-	-	4	132		120	-	144	196		168	152	
26	-	144	84	208	124	140	8	144		-	-	196	148		-	-	
27	-	-	-	160	84	-	0	144		164	-	-	4		172	-	
28	212	-	128	-	-	8	172	132		156	-	-	-		-	156	
29	-	-	144	-	156		148	140		168	0-	-		200	204		
30	-	-	144	-	144		140	132		168	212	-		-	-		
31	-		-	-			128			148		-			196		

Table 19. Mean counts of harbor seals hauled out in Prince William Sound during pupping and molting period surveys, 1984-1993.

	Pupping period		
Year	Non-Pups	Pups	Molting period
1984	---	---	1,796
1988	---	---	1,057
1989	750	170	807
1990	726	171	780
1991	619	167	921
1992	516	147	769
1993	574	136	774

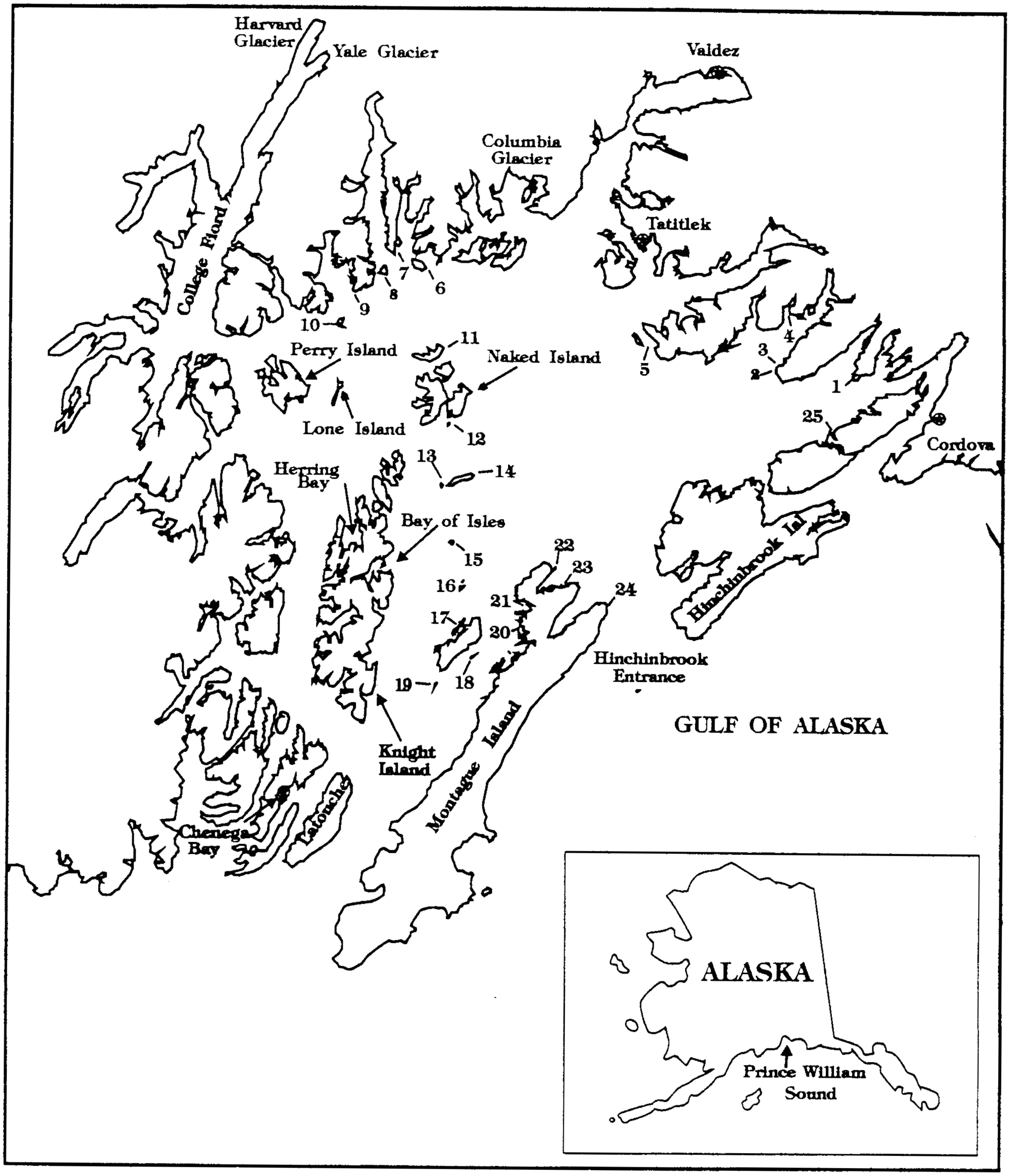

Figure 1. Map of Prince William Sound showing oiled and unoiled trend count sites and other locations referred to in text.

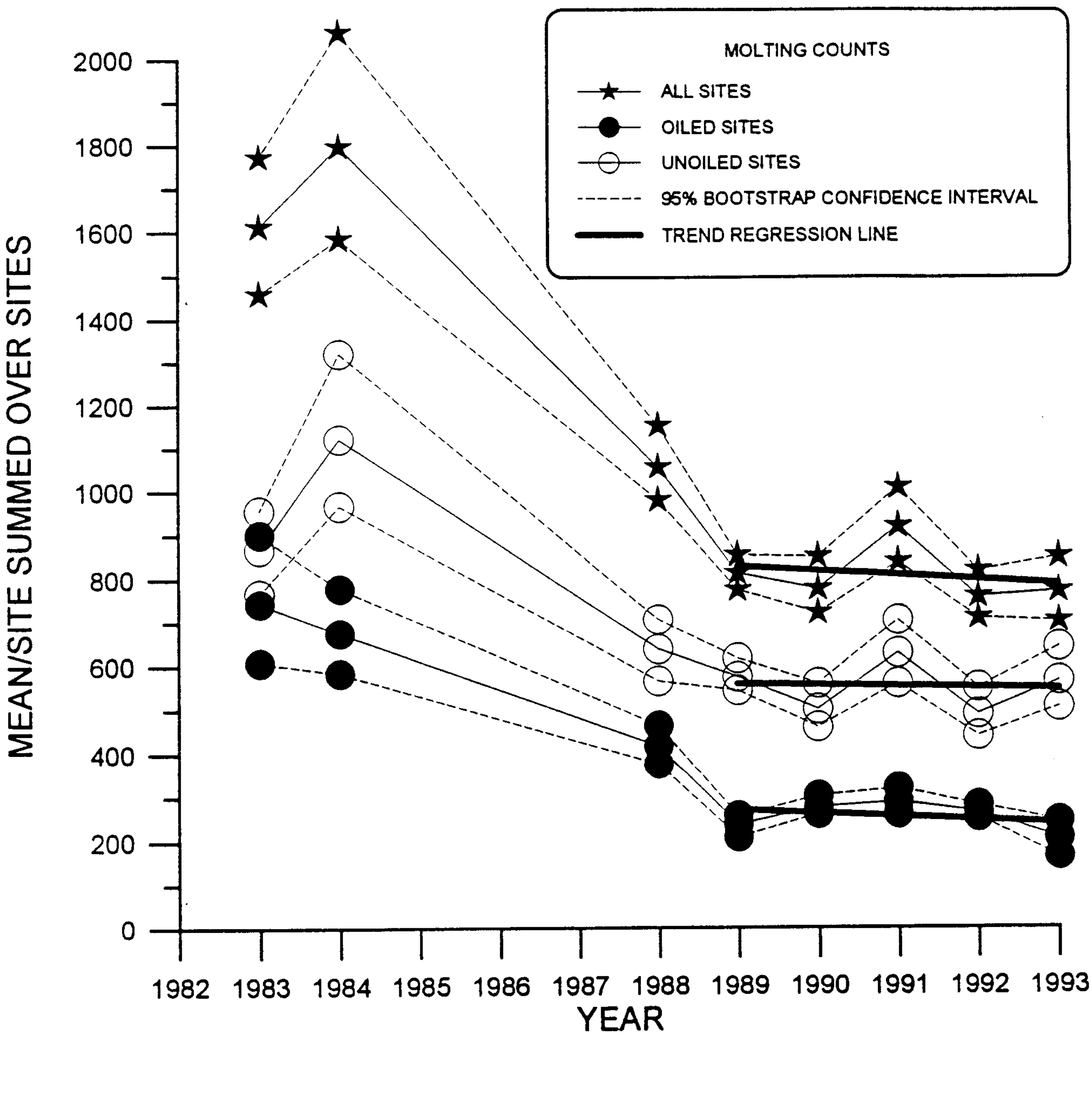

Figure 2. Trend in numbers of harbor seals in Prince William Sound based on counts made during August- September 1983-1993.

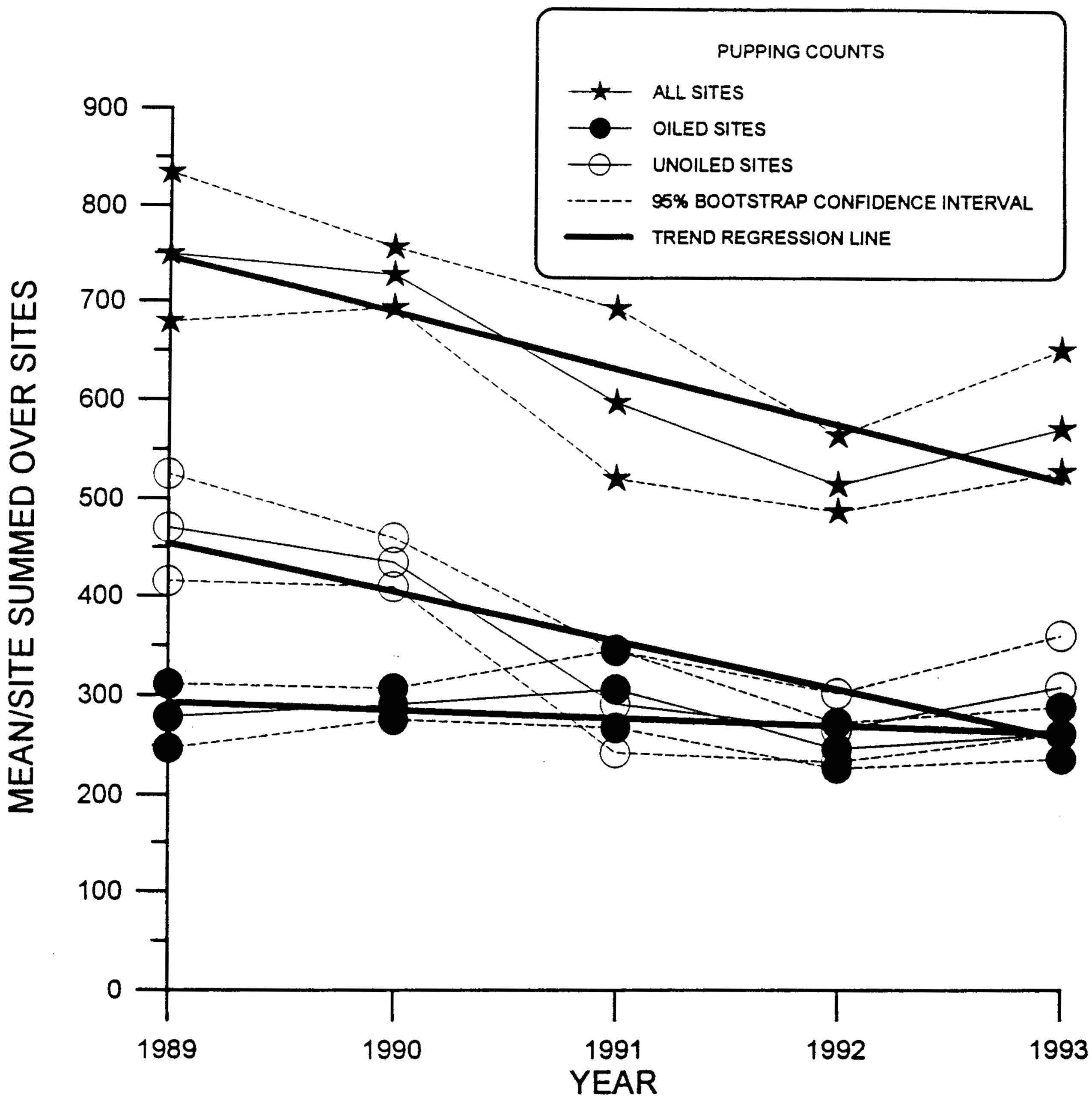

Figure 3. Trend in numbers of harbor seals in Prince William Sound based on counts made during June 1989-1993.

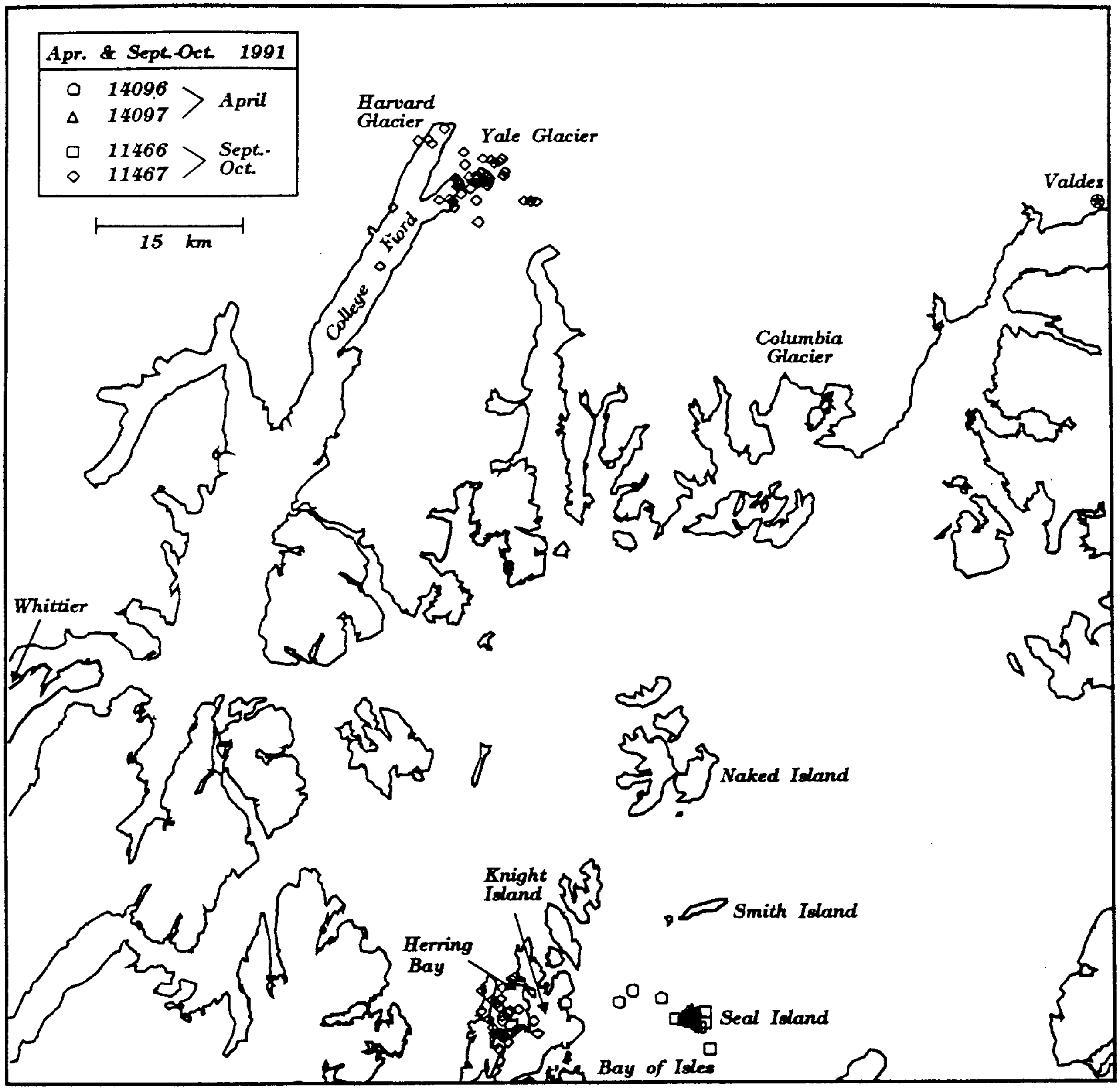

Figure 4. Map of Prince William Sound showing movements of satellite tagged seals during April-June and September-October 1991.

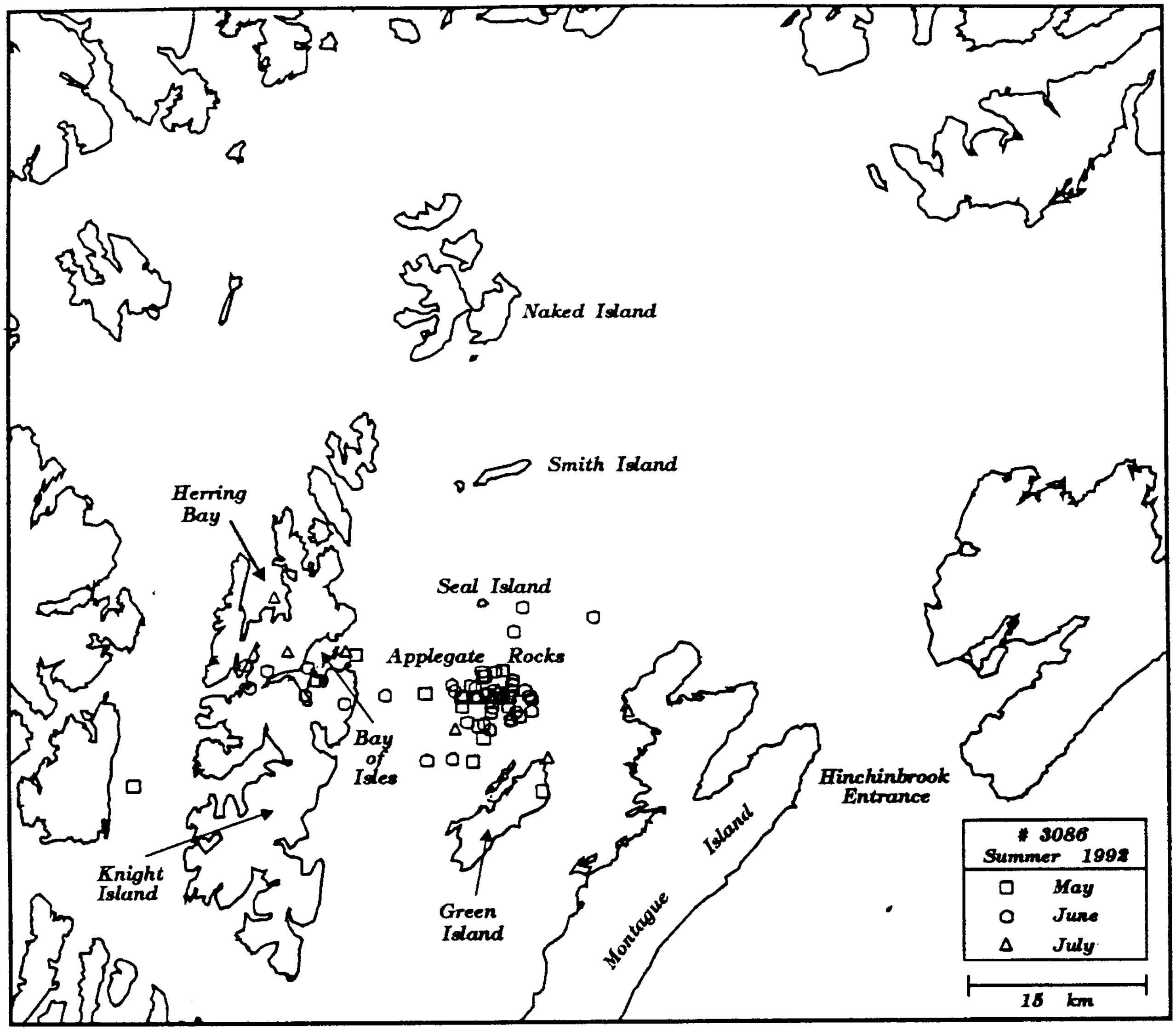

Figure 5. Map of Prince William Sound showing movements of satellite tagged seal 3086, 15 May-7 July 1992.

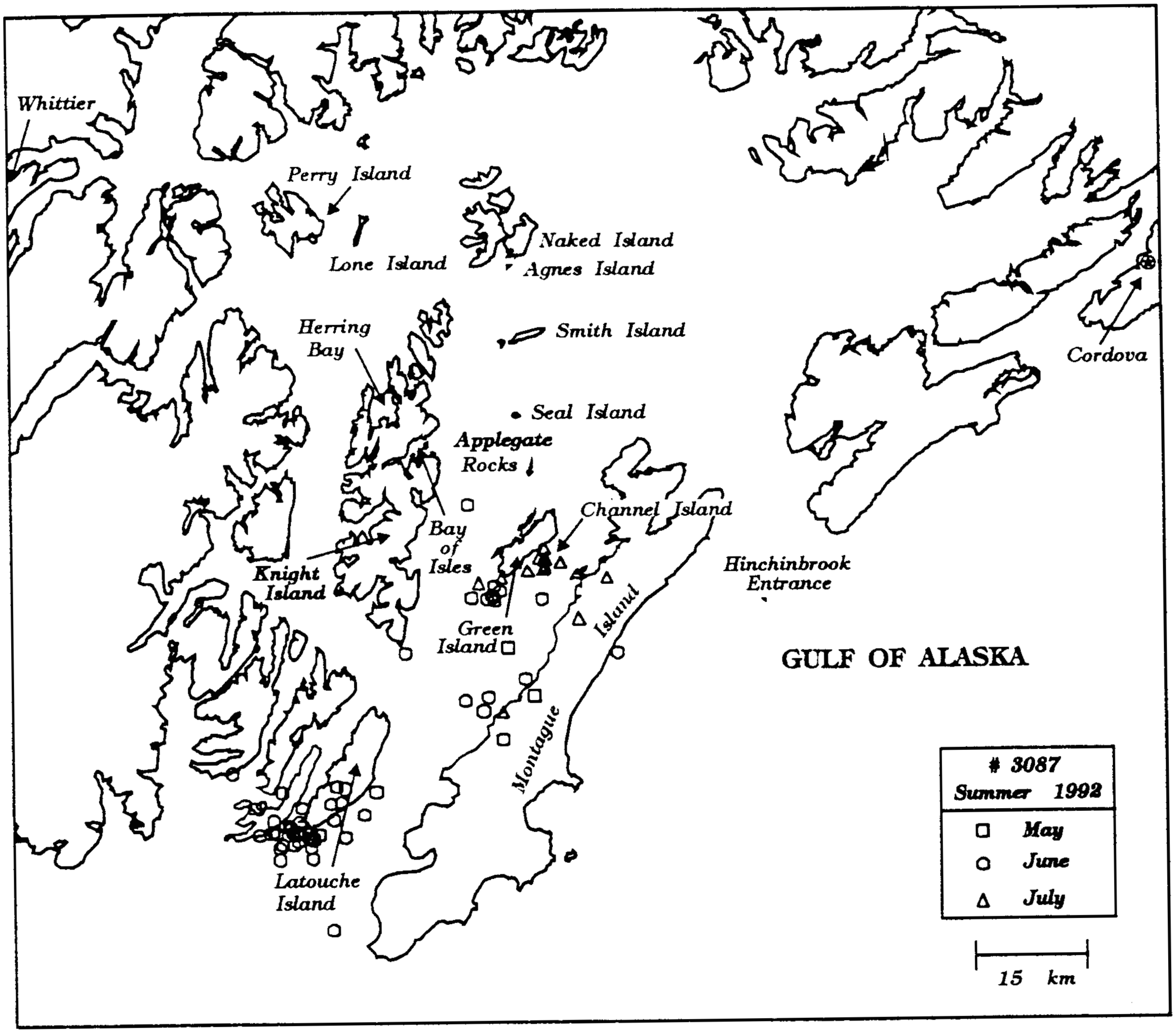

Figure 6. Map of Prince William Sound showing movements of satellite tagged seal 3087, 15 May-11 July 1992.

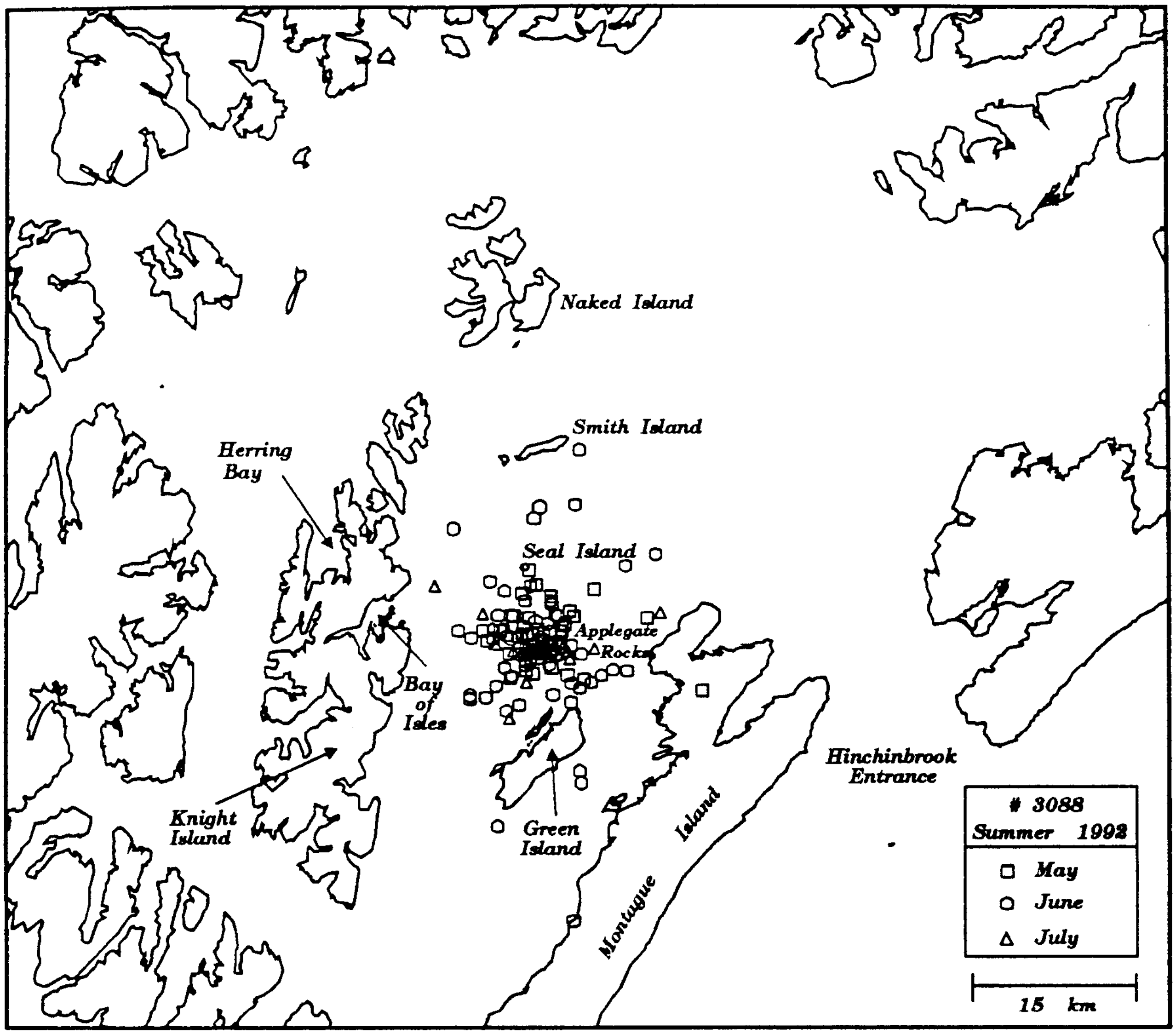

Figure 7. Map of Prince William Sound showing movements of satellite tagged seal 3088, 15 May-19 July 1992.

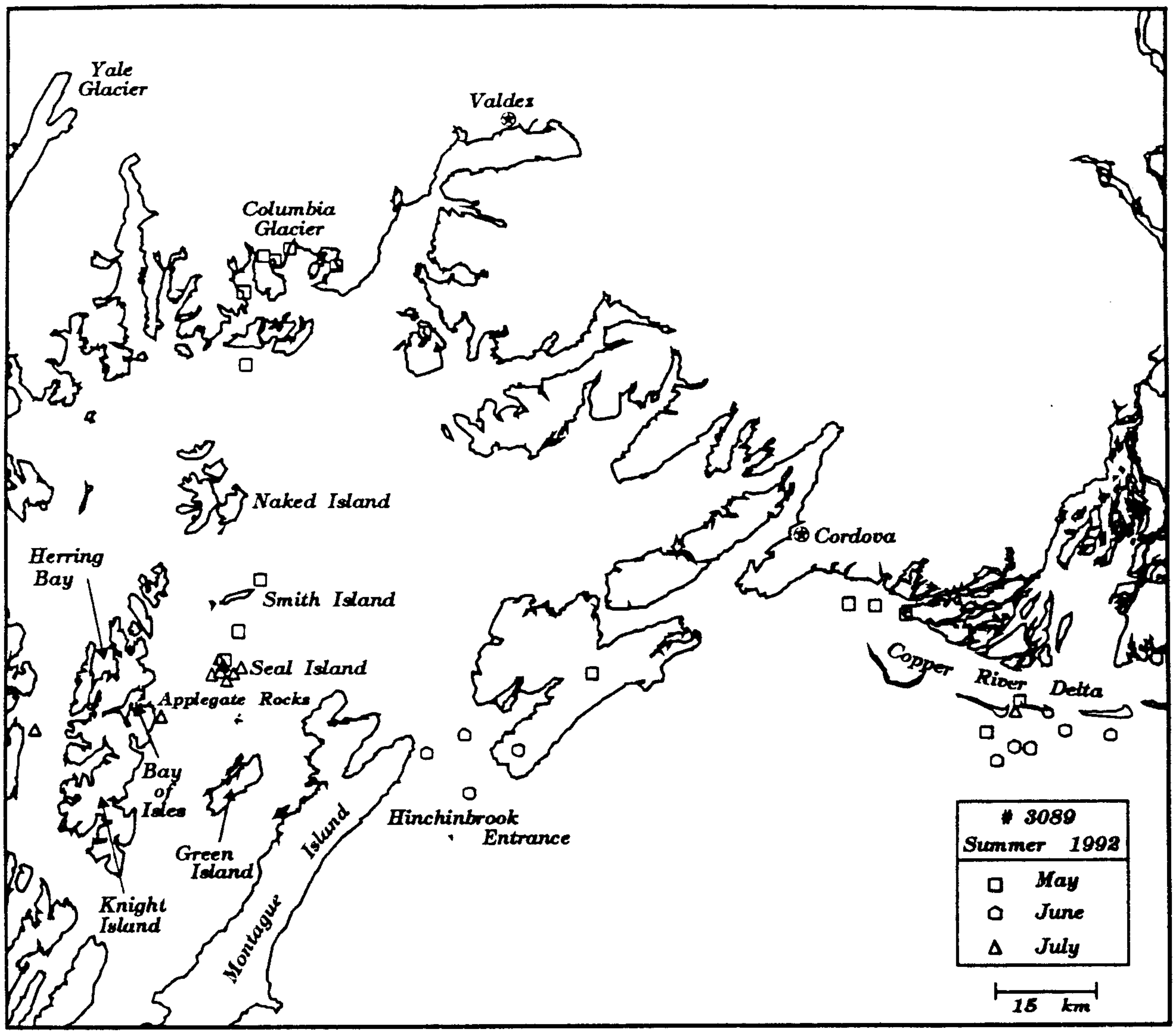

Figure 8. Map of Prince William Sound and the Copper River Delta showing movements of satellite tagged seal 3089, 15 May-24 July 1992.

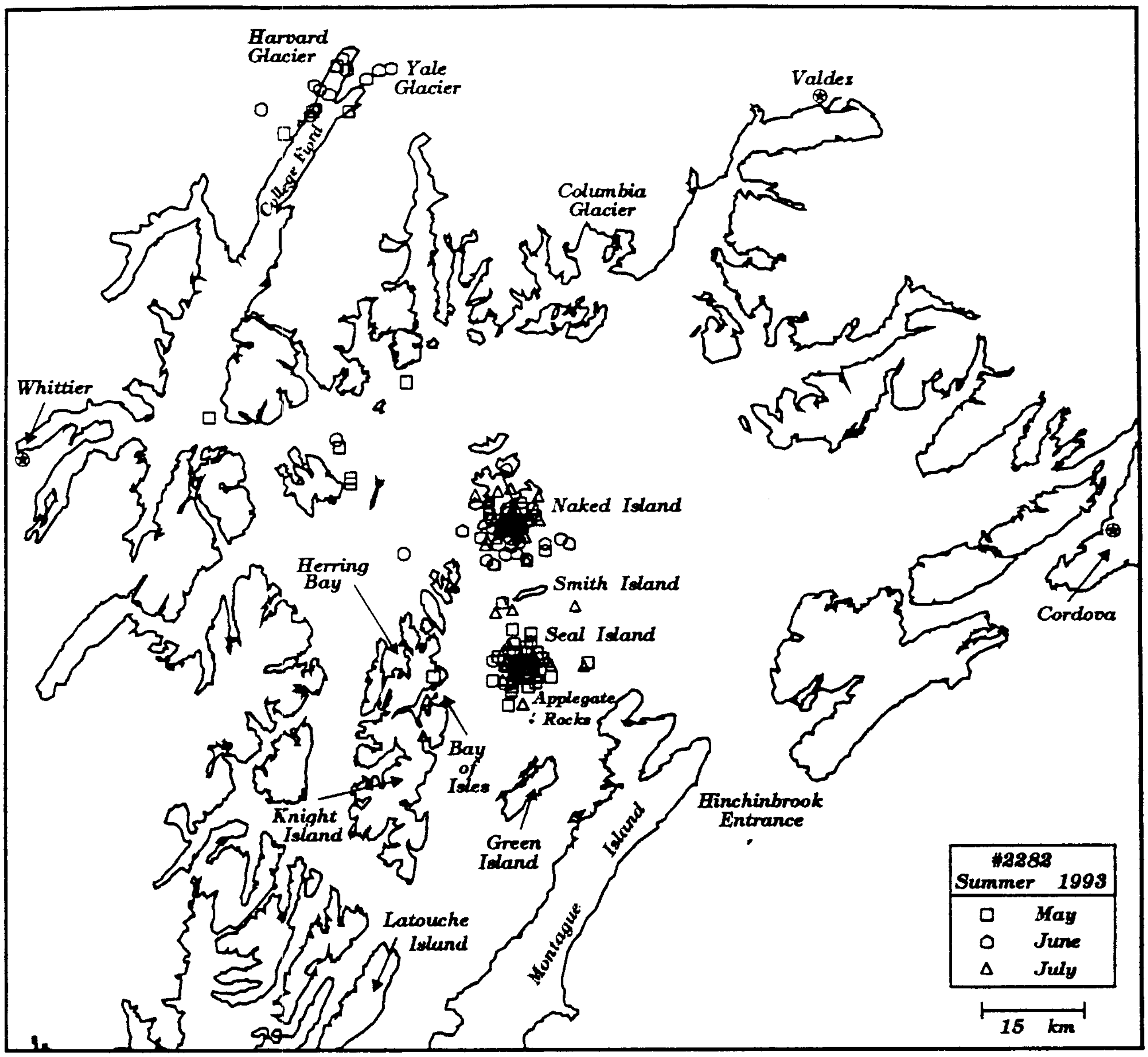

Figure 9. Map of Prince William Sound showing movements of satellite tagged seal 2282, 7 May-28 July 1993.

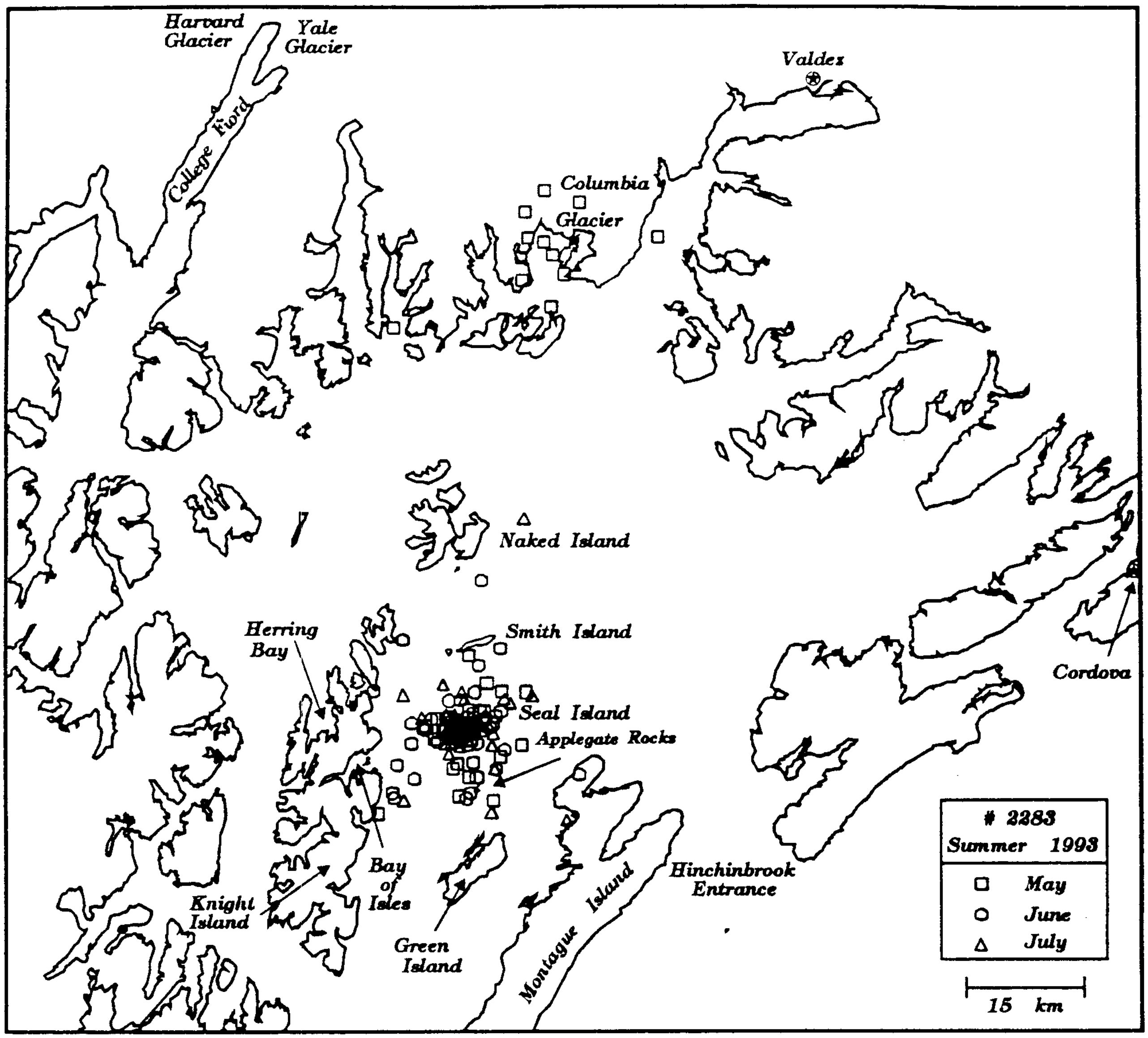

Figure 10. Map of Prince William Sound showing movements of satellite tagged seal 2283, 7 May-20 July 1993.

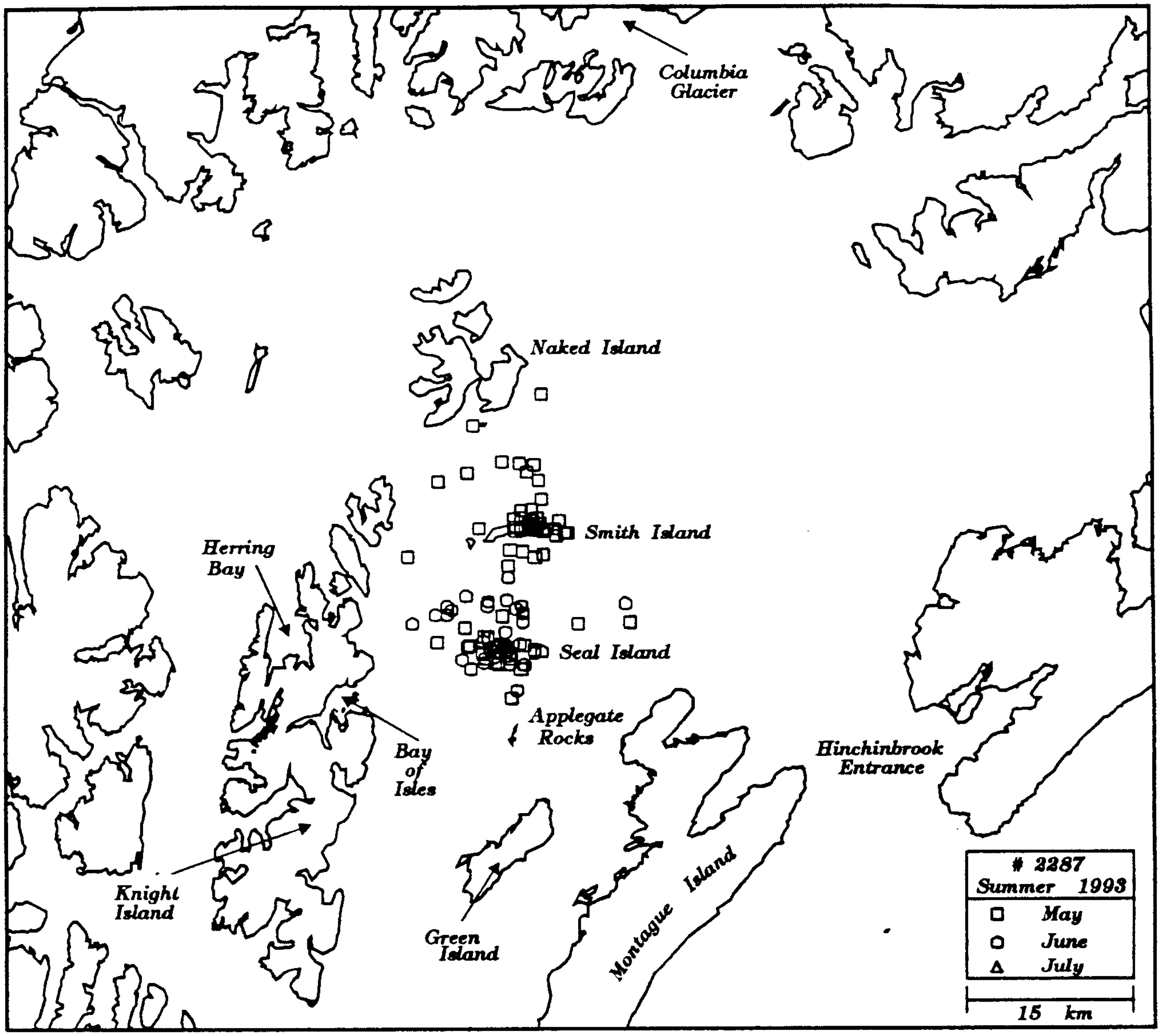

Figure 11. Map of Prince William Sound showing movements of satellite tagged seal 2287, 7 May-14 July 1993.

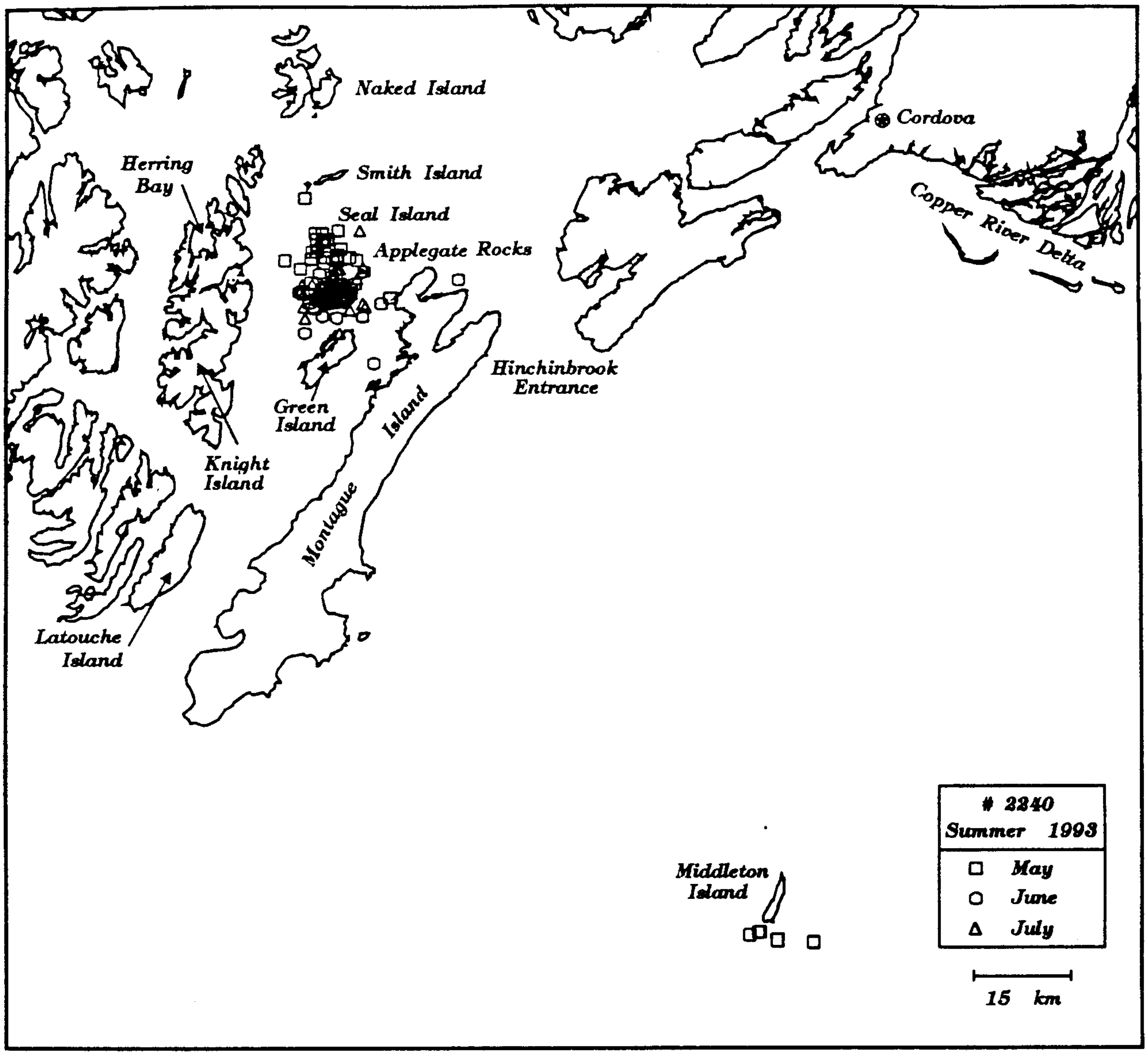

Figure 12. Map of Prince William Sound and the Gulf of Alaska showing movements of satellite tagged seal 2240, 8 May-1 August 1993.

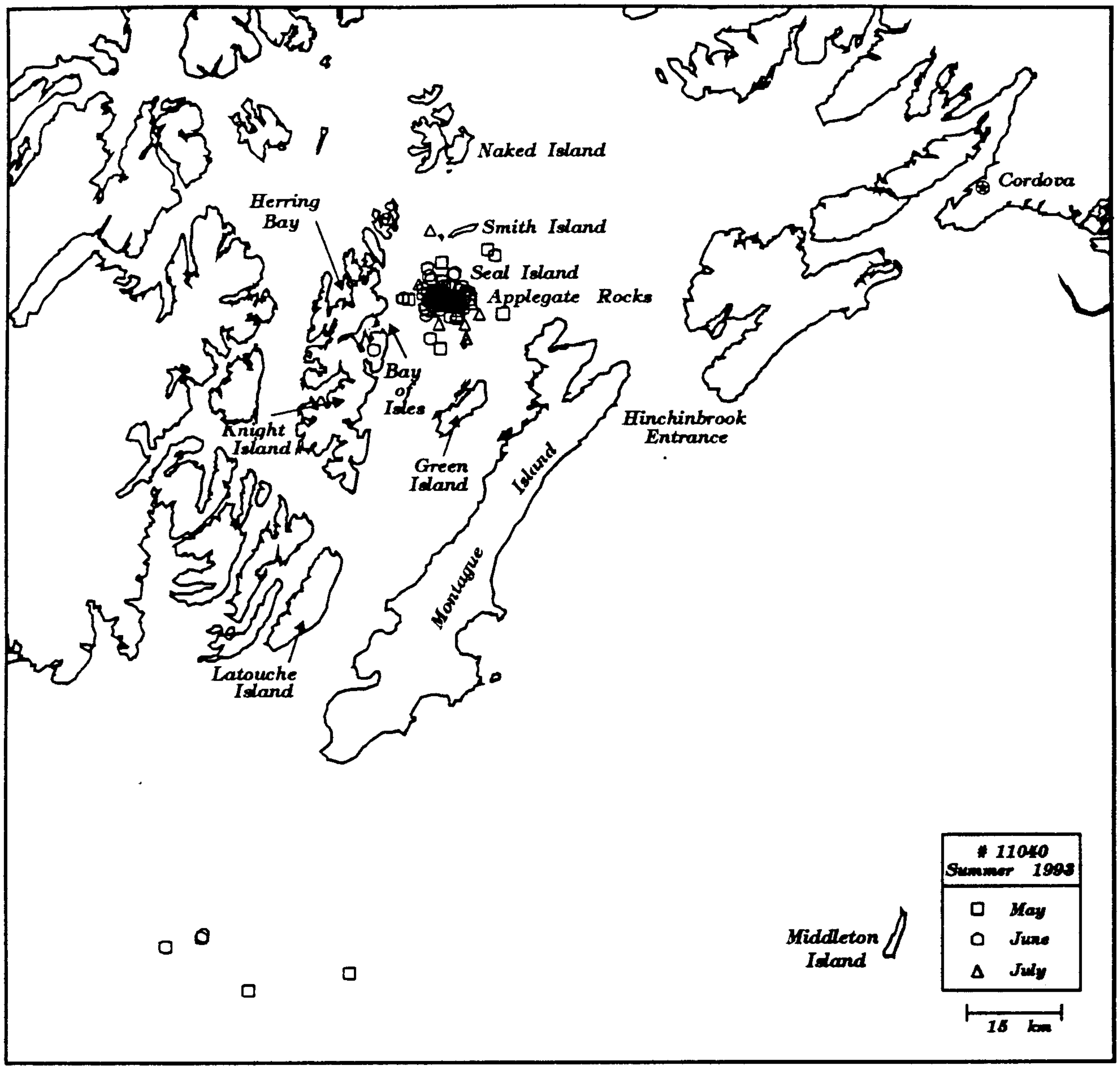

Figure 13. Map of Prince William Sound and the Gulf of Alaska showing movements of satellite tagged seal 11040, 8 May-8 July 1993.

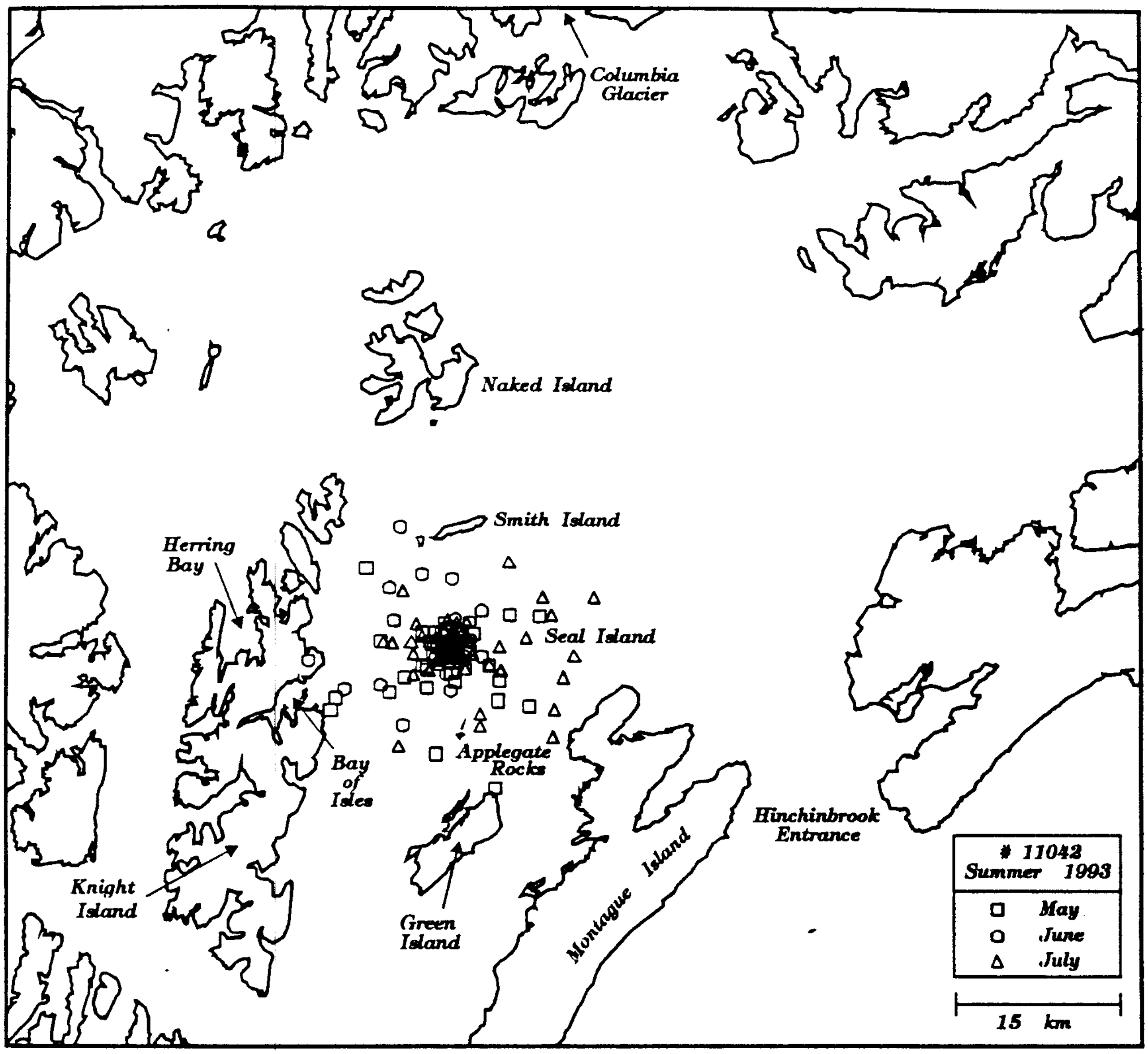

Figure 14. Map of Prince William Sound showing movements of satellite tagged seal 11042, 9 May-25 July 1993.

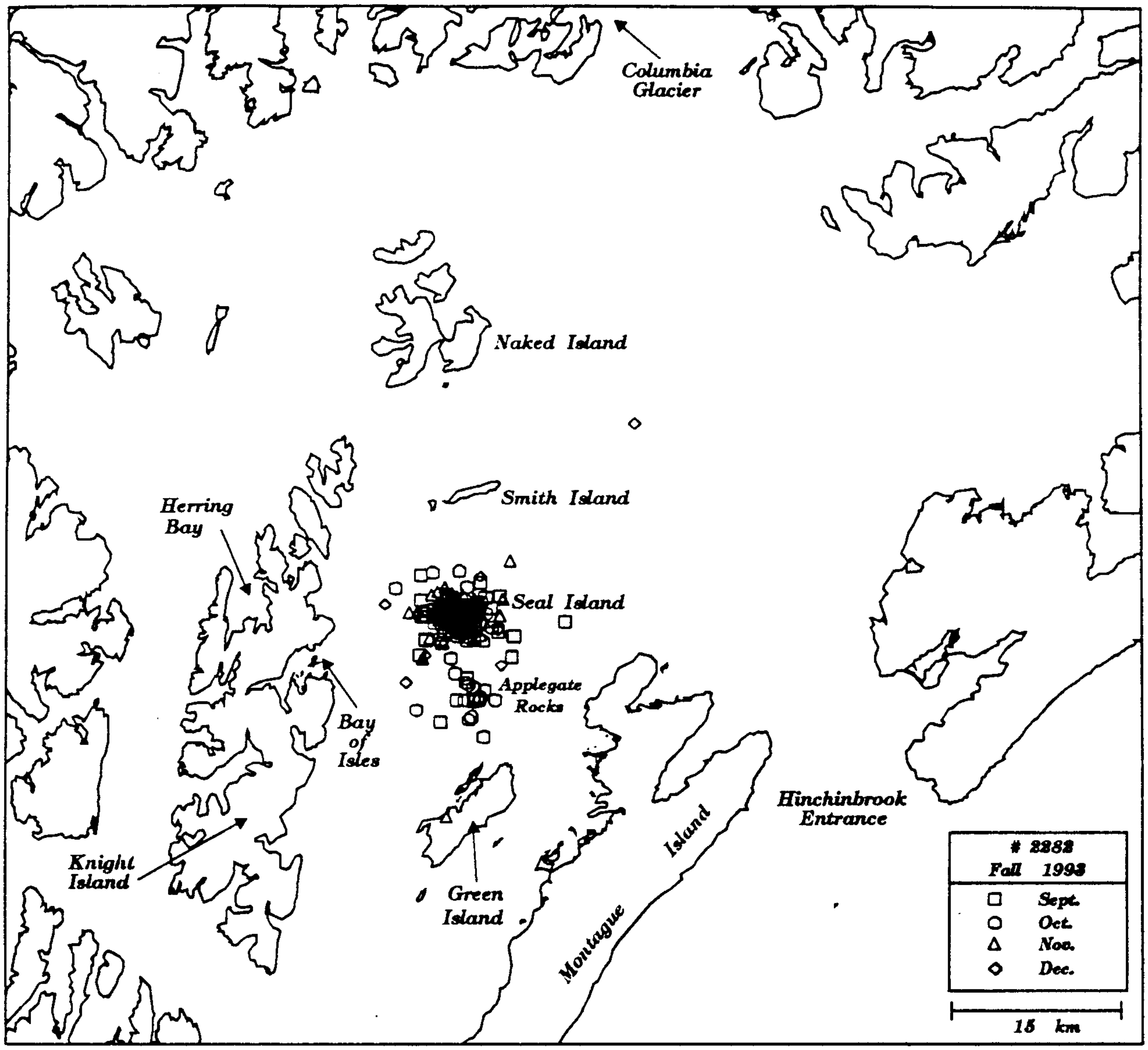

Figure 15. Map of Prince William Sound showing movements of satellite tagged seal 2282, 15 September-31 December 1993.

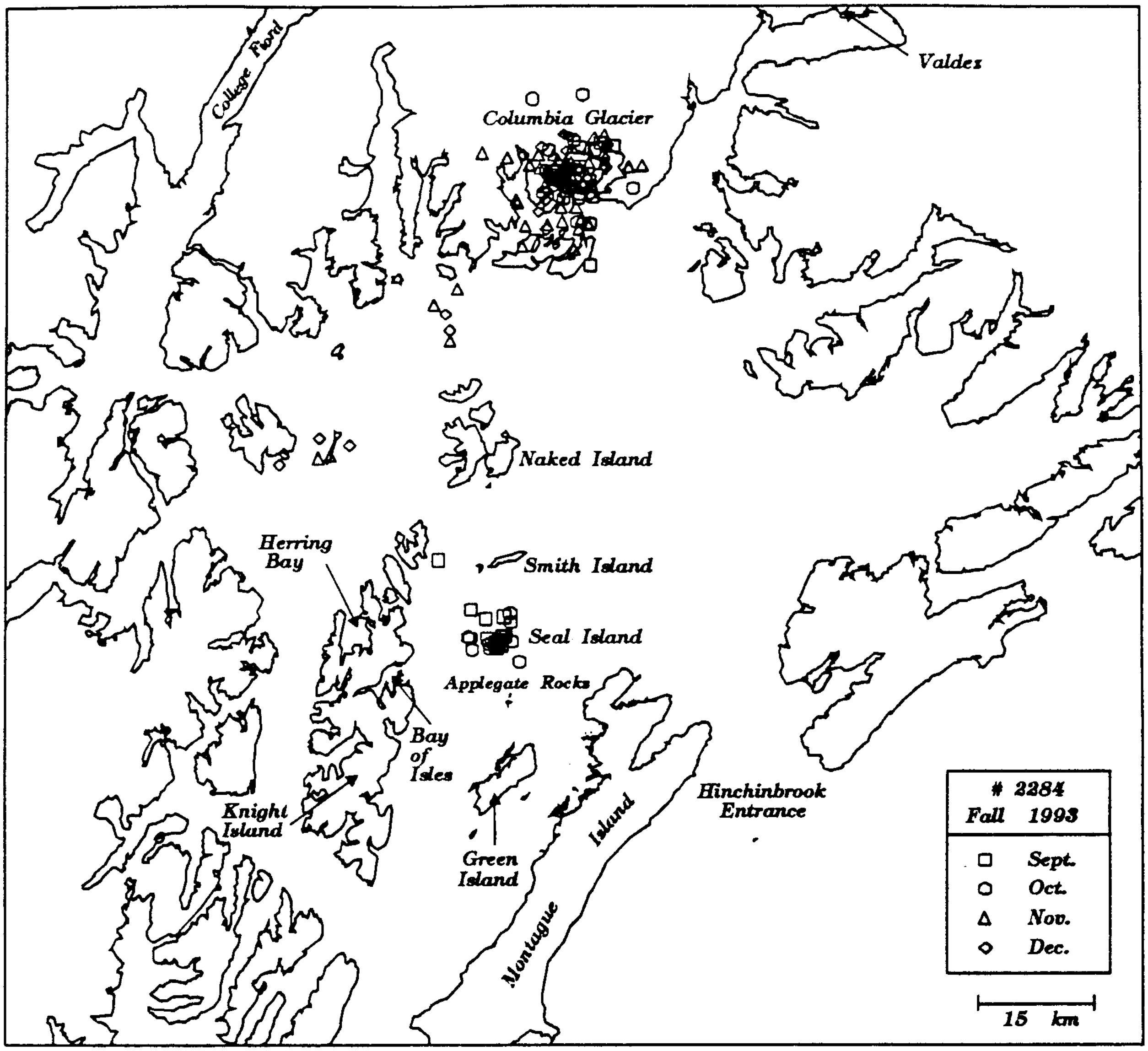

Figure 16. Map of Prince William Sound showing movements of satellite tagged seal 2284, 15 September-31 December 1993.

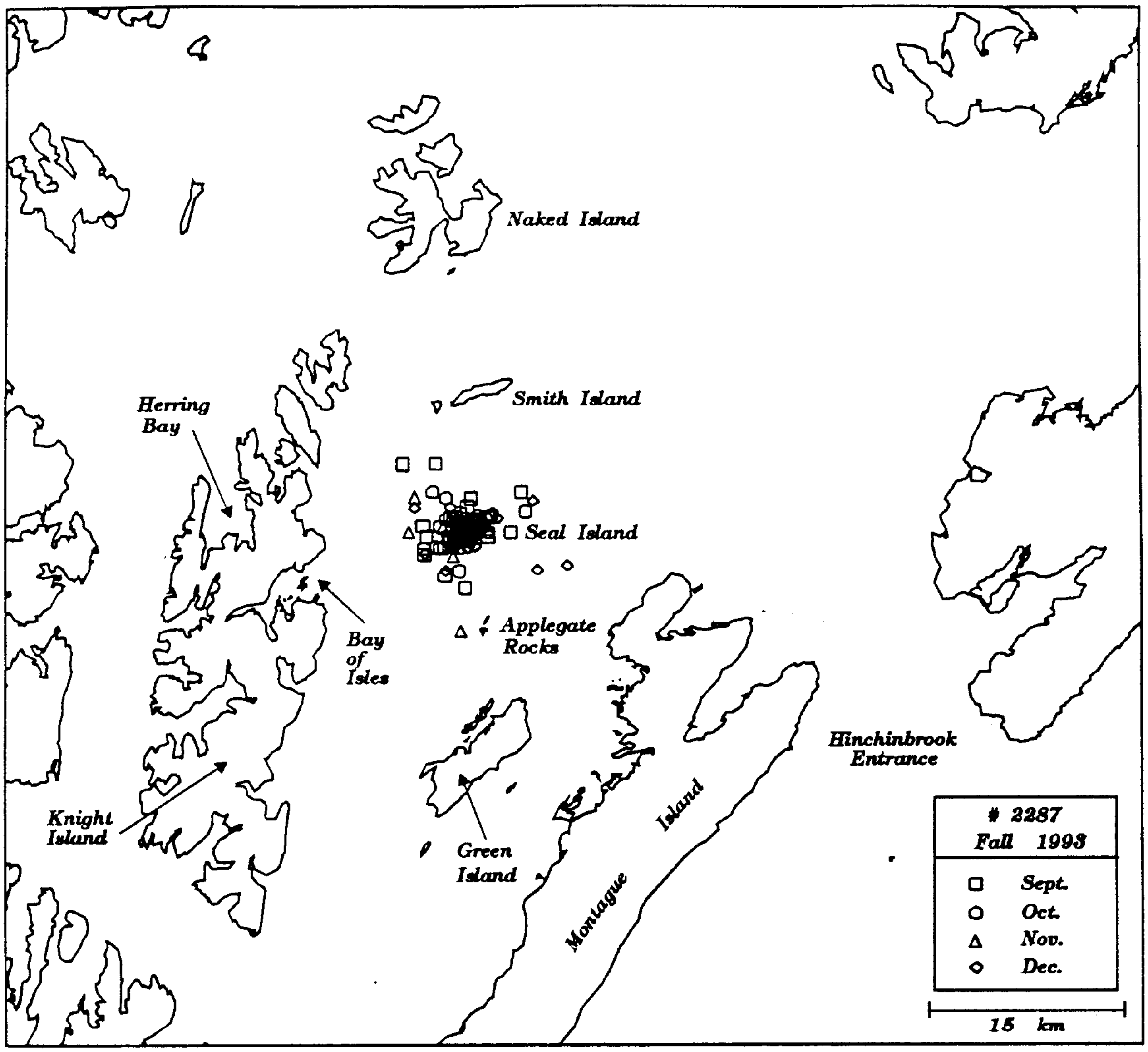

Figure 17. Map of Prince William Sound showing movements of satellite tagged seal 2287, 15 September-31 December 1993.

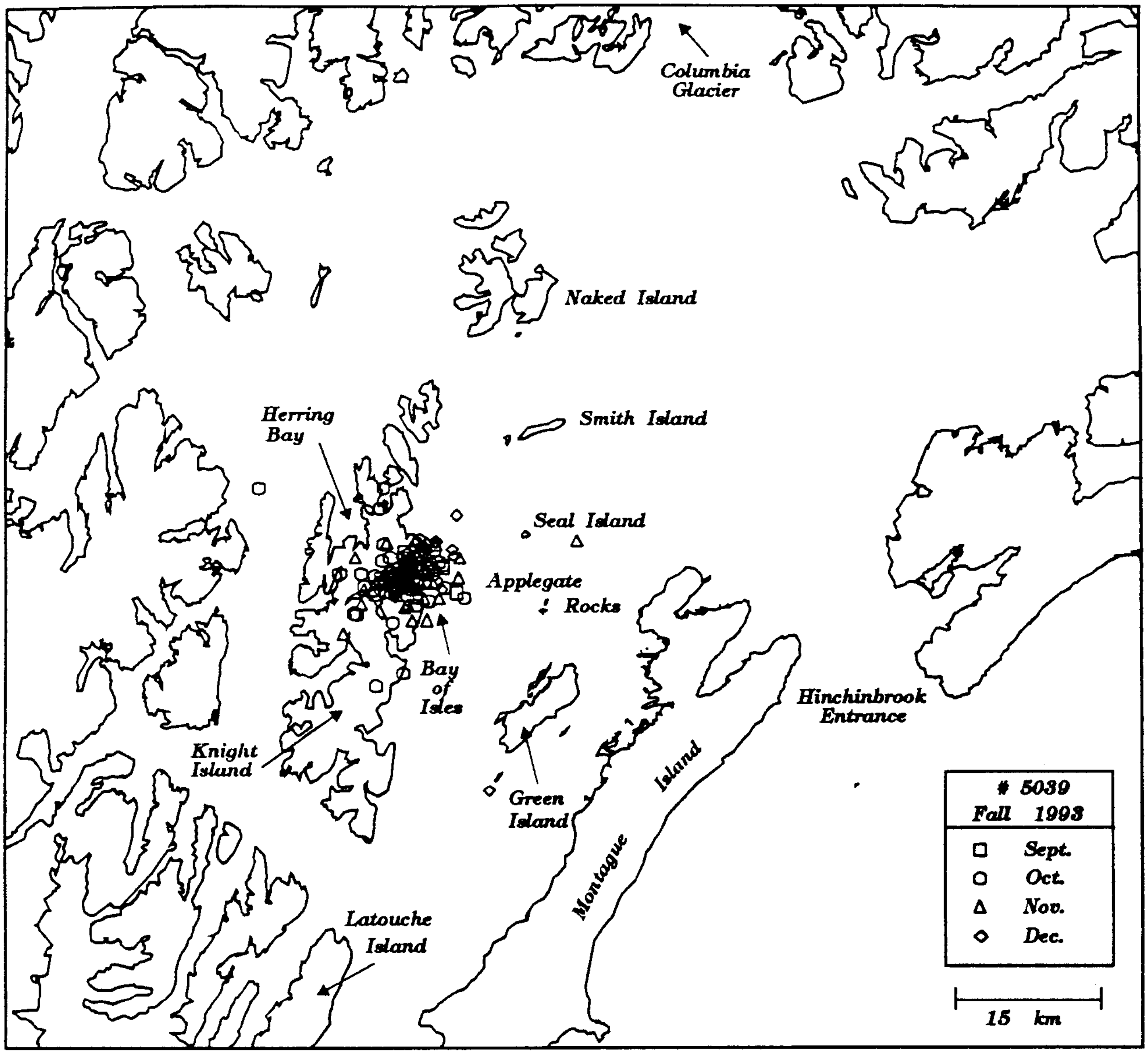

Figure 18. Map of Prince William Sound showing movements of satellite tagged seal 5039, 16 September-31 December 1993.

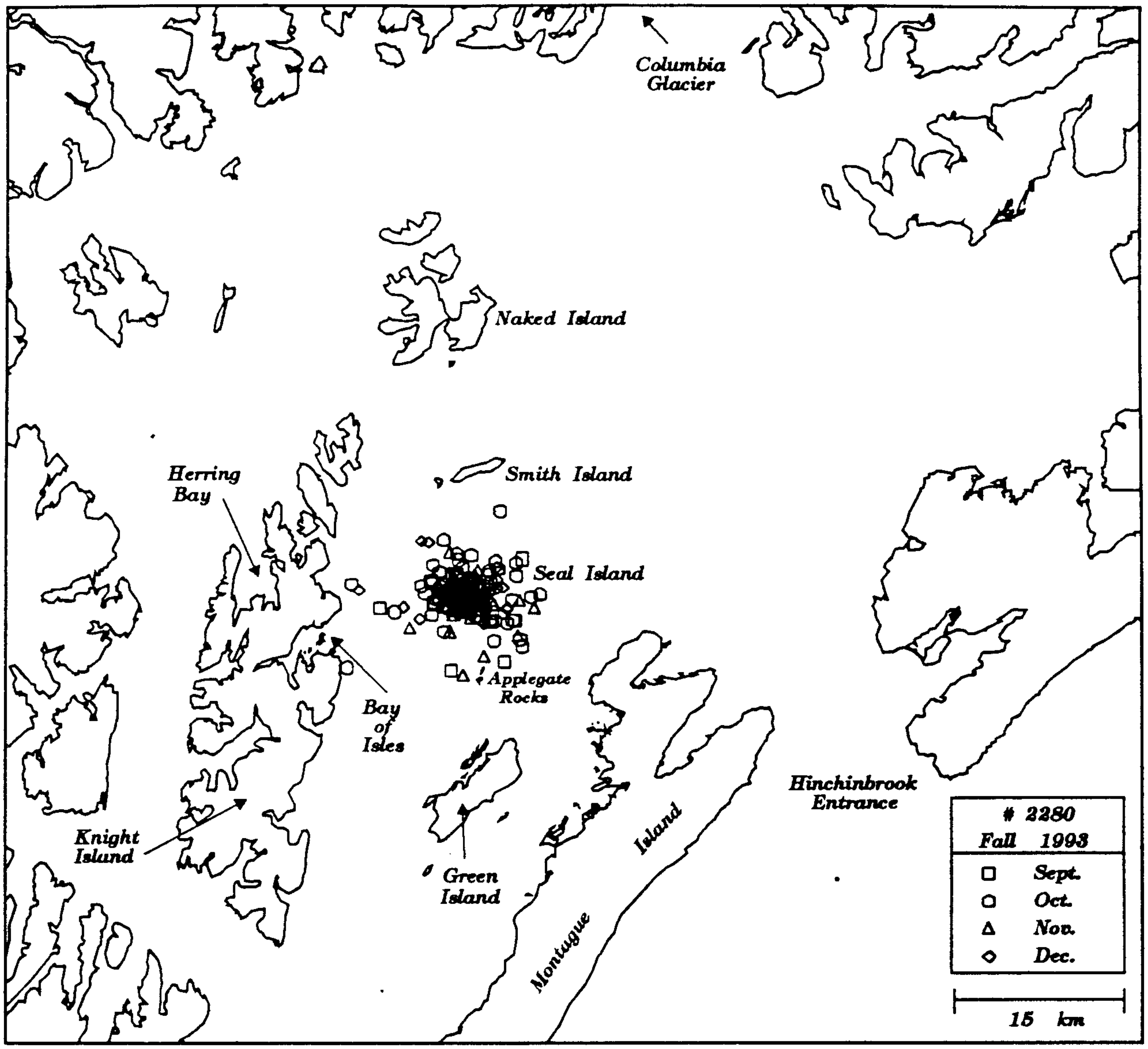

Figure 19. Map of Prince William Sound showing movements of satellite tagged seal 2280, 18 September-31 December 1993.

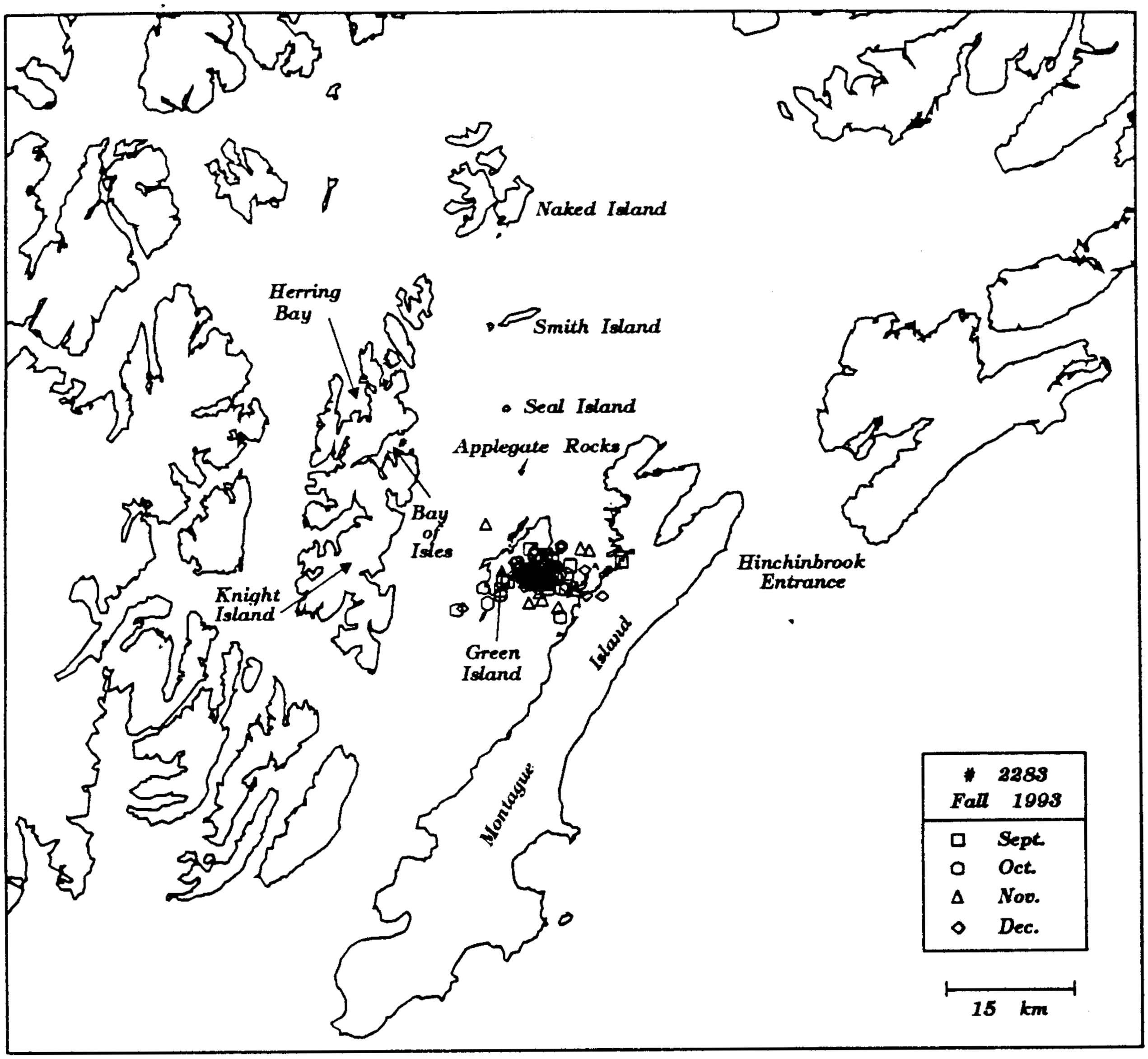

Figure 20. Map of Prince William Sound showing movements of satellite tagged seal 2283, 18 September-31 December 1993.

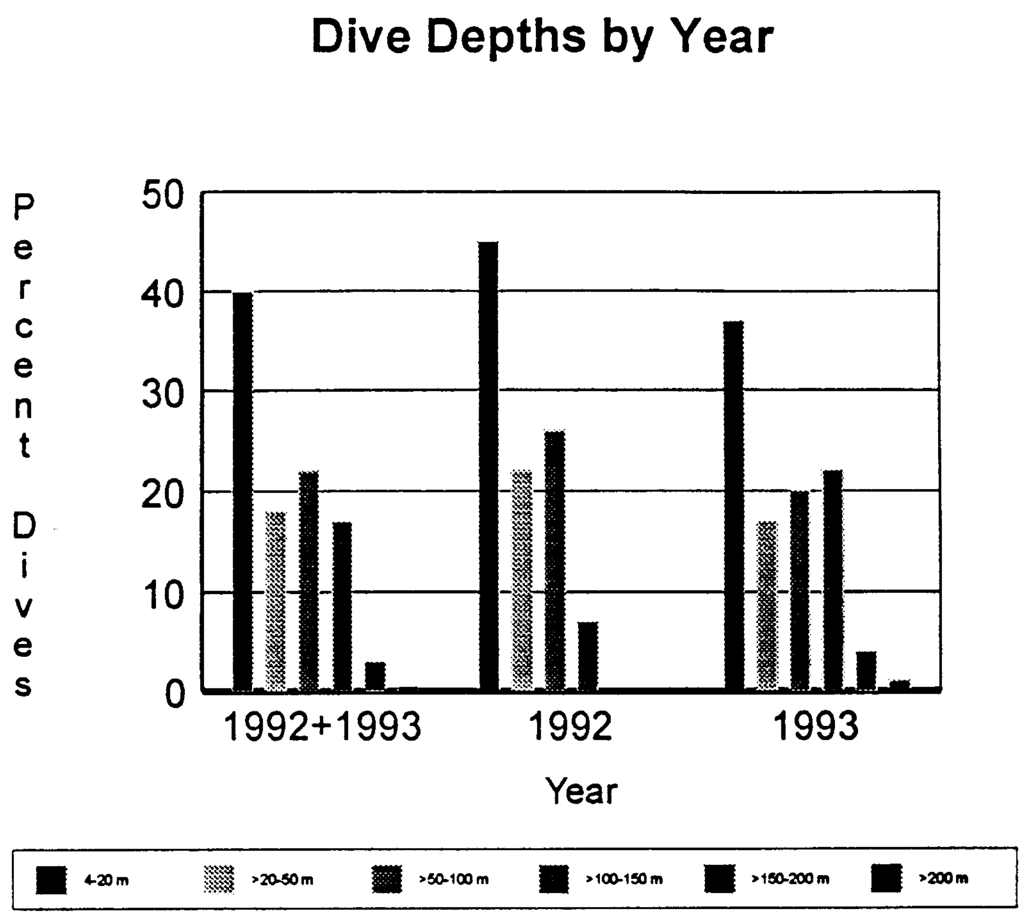

Figure 21. Percent of dives in six depth bins for 10 satellite-tagged harbor seals in Prince William Sound, May-July 1992 and 1993, combined by year.

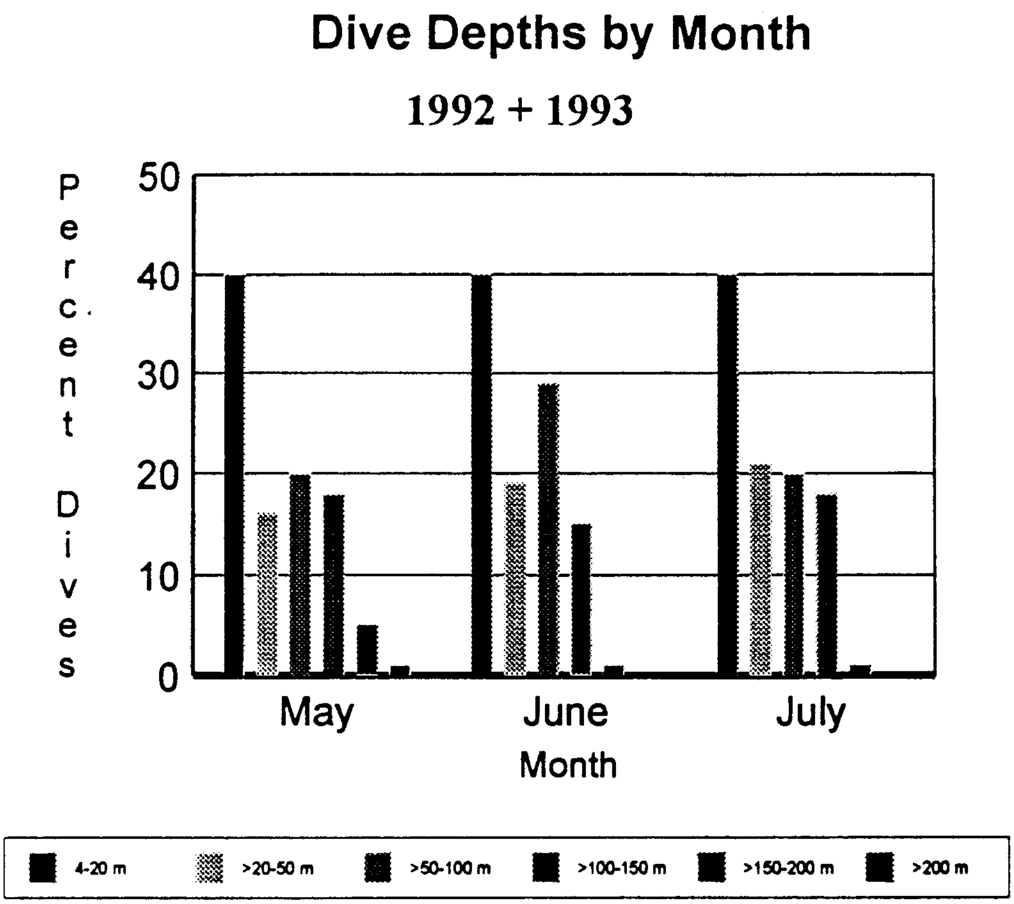

Figure 22. Percent of dives in six depth bins for 10 satellite-tagged harbor seals in Prince William Sound, May-July 1992 and 1993, combined by month.

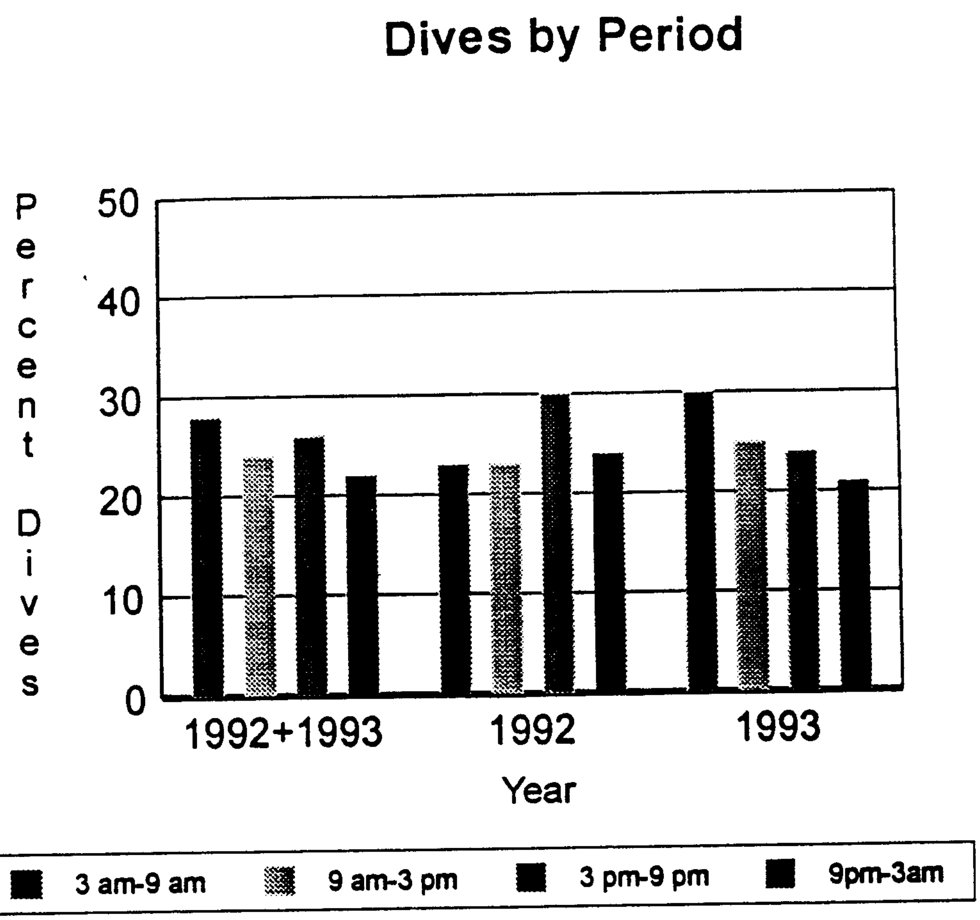

Figure 23. Percent of dives in four six-hour periods of the day for 10 satellite-tagged harbor seals in Prince William Sound, May-July 1992 and 1993.

Appendix A. Repetitive counts of harbor seals on selected haulout sites in Prince William Sound, August-September 1984 (ADF&G, unpublished). Dashes indicate that no count was made.

	Date (August/September)							
Site	22	27	28	29	30	31	1	2
Sheep Bay	0	29	60	78	66	47	90	0
Gravina Island	1	37	36	49	42	31	1	15
Gravina Rocks	29	48	66	20	63	48	65	18
Olsen Bay	49	122	195	197	158	154	239	89
Porcupine	4	14	19	54	53	27	41	32
Fairmount	57	83	109	110	89	86	133	117
Payday	16	12	8	13	13	11	13	10
Olsen Island	12	34	34	54	48	46	46	47
Point Pellew	6	9	7	28	39	35	43	19
Little Axel Lind	31	17	35	30	29	28	33	22
Storey Island	5	10	0	18	11	12	16	20
Agnes Island	42	55	89	104	67	91	109	103
Little Smith I.	72	23	127	99	82	108	66	56
Big Smith I.	7	83	146	84	117	162	109	82
Seal Island	142	166	149	118	78	116	90	58
Applegate Rocks	221	199	154	435	195	212	238	162
Green Island	4	72	85	105	43	70	37	78
Channel Island	264	472	289	226	501	294	59	157
Little Green I.	17	14	49	60	70	81	62	128
Port Chalmers	8	11	77	106	72	86	143	77
Stockdale Hbr	54	0	38	23	39	22	32	75
Montague Point	0	43	24	69	45	61	76	61
Rocky Bay	0	39	49	53	43	39	37	36
Schooner Rocks	0	88	86	90	112	74	63	64
Canoe Passage	4	0	17	6	7	16	31	28

Appendix B. Repetitive counts of harbor seals on selected haulout sites in Prince William Sound, August-September 1988 (Pitcher 1989). Dashes indicate that no count was made.

	Date (August/September)									
Site	28	2	5	6	7	8	9	13	14	15
Sheep Point	4	3	4	6	8	13	28	31	11	--
Gravina Island	21	0	0	1	3	2	37	38	10	--
Gravina Rocks	36	31	49	41	19	35	52	65	52	--
Olsen Bay	129	68	95	72	25	63	98	84	82	--
Porcupine	10	0	0	0	0	0	16	6	0	--
Fairmount	72	74	68	1	14	35	28	--	--	--
Payday	2	0	0	1	0	0	0	9	3	--
Olsen Island	18	20	9	5	14	1	12	15	13	--
Point Pellew	32	28	28	25	22	21	0	8	12	--
Little Axel Lind	13	14	19	19	9	32	13	21	26	--
Storey Island	3	5	1	0	2	7	10	14	2	--
Agnes Island	41	37	40	56	--	48	13	35	43	--
Little Smith I.	52	60	31	13	--	11	3	43	33	38
Big Smith I.	60	78	54	96	--	83	--	78	76	98
Seal Island	82	79	85	61	--	52	--	82	61	59
Applegate Rocks	99	166	219	185	--	--	--	127	125	--
Green Island	13	66	55	50	--	29	--	38	38	48
Channel Island	195	75	59	52	--	47	--	81	--	70
Little Green I.	--	95	--	67	--	--	--	55	13	24
Port Chalmers	--	98	51	61	--	73	--	68	76	59
Stockdale Hbr	23	76	51	46	--	36	--	50	52	36
Montague Point	24	35	30	46	--	44	--	18	29	33
Rocky Bay	0	24	7	9	--	4	--	23	20	2
Schooner Rocks	20	66	78	84	--	86	--	68	76	54
Canoe Passage	0	32	78	6	--	22	0	91	62	--

Appendix C. Repetitive counts of harbor seals on selected haulout sites in Prince William Sound, September 1989. Dashes indicate that no count was made.

	Date (September)									
Site	3	4	7	8	9	11	12	13	15	16
Sheep Point	0	0	0	--	0	0	0	--	0	0
Gravina Island	13	9	--	--	--	--	12	--	11	54
Gravina Rocks	43	50	44	--	37	23	23	--	15	28
Olsen Bay	62	66	55	--	37	19	27	--	--	33
Porcupine	12	10	--	--	4	4	13	--	2	2
Fairmount	53	47	21	39	28	48	--	--	1	23
Payday	4	1	0	0	0	4	--	--	0	3
Olsen Island	9	2	10	12	13	11	--	--	0	0
Point Pellew	32	22	24	22	25	28	--	--	32	5
Little Axel Lind	11	21	25	27	25	26	--	--	23	25
Storey Island	0	0	4	5	0	1	--	--	4	10
Agnes Island	26	60	47	54	22	29	--	--	18	26
Little Smith I.	7	24	--	40	28	9	--	--	20	17
Big Smith I.	46	44	--	52	24	--	--	--	46	34
Seal Island	41	59	--	22	26	35	--	--	30	41
Applegate Rocks	--	--	--	61	103	96	--	--	--	72
Green Island	3	29	--	28	14	17	--	--	32	2
Channel Island	--	116	--	--	--	--	--	--	--	--
Little Green I.	--	13	--	--	--	35	--	--	--	47
Port Chalmers	--	--	--	56	32	67	--	--	74	78
Stockdale Hbr	--	63	--	52	57	47	--	--	29	15
Montague Point	32	48	--	47	23	--	--	39	40	27
Rocky Bay	19	19	--	12	11	7	--	9	4	7
Schooner Rocks	63	62	--	31	58	73	--	87	67	31
Canoe Passage	0	71	8	1	34	54	--	2	2	0

Appendix D. Repetitive counts of harbor seals on selected haulout sites in Prince William Sound, August-September 1990. Dashes indicate that no count was made.

Site	Date (August/September)							
	28	29	30	31	1	4	7	11
Sheep Point	0	0	0	0	2	0	0	0
Gravina Island	4	0	3	3	3	13	11	3
Gravina Rocks	37	--	15	31	24	24	11	8
Olsen Bay	87	79	83	104	50	62	50	39
Porcupine	1	0	0	0	0	0	4	0
Fairmount	43	19	27	36	31	4	6	6
Payday	13	0	8	2	1	2	0	4
Olsen Island	12	7	14	15	3	0	15	17
Point Pellew	33	31	20	26	24	15	17	16
Little Axel Lind	15	14	15	17	10	8	19	23
Storey Island	0	0	10	4	1	0	5	0
Agnes Island	50	41	43	45	29	19	27	37
Little Smith Island	43	33	32	20	31	21	26	29
Big Smith Island	31	27	29	32	31	18	40	--
Seal Island	39	23	41	50	46	35	--	--
Applegate Rocks	151	109	98	104	122	110	--	113
Green Island	7	28	29	47	14	13	24	24
Channel Island	--	45	36	--	--	--	--	--
Little Green Island	--	15	21	32	27	--	--	46
Port Chalmers	--	79	131	--	119	--	95	96
Stockdale Harbor	39	52	57	48	59	39	42	55
Montague Point	29	49	40	46	27	17	33	48
Rocky Bay	7	16	18	11	13	1	9	10
Schooner Rocks	25	58	48	53	51	43	6	56
Canoe Passage	41	16	12	11	61	3	0	39

Appendix E. Repetitive counts of harbor seals on selected haulout sites in Prince William Sound, August-September 1991. Dashes indicate that no count was made.

	Date (August/September)									
Site	22	23	24	26	27	28	29	30	31	01
Sheep Point	0	0	0	4	0	0	0	--	0	2
Gravina Island	5	5	19	28	11	11	11	2	18	21
Gravina Rocks	13	21	38	31	28	28	29	24	32	21
Olsen Bay	119	125	75	101	85	63	58	42	60	75
Porcupine	12	13	17	2	10	17	20	17	21	12
Fairmount	22	--	--	22	1	9	26	21	22	16
Payday	3	7	--	8	11	0	2	5	2	5
Olsen Island	0	0	--	11	15	15	14	15	16	5
Point Pellew	29	41	--	13	11	20	--	24	24	24
Little Axel Lind	12	--	--	6	10	12	8	10	10	15
Storey Island	0	0	--	0	0	0	2	0	2	0
Agnes Island	61	52	--	34	32	--	48	34	27	20
Little Smith I.	26	25	18	28	23	22	22	27	28	27
Big Smith Island	42	35	--	15	34	27	34	35	40	34
Seal Island	78	--	65	50	--	--	51	52	73	70
Applegate Rocks	169	--	94	88	92	95	9	14	115	56
Green Island	10	--	40	33	29	24	29	15	--	19
Channel Island	235	--	213	211	54	--	24	36	31	35
Little Green I.	26	--	17	0	2	6	6	32	--	34
Port Chalmers	75	--	96	98	75	129	152	--	139	104
Stockdale Hbr	32	--	57	45	50	51	--	43	44	53
Montague Point	32	--	27	24	34	28	27	30	27	20
Rocky Bay	26	--	25	25	26	18	28	13	25	1
Schooner Rocks	68	--	58	56	56	81	42	47	43	49
Canoe Passage	0	27	104	75	24	45	--	--	74	55

Appendix F. Repetitive counts of harbor seals on selected haulout sites in Prince William Sound, August-September 1992. Dashes indicate that no count was made.

	Date (August/September)									
Site	27	27	28	29	30	1	2	3	5	6
Sheep Point	0	1	0	1	0	0	1	0	1	0
Gravina Island	41	26	41	14	22	28	21	11	24	11
Gravina Rocks	33	26	34	42	33	36	25	33	37	13
Olsen Bay	51	76	70	75	9	31	14	40	39	9
Porcupine	11	14	20	7	8	0	--	5	3	0
Fairmount	--	17	15	15	1	5	--	14	14	13
Payday	1	0	0	0	0	0	--	0	0	1
Olsen Island	4	0	0	8	6	8	--	4	8	0
Point Pellew	12	17	15	10	11	14	--	11	14	9
Little Axel Lind	9	6	9	4	7	8	--	6	7	5
Storey Island	0	0	0	1	0	0	--	0	0	0
Agnes Island	57	61	56	52	47	41	--	41	29	17
Little Smith I.	41	28	35	29	25	33	--	38	36	33
Big Smith I.	53	41	42	44	37	36	--	51	45	44
Seal Island	71	65	43	51	37	59	--	--	35	51
Applegate Rocks	74	--	59	56	51	63	--	37	75	108
Green Island	40	42	24	49	36	23	--	46	46	29
Channel Island	116	46	92	100	106	119	--	--	26	17
Little Green I.	18	71	62	--	55	56	--	60	52	64
Port Chalmers	53	67	49	81	73	83	--	57	63	35
Stockdale Hbr	52	54	46	53	47	39	--	32	31	28
Montague Point	4	10	5	13	12	9	--	22	5	7
Rocky Bay	30	20	28	19	19	29	--	23	27	21
Schooner Rocks	47	67	50	64	63	50	--	57	56	59
Canoe Passage	5	2	0	25	54	53	31	10	40	34

Appendix G. Repetitive counts of harbor seals on selected haulout sites in Prince William Sound, August-September 1993. Dashes indicate that no count was made.

	Date (August/September)						
Site	24	25	26	27	28	3	5
Sheep Point	2	0	0	1	--	0	22
Gravina Island	8	10	19	--	--	28	--
Gravina Rocks	44	--	34	27	--	42	44
Olsen Bay	85	59	86	78	--	60	69
Porcupine	5	2	0	0	2	4	6
Fairmount	26	21	18	23	24	11	14
Payday	0	1	0	0	0	0	1
Olsen Island	0	0	1	0	2	5	8
Point Pellew	8	0	12	12	9	15	15
Little Axel Lind	0	0	2	2	1	5	8
Storey Island	0	0	0	0	0	0	2
Agnes Island	50	18	0	10	20	21	36
Little Smith Island	37	22	32	24	10	27	18
Big Smith Island	48	29	44	19	25	46	40
Seal Island	33	49	39	30	40	48	47
Applegate Rocks	74	--	22	72	34	--	69
Green Island	28	--	12	20	19	52	38
Channel Island	207	--	213	54	69	--	47
Little Green Island	31	--	56	54	58	22	66
Port Chalmers	102	--	114	127	113	108	121
Stockdale Harbor	0	--	14	17	19	16	19
Montague Point	0	--	0	4	0	2	1
Rocky Bay	24	--	11	22	23	34	16
Schooner Rocks	87	--	54	59	71	32	--
Canoe Passage	13	28	41	11	--	13	--

Appendix H. Repetitive counts of harbor seals and seal pups (#/#) on selected haulout sites in Prince William Sound, June 1989. Dashes indicate that no count was made.

	Date (June)								
Site	8	11	16	17	18	19	20	26	27
Sheep Point	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Gravina Island	2/0	0/0	0/0	0/0	0/0	3/2	19/1	0/0	0/0
Gravina Rocks	7/0	0/0	0/0	0/0	1/0	2/0	11/1	9/0	13/1
Olsen Bay	62/13	47/6	66/25	---	65/14	69/20	76/18	---	88/13
Porcupine	18/1	8/3	3/2	3/0	---	12/3	24/4	0/0	1/0
Fairmount	17/5	23/7	29/5	17/7	6/4	2/1	10/4	19/9	27/6
Payday	1/1	2/1	3/1	6/5	6/3	1/1	1/0	11/10	6/6
Olsen Island	0/0	8/1	14/1	5/1	13/3	6/2	---	17/4	13/4
Point Pellew	15/2	16/4	18/5	6/1	3/2	5/1	---	12/5	13/5
Little Axel Lind	4/0	6/0	4/0	3/1	1/0	0/0	---	0/0	2/0
Storey Island	8/1	2/1	0/0	1/1	0/0	8/1	6/0	1/0	1/0
Agnes Island	26/10	30/7	29/9	25/9	25/9	34/7	25/7	34/13	---
Little Smith I.	36/9	10/2	9/5	8/4	10/1	7/2	7/1	2/0	8/4
Big Smith I.	12/5	23/4	11/6	15/7	---	21/8	17/7	15/6	28/13
Seal Island	48/23	22/6	39/14	39/16	48/12	40/11	68/12	50/18	63/14
Applegate Rocks	199/19	---	---	133/29	126/16	---	134/23	133/56	180/44
Green Island	32/11	16/4	18/9	15/5	25/10	17/5	26/8	22/9	23/10
Channel Island	93/12	74/5	76/12	61/18	---	45/7	90/9	152/20	140/12
Little Green I.	90/6	---	85/30	83/13	64/16	82/11	93/18	118/19	88/9
Port Chalmers	104/21	67/18	62/19	61/15	65/14	86/20	91/23	83/21	54/17
Stockdale Hbr	28/0	17/5	9/3	14/5	11/0	16/2	25/3	32/9	27/7
Montague Point	32/0	26/8	17/6	14/4	8/3	13/2	18/5	1/1	9/4
Rocky Bay	31/6	21/6	23/11	22/9	14/6	30/10	32/9	27/8	22/6
Schooner Rocks	54/5	36/4	24/8	24/6	17/3	10/4	24/5	38/10	32/6
Canoe Passage	1/0	0/0	0/0	0/0	1/0	0/0	0/0	1/0	1/0

Appendix I. Repetitive counts of harbor seals and seal pups (#/#) on selected haulout sites in Prince William Sound, June 1990. Dashes indicate that no count was made.

	Date (June)								
Site	7	8a	8b	9	10	11	12	13	15
Sheep Point	4/0	3/0	4/0	4/0	1/0	1/0	0/0	1/0	1/0
Gravina Island	13/0	18/0	1/0	15/0	17/0	14/0	0/0	7/0	14/0
Gravina Rocks	5/1	6/1	0/0	9/1	9/1	9/0	0/0	7/1	0/0
Olson Bay	41/12	---	67/33	51/18	69/17	71/27	49/21	31/12	59/24
Porcupine	2/1	3/1	1/0	2/1	2/1	1/1	2/1	3/1	0/0
Fairmount	11/4	10/0	13/5	---	---	2/2	10/6	6/1	17/9
Payday	0/0	0/0	0/0	---	---	0/0	0/0	0/0	1/1
Olsen Island	0/0	0/0	1/1	---	---	12/3	6/1	1/0	2/1
Point Pellew	7/1	7/2	5/1	---	---	8/2	8/1	9/1	10/2
Little Axel Lind	2/0	1/0	2/0	---	---	0/0	0/0	0/0	3/0
Storey Island	8/0	5/1	4/2	---	---	6/2	7/3	0/0	6/1
Agnes Island	44/12	54/14	43/18	44/12	---	54/17	30/13	35/16	36/18
Little Smith I.	24/5	25/7	18/6	18/7	---	12/5	25/11	13/3	14/6
Big Smith I.	20/4	24/5	22/11	13/4	---	16/7	15/2	15/4	21/5
Seal Island	54/20	60/21	53/22	32/17	---	53/19	40/23	37/19	45/15
Applegate Rocks	132/39	137/26	140/39	122/34	---	130/38	158/37	121/34	157/43
Green Island	20/6	26/17	23/14	29/18	---	30/15	33/18	29/17	33/22
Channel Island	64/2	75/2	---	58/3	---	86/3	96/3	53/5	76/2
Little Green I.	61/4	54/5	78/7	57/9	---	76/8	47/8	100/2	---
Port Chalmers	98/19	92/28	---	110/30	---	94/29	84/23	84/22	103/20
Stockdale Hbr	26/0	22/0	25/0	37/0	---	30/0	35/0	---	23/0
Montague Point	24/2	21/1	---	26/1	---	28/1	21/0	16/1	---
Rocky Bay	17/3	13/3	---	28/6	---	25/9	23/7	18/6	---
Schooner Rocks	21/1	17/3	35/5	31/4	---	21/4	11/2	42/4	24/4
Canoe Passage	0/0	0/0	1/0	3/2	---	3/2	0/0	0/0	0/0

Appendix J. Repetitive counts of harbor seals and seal pups (#/#) on selected haulout sites in Prince William Sound, June 1991. Dashes indicate that no count was made.

	Date (June)										
Site	11	12a	12b	13a	13b	14a	14b	16	18	19	20
Sheep Point	0/0	0/0	0/0	0/0	1/0	1/0	0/0	0/0	x	0/0	0/0
Gravina Island	0/0	0/0	1/0	6/0	3/0	4/0	0/0	11/1	5/1	0/0	0/0
Gravina Rocks	0/0	0/0	0/0	0/0	2/0	0/0	0/0	2/1	4/0	0/0	0/0
Olson Bay	26/12	24/14	15/10	x	13/10	8/5	21/14	24/9	33/15	20/8	46/15
Porcupine	0/0	7/4	1/0	12/3	0/0	12/3	---	9/3	10/3	10/1	2/1
Fairmount	12/2	4/2	13/3	11/4	17/3	14/4	---	---	4/1	8/5	15/6
Payday	1/1	1/1	4/1	1/0	4/2	5/1	---	---	0/0	8/1	4/1
Olsen Island	0/0	0/0	1/0	3/2	5/1	5/2	---	---	0/0	7/0	5/2
Point Pellew	6/0	0/0	3/0	8/0	5/0	1/0	---	---	1/0	3/0	4/0
Little Axel Lind	1/1	1/0	3/1	0/0	4/1	1/0	---	---	0/0	5/0	7/0
Storey Island	0/0	1/1	0/0	1/1	1/0	1/0	---	---	---	0/0	0/0
Agnes Island	26/12	20/7	31/14	39/14	46/16	42/14	37/10	47/16	---	48/15	52/17
Little Smith I.	15/3	12/5	11/8	15/6	17/8	14/6	11/6	14/6	---	12/6	19/8
Big Smith I.	29/6	22/7	27/5	19/5	32/6	28/5	15/3	21/6	---	23/5	27/5
Seal Island	56/25	70/26	63/21	76/28	87/39	74/29	70/26	69/34	---	72/34	55/26
Applegate Rocks	73/29	130/43	75/26	126/57	129/33	159/54	157/36	147/52	---	177/53	185/48
Green Island	23/10	24/7	29/14	25/11	36/10	---	19/11	19/12	---	24/15	24/10
Channel Island	29/4	52/1	45/1	60/4	46/3	61/4	53/5	53/5	---	88/3	94/4
Little Green I.	5/3	---	30/5	58/8	55/9	54/5	34/6	55/9	---	62/5	12/2
Port Chalmers	44/5	58/19	69/12	86/19	91/27	40/8	43/15	94/28	---	85/20	29/13
Stockdale Hbr	13/1	15/0	14/0	17/0	16/0	1/0	5/0	14/0	---	24/0	8/0
Montague Point	10/1	17/1	13/2	19/1	14/1	18/1	13/1	20/1	---	14/1	12/2
Rocky Bay	12/5	0/0	18/3	19/5	25/7	22/7	14/3	23/6	---	27/8	25/2
Schooner Rocks	24/1	---	20/4	9/1	28/4	25/4	24/3	39/3	---	28/4	21/4
Canoe Passage	0/0	1/1	1/1	5/1	1/1	0/0	1/1	0/0	1/1	1/0	0/0

Appendix K. Repetitive counts of harbor seals and seal pups (#/#) on selected haulout sites in Prince William Sound, June 1992. Dashes indicate that no count was made.

	Date (June)			
Site	14	16	19	20
Sheep Point	8/1	0/0	1/0	4/1
Gravina Island	0/0	6/0	3/0	0/0
Gravina Rocks	5/0	10/0	10/0	10/0
Olsen Bay	19/4	32/17	24/9	24/7
Porcupine	1/0	3/0	3/1	0/0
Fairmount	6/2	---	20/5	23/6
Payday	0/0	---	8/0	2/1
Olsen Island	1/1	---	0/0	1/1
Point Pellew	6/0	---	6/0	4/1
Little Axel Lind	1/0	---	1/0	0/0
Storey Island	1/0	---	3/0	0/0
Agnes Island	50/16	35/16	44/14	29/6
Little Smith Island	7/5	12/6	17/3	17/4
Big Smith Island	9/2	20/5	16/5	15/3
Seal Island	50/30	54/24	45/16	34/19
Applegate Rocks	104/40	52/23	85/36	94/45
Green Island	61/19	38/6	42/13	57/13
Channel Island	71/4	64/5	62/19	78/4
Little Green Island	28/2	24/8	43/10	50/8
Port Chalmers	28/10	21/4	41/17	62/24
Stockdale Harbor	1/0	4/0	18/3	0/0
Montague Point	10/0	16/2	9/0	15/2
Rocky Bay	9/4	6/1	9/2	14/6
Schooner Rocks	38/4	37/6	18/8	25/4
Canoe Passage	0/0	1/0	0/0	0/0

Appendix L. Repetitive counts of harbor seals and seal pups (#/#) on selected haulout sites in Prince William Sound, June 1993. Dashes indicate that no count was made.

	Date (June)					
Site	7	8	9	20	21	22
Sheep Point	1/0	3/1	--	19/0	17/0	10/0
Gravina Island	5/1	7/0	0/0	6/0	14/0	6/0
Gravina Rocks	7/0	7/0	0/0	--	14/1	16/3
Olsen Bay	19/6	47/11	31/11	--	34/10	45/9
Porcupine	0/0	0/0	0/0	7/0	0/0	9/0
Fairmount	5/2	19/3	11/3	25/3	15/2	10/2
Payday	0/0	3/2	5/0	8/0	4/1	1/0
Olsen Island	3/2	1/0	5/1	9/2	11/3	4/1
Point Pellew	14/0	11/0	9/0	0/0	0/0	3/1
Little Axel Lind	0/0	0/0	0/0	0/0	0/0	0/0
Storey Island	1/1	0/0	3/0	1/1	0/0	1/0
Agnes Island	13/5	30/8	34/9	45/10	41/11	37/8
Little Smith Island	3/2	14/8	10/5	13/5	16/5	15/4
Big Smith Island	27/6	31/7	18/2	14/9	13/3	15/4
Seal Island	27/7	48/15	43/17	47/19	49/14	37/12
Applegate Rocks	94/43	132/46	121/35	102/25	107/18	93/21
Green Island	53/11	58/18	54/16	44/10	34/10	43/14
Channel Island	7/1	39/0	13/0	41/0	109/2	110/0
Little Green Island	31/3	41/6	30/5	45/5	46/8	49/6
Port Chalmers	77/10	90/29	113/26	73/17	70/11	65/13
Stockdale Harbor	0/0	3/1	0/0	3/0	0/0	1/0
Montague Point	0/0	0/0	9/1	5/0	5/0	8/2
Rocky Bay	17/4	6/1	20/4	18/4	20/1	26/7
Schooner Rocks	19/3	29/4	28/4	9/4	16/5	17/5
Canoe Passage	0/0	0/0	0/0	0/0	0/0	0/0

Appendix M. Number and percent of dives in six depth bins, by month, for three satellite-tagged harbor seal in Prince William Sound, April-June and September 1991. Depth bins for spring SLTDRs were: bin 1 - 4-10 m; bin 2 - 11-50 m; bin 3 - 51-100 m; bin 4 - 101-150 m; bin 5 - 151-200 m; bin 6 - >200 m. For September SLTDRs bins 1 and 2 were 4-20 m and 21-50 m. Other bins were the same.

	BIN 1		BIN 2		BIN 3		BIN 4		BIN 5		BIN 6		Total
Month	sum	percent	sum	percent	sum	percent	sum	percent	sum	percent	sum	percent	of Bins
14096													
April 20-30	0	0.0	5	20.8	11	45.8	8	33.3	0	0.0	0	0.0	24
May	8	8.8	41	45.1	40	44.0	2	2.2	0	0.0	0	0.0	91
June 1-20	26	16.3	96	60.0	38	23.8	0	0.0	0	0.0	0	0.0	160
11466													
September 12-14	180	58.6	54	17.6	36	11.7	7	2.3	23	7.5	7	2.3	307
11467													
September 13-15	279	65.0	56	13.1	84	19.6	5	1.2	3	0.7	2	0.5	429

Appendix N. Number and percent of dives in six depth bins, by month, for four satellite-tagged harbor seals in Prince William Sound, May-July 1992. Depth bins are: bin 1 - 4-20 m; bin 2 - 21-50 m; bin 3 - 51-100 m; bin 4 - 101-150 m; bin 5 - 151-200 m; bin 6 - >200 m.

SLTDR 3086 - Depth

Month	Period	BIN 1		BIN 2		BIN 3		BIN 4		BIN 5		BIN 6		Total of Bins	N
		sum	percent	sum	percent	sum	percent	sum	percent	sum	percent	sum	percent		
May	0	244	46.5	251	47.9	26	4.9	0	0.0	3	0.5	0	0.0	524	14
	1	153	24.4	159	25.4	312	49.8	2	0.3	0	0.0	0	0.0	626	14
	2	330	42.6	106	13.7	336	43.4	1	0.1	0	0.0	0	0.0	773	15
	3	86	33.7	111	43.5	56	21.9	2	0.7	0	0.0	0	0.0	255	14
	All Periods Combined:	813	37.3	627	28.7	730	33.5	5	0.2	3	0.1	0	0.0	2178	57
June	0	206	20.1	699	68.3	115	11.2	3	0.2	0	0.0	0	0.0	1023	21
	1	153	15.4	183	18.4	642	64.7	13	1.3	0	0.0	0	0.0	991	19
	2	181	16.7	166	15.3	722	66.9	10	0.9	0	0.0	0	0.0	1079	22
	3	131	11.6	253	22.5	732	65.3	5	0.4	0	0.0	0	0.0	1121	23
	All Periods Combined:	671	15.9	1301	30.8	2211	52.4	31	0.7	0	0.0	0	0.0	4214	85
July	0	75	54.7	51	37.2	11	8.0	0	0.0	0	0.0	0	0.0	137	4
	1	2	1.9	11	10.6	89	86.4	1	0.9	0	0.0	0	0.0	103	4
	2	33	23.0	7	4.9	102	71.3	1	0.7	0	0.0	0	0.0	143	4
	3	34	19.7	33	19.1	103	59.8	2	1.1	0	0.0	0	0.0	172	5
	All Periods Combined:	144	25.9	102	18.3	305	54.9	4	0.7	0	0.0	0	0.0	555	17

Appendix N. Continued.

SLTDR 3087 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	178	55.4	67	20.8	71	22.1	5	1.5	0	0.0	0	0.0	321	8
	1	48	20.3	58	24.5	90	38.1	40	16.9	0	0.0	0	0.0	236	9
	2	105	23.0	26	5.7	24	5.2	301	66.0	0	0.0	0	0.0	456	10
	3	130	34.3	76	20.1	62	16.4	110	29.1	0	0.0	0	0.0	378	9
	All Periods Combined:	461	33.1	227	16.3	247	17.7	456	32.7	0	0.0	0	0.0	1391	36
June	0	64	15.7	89	21.8	212	52.0	42	10.3	0	0.0	0	0.0	407	26
	1	119	28.2	32	7.6	125	29.6	142	33.7	1	0.2	2	0.4	421	24
	2	449	47.9	29	3.1	206	22.0	239	25.5	11	1.1	2	0.2	936	25
	3	492	78.8	14	2.2	56	8.9	62	9.9	0	0.0	0	0.0	624	25
	All Periods Combined:	1124	47.0	164	6.8	599	25.0	485	20.3	12	0.5	4	0.1	2388	100
July	0	21	14.6	42	29.3	75	52.4	5	3.5	0	0.0	0	0.0	143	6
	1	6	4.6	40	31.2	31	24.2	51	39.8	0	0.0	0	0.0	128	7
	2	10	12.2	5	6.1	4	4.8	63	76.8	0	0.0	0	0.0	82	7
	3	13	10.4	8	6.4	22	17.6	82	65.6	0	0.0	0	0.0	125	5
	All Periods Combined:	50	10.4	95	19.8	132	27.6	201	42.0	0	0.0	0	0.0	478	25

Appendix N. Continued.

SLTDR 3088 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	142	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	142	17
	1	19	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	19	17
	2	186	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	186	16
	3	81	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	81	16
	All Periods Combined:	428	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	428	66
June	0	127	51.8	60	24.4	56	22.8	2	0.8	0	0.0	0	0.0	245	21
	1	54	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	54	20
	2	259	79.6	30	9.2	30	9.2	6	1.8	0	0.0	0	0.0	325	20
	3	290	80.5	19	5.2	28	7.7	15	4.1	8	2.2	0	0.0	360	21
	All Periods Combined:	730	74.1	109	11.0	114	11.5	23	2.3	8	0.8	0	0.0	984	82
July	0	2	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	5
	1	2	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	4
	2	216	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	216	4
	3	55	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	55	5
	All Periods Combined:	275	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	275	18

Appendix N. Continued.

SLTDR 3089 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	518	67.5	233	30.3	14	1.8	1	0.1	1	0.1	0	0.0	767	12
	1	622	81.6	93	12.2	47	6.1	0	0.0	0	0.0	0	0.0	762	12
	2	604	87.5	60	8.7	26	3.7	0	0.0	0	0.0	0	0.0	690	13
	3	421	76.6	83	15.1	44	8.0	1	0.1	0	0.0	0	0.0	549	11
	All Periods Combined:	2165	78.2	469	16.9	131	4.7	2	0.0	1	0.0	0	0.0	2768	48
June	0	683	73.0	225	24.0	27	2.8	0	0.0	0	0.0	0	0.0	935	11
	1	444	75.1	116	19.6	30	5.0	1	0.1	0	0.0	0	0.0	591	8
	2	300	62.1	143	29.6	40	8.2	0	0.0	0	0.0	0	0.0	483	8
	3	307	63.5	159	32.9	17	3.5	0	0.0	0	0.0	0	0.0	483	9
	All Periods Combined:	1734	69.5	643	25.8	114	4.5	1	0.0	0	0.0	0	0.0	2492	36
July	0	152	51.7	131	44.5	11	3.7	0	0.0	0	0.0	0	0.0	294	5
	1	177	48.3	71	19.4	112	30.6	6	1.6	0	0.0	0	0.0	366	7
	2	261	69.7	58	15.5	50	13.3	5	1.3	0	0.0	0	0.0	374	7
	3	134	44.5	80	26.5	60	19.9	27	8.9	0	0.0	0	0.0	301	6
	All Periods Combined:	724	54.2	340	25.4	233	17.4	38	2.8	0	0.0	0	0.0	1335	25

Appendix O. Number and percent of dives in six duration bins, by month, for four satellite-tagged harbor seals in Prince William Sound, May-July 1992. Duration bins are: bin 1 - 1-120 sec; bin 2 - 121-240 sec; bin 3 - 241-360 sec; bin 4 - 361-480 sec; bin 5 - 481-600 sec; bin 6 - >600 sec.

SLTDR 3086 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	127	27.8	247	54.1	64	14.0	12	2.6	0	0.0	6	1.3	456	12
	1	115	19.4	361	61.0	103	17.4	8	1.3	2	0.3	2	0.3	591	14
	2	270	34.9	352	45.5	127	16.4	4	0.5	4	0.5	16	2.0	773	15
	3	60	23.5	131	51.3	51	20.0	10	3.9	2	0.7	1	0.3	255	14
	All Periods Combined:	572	27.5	1091	52.5	345	16.6	34	1.6	8	0.3	25	1.2	2075	55
June	0	160	14.2	756	67.1	179	15.9	29	2.5	0	0.0	2	0.1	1126	23
	1	125	11.7	623	58.6	281	26.4	27	2.5	2	0.1	5	0.4	1063	21
	2	199	16.2	565	46.1	421	34.3	23	1.8	4	0.3	13	1.0	1225	24
	3	110	9.8	737	65.7	248	22.1	17	1.5	2	0.1	7	0.6	1121	21
	All Periods Combined:	594	13.1	2681	59.1	1129	24.9	96	2.1	8	0.1	27	0.6	4535	89
July	0	33	15.8	79	37.9	61	29.3	27	12.9	7	3.3	1	0.4	208	6
	1	2	1.9	69	66.9	29	28.1	0	0.0	2	1.9	1	0.9	103	4
	2	26	18.1	76	53.1	36	25.1	3	2.1	1	0.7	1	0.7	143	4
	3	21	12.2	119	69.1	29	16.8	1	0.5	0	0.0	2	1.1	172	4
	All Periods Combined:	82	13.1	343	54.7	155	24.7	31	4.9	10	1.6	5	0.8	626	18

Appendix O. Continued.

SLTDR 3087 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	243	50.9	202	42.3	29	6.0	2	0.4	1	0.2	0	0.0	477	9
	1	61	15.5	186	47.4	135	34.4	5	1.2	4	1.0	1	0.2	392	13
	2	82	23.4	96	27.4	145	41.4	20	5.7	3	0.8	4	1.1	350	6
	3	41	12.8	113	35.5	156	49.0	6	1.8	1	0.3	1	0.3	318	8
	All Periods Combined:	427	27.7	597	38.8	465	30.2	33	2.1	9	0.5	6	0.3	1537	36
June	0	59	16.9	114	32.7	128	36.7	36	10.3	3	0.8	8	2.3	348	26
	1	99	28.4	73	20.9	115	33.0	44	12.6	7	2.0	10	2.8	348	23
	2	409	43.7	202	21.6	212	22.7	82	8.7	10	1.0	19	2.0	934	24
	3	402	63.1	78	12.2	103	16.1	25	3.9	4	0.6	25	3.9	637	25
	All Periods Combined:	969	42.7	467	20.6	558	24.6	187	8.2	24	1.0	62	2.7	2267	98
July	0	46	32.1	66	46.1	26	18.1	2	1.4	0	0.0	3	2.1	143	7
	1	9	3.4	108	41.7	135	52.1	5	1.9	1	0.3	1	0.3	259	8
	2	5	3.3	42	28.0	96	64.0	3	2.0	1	0.6	3	2.0	150	8
	3	12	9.6	38	30.4	74	59.2	0	0.0	0	0.0	1	0.8	125	5
	All Periods Combined:	72	10.6	254	37.5	331	48.8	10	1.4	2	0.3	8	1.1	677	28

Appendix O. Continued.

SLTDR 3088 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	109	76.7	16	11.2	13	9.1	1	0.7	0	0.0	3	2.1	142	17
	1	17	89.4	1	5.2	0	0.0	0	0.0	0	0.0	1	5.2	19	17
	2	148	79.1	22	11.7	11	5.8	1	0.5	3	1.6	2	1.0	187	17
	3	84	80.7	13	12.5	5	4.8	0	0.0	0	0.0	2	1.9	104	17
	All Periods Combined:	358	79.2	52	11.5	29	6.4	2	0.4	3	0.6	8	1.7	452	68
June	0	83	41.9	55	27.7	50	25.2	8	4.0	0	0.0	2	1.0	198	21
	1	53	43.0	25	20.3	39	31.7	3	2.4	1	0.8	2	1.6	123	21
	2	222	68.3	39	12.0	41	12.6	10	3.0	3	0.9	10	3.0	325	20
	3	210	56.9	46	12.4	53	14.3	32	8.6	3	0.8	25	6.7	369	21
	All Periods Combined:	568	55.9	165	16.2	183	18.0	53	5.2	7	0.6	39	3.8	1015	83
July	0	1	50.0	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	2	5
	1	2	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	5
	2	196	90.7	8	3.7	5	2.3	2	0.9	1	0.4	4	1.8	216	4
	3	40	72.7	3	5.4	3	5.4	2	3.6	0	0.0	7	12.7	55	5
	All Periods Combined:	239	86.9	11	4.0	8	2.9	4	1.4	1	0.3	12	4.3	275	19

Appendix O. Continued.

SLTDR 3089 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	422	65.1	225	34.7	0	0.0	1	0.1	0	0.0	0	0.0	648	11
	1	540	70.8	214	28.0	8	1.0	0	0.0	0	0.0	0	0.0	762	12
	2	513	74.2	171	24.7	6	0.8	1	0.1	0	0.0	0	0.0	691	14
	3	463	75.1	152	24.6	1	0.1	0	0.0	0	0.0	0	0.0	616	12
	All Periods Combined:	1938	71.3	762	28.0	15	0.5	2	0.0	0	0.0	0	0.0	2717	49
June	0	736	82.1	159	17.7	1	0.1	0	0.0	0	0.0	0	0.0	896	11
	1	349	70.7	125	25.3	19	3.8	0	0.0	0	0.0	0	0.0	493	7
	2	296	67.8	127	29.1	12	2.7	1	0.2	0	0.0	0	0.0	436	7
	3	436	63.1	218	31.5	37	5.3	0	0.0	0	0.0	0	0.0	691	10
	All Periods Combined:	1817	72.2	629	25.0	69	2.7	1	0.0	0	0.0	0	0.0	2516	35
July	0	178	57.6	126	40.7	5	1.6	0	0.0	0	0.0	0	0.0	309	6
	1	167	61.1	104	38.1	2	0.7	0	0.0	0	0.0	0	0.0	273	7
	2	315	71.4	118	26.7	8	1.8	0	0.0	0	0.0	0	0.0	441	9
	3	311	60.7	173	33.7	27	5.2	1	0.2	0	0.0	0	0.0	512	7
	All Periods Combined:	971	63.2	521	33.9	42	2.7	1	0.0	0	0.0	0	0.0	1535	29

Appendix P. Number and percent of dives in six depth bins, by month, for six satellite-tagged harbor seals in Prince William Sound, May-July 1993. Depth bins are: bin 1 - 4-20 m; bin 2 - 21-50 m; bin 3 - 51-100 m; bin 4 - 101-150 m; bin 5 - 151-200 m; bin 6 - >200 m.

SLTDR 2240 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	38	15.6	27	11.1	26	10.7	89	36.6	63	25.9	0	0.0	243	16
	1	85	26.5	11	3.4	9	2.8	143	44.6	71	22.1	1	0.3	320	17
	2	491	80.2	20	3.2	14	2.2	37	6.0	41	6.7	9	1.4	612	18
	3	111	61.3	15	8.2	17	9.3	34	18.7	4	2.2	0	0.0	181	14
	All Periods Combined:	725	53.4	73	5.3	66	4.8	303	22.3	179	13.2	10	0.7	1356	65
June	0	150	22.1	207	30.5	178	26.2	137	20.2	5	0.7	0	0.0	677	20
	1	283	26.8	190	18.0	139	13.2	412	39.1	25	2.3	4	0.3	1053	22
	2	257	31.9	109	13.5	118	14.6	268	33.3	52	6.4	0	0.0	804	21
	3	260	48.6	99	18.5	89	16.6	80	14.9	6	1.1	0	0.0	534	20
	All Periods Combined:	950	30.9	605	19.7	524	17.0	897	29.2	88	2.8	4	0.1	3068	83
July	0	970	65.4	461	31.1	38	2.5	13	0.8	0	0.0	0	0.0	1482	17
	1	241	24.9	381	39.4	259	26.7	86	8.8	0	0.0	0	0.0	967	18
	2	229	45.1	141	27.8	108	21.3	29	5.7	0	0.0	0	0.0	507	20
	3	97	39.9	79	32.5	41	16.8	26	10.7	0	0.0	0	0.0	243	15
	All Periods Combined:	1537	48.0	1062	33.2	446	13.9	154	4.8	0	0.0	0	0.0	3199	70
August	0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1
	3	8	33.3	4	16.6	12	50.0	0	0.0	0	0.0	0	0.0	24	2
	All Periods Combined:	9	36.0	4	16.0	12	48.0	0	0.0	0	0.0	0	0.0	25	3

Appendix P. Continued.

SLTDR 2282 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	225	25.6	103	11.7	212	24.1	287	32.7	29	3.3	21	2.3	877	21
	1	223	31.7	57	8.1	80	11.4	238	33.9	76	10.8	28	3.9	702	22
	2	275	43.7	50	7.9	31	4.9	205	32.5	43	6.8	25	3.9	629	22
	3	107	33.2	11	3.4	37	11.4	108	33.5	47	14.6	12	3.7	322	21
	All Periods Combined:	830	32.8	221	8.7	360	14.2	838	33.1	195	7.7	86	3.4	2530	86
June	0	1035	63.8	289	17.8	206	12.7	75	4.6	13	0.8	3	0.1	1621	28
	1	1284	83.5	94	6.1	68	4.4	65	4.2	19	1.2	7	0.4	1537	29
	2	618	74.1	67	8.0	67	8.0	72	8.6	9	1.0	0	0.0	833	25
	3	375	58.8	68	10.6	102	16.0	74	11.6	17	2.6	1	0.1	637	27
	All Periods Combined:	3312	71.5	518	11.1	443	9.5	286	6.1	58	1.2	11	0.2	4628	109
July	0	382	39.6	190	19.7	221	22.9	171	17.7	0	0.0	0	0.0	964	27
	1	202	38.5	47	8.9	107	20.4	165	31.4	3	0.5	0	0.0	524	24
	2	504	56.1	57	6.3	92	10.2	226	25.1	19	2.1	0	0.0	898	27
	3	442	53.1	55	6.6	110	13.2	222	26.7	2	0.2	0	0.0	831	27
	All Periods Combined:	1530	47.5	349	10.8	530	16.4	784	24.3	24	0.7	0	0.0	3217	105

Appendix P. Continued.

SLTDR 2283 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	287	20.6	370	26.6	605	43.5	75	5.4	41	2.9	10	0.7	1388	23
	1	520	44.4	124	10.5	278	23.7	229	19.5	18	1.5	2	0.1	1171	21
	2	494	52.9	102	10.9	122	13.0	204	21.8	7	0.7	4	0.4	933	23
	3	354	41.2	101	11.7	286	33.3	96	11.1	17	1.9	4	0.4	858	23
	All Periods Combined:	1655	38.0	697	16.0	1291	29.6	604	13.8	83	1.9	20	0.4	4350	90
June	0	105	9.8	57	5.3	532	49.6	377	35.2	0	0.0	0	0.0	1071	30
	1	48	4.3	51	4.5	319	28.6	687	61.6	9	0.8	0	0.0	1114	29
	2	149	20.7	115	16.0	97	13.5	356	49.5	1	0.1	0	0.0	718	27
	3	179	36.3	26	5.2	99	20.1	188	38.2	0	0.0	0	0.0	492	30
	All Periods Combined:	481	14.1	249	7.3	1047	30.8	1608	47.3	10	0.2	0	0.0	3395	116
July	0	54	6.8	69	8.7	502	63.5	165	20.8	0	0.0	0	0.0	790	19
	1	36	11.1	19	5.9	164	50.9	103	31.9	0	0.0	0	0.0	322	18
	2	56	10.0	14	2.5	72	12.9	413	74.4	0	0.0	0	0.0	555	19
	3	29	7.2	25	6.2	142	35.5	204	51.0	0	0.0	0	0.0	400	19
	All Periods Combined:	175	8.4	127	6.1	880	42.5	885	42.8	0	0.0	0	0.0	2067	75

Appendix P. Continued.

SLTDR 2287 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	150	20.3	185	25.1	167	22.6	214	29.0	19	2.5	1	0.1	736	24
	1	118	16.3	149	20.6	177	24.5	262	36.3	14	1.9	0	0.0	720	25
	2	200	28.2	155	21.8	150	21.1	165	23.3	29	4.1	9	1.2	708	24
	3	173	23.1	124	16.5	187	25.0	227	30.3	32	4.2	5	0.6	748	25
	All Periods Combined:	641	22.0	613	21.0	681	23.3	868	29.8	94	3.2	15	0.5	2912	98
June	0	113	23.3	101	20.8	129	26.6	136	28.0	6	1.2	0	0.0	485	13
	1	107	24.2	125	28.3	77	17.4	128	29.0	4	0.9	0	0.0	441	13
	2	95	30.1	62	19.6	71	22.5	79	25.0	8	2.5	0	0.0	315	12
	3	111	32.7	67	19.7	87	25.6	68	20.0	6	1.7	0	0.0	339	14
	All Periods Combined:	426	26.9	355	22.4	364	23.0	411	26.0	24	1.5	0	0.0	1580	52

Appendix P. Continued.

SLTDR 11040 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	329	47.9	218	31.7	106	15.4	25	3.6	8	1.1	0	0.0	686	16
	1	120	38.9	35	11.3	28	9.0	24	7.7	100	32.4	1	0.3	308	15
	2	259	53.4	37	7.6	33	6.8	77	15.8	79	16.2	0	0.0	485	15
	3	174	19.3	42	4.6	112	12.4	202	22.4	200	22.2	171	18.9	901	15
	All Periods Combined:	882	37.0	332	13.9	279	11.7	328	13.7	387	16.2	172	7.2	2380	61
June	0	168	45.4	49	13.2	151	40.8	2	0.5	0	0.0	0	0.0	370	17
	1	287	60.0	52	10.8	58	12.1	57	11.9	24	5.0	0	0.0	478	18
	2	422	73.5	54	9.4	56	9.7	18	3.1	23	4.0	1	0.1	574	17
	3	198	54.8	36	9.9	44	12.1	20	5.5	48	13.3	15	4.1	361	16
	All Periods Combined:	1075	60.2	191	10.7	309	17.3	97	5.4	95	5.3	16	0.9	1783	68
July	0	53	44.5	20	16.8	24	20.1	22	18.4	0	0.0	0	0.0	119	8
	1	118	86.1	4	2.9	4	2.9	11	8.0	0	0.0	0	0.0	137	7
	2	233	93.2	0	0.0	1	0.4	16	6.4	0	0.0	0	0.0	250	7
	3	71	54.6	3	2.3	25	19.2	31	23.8	0	0.0	0	0.0	130	7
	All Periods Combined:	475	74.6	27	4.2	54	8.4	80	12.5	0	0.0	0	0.0	636	29

Appendix P. Continued.

SLTDR 11042 - Depth

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	159	38.5	11	2.6	122	29.6	95	23.0	25	6.0	0	0.0	412	22
	1	28	32.9	9	10.5	23	27.0	14	16.4	11	12.9	0	0.0	85	19
	2	118	24.2	28	5.7	80	16.4	177	36.3	84	17.2	0	0.0	487	21
	3	248	28.1	39	4.4	191	21.6	308	34.9	96	10.8	0	0.0	882	20
	All Periods Combined:	553	29.6	87	4.6	416	22.2	594	31.8	216	11.5	0	0.0	1866	82
June	0	108	20.3	99	18.6	221	41.6	93	17.5	10	1.8	0	0.0	531	14
	1	72	10.9	308	46.6	238	36.0	40	6.0	2	0.3	0	0.0	660	12
	2	77	10.8	384	53.8	127	17.8	111	15.5	14	1.9	0	0.0	713	13
	3	189	25.4	277	37.3	120	16.1	126	16.9	28	3.7	2	0.2	742	13
	All Periods Combined:	446	16.8	1068	40.3	706	26.6	370	13.9	54	2.0	2	0.0	2646	52
July	0	265	33.5	240	30.3	131	16.5	140	17.7	15	1.9	0	0.0	791	21
	1	144	19.2	372	49.7	101	13.5	124	16.5	7	0.9	0	0.0	748	21
	2	184	31.6	129	22.2	98	16.8	155	26.6	15	2.5	0	0.0	581	20
	3	361	43.3	211	25.3	71	8.5	131	15.7	57	6.8	1	0.1	832	22
	All Periods Combined:	954	32.3	952	32.2	401	13.5	550	18.6	94	3.1	1	0.0	2952	84

Appendix Q. Number and percent of dives in six duration bins, by month, for six satellite-tagged harbor seals in Prince William Sound, May-July 1993. Duration bins are: bin 1 - 1-120 sec; bin 2 - 121-240 sec; bin 3 - 241-360 sec; bin 4 - 361-480 sec; bin 5 - 481-600 sec; bin 6 - >600 sec.

SLTDR 2240 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	26	11.1	36	15.4	52	22.3	83	35.6	22	9.4	14	6.0	233	15
	1	80	25.0	16	5.0	100	31.2	103	32.1	12	3.7	9	2.8	320	17
	2	428	74.6	41	7.1	51	8.9	30	5.2	5	0.8	18	3.1	573	17
	3	123	50.8	22	9.0	51	21.0	34	14.0	3	1.2	9	3.7	242	14
	All Periods Combined:	657	48.0	115	8.4	254	18.5	250	18.2	42	3.0	50	3.6	1368	63
June	0	89	13.1	153	22.6	304	44.9	101	14.9	9	1.3	21	3.1	677	20
	1	216	21.2	220	21.6	425	41.7	119	11.6	22	2.1	16	1.5	1018	21
	2	229	28.4	183	22.7	249	30.9	119	14.8	11	1.3	13	1.6	804	21
	3	177	28.7	120	19.4	241	39.1	60	9.7	8	1.3	10	1.6	616	21
	All Periods Combined:	711	22.8	676	21.7	1219	39.1	399	12.8	50	1.6	60	1.9	3115	83
July	0	911	58.8	500	32.3	109	7.0	9	0.5	4	0.2	15	0.9	1548	18
	1	134	15.5	543	63.0	157	18.2	10	1.1	4	0.4	13	1.5	861	17
	2	160	33.7	248	52.3	59	12.4	2	0.4	0	0.0	5	1.0	474	18
	3	83	26.1	159	50.0	55	17.3	11	3.4	2	0.6	8	2.5	318	16
	All Periods Combined:	1288	40.2	1450	45.3	380	11.8	32	1.0	10	0.3	41	1.2	3201	69
August	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	1	1
	2	0	***.*	0	***.*	0	***.*	0	***.*	0	***.*	0	***.*	0	1
	All Periods Combined:	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	1	2

Appendix Q. Continued.

		SLTDR 2282 - Duration													
Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	147	21.5	47	6.8	128	18.7	231	33.8	111	16.2	18	2.6	682	17
	1	236	30.1	67	8.5	180	22.9	212	27.0	68	8.6	20	2.5	783	23
	2	278	42.5	37	5.6	128	19.5	117	17.8	68	10.4	26	3.9	654	23
	3	98	26.7	28	7.6	70	19.1	112	30.6	39	10.6	19	5.1	366	22
	All Periods Combined:	759	30.5	179	7.2	506	20.3	672	27.0	286	11.5	83	3.3	2485	85
June	0	867	57.4	229	15.1	223	14.7	116	7.6	31	2.0	42	2.7	1508	26
	1	1211	76.1	162	10.1	107	6.7	63	3.9	22	1.3	26	1.6	1591	29
	2	556	62.6	114	12.8	99	11.1	79	8.9	15	1.6	25	2.8	888	29
	3	290	43.8	90	13.6	145	21.9	90	13.6	16	2.4	30	4.5	661	28
	All Periods Combined:	2924	62.9	595	12.8	574	12.3	348	7.4	84	1.8	123	2.6	4648	112
July	0	295	30.9	266	27.9	321	33.7	40	4.2	6	0.6	24	2.5	952	26
	1	190	33.6	163	28.8	170	30.0	29	5.1	1	0.1	12	2.1	565	25
	2	424	47.2	131	14.5	251	27.9	56	6.2	4	0.4	32	3.5	898	27
	3	339	40.7	165	19.8	272	32.7	35	4.2	4	0.4	16	1.9	831	27
	All Periods Combined:	1248	38.4	725	22.3	1014	31.2	160	4.9	15	0.4	84	2.5	3246	105

Appendix Q. Continued.

SLTDR 2283 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	293	21.1	844	60.8	216	15.5	29	2.0	4	0.2	2	0.1	1388	23
	1	565	43.4	449	34.5	245	18.8	33	2.5	4	0.3	4	0.3	1300	23
	2	452	48.3	268	28.6	179	19.1	28	3.0	2	0.2	5	0.5	934	24
	3	266	31.0	377	43.9	189	22.0	18	2.1	2	0.2	6	0.7	858	23
	All Periods Combined:	1576	35.1	1938	43.2	829	18.5	108	2.4	12	0.2	17	0.3	4480	93
June	0	89	8.3	385	35.9	472	44.0	107	9.9	14	1.3	4	0.3	1071	30
	1	39	3.6	461	43.4	494	46.5	48	4.5	13	1.2	6	0.5	1061	28
	2	122	15.5	260	33.1	357	45.5	33	4.2	8	1.0	4	0.5	784	28
	3	161	32.7	181	36.7	144	29.2	5	1.0	0	0.0	1	0.2	492	30
	All Periods Combined:	411	12.0	1287	37.7	1467	43.0	193	5.6	35	1.0	15	0.4	3408	116
July	0	51	6.4	377	47.7	305	38.6	48	6.0	7	0.8	2	0.2	790	19
	1	27	8.3	162	50.3	115	35.7	17	5.2	0	0.0	1	0.3	322	18
	2	46	8.2	226	40.7	263	47.3	19	3.4	1	0.1	0	0.0	555	19
	3	29	7.2	204	51.0	152	38.0	11	2.7	0	0.0	4	1.0	400	19
	All Periods Combined:	153	7.4	969	46.8	835	40.4	95	4.6	8	0.3	7	0.3	2067	75

Appendix Q. Continued.

SLTDR 2287 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	117	16.0	333	45.7	257	35.3	19	2.6	2	0.2	0	0.0	728	24
	1	107	14.8	324	45.0	283	39.3	6	0.8	0	0.0	0	0.0	720	25
	2	163	22.0	350	47.2	207	27.9	16	2.1	0	0.0	5	0.6	741	25
	3	155	19.5	336	42.3	265	33.3	35	4.4	2	0.2	1	0.1	794	26
	All Periods Combined:	542	18.1	1343	45.0	1012	33.9	76	2.5	4	0.1	6	0.2	2983	100
June	0	102	19.0	170	31.7	255	47.5	8	1.4	1	0.1	0	0.0	536	14
	1	50	11.3	276	62.5	111	25.1	4	0.9	0	0.0	0	0.0	441	13
	2	65	20.6	103	32.7	136	43.1	10	3.1	0	0.0	1	0.3	315	12
	3	53	18.1	114	39.0	117	40.0	8	2.7	0	0.0	0	0.0	292	13
	All Periods Combined:	270	17.0	663	41.8	619	39.0	30	1.8	1	0.0	1	0.0	1584	52

Appendix Q. Continued.

SLTDR 11040 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	216	25.8	342	40.9	238	28.4	32	3.8	5	0.6	3	0.3	836	18
	1	97	27.7	45	12.8	130	37.1	62	17.7	6	1.7	10	2.8	350	15
	2	206	39.4	69	13.2	116	22.2	117	22.4	5	0.9	9	1.7	522	16
	3	135	31.1	91	20.9	167	38.4	37	8.5	1	0.2	3	0.6	434	17
	All Periods Combined:	654	30.5	547	25.5	651	30.3	248	11.5	17	0.7	25	1.1	2142	66
June	0	266	63.3	50	11.9	88	20.9	9	2.1	2	0.4	5	1.1	420	17
	1	184	46.1	63	15.7	106	26.5	35	8.7	5	1.2	6	1.5	399	17
	2	363	63.2	65	11.3	91	15.8	34	5.9	7	1.2	14	2.4	574	17
	3	203	50.0	56	13.7	86	21.1	55	13.5	3	0.7	3	0.7	406	17
	All Periods Combined:	1016	56.4	234	13.0	371	20.6	133	7.3	17	0.9	28	1.5	1799	68
July	0	40	33.6	38	31.9	17	14.2	11	9.2	3	2.5	10	8.4	119	8
	1	99	72.2	15	10.9	12	8.7	3	2.1	2	1.4	6	4.3	137	7
	2	191	76.4	16	6.4	15	6.0	8	3.2	7	2.8	13	5.2	250	7
	3	66	50.7	12	9.2	47	36.1	5	3.8	0	0.0	0	0.0	130	7
	All Periods Combined:	396	62.2	81	12.7	91	14.3	27	4.2	12	1.8	29	4.5	636	29

Appendix Q. Continued.

SLTDR 11042 - Duration

Month	Period	BIN 1 sum	BIN 1 percent	BIN 2 sum	BIN 2 percent	BIN 3 sum	BIN 3 percent	BIN 4 sum	BIN 4 percent	BIN 5 sum	BIN 5 percent	BIN 6 sum	BIN 6 percent	Total of Bins	N
May	0	129	31.3	31	7.5	176	42.7	52	12.6	14	3.4	10	2.4	412	22
	1	22	26.8	6	7.3	27	32.9	20	24.3	5	6.1	2	2.4	82	20
	2	84	19.8	41	9.6	145	34.2	111	26.2	32	7.5	10	2.3	423	21
	3	188	19.6	166	17.3	346	36.1	183	19.1	44	4.5	31	3.2	958	23
	All Periods Combined:	423	22.5	244	13.0	694	37.0	366	19.5	95	5.0	53	2.8	1875	86
June	0	75	14.1	135	25.4	227	42.7	73	13.7	13	2.4	8	1.5	531	14
	1	45	5.2	281	32.7	405	47.1	107	12.4	10	1.1	11	1.2	859	15
	2	52	6.8	273	35.8	326	42.7	86	11.2	13	1.7	12	1.5	762	14
	3	83	11.1	227	30.5	345	46.5	73	9.8	12	1.6	2	0.2	742	13
	All Periods Combined:	255	8.8	916	31.6	1303	45.0	339	11.7	48	1.6	33	1.1	2894	56
July	0	162	19.5	379	45.8	260	31.4	11	1.3	4	0.4	11	1.3	827	21
	1	117	15.1	399	51.5	228	29.4	27	3.4	0	0.0	3	0.3	774	19
	2	136	24.7	190	34.5	184	33.4	33	6.0	2	0.3	5	0.9	550	18
	3	274	36.1	213	28.1	220	29.0	31	4.0	3	0.4	17	2.2	758	21
	All Periods Combined:	689	23.6	1181	40.6	892	30.6	102	3.5	9	0.3	36	1.2	2909	79