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ASSESSMENT OF INJURIES TO KILLER WHALES IN PRINCE WILLIAM SOUND

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EXECUTIVE SUMMARY

Photographs of individual killer whales occurring in Prince William Sound were collected from 16 to 24 May and from 5 June to 13 September 1991 to assess the impact of the Exxon Valdez oil spill on killer whale life history and ecology.

In Prince William Sound, research vessels traversed 7,340 nautical miles in search of whales or while photographing whales; reflecting 110 days of field research. During the 1991 season, seven resident pods and four transient pods were identified from Prince William Sound, representing 54 encounters.

Photographic analysis of resident pods revealed one additional animal missing from AB pod. The thirteen AB pod whales missing during the 1989 and 1990 investigations were not seen in 1991. A total of 14 whales are missing from AB pod for the three-year period (1989 through 1991). Preliminary analysis indicates that no other animals from resident pods are missing. Of the seven 1989 missing animals in AB pod, two were reproductively active females that have left behind calves that are two and three years old. The remaining missing whales from AB pod are three juveniles of unknown sex and two adult females that have not reproduced since 1984. Of the six whales missing in 1990 in AB pod, two were adult females, one was an adult male, and three were juveniles (two were born in 1988 and one was born in 1986). The mother of the juvenile born in 1986 was documented as missing during the 1989 investigations. The additional missing whale in 1991 is a subadult male. A 1988-89 mortality rate of 19.4% was calculated for AB pod; 10 times the expected rate for resident pods based on over 24 years of research. The 1989-90 mortality rate was 20.7%. The 1990-91 mortality rate will not be available until 1992. Prior to 1989, an annual natural mortality rate of 1.8% had been calculated for Prince William Sound resident killer whales. An average annual reproductive rate of Prince William Sound resident killer whales is 3.8%. In 1989, calves were only observed in AE and AJ pods. In 1990, calves were seen in AE (n = 1), AJ (n = 1), AK (n = 1), and AN (n = 4 over a two-year period) pods. In 1990, calves were observed in AB pod (n = 1) and AK pod (n = 1).

AT pod (a transient pod from Prince William Sound) may be missing 10 to 11 whales. A subgroup of four AT pod members was photographed behind the Exxon Valdez 3 days after the grounding on Bligh Reef. At least three of these members were listed as missing during the 1990 season. They remained missing during the 1991 encounters.

In late August and early September each year, multi-pod aggregations are typically reported in lower Knight Island Passage and Montague Strait. In 1991, typical multi-pod aggregations did not occur. Observations of killer whale pods were of a short-term

nature and in contrast with other years the whales did not use lower Knight Island Passage but remained in Montague Strait. Despite increased effort over the last three years (1989 to 1991) the number of encounters with killer whales appears to be decreasing. Unfortunately, changes in habitat useage cannot be adequately demonstrated due to lack of quantitative data from past studies.

No reports of stranded killer whales were received during the 1991 season in Prince William Sound.

OBJECTIVES

1. To count the number of killer whales entering Prince William Sound.
2. To test the hypothesis that killer whale distribution within Prince William Sound and adjacent waters is similar to that reported for previous years.
3. To test the hypothesis that pre- and post-oil spill killer whale pod structure and integrity have remained the same.
4. To test the hypothesis that killer whale natality has not changed since the Exxon Valdez oil spill.
5. To test the hypothesis that killer whale mortality rates have not changed since the Exxon Valdez oil spill.
6. Identify potential alternative methods and strategies for restoration of lost use, populations, or habitat where injury is identified.

INTRODUCTION

The killer whale, Orcinus orca, occurs in all oceans of the world. Population estimates, based on photo-identification studies, are available for three North Pacific regions (Washington State waters, inland waterways of British Columbia and Prince William Sound, Alaska). Current population estimates for Prince William Sound are 11 resident pods (representing 245 whales) and eight transient pods (representing 52 whales).

The purpose of this study was to obtain photographs of individual killer whales occurring in Prince William Sound from mid May to September 1991. Calves were also documented. Photographs were compared to the Alaskan photographic database for the years 1977 to 1990 to determine if changes occurred in whale abundance, seasonal distribution, pod structure and integrity, continuity of habitat

useage, and mortality and natality rates. Results of the research will allow determination of the extent of injury (displacement) or loss (reduction in numbers) to killer whale populations as a result of the Exxon Valdez oil spill.

STUDY METHODOLOGY

Personnel from the National Marine Mammal Laboratory (NMML), Seattle, Washington (Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA/DOC) developed and coordinated the killer whale damage assessment activities associated with the Exxon Valdez oil spill. Although NMML personnel participated in field studies, the majority of field work was conducted by contractors that have recognized expertise in the study areas of concern. Studies were conducted in Prince William Sound. Field studies were conducted under federal permits issued through the Marine Mammal Protection Act (MMPA) or Endangered Species Act (ESA).

Field Procedures

A shore-based camp was established in Prince William Sound to conduct photo-identification studies on killer whales (16 - 24 May and from 5 June to 13 September 1991). The camp was located in the southwestern region at Squire Island (off the southwest side of Knight Island). The camp was fully self-contained with necessary items for camp and vessel safety. The Squire Island camp was staffed by two biologists and one small boat. Two biologists, working aboard a live-aboard vessel, were also dedicated to killer whale surveys. Research personnel communicated among themselves via marine radios. For consistency in data collection, key personnel remained in the field throughout the field season.

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. Travel routes typically taken by whales were surveyed. Upon sighting whales, researchers would stop further search efforts and approach the whales to collect photo-identification information. A killer whale survey form was completed for each encounter. When whales were encountered, researchers selected a vessel course and speed to approximate the animals' course and speed to facilitate optimal photographic positioning.

To obtain a high-quality photograph, an approach within 30-60 meters was required. Photographs were taken of the left side of the whale's dorsal fin and saddle patch. High-performance 35 mm camera systems (i.e., Nikon, Canon, Pentax) with motor drives and 300 mm lens were used to collect the data. 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 a single photographic laboratory and processed throughout the season to allow field personnel to obtain necessary feedback within two weeks of encounters. Proper labelling of exposed film included date, roll number, photographer's initials, location, species code, and ASA setting. To avoid confusing the identification of whales, a new roll of film was used for each encounter.

Daily effort logs were maintained. These logs permitted 1) quantification of the amount of time searching for whales vs photographing whales, 2) quantification of search effort under different weather conditions; 3) daily vessel trackline, and 4) an estimation of number of vessels/aircraft encountered in the study area.

To increase the sighting effort within Prince William Sound to ensure that all whales were being seen and photographed, a marine mammal sighting network was organized throughout the Prince William Sound area. This network recorded all sightings of whales collected opportunistically from Alaskan State Ferries and private aircraft and boaters. Whale sightings were reported directly to the whale damage assessment vessels. Field teams responded by searching out the area where whales were reported to collect photographic data.

Data Analysis

All exposed film of killer whales collected during the 1991 field season was analyzed for individual identification. Each negative (or prints as needed) was placed under a dissection microscope for identification purposes and notes and sketches made. Sub-standard photographs (not showing enough detail or improper angle/side) were not used; thus reducing the probability of mis-matching photographs. Photographs were then grouped by individual and each identified whale was visually compared to the historical photographic database available through the National Marine Mammal Laboratory and the Pacific Biological Station Nanaimo, British Columbia, Canada. Once an individual whale was identified, it was relatively easy to identify the pod to which it belongs. Once all photographs were entered and evaluated, it was then possible to determine 1) if all members of the pod were present, and 2) if pod structure/integrity is similar to previous years. Any missing animals were noted. If animals are found missing, it is imperative that 1992 studies be done to verify the missing individuals the

following season. The stability of resident pods over time is such that if an individual is listed as missing for at least one year; that missing whale is considered dead. Unfortunately, due to the highly variable nature of transient pods, pod structure and mortality rates cannot be conclusively documented for transient groups to assess damage.

Calves of the year were identified by size, their mothers identified, and natality calculated. Mortality rates through 1990 were calculated for resident groups. Mortality rates for 1991 will not be available until after 1992 observations. Finite annual reproductive rates (RR) and mortality rates (MR) for each pod were calculated as follows:

$$\text{MR} = \frac{\text{NM}}{\text{NP}} \quad \text{where: NM} = \text{number of whales missing from the pod in given year.}$$
$$\text{NR} = \text{number of new calves in a pod in a given year.}$$
$$\text{NP} = \text{number whales present at end of previous year.}$$
$$\text{RR} = \frac{\text{NR}}{\text{NP}}$$

General location of whales will be recorded each time photographs are taken; allowing comparisons of pod movements (= habitat useage) among years. Habitat use comparisons of resident whales will be made on a qualitative basis.

STUDY RESULTS

Objective 1. Between 16-24 May and 5 June to 13 September 1991, research vessels traversed 7,340 nautical miles in Prince William Sound in search of whales or while photographing whales (Figure 1). This coverage reflects a total of 89 operable days of field research plus an additional 21 days in which researchers were confined to camp due to weather. The effort expended during the 1989, 1990, and 1991 seasons on killer whale research represents the most complete coverage of this species in Prince William Sound.

In 1991, seven resident pods and four transient pods were reported in Prince William Sound. Examples of killer whale photographs collected for identification purposes are given in Figure 2.

Objective 2. In Prince William Sound, areas of known whale concentrations and movement patterns were qualitatively compared between 1991 and the database available for 1984-1990. The presence of whales in certain areas and times could only be looked at for resident pods since the occurrence of transient groups from year to year is highly variable.

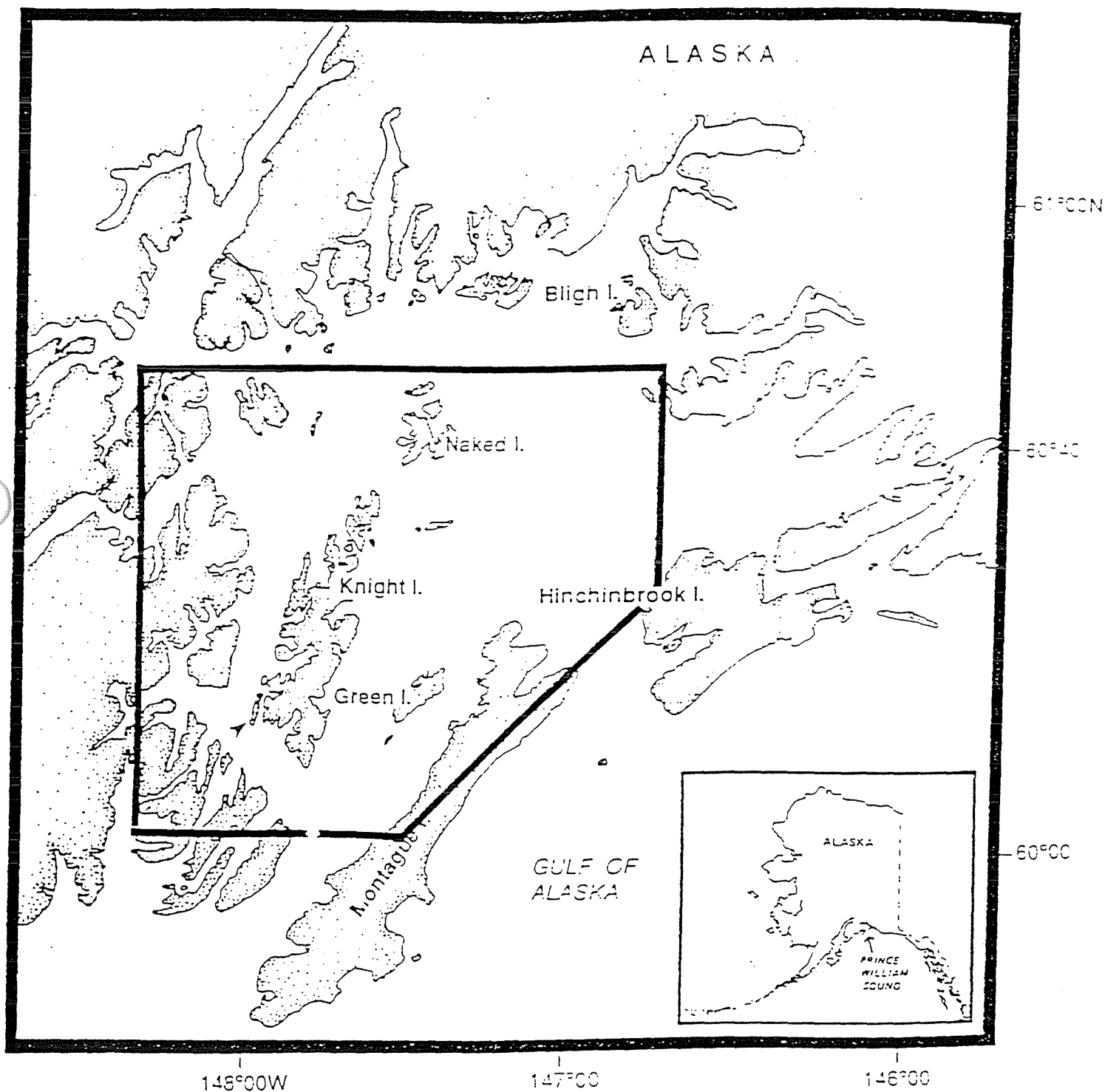
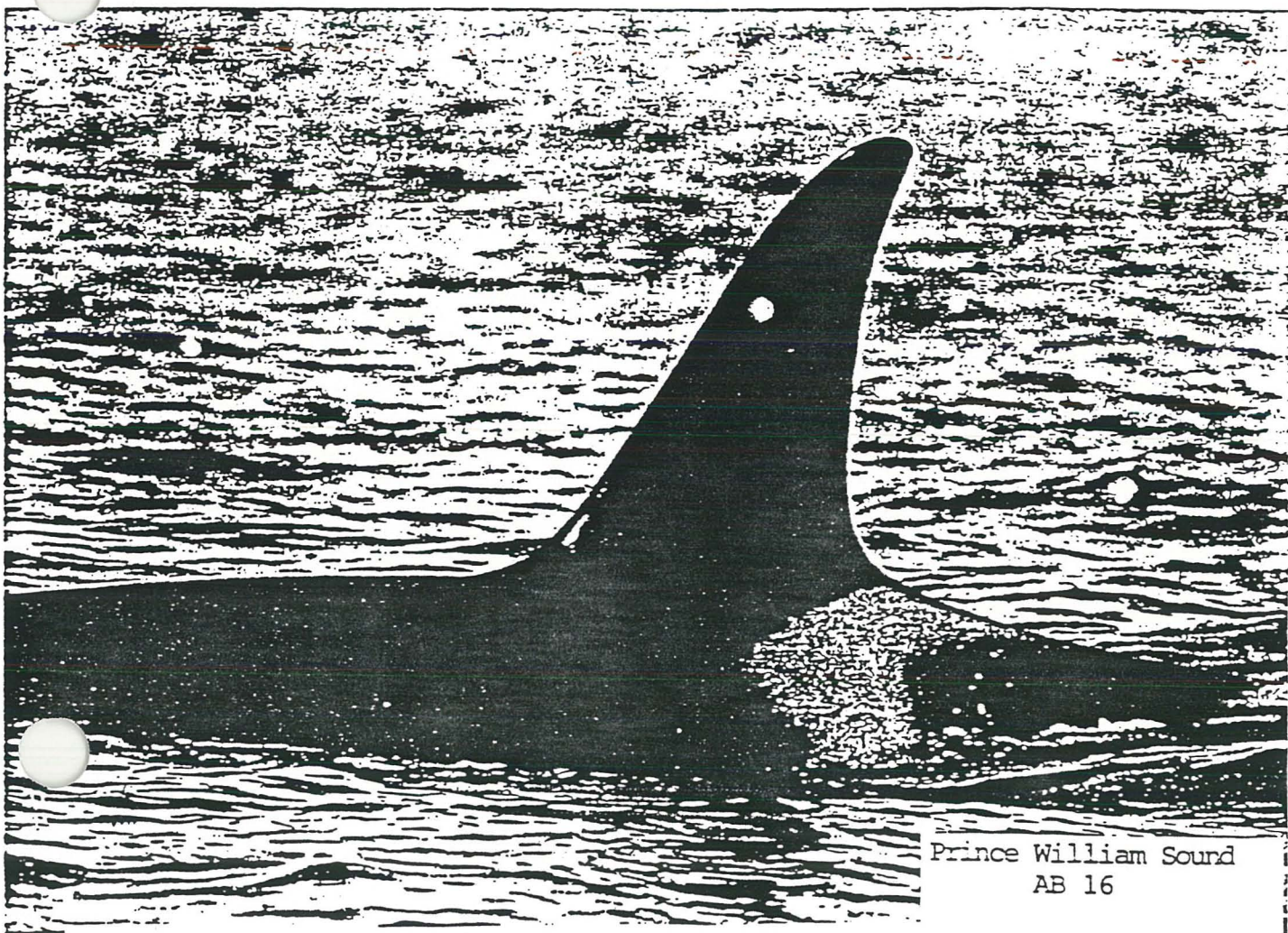


Figure 1. Approximate boundary of the killer whale study area, Prince William Sound, Alaska, 1990. The Squire Island camp is marked (▴).



Prince William Sound

AB 17



Prince William Sound

AB 16

In late summer and early fall, multi-pod aggregations typically occur in lower Knight Island Passage and Montague Strait. In 1991, typical multi-pod aggregations did not occur. Observations of killer whale pods were of a short-term nature and in contrast with other years the whales did not use lower Knight Island Passage but remained in Montague Strait. Despite increased effort over the last three years (1989 to 1991) the number of encounters with killer whales appears to be decreasing. Unfortunately, changes in habitat useage cannot be adequately demonstrated due to lack of quantitative data from past studies.

Objective 3. Preliminary analysis of photographs of resident killer whale pods revealed one additional animal missing from AB pod. If this one whale is confirmed missing in 1992, a total of 14 animals will be considered dead from this pod for the three-year period. Of the seven missing animals from AB pod, two were reproductively active adult females which had calves of two and three years old, respectively. The other missing AB pod members were three juveniles of unknown sex and two adult females that have not reproduced since 1984. Of the six whales missing in 1990 in AB pod, two were adult females, one was an adult male, and three juveniles (two were born in 1988 and one was born in 1986). The mother of the juvenile born in 1986 was documented as missing during the 1989 investigations. The missing 1991 whale is a subadult male. Pod structure has significantly changed in AB pod based on comparison of association patterns among individual whales. No other resident whales are reported missing for 1991.

At present there are 10 and possibly 11 whales missing from AT pod (a transient pod in Prince William Sound). Researchers encountered this pod 10 times during the 1991 season. Three of these missing animals (AT 5, AT 7 and AT 8) were photographed behind the Exxon Valdez on or about 27 March 1989.

Objective 4. An annual reproductive rate of Prince William Sound killer whales was 3.8% combined for the period of 1984 to 1989 (excluding AB pod). A combined annual reproductive rate of 5.1% was calculated for British Columbia killer whales for the years 1973 through 1987. In Prince William Sound, calves were observed in AE, AJ, AK, and AN pods in 1990. A rise in the reproductive rate of AB pod was documented for the years 1985-86 at 6.3%, 1986-87 at 6.4%, and 1987-88 at 15.6%. Increased natality followed an increase in mortality rates documented for this particular pod. Calves were not observed in AB pod during the 1990 season. However, a AB calf was documented during the 1991 season.

Objective 5. A combined annual mortality rate for all Prince William Sound resident killer whale pods was 1.8%, covering the years from 1984 to 1988. Similar mortality has been noted for resident pods off British Columbia, where a annual combine rate of 2.2% (1973-88) has been documented. The long-term stability of pod structure in resident killer whales allows determination of deaths

within pods. Unfortunately, it is more difficult to assess mortality in transient groups since their social structure is different from resident groups. In 19 years of study with resident pods in British Columbia, Canada and Puget Sound, Washington and in 5 years of study in Prince William Sound, there has been no immigration or emigration from one pod to another or between matrilineal groups within the pod. When a whale is missing from its pod and matrilineal group over a period of one season and confirmed the following season, the missing whale can safely be assumed to be dead. No animal consistently missing from a resident group has ever returned to its pod or appeared in another pod in 24 years of research in the United States and Canada. If the fourteen missing whales from AB pod are not seen in 1992, the resultant annual mortality rate for this pod would be greater than 19.%; a value 10 times the expected rate based on 24 collective years of research with killer whales. AB pod has suffered high mortality rates in 1984-85 (8.5%) and 1985-86 (9.4%) with deaths linked to bullet wounds obtained in interactions with the blackcod longline fisheries in Prince William Sound. With the cessation of shooting, mortality declined to 3.2% in 1986-87 and 3.1% in 1987-88. The extreme nature of the potential injury (fourteen missing animals from one pod in such a short time period) argues for an agent of potent and unusual severity.

No killer whales were reported as stranded in Prince William Sound during the 1991 season.

Objective 6. A monitoring program is being considered.

STATUS OF INJURY ASSESSMENT

We have been successful in meeting our objectives listed in the study plan. To date, seven resident and four transient pods of killer whales have been documented in Prince William Sound during the 1991 field season.

Of utmost concern is the loss of the fourteen members of AB pod. It is very possible that AB pod was in the Naked Island area when fresh oil was blown down into that area on 27 March 1989. AB pod is known to frequent the Naked Island area in early spring presumably to feed on herring and become involved with the blackcod fishery that typically opens 1 April. Although killer whale pods are seen in tightly grouped formation when resting and socializing; often when feeding or travelling they are spread out across distances of a mile or greater. It is possible that within a specific pod that some whales and not others could have come in direct contact with oil.

Although numerous encounters ($n = 10$) occurred with AT pod (a transient pod of 22 whales) during the 1991 investigations, at least 10 whales were listed as missing. Three of these missing

whales were photographed directly behind the Exxon Valdez three days after the vessel ran aground on Bligh Reef.

An annual 1990/91 mortality rate for AB pod of 20.7% was calculated based on the disappearance of six AB individuals; an unprecedented annual mortality rate for killer whale populations based on 24+ years of research.

Reproductive rates for 1991 have not as yet been calculated. If the long-term effects of the oil spill are considered, changes may not be expected in natality until the fourth year (approximate calving interval of killer whales). Field studies in 1992 are needed to 1) determine if the missing whales from AB and AT pods documented in 1991 return in 1992; 2) calculate 1991 killer whale mortality rates; 3) document 1992 natality; 4) obtain fourth year information on killer whale movements within the Sound; 5) monitor the five pods that were observed to swim directly through oil to evaluate long-term effects; and, 6) complete our overall evaluation of the impact of the Exxon Valdez oil spill on Prince William killer whale natural history and ecology.