Exxon Valdez Oil Spill
State/Federal Natural Resource Damage Assessment Final Report

Effects of the *Exxon Valdez* Oil Spill on the Abundance and Distribution of Humpback Whales (*Megaptera novaeangliae*) in Prince William Sound

Marine Mammal Study Number 1
Final Report

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Study History: Marine Mammal Study Number 1 was initiated in 1989 to determine the effects of the spill on Prince William Sound humpback whales. Concurrent studies were conducted in Southeast Alaska during the 1989 season to determine if humpback whales avoided contaminated waters and moved elsewhere. Based on concerns raised about individual humpback whales coming into direct contact with oil during the 1989 season, followup studies to assess injury to humpback whales were conducted in Prince William Sound during 1990. A book chapter regarding the project was published in 1994 (von Ziegesar, O., E. Miller, and M. E. Dahlheim. 1994. Impacts on Humpback Whales in Prince William Sound. In: Marine Mammals and the *Exxon Valdez*. Academic Press. T. R. Loughlin (editor), pp. 173-191).

Abstract: Photo-identification studies of Prince William Sound humpback whales were conducted from May to September in 1989 and 1990 to assess the impact of the spill on humpback whale life history and ecology. In 1989, concurrent studies were conducted in Southeast Alaska on humpback whales to determine if whales avoided contaminated waters of Prince William Sound and moved to other northern feeding areas. In 1989, photographic analysis of Prince William Sound humpbacks resulted in the identification of 59 whales. In 1990, 66 whales were documented. More whales were seen in these two seasons than any year previous to the spill. The increase in whale sightings may have been due to the increase in effort during the 1989 and 1990 season. Because of the difference in survey effort before and after the spill, it is impossible to determine if there was a difference in the number of humpback whales using the Sound. Distribution varied among years and may be related to prey distribution. Only one Prince William Sound humpback whale was documented to move from Prince William Sound to southeastern Alaska during the 1989 season. Calving rates during 1989 and 1990 were not significantly different than in previous years. No reports of dead stranded humpback whales occurred during the study period. No observations were made of humpback whales swimming through oil.

Key Words: Abundance, distribution, humpback whales, *Megaptera novaeangliae,* mortality, photo-identification, Prince William Sound, Southeast Alaska, reproduction.

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EXECUTIVE SUMMARY

Photographs of individual humpback whales occurring in Prince William Sound were collected from May to September in 1989 and 1990 to assess the impact of the *Exxon Valdez* oil spill on humpback whale life history and ecology. In Prince William Sound, research vessels traversed an average of 10,138 nautical miles in search of whales or while photographing whales; reflecting an average of 253 days of field research each year.

In 1989, photographic analysis of Prince William Sound humpbacks revealed 59 whales identified in 119 encounters. In 1990, 66 whales were identified in 201 encounters. There were more whales counted in Prince William Sound in these two seasons than any year previous to the oil spill. However, the number of humpback whales encountered per day was less in 1989 and 1990 than in 1988. This is probably due to the increase in effort and areas surveyed in 1989 and 1990. Because of the difference in survey effort before and after the oil spill, it is difficult to determine whether there was a difference in the number of humpback whales using Prince William Sound.

The distribution of whales in Prince William Sound during the 1989-90 season was compared to previous data. In 1988, more whales used the Lower Knight Island Passage area than in 1989. In 1990, whales were once again documented to use the Lower Knight Island Passage area. Increased vessel and aircraft traffic could have been a factor for the temporary re-distribution of whales observed during the 1989 season. However, distribution of prey may be a major contributing factor as well. Despite considerable research effort, only one Prince William Sound humpback whale was documented to move from Prince William Sound to southeastern Alaska during the 1989 season.

The mean crude calving rate (CCR) for 1980 through 1988 for Prince William Sound humpback whales was 9.47% (SE = 1.2, range 3.6 to 14.6%). The CCR for 1989 (6.3%) and 1990 (10.8%) was not significantly different than in previous years. No reports of dead stranded humpback whales occurred within Alaskan waters during the study period. No observations were made of humpback whales swimming through oil.

INTRODUCTION

Humpback whales (*Megaptera novaeangliae*) number about 10,000 animals worldwide (Johnson and Wolman 1984) of which at least 1,400 occur in the North Pacific Ocean (Wada 1980, Johnson and Wolman 1984, Baker et al. 1987). North Pacific humpback whales winter in waters off Hawaii, Mexico, and Japan. During summer they range widely across the North Pacific. Concentrations have been identified from California (Calambokidis et al. 1990), southeastern Alaska (Baker et al. 1985, 1992), and Prince William Sound, Alaska (von Ziegesar and Matkin 1985). Summer aggregations of humpback whales have also been documented in the Kodiak Archipelago, south side of the Alaskan Peninsula, and the Aleutian Island Chain and Bering Sea (Berzin and Rovnin 1966, Wada 1980, Rice and Wolman 1982, Leatherwood et al. 1983, Morris et al. 1983).

Interchange between summer foraging areas is not well understood, however site fidelity has been reported. Site fidelity with respect to feeding grounds appears to be passed through maternal lines (Martin et al. 1984, Baker et al. 1987, Clapham and Mayo 1987, Baker et al.

1990). Prior to 1989, only four individual whales have been known to move between Prince William Sound and southeastern Alaska (Darling and McSweeney 1985, Baker et al. 1986, McSweeney, unpublished). Preliminary comparisons of humpback whale photographs collected off Kodiak Island in 1992 by NOAA personnel to photographs collected from Prince William Sound also suggest minimal interchange between the two areas (Dahlheim, pers. commn.). Early discovery tag investigations, however, did show movements by humpbacks between the Aleutian Islands and the central coast of Alaska outside of Prince William Sound (Nishiwaki 1966).

Each year, between June and September, approximately 60-100 humpback whales come into Prince William Sound to feed; with many of the same individuals returning from year to year (von Ziegesar 1992). In Prince William Sound, many whales have over seven years of sighting history (von Ziegesar 1992). Recent observations suggest that a small number of whales may even overwinter in the area (Monet, pers. commn.).

Population studies on humpbacks in Prince William Sound began in 1977. Studies have included line transect aerial and shipboard surveys and observations from land-based stations (Hall 1979, Matkin and Matkin 1981), radiotelemetry (Watkins et al. 1981), and photo-identification studies using pigmentation patterns on the ventral side of the fluke and the shape of the trailing edge of the fluke (Hall 1981; von Ziegesar 1984, 1992). Photo-identification was first described as a reliable method of recognizing humpback whales in the North Atlantic by Katona et al. (1979), Katona and Kraus (1979), and Katona and Whitehead (1981). The ability to recognize individual whales can result in information on minimum counts, reproductive rates, and movement patterns.

The oil spilled from the *Exxon Valdez* in the spring of 1989 could have far reaching impacts on the ecosystem of Prince William Sound. The potential impacts to Prince William Sound humpback whales could range from a displacement of whales from habitual feeding areas to a reduction of prey or possible physiological impacts from oil toxicity, including reproductive failure or mortality.

The purpose of this study was to obtain photographs of individual humpback whales occurring in Prince William Sound from mid-May to September 1989 and 1990. In 1989, studies were also conducted in southeastern Alaska to test the hypothesis that whales from Prince William Sound were not displaced there. All photographs were compared to the Prince William Sound photographic database for the years 1977 to 1988 (Von Ziegesar 1992) to determine if changes occurred in whale abundance, seasonal distribution, and natality and mortality rates. Results of the research allowed determination of the extent of injury (displacement) or loss (reduction in numbers) to humpback whale populations as a result of the *Exxon Valdez* oil spill.

OBJECTIVES

1. To count the number and individually identify humpback whales in Prince William Sound and southeastern Alaska.
2. To test the hypothesis that humpback whale distribution and abundance within Prince William Sound and adjacent waters is similar to that reported for previous years.
3. To test the hypothesis that humpback whale natality had not changed since the spill.

4. To test the hypothesis that humpback whale mortality rates have not changed since the spill.

METHODS

Field Procedures - Prince William Sound

In 1989, three shore-based camps were operated in Prince William Sound (23 May through 15 September; Fig. 1). One camp was initially located in the northwestern area of Prince William Sound at Perry Island. Another camp was located in the southwestern region at Squire Island (off the southwest side of Knight Island). The third camp was located at Double Bay (northern end of Hinchinbrook Island). The Perry Island camp was moved to Pt. Nowell in early July based on whale distributional data collected during the study. In 1990, one shore-based camp was established (15 May through 8 September) at Squire Island (off the southwest side of Knight Island). An 8.5 m bowpicker-style fishing vessel was used as a mobile camp and research platform during the 1990 season (replacing two of the shore-based camps). When available, the 12.8 m F/V Lucky Star (equipped with a 6.4 m inboard/outboard powered skiff) assisted in the collection of humpback photographs. All camps/research platforms were staffed by at least two biologists. Each camp had the use of a small, outboard motor boat (vessels ranging in length from 5.0 to 6.5m). Additional research support was provided to the humpback whale research team by personnel working on Prince William Sound killer whale damage assessment studies (Dahlheim and Matkin 1993).

Weather permitting, field personnel spent an average of 8 to 10 hours per day conducting boat surveys searching for or photographing whales. Specific areas, known for whale concentrations, were investigated first. However, if reports of whales were received from other sources (e.g, sighting network described below) those areas were examined. If whales were not located in "known" areas and opportunistic sighting reports were not available, a general search pattern was developed and implemented. When whales were sighted, researchers slowly approached the whales to collect photo-identification information. To obtain a high-quality photograph, an approach within 25-50 meters was required. Animals were approached from behind and photographs were taken of the ventral surface of the fluke as the animal dove (Fig. 2). At least two photographs of each whale was taken before resuming surveys. Whales that did not show flukes upon diving were followed for at least five dive sequences. If they still did not raise their flukes, the dorsal fin was photographed. Individuals identified by dorsal fin photographs were not included in the final tally of whales unless the dorsal fin photograph was later matched with one taken when the fluke was also photographed. Dorsal fin and fluke photographs were collected for females and calves because calves often do not raise their flukes.

Successful detection, approach and taking of identification photographs of whales was defined as an "encounter". An "aggregation" consisted of more than four whales. Although there were small groups or pairs moving synchronously within aggregations of feeding humpbacks, data on all animals were included as one encounter.

High-performance 35 mm camera systems (i.e., Nikon, Canon, Pentax) with motor drives and 300 mm lens were used. Shutter speed was set to 1/1000th second, or the highest speed

possible. Black and white Ilford HP5 film (ASA 400) was used; taken and developed at ASA 1600. Exposed film was developed by the same photographic laboratory and processed throughout the season to allow field personnel to obtain necessary feedback. Proper labelling of exposed film included date, roll number, photographer's initials, location, species code, and ASA setting. Daily effort logs (Fig. 3) were maintained which permitted 1) quantification of the amount of time searching for whales versus photographing whales, 2) quantification of search effort under different weather conditions, and 3) daily vessel trackline. A humpback whale encounter form was completed each time whales were photographed (Fig. 4). The encounter form included date, time, location, count, other species interactions, film frames, behavioral observations, and sketches of the fluke and dorsal fin.

In addition to the photographic work in Prince William Sound, aerial surveys were conducted in 1989 to locate whales occurring on the eastern side of Prince William Sound. If displacement occurred, whales could potentially move from the western Sound into the eastern sector of Prince William Sound rather than moving out of the area. All cetaceans observed during the survey flights were recorded.

Systematic aerial surveys were conducted over eastern Prince William Sound between 11 June and 25 September 1989. Surveys were flown in a Cessna 180 staffed by two observers and the pilot. Airspeed averaged 115 kts and average altitude was 320 m. The survey route consisted of 23 transects connecting 24 waypoints. The waypoints were either obvious landmarks or locations preset into the Loran C. Sighting locations were obtained off the Loran C. Each survey covered approximately 328 nautical miles averaging 3.8 hrs in duration. The transect grid width was 4 nautical miles. Survey schedules were weather dependent making sighting conditions comparable between surveys.

To increase the sighting effort within Prince William Sound ensuring that all whales were being seen and photographed, a marine mammal sighting network was organized throughout Prince William Sound. This network recorded all sightings of whales collected opportunistically from Alaskan State Ferries, and private aircraft and boats. Whale sightings were reported either to a coordinator in Cordova, Alaska (who then passed the sighting information along to the field crews) or directly to the whale research vessels. Field teams responded by searching out the area where whales were reported to collect photographic data.

Field Procedures - Southeastern Alaska

Two shore-based camps and one floating camp were established in Southeastern Alaska in 1989 to conduct photo-identification studies on humpback whales (1 June through 30 September 1989; Fig. 5). One shore-based camp was located at Glacier Bay National Park and the other at The Brothers Islands (a group of islands off the southeast corner of Admiralty Island in Frederick Sound). Glacier Bay personnel surveyed the waters of Glacier Bay, Pt. Adolphus, Cross Sound and then east and south into Icy Strait. The camp at Frederick Sound was responsible for surveying Stephens Passage and Frederick Sound and included at least four researchers operating two vessels. The floating camp provided coverage in Upper Stephens Passage, Lynn Canal, Chatham Strait and the eastern side of Icy Strait. This vessel routinely transited areas not surveyed by researchers from the other two

camps. Field methods in southeastern Alaska were similar to those described for Prince William Sound.

A marine mammal sighting network was also organized throughout southeastern Alaska which included sightings collected from the Alaskan State Ferries, and private aircraft and boats. Sightings were reported to the biologist stationed at Glacier Bay, who then relayed this information to other southeastern Alaskan whale researchers. Appropriate teams were dispatched to the area to collect photographic information.

Field Procedures - Kodiak Archipelago

In 1989, an opportunity arose to place a marine mammal observer aboard a fisheries research vessel operating in offshore waters between Prince William Sound and Kodiak Island. This region extends westward from 147 o W longitude to 155 o W longitude on the south side of Kodiak Island and southward to 57 o 30'N latitude in Shelikof Strait. Attempts were made to collect humpback whale photographs from the fisheries research vessel.

Data Analysis

All exposed film of humpback whales collected during the 1989-90 field seasons was analyzed for individual identification. Individual humpback whales were identified using photographic negatives and contact sheets. Each individual whale identified was visually compared to the historical photographic database available from Prince William Sound (von Ziegesar, 1992). Photographs taken under poor conditions or from a bad angle were often enlarged and re-examined. Questionable identifications and new whales were confirmed by a second experienced researcher.

Survey design and effort to locate humpback whales varies considerably from year to year in Prince William Sound. Thus patterns of whale distribution were only subjectively analyzed and compared.

Calves of the year were identified by their smaller size and close association with an adult whale; presumed to be the mother. Observed natality (number of calves per adult female/mother) was noted. Crude annual calving rates (CCR) were calculated as a percentage of the total population as follows:

$$CCR = \frac{NR}{NP}$$

where NR = number of new calves seen in a given year, and
NP = number of whales present in that year (including calves).

An Analysis of Variance was used to determine if significant differences occurred in CCR among years.

To assess mortality, all reports of cetaceans found stranded were responded to. Lack of systematic effort in previous years permitted only qualitative comparisons to be made between number of whales found stranded and past strandings.

RESULTS

Prince William Sound -- Photo-Identification Studies

Between 23 May and 15 September 1989, four dedicated research vessels traversed 9,623 nautical miles in Prince William Sound in search of whales or while photographing whales. This coverage reflects a total of 260 operable days of field research plus an additional 44 days in which researchers were unable to work due to inclement weather. Between 15 May and 8 September 1990, research vessels traversed 10,653 nautical miles in Prince William Sound in search of whales or while photographing whales. This represents a total of 247 operable days of field research. There were 34 days lost due to inclement weather, mechanical difficulties or logistics. When the 1989-90 effort is compared to previous years (e.g., 1988 survey duration was from 8 June to 8 September representing 45 operable days and 2,008 miles surveyed; Table 1), it is obvious that the 1989-90 research effort represents a more complete coverage of the Prince William Sound area.

In 1989, 59 individual humpback whales were identified in Prince William Sound in 119 encounters (Table 2). Twenty-two (22) of these whales (37%) were termed "new" whales since they had not been previously documented in the area. A "core group" of nine whales were seen five or more times in Prince William Sound over an 8-week time period. These particular animals have occurred in Prince William Sound in six of 12 summer seasons (von Ziegesar 1992). The highest rate of humpback encounters per day occurred in the southwestern section of Prince William Sound (Squire Island camp). There were 48 individual whales identified from this area with 29% (n = 14) listed as new whales. In the southeastern portion (Hinchinbrook camp), there were 0.40 encounters per day. Eighteen whales were identified and 11 (61%) were new animals. Personnel from the Perry Island and Pt. Nowell camp (northwestern Prince William Sound) reported 0.26 encounters per day and identified 16 whales. Of the 16 whales seen, four (25%) were new animals. All whales photographed in the northwestern section of Prince William Sound were also photographed in the Squire Island and Hinchinbrook areas. However, field personnel working the southwestern (Squire Island) and southeastern (Hinchinbrook Island) camps photographed whales in their respective areas that were not photographed by other research teams.

In 1990, 66 individual humpback whales were identified in Prince William Sound in 201 encounters (Table 2). Fifteen (15) of these whales (22%) were "new" whales. The 1989-90 counts of individual whales represented the largest number of humpback whales ever photographed in Prince William Sound.

Southeastern Alaska/Kodiak Island -- Photo-Identification Studies

Between June and September 1989, concurrent photo-identification studies were conducted in southeastern Alaska. A total of 230 days were spent searching for whales, representing 1,011 hours. In addition to the summer field season, surveys were also conducted in southeastern Alaska during the late fall and early winter 1989/90 season. A total of 558 individual humpback whales have been identified from southeastern Alaska (Table 3); representing the largest number of whales reported for that area in any one season. Most encounters occurred in Frederick Sound where 406 whales were identified.

Between 8 September and 18 October 1989, marine mammal surveys were conducted off Kodiak, Alaska (Table 3). Out of 399 available daylight hours, 155.5 hours were spent conducting sighting surveys. Approximately 30.7% (122.5 hrs) were lost to survey effort due to inclement weather. Cetaceans composed the majority of observations. Although 10 sightings of humpback whales were reported (totalling 39 animals), bad weather precluded collection of whale photographs.

Prince William Sound -- Aerial Surveys

In 1989, aerial surveys covering 3,504 nautical miles were flown in Prince William Sound, representing 47 hours flight time. Sixteen surveys were attempted; eleven were completed. Survey effort was comparable between June and August (average of 12.5 hrs/month) but declined in September (5.7 hrs). Humpback whales were only seen in July, totalling 10 animals in 6 encounters (Table 3). Without photo-documentation, we are unable to identify the humpback whales seen by the aerial survey team; therefore the total count may include duplicate sightings of the same individuals.

Humpback Whale Distribution

Between 25 May and 24 June 1989, the Lower Knight Island Passage had the highest concentrations of humpback whales (n = 48). The number of whales occurring in this area decreased to 30 between 25 June and 24 July 1989. The following month (25 July to 24 August), field personnel reported concentrations of whales between Point Nowell and Crafton Island as well as the northern end of Bainbridge Passage. Few sightings occurred in the Lower Knight Island Passage area during this time period. Between 25 August and 14 September whales were observed in the north end of Bainbridge Passage and also in Montague Strait between Hanning Bay and LaTouche Island.

The distribution of whales observed in 1989 was compared to that collected in 1988. In 1988, more whales were observed in Lower Knight Island Passage. An aggregation of humpback whales was observed around Hinchinbrook Entrance in July of 1989 and it was noted that some of these whales did not enter the Sound (von Ziegesar et al., in press). However, it is difficult to determine if this distributional pattern of humpback whales is unusual since prior investigations have not been focussed on this open ocean entrance of the Sound. During the 1989 season, the number of vessels working in Prince William Sound, associated with clean-up activities, far exceeded the number observed in the past. As a result, more interactions likely occurred between vessels and humpback whales. This included unintentional high-speed approaches by vessels unaware of the presence of whales and the intentional approach and pursuit of whales for recreation. On two occasions, helicopters were seen hovering over humpback whales. These activities may account for changes in whale movements or time spent by whales in an area. However, prey distribution and abundance must be considered when examining movements of humpback whales.

In 1990, humpback whale distribution in Lower Knight Island Passage appeared similar to previous years. Large concentrations of humpback whales were consistently found at the south end of Dangerous Passage (entrance of Icy Bay) during July and August 1990.

To investigate possible displacement of Prince William Sound humpback whales to adjacent waters, photographs of individual humpback whales collected in southeastern Alaska

were compared to the Prince William Sound whale photo-identification catalog. Only one Prince William Sound humpback whale (X54) was observed in southeastern Alaska despite considerable effort (total of 558 individual whales identified from southeastern Alaska). Whale number X54 was seen in Prince William Sound on 20 July 1989 and then observed in Southeastern Alaska on 29 August 1989.

Reproductive Rates

Figure 6 illustrates the annual crude calving rate (CCR) observed for Prince William Sound humpback whales from 1980 through 1990. In 1989, four females with calves were identified. Eight female-calf pairs were identified in 1990. Seven of those females were documented in Prince William Sound in 1989 and therefore were pregnant and feeding there the year of the spill. The mean CCR for years 1980 through 1988 (von Ziegesar 1992) was 9.47% (SE = 1.2, range 3.6-14.6%). The CCR for 1989 (6.3%) is below the mean for past years, however calving rates are highly variable. An Analysis of Variance determined that the CCR in 1989 was not significantly different than the CCR in any of the other years ($F_{1,6} = 0.08$, $p = 0.42$). When only years with a sample of more than 30 identified adults were analyzed the results were still not significant ($F_{1,4} = 1.68$, $p = 0.28$). The CCR in 1990 was above the mean (10.8) but not significantly different than any other year ($F_{1,6} = 0.04$, $p = .86$).

Mortality Rates

There were no humpback whale deaths or strandings observed or reported during 1988-90 in Prince William Sound. Humpback whales were never observed swimming directly in oil.

DISCUSSION

Fifty-nine individual humpbacks were documented in Prince William Sound during the 1989 field season and 66 were documented in 1990. Aerial surveys confirmed the fact that researchers conducting photo-identification studies were not missing substantial concentrations of humpback whales in the eastern part of Prince William Sound. When the minimum counts of whales obtained from 1989-90 were compared to those counts collected prior to the spill, there was not a significant decline observed in the number of humpback whales using Prince William Sound. In fact the 1989-90 seasons documented higher numbers of humpback whales than previously reported for Prince William Sound. The increased number of individual whales identified in Prince William Sound in 1989-90 is probably due to the increased level of effort in the area after the oil spill.

Although the absolute numbers of humpback whales identified in 1989 and 1990 were much higher than in 1988, the number of encounters per day were much lower (Table 2). This means that on average the observers had to go farther to find whales. However, there are problems with comparing the data from 1988 with 1989 and 1990. The 1988 field season was conducted primarily in the southwest section of Prince William Sound, which is known for its high concentration of humpback whales. The 1989 and 1990 surveys included much of Prince William Sound outside of this area. Therefore, the lower numbers of humpback whales found per day in 1989 and 1990 may have been due to the inclusion of

areas that typically have low humpback whale usage. In fact, the highest rate of humpback encounters in 1989 occurred in the southwest section of Prince William Sound.

Because of this discrepancy in study areas between years, it is difficult to draw conclusions concerning the abundance of humpback whales in Prince William Sound in 1989 and 1990. However, a comparison can be made of the southwest region, excluding the rest of the Sound. Thiry-one percent fewer humpback whales were identified in this region in 1989 than in 1988. It is unknown whether these whales were not present due to the oil spill, increased traffic, or natural causes.

The counts obtained from photo-identification studies represent minimum counts. The use of mark-recapture models on populations of whales such as the humpbacks in Prince William Sound is problematic due to the violations of the necessary assumptions. Hammond (1986, 1987, 1990) and others have investigated the consequences of violating the assumptions of some of the mark-recapture models. The effects of immigration/birth and emigration/death, heterogeneity of capture probabilities between whales due to individual behavior patterns (i.e., approachability), age class, or reproductive status and variability in sampling effort precluded the use of mark-recapture analysis in this study.

The extent of the geographical range of humpback whales inhabiting Prince William Sound is unknown. A comparison of photographs of Prince William Sound humpback whales with photographs collected from southeastern Alaska suggest minimal interchange of whales between areas.

Observed reproductive rates of humpback whales within Prince William Sound in 1989-90 were highly variable. This high variability in crude annual calving rates (CCR) is not unusual for baleen whales (Mizroch and York 1984). The CCR for 1989 was below the mean (6.3%) and the mean CCR for 1990 was above the mean (10.8%). However, no significant differences could be detected when the rates were compared to those previously documented for Prince William Sound humpbacks. Results from studies in the north Atlantic (Clapham and Mayo 1990) and southeastern Alaska (Baker et al. 1992) report crude calving rates in the same range as those reported for Prince William Sound. The number of calves observed in 1989 was below average with four identified pairs. In 1990, seven of the eight calves documented in Prince William Sound were born to females that were feeding in Prince William Sound while pregnant in 1989 after the oil spill.

Because humpback whales do not remain in defined groups, and Prince William Sound is not a "closed" area (all whales are not seen there all years), it is difficult to determine mortality rates for humpback whales. There were no reports of dead, stranded humpback whales during either the 1989 or 1990 season. The majority of humpback whales begin entering Prince William Sound in mid to late June. Only two sightings of humpback whales were reported in March and April (NOAA Hazmat).

During summer, humpback whales were observed feeding in areas that had been heavily oiled. Some animals may have consumed contaminated prey or ingested small amounts of residual oil while surface feeding. Impacts on the whales, through contact with chemicals to the eyes or skin, or inhalation of toxic fumes have been reported by Henson (1985), and Geraci and St Aubin (1985). There has been no research on the long term impacts of contaminates on migratory mammals such as baleen whales. Because these animals fast while occupying their winter range and then replenish fat reserves in a thick blubber layer

during summer months, impacts may be unique. Given that this species exhibits strong site fidelity and that the Prince William Sound population of humpback whales appears small and distinct from other populations of feeding humpback whales occurring in Alaskan waters, the Prince William Sound humpback whale population could be extremely vulnerable to a major disturbance especially if the timing of that disturbance coincided with the peak occurrence of whales within the area.

CONCLUSIONS

From the available data, it is difficult to determine whether the *Exxon Valdez* oil spill had any measureable impact on the number of humpback whales occurring in Prince William Sound. The greatest number of humpback whales ever reported in Prince William Sound occurred in 1989-90, 59 and 66 identified individuals, respectively, although the number of whales identified per day and mile was much lower than in 1988. This may be the result of surveying a much larger portion of Prince William Sound including low density areas of humpback whales. The re-distribution of whales in Lower Knight Island Passage in late June and July 1989 was temporary and may have been prey related. In 1990, whales were once again noted in Lower Knight Island Passage area. In 1989, the reproductive rate was low but in 1990 it was above historical levels. When compared to previous years, no significant differences could be detected in calving rates. Throughout most of their range, humpback whale reproductive rates are characterized by high variability. There were no humpback whale deaths or strandings observed during 1989-90 in Prince William Sound.

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Table 1. Survey effort in Prince William Sound for the years 1988, 1989 and 1990.

Year	1988	1989	1990
Beginning and end date	8 June - 8 Sept	23 May - 15 Sept	15 May - 8 Sept
Survey days	45	260	247
Number of miles surveyed	2,008	9,623	10,653

Table 2. Number of individually identified humpback whales in Prince William Sound (1988 - 1990).

	1988	1989	1990
Encounters	77	119	201
Encounters/day	1.71	0.45	0.81
Total number of ID's	35	59	66

Table 3. Summary of 1989 effort for Prince William Sound aerial surveys, photo-identification studies in southeastern Alaska, and vessel surveys off Kodiak Island.

	Prince William Sound Aerial Surveys	Southeastern Alaskan Photo-Id Studies	Kodiak Island Vessel Surveys
Dates	June - August	June - September	8 Sept - 18 Oct
Effort	47 hrs	1,011 hrs (230 days)	155.5 hrs
Nautical miles	3,504	12,400	Less than 500
Humpback encounters	6	2,448	10
# of humpback whales	10*	558**	39*

*Total number of animals observed. Whales were not photo-identified and could represent duplicate sightings of the same individual.

**Includes animals seen during fall and winter 89/90 surveys.

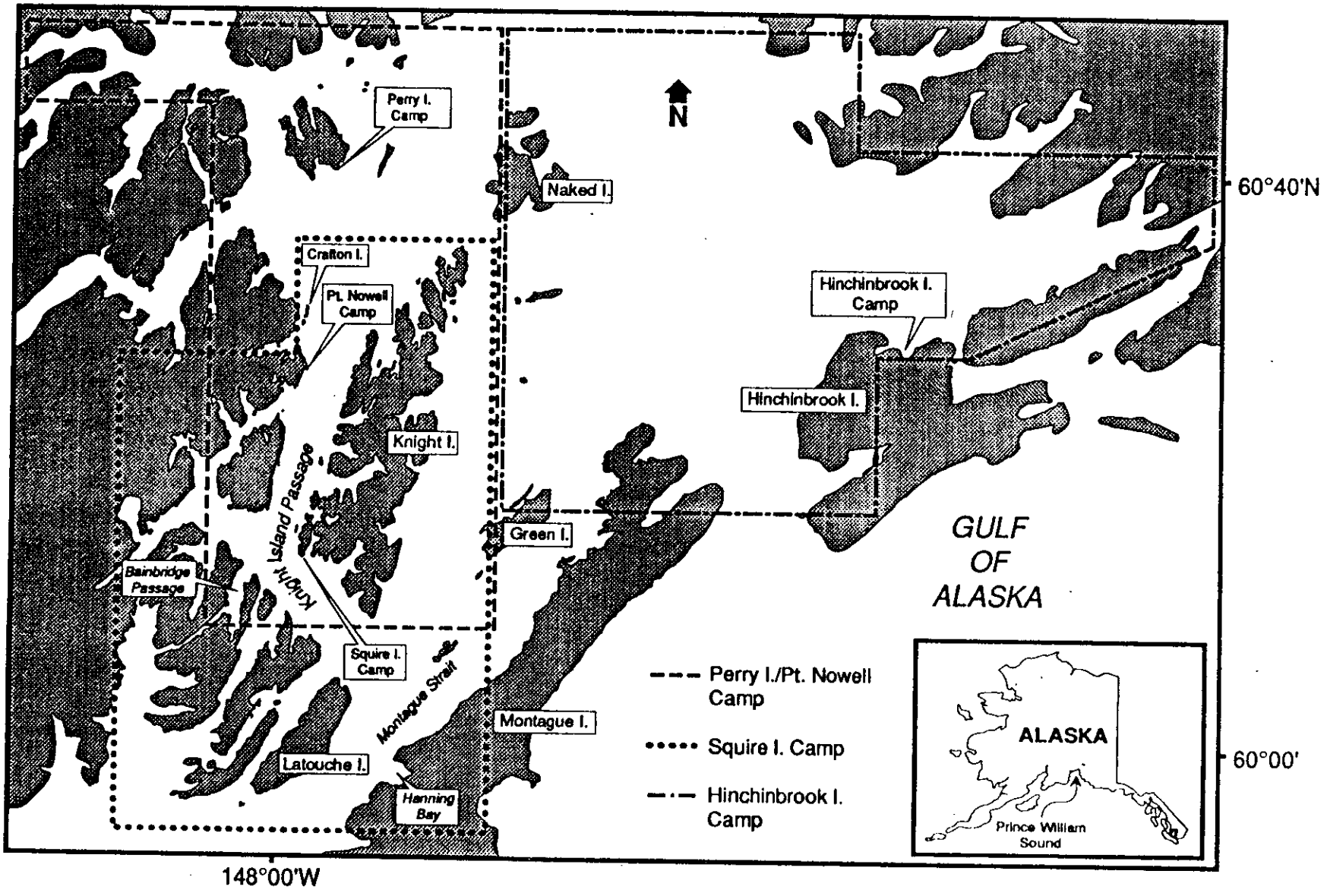

Figure 1. Approximate range covered by shore-based field stations in Prince William Sound.

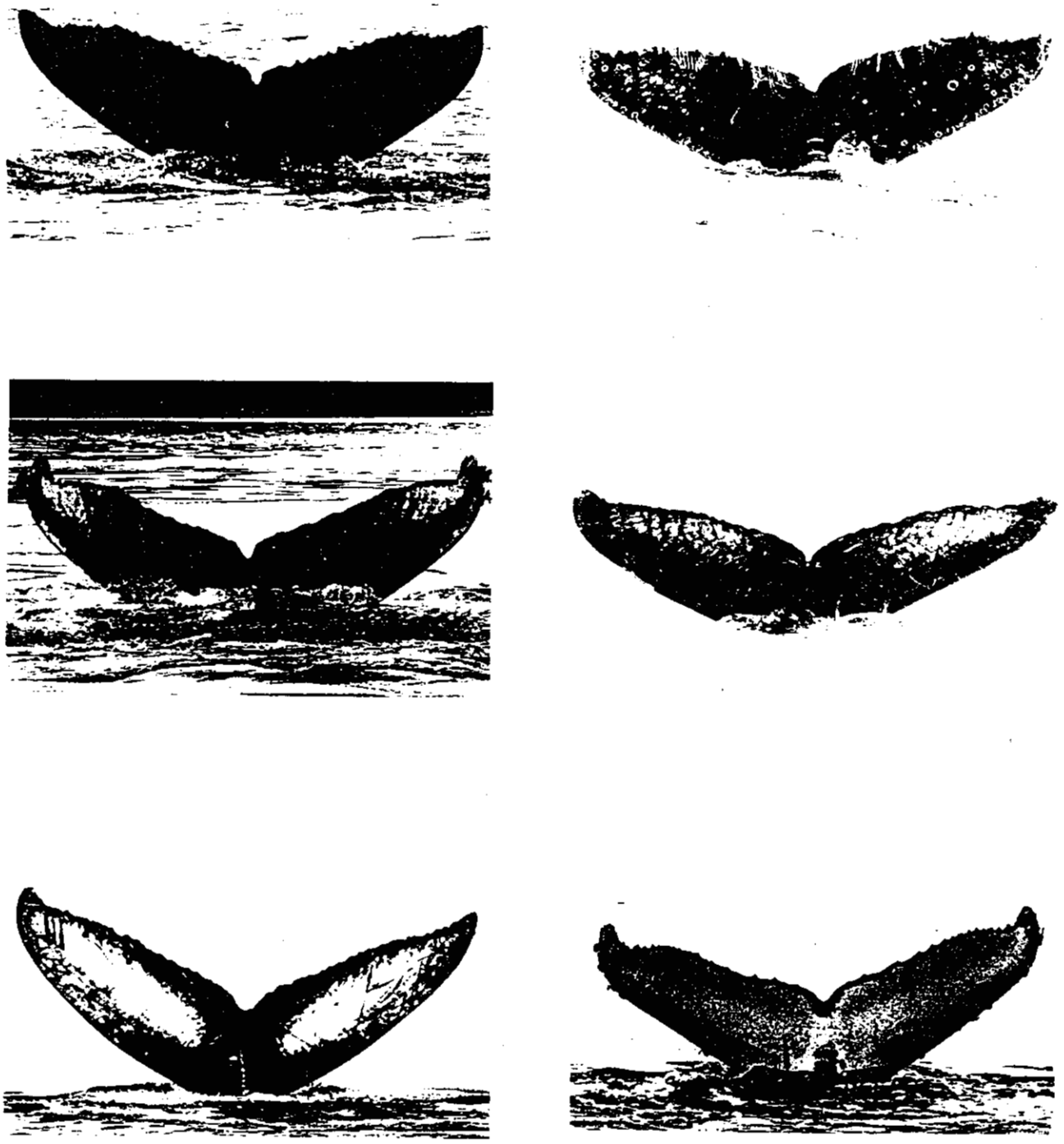

Figure 2. Examples of identification photographs (ventral side of fluke) of humpback whales.

D A I L Y L O G

DATE_____ PLATFORM_____

_____

START LOCATION _____ END LOCATION_____

_____ _____

_____ _____

START TIME _____ END TIME_____

BEGIN ENGINE HRS._____ END ENGINE HRS._____

ACTIVITIES/PERSONNEL For example: Record Beaufort Scale and Visibility Code (see attached), general weather conditions, presence/type of oil, yes/no cleanup activities, number of aircraft/vessels in area. Observer's name.

_____

_____

_____

_____

_____

_____

_____

COMMENTS_____

_____

_____

_____

_____

** Vessel trackline for each day accompanies Daily Log Form.

Figure 3. Example of daily effort log.

HUMPBACK WHALE SURVEY FORMS

Observers_____
Platform _____

Date/Encounter#_____Time (Beg-End)_____

Location (Beg-End)_____

_____

Estimated Composition (Total Number of Adults/Juveniles/Cow-calf pairs)_____

_____

Recognized Individuals _____

_____

Film (Date/Roll #/Photographer and Location)_____

_____

Number of Whales Observed vs Number Photographed_____

Drawings of Flukes and Dorsal Fins:

Comments_____

_____

_____

_____

_____

_____

** Complete chart on reverse side depicting whale track.

Figure 4. Example of humpback whale encounter form.

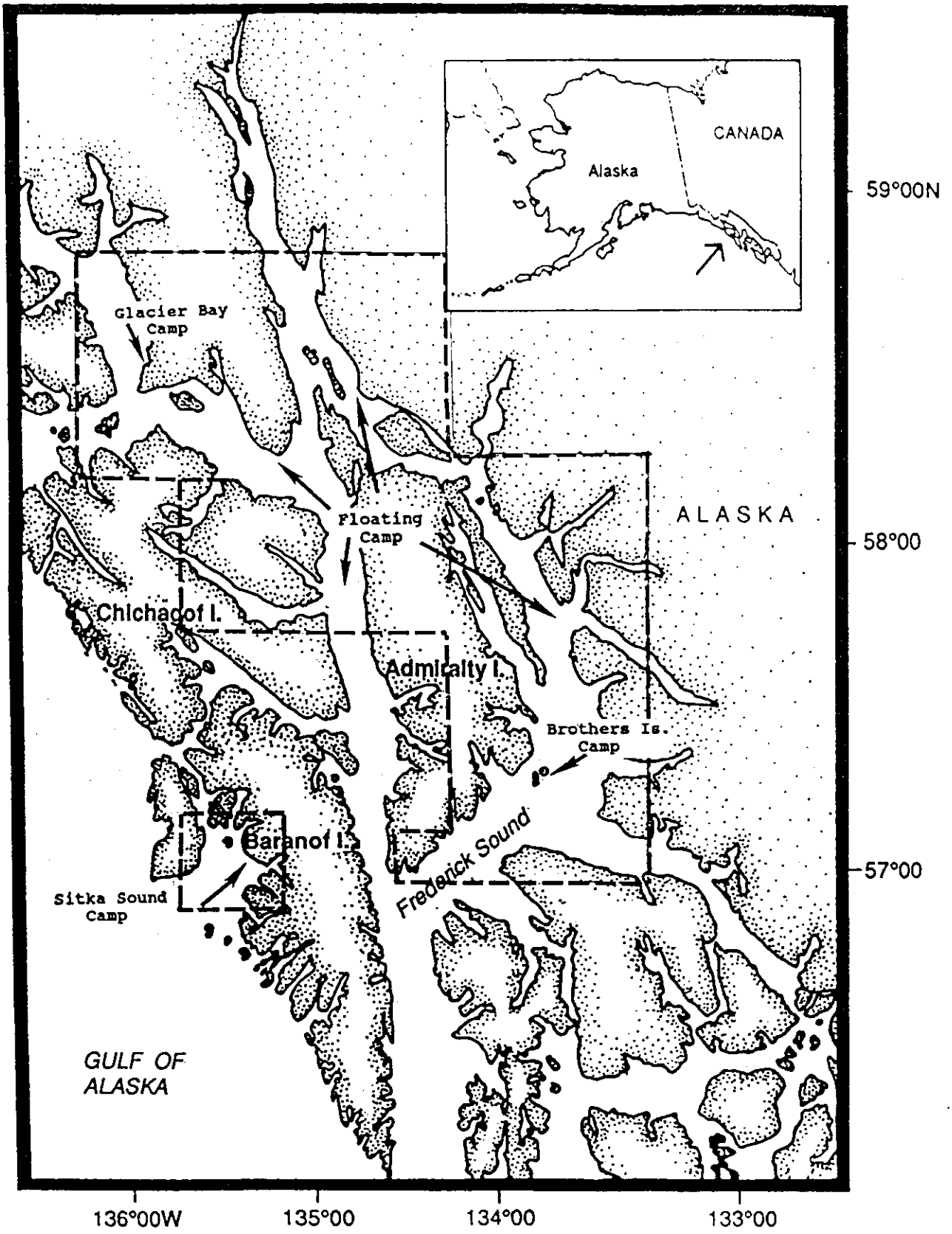

Figure 5. Approximate range covered by the four field research stations in Southeast Alaska.

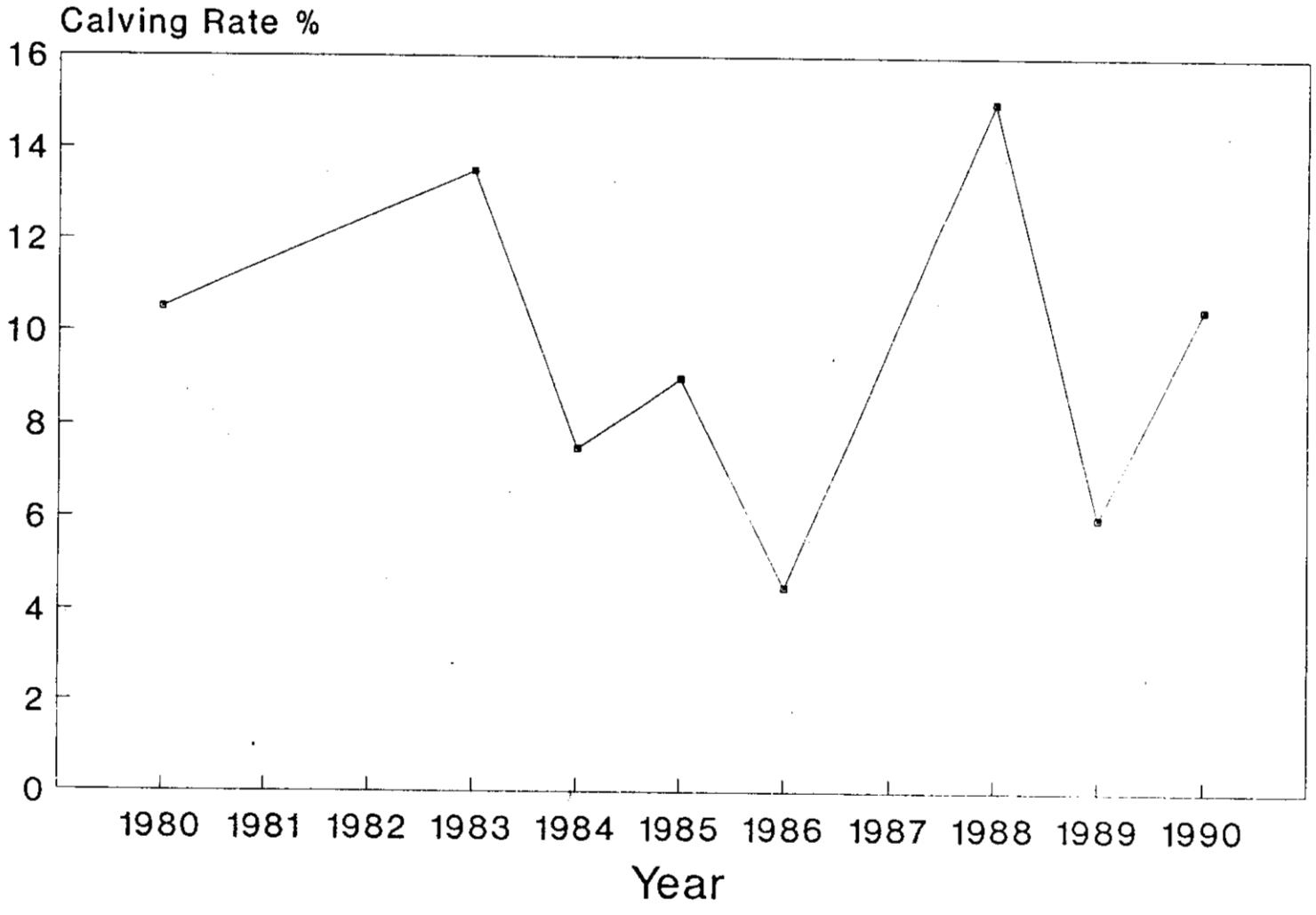

Figure 6. Humpback whale annual curde reproductive rate (1980-1990).