Environmental Assessment of the Alaskan Continental Shelf

Volume 1

Principal Investigators' Reports
October–December 1976

NOAA

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VOLUME 1. RECEPTORS (BIOTA):
MARINE MAMMALS; MARINE BIRDS; MICROBIOLOGY

VOLUME 2. RECEPTORS (BIOTA):
FISH; PLANKTON; BENTHOS; LITTORAL

VOLUME 3. EFFECTS; CONTAMINANT BASELINES; TRANSPORT

VOLUME 4. HAZARDS; DATA MANAGEMENT

Environmental Assessment of the Alaskan Continental Shelf

October-December 1976 quarterly reports from Principal Investigators participating in a multi-year program of environmental assessment related to petroleum development of the Alaskan Continental Shelf. The program is directed by the National Oceanic and Atmospheric Administration under funding from and for use by the Bureau of Land Management.

ENVIRONMENTAL RESEARCH LABORATORIES
Boulder, Colorado
February 1977

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VOLUME 1

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RU# 34

NO REPORT WAS RECEIVED

A final report is expected next quarter

Quarterly Report

Contract No. R7120804
Research Unit 67
Period 1 October 1976
31 December 1976
Number of pages 15

BASELINE CHARACTERIZATION OF MARINE MAMMALS IN THE BERING SEA

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National Marine Fisheries Service
Northwest and Alaska Fisheries Center
Marine Mammal Division
7600 Sand Point Way NE
Seattle, Washington 98115

28 December 1976

Research Unit 67

Sixth Quarterly Report, October-December, 1976

I. Task objectives.

The overall objectives of RU67 are to develop a comprehensive report outlining baseline characterization of marine mammals in the Bering Sea by identifying important life history and general ecological considerations from the literature, and from seasonal distribution and abundance data collected in the field.

Sixth quarter objectives included 1) completing the counting of several hundred 35 mm slides from photographs taken of northern sea lions, Eumetopius jubatus, on islands in the eastern Aleutian Islands in August, 1976; and 2) engaging in an intensive ship, helicopter and land survey of seals and sea lions on several eastern Aleutian islands in October, 1976. The ship's cruise report of the October effort is included in this report as a special Addendum. Most of this quarter's activities are reported there.

II. Field or laboratory activities (also see Addendum).

A. Field or ship trips.

1. Field - Surveyor, 18-29 October 1976, from Kodiak Is. to the eastern Aleutian Islands, including survey using the Bell 206B (N49593) helicopter.
2. Laboratory - data reduction and formatting of remaining 1976 data collected under RU67 that was not submitted in October 1976.

B. Scientific party

Lt. Roger Mercer	
Robert Everitt	all are employees of the
Bruce Krogman	Marine Mammal Division
Carl Peterson	
David Rugh	

C. Methods.

1. Field sampling - see Addendum.
2. Laboratory - logging data, editing and finalizing into NODC format for carding. Data processed for EDS storage.

D. Sample localities/ship or aircraft tracklines. A summary of the general survey route using the Bell helicopter during the October Surveyor cruise is covered in Figure 2 of the Addendum report.

III. Results.

Specific sighting data for the on-land and helicopter surveys are covered in Table 2 of the Addended report.

IV. Preliminary interpretation of results.

Although northern sea lions were not found to be abundent on islands in the eastern Aleutian Islands during October, we have established that the islands represent important hauling out areas for the species during this time of the year. The fact that 13,329 Eumetopius were seen (about 82% of the total for the same islands surveyed in June 1976: total for all islands counted in June 1976 = 23,381; total for the same islands counted in October and June 1976 = 16,162) indicates that many more sea lions remain on these islands during the fall than was expected. Admittedly, however, there are essentially no previous survey data known to exist during October.

V. Problems encountered/recommended changes. None

VI. Estimate of funds expended.

Salaries/overtime	$8,100
Equipment/computer	400
Travel/per diem	2,400
	$10,900

VII. Revised data submission schedule. Our 15 April 1976 aerial survey is the last remaining RU67 spring survey not formatted. It will be sent in NODC format on computer cards within two weeks. The remaining RU67 surveys (fall 1975 and fall 1976) will be finalized during the seventh quarter and submitted with the annual report.

VIII. Revised milestone chart.

Activity	Period of accomplishment
1) Preparation of annual report	March
2) Finalizing remaining RU67 1975-76 data into NODC format	February
3) Prepare for field season	February-March
4) Begin first FY77 aerial survey in Bering Sea	approximate dates: 28 March-8 April

RU67 ADDENDUM FY76

MARINE MAMMAL SURVEY
EASTERN ALEUTIAN ISLANDS

17-29 October 1976

NOAA SHIP SURVEYOR

Research Personnel:

Robert Everitt
Bruce Krogman
Roger Mercer
Carl Peterson
David Rugh

Principal Investigators:

Clifford Fiscus
Howard Braham
Roger Mercer
David Rugh

OCSEAP (RU 67-68)

Marine Mammal Division, NWAFC
National Marine Fisheries Service
Seattle, Washington 98115

December 1976

Summary Report, NOAA Ship Surveyor Cruise RP-4-SU-76B, 18-29 October 1976

by Roger W. Mercer, Bruce Krogman and David Rugh

The NOAA ship Surveyor departed Womens Bay, Kodiak at 1037 hours 18 October and returned 0800 hours 29 October. A continuous marine mammal watch was maintained from the bridge by two or more observers during daylight hours while underway (Figure 1). Aerial (Figure 2) and land surveys were carried out along the shores of those eastern Aleutian Islands listed in the report.

OCSEAP Research Units:

#67 Baseline Characterization of Marine Mammals in the Bering Sea.

#68 Abundance and Seasonal Distribution of Marine Mammals in the Gulf of Alaska.

Research Personnel:

Roger Mercer	Marine Mammal Division, National Marine Fisheries Service, NOAA
Bruce Krogman	- do -
Robert Everitt	- do -
David Rugh	- do -
Carl Peterson	- do -

Purpose of Study:

The goals of these projects are to provide baseline data on the abundance, seasonal distribution and breeding locales of marine mammals in the Bering Sea, Gulf of Alaska and eastern Aleutian Islands.

Specific Objectives of Leg VI SURVEYOR Cruise:

A. Aerial and shipboard transect sampling of cetacean and pinniped stocks feeding in or migrating through the survey area during the latter part of October.

B. Make visual estimates and photographs of northern sea lion, (*Eumetopias jubatus*) and harbor seal (*Phoca vitulina*) rookeries and hauling areas on Adugak, Bogoslof and Ugamak Islands.

C. Determine sex and age composition of sea lions (E. jubatus) by on-site enumeration of hauled out animals.

D. Collect tissue and skeletal samples from dead animals stranded on shore for supportive age and distribution data.

E. Collect northern sea lions (E. jubatus) encountered pelagically in large feeding groups to be used for supportive trophic data. (None seen or collected)

Methods:

1. Shipboard and aerial surveys were conducted while in transit to, from and within the survey area in an effort to locate and photograph migrating or feeding cetaceans and pinnipeds.

2. Photographic census flights were made over as many pinniped rookeries and hauling areas as time and weather would permit. Visual estimates were made and photographs taken for later use in counting hauled out animals.

3. On-site counts were made where possible of rookeries and hauling areas for use as ground truth comparisons with aerial estimates and photo counts.

4. Tissue and skeletal samples were collected from dead pinnipeds near rookeries or hauling areas and from stranded cetaceans discovered by previous aerial reconnaissance flights.

Accomplishments:

A. Approximately 157 man hours were spent watching for marine mammals from the flying bridge over 828 nautical miles of ship's trackline during the entire voyage. Sightings made from the ship during transit have been tabulated (Table 1). Research effort is summarized in Table 4.

B. Approximately 270 nautical miles of aerial survey work other than rookery and hauling area surveys was conducted.

Aerial surveys were flown using a Bell 206B helicopter capable of carrying three passengers and having an approximate cruising limit of two hours at 100 knots. Overwater surveys were conducted at an altitude of 100m; rookery and hauling ground surveys at 250 m. All aerial surveys were initiated from the helipad of the NOAA ship Surveyor (OSS-32). As weather permitted, two surveys were flown from October 21 to 25.

The original objective of the aerial surveys was to dilineate cetacean migrations, particularly of gray whales (Eschrichtius robustus) near

Unimak Pass and in the Gulf of Alaska. Unfortunately, due to foul weather, only two gray whale surveys were made (one on 21 October and one on 24 October) and no gray whales were encountered. Only three cetaceans, two killer whales (Orcinus orca) and one tentative minke whale (Balaenoptera acutorostrata), were seen during helicopter flights.

Sea lion rookeries and hauling areas on Amak Island (and nearby islets), the Krenitzin Islands, Unalaska Island, Umnak Island, and adjacent islands, were surveyed from the air.

C. Visual counts and photographs were made from the helicopter (Bell 206B, N49593) of rookeries and hauling areas on the SW portion of Umnak, the NE portion of Unalaska, Adugak, Samalga, Bogoslof, Ogchul, Vsevidof, and Amak Islands, most of the Krenitzen Island group, and the north and south coasts of Unimak Island. Visual estimates are presented in Table 2.

D. On-site counts of northern sea lion (E. jubatus) were made on Bogoslof Island, the rocks off the NE end of Adugak Island and two hauling areas at the north end of Amak Island. Counts of the total number of animals, pups, and bulls have been tabulated (Table 2).

E. A full count of dead pinnipeds was made on Bogoslof Island and a partial count over approximately one mile of shoreline was made on Amak Island. Two dead adult, and 168 dead pups (E. jubatus) were found on Bogoslof and two adults and one pup (E. jubatus) were found on Amak Island. Some animals may have been covered by windrows of kelp and missed on the beach at Bogoslof.

F. Tissue and skeletal samples were collected from dead sea lions (E. jubatus) on Bogoslof and Amak Islands and whale skulls were collected from stranded specimens on Unalaska and Unimak Islands. Tissue and skeletal samples are listed in Table 3.

G. No large feeding congregations of sea lions (E. jubatus) were encountered during this leg and, consequehtly, no collections of E. jubatus specimens were made.

Remarks:

Weather was generally good for October and all major objectives of the cruise were met. The Bell 206B helicopter launched from a vessel such as the SURVEYOR is an excellent method for obtaining on-site pup ratio and mortality counts on scattered rookeries such as those encountered on this cruise. The officers and crew of the SURVEYOR were a positive element in making this a successful cruise and we wish to express our gratitude for the helpful cooperation we received.

Table 1.--Number of animals seen from NOAA ship *Surveyor*, by day and by species, from 18 to 28 October 1976.

Species	Days										
	18	19	20	21	22	23	24	25	26	27	28
Enhydra lutris										1	
Phoca vitulina	3								20	1	1
Eumetopias jubatus											
(in the water)	1	1	20	45				5	43	8	11
(hauled out)									2020		1000
Callorhinus ursinus			1	16				1			
Unidentified pinniped	1		2								
Phocoenoides dalli		2	6	15					2	5	
Orcinus orca								3		1T *	
Balaenoptera acutorostrata				1T						1T	
Balaenoptera borealis										2T	
Balaenoptera physalus			1								
Megaptera novaengliae		2									
Unidentified cetacean			2							1	1

* A "T" is placed after the number to indicate tentative identification.

Table 2.--Numbers of animals estimated and/or counted on hauling area and rookery surveys during cruise of NOAA ship *Surveyor*, 18 to 28 October 1976.

	Species								
	Sea lion (E. jubatus)				Harbor seal (Phoca vitulina)			Sea otter (Enhydra lutris)	
	Estimate	Count			Estimate	Count		Estimate	Count
Major hauling area	numbers	Pups	Bulls	Total	numbers	Pups	Total	numbers	numbers
Amak Is.*	825	2	14+	1,023	49	-	-	6	-
Sea Lion Rock	1,860	-	-	-	-	-	-	-	-
Ugamak Is. **	2,827	-	-	-	-	-	-	-	-
Round Is.	158	-	-	-	-	-	-	-	-
Tigalda Is.	40	-	-	-	-	-	-	-	-
Billings Head (Akun Is.)	1,097	-	-	-	-	-	-	-	-
Tanginak Is.	30	-	-	-	-	-	-	-	-
Cape Morgan (Akutan Is.)	2,320	-	-	-	-	-	-	-	-
Reef Bight (Akutan Is.)	258	-	-	-	-	-	-	-	-
Bishop Point (Unalaska Is.)	100	-	-	-	-	-	-	-	-
Adugak Is.***	975	98	3+	905	10	-	-	-	-
Ogchul Is.***	1,235	140	0	1,880	-	-	-	-	-
Bogoslof Is.	350	160	5+	427	20	1	24	-	-
Bechevin Bay (Unimak Is.)	-	-	-	-	50	-	-	90	-

Table 2.--Numbers of animals estimated and/or counted on hauling area and rookery surveys during cruise of NOAA ship SURVEYOR, 18 to 28 October 1976--Continued.

	Species								
	Sea lion (E. jubatus)				Harbor seal (Phoca vitulina)			Sea otter (Enhydra lutris)	
	Estimate	Count			Estimate	Count		Estimate	Count
Major hauling area	numbers	Pups	Bulls	Total	numbers	Pups	Total	numbers	numbers
Umnak Is. (Includes Samalga Is.)	-	-	-	-	580	-	-	42	-
Total counts (for all aerial surveys)	13,329				1,002			146	

* Only two rookeries on the north end of the island could be counted from land. Aerial estimates include all rookeries on the island.

** Two killer whales (*Orcinus orca*) were observed on 21 October off the NE tip of Ugamak Is. swimming within 100 meters of sea lions (*E. jubatus*) hauled out on the island.

*** Partial counts; most but not all of the island was surveyed.

Table 3.--List of samples collected during cruise of NOAA ship *Surveyor*, 18 to 28 October 1976.

Specimen number	Description	Samples collected	Photos
Northern sea lion (*Eumetopias jubatus*) collected at Bogoslof Is., 23 October 1976			
B 1	Fecal material taken from a point 107 feet above MHWL near edge of vertical cliff.	Feces	Roll B5, frames 26-28
B 2	Adult, sex unknown, died this season, well decomposed, 50 m from bluff, 200 m from MHWL.	Skull Femur	Roll B7, frame [illegible]
B 3	Pup skeleton, found 150 m from MHW.	Skull	None
B 4	Pup, died this season.	Skull	Roll B7, frames 10-13
B 5	Pup, female, died this season, 50 m from MHW, 122 cm SL.	Skull	Roll B7, frames 14-16
B 6	Pup, died very recently, male, 150 cm SL.	Skull Baculum Heart Testicles Kidney Diaphragm Lung Fat Rocks from stomach	Roll B7, frames 18-21
B 7	Adult, decomposed, 40 m from MHW.	Skull	Roll B7, frames 22-23-24
B 8	Pup, female, died this season, 133 cm SL	Skull Heart Ovaries Kidney Lung Pancreas	Roll B7, frame 35
B 9	Pup, male, 128 cm SL.	Baculum	-
B10	Pup	Skull	-

Table 3.--List of samples collected during cruise of NOAA ship SURVEYOR, 18 to 28 October 1976--Continued.

Specimen number	Description	Samples collected	Photos
-	Pup, 132 cm SL	-	-
-	Pup, 134 cm SL	-	Roll C5, frame 24
-	Pup, 128 cm SL	-	Roll C5, frame 25
-	Pup, approx. 91 cm SL	-	Roll C5, frame 25
Northern sea lion (Eumetopias jubatus) collected at Amak Is., 24 October 1976			
1	Pup, only skeleton left.	Skull	None
2	Adult, sex unknown, at MHWL.	Skull	Roll A9, frames 18-19.
Goosebeaked whale (Ziphius cavirostris) collected On Unalaska Is. (Lat. 53°53.8' N, Long. 167°27.5'W), 23 October 1976.			
3		Skull	
Gray whale (Eschrichtius robustus), collected on Unimak Is. (Lat. 55°01.5' N, Long. 163°55.0' W), 24 October 1976.			
4		Skull	

The following substrate samples were collected from Bogoslof Is. on 23 October 1976:

Sector B2 (sand from the beach where P. vitulina hauled out);
Sector B5 (rocks and hair from the E. jubatus bull's "bed");
Sector C4 (sand from the hummocked area near the E. jubatus rookery);
Sector C4 (pebbles from the beach);
Sector C4 (sand from the same beach);
Sector C3 (pebbles from near the E. jubatus rookery).

Table 4.--Summary of research effort.

	Everitt	Krogman	Mercer	Peterson	Rugh	Total
Hours on bridge watch	22.3+	31.6+	24.3+	26.1+	42.4+	146.7+
No. of sightings from the bridge	7	7	16	19	25	74
Total nautical miles						270
Hours on land	9.6	15.1	16.7	14.8	15.3	71.5
Hours on aerial survey	15.8	7.9	5.8	5.0	6.5	41.0
Total aerial track miles						861
Total aerial data recordings						277

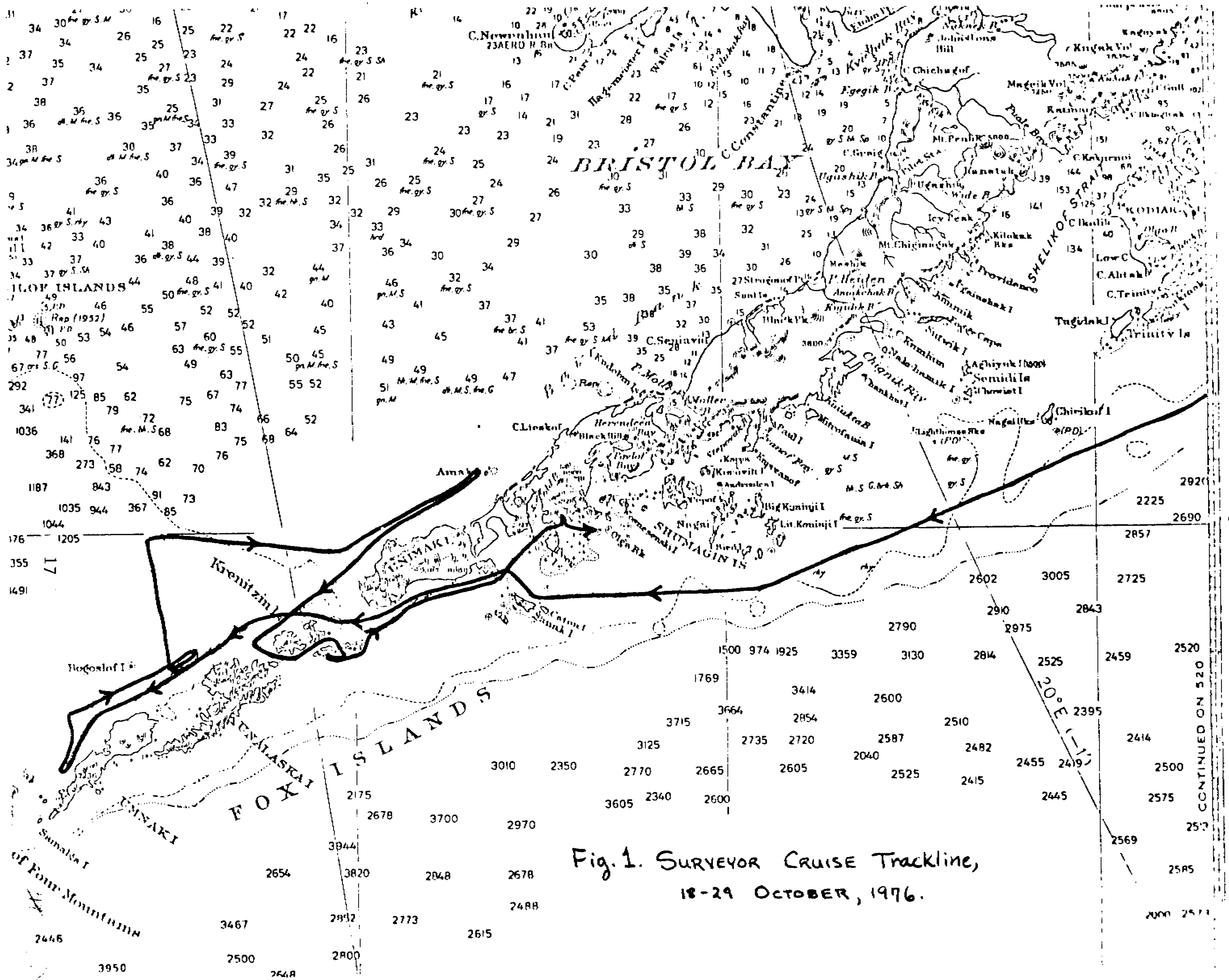

Fig. 1. Surveyor Cruise Trackline, 18-29 October, 1976.

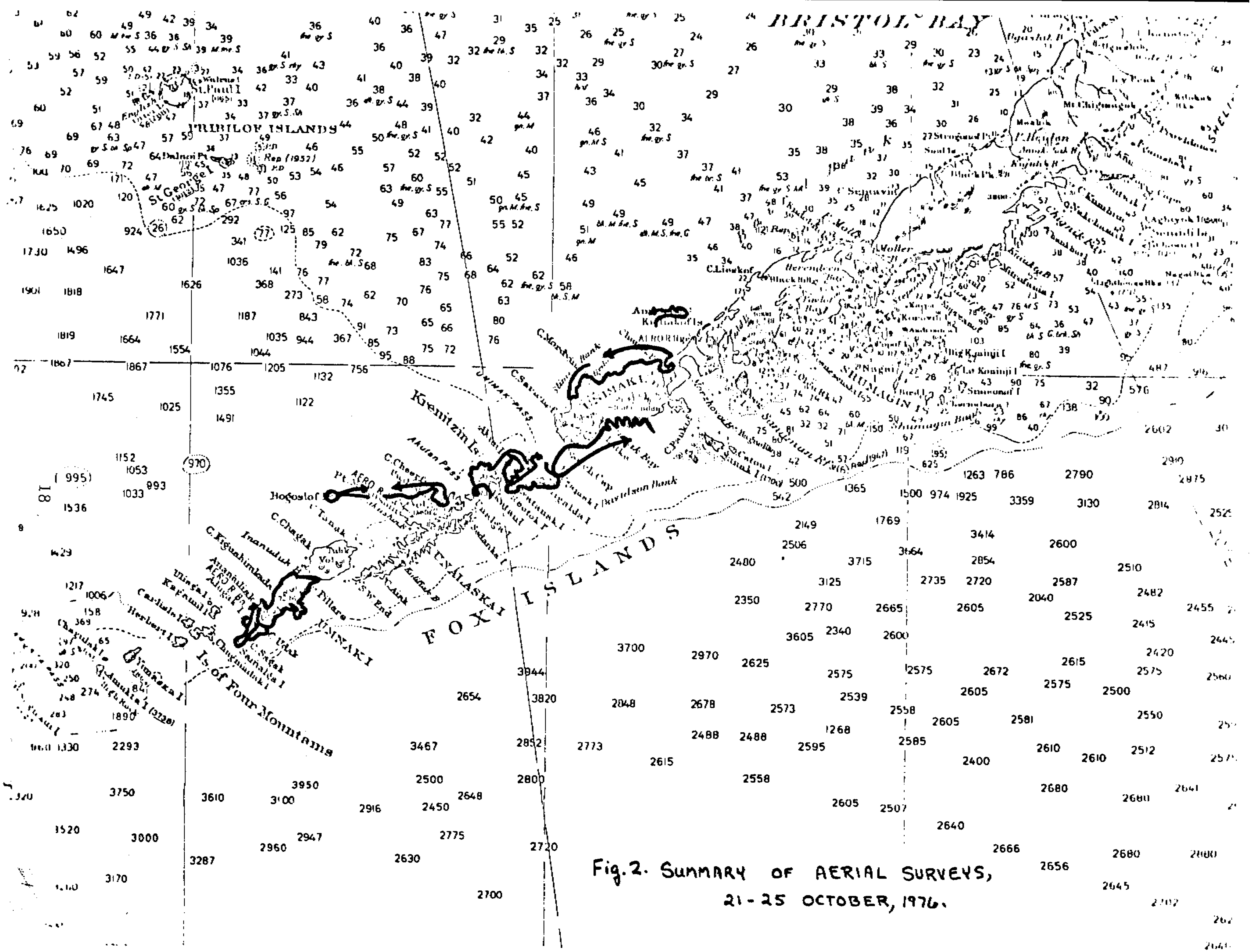

Fig. 2. SUMMARY OF AERIAL SURVEYS, 21-25 OCTOBER, 1976.

RU# 68
July-Sept. 1976

SEASONAL DISTRIBUTION AND RELATIVE ABUNDANCE OF MARINE MAMMALS IN THE GULF OF ALASKA

by

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Roger W. Mercer

and

Robert D. Everitt

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Patrick D. McGuire

Carl E. Peterson

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for Contract number R7120806
OUTER CONTINENTAL SHELF ENVIRONMENTAL ASSESSMENT PROGRAM
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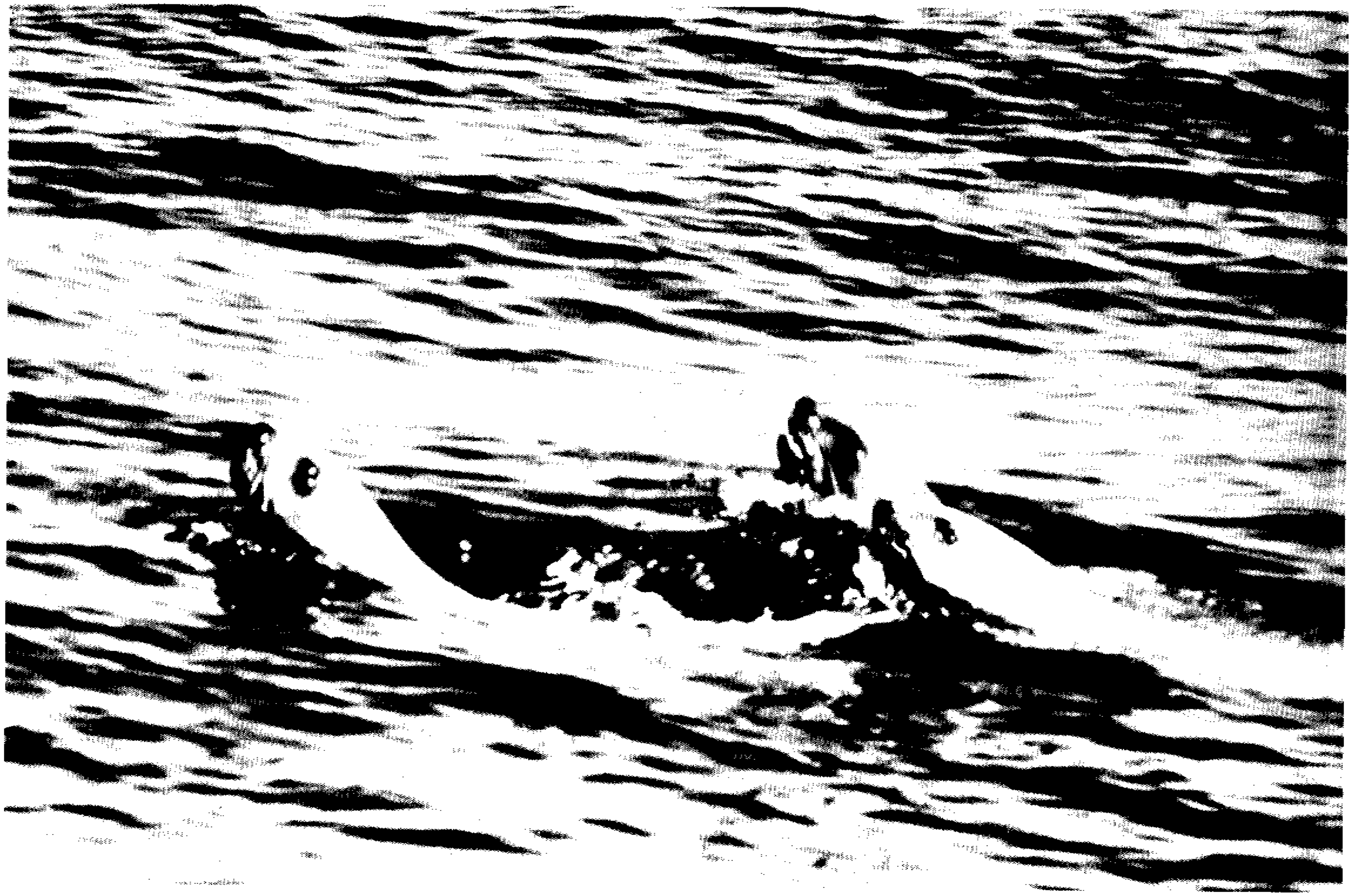
U.S. Department of the Interior
Bureau of Land Management

October 1976

*Marine Mammal Division, National Marine Fisheries Service, NOAA,
7600 Sand Point Way NE, Seattle, WA 98115



Northern sea lions, Eumetopius jubatus, June 1976.

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ACKNOWLEDGEMENTS

The collection of sighting data by Marsha Caunt and KennethRaedeke of the Marine Mammal Division while aboard NOAA ships was greatly appreciated. Nancy Severinghaus has done the very important task of annotating hundreds of published and unpublished documents. Ethel Todd, also of the Marine Mammal Division, assisted in editing and typing the manuscript.

Donald Calkins, Kenneth Pitcher and Karl Schneider of the Anchorage Office, Alaska Department of Fish and Game, provided us with unpublished sightings and suggestions as to species distribution and abundance. Marine Mammal Officers of the Platforms of Opportunity Program (NOAA) aboard NOAA ships also provided sighting data.

INTRODUCTION

This document is the result of a contract with the Environmental Research Laboratory, NOAA, Boulder, Colorado, to summarize existing knowledge and to collect research data on the seasonal occurrence of marine mammals in the Gulf of Alaska. The contract is part of the Outer Continental Shelf Environmental Assessment Program (OCSEAP) funded by the Bureau of Land Management, Department of the Interior.

The pelagic and coastal waters over the Outer Continental Shelf of the Gulf of Alaska are expected to be important areas for oil-gas research and tanker traffic. Within or near the Gulf, major oil-lease sites exist: (1) Aleutian Shelf, (2) Kodiak Shelf, (3) Northeast Gulf of Alaska, and (4) Lower Cook Inlet. Our OCSEAP research unit number 68 deals with the first three. This report is a comprehensive final report of sightings from pelagic observations in the Northeast Gulf and Kodiak Shelf area specifically covering the period of the terms of the contract, 1 July 1975 to 1 October 1976. Data collected by Marine Mammal Division personnel since 1958 have also been included in this report. During FY 77, we will concentrate our survey efforts under research unit number 68 along the coast and pelagic waters from Kodiak Island west to the Aleutian Shelf lease site located southwest of Umnak Island, in the eastern Aleutian Islands. Data obtained from the Northeast Gulf and Kodiak Island areas during FY 77 will be included in the Final RU68 report as an addendum to allow updating of the Gulf of Alaska research effort.

Coastal areas near oil-lease sites represent localized habitats for breeding marine mammals such as the northern sea lion, Eumetopius jubatus, and seasonally migrating animals, e.g., the California gray whale, Eschrichtius robustus. The objectives of this project were to provide a better understanding of the relative seasonal distribution and abundance of all marine mammals in the Gulf of Alaska. These objectives are accomplished by integrating sighting records taken aboard NOAA ships and chartered vessels working in the Gulf, historical sealing and whaling records, and distribution and abundance estimates from the literature.

While we are reporting sighting data from throughout the Gulf, our specific objectives were to provide information on coastal and pelagic marine mammal occurrences from the northeast coast of the Gulf (i.e., from approximately Yakutat Bay) to Kodiak Island. Under subcontract to the National Marine Fisheries Service, NWAFC, the Alaska Department of Fish and Game, Game Division, completed two reports in 1975 on distribution and abundance of marine mammals along the coast of the Gulf of Alaska (Calkins et al., 1975) and in Prince William Sound

(Pitcher, 1975). Data presented in this report reflect observations made offshore. Cooperative efforts have been maintained with Gulf of Alaska OCSEAP research units 229 (biology of the harbor seal), 240 (abundance and distribution of the sea otter), and 243 (ecology of the northern sea lion) in order to assure area coverage continuity. This report does not cover sea otters, nor coastal activities of sea lions and harbor seals.

Sighting records from inexperienced persons are often unreliable. Even under ideal environmental conditions, such as those in Figures 1-4, the identification of marine mammals at sea is very difficult. For that reason a much larger data base exists than could be reported here. Many recordings of data collected over the past several years could not be used as "proof" of specific sightings. We report here only those data that we are reasonably sure are accurate species identifications. Questionable data were rejected.

We relied heavily on previously published accounts for distribution and abundance projections. Discussion of historical information has, for convenience sake, been included in the "Species Distribution" section rather than reviewed separately in the "Introduction." Because commercial and aboriginal sealing and whaling can be useful in understanding historical distribution and abundance, we have discussed them separately. As part of our objectives, we have attempted to annotate all published accounts on marine mammals in the Gulf. Because of the comprehensive nature of such a task, we are providing only part of that bibliography. A complete annotated bibliography for the Gulf will be included with the bibliography that is being compiled for the Bering, Chukchi, and Beaufort Seas.

STUDY AREA

The study area for this portion of our research in the Gulf of Alaska included the pelagic waters from Lat. 52°N., north to the Alaska coast, from Long. 130°W. on the east to 155°W on the west; excluding Cook Inlet and Prince William Sound. Those areas of principal responsibility included the northeast and northwest Gulf (Kodiak Island region) over the Continental Shelf. Defined by the 100 fathom (182.9 m) contour (Fig. 5), the Continental Shelf extends from approximately 10 km off Yakatak Bay in the northeast Gulf, some 100 km from the entrance to Prince William Sound in the northern Gulf and to 200 km off Kodiak Island.

In the Gulf proper, surface currents flow west to east along the southern edge of the study area towards the coast of Southeastern Alaska. Near the Subarctic Current Divergence, the Alaska Current flows north over the Continental Shelf towards the northeast Gulf and then west along the coast past Kodiak

Figure 1. Killer whales, Orcinus orca, over Fairweather Grounds, April 1976 (Photo by Ens. Wenker, NOAA Corps).

Figure 2. Dall porpoise, Phocoenoides dalli, August 1976.

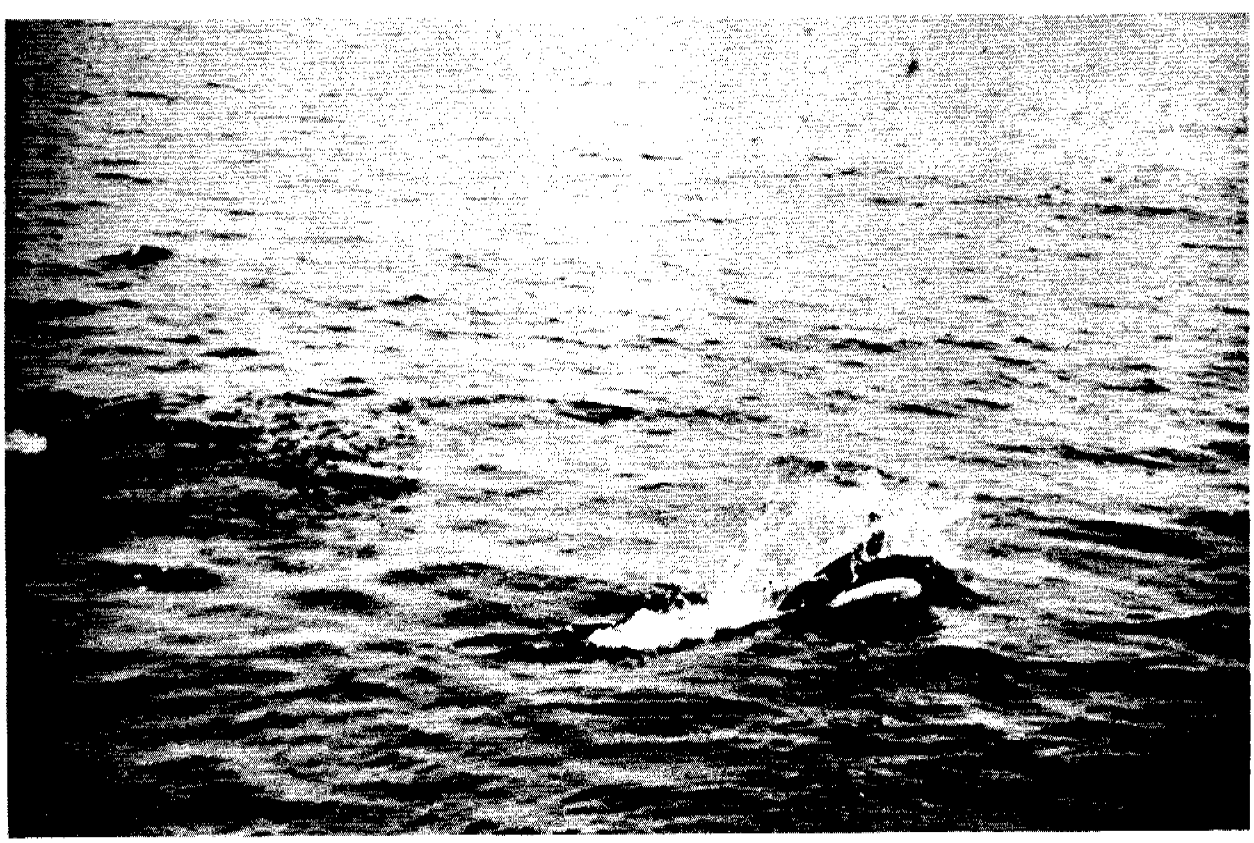

Figure 3. Northern fur seals, Callorhinus ursinus, resting at surface, July 1973.

Figure 4. Sei whale, Balaenoptera borealis, June 1976.

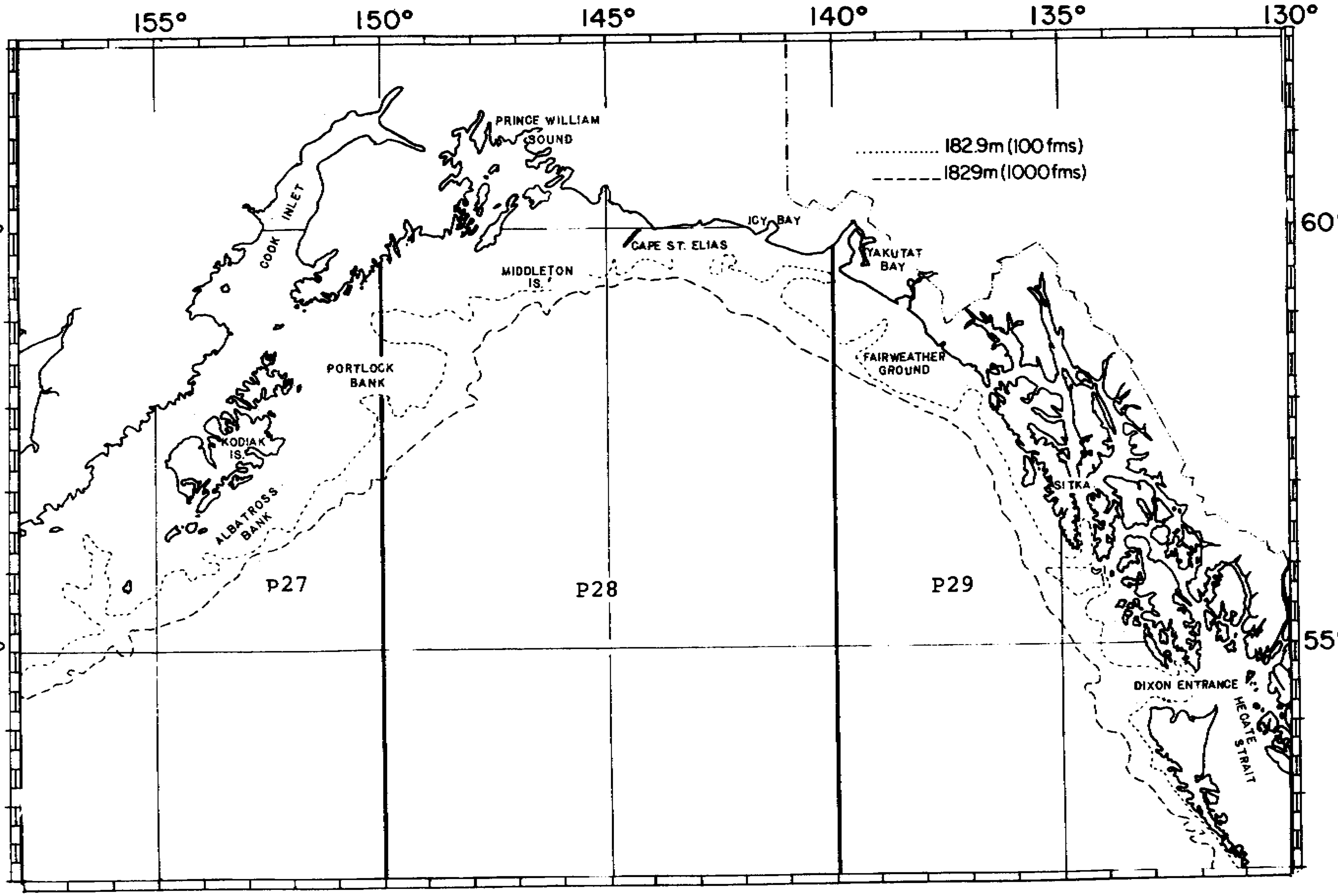

Figure 5.--Gulf of Alaska study area where Marine Mammal Division personnel have been collecting sighting data since 1958 on the distribution and numbers of marine mammals. P27, P28, and P29 represent arbitrary whaling statistic research areas. The outer Continental Shelf is delineated by the 100 fathom (182.9 m) line.

Island, the Alaska Peninsula, and the Aleutian Islands (Ingraham et al., 1976). The current flows at approximately 0.3 knots (0.2 mph) near-shore, increasing to about 1.0-2.0 knots (0.6-1.3 mph) offshore over the Continental Shelf.

Mean surface temperatures 60 km (100 miles) offshore Kodiak Island range from 7°-12°C in the summer and 2°-4°C in the winter (Favorite et al., 1976). Summer offshore temperatures in the northeast Gulf area are 10°-16°C, and winter temperatures 5°-7°c (Dodimead et al., 1963; Favorite et al., 1976). Surface air temperature differentials in the Gulf seldom exceed 0.5°-1.0°C, with an increase gradient closer to shore (Dodimead et al., 1963).

Prominent near-shore shoal areas over the Continental Shelf are Fairweather Ground in the northeast Gulf, Middleton Platform in the northern Gulf, both at depths of 30 to 100 fathoms and Portlock and Albatross Banks near Kodiak Island. Many seamounts occur within the central portion of the study area near Lat. 56°N.

MATERIALS AND METHODS

Data collected came from essentially three sources: (1) Marine Mammal Division personnel trained under this OCSEAP project and stationed aboard NOAA and OCSEAP chartered ships from November 1975 through June 1976; (2) Marine Mammal Division pelagic fur seal researchers working in the Gulf of Alaska from 1958 to 1968; and (3) from NOAA ship's officers and crew members trained by one of us (R.W.M.) in the identification of marine mammals under the Platforms of Opportunity Program (POP). Personnel aboard the U.S. Coast Guard ice breaker POLAR STAR also contributed sightings. Vessel cruises since 1958, for which we are reporting data, are summarized in Table 1.

Data collection generally came as sightings of opportunity; that is, no systematic or analytical procedures were used to standardize the sampling or the routes taken by the ships (i.e., random or systematic transects were not drawn for our experimental needs). Sightings were recorded as encountered, as with NOAA ship's officers, or during watches when a concerted effort was maintained to observe and record all animals encountered, as with Marine Mammal Division personnel. When practical, ship's trackline position, time, weather, and animal behavior (e.g., direction of travel, group composition, etc.) were recorded on a periodic and regular basis. In this way, a qualitative estimate of observation effort could be made, thus of some value in evaluating distribution projections. No quantitative estimates of abundance can be made using these methods; with the exception of pelagic fur seal data collected prior to 1975.

Table 1.--List of ship cruises, 1958-76, from which marine mammal sighting data were used. Data came from Marine Mammal Division (MMD) personnel during pelagic fur seal (PFS), OCSEAP (OCS) related research, and from Platform of Opportunity Program (POP) sightings during NOAA Fleet or OCSEAP charter ship cruises. "Dates" are the approximate cruise periods; "Location" refers to the general area where the survey or activity took place; NW-northwest Gulf (west of Long. 150°W),NE-northeast Gulf (Long. 130°W, north of Lat. 59°N),SE-southeast Gulf (south of Lat. 59°N, east of Long. 140°W), and Cent-central Gulf (Long. 140°-150°W, south of Lat. 59°N).

Dates	Ship/vessel	Location	Survey
23 Feb. - 11 June 1958	Lindy (C)*	SE, Cent., NE	PFS (MMD)
11 May - 1 June 1958	Trinity (C)	NE	"
3 Mar. - 2 June 1960	Tacoma (C)	SE, Cent., NW	"
21 Apr. - 25 Aug. 1960	Windward (C)	SE, Cent., NE, NW	"
6 Feb. - 5 Mar. 1961	Harmony (C)	SE	"
5 May - 20 Sept.1962	Tacoma (C)	SE, Cent.	"
October 1962	Harmony (C)	Cent., NW	"
24 June - 11 Sept.1963	Harmony (C)	Cent., NW	"
June 1964	Harmony (C)	SE	"
18 May - 24 Aug. 1968	New St. Joseph (C)	Cent., NW	"
21 Mar. - 19 Apr. 1974	Fairweather (N)	SE	POP
8 May - 24 Aug. 1974	Fairweather (N)	Cent.	"

Table 1.--Continued

Dates	Ship/vessel	Location	Survey
28 Jan. - 5 Mar. 1975	Oceanographer (N)	Cent.	POP
5 Mar. -15 Aug. 1975	MacArthur (N)	Cent., SE	"
3 Apr. -13 July 1975	Oregon (N)	Cent.	"
22 Apr. -26 Aug. 1975	Rainier (N)	Cent.	"
28 Apr. - 9 June 1975	Townsend Cromwell (N)	Cent.	"
6 May -22 Oct. 1975	Davidson (N)	Cent., SE	"
9 May -23 June 1975	Discoverer (N)	SE, NE	"
31 May -10 Aug. 1975	RV Tordenskjold (C)	Cent.	"
5 Aug. - 5 Dec. 1975	Discoverer (N)	NE, SE	OCS/POP
7 Apr. -30 Apr. 1976	Discoverer (N)	Cent.	OCS/POP
29 Apr. -22 June 1976	Polar Star (G)	NE, Cent.	POP
6 June -25 June 1976	Surveyor (N)	Cent., NE	OCS(MMD)
8 June -22 June 1976	Miller Freeman (N)	Cent.	OCS(MMD)

*(N)-NOAA; (C)-Charter; (G)-Coast Guard.

Sighting records were transferred onto a computerized format for archiving, plotting, and analysis. The data management procedures that were performed are outlined in Figure 6.

Presentation of the results include sighting data, tabulated by species in chronological order (Appendix Tables A-1 to A-17). Plots of sightings were made by species by month in the survey area using a 1:4,860,700 scale Mercator projection (Appendix Figures A-1 to A-119).

Northern fur seal data have been presented on a density per hour effort basis in a manner previously reported on (Marine Mammal Biological Laboratory, 1970). All other sightings are plotted as raw data values only (Appendix A).

COMMERCIAL AND ABORIGINAL FUR SEAL HUNTING

Coastal Indians, Aleuts, and Eskimos took the northern fur seal whenever and wherever the seals entered their hunting areas. In the Gulf of Alaska, the Tlingit hunted off the seaward sides of Chichagof, Baranof, and Kruzof Islands and in the bays on their westward sides which are regularly frequented by fur seals in pursuit of herring schools. The impact of subsistence hunting on the fur seal was negligible.

Pelagic commercial sealing began in the 1870's and continued until 1911. Most of the pelagic sealers were American, Canadian, or Japanese nationals. Between 1868 and 1909 almost a million skins were taken at sea (Riley, 1967). After 1897, it was unlawful for American citizens to engage in pelagic sealing and after the North Pacific Fur Seal Convention of 1911 took effect, all pelagic sealing was outlawed.

Pelagic sealing was carried out on several "sealing grounds" in the North Pacific and Bering Seas, with catch statistics being pooled under several broad geographic areas. The northwest coast sealing ground area extended from California to the Pacific side of the Alaska Peninsula (Townsend, 1896; 1899). It is possible to obtain distribution information on fur seals in the Gulf of Alaska by examining individual logbook records listing daily positions and catches. For example, the Schooner MARY ELLEN hunted off Southeast Alaska 22-31 May 1885 taking 117 seals, best daily catch 48, and from 1-9 June 1885 in the Gulf of Alaska taking 78 seals, best daily catch 38. The total catch for this vessel from California to the Bering Sea in 1885 was 2,304. In 1886, the MARY ELLEN hunting in the Gulf off the Continental Shelf in deep water took 334 seals, best daily catch 151, from 1-3 June; and 838 seals, best daily catch 197, from 6-23 June. The MARY ELLEN total catch in 1886 was 4,295.

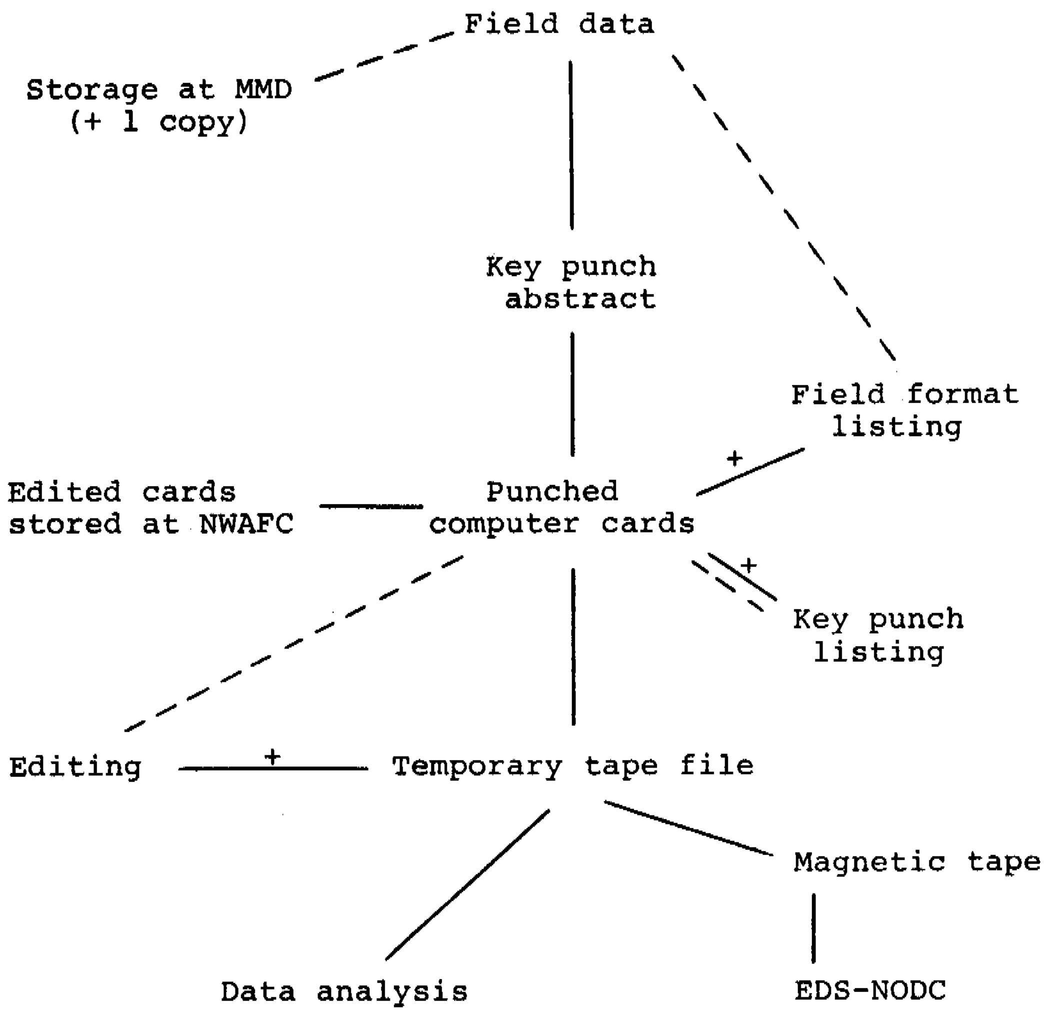

Figure 6. Data management quality control procedures during data acquisition and processing for OCSEAP research activities; -----verified or corrected; + program required step. NWAFC - Northwest and Alaska Fisheries Center; MMD - Marine Mammal Division; EDS-NODC - Environmental Data Service-National Oceanographic Data Center.

Townsend (1899) prepared a map of the North Pacific and Bering Sea showing the position of one day's sealing, coded by month. The map was based on log records of 123 vessels engaged in pelagic sealing from 1883 to 1897, and was used to demonstrate the seasonal movements of the fleet. The map indicates that sealing in the Gulf was carried out both on the Continental Shelf and in deep water. Sealing began in March and extended through May off Southeastern Alaska and north and west to Middleton Island, and in June off Kodiak Island on Portlock and Albatross Banks. Sealers called the entire eastern Gulf area, between Sitka and Middleton Island, "Fairweather Grounds."

Alexander (1953), writing in 1892, stated that 10 years before only a few vessels were engaged in pelagic sealing, but that in 1892 the fleet had increased to 125. Riley (1967) indicated that pelagic sealing peaked in 1894 when 61,838 seals were reported taken. During the period 1890-1908, the pelagic catch exceeded the Pribilof Island land catch each year. The Pribilof Islands population was reduced to about 300,000 animals by 1909 (Nat.Mar.Fish.Serv.,1976). American and Canadian vessels hunted seals in the Gulf of Alaska from about 1880 to 1911.

A provision in the 1911 Convention allowed for an aboriginal take of fur seals, if taken in the traditional way without fire-arms. Indians took seals off Washington, British Columbia, and Southeast Alaska. The Convention restricted certain aboriginal privileges by prohibiting the killing of fur seals within the 3-mile limit in the waters of Alaska (Bower and Aller, 1915).

Ball (in Bower, 1925) described the method used by Tlinkit sealers in the spring of 1923. That year nine parties, five men each, engaged in pelagic sealing. The preferred sealing area was described as a zone about 40 miles long by 15 miles wide, located about 5 miles outside the 100 f curve off Sitka Sound. Kenyon (1955) described a seal hunt and hunting methods used in 1951. This was the last year any significant number of seals were taken off Sitka in the traditional manner.

Catch data for Southeastern Alaska aboriginal sealing are presented in Table 2. Fur seal distribution using pelagic fur seal catch data are summarized for the species under the "Species Distribution" section.

COMMERCIAL WHALING IN THE GULF OF ALASKA

Russian and English traders became active in Alaska and along the west coast of North America following the voyages of Vitus Bering, 1741, and James Cook, 1776-1780. The sea otter (*Enhydra lutris*) and later the northern fur seal (*Callorhinus ursinus*) were primary targets. American whalers came into the

Table 2.--Aboriginal take of fur seals off Sitka, Alaska, 1917-1955*

Year	Male	Female	Fetal	Total	Months	Year	Male	Female	Total	Months
1917	2			2	May	1937	19	97	116	Feb-May
1918						1938	2	90	92	Apr-May
1919						1939	1	30	31	Apr-May
1920						1940	12	24	36	Apr-May
1921				199	May-June	1941				
1922	409	116	1	526	May-June	1942				
1923	408	145	73	533	Mar-June	1943				
1924	8			8		1944	1	15	16	
1925	189	50	40	279		1945	30	9	39	
1926	36	3	1	40		1946	22	333	355	
1927	336	158	49	543		1947	1	24	25	
1928	457	220	96	773		1948	29	173	202	
1929	582	291	122	995	Apr-June	1949				
1930	29	31	25	85	May	1950		41	41	
1931	5	14	2	21	May	1951		188	189	
1932	25	45	8	78	Mar-June	1952				
1933	20	43		63	May-June	1953				
1934	3	8		11	Apr-May	1954				
1935	26	33		59	May	1955			2	
1936	4	7		11	Apr					

*Male-female-fetal columns do not always add up to each year's total as some seals were not sexed.

Note: Data from U.S. Fish and Wildlife Service annual reports on Alaska Fisheries and Fur Seal Industries, 1917-55.

Gulf in the early 1800's pursuing the right whale (Balaena glacialis) on the "Kodiak Grounds," and then moved into the Bering Sea in the mid-1800's in pursuit of the bowhead whale (Balaena mysticetus).

The stocks of commercially valuable marine mammals, i.e., fur seal, sea otter, right whale, bowhead whale, and Pacific walrus (Odobenus rosmarus) were greatly reduced during the 19th century and early years of the 20th century. Right whale stocks became so low they were no longer hunted commercially.

Since 1900, whaling was carried out from United States shore stations at Bay Center, Grays Harbor, Washington (Scheffer and Slipp, 1948), and from Tyee, Whale Bay, Akutan Island and Port Hobron, Alaska. From 1919 through 1929 blue (Balaenoptera musculus), fin (B. physalus), humpback (Megaptera novaeangliae), and sperm (Physeter macrocephalus) whales comprised most of the U.S. shore station catches (Kellogg, 1931). With one exception, there has been no commercial fishery for the large whales in the eastern North Pacific by United States nationals since World War II.

The United States prohibited U.S. nationals from engaging in commercial whaling and the importation into the United States of whale products after December 1971. The Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973 have increased these restrictions. Whale stock assessment and regulation are presently under oversight responsibility by the International Whaling Commission.

Commercial whaling has been carried out by Japanese and Soviet whaling fleets in the North Pacific Ocean and the Bering Sea since the early 1930's. Aside from shore stations in the western Pacific, the first pelagic whaling fleet in the North Pacific was that of the Soviet factoryship ALEUT beginning in 1934. The Japanese began pelagic whaling in the western North Pacific near Bonin Island in 1946 (Committee on Whaling Statistics, 1948). The Japanese began pelagic whaling near the Aleutian Islands and Bering Sea in 1952. The Soviets began to whale around the Aleutian Islands in 1957. By 1955, the stocks of commercially valuable whales in the Okhotsk Sea and the Commander Islands-Kamchatka Peninsula region had been reduced (Berzin and Rovnin, 1966).

Nishiwaki (1966a) states that the Japanese fleets operated near the Aleutian Islands from the end of May until early September. Soviet fleets whale in the same area at the same time of the year. Both Soviet and Japanese fleets actively whaled from the Aleutian Islands eastward into the Gulf of Alaska.

Table 3 lists 1965-75 catch data by species and area for Japanese and Russian whaling fleets working in the Gulf of Alaska.

Rice (1963) states that the stocks of baleen whales in the Southern Hemisphere continued to decline this century, as predicted by biologists, and that when whaling was found to no longer be profitable some fleets were expected to increase their activities in the North Pacific. North Pacific catches exceeded that of the Antarctic in 1967; and during the 1969-70 season catches were doubled. The USSR operated four whaling fleets in the North Pacific (including the Gulf) from 1963 to 1967; three from 1968 to 1969; and two from 1970 to 1975. The Japanese have operated three fleets since 1963. Since 1965, catches and catch effort of preferred cetaceans (fin, sei, and sperm whales) have been steadily declining (Figure 7). A preliminary analysis of data displayed in Table 3 indicates that greater numbers of these whales have been harvested in the central portion of the Gulf, i.e., area P28. It would not appear that harvest effort is substantially different between areas; however, this assumption cannot be verified. It has been inferred that the preferred whaling grounds are at the edges of sector P28, i.e., Northeast Gulf and off Kodiak Island, because more whales are expected to occur here than in other areas of the Gulf (Nasu, 1966). Harvest records and recent sighting data support the conclusion that for the commercially valuable large cetaceans, the areas in the Gulf over and adjacent to the Continental Shelf from Southeast Alaska to Kodiak Island and west along the Alaska Peninsula and Aleutian Islands chain represent important temporal and spatial locations for species distribution; especially related to feeding (Nemoto and Kasuya, 1965).

Pooled Japanese and Russian harvest data by area, P27 (Western Gulf), P28 (Central Gulf), and P29 (Eastern Gulf) (Table 3) indicate: (using Friedman Rank Sums, general alternatives, two-way layout distribution-free test; Hollander and Wolfe, 1973).

1. More fin whales are taken in P28>P27>P29, while more sperm whales are taken in P29>P27>P28 (α level of significance = 0.001).
2. Sei whales are taken in equal numbers by area ($\alpha = 0.250$).
3. In P27 and P29 sperm>sei>fin whales are taken ($\alpha = 0.006$); but no significant difference in the number of whales taken in P28 occurs ($\alpha = 0.570$).
4. More whales are taken in P28 than in either P27 or P29 ($\alpha = 0.001$).

We cannot be sure that whaling effort and frequency of occurrence are comparable by species, or that whaling effort was equal between the three areas of the Gulf. If these two assumptions are accepted, it would appear that greater numbers of large

Table 3.--Total number of pelagic catches of fin (Balaenoptera physalus), sei (B. borealis), and sperm (Physeter macrocephalus) whales by Japanese and Russian whaling fleets in three International Whaling Commission designated harvest areas (P27, P28, and P29) in the Gulf of Alaska, 1965-75. Area P27 is from Long. 150°W, west to Long. 160°W; P28 from Long. 140°W to Long. 150°W; and P29 from Long. 130°W, west to Long. 140°W (see Figure 5). Bryde's whales (B. edeni) are included in sei whale takes; blue (B. musculus) and humpback (Megaptera novaeangliae) whales have been protected under international agreement since 1966; mink whales (B. acutorostrata) in the Gulf are not harvested by the Russians, and only two have been taken by the Japanese (1971); (n) represents the number of sample years of available data. No distinction was made as to missing data or negative whaling activity. Both nations have greatly reduced their harvest effort since the 1967-68 season.

Harvest area	Fin whale		Sei whale		Sperm whale	
	Japan	Russia	Japan	Russia	Japan	Russia
P27 (n)	477(8)	106(3)	645(7)	67(3)	909(9)	593(3)
Total	583		712		1,502	
P28(n)	1,069(11)	301(4)	1,421(10)	235(6)	1,116(11)	1,528(6)
Total	1,370		1,656		2,644	
P29(n)	276(6)	174(5)	160(6)	152(4)	482(8)	1,011(5)
Total	450		312		1,493	

Note: Data for 1965-75 were taken from Japanese and Soviet catch statistics forwarded to the International Whaling Commission.

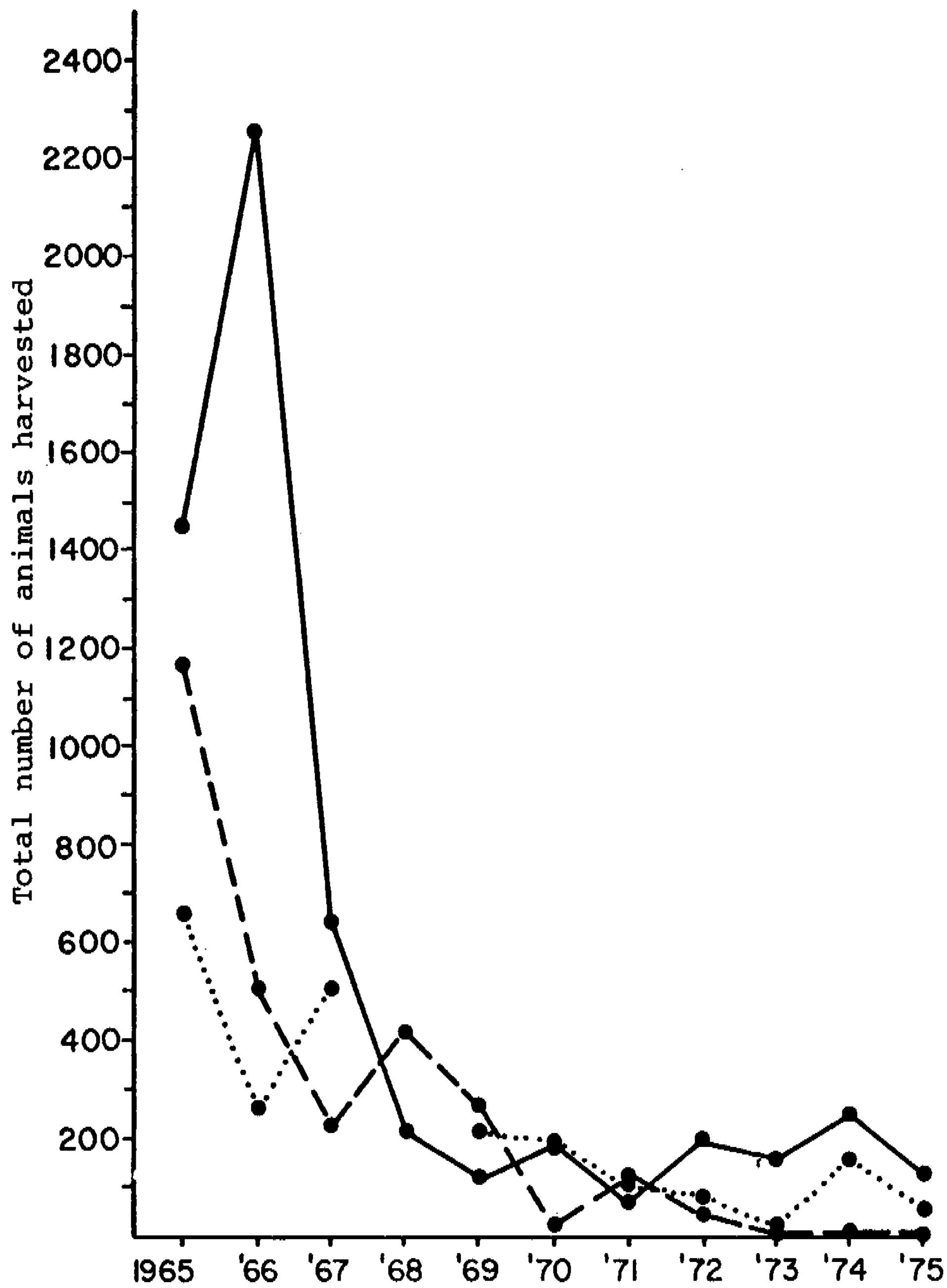

Figure 7. Annual change in pooled Japanese and Russian whale catch data for fin, sei and sperm whales in three International Whaling Commission statistical regions of the Gulf of Alaska: P27-western Gulf(---), P28-central Gulf(▬▬) and P29-eastern Gulf(···).

cetaceans, e.g., fin, sei, and sperm whales, might be expected to occur in the north central portion of the Gulf than in the eastern or western Gulf. Japanese and Russian whaling fleets are known to frequent specific areas in the Pacific Ocean where the probability of catching certain species of whales is greater (M. Tillman, pers. comm.). It must be emphasized that these conclusions are preliminary, requiring a larger data base if we are to increase our statistical precision.

SPECIES DISTRIBUTION

NORTHERN FUR SEAL (Callorhinus ursinus)

Northern fur seals are found in the Gulf of Alaska throughout all months of the year (North Pacific Fur Seal Commission, 1962). Peak numbers of seals occur from March to June. Townsend's (1899) chart graphically presents the monthly distribution of seals in the North Pacific Ocean as indicated by pelagic sealing records. The sealers went to and hunted in the areas where they could expect to find the most seals. Sealing began in December and January off the coast of California and as the seals moved northward the sealers followed, hunting off Southeastern Alaska in March, and moving northwestward generally following the Continental Shelf, arriving off Kodiak Is. in May and June.

Kenyon and Wilke (1953) and Wilke and Kenyon (1954) summarize the extent of our knowledge of seasonal North Pacific fur seal distribution up to 1952. Taylor, Fujinaga, and Wilke (1955) describe the first cruise by research biologists in search of pelagic fur seals in the Gulf of Alaska. Two vessels sailed north and westward from Dixon Entrance to Sitka, across Fairweather Grounds to the northeastern gulf, and southwestly to Kodiak from 6 June to 3 July 1952. They found a few seals south of Cape St. Elias, but most were encountered on Portlock Bank in the present Gulf of Alaska-Kodiak proposed lease area. They collected 388 seals; 128 males of which only 3 were older than 4 years, and 260 females of which 178 were older than 4 years.

With the signing of the Interim Convention on Conservation of North Pacific Fur Seals on 9 February 1957, and entered into on 14 October 1957, the United States, Canada, Japan, and the Soviet Union were each required to carry out research on land and at sea on fur seals. As a result, U.S. and Canadian scientists have made periodic surveys and collections of fur seals in the Gulf of Alaska. Data gathered during these voyages form the basis for the following description of northern fur seal movements.

Seals seen per hour of observation during U.S. pelagic fur seal voyages in the eastern and western Gulf of Alaska are shown by month and year in Table A-2 and Figures A-1 through A-20. Seals seen by NOAA ships' marine mammal officers, or Marine Mammal Division observers are shown by month in Figures A-33 through A-41.

The fur seal population reaches its lowest point of the year in the Gulf during August, September, and October. On 19 August 1968 five seals were sighted off Chirikof Island; on 20 August, eight seals were seen near Albatross Bank, and while on a 3-day crossing between Kodiak and Sitka only one seal was seen (MMBL, 1970) (Figures A-11 and A-20). Three seals were sighted by observers aboard NOAA ships in August (Figure 39). No sighting records exist for September, and no fur seal research vessels have operated in the Gulf of Alaska during September. We have one sighting reported from a NOAA ship in October (Figure 40). One fur seal research vessel crossed the Gulf without sighting fur seals in 1962.

We have no sighting records in the Gulf of Alaska in November as no fur seal research vessel or NOAA ship has operated in the Gulf in November. Migrating seals arrived and increased in numbers off the Washington coast in November and December 1967 (MMBL, 1970). It is reasonable to expect that the same pattern is followed in the Gulf of Alaska, despite the westward flowing Alaska Gyre in the northern Gulf. We have two sightings from a NOAA ship in the Gulf in December (Figure 41). Wilke and Kenyon (1954) state that seals appear in the inlets of south-eastern Alaska beginning in early December. On 3 December 1965, the Canadian research ship G. B. REED with Canadian and U.S. fur seal biologists aboard departed Unalaska Island bound for Kodiak. Six fur seals were seen during the voyage, two of which were in Sitkinak Strait near Kodiak. On 7 December the ship departed Kodiak and made a direct crossing south of the Continental Shelf to Sitka. The crossing was made under excellent conditions; no fur seals were seen (Pike et al., 1966).

We have no January sightings, however, no research vessels have operated in the Gulf during this month. Wilke collected 107 fur seals in January 1951 near Sitka (Taylor et al., 1955); all were females 4 years old or older. Kenyon and Wilke (1953), citing a letter from the U.S. Coast Guard, state that the seals are widely dispersed at sea in January but that the greatest numbers are found along the Alaska coast from Sitka south.

Our lack of records for the period September through January in the Gulf of Alaska is the result of few or no ship surveys in the area and the fact that sea conditions at this time are generally extremeley poor for viewing seals.

In February 1958, U.S. researchers found seals concentrated in Sitka Sound and a short distance offshore (Figure A-1) During the February 1958 cruise, 63 seals were collected including 22 yearlings, 12 were males and 10 were females, and 41 females all over 10 years of age except one 4-year-old and one 5-year-old. An examination of stomach contents determined that herring was the principal prey species consumed (Wilke et al., 1954). Seals range throughout the Gulf in February, occasionally entering protected waters after herring schools. A group of mostly adult females winter in northern Hecate Strait and Dixon Entrance each year (Pike et al., 1961). Recent February sightings from NOAA ships are shown in Figure 34.

U.S. research vessels operated off southeastern Alaska in March 1958, 1960, and 1961, working mostly off Sitka (Figures A-2 to A-4). Severe sea conditions generally restricted movement of vessels offshore. Seals collected during these voyages were generally taken in Sitka Sound or inshore and were mainly adult females. The major prey species by abundance found in fur seal stomachs were herring, following by squid and capelin.

U.S. research vessels operated in the Gulf of Alaska in April 1958 and 1960 (Figures A-5, A-6, and A-12). Seals were found in most areas surveyed; adult females comprised a major part of the collections, and adult males were seen and collected in the offshore areas. It is of interest that Alexander (1953) writing in 1892 said that a larger portion of the seals found north of Cross Sound and east of Middleton Island were males. While this may not be the case in late spring when major movements of adult females through the area occurs, adult males are encountered south of Cross Sound and is thus a major wintering area for adult males. Concentrations of seals have been encountered on the Fairweather Grounds, off Cape St. Elias, and on Portlock and Albatross Banks off Kodiak in April. Recent April sightings from NOAA ships are shown in Figure 35.

U.S. research vessels have operated in the Gulf of Alaska in May 1958, 1962, and 1968 (Figures A-7 to A-9 and A-13 to A-16). Fur seals are found throughout the Gulf in May and concentrations have been encountered far at sea in the middle of the gulf. However, seals are most abundant along the edge of the Continental Shelf and on the banks off Kodiak where large schools of capelin and sand lance are frequently found at this season. The fur seal population is probably larger in the Gulf of Alaska in May than in other months, closely followed by April and June. Most adult males have moved out of the Gulf by early May bound for the Pribilof Islands. Seventy percent of a sample of 232 seals collected on Portlock Bank in 1960 were females 10 years old or older. The males in the collection were all 5 years old or younger (NPFC, 1962). These older, mostly pregnant females were en route to the Pribilof Islands where the pupping season peaks the first week of July. Recent May sightings from NOAA ships are shown in Figure 36.

U.S. research vessels have operated in the Gulf of Alaska during the month of June in 1952, 1958, 1960, and 1968 (Figures A-10 and A-17 to A-19). Canadian research vessels have operated in the Gulf during the month of June in 1959, 1962, 1963, and 1968 (Pike et al., 1959; 1962; 1963; 1968). Much of our information on fur seal distribution in June is taken from the Canadian reports. Recent June sightings from NOAA ships are shown in Figure 37.

Seals are still found in localized concentrations throughout the Gulf in June. In 1952, the greatest concentration was found on Portlock Bank (Taylor et al., 1955). Of 388 seals taken, only 15.2% were older than 10 years. The 1952 expedition and several in subsequent years cruised Shelikof Strait without sighting fur seals. It is concluded that few if any seals use this strait in spring migration.

Canadian expeditions have regularly found concentrations of fur seals near Middleton Island (Pike et al., 1958; 1968) and on Portlock Bank (Pike et al., 1962; 1963; 1968). During the first 2 weeks in June 1963, adult females over 10 years of age predominated in the catch on Portlock Bank. In late June 1968, also on Portlock Bank, 142 seals were taken with 32% of the catch males age 2-4 years, 11% females age 2-3 years, and 57% females older than 3 years.

No U.S. research vessels have operated in the Gulf in July. Canadian research vessels have operated in the Gulf during the month of July in 1958 and 1963 (Pike et al., 1958; 1963; NPFSC, 1962). In 1958, the Canadians operated in the Gulf from 19 to 24 July. Their vessel cruised west from Cape Spencer on 19 July and located a concentration of seals on Portlock Bank on 21 July. Of 36 seals taken, no males were older than 2 years and no females were older than 6 years. During the first two weeks of July 1963, a Canadian vessel collected 20 seals on Portlock Bank mostly immature males and females. Pregnant female seals almost entirely disappear from the Gulf by mid-July, the remaining seals being immatures of both sexes. Recent July sightings from NOAA ships are shown in Figure 38.

In summary, northern fur seals are present in the waters of the Gulf of Alaska throughout the year, with fluctuations in numbers, age, and sex. They are found in all parts of the Gulf from the inside waters of Southeastern Alaska, Prince William Sound, and Kodiak Island to the offshore waters in mid-Gulf. In August, September, and October, most seals encountered are immature yearling males and females, few in number and widely dispersed. In November, adult males and females should begin to appear in the Gulf. Although we have no sighting records, we can infer this because of the known occurrence of seals in adjoining areas. In December, adults begin to appear along the Continental Shelf in the Gulf, and in past years have been reported from the inside waters of Southeastern Alaska. By January, the yearlings born six months previously occur along the Continental Shelf from the eastern Gulf of Alaska south to Washington. Although data are lacking, adult males are probably on the Gulf wintering grounds in maximum numbers. Adult females are in certain areas of the Gulf as apparent semi-residents, but in other areas they seem to appear for a short time and then move on. Yearlings appear to be moving southward in January and, depending on the severity of offshore sea conditions, may sometimes appear in considerable numbers in the protected waters of southeastern Alaska and British Columbia.

Seal movements in the Gulf of Alaska in February and March are similar to those described for the month of January, however, the first northward movements of adult females from southern waters probably occur in late March. In April, adult males start their movement westward towards the Bering Sea and the influx of adult females from the south, where they have wintered off the Washington, Oregon, and California coasts, begins in earnest.

During the month of May the Gulf population is at its highest point. Some adult males are still present, although the older animals are already on or soon will arrive at the Pribilof Islands. The major movement of adult females (mostly pregnant) through the Gulf occurs in May. Young animals of both sexes are also present but in small numbers.

The fur seal population of the Gulf undergoes a great change in June. The older males are essentially gone. The last of the older pregnant females continue on their way towards the Pribilof Islands where the peak of the pupping season occurs the first week in July. Immature males and females form a higher proportion of the population in the Gulf in June. In July, the last of the pregnant females (mostly young animals in their first pregnancy) move on west, and the population in the Gulf is comprised almost entirely of immatures of both sexes.

The entire Continental Shelf area of the Gulf of Alaska, including the northeast and Kodiak lease sites, is a critical habitat for fur seals. The greatest numbers of animals will pass through these areas from April through June. The least critical period for fur seals in the Gulf occurs in August through October when their numbers are lowest.

Major prey species taken by fur seals are capelin, sand lance, Alaska pollock, and off the Continental Shelf, squids of the family Gonatidae.

The Pribilof Islands northern fur seal population is estimated to contain 1,300,000 to 1,600,000 animals; the non-Pribilof population is estimated to be 452,000. Thus, the world population estimate is at least 1,752,000. It is also estimated that at least 96% of the seals found in migration off the western coast of North America are of Pribilof origin, less than 4% are of Asian origin, and that probably less than 10% of the seals found wintering off the coast of Japan and in the western North Pacific are of Pribilof origin (NMFS, 1976). Using these population estimates and percentages and rounding to the nearest thousand, it appears that about 565,000 seals winter in the western North Pacific Ocean and 1,189,000 in the eastern North Pacific Ocean. Based on pelagic fur seal research carried on by the National Marine Fisheries Service since 1952 and from historical records, a significant portion of the more than one million fur seals may pass through the waters of the Gulf of Alaska at some time during their annual migrations to and from the Pribilof Islands.

NORTHERN (STELLER) SEA LION (Eumetopias jubatus)

The northern sea lion ranges over the Continental Shelf and slope of the Gulf of Alaska throughout most of the year. Inshore movements, and the location of rookeries and hauling grounds used by sea lions are described in two RU#68 subcontract studies by Calkins et al. (1975) for the Gulf of Alaska and by Pitcher (1975) for Prince William Sound.

Major breeding and pupping rookeries and hauling areas are found in the northeastern Gulf from Cape St. Elias to Pt. Elrington adjacent to the northeast Gulf lease site (Pitcher, 1975). In the Barren Island group near the entrance to Cook Inlet, Sugarloaf Island supports one of the largest rookeries in the northern Gulf (Calkins et al., 1975). Marmot Island, off Afognak Island, equals the Sugarloaf Island population and Cape Barnabas and Two-headed Island on and near Sitkalidak Island also support large numbers of sea lions (Calkins et al., 1975). The Kodiak lease area lies adjacent to Marmot Island and to lesser hauling areas between Afognak and the Trinity Islands.

Northern sea lions observed from pelagic fur seal vessels and by marine mammal officers and Marine Mammal Division observers aboard NOAA ships are summarized by month in Table A-1 and Figures A-21 through A-32.

Generally speaking, sea lions found in the offshore areas are more apt to be mature, with slightly more males present than females. From the examination of monthly sightings of sea lions as indicated in Figures A-21 through A-32 it appears that more sea lions are at sea during April, May, June, and August than during other months; however, this may be misleading, an artifact of sampling, as sighting effort was greater during these months. Fewer animals are at sea during June and July, because most adults are on the breeding rookeries and hauling areas, and during midwinter (Pitcher, 1975). Calkins et al. (1975) estimate that between Cape Spencer in the eastern Gulf and Scotch Cape at the entrance to the Bering Sea, the minimum number of sea lions present is 95,825.

Sea lions from these major breeding and hauling areas will normally move from 5 to 15 miles offshore in large groups to feed, or when found farther offshore they occur singly or in groups of 2 to 12 (Fiscus and Baines, 1966). One of us (C.F.) collected six sea lions feeding on natural prey items (i.e., not following fishing vessels) offshore in the Gulf of Alaska (Fiscus and Baines, 1966). Rockfish, sculpins, lampfish, herring, flatfish (not halibut), sand lance, capelin, and salmon were identified from their stomachs. A report on damage caused by sea lions to the Japanese sablefish industrystates that high damage is experienced off Baranof and Chichagof Islands, and from Kayak Island in the northeastern Gulf westward to the Aleutian Islands (North Pacific Longline Gillnet Association, 1976). The studies of Calkins and Pitcher (RU 243) will provide new and needed data on feeding forays and prey species of sea lions in the Gulf of Alaska.

HARBOR SEAL (Phoca vitulina richardii)

The harbor seal in the Gulf of Alaska is essentially an inshore species. Its habitat, distribution, numbers, and feeding habits are thoroughly covered by Calkins et al. (1975) for the Gulf of Alaska and by Pitcher (1975) for Prince William Sound.

Single animals do venture out over the Continental Shelf at times, and sightings of this species from pelagic fur seal research vessels and NOAA ships are summarized in Table A-3 and Figures A-42 through A-49. Most sightings were made on Portlock and Albatross Banks off Kodiak Island.

CALIFORNIA SEA LION (*Zalophus californianus*)

The California sea lion normally ranges north into southern British Columbia waters in winter (Bigg, 1973), but is not known to frequent the Gulf of Alaska. We have no records from the Gulf of Alaska; however, an adult male was photographed at Pt. Elrington, Elrington Island, Prince William Sound on 27 June 1973 (K. Schneider, Alaska Dept. Fish and Game, pers. comm.). Schneider's account constitutes the first record of this species from Alaska.

NORTHERN ELEPHANT SEAL (*Mirounga angustirostris*)

The northern elephant seal seldom frequents the Gulf of Alaska. Four sighting records from the Gulf and Southeast Alaska exist. An adult male was found dead on a beach near Kassan, Prince of Wales Island (Willet, 1943). An immature male was found dead on Middleton Island in late April 1975 (D. Calkins, Alaska Dept. Fish and Game, pers. comm.). A live adult male was sighted on 5 May 1962, in Lat. 56°04'N, Long. 134°31'W, 7 miles southeast of Cape Ommaney, Baronof Island (C. Fiscus, pers. observ.). A second sighting from the NOAA ship TOWNSEND CROMWELL was made 29 May 1975 in Lat. 59°21'N, Long. 145°51'W, about 17 miles southeast of Middleton Island (Table A-4).

The elephant seal population has recovered from a low of less than 100 animals in the 1890's to an estimated 30,000+ animals (Peterson and LeBoeuf, 1969), reoccupying its known breeding range from central California to Baja California, Mexico (Kenyon, 1965; Radford et al., 1965).

CALIFORNIA GRAY WHALE (*Eschrichtius robustus*)

In January and February gray whales breed and calve in lagoons along the coast of Baja California, Mexico, migrate north to the Bering and Chukchi Seas to feed from May through October, then return to Lower California in winter (Rice and Wolman, 1971). The migration route between Mexico and British Columbia is well established (Pike, 1962; Rice, 1965; Rice and Wolman, 1971; Leatherwood, 1974); however, little data exist concerning distribution and migratory pathways from British Columbia to the Chukchi Sea. Gray whales generally travel within 3 km of the shore while along the California coast (Rice and Wolman, 1971) and are believed to identify shore landmarks while migrating north (Pike, 1962). If they continue to migrate close to shore they may pass through oil lease sites in the northeast Gulf of Alaska and near Kodiak Island.

There is no evidence of gray whales crossing the open ocean or swimming far from land while migrating into or out of the Gulf of Alaska. Data collected to date by the Marine Mammal Division for the Gulf of Alaska are minimal; however, there is an indication that gray whales do occur along the northern coast of the Gulf in the near-shore environment (Table A-5 and Figures A-51 and A-52). Calkins (pers. comm.) reports observing 35 gray whales north and east of Kodiak Island from 12 to 23 April 1976. Wilke and Fiscus (1961) report sighting gray whales near Kodiak Island in May. Survey ships used to collect these data, e.g., pelagic fur seal vessels and NOAA ships, generally avoid near-shore shallow waters, thus reducing sighting opportunities.

Although data are limited, by extrapolating from behavioral and distribution information taken from studies in California and Alaska (Ichihara, 1958; Maher, 1960; Wilke and Fiscus, 1961; Pike, 1962; Rice and Wolman, 1971), the route of migration through the Gulf can be predicted. That is, gray whales might be expected to occur along the entire north coast of the Gulf from March through November, with peak occurrences in the north-east Gulf and Kodiak Island from April through May, and again in November and December. Additional sighting data collected by personnel from the U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game should help to clarify this hypothesis.

Prior to the 1960's, very little quantitative population data existed on the gray whale. The pre-exploitation population probably did not exceed 15,000 animals (Henderson, 1972). Whaling activity during the last half of the 19th century brought the species to near extinction. No reliable population data exist for the first half of the 20th century. Recent population abundance estimates have varied greatly between researchers. Hubbs and Hubbs (1967), using aerial surveys, estimated the wintering Baja population at 3,000 for the period 1952-64. Gilmore (1960) placed the population at 7,500 animals. From data collected on the southern migration along California, Adams (1968) made an estimate of 18,300 animals. Zimushko (1970) censusing gray whales in the Bering and Chukchi Seas, using aerial survey, estimated the population at 4,800 animals. The most comprehensive counts to date are those of Rice and Wolman (1971) who place the population at 11,000 animals.

Although it is difficult to be precise about the number of gray whales that frequent the northeast Gulf and near Kodiak Island, a large fraction of the population may be assumed to spend part of their time within the Gulf of Alaska lease sites. Most gray whales probably migrate through the lease sites, however, "resident" individuals are found all along the West Coast, including Alaska (Pike, 1962; Rice and Wolman, 1971; authors, pers. obser.).

Peak periods of gray whale abundance at, for example, Yankee Point, California (collected in December and January), may have corresponding periods of peak activity throughout the Gulf some weeks earlier in the season. Peak activity in the Gulf may be approximated from data collected in California using: (1) 200 animals per 10 hours of observation time passing Yankee Point (peak counts from the 1968-69 survey; Rice and Wolman, 1971), (2) a nighttime population sighting adjustment coefficient of 2.4 (Rice and Wolman, 1971), and (3) estimating that gray whales migrate at speeds of 4 to 5 knots when traveling south, or about 100 nautical miles (nmi) per day (Pike, 1962; Rice and Wolman, 1971). Using these parameters, and assuming gray whales migrate south along the northern coast of the Gulf (we have no data to the contrary), we might expect that as many as 5,000 whales could pass the Kodiak Island region around 15-20 December. As described below, these temporal estimates are supported by Pike (1962):

Direction of migration	Sample location	Approximate time of year
North	Dixon Entrance	Early May
North	Kodiak Island	Mid-May
South	Kodiak Island	Mid-December
South	Dixon Entrance	Late December

We assume gray whale migration behavior is similar in the Gulf to that observed along the coasts of Washington, Oregon, and California, but this assumption needs to be tested.

An estimate of the maximum number of animals reaching the northeast Gulf and Kodiak Island areas in the spring is more difficult to make at this time because less data exist on the numbers of animals seen migrating north from Lower California. As a general rule, newly impregnated females leave Baja California in late February before adult males which follow in early March. Anestrous females leave in early March, and immatures of both sexes begin leaving in mid- to late-March (Rice and Wolman, 1971). It is assumed that this relationship holds true in Alaska and that pregnant females would be the first to enter the Gulf lease sites in the spring. Recent sightings by Marine Mammal Division aerial survey crew members in the Bering Sea (RU67) indicate that adults with young of the year may migrate later in the season, and that the above age-sex temporal migration scheme may be biased, as suggested by Rice and Wolman (1971). Preliminary data from RU67 indicate that smaller adults (immatures?) are the first to move into the Bering Sea in the spring.

MINKE WHALE (Balaenoptera acutorostrata)

Minke or little-piked whales, range from the Chukchi Sea to the equator, and frequent near-shore habitats on the Continental Shelf and shelf slope (Nishiwaki, 1966b). The greatest concentration of Pacific minke whales, during the winter season, occurs near the Channel Islands off southern California. During the summer months minke whales are found in abundance in the Gulf of Alaska (Rice, 1974). Numerous sightings exist for minke whales on Portlock and Albatross Banks and in Prince William Sound during the month of May; and in Kachemak Bay during August. Sighting records over the shelf from February through November are summarized in Table A-6 and Figures A-53 through A-61.

Pacific minke whales might distribute themselves similarly to their Atlantic counterparts which are thought to segregate by age, with older animals ranging farther north during the summer season (Fraser, 1953; Schwartz, 1962; Sergeant, 1963; Jonsgard, 1951); and by sex, with females usually found feeding in coastal waters and males in offshore waters during migration to the northeastern Atlantic (Jonsgard, 1966). Minke whales are known to feed upon small schooling fishes (Omura and Sakiura, 1956) and thus they might be expected to frequent areas of high productivity such as Fairweather Ground, and Portlock or Albatross Banks.

Extensive harvest data generally are not available for minke whales in the North Pacific, and little is known about abundance or seasonal distribution of this species in the Gulf. They have never been exploited in the Gulf. No abundance estimates can be made at this time.

SEI WHALE (Balaenoptera borealis)

Table A-7 and Figures A-62 through A-64 summarize our sighting records on sei whales from 1958 to 1976. The seasonal ranges of the sei whale include summer feeding activities in the North Pacific and Gulf of Alaska, and a poorly understood winter range off the west coast of North America. In the southeastern North Pacific during the winter they are sparsely scattered from Point Piedras Blancas, California, to the vicinity of the Islas Revillagigedo, Baja California, Mexico (Rice, 1974). The largest known concentration of this species in the Gulf of Alaska is during the summer season in the area near and just east of Portlock Bank (Nemoto and Kasuya, 1965; Berzin and Rovnin, 1966; Nishiwaki, 1966a).

The original population of sei whale stocks in the North Pacific has been estimated at 40-42,000 animals (Ohsumi et al., 1971; Tillman, 1975). Stocks have been reduced by commercial whaling pressure to a present (1974) estimated population of 8,600 animals (Tillman, 1976).

Sei whales feed almost exclusively on copepods (*Calanus cristatus* and *C. plumchrus*) in the Gulf, and fish, euphausiids, and *Calanus pacificus* in the North Pacific (Nemoto and Kasuya, 1965; Kawamura, 1973). Euphausiids are also the principal food items of the right whale (*Balaena glacialis*) (Omura, 1974); consequently, sei whales might occur in the central and eastern Gulf of Alaska as indicated by Townsend's (1935) plots for right whales.

FIN WHALE (*Balaenoptera physalus*)

The location and number of fin whales sighted by NOAA and NMFS personnel by month since 1958 are summarized in Table A-8 and Figures A-65 through A-70. Calkins (pers. comm.) reports sighting 10 fin whales off Afognak Island (NW Gulf) on 22 April 1976. This sighting is not shown on our charts (Fig. 66).

The Gulf of Alaska represents a significant portion of the summer feeding range of North Pacific stocks of fin whales (Nasu, 1966). The largest concentrations in the Gulf from June to August occur from Long. 144°W to 150°W and from Lat. 56°N to 59°N, including part of Portlock Bank (Nemoto and Kasuya, 1965; Nishiwaki, 1966b). Fin whales begin to migrate south in September to their wintering grounds from Baja California, Mexico to northern California; probably extending well offshore. This area may overlap with the summer range of some portions of the fin whale population which extends as far south as Southern California (Rice, 1974). Fin whales do not migrate along a narrow corridor such as is typical of migrating gray whales, however, their migration routes are not well defined (Nishiwaki, 1966a).

The original population of fin whales for the North Pacific has been estimated at 44,000 animals (Ohsumi and Wada, 1974). Commercial whaling activities reduced this original stock to approximately 16,000 animals (ibid). Rice (1974) has estimated the population of harvestable animals summering in the eastern North Pacific to be approximately 9,000. Few quantitative population data exist to adequately assess present distribution and abundance in the Gulf.

BLUE WHALE (Balaenoptera musculus)

The number of blue whales sighted by month and by location, reported by NOAA and NMFS personnel since 1958, are summarized in Table A-9 and Figures A-71 and A-72.

A large portion of the North Pacific blue whale stock is found from the equator to Baja California, Mexico, in October and then again from February to June. In Alaskan waters they are seen from late June until late August (Rice, 1974). Three major concentrations of blue whales have been identified in the northern summer range; the eastern Gulf of Alaska from Long. 130°W to 140°W; south of the eastern Aleutian Islands from Long. 160°W to 180°W; and from the far western Aleutian Islands to the Kamchatka Peninsula (Rice, 1974). Japanese tagging experiments have shown that these are not discrete subpopulations, and that animals will move from one area to another in both a westerly and easterly direction (Ivashin and Rovnin, 1967).

The pre-whaling population of blue whales in the North Pacific has been estimated to be from 4,900 (Wada, 1975) to 6,000 (Rice, 1974). The Pacific stock has been reduced by commercial whaling to an estimated 1,600 animals (Wada, 1973). In 1966, blue whales in the North Pacific were placed under complete protection from commercial whaling by International Whaling Commission member nations. Since 1966 there has apparently been no significant recovery of the stock as has been in part the case with the humpback whale (Megaptera novaeangliae) (Tillman, 1975).

HUMPBACK WHALE (Megaptera novaeangliae)

The number of humpback whales seen by month and by location, reported by NOAA and NMFS personnel since 1958, are summarized in Table A-10 and Figures A-73 through A-79.

Humpback whales frequent three main regions in the Gulf of Alaska from April through December: (1) south of Kodiak Island, Albatross and Portlock Banks; (2) Montague Strait-Prince William Sound area; and (3) the inland waters of Southeastern Alaska, Stephen's Passage, and Frederick Sound. Humpbacks begin migrating south from Alaskan waters during late December for winter calving grounds in warmer waters off the coast of Mexico and perhaps among Pacific Islands such as the Hawaiian Archipelago. The majority of animals remain on the wintering grounds until late February and early March at which time they will begin returning to the summer feeding grounds in the Gulf of Alaska.

The pre-whaling population estimate of humpback whales in the North Pacific was thought to have been several thousand (Tillman, 1975); their numbers were considerably reduced between 1962 and 1965. In 1966, the International Whaling Commission placed the North Pacific humpback whale stock under complete protection from commercial whaling by member nations. Since 1966 this stock has been reported to be increasing with a total present population for the North Pacific estimated at 1,400 animals (Wada, 1975). Personnel of the Cetacean Task group at the Marine Mammal Division, NMFS, estimate that the population in the Gulf of Alaska is about 60 animals (Rice, pers. comm.).

NORTH PACIFIC WHITESIDE DOLPHIN (*Lagenorhynchus obliquidens*)

The North Pacific whiteside dolphin has been sighted from Valdez, Alaska to Baja California, Mexico (Scheffer, 1950a; Miller and Kellogg, 1955; Pike, 1956; Daugherty, 1965; Nishiwaki, 1966a) showing a preference for coastal temperate waters of the North Pacific Ocean. Nishiwaki (1966a:32) describes it as "one of the most abundant species," presumably comparing it to all porpoises of the North Pacific. At least 1,000 were reported by Pike (1959) in a single sighting 25 miles northwest of Queen Charlotte Island (Lat. 53°34'N, Long. 133°40'W) on 16 June 1959, and according to National Marine Fisheries Service reports, approximately 2,000 were seen in one pod in Lat. 57°34'N, Long. 140°33'W on 21 May 1968. Fifty-five other sightings were recorded between 1958 and 1975 (Table A-11 and Figures A-80 through A-83).

Based on 30 recorded observations prior to the NMFS studies, Pike (1956:11) described *L. obliquidens* as "probably common along the west coast of North America." Sleptsov (1955) makes a taxonomical differentiation between *L. obliquidens* and *L. ognevi*, the latter inhabiting the western half of the North Pacific, and *L. ognevi* was reported to have been "encountered constantly" in the Okhotsk Sea. Rice (in press) lists only *L. obliquidens* from the North Pacific Ocean.

KILLER WHALE (*Orcinus orca*)

Killer whales are thought to be present in the Gulf of Alaska during all months of the year, preferring shallow areas on the Continental Shelf (Jonsgard and Lyshoel, 1970). It is believed they generally stay within 200 miles of shore. Monthly sightings of *Orcinus* indicate that they are most frequent between Kodiak Island and Prince William Sound, although our sample size during other months is small (Table A-13 and Figures A-84 through A-91). Group sizes of up to 10 individuals are common, although groups of over 100 individuals have been reported. During a 1-day census on 27 July 1971, 62 animals were recorded in Southeastern Alaska (Bigg, 1972). Five hundred animals were recorded on 24 April 1973, 24 miles northeast of Middleton Island (J. H. Branson, NMFS, Enforcement Division, pers. comm.). Despite numerous sighting records no population estimates are available for this species in the Gulf.

Pike and MacAskie (1969) suggest that the British Columbia population of killer whales is probably resident. Little seasonal variation in population size was noted by Pike and MacAskie from logbook records for the period 1959-64. Despite the large accumulation of records, many of which contain details of size and sex composition of groups and direction of travel, it was not possible to determine any orderly pattern of movement or migration. Local or seasonal movements may be related to food supply (Mitchell, 1975).

Killer whales exhibit a high degree of group hunting, particularly when feeding on marine mammals. A small pod of killer whales was observed attacking and killing a minke whale on 29 April 1976, at approximately Lat. 58°22'N, Long. 138°21'W (Marsha Caunt, Marine Mammal Division observer). They are known to also feed on fish, cephalopods, and birds (Nishiwaki and Handa, 1958). According to Nishiwaki and Handa older killer whales feed on marine mammals. Young animals are believed to feed mainly on fish and cephalopods. Sergeant and Fisher (1957) believe movements of _Orcinus_ off Eastern Canada are associated with migrations of rorquals and seals.

It is not known what effect fish migrations in the Gulf of Alaska have upon killer whale distribution, however, "they do seem to follow fish stocks during [fish] migrations, moving in [coastal areas] with the fish, moving out when they leave" (M. Bigg quoted in Davis, 1974). It is believed that spawning salmon are an important food item in Puget Sound during the summer, but no data are available to support this assumption (Rice, 1968). Jonsgard and Lyshoel (1970) conclude that the distribution and migration of killer whales in the northeast North Atlantic seem to be dependent upon the distribution and migration of herring. In the stomach of a killer whale taken near Kodiak Island on 20 May 1960, a 23-pound halibut was found (Rice, 1968). Distribution and abundance of _Orcinus_ in the Kodiak Island and Northeast Gulf lease sites may thus be seasonally dependent upon food availability and density.

HARBOR PORPOISE (*Phocoena phocoena*)

The harbor porpoise is a boreal-temperate zone species (Gaskin et al., 1974) found along much of the North Pacific coast between Point Barrow, Alaska (Hall and Bee, 1954), and central California (Daugherty, 1965; Nishiwaki, 1966a; Gaskin et al., 1974) or as far south as Mexico (Pike, 1956). In the Gulf of Alaska our data show 280 sightings made during 6 years of irregular observations between 1958 and 1976 (Table A-14 and Figures A-92 through A-100). Sightings were made throughout the year, especially in the near-shore areas of the Northeast Gulf; and, in May south of Kodiak Island on Albatross and Portlock Banks (Figure 96). Scheffer (1972) estimated the total population in the Gulf of Alaska to be about 1,000. This value seems too small considering the number of incidental sightings made throughout the Gulf.

P. phocoena is common in bays, estuaries, and tidal channels where it is exposed to encounters with man. Scheffer (1972) reports this species as being of no commercial interest in the North Pacific. An *ad hoc* group at the 1975 conference for the Advisory Committee on Marine Resources Research described *P. phocoena* as being heavily harvested elsewhere; and that its population status is in urgent need of assessment (Anonymous, 1976).

DALL PORPOISE (*Phocoenoides dalli*)

Dall porpoises are distributed between their southern limit near Northern Baja California, Mexico, and their northern limit either near the Aleutian Islands (Pike, 1956; Daugherty, 1965), opposite Cape Navarin (Lat. 62°N, Long. 179°E) (Nishiwaki, 1966a), or as far north as the Chukchi Sea (Sleptsov, 1961). The species was originally identified near the Aleutian Islands by William H. Dall in 1873 (True, 1885). Reports of other specimens have been collected from around the Gulf of Alaska by True (1889), Miller (1929; 1930), Ulmer (1943), and Benson and Groody (1942). Nichols (1926; 1950) noted frequent sightings all along the east side of the Gulf of Alaska. He identified *P. dalli* as far as 350 miles southeast of Kodiak Island (Lat. 53°36'N, Long. 145°37'W). The farthest from land Scheffer (1949) reported sightings was 60 miles east of Kodiak Island and 50 miles south of Yakataga Island. Seventy-two observations including 350 individuals indicated a strong preference by this species for wide straits and where ocean currents merge (Scheffer, 1949). Cowan (1944) also comments on the preference of *P. dalli* for channels between islands. Sightings by the authors around the Aleutian Islands confirm these observations.

Three populations of *Phocoenoides* are recognized in the North Pacific and adjacent seas (Kasuya, 1976). Of these, only one inhabits the waters east of Long. 170°E. This population, as with others near Japan, is probably migratory in north-south directions.

Cowan and Guiguet (1965:261) describe *P. dalli* as, "the most abundant porpoise north of Vancouver Island." Scheffer (1972) estimated the total population in the Gulf of Alaska at 2,000, although he had earlier published an account (1950) of several thousand porpoises, probably *P. dalli*, in a single pod between Seward and Cape Spencer on 26 October 1949. Southeast Alaska is attributed to having the greatest abundance of *P. dalli* in the North Pacific (Cowan, 1944; Scheffer, 1949), although Benson (1946) believes this to be biased by the greater number of observers in the area. In our data, 508 sightings were made between 1958 and 1976 (Table A-15 and Figures A-101 through A-110). Most sightings during this 18-year period took place during April, May, and June (Figures A-104 through A-106), with a general shift from east (April) to west (May) and south (June). *P. dalli* may be the most common cetacean ranging from the Northeast Gulf to Kodiak Island.

The Japanese high seas gillnet salmon fishery kills more than 10,000 animals annually (Mizue and Yoshida, 1965; Mizue et al., 1966), but they rarely operate their vessels east of Long. 175°W. Their influence on Gulf of Alaska populations is probably only indirect, or may affect only long-distance migrating animals. Scheffer (1972) reports no commercial interest in *P. dalli* in the Gulf of Alaska. The Advisory Committee on Marine Resources Research (Anonymous, 1976) classified *P. dalli* as a heavily fished species for which there is an urgent need of a population assessment.

BELUGA OR WHITE WHALE (*Delphinapterus leucas*)

The beluga whale has been reported to be the most numerous and widely distributed cetacean in the Arctic (Yablokov and Bel'kovich, 1967). In the Gulf of Alaska they are resident in Cook Inlet with some movement to Gulf waters. This population may number 500 animals (US Dept. Commerce, 1976). Between May 1974 and September 1975, 621 sightings were recorded for Cook Inlet (Table A-16 and Figures A-111 through A-115) mostly during July and August. It has been assumed the species does not go south or east of Cook Inlet along the Alaska coast (Osgood, 1904), but Scheffer and Slipp (1948) reported a single sighting near Crab Point, Washington. The only documented sighting of *D. leucas* in the Gulf, outside of Cook Inlet, was made by

Donald Calkins, Alaska Department of Fish and Game (pers. comm.) in Yakatat Bay on 31 May 1976. Twenty-one white adults and five gray subadults were observed. It may be that competition with more modern species of Delphinidae prevents *D. leucas* from expanding its range to more optimal feeding habitats to the south, as suggested for Atlantic stocks by Sergeant and Brodie (1975).

Migratory patterns of *D. leucas* along the coast of Alaska are essentially unknown (Kleinenberg et al., 1964; Klinkhart, 1966), although their appearance seems to be closely related to the activities of their prey species, especially smelt, salmon smolts, and Arctic cod (Brooks, 1955; Kleinenberg et al., 1964; Klinkhart, 1966; Yablokov and Bel'kovich, 1967; and others). Beluga, or belukha, whales are usually associated with shallow bays or estuaries or large rivers (Vladykov, 1944) often where water temperatures are relatively warm (Sergeant and Brodie, 1975) and turbid. Their surface feeding preferences (Brooks, 1955) and sensitivity to human activity during the calving season (Sergeant and Brodie, 1975) make this species especially vulnerable to developments along the Continental Shelf. As described by Kleinenberg et al. (1964) and Yablokov and Bel'kovich (1967), *D. leucas* is a harvested species. The Cook Inlet population was harvested once in 1930 when 100 animals were netted in the Beluga River; no animals returned to that area, and the venture was subsequently abandoned (Klinkhart, 1966).

SPERM WHALE (*Physeter macrocephalus*)

From May 1958 to November 1975, 43 sperm whale sightings were made by NOAA and NMFS personnel in the Gulf (Table A-17 and Figures A-116 through A-119).

Whaling explorations from 1959 to 1963 have established that the largest concentration of sperm whales occurs in the northeast Pacific rather than off Asia. One of the more northern concentrations is believed to be in the area of Lat. 52°N, Long. 148°W (Berzin, 1971). Sperm whales occur frequently along the southern edge of the study area from Long. 130°W to 150°W generally evenly distributed (Berzin, 1971).

Male sperm whales occur in the Gulf of Alaska during the summer months, but seldom during the winter. Females and young males are generally not seen above Lat. 50°N, which coincides in that area with the 10° isotherm (Berzin and Rovnin, 1966; Nishiwaki, 1967). Females and young males are reportedly seen in the eastern Aleutian Islands as early as early March with most arriving in April (Berzin, 1971). "The bulk of the males occur from Kodiak Island west along the Aleutian Arc up to the Komandorski Islands" (Berzin, 1971:160); and, concentrate east of Portlock Bank to about Long. 146°W (Nishiwaki, 1966b). Male concentrations occur south of Kodiak Island (Berzin, 1971).

The North Pacific population of male sperm whales is estimated to be about 90,000 animals (D. Rice, pers. comm.). An estimate of the total population (males and females) has been placed at 150,000 animals (Nishiwaki, 1966b). It is not known what proportion of the population enters the Gulf.

Those sperm whales thought to frequent the area near Kodiak Island and east are believed to migrate from the eastern Aleutian Islands, while others migrating north proceed into the Bering Sea, though the straits of the Aleutian Islands, along the Continental Shelf slope (Berzin, 1971). Males may be more likely to occur in areas of high cephalopod productivity on the Continental Shelf or along the slope earlier in the year than females. Not until June, as waters warm and schools of squid increase, do nutrition requirements of female sperm whales improve (Tarasevich, 1965).

SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*)

Short-finned pilot whales travel in groups of a few to perhaps several hundred animals. Though they may be found close to shore at any time of the year, they are generally near shore in the early spring when they follow the migration of squid, their primary food. The remainder of the year they are primarily offshore animals. Though no long distance migration has been described, populations may shift north in the summer and south in the winter in response to changes in water temperature (Leatherwood et al., 1972). No population estimates are available. We have no data from NOAA and NMFS records.

Pilot whales are known from Alaskan waters on the basis of only a few published records. A specimen, reported as *G. scammonii*, was taken near Kanatak on the Alaska Peninsula in September 1937 (Orr, 1951). Four pilot whales were sighted in the Gulf of Alaska by the MV FORT ROSS in August 1957 in Lat. 54°48'N, Long. 143°47'W, about 400 miles west of Dixon Entrance (Pike and MacAskie, 1969)

GRAY GRAMPUS OR RISSO'S DOLPHIN (Grampus griseus)

There are no documented sightings of Grampus griseus from the study area. Our researchers located three G. griseus at 1338 hours on 3 March 1976 (Lat. 49°50'N, Long. 128°30'W). This sighting is believed to be the northernmost sighting ever recorded at that time of year (Rice, pers. comm.). These animals were seen moving north.

Nishiwaki (1966a) describes G. griseus as being intolerant of temperatures below 7.5°C; sustained exposure to water cooler than 5°C would likely be lethal. The Gulf of Alaska surface temperatures are consistenly below 5°C in the winter, and though the Gulf temperatures range between 10° and 18°C in the summer (Favorite et al., 1976), this may still be a limiting factor. According to Pike (1956), Grampus are widely distributed in the Northern and Southern Hemispheres. Guiguet and Pike (1965), Stroud (1968), and Hatler (1971) document several sightings north of the California coasts but none north of Lat. 50°N.

NORTHERN RIGHT WHALE DOLPHIN (Lissodelphis borealis)

The northern right whale dolphin is generally confined to temperate waters between Lat. 30°N and 50°N (Leatherwood and Walker, 1975), although Scammon (1874), Pike (1956), and Daugherty (1965) report sightings as far north as the Bering Sea; the latter two authors probably referring to Scammon's report. Nishiwaki's study (1966b) of catch data from Japanese fishing boats also reports that L. borealis occurs in the Bering Sea.

L. borealis seem to prefer temperate waters of approximately 15°C, and since Gulf of Alaska surface waters are well below that in the winter and range from 10° to 18°C in the summer (Favorite et al., 1976) they might be expected only as summer visitants with "uncertain northern limits" (Scheffer, 1972:201). Leatherwood and Walker (1975), in summarizing 207 sightings, estimate the total population in the North Pacific at greater than 10,000 animals with "pods" ranging from 1 to 2,000; averaging 110 animals. Scheffer (1950b) estimated 5,320 dolphins, perhaps L. borealis, in a single sighting in Lat. 43°07'N, Long. 139°03'W on 13 July 1949. This would indeed be a remarkable sighting if the true total for the North Pacific population is only two times the number seen at a single place.

Leatherwood and Walker (1975) describe the range of L. borealis as largely unknown in the open Pacific though the species probably occurs across the North Pacific crescent.

None were noted between 1958 and 1976 (our data). Although the lack of a dorsal fin and its slender contours make L. borealis readily identifiable, the rarity of its sightings may bias casual observations towards more expected species.

RIGHT WHALE (Balaena glacialis)

Right whales, in spite of complete protection by international agreement since 1937, are still so rare as to be classified as an endangered species under the terms of the U.S. Endangered Species Act. Current estimates place the right whale population for the North Pacific at about 150-200 animals (Wada, 1973; 1975).

Nineteenth century whaling records (Townsend, 1935) show that approximately 40% of 2,118 right whales (n = 1,017) harvested in the North Pacific were taken in the Gulf of Alaska. Recent sightings in the Gulf have been reported by Japanese and Soviet whale catcher and scouting boats (Omura et al., 1969; Klumov, 1962). Catches include one right whale taken accidentally by Canadian shore whalers near Vancouver Island in 1951 (Pike, 1962), and three whales taken by Japan on Albatross Bank near Kodiak Island in 1961 for research under permit by the International Whaling Commission. No verifiable right whale sightings in the Gulf have been reported by NOAA personnel engaged in the Platforms of Opportunity Program for 1975-76. Sightings have been made south and east of Kodiak Island from May to September in recent years (D. Rice, pers. comm.). Both International Whaling Commission records and Townsend's data indicate that right whales occur in the Gulf from May through September with the majority being found in the central and eastern portions of the Gulf.

Available information suggests that right whales feed primarily upon copepods in the North Pacific (Tomilin, 1957) and copepods and euphasiids in the Gulf (Omura, 1974), which are commonly found in the upper (photic) layer of the water column.

GIANT BOTTLENOSE WHALE (Berardius bairdi)

The giant bottlenose whale is endemic to the North Pacific, ranging from St. Matthew Island in the Bering Sea through the Gulf of Alaska and south to Southern California (Rice, 1974). Seasonal movements of this species are poorly understood, however, migrations of Berardius in the western Pacific tend to coincide with the seasonal occurrence of the squid Todorades pacificus, and other cephalopods (*Gonatus* spp.) (Nishimura, 1970). Whaling records off Japan indicate a greater abundance of *B. bairdi* in waters deeper than the 1000m contour of the Continental Shelf (Nishiwaki and Oguro, 1971).

The predominance of males in catches off the west coast and off Japan suggests a partial geographical segregation of the sexes (Rice, 1974). Studies of *Berardius* off Japan have shown that pairing takes place between late November and early May, the peak of the breeding season occurring in February (Nishiwaki, 1972). Calves are born in December (Omura et al., 1955). Similar periods for breeding and calving are assumed to hold true for the eastern North Pacific and the Gulf of Alaska. We have no data, however, on distribution and abundance in the Gulf.

B. bairdi feeds primarily on squids and ground fishes which frequent the Continental Shelf (Nishiwaki, 1972), but also consumes deep sea fishes when available (Nishiwaki and Oguro, 1971). In addition, the stomachs of some specimens have contained benthic animals such as ascidians, sea cucumbers, starfishes, and crabs (Nishiwaki, 1972).

BERING SEA BEAKED WHALE (*Mesoplodon stejnegeri*)

The known range of *M. stejnegeri*, a subarctic species, is believed to extend from Akita Beach, Japan, north to the Commander and Pribilof Islands in the Bering Sea through the Gulf of Alaska south to Yaquina Bay, Oregon (Moore, 1963a). The distribution of this species is based upon rare strandings and sightings such as a floating carcass examined off Cape Edgecumbe in the Gulf of Alaska (Fiscus et al., 1969). Although very little is known about the distribution and the abundance of these whales, it is possible that they principally inhabit the deeper waters of the Continental Shelf as has been suggested for the Atlantic species *M. bidens* (Moore, 1966).

We have collected no sighting data on *M. stejnegeri* in the Gulf.

GOOSE BEAKED WHALE (*Ziphius cavirostris*)

The goose beaked whale (Cuvier's beaked whale) is found in all oceans (Scheffer and Rice, 1963), except from Arctic and Antarctic waters (Moore, 1963b). *Z. cavirostris* is probably more abundant than other beaked whales in the eastern North Pacific (Leatherwood et al., 1972), as strandings are not uncommon (Mitchell, 1968). Population trends and migrational patters are unknown. Estimates of abundance are not available. We have collected no sighting data on Z. cavirostris from the Gulf of Alaska.

Ziphius is considered to be a pelagic species (Moore, 1963b) often taken in deep waters (Nishiwaki and Oguro, 1972) where it is believed to travel in groups averaging 30-40 animals. Old males are often solitary (Mitchell, 1968).

These deep diving whales feed mainly on squid; with fish, sea cucumbers, crabs, and star fish also included in their diet (Mitchell and Houck, 1967; Nishiwaki and Oguro, 1972).

SUMMARY

Our understanding of marine mammal distribution and abundance in the Gulf of Alaska study area is not complete. A comprehensive overview of the expected frequency of occurrence of all species by month is summarized in Table 4. Most marine mammals occur in the Gulf throughout the year. Unfortunately, few reliable data exist for the winter months. Some species do not frequent near-shore environs; and are not well represented because of inadequate sampling.

Population projections in the Gulf are admittedly unrefined, but are believed to be the best available estimates. Knowing where marine mammals feed, what type of food resources they consume, and the general region of the Gulf they are most likely to be found can help us to evaluate which species might be impacted by certain types of oil-related perturbations. These parameters plus preliminary population estimates have been summarized in Table 5. Missing data in the table reflect our lack of knowledge.

The direct impact of oil on individual species of marine mammals is as yet unclear. Sea otters and fur seals would probably be greatly affected because oiling of their pelage would destroy thermal insulation, essential for proper temperature control. Animals directly affected by oil are expected to die; however, quantitative documentation is lacking. Surface filter feeding cetaceans, such as right whales (Watkins and Schevill, 1976), might also be directly impacted by oil fouling baleen plates.

Consideration of how certain marine mammals are to be impacted requires an independent analysis of temporal and spatial trends at specific sites where animals are likely to be found; such as: Portlock and Albatross Banks, Fairweather Ground, and Middleton Shelf. Local "systems" related studies are expected

Table 4.--Checklist of marine mammals by month of the year in pelagic waters of the Gulf of Alaska (Lat. 52°N, Long. 131°W to Long. 155°W) excluding Cook Inlet and Prince William Sound; and sea otters. Projections were made from data collected from (1) Marine Mammal Division's Outer Continental Shelf Environmental Assessment Program, 1975-76; (2) Platforms of Opportunity Program (NOAA), 1974-76; (3) pelagic fur seal research, 1958-68; and (4) historical records summarized from the literature. 0=species present, +=greatest frequency; -=not known or expected to occur; blank=no data available.

Marine mammal species	Months of the year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
N. fur seal	0	0	0	+	+	+	0	0	0	0	0	0
N. sea lion		0	0	+	+	0	0	0	+	0	0	
Harbor seal		0	0	0	+	0		0	0	0		
Gray whale	0			0	+	0					0	+
Minke whale		0	0	0	+	+	0	0	0		+	
Sei whale	-	-		+	+	+	0	0				-
Fin whale	-	-	0	+	+	+	0	0		0		-
Blue whale	-	-	-		0	+	0	0			-	-
Humpback whale	-	-	0	+	+	+	0	+		0		-
N. Pacific white-side dolphin		0		0	+	+					0	
Killer whale	0	0	+	+	+	+	+	+	0	0	0	0
Harbor porpoise		0	0	0	+	+	0	0	0	0	0	
Dall porpoise		0	0	+	+	+	0		0	0	0	0
Beluga					0							
Sperm whale	-	-	-		+	+			0		0	-
Pilot whale								0				
Gray grampus	-	-	-	-						-	-	-
Right whale	-	-			0	0	0	0	0			-
N. right whale dolphin	-	-	-	-						-	-	-
Giant bottlenose whale												
Bering Sea beaked whale												
Goose-beaked whale												

Table 5.--Summary of population size estimates of marine mammals and regions of the Gulf where individual species are most likely to frequent. General food resources and vertical zone of the ocean where animals feed are also included. NE=no estimate available.

Marine mammal species	Approximate population size1/	Region of the gulf2/	Principal food type	Feeding strata3/
N. fur seal	1,189,000 (NP)	OS	fish	MW
N. sea lion	100,000 (NP)	C	fish	S,MW
Harbor seal	100,000?(GA)	C	fish	S,MW
Gray whale	11,000 (W)	C	amphipods	B,S
Minke whale	NE	C,OS	fish, copepods	S
Sei whale	8,600 (NP)	OS	copepods	S
Fin whale	9-16,000 (NP)	OS	euphasiids copepods	S
Blue whale	1,600 (NP)	O	euphasiids	MW
Humpback whale	1,400 (NP) 60 (GA)	C	euphasiids, fish	S
N. Pacific white-side dolphin	NE	C	fish	MW
Killer whale	NE	C	fish, cephalopods pinnipeds	S
Harbor porpoise	1,000+(GA)	C	fish	S
Dall porpoise	2,000+(GA)	C,OS	fish	S
Beluga	500 (CI)	C	fish	S
Sperm whale	150,000 (NP)	O	cephalopods fish	B,MW
Pilot whale	NE	OS	cephalopods fish	
Grampus	NE	OS		
Right whale	200 (NP)	OS	copepods euphasiids	S
N.right whale dolphin	10,000+(NP)	OS		
Giant bottlenose whale	NE	O,OS	fish cephalopods	B,MW
Bering Sea beaked whale	NE	O,OS		
Goose-beaked whale	NE	O,OS	cephalopods fish	

1/ Cook Inlet (CI), Gulf of Alaska (GA), eastern N. Pacific (NP), and World (W) population(s).

2/ Coastal (C), offshore (OS-continental shelf), oceanic (O-shelf slope and ocean floor).

3/ Surface (S-photic zone), mid-water (MW), benthic (B-ocean floor).

to prove cost effective. Many different marine mammal species occur together in time, thus increasing the chances of obtaining multi-species information at one location. Studies on local petroleum related problems, similar to those described by Isakson et al. (1975), might prove to be important if we are to gain a better understanding of the relationship between energy development and marine mammals.

Data presented in this report represent a preliminary synthesis of most of the sighting information sent to us to date. We anticipate more data will become available from the study area as OCSEAP research continues. New information will be added to our ongoing RU68 project as it is received.

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APPENDIX A

Figures A-1 to A-120

Tables A-1 to A-17

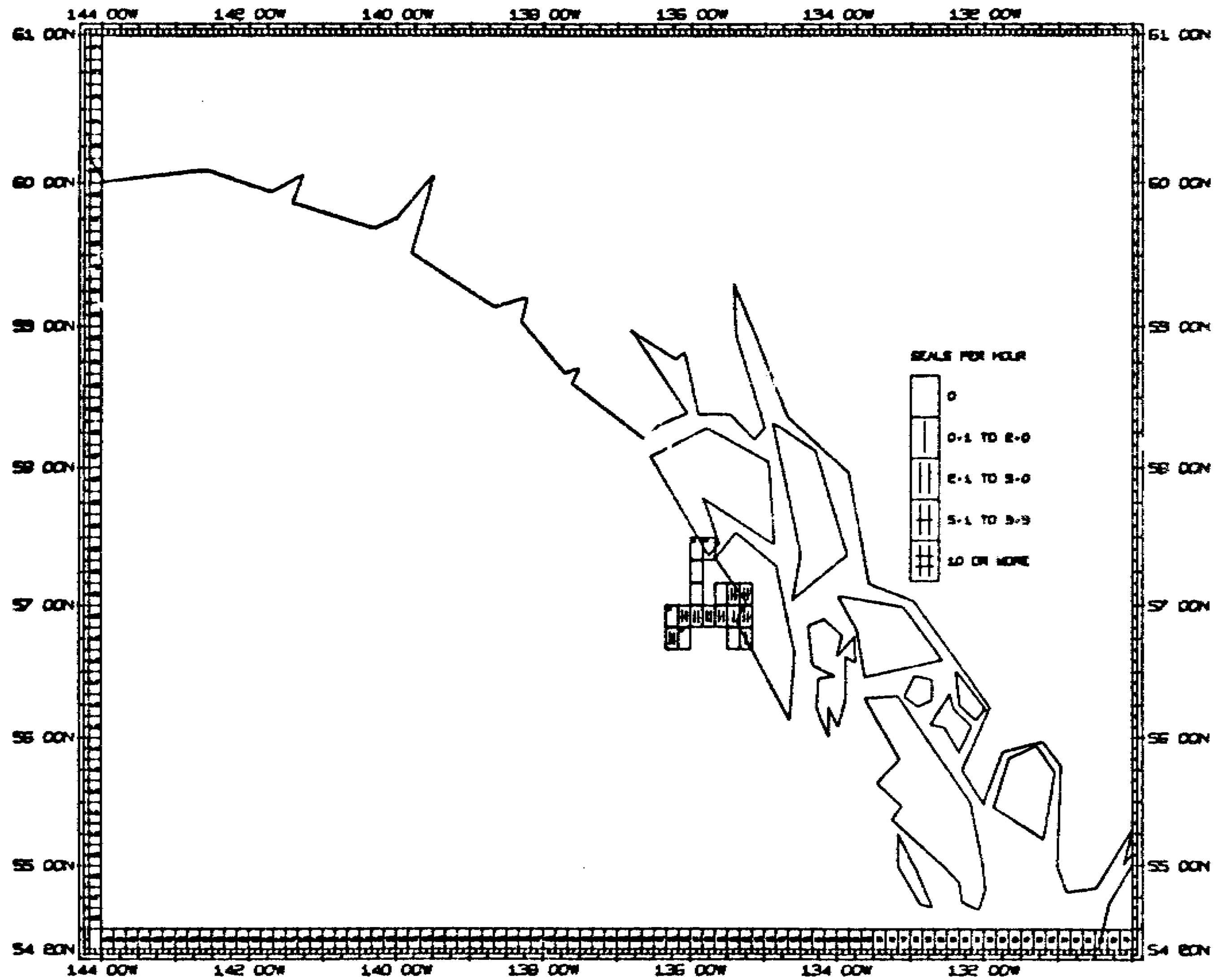

Figure A-1 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in February 1958, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

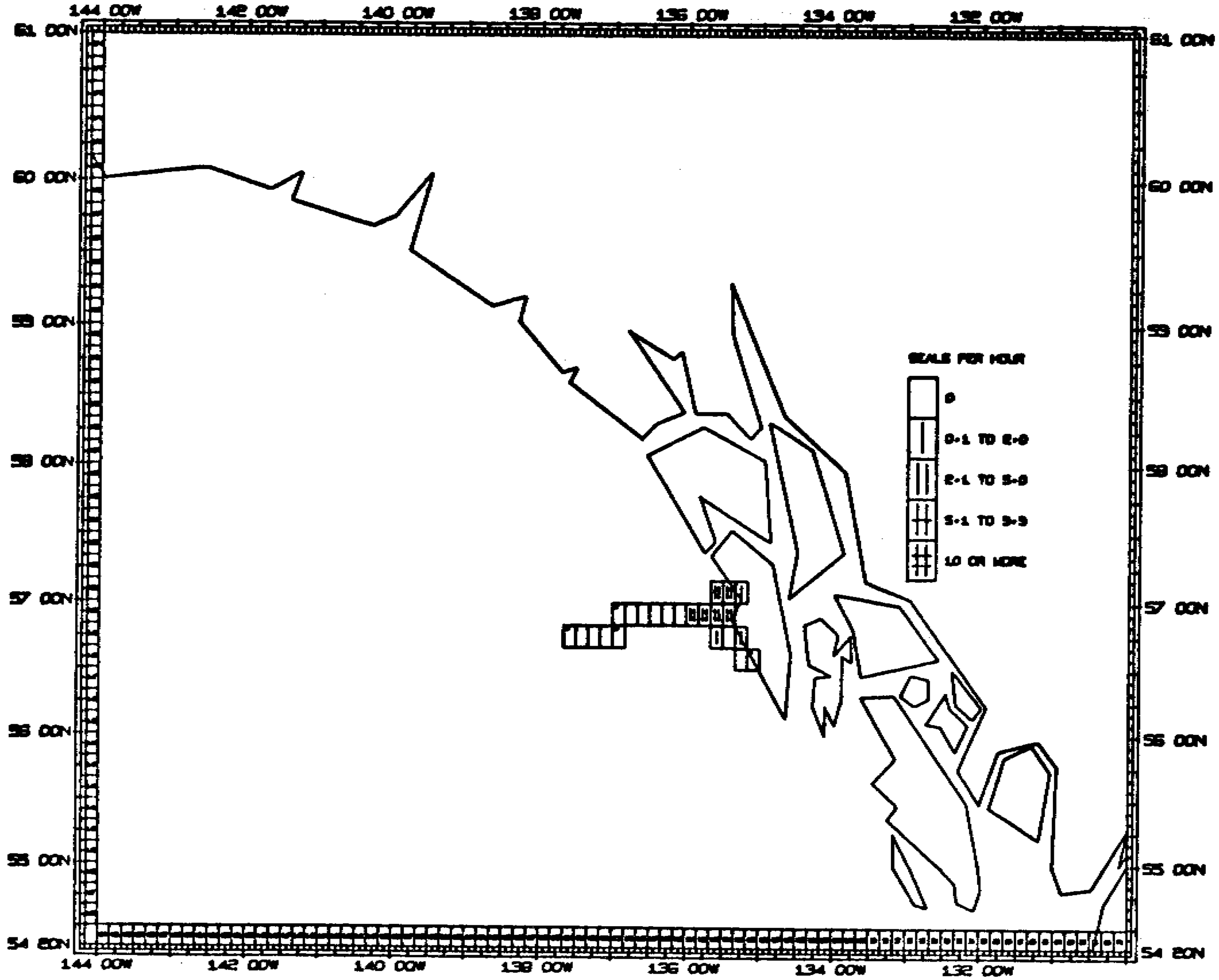

Figure A-2 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in March 1958, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

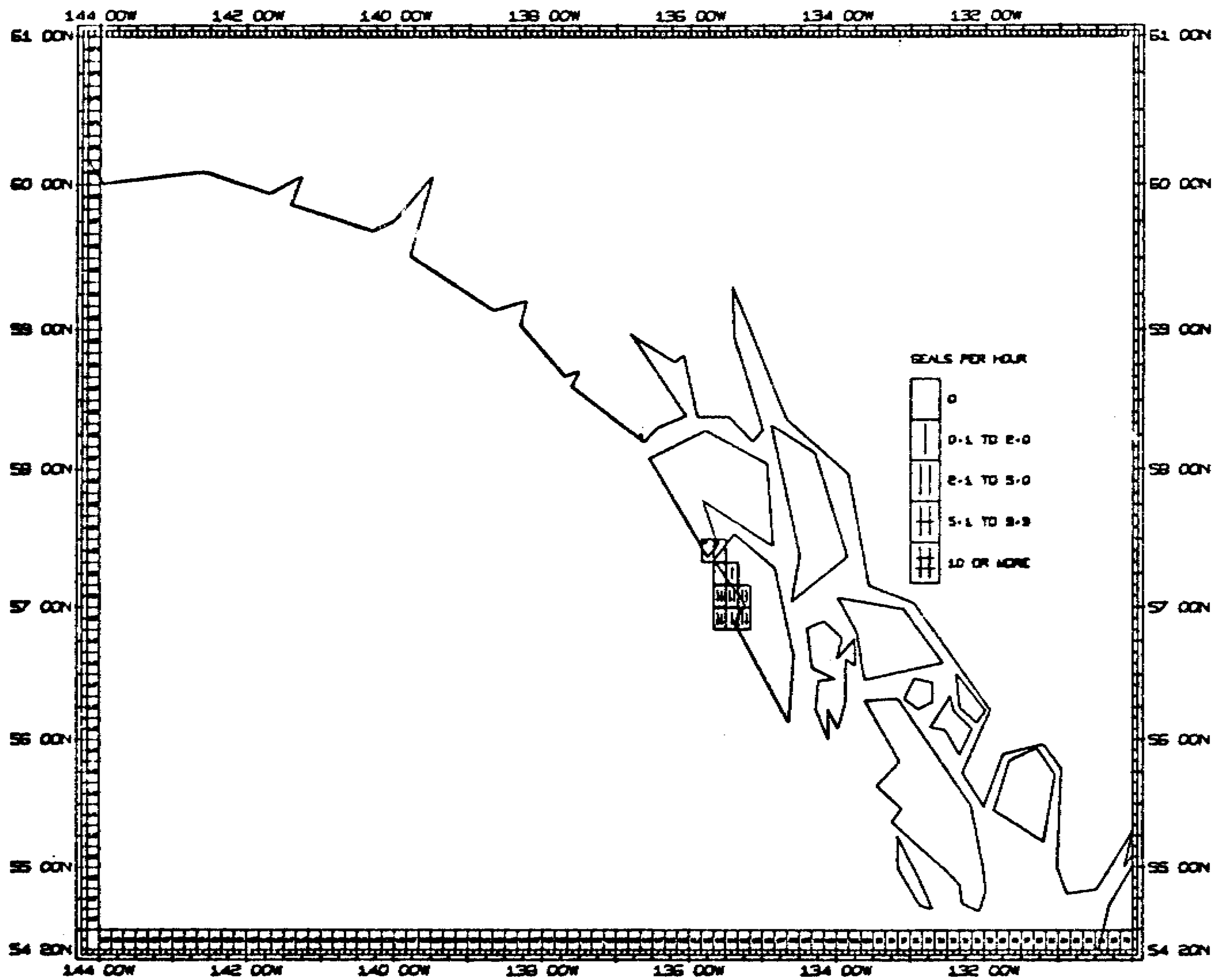

Figure A-3 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in March 1960, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

Figure A-4 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in March 1961, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

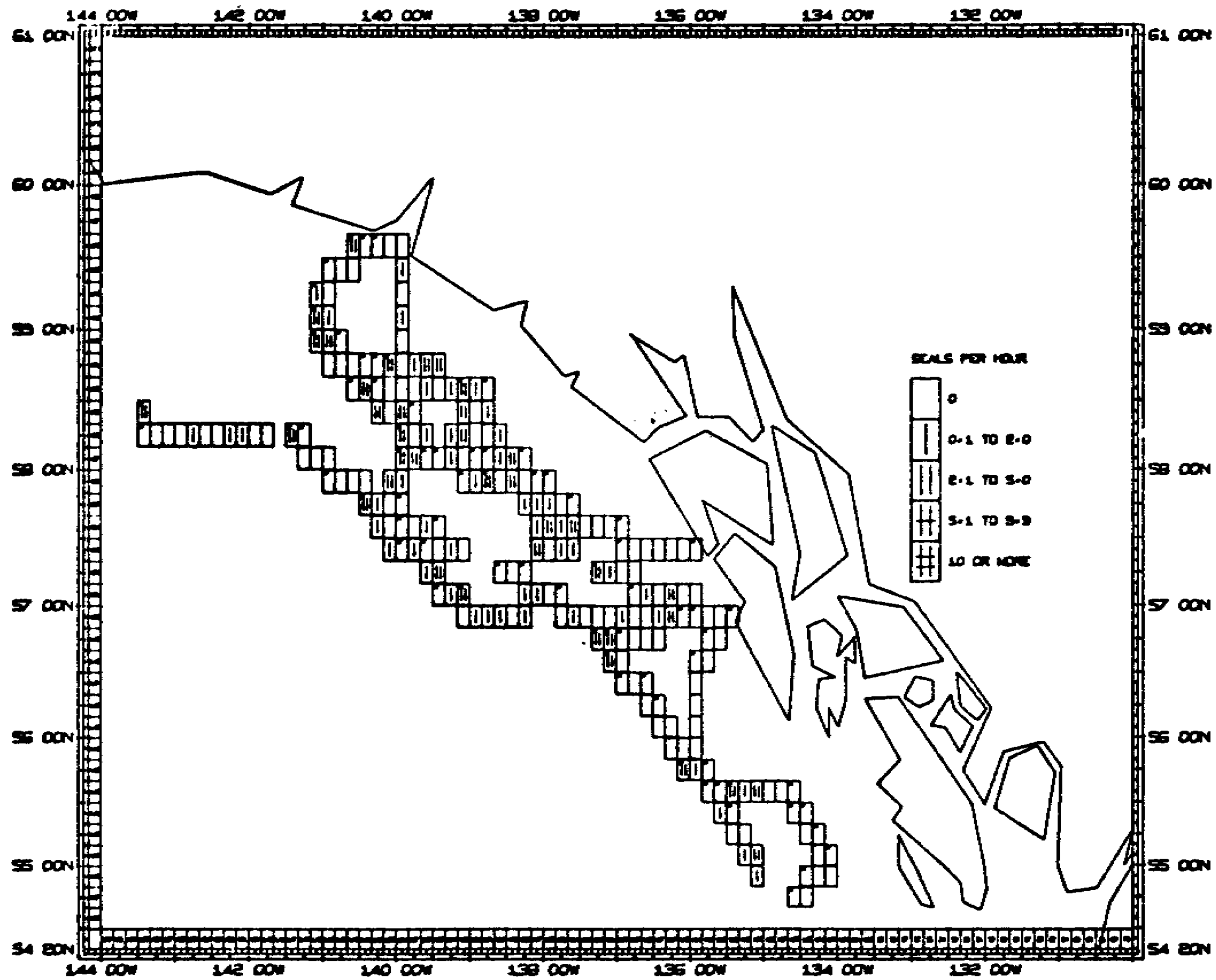

Figure A-5 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in April 1958, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

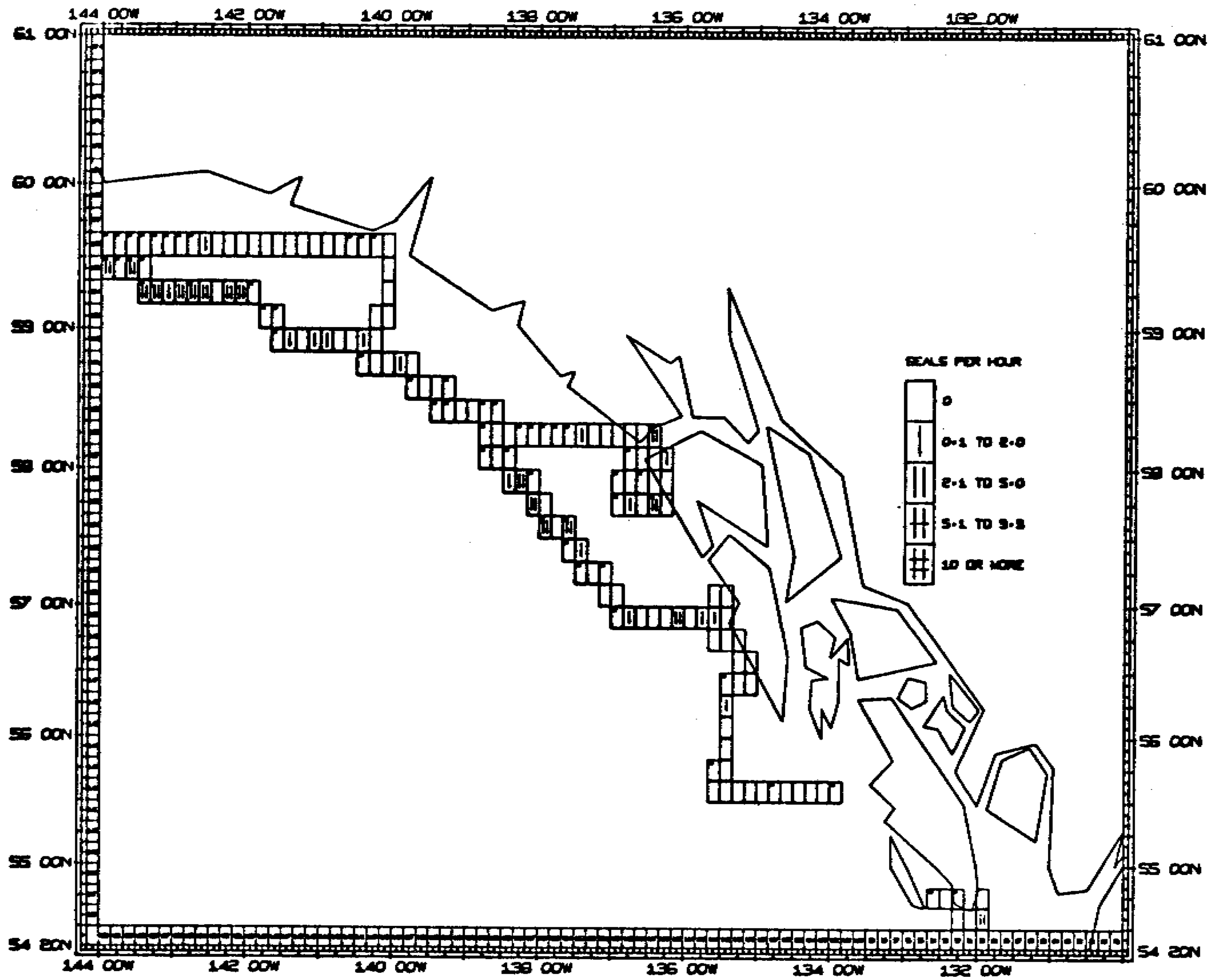

Figure A-6 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in April 1960, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

Figure A-7 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in May 1958, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

Figure A-8 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in May 1962, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

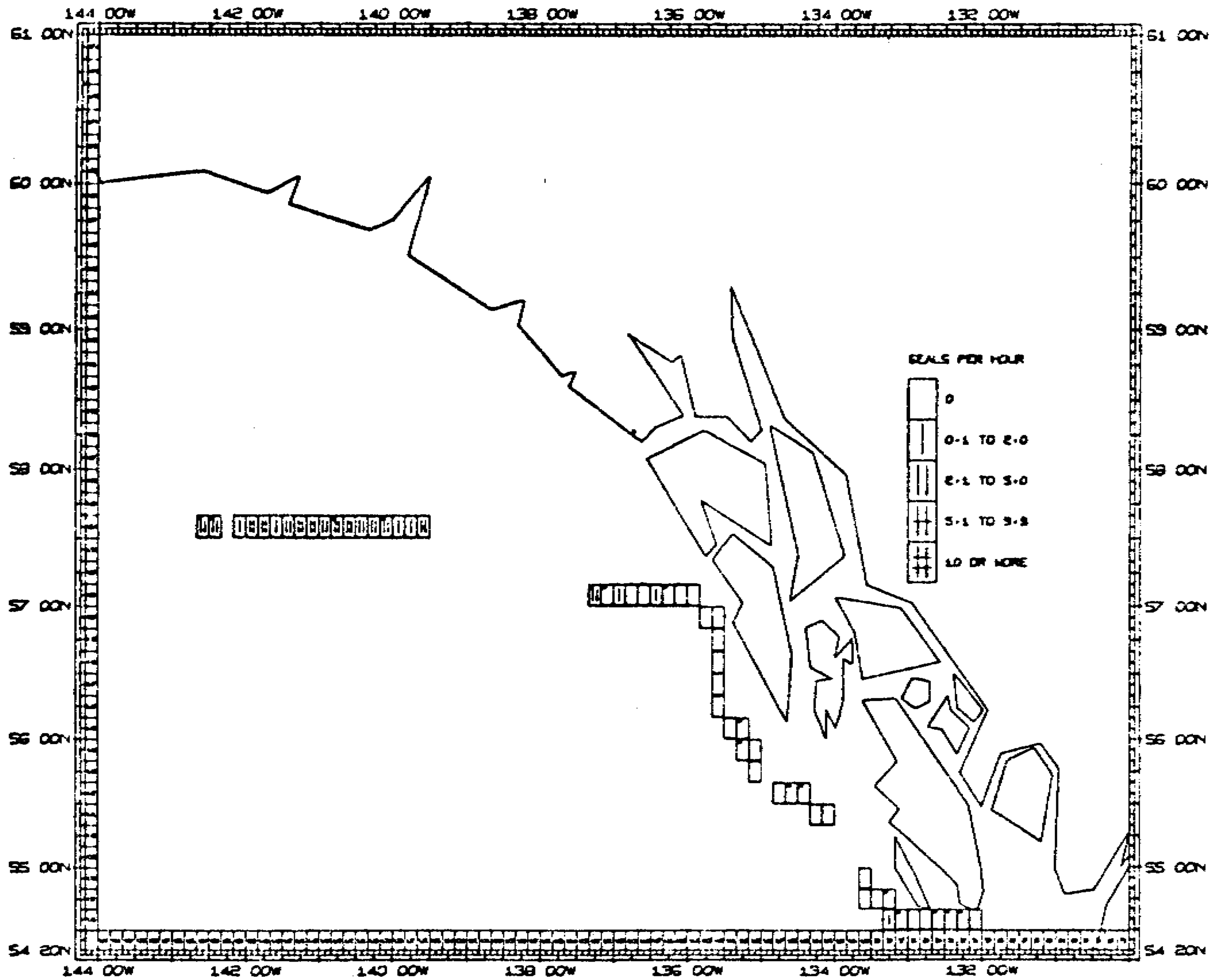

Figure A-9 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in May 1968, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

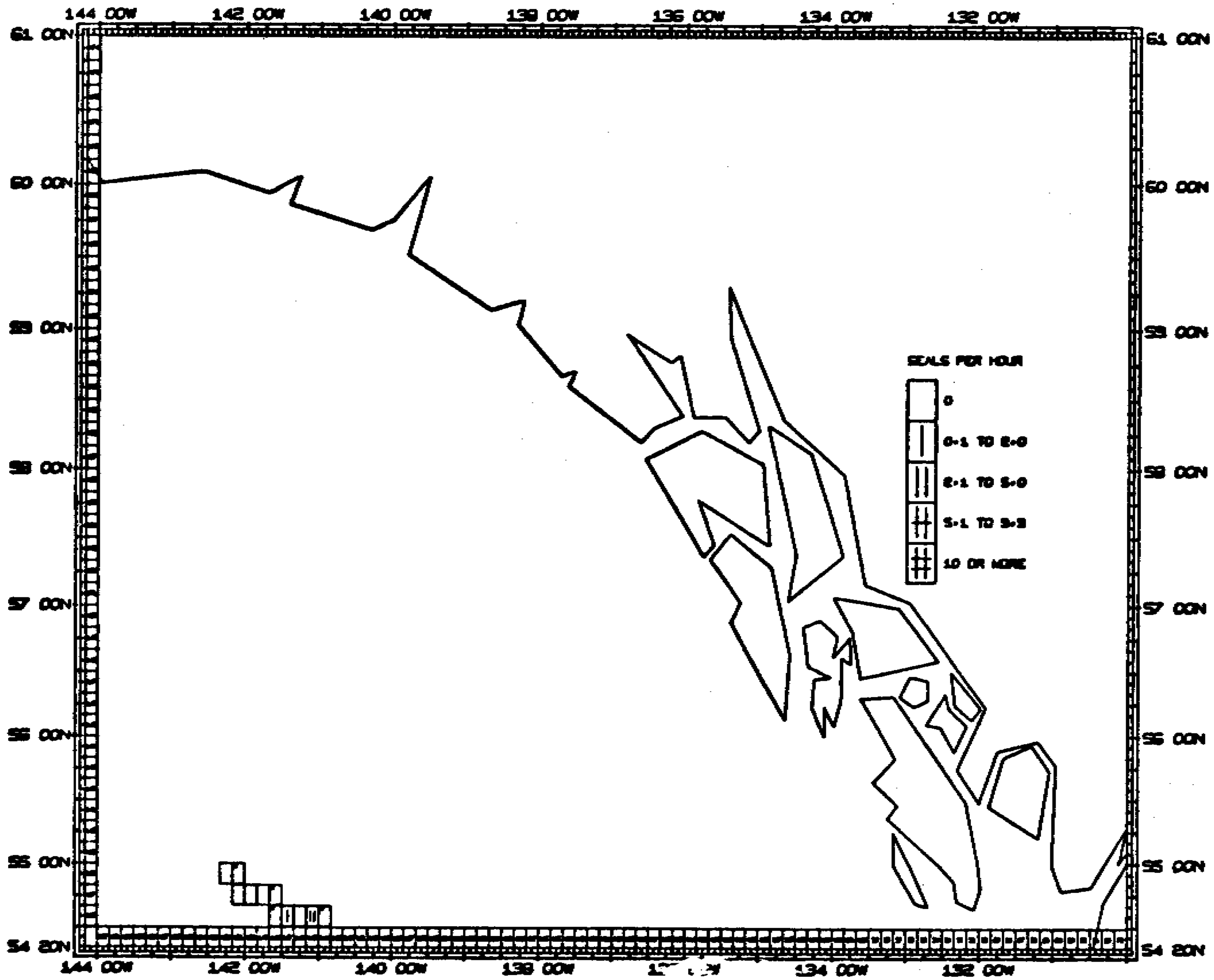

Figure A-10 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in June 1960, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

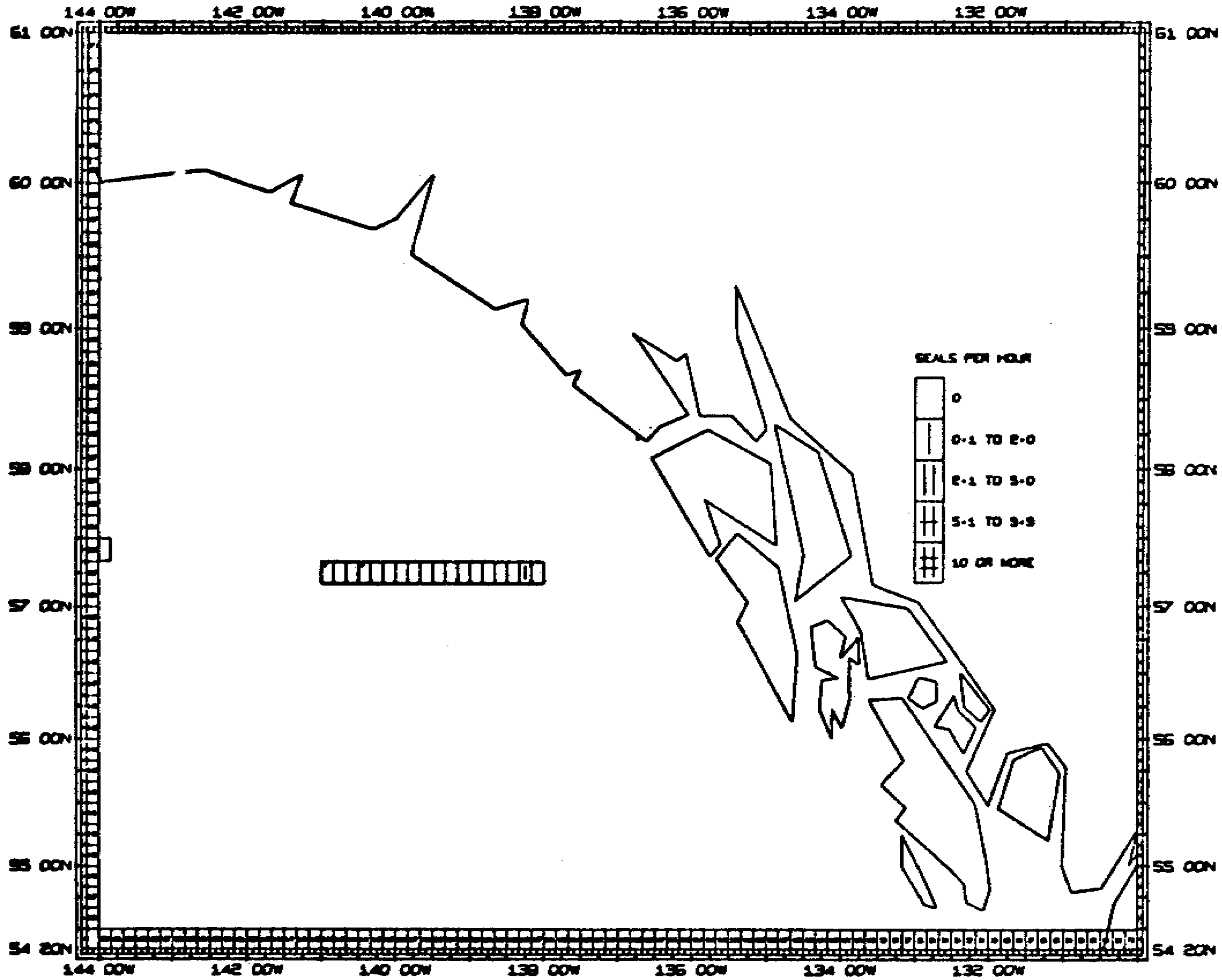

Figure A-11 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in August 1968, in the Gulf of Alaska (Eastern Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

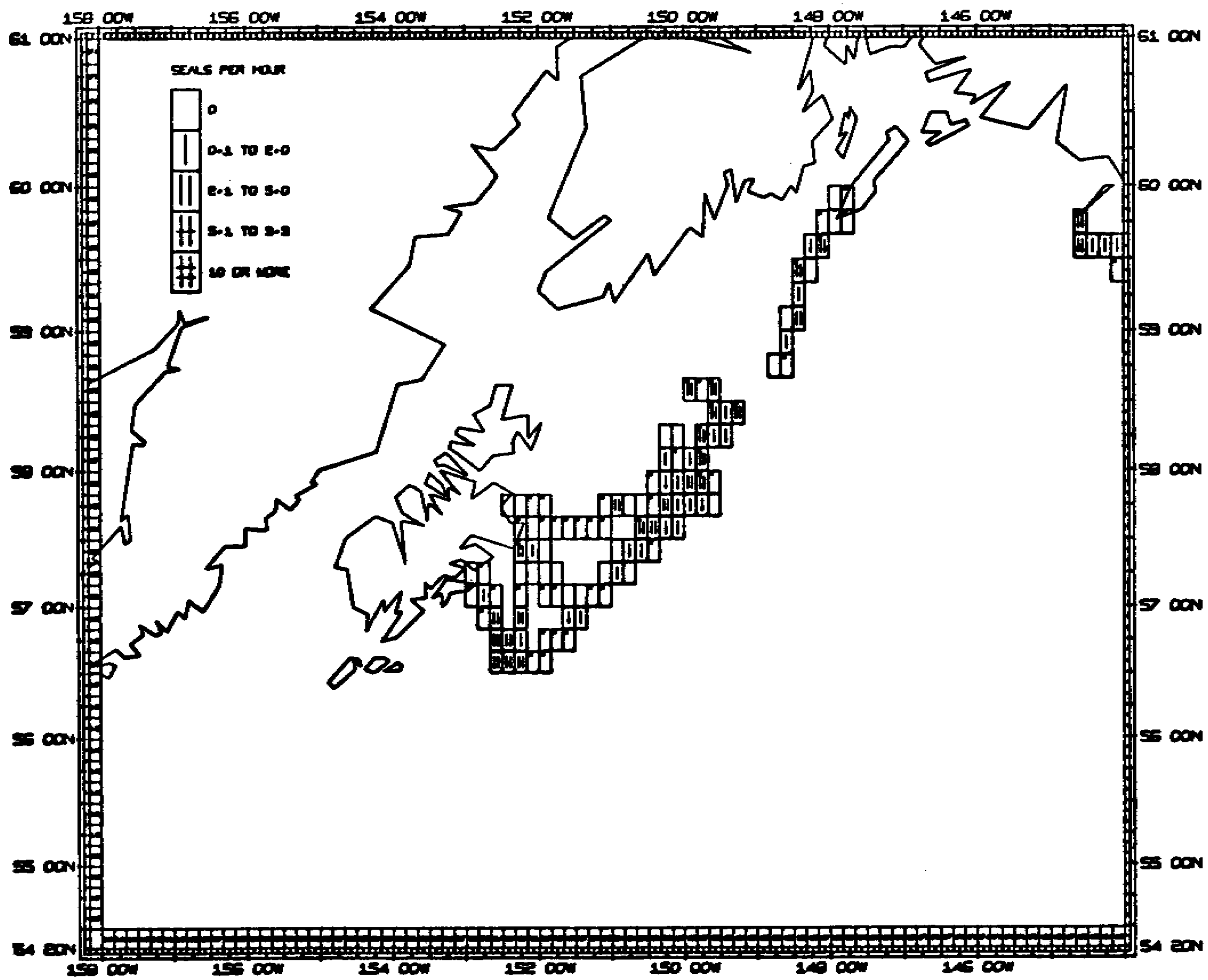

Figure A-12 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in April 1960, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

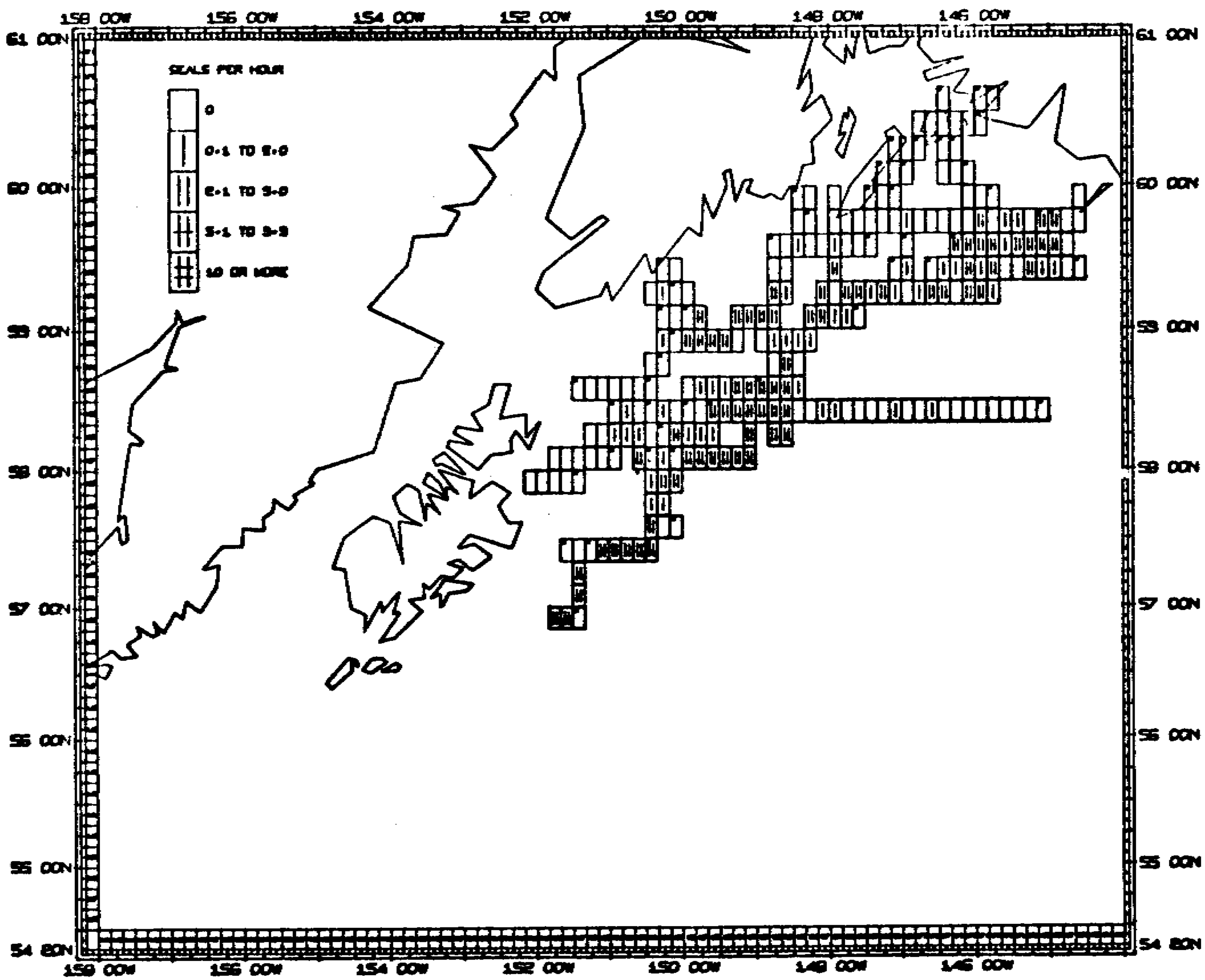

Figure A-13 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in May 1958, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

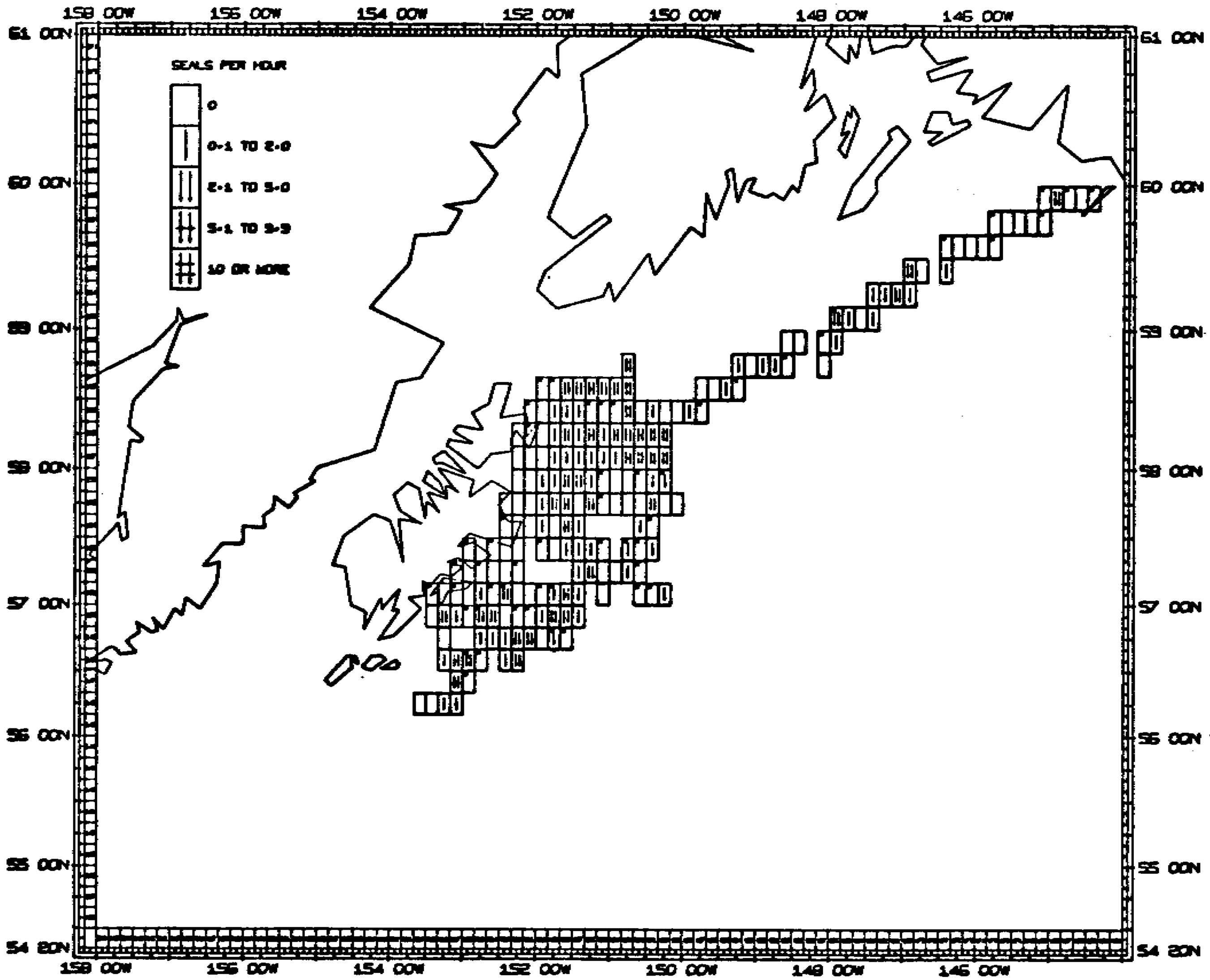

Figure A-14 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in may 1960, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

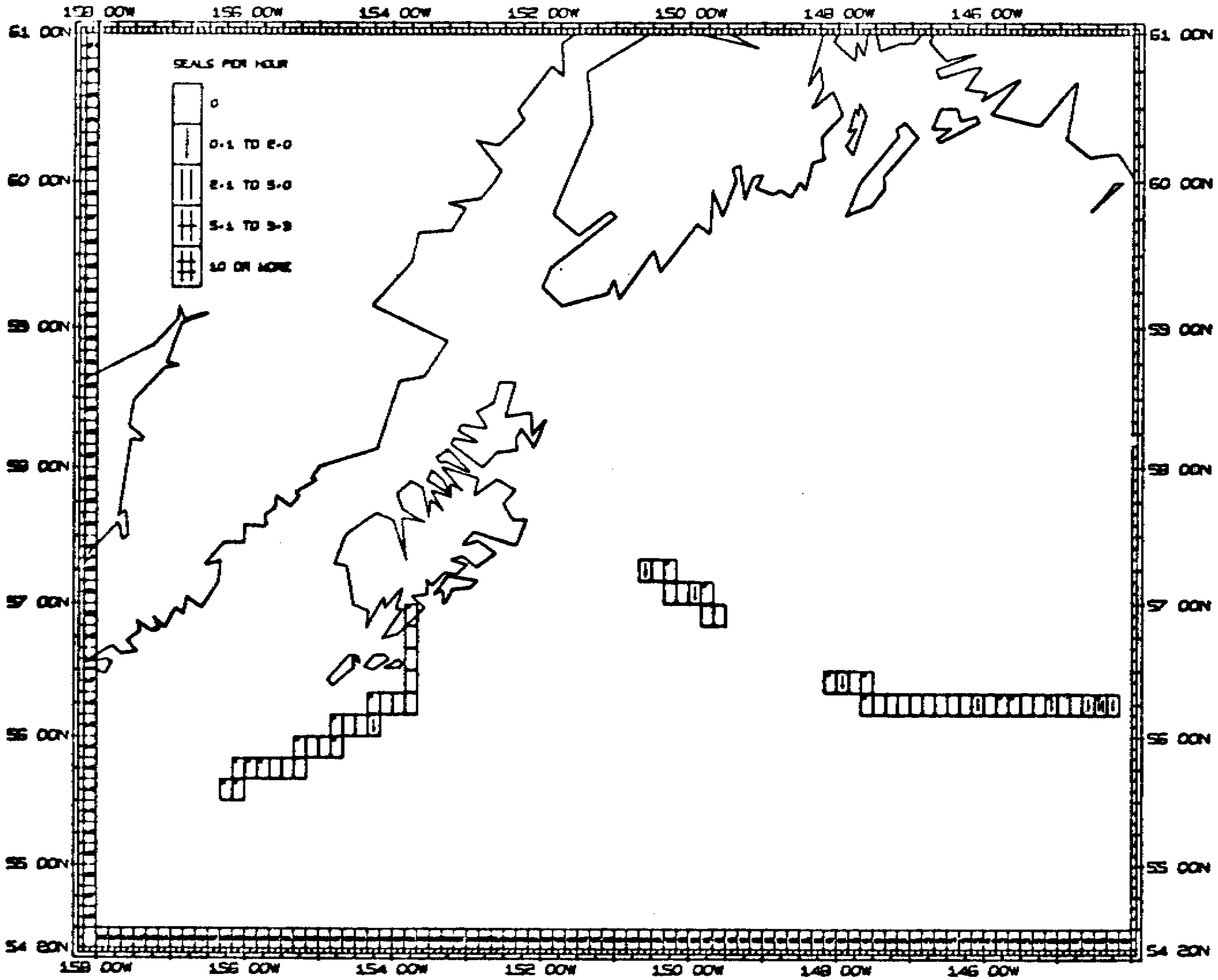

Figure A-15 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in May 1962, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 mintues of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

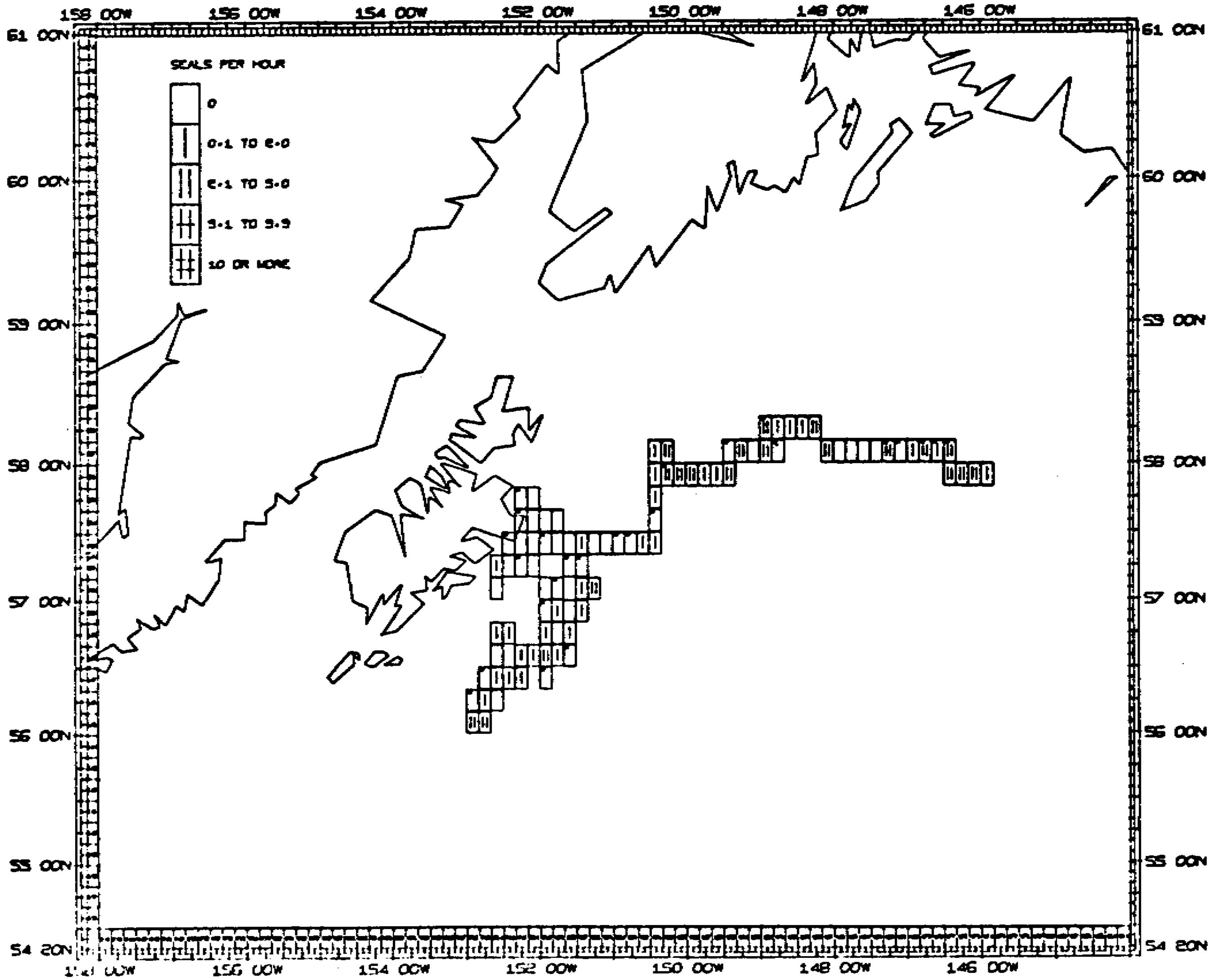

Figure A-16 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in May 1968, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

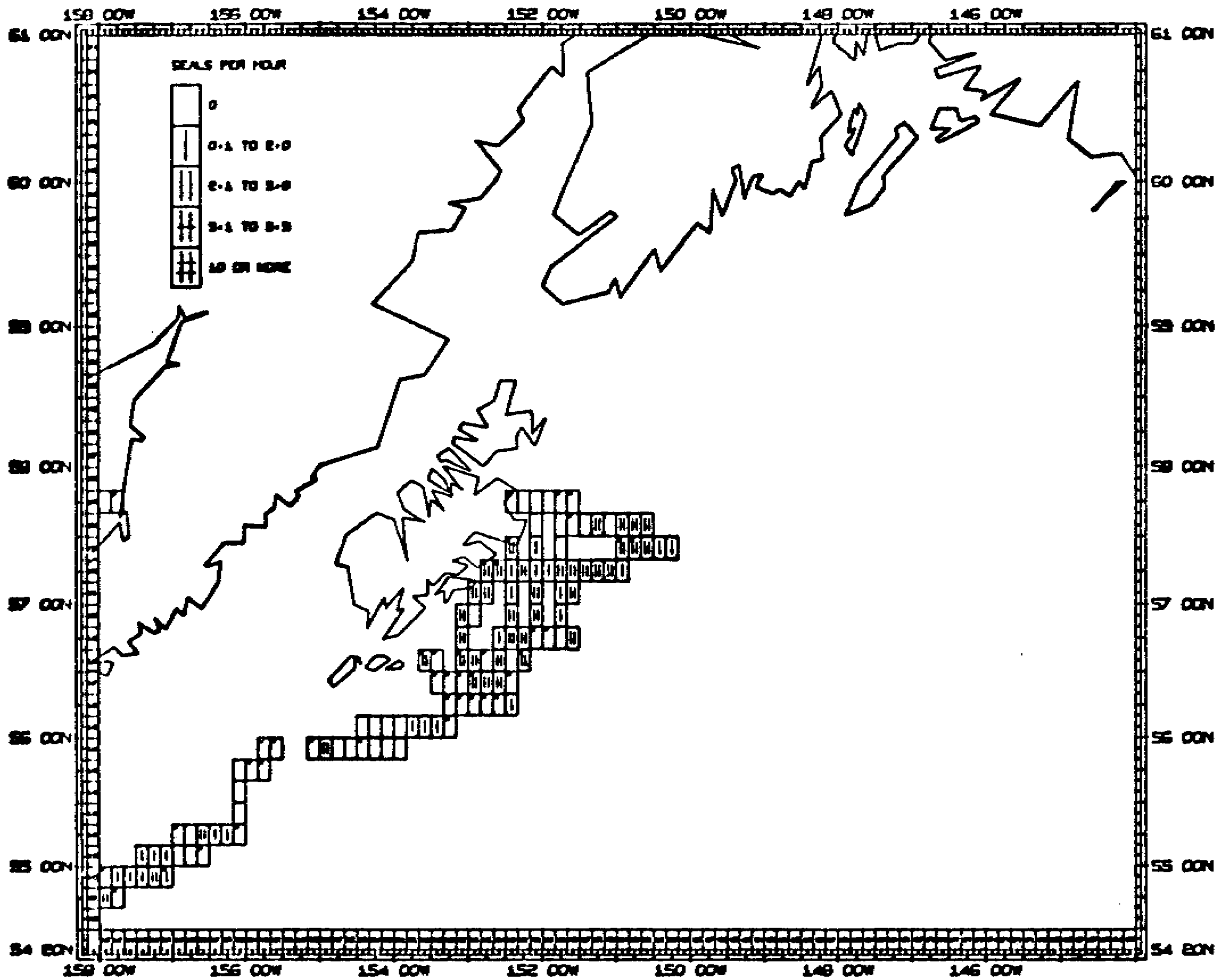

Figure A-17 -- Number of seals seen per hour of effort in each area unit occupied by a research vessel in June 1958, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

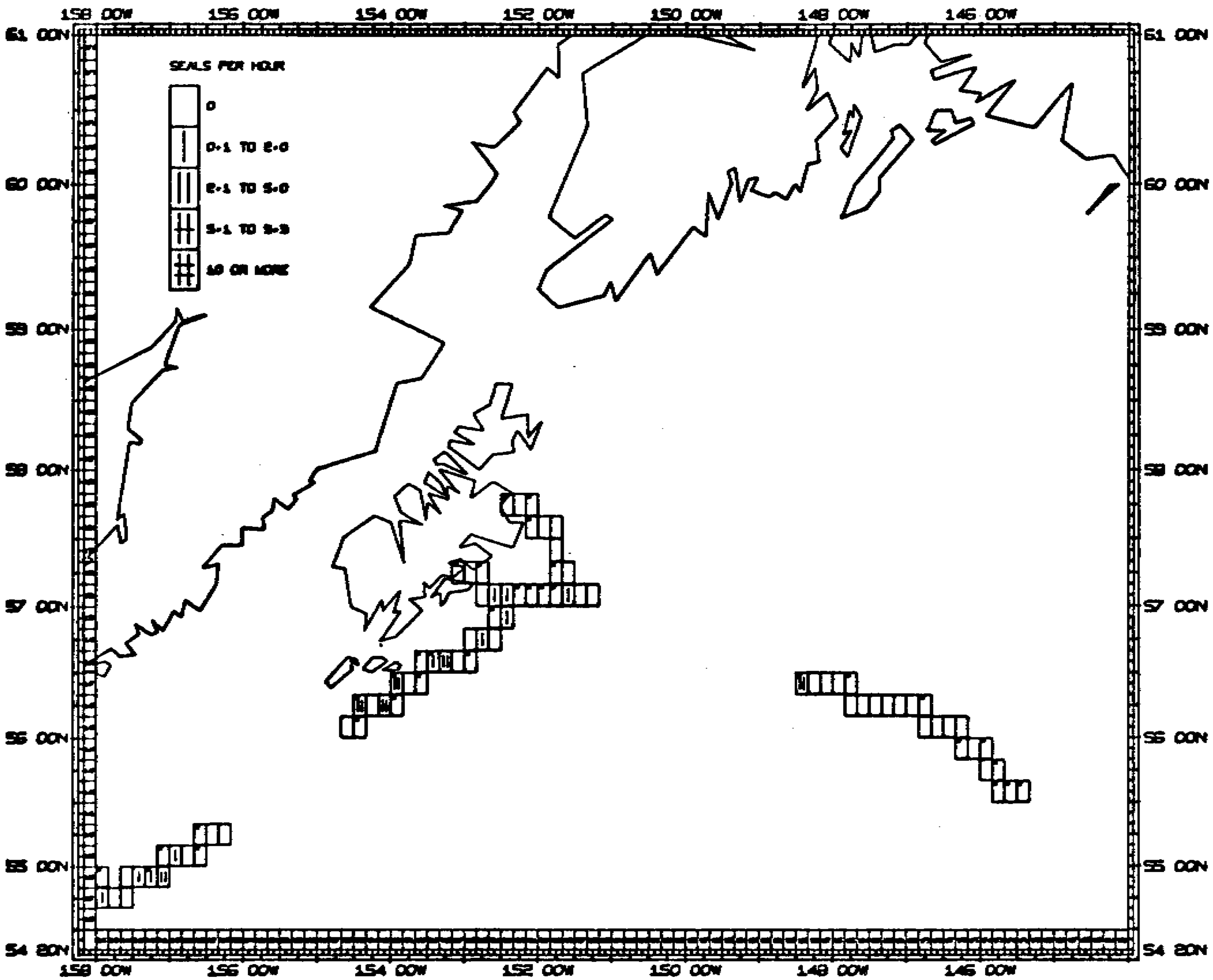

Figure A-18 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in June 1960, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

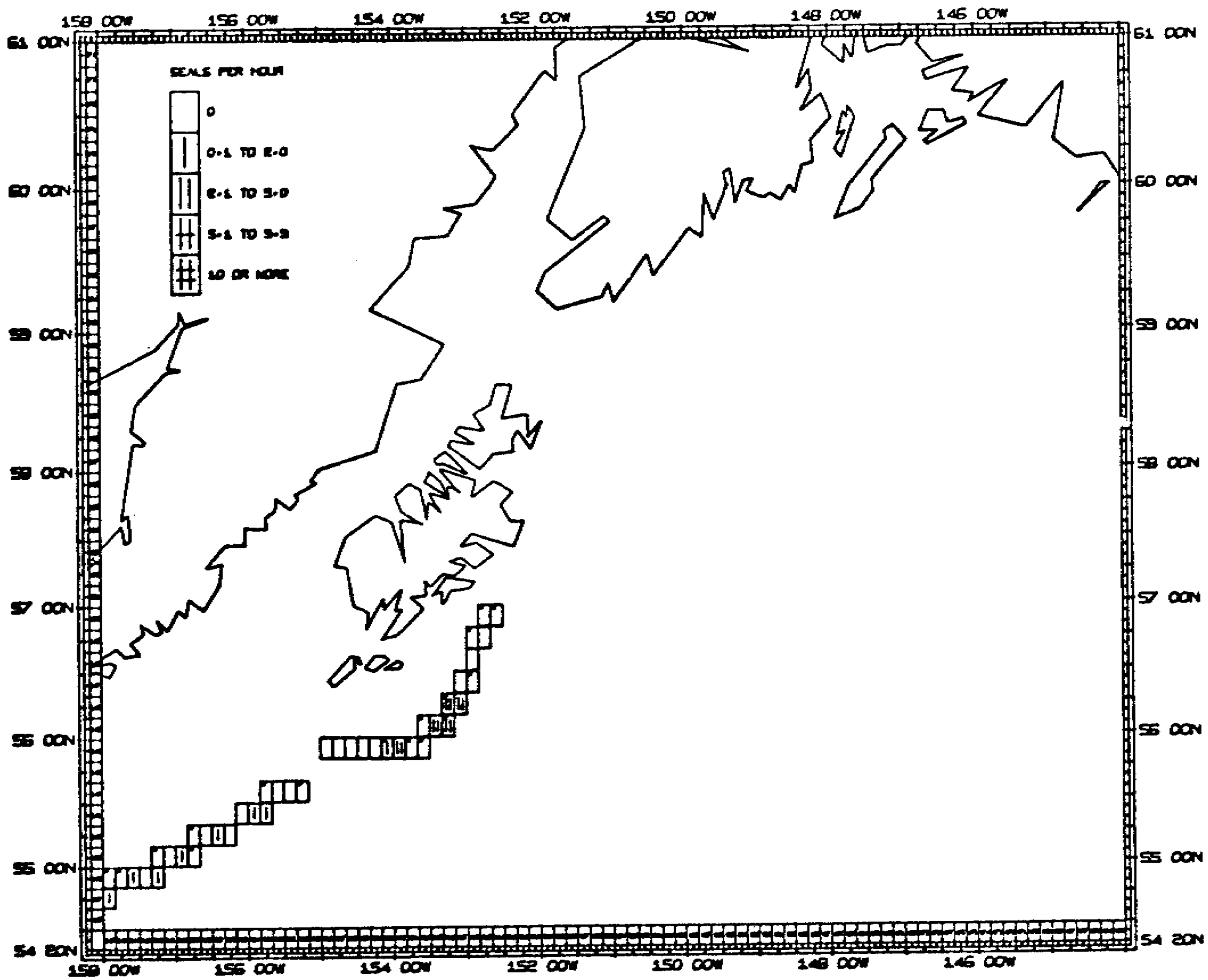

Figure A-19 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in June 1968, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

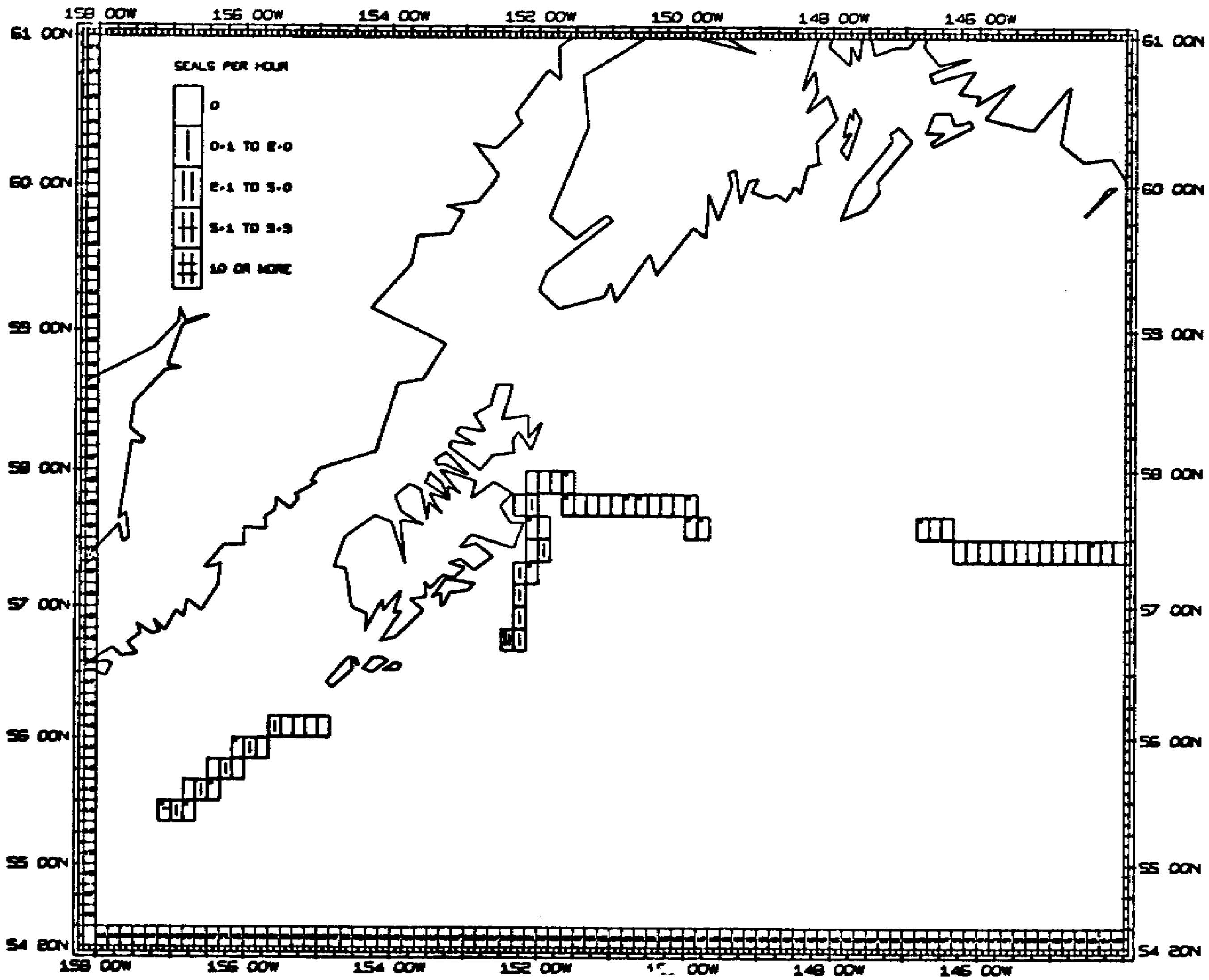

Figure A-20 -- Number of seals seen per hour of effort in each areal unit occupied by a research vessel in August 1968, in the Gulf of Alaska (Western Gulf). The sides of each unit measure 10 minutes of latitude by 10 minutes of longitude. Units occupied for less than 0.5 hour are marked "x."

Figure A-21. Northern sea lion, Eumetopias jubatus, sightings reported for January, 1958-1976.

Figure A-22. Northern sea lion, Eumetopias jubatus, sightings reported for February, 1958-1976.

Figure A-23. Northern sea lion, *Eumetopias jubatus*, sightings reported for March, 1958-1976.

Figure A-24. Northern sea lion, Eumetopias jubatus, sightings reported for April, 1958-1976.

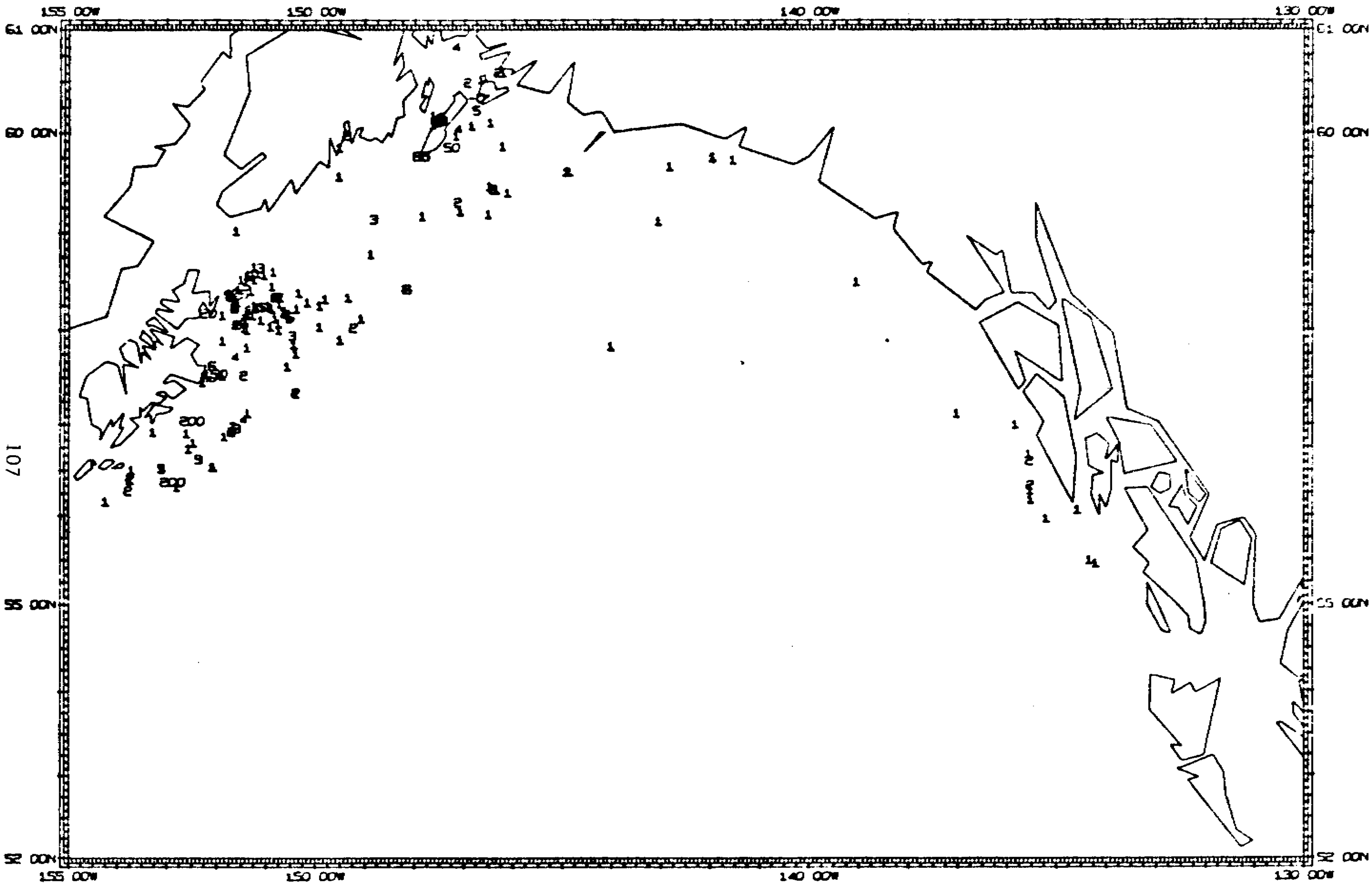

Figure A-25. Northern sea lion, Eumetopias jubatus, sightings reported for May, 1958-1976.

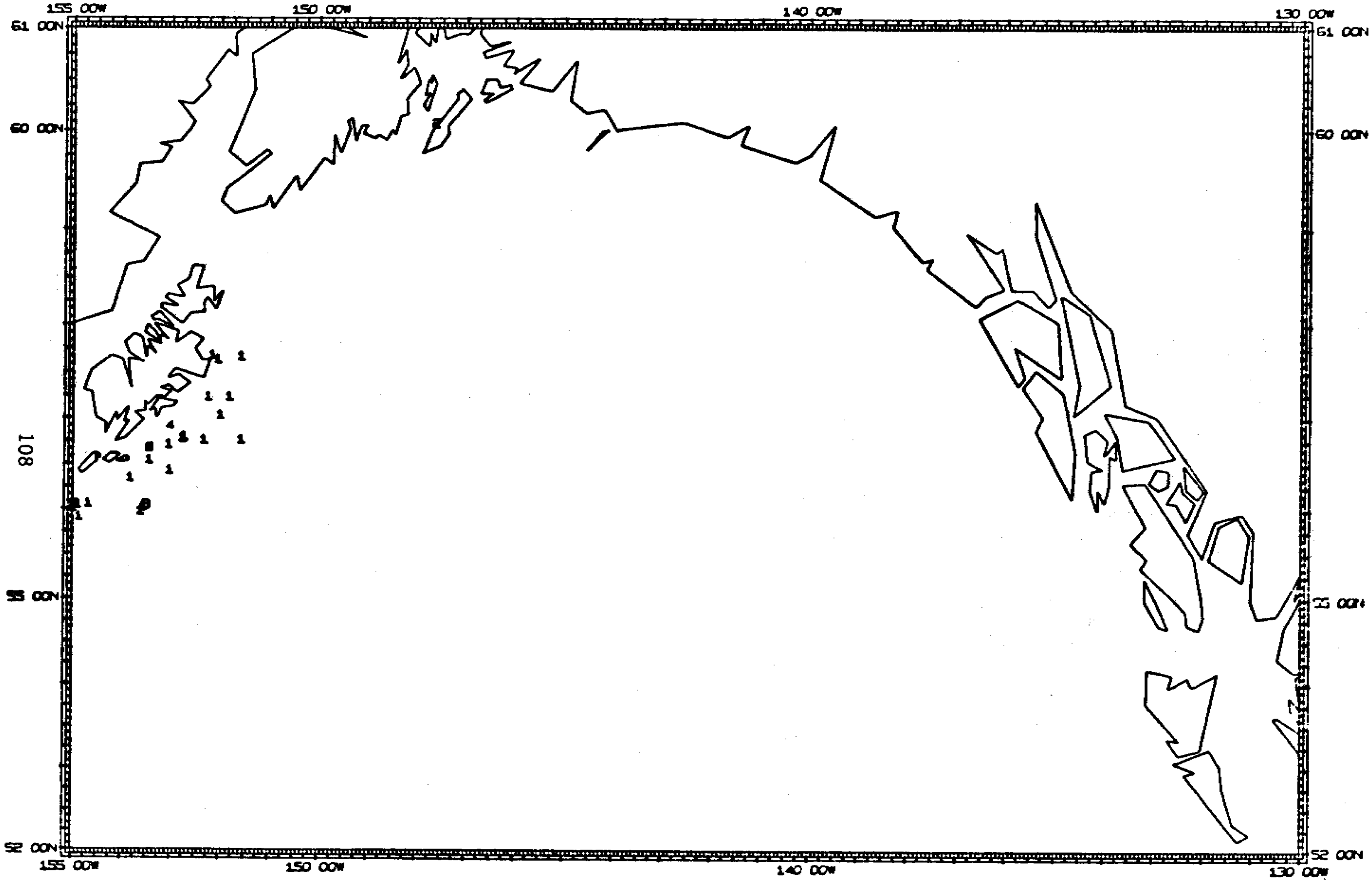

Figure A-26. Northern sea lion, *Eumetopias jubatus*, sightings reported for June, 1958-1976.

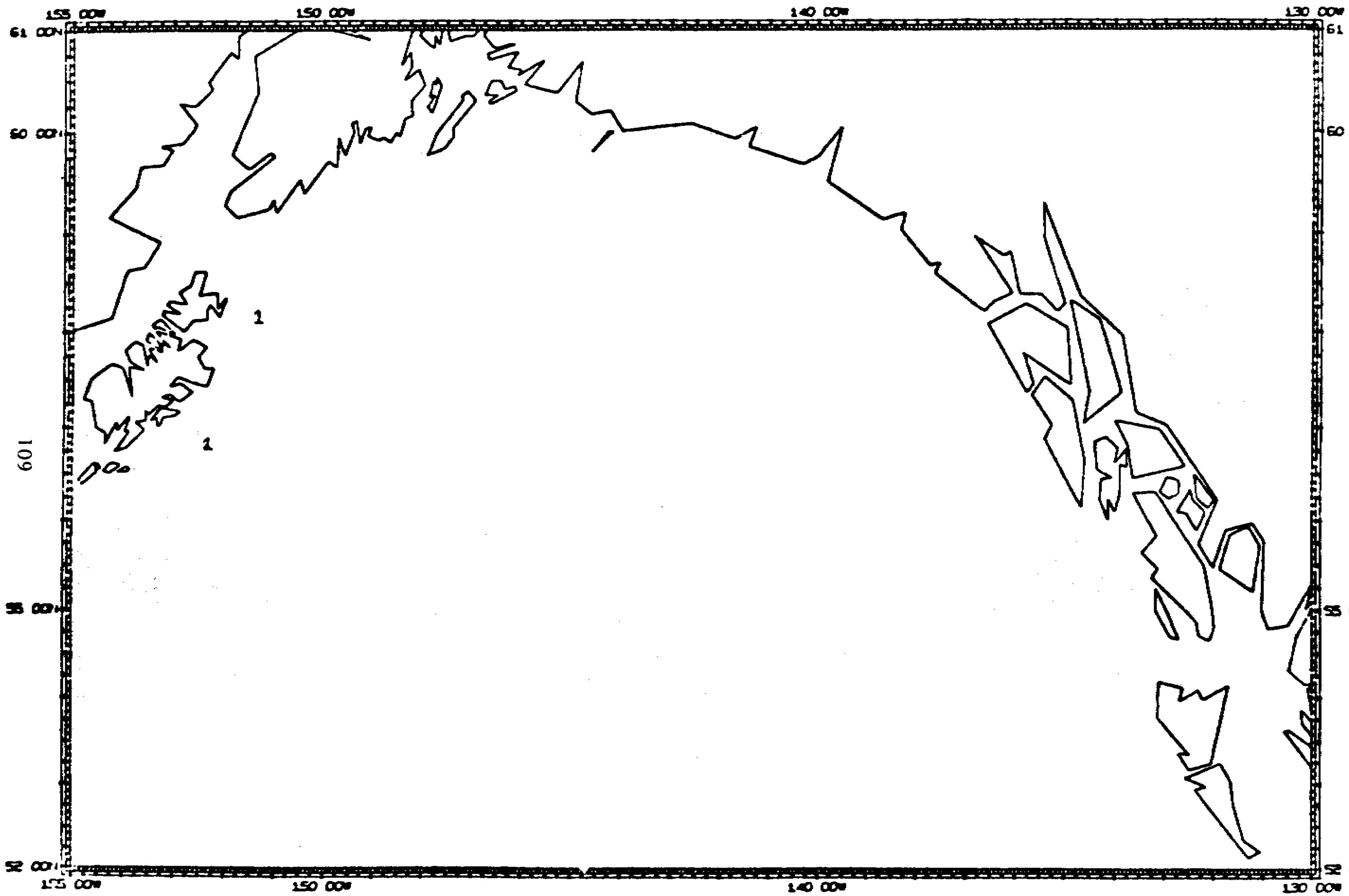

Figure A-27. Northern sea líon, Eumetopias jubatus, sightings reported for July, 1958-1976.

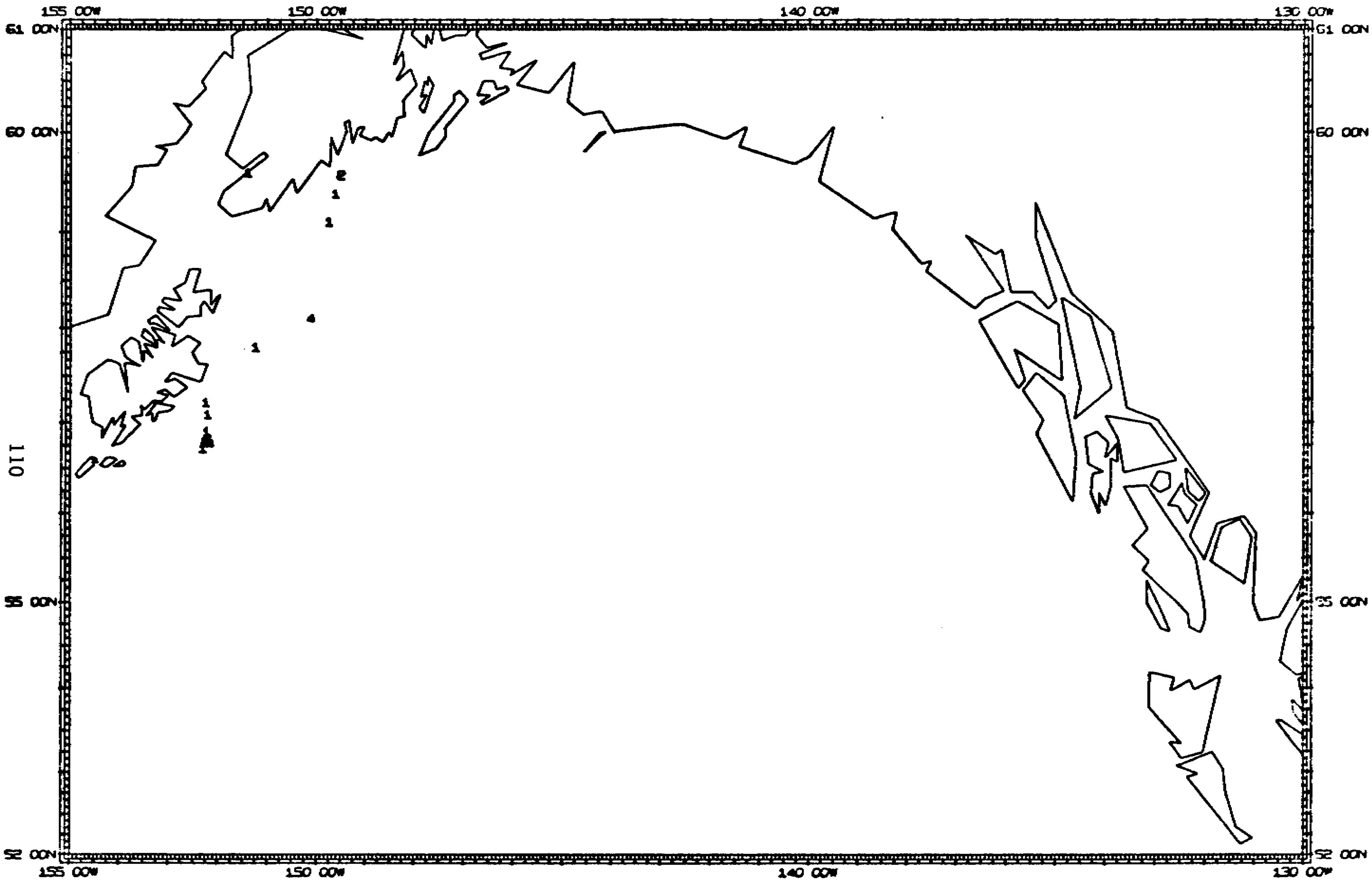

Figure A-28. Northern sea lion, Eumetopias jubatus, sightings reported for August, 1958-1976.

Figure A-29. Northern sea lion, Eumetopias jubatus, sightings reported for September, 1958-1976.

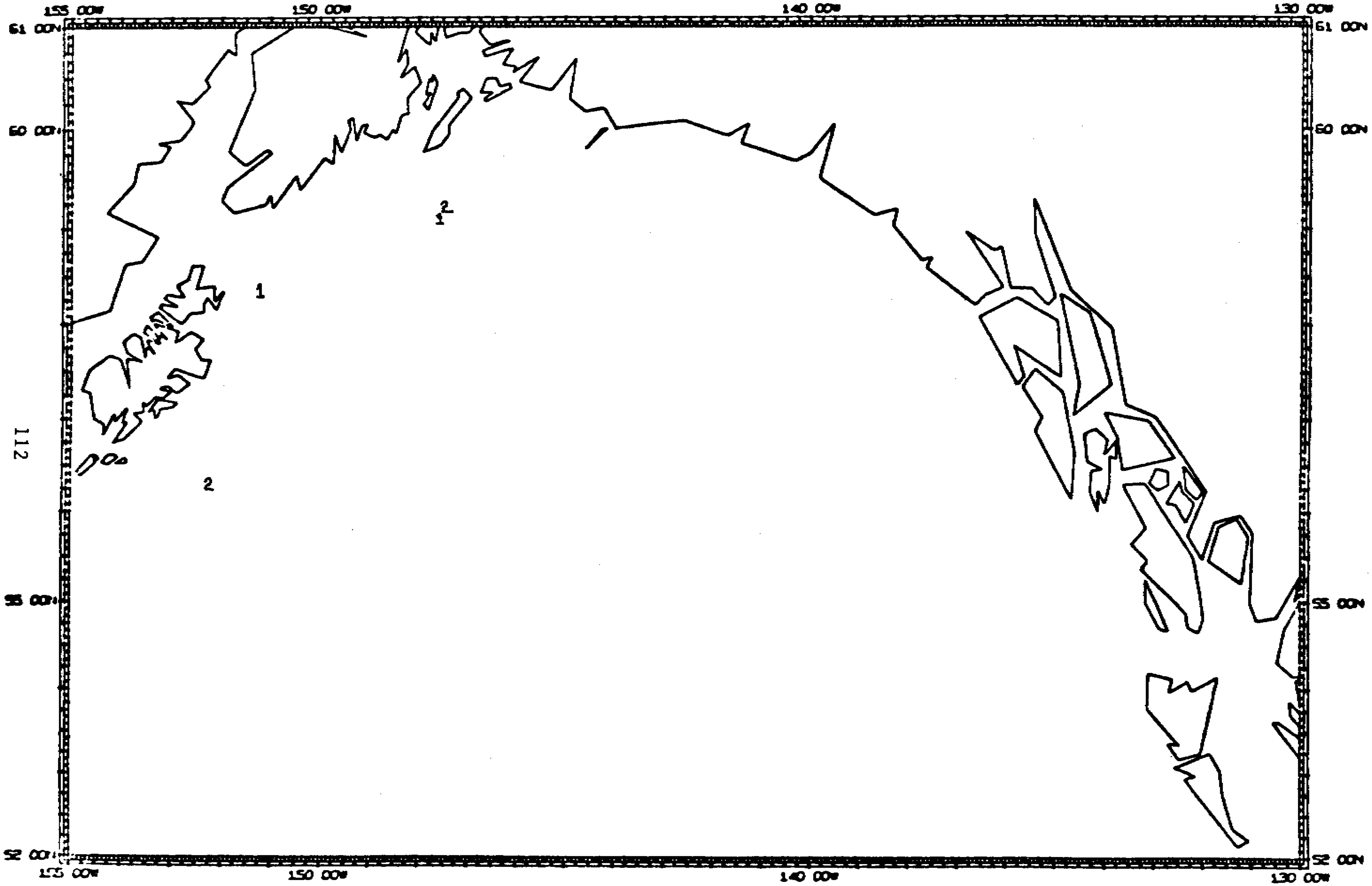

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Figure A-30. Northern sea lion, Eumetopias jubatus, sightings reported for October, 1958-1976.

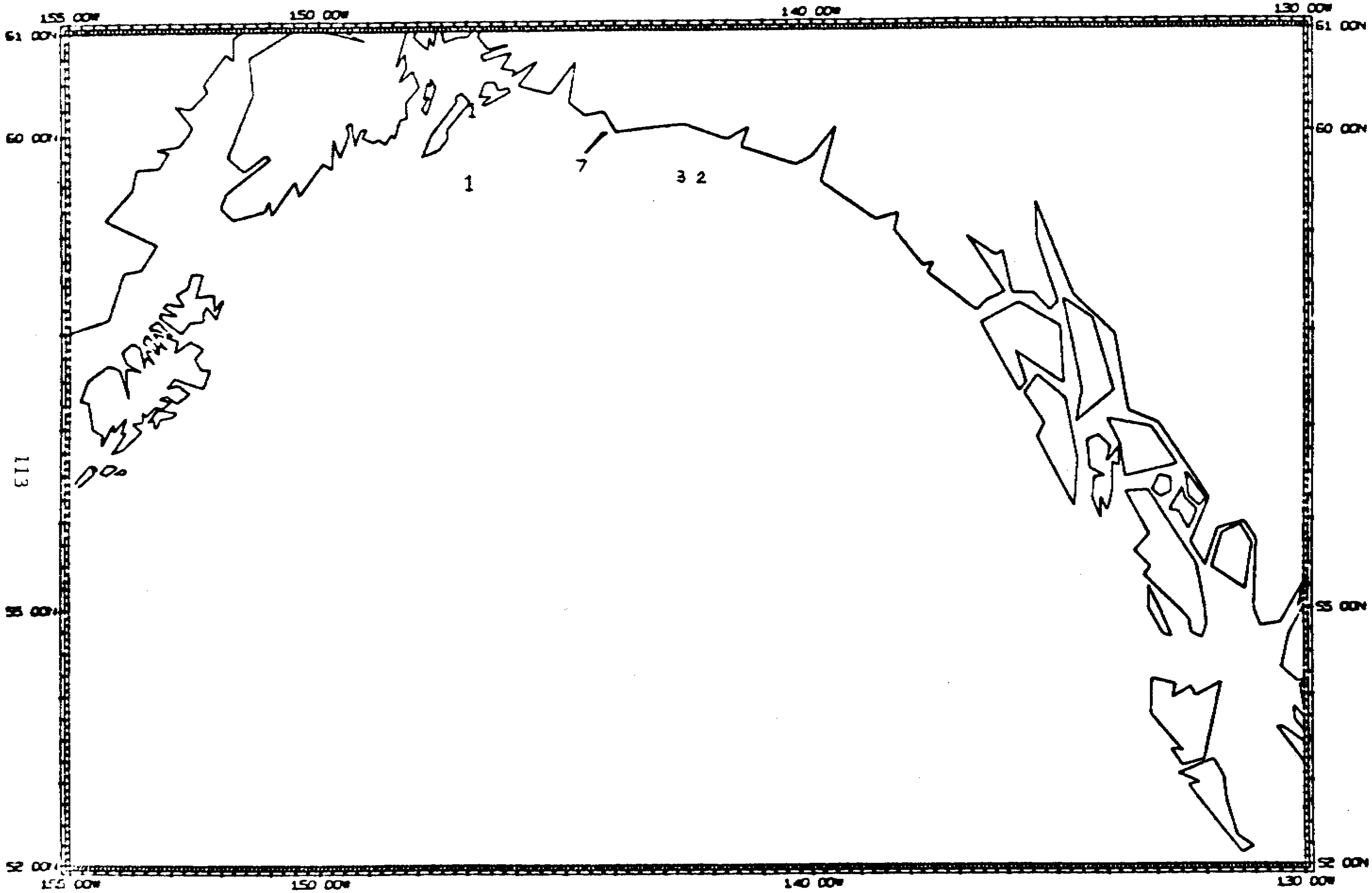

Figure A-31. Northern sea lion, Eumetopias jubatus, sightings reported for November, 1958-1976.

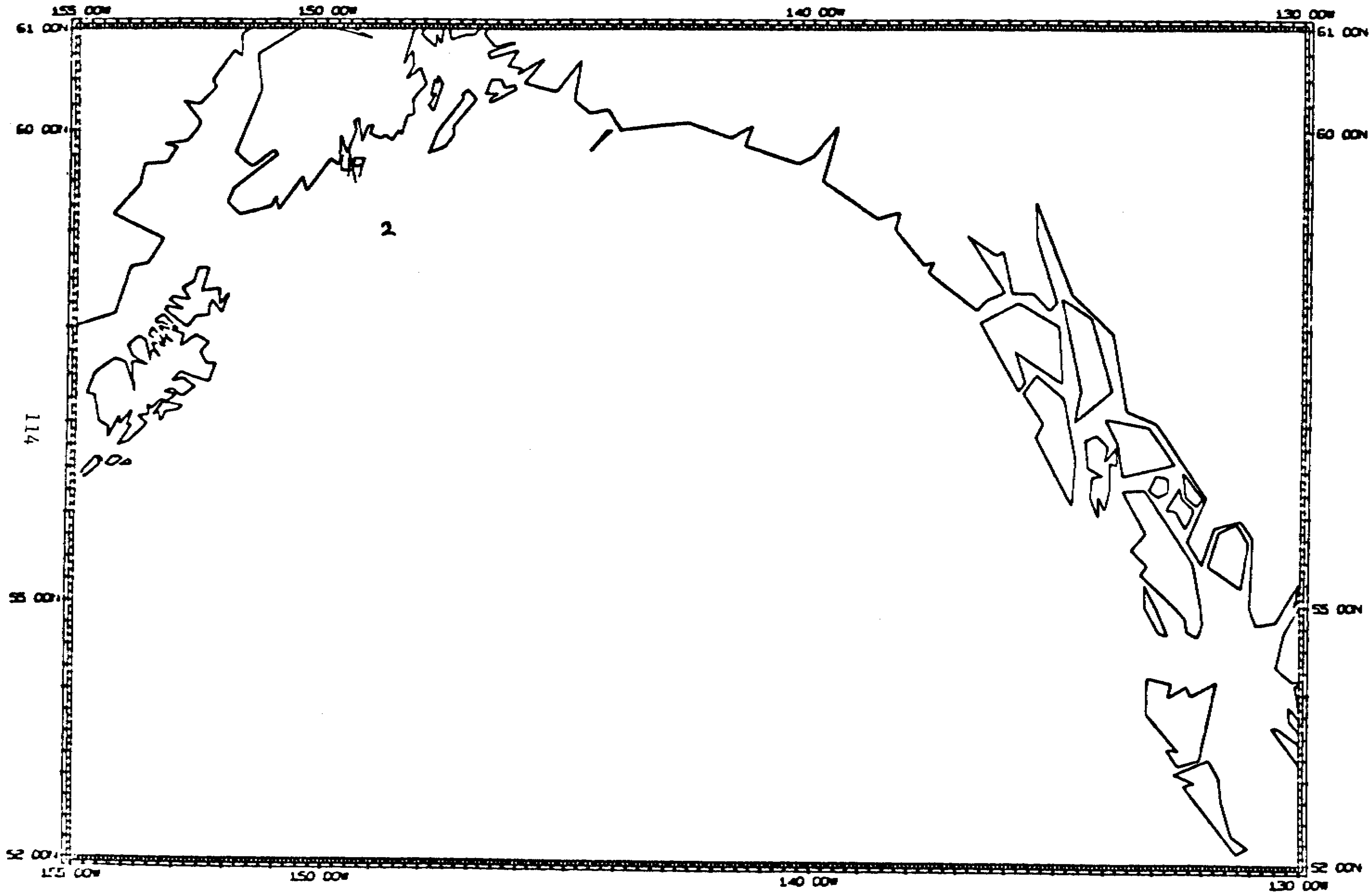

Figure A-32. Northern sea lion, Eumetopias jubatus, sightings reported for December, 1958-1976.

Figure A-33. Northern fur seal, Callorhinus ursinus, sightings reported for January, 1958-1976.

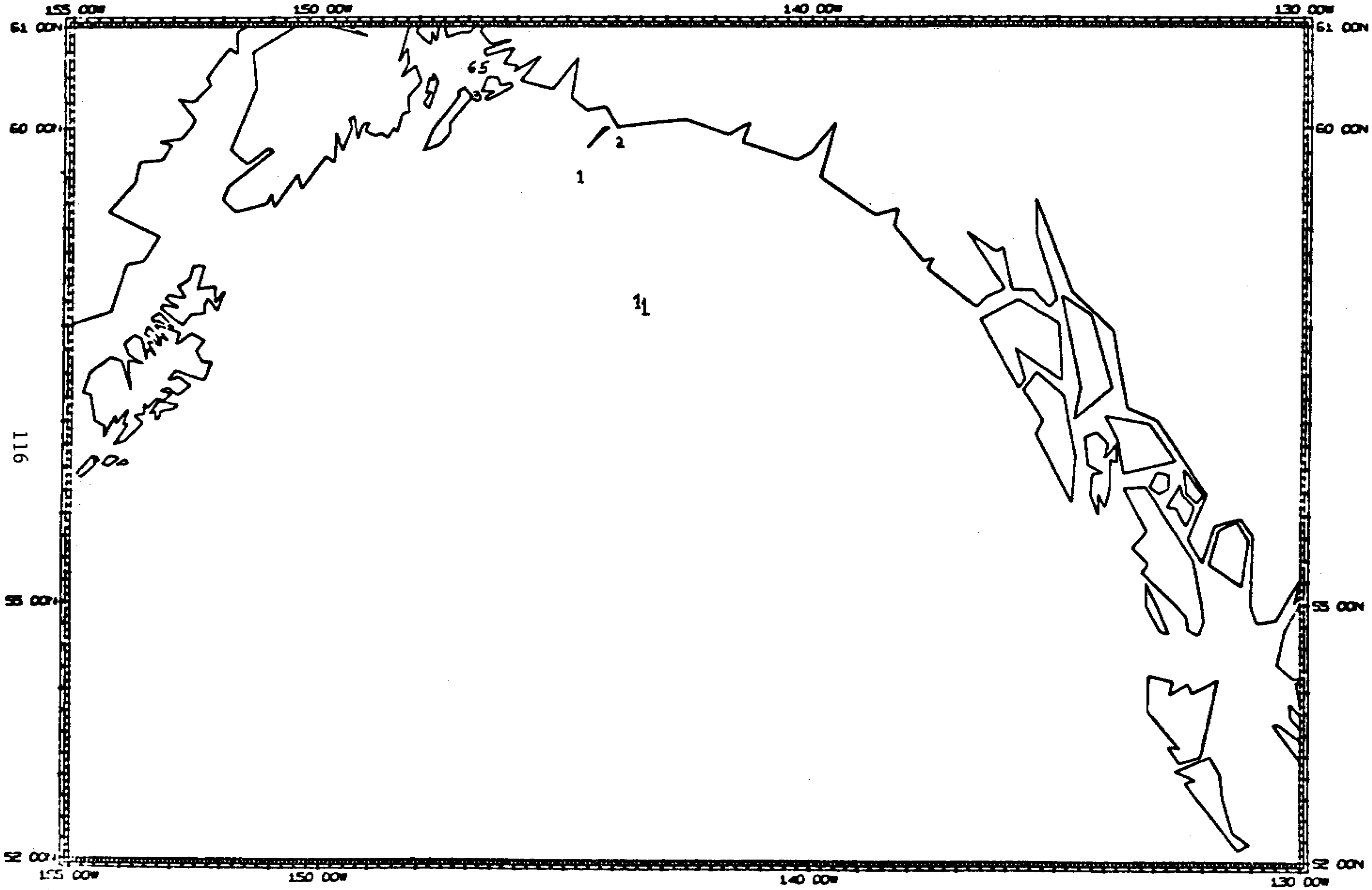

Figure A-34. Northern fur seal, Callorhinus ursinus, sightings reported for February, 1958-1976.

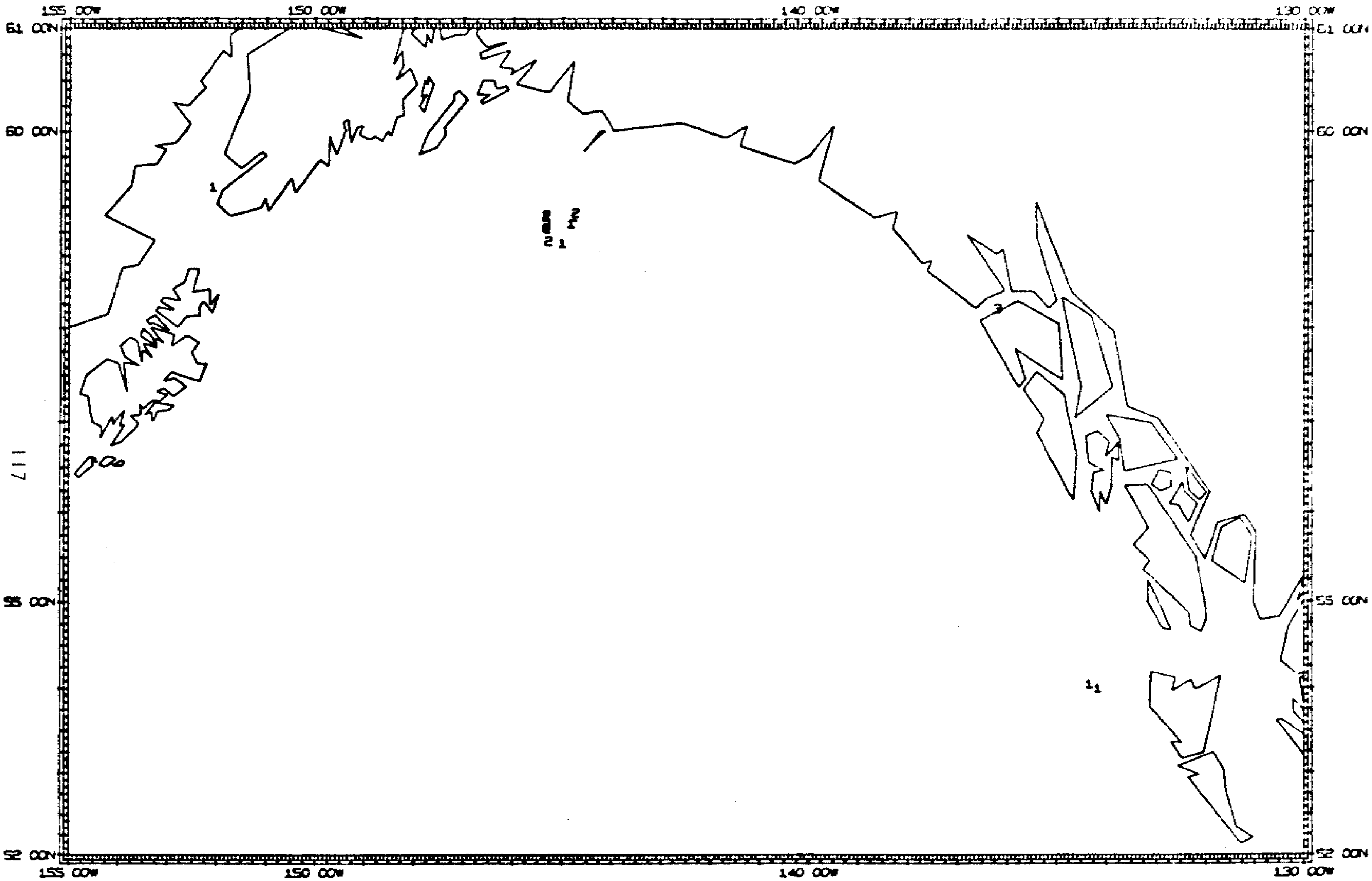

Figure A-35. Northern fur seal, Callorhinus ursinus, sightings reported for April, 1958-1976.

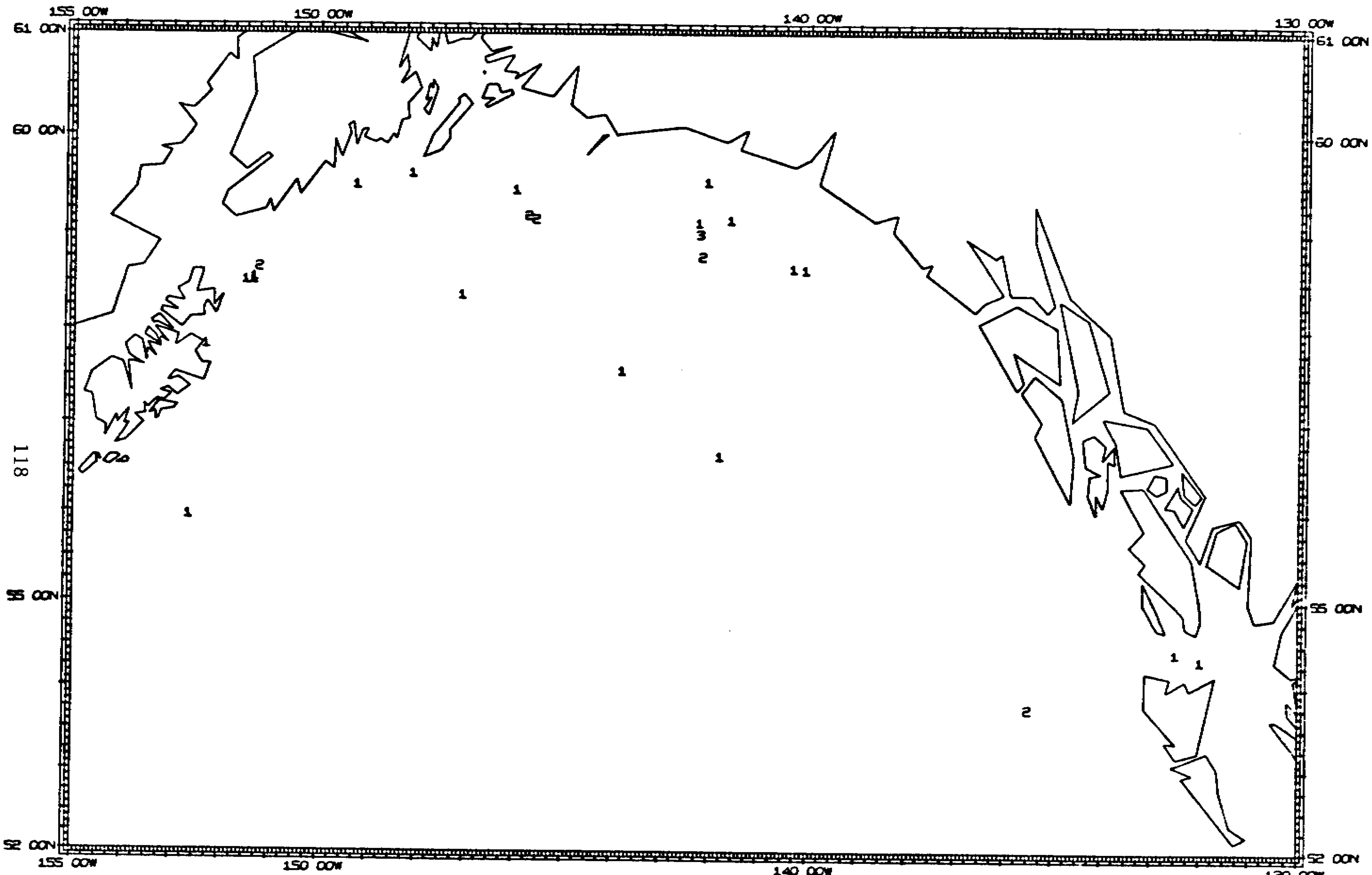

Figure A-36. Northern fur seal, Callorhinus ursinus, sightings reported for May, 1958-1976.

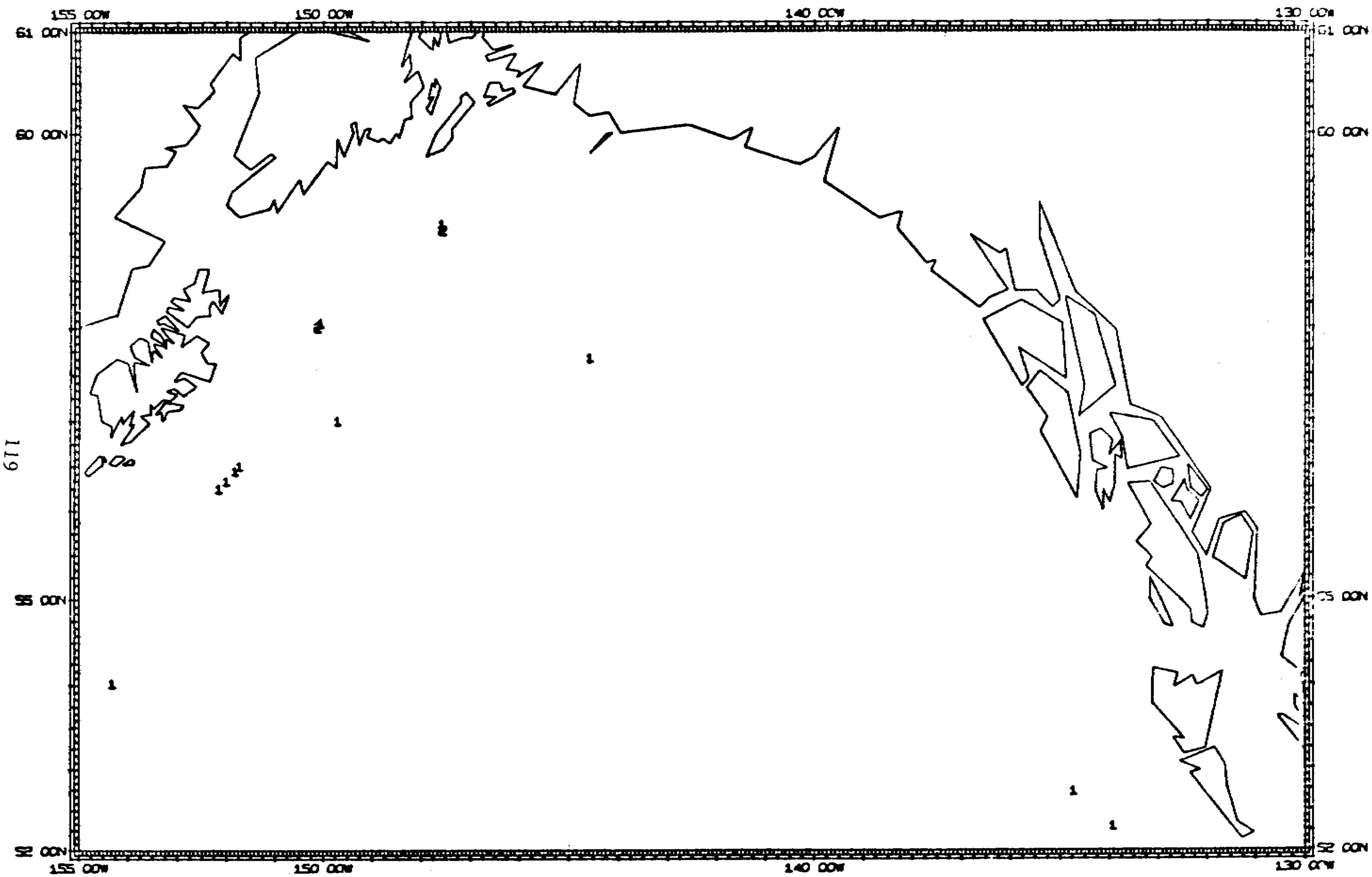

Figure A-37. Northern fur seal, Callorhinus ursinus, sightings reported for June, 1958-1976.

Figure A-38. Northern fur seal, Callorhinus ursinus, sightings reported for July, 1958-1976.

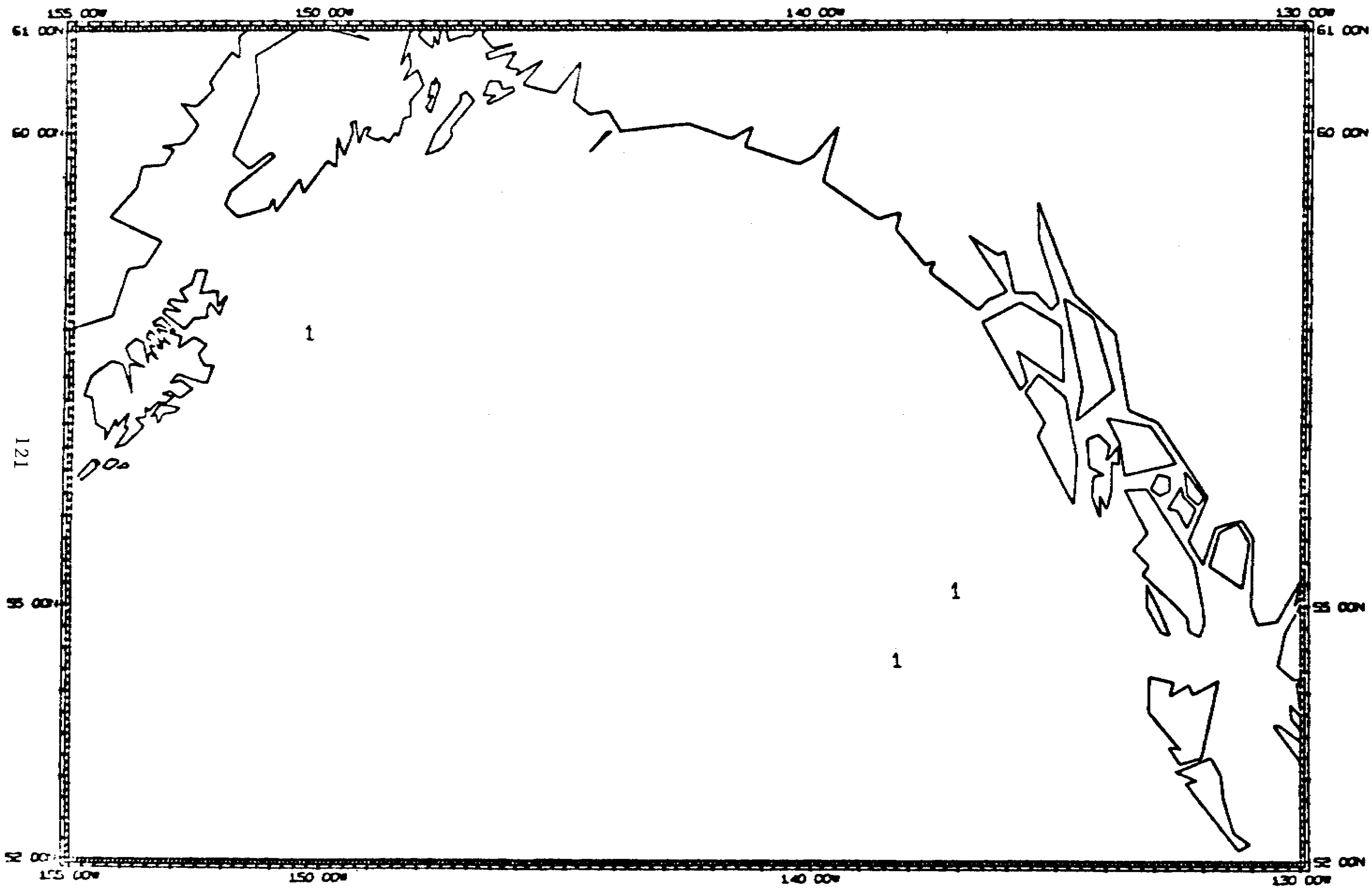

Figure A-39. Northern fur seal, *Callorhinus ursinus*, sightings reported for August, 1958-1976.

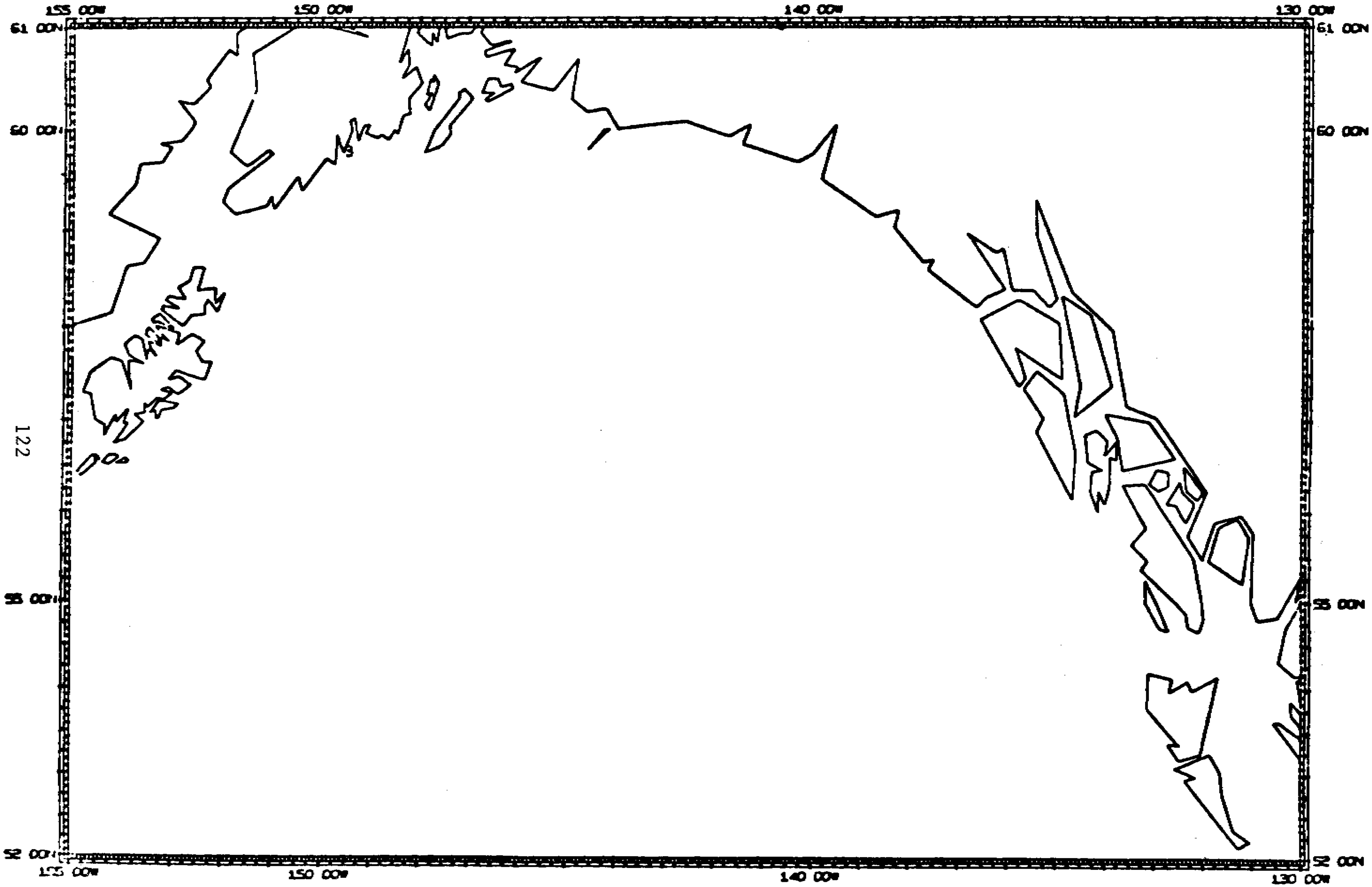

Figure A-40. Northern fur seal, Callorhinus ursinus, sightings reported for October, 1958-1976.

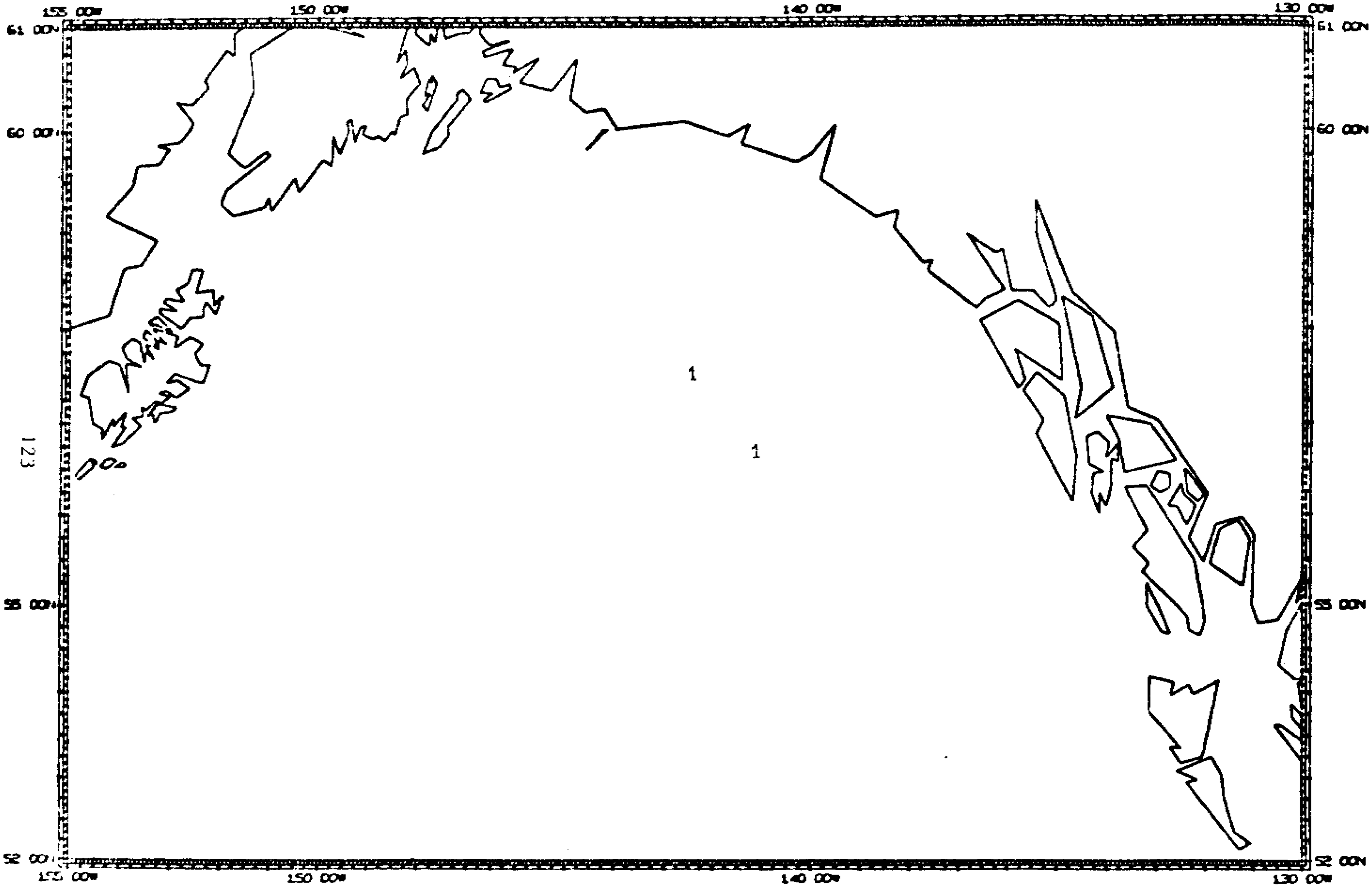

Figure A-41. Northern fur seal, Callorhinus ursinus, sightings reported for December, 1958-1976.

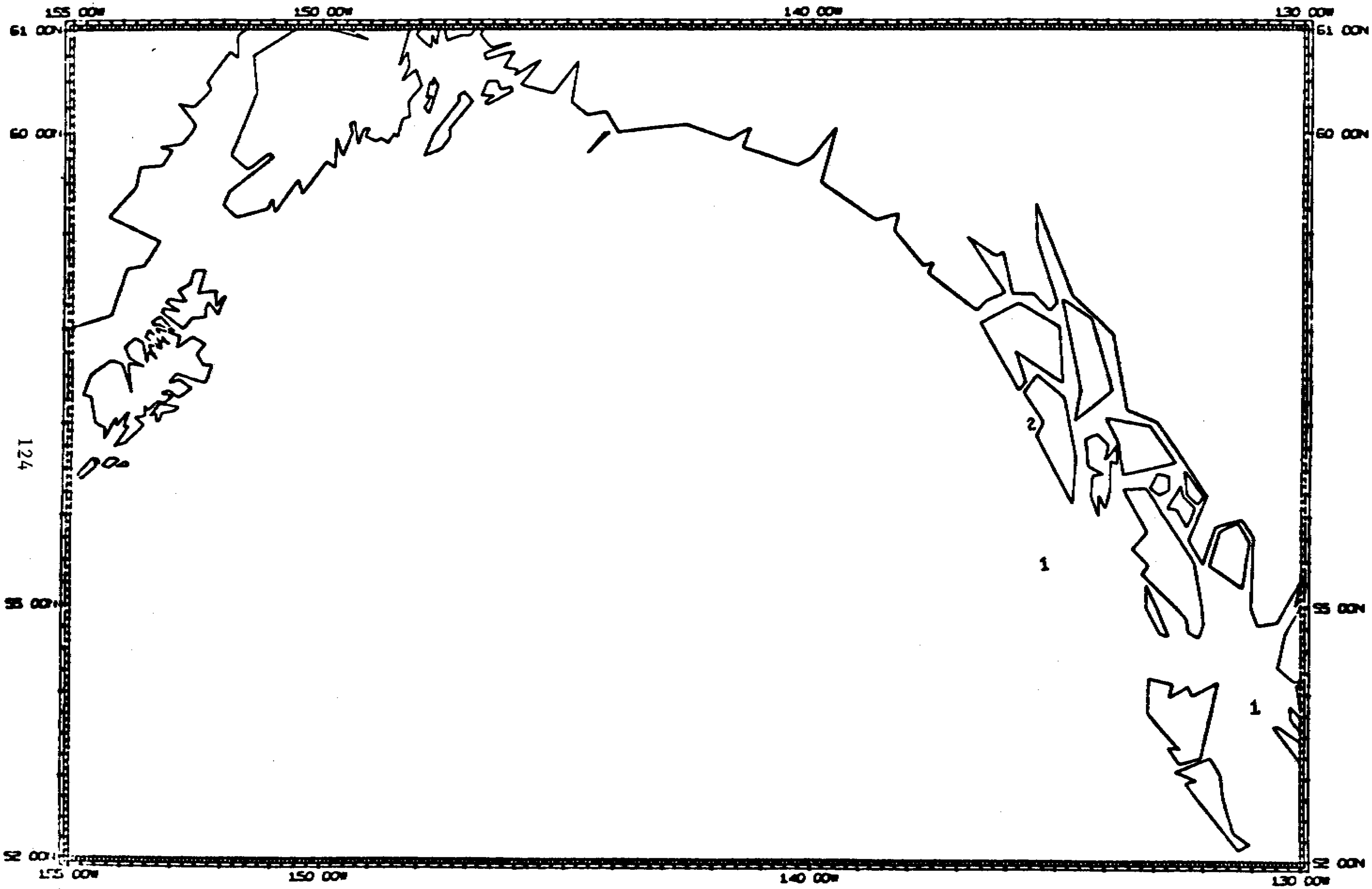

Figure A-42. Harbor seal, Phoca vitulina, sightings reported for February, 1958-1976.

Figure A-43. Harbor seal, *Phoca vitulina*, sightings reported for March, 1958-1976.

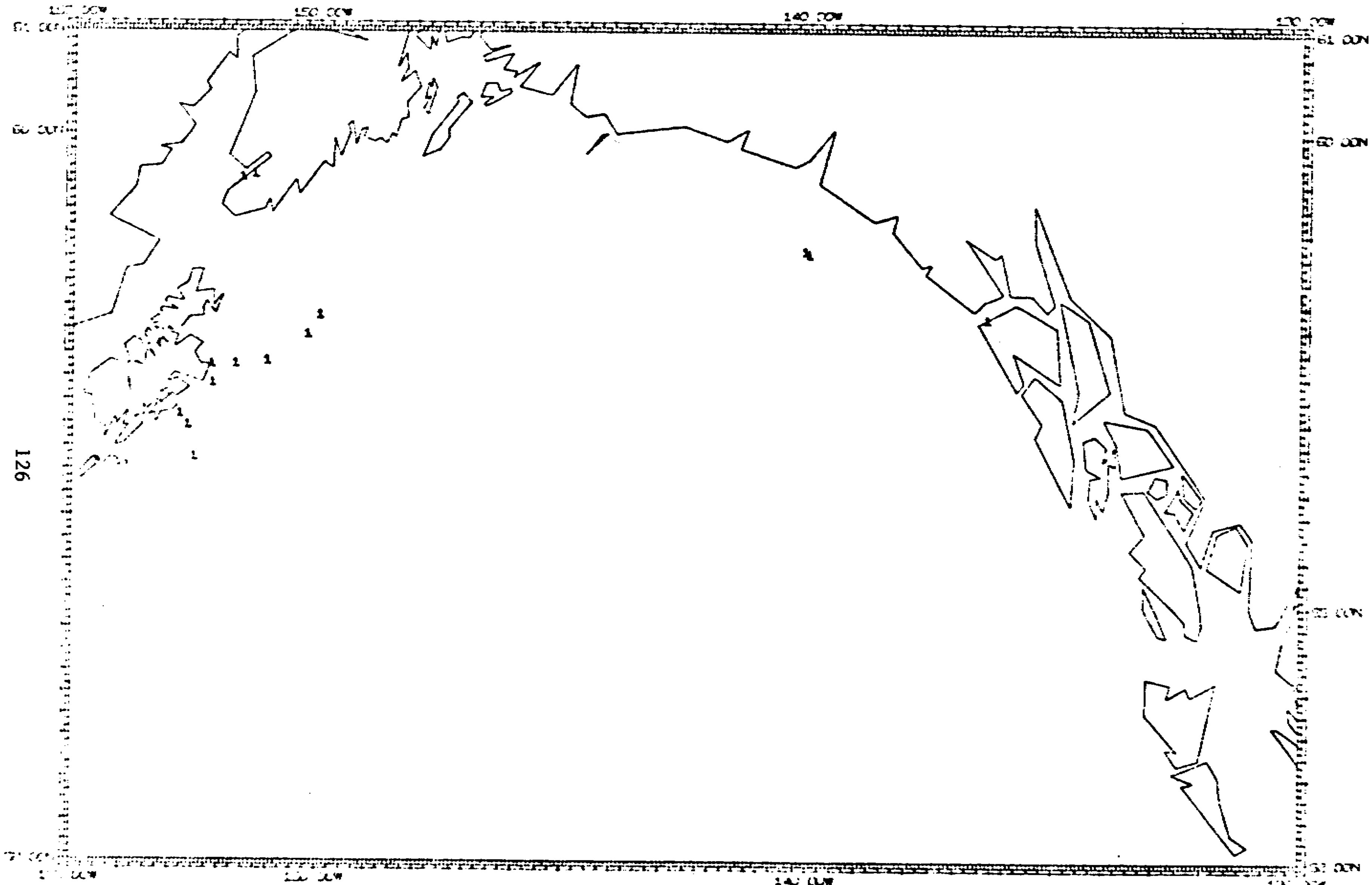

Figure A-44. Harbor seal, Phoca vitulina, sightings reported for April, 1958-1976.

Figure A-45. Harbor seal, *Phoca vitulina*, sightings reported for May, 1958-1976.

Figure A-46. Harbor seal, Phoca vitulina, sightings reported for June, 1958-1976.

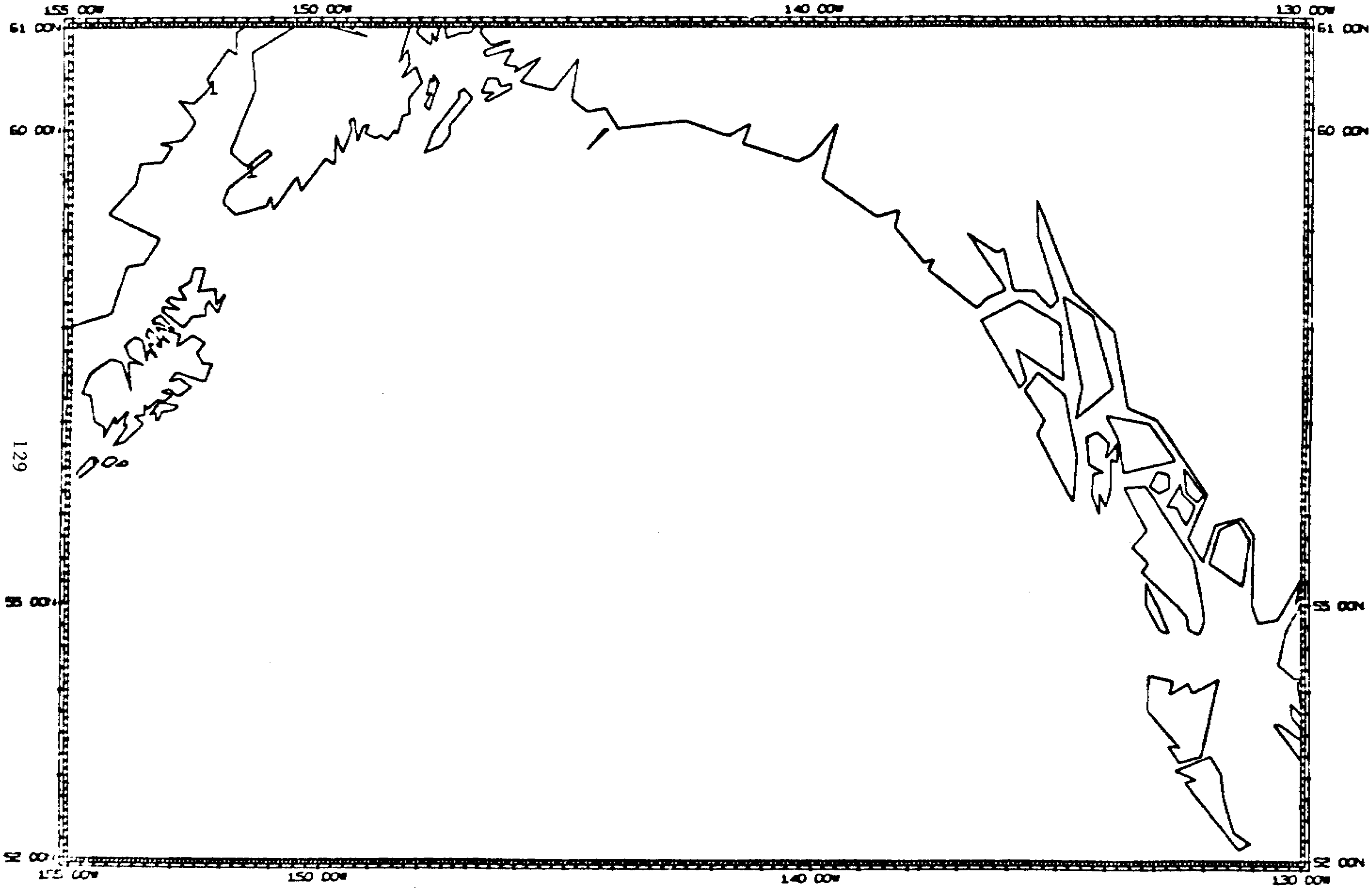

Figure A-47. Harbor seal, Phoca vitulina, sightings reported for August, 1958-1976.

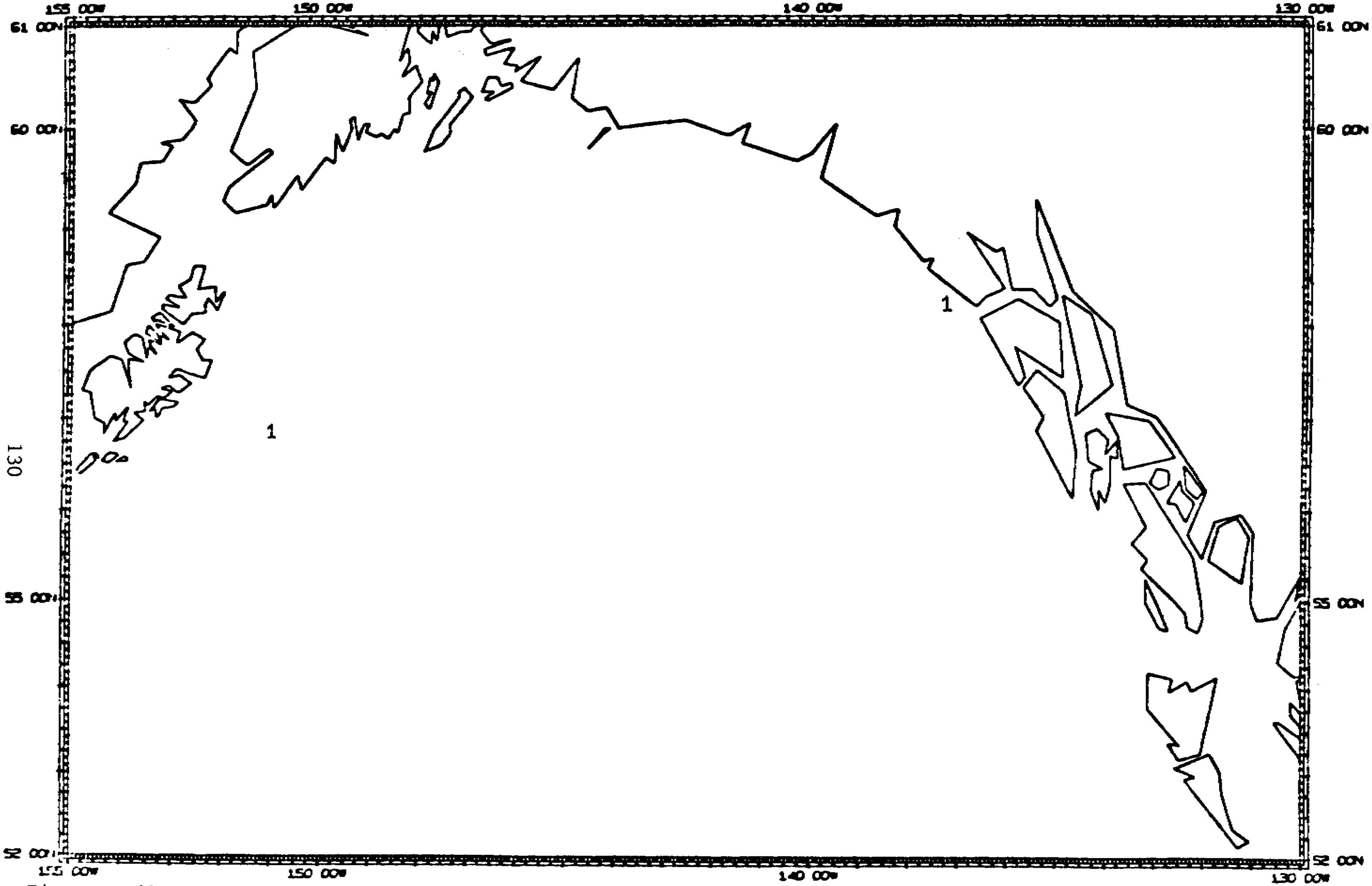

Figure A-48. Harbor seal, Phoca vitulina, sightings reported for September, 1958-1976.

Figure A-49. Harbor seal, *Phoca vitulina*, sightings reported for October, 1958-1976.

Figure A-50. Northern elephant seal, Mirounga angustirostris, sightings reported for May, 1958-1976.

Figure A-51. Gray whale, Eschrichtius robustus, sightings reported for April, 1958-1976.

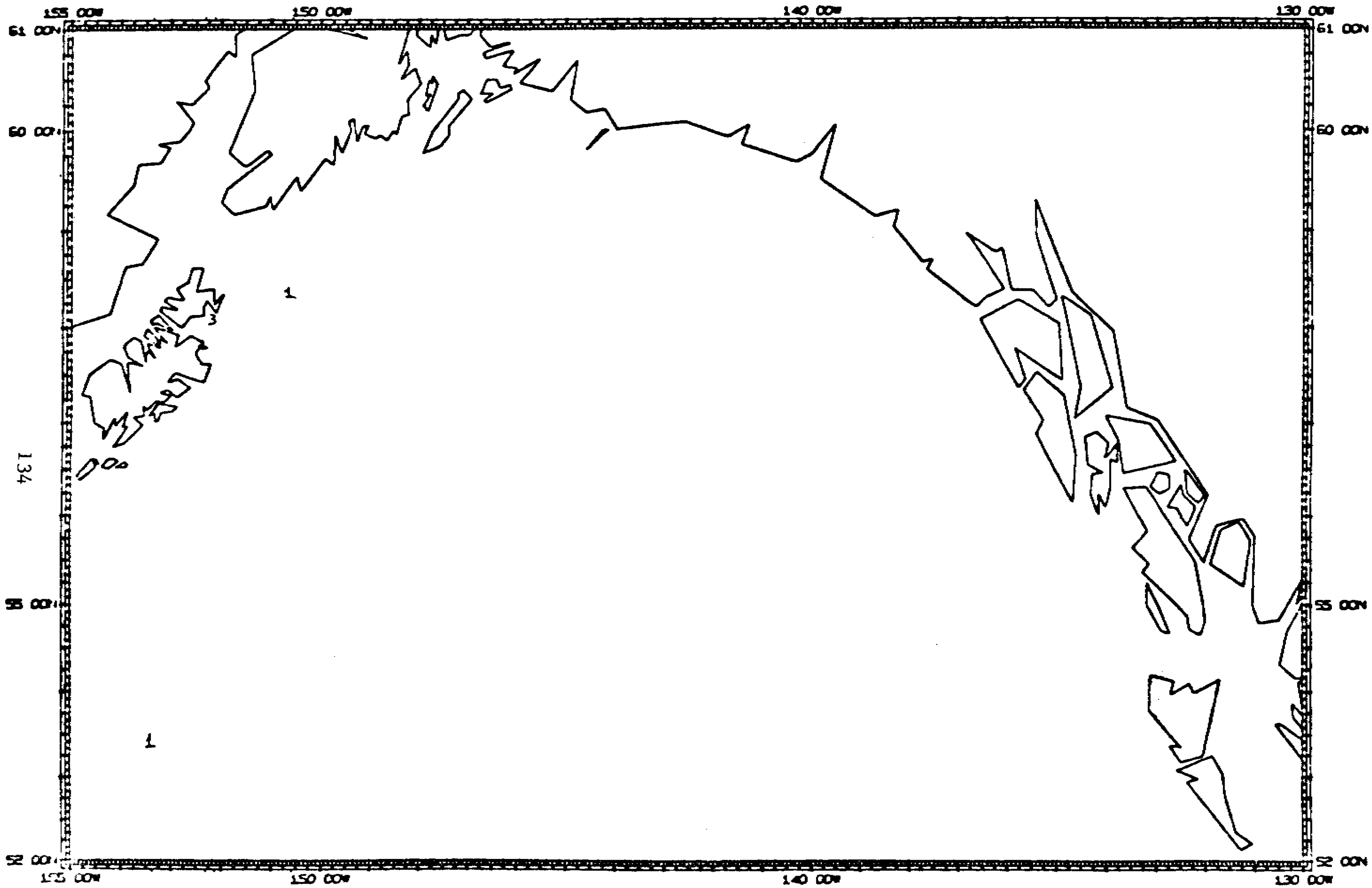

Figure A-52. Gray whale, *Eschrichtius robustus*, sightings reported for May, 1958-1976.

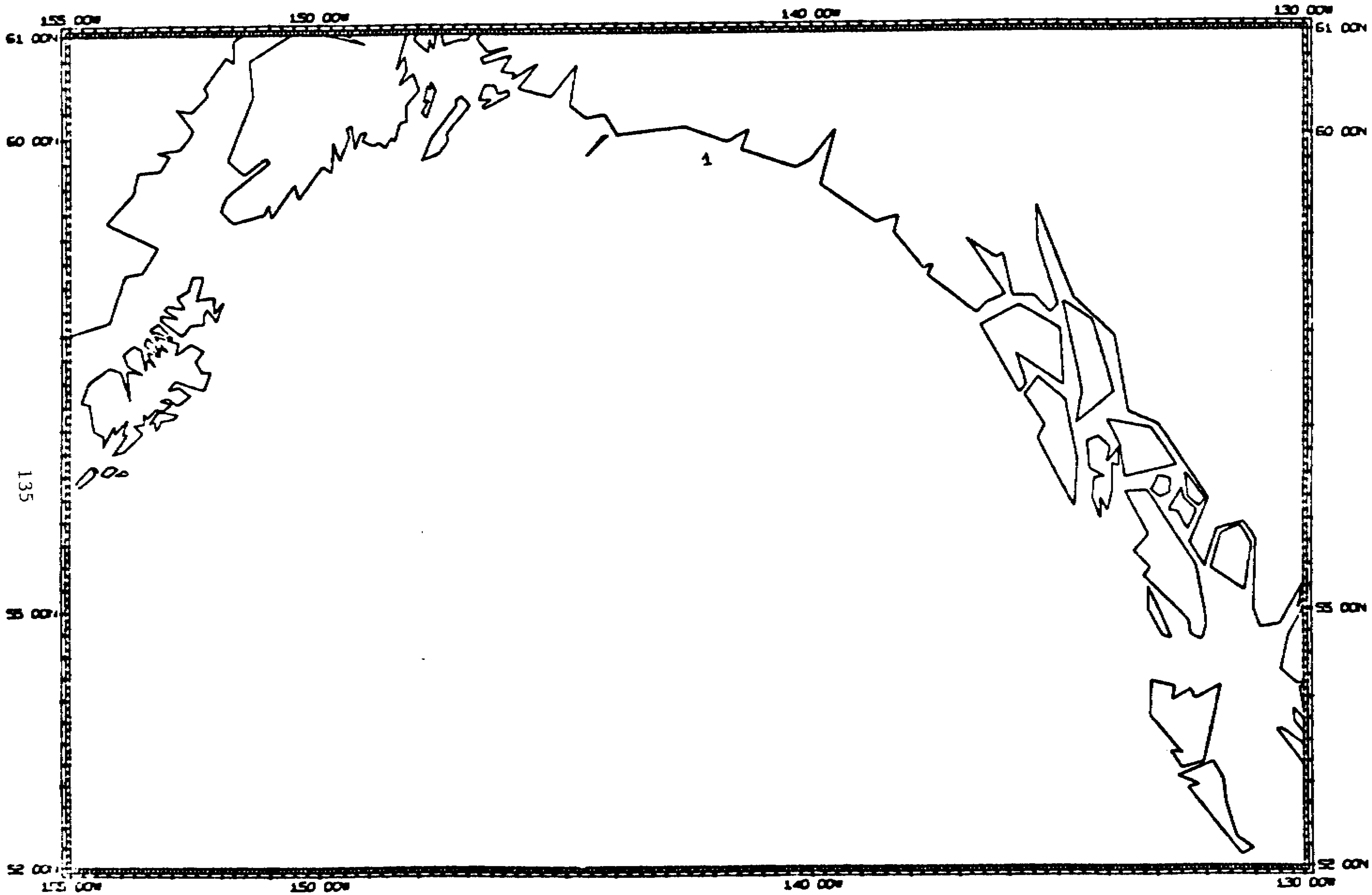

Figure A-53. Minke whale, Balaenoptera acutorostrata, sightings reported for February, 1958-1976.

Figure A-54. Minke whale, Balaenoptera acutorostrata, sightings reported for March, 1958-1976.

Figure A-55. Minke whale, Balaenoptera acutorostrata, sightings reported for April, 1958-1976.

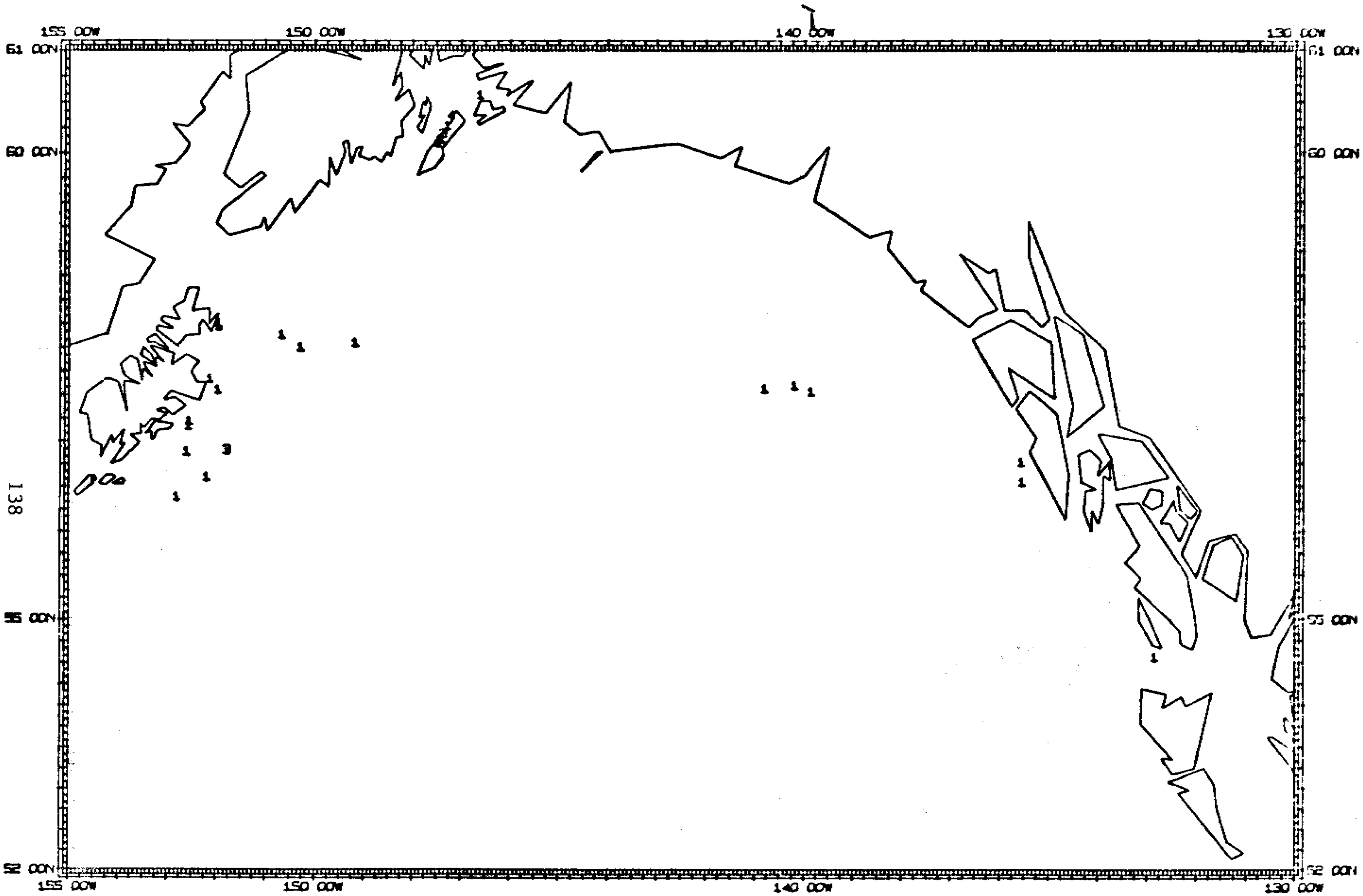

Figure A-56. Minke whale, Balaenoptera acutorostrata, sightings reported for May, 1958-1976.

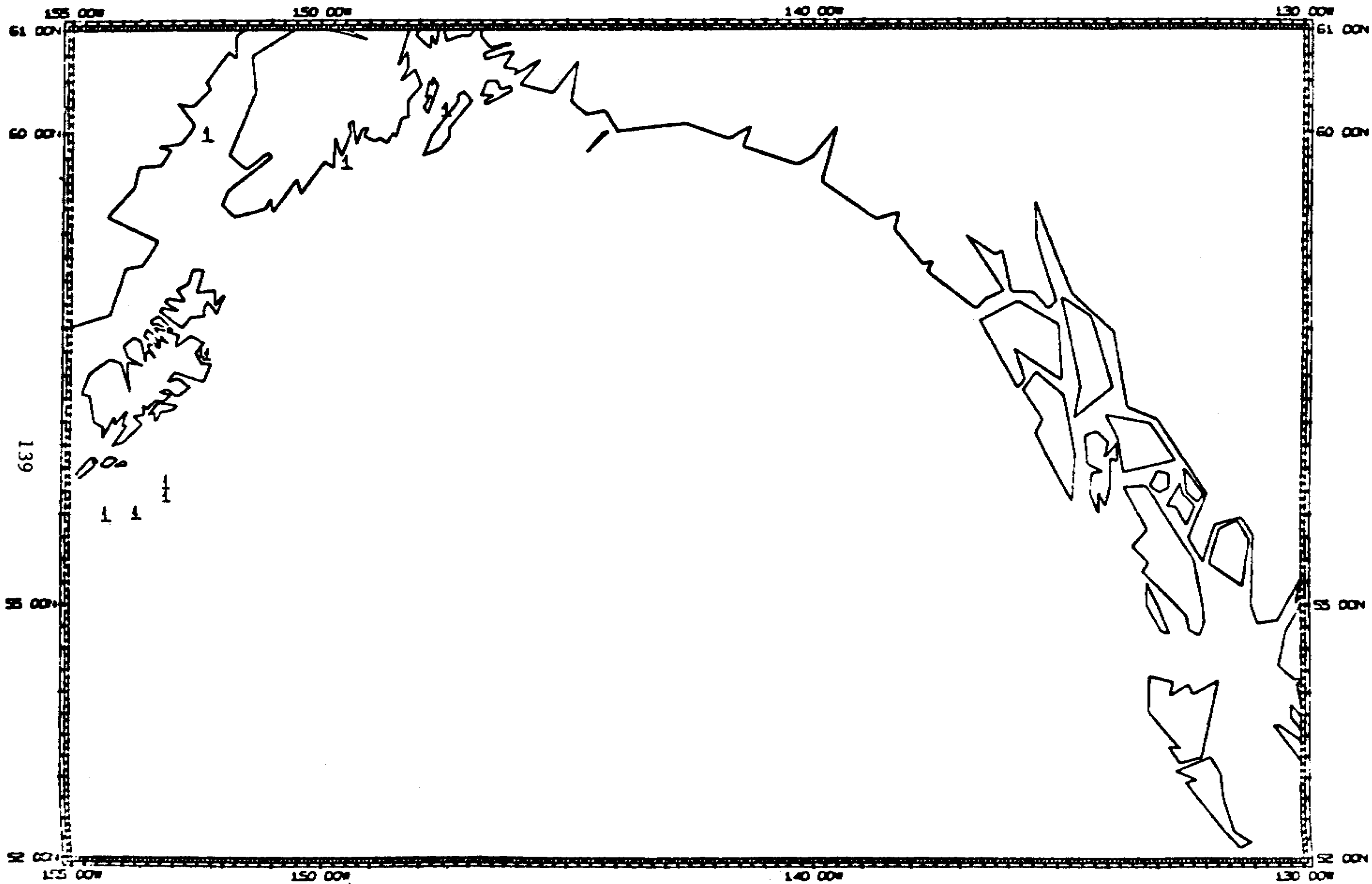

Figure A-57. Minke whale, Balaenoptera acutorostrata, sightings reported for June, 1958-1976.

Figure A-58. Minke whale, Balaenoptera acutorostrata, sightings reported for July, 1958-1976.

Figure A-59. Minke whale, *Balaenoptera acutorostrata*, sightings reported for August, 1958-1976.

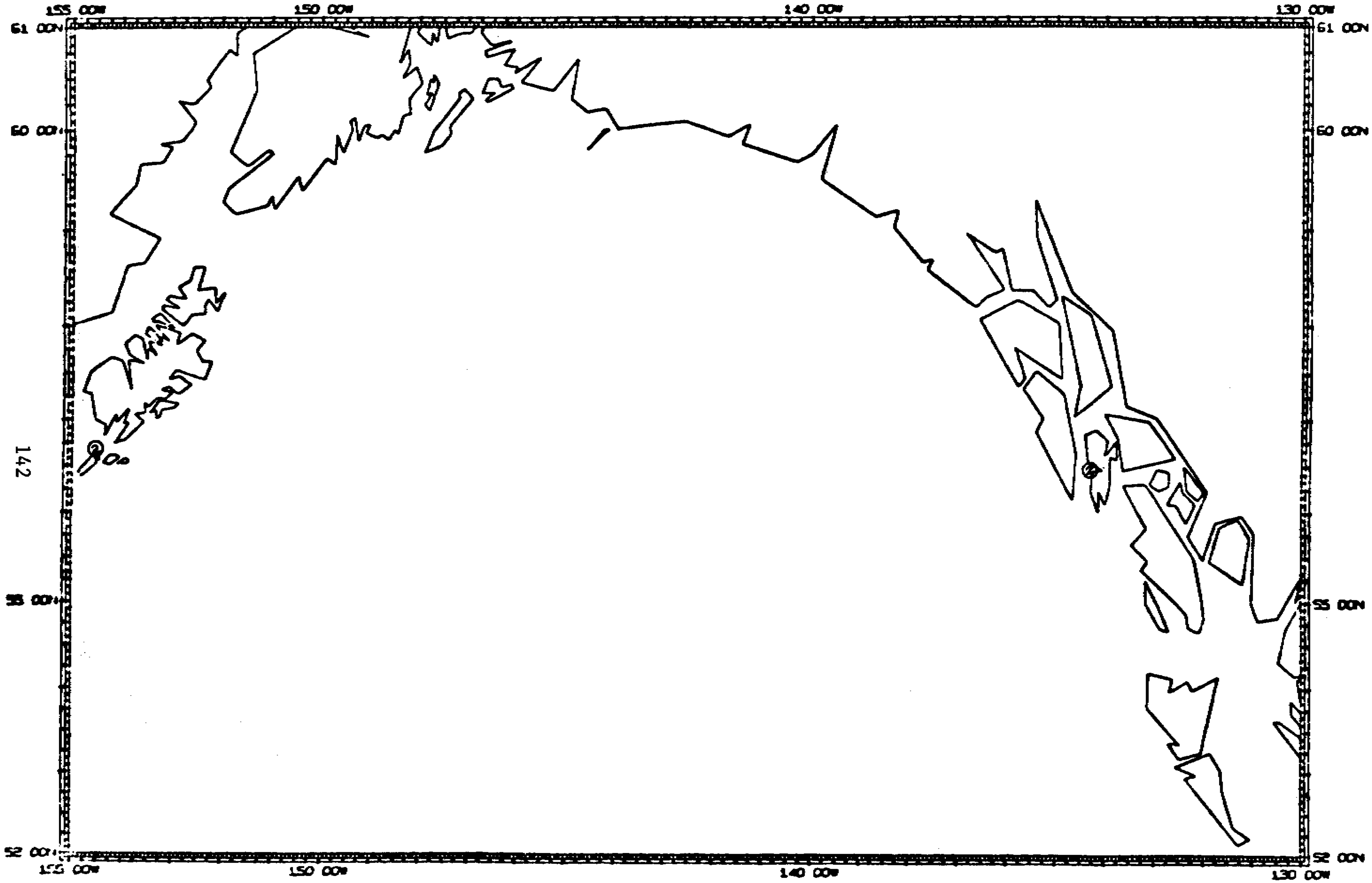

Figure A-60. Minke whale, Balaenoptera acutorostrata, sightings reported for September, 1958-1976.

Figure A-61. Minke whale, Balaenoptera acutorostrata, sightings reported for November, 1958-1976.

Figure A-62. Sei whale, *Balaenoptera borealis*, sightings reported for April, 1958-1976.

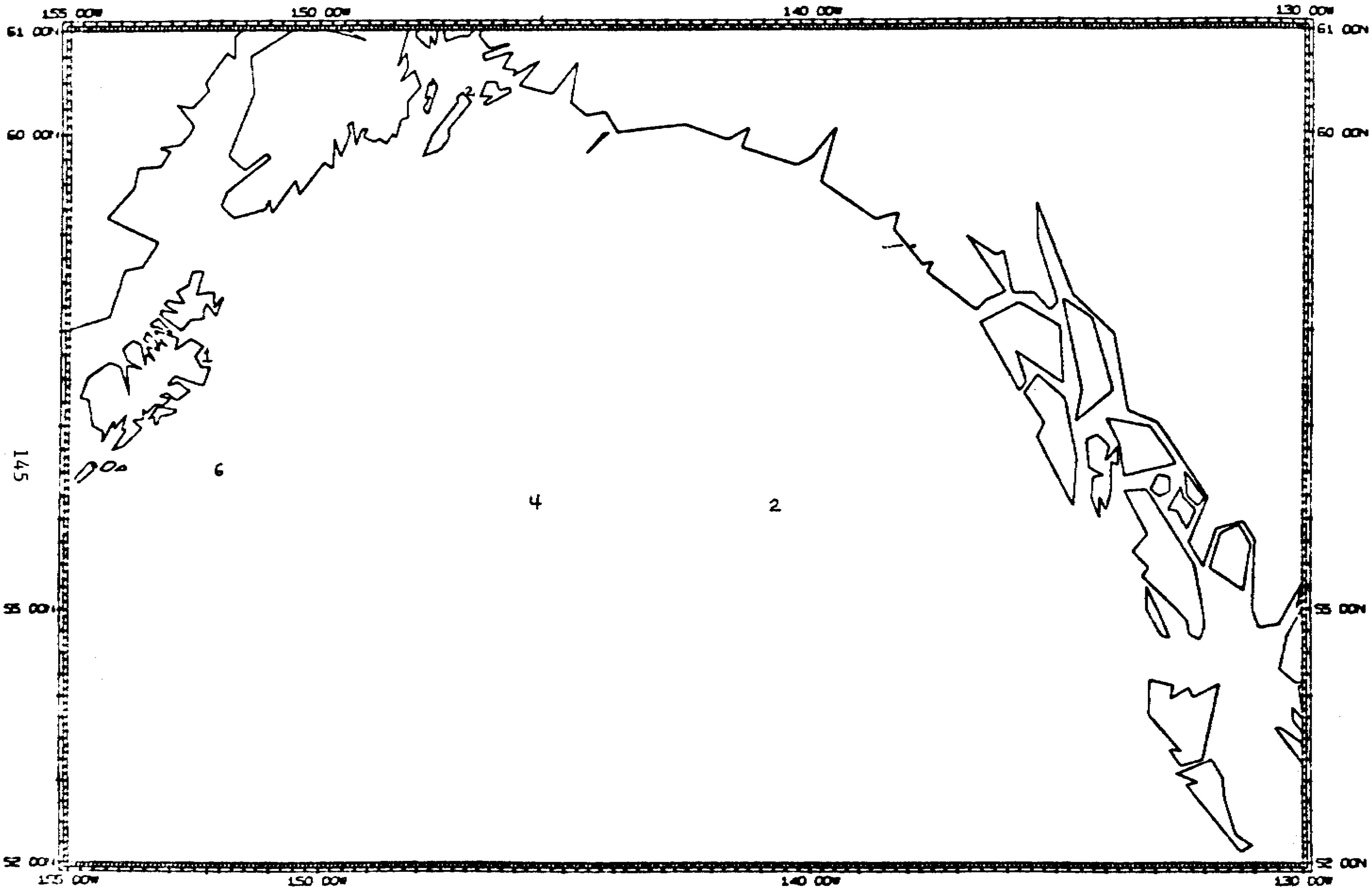

Figure A-63. Sei whale, Balaenoptera borealis, sightings reported for May, 1958-1976.

Figure A-64. Sei whale, Balaenoptera borealis, sightings reported for June, 1958-1976.

Figure A-65. Fin whale, Balaenoptera physalus, sightings reported for March, 1958-1976.

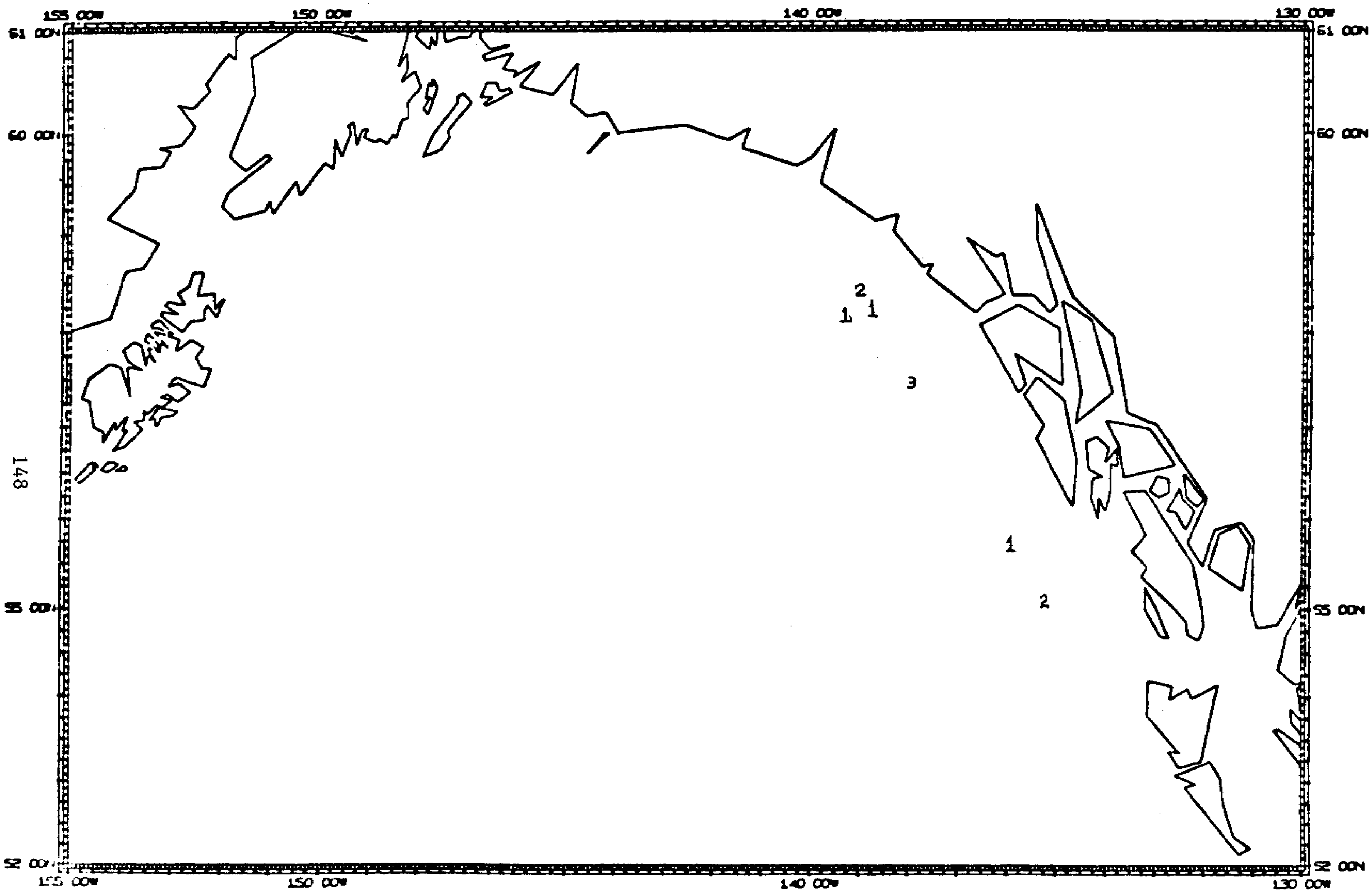

Figure A-66. Fin whale, <u>Balaenoptera</u> <u>physalus</u>, sightings reported for April, 1958-1976.

Figure A-67. Fin whale, Balaenoptera physalus, sightings reported for May, 1958-1976.

Figure A-68. Fin whale, Balaenoptera physalus, sightings reported for June, 1958-1976.

Figure A-69. Fin whale, Balaenoptera physalus, sightings reported for July, 1958-1976.

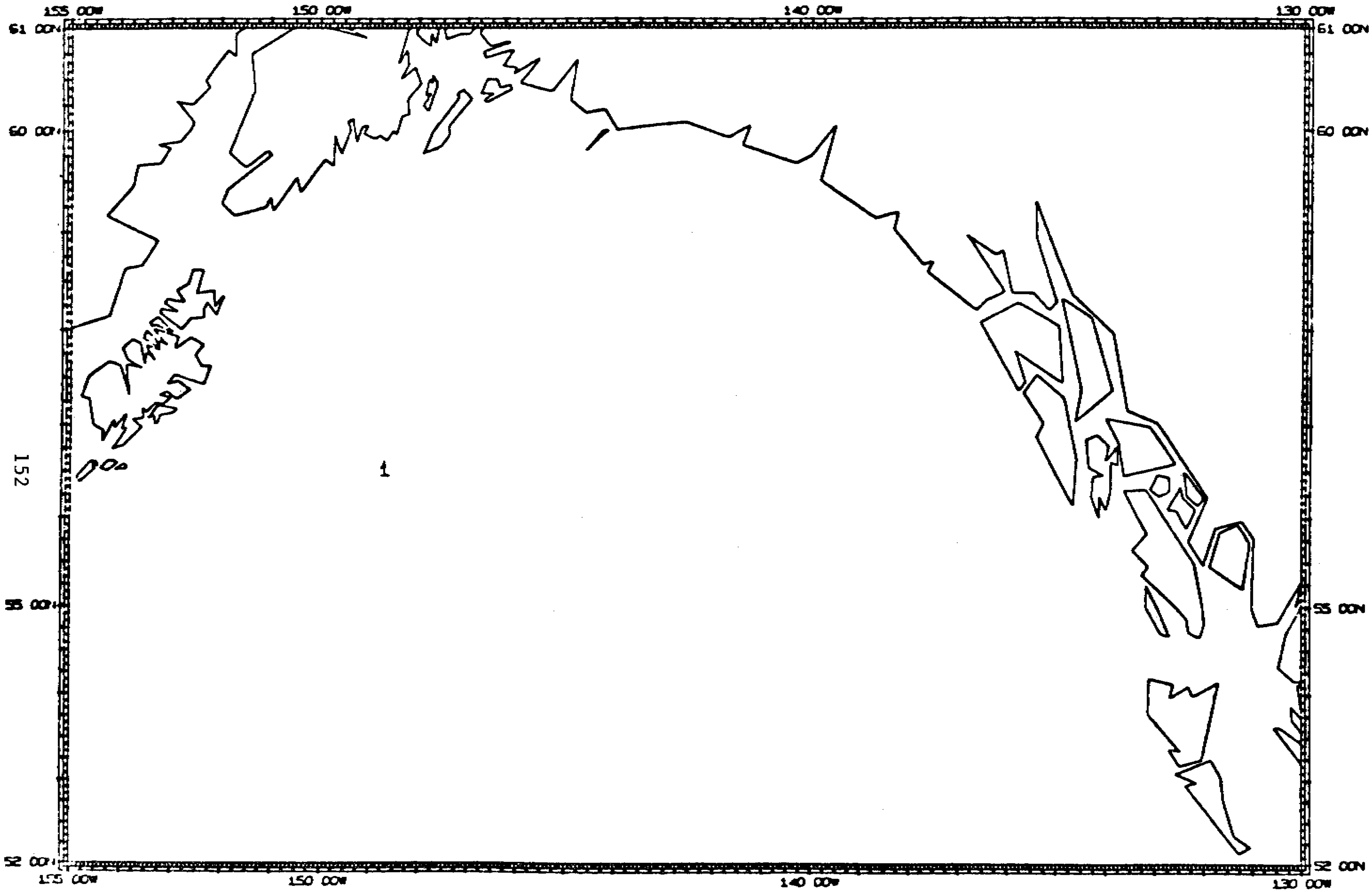

Figure A-70. Fin whale, Balaenoptera physalus, sightings reported for October, 1958-1976.

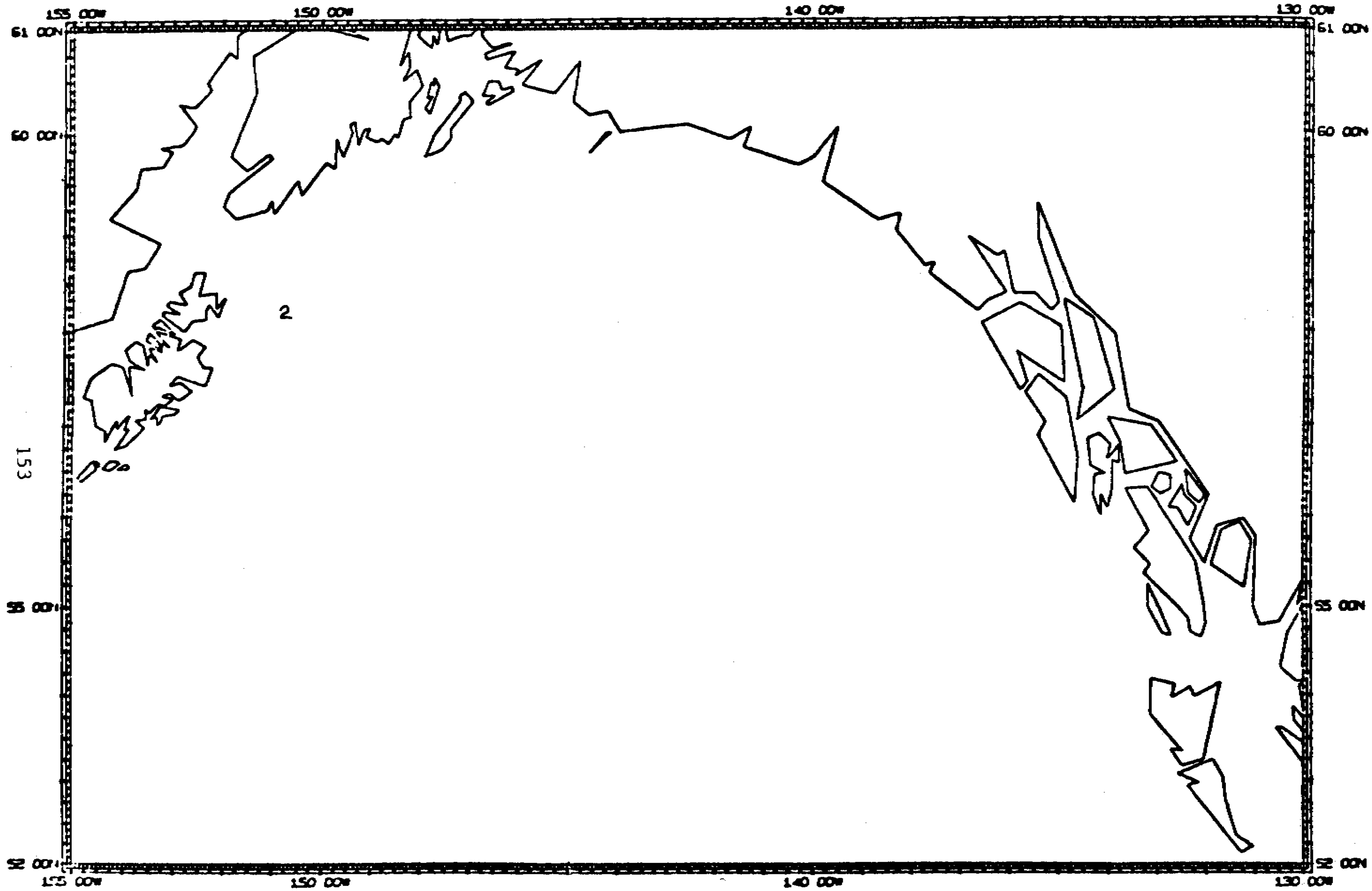

Figure A-71. Blue whale, Balaenoptera musculus, sightings reported for May, 1958-1976.

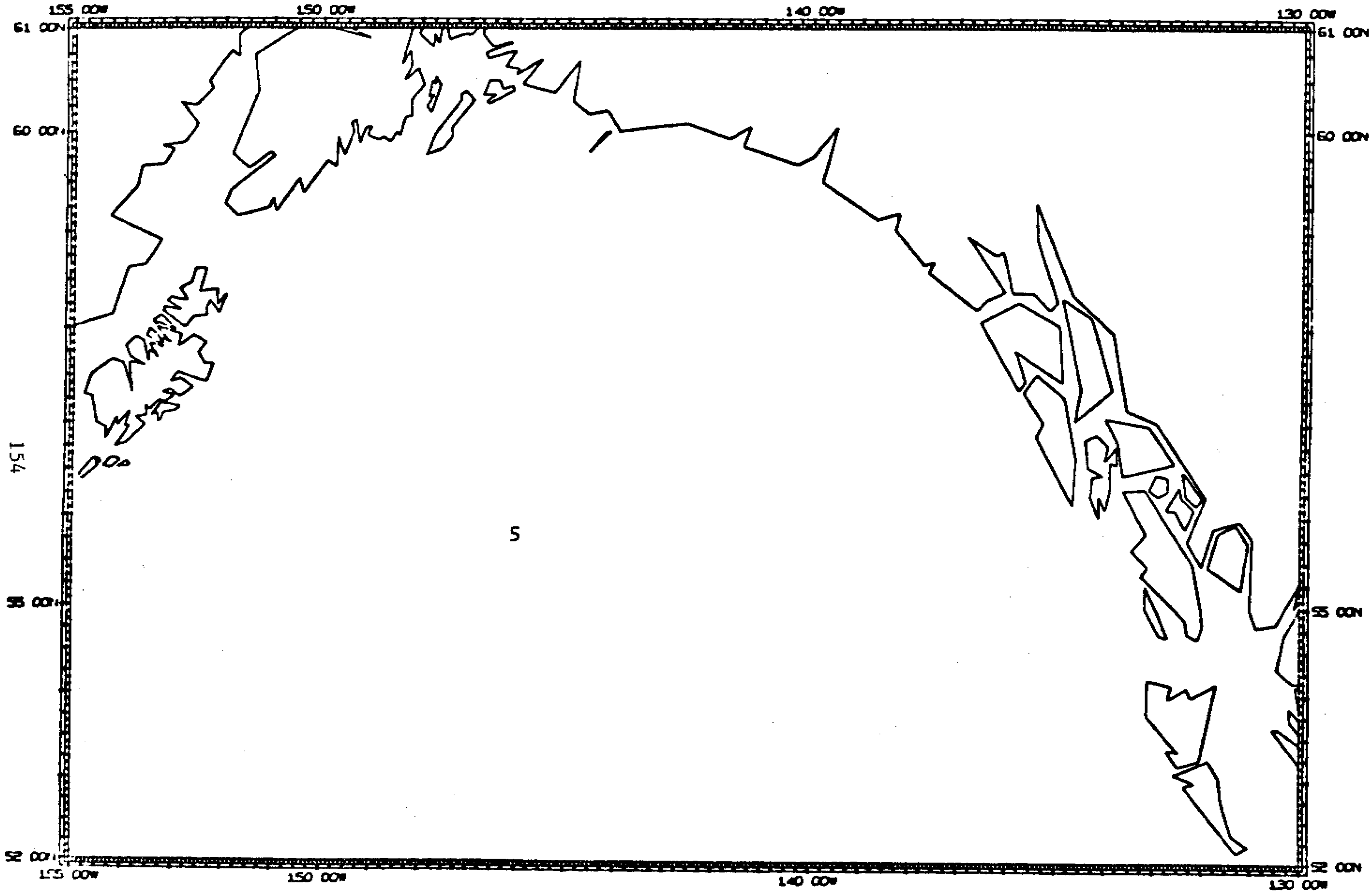

Figure A-72. Blue whale, Balaenoptera musculus, sightings reported for June, 1958-1976.

Figure A-73. Humpback whale, Megaptera novaengliae, sightings reported for March, 1958-1976.

Figure A-74. Humpback whale, Megaptera novaengliae, sightings reported for April, 1958-1976.

Figure A-75. Humpback whale, *Megaptera novaengliae*, sightings reported for May, 1958-1976.

Figure A-76. Humpback whale, Megaptera novaengliae, sightings reported for June, 1958-1976.

Figure A-77. Humpback whale, Megaptera novaengliae, sightings reported for July, 1958-1976.

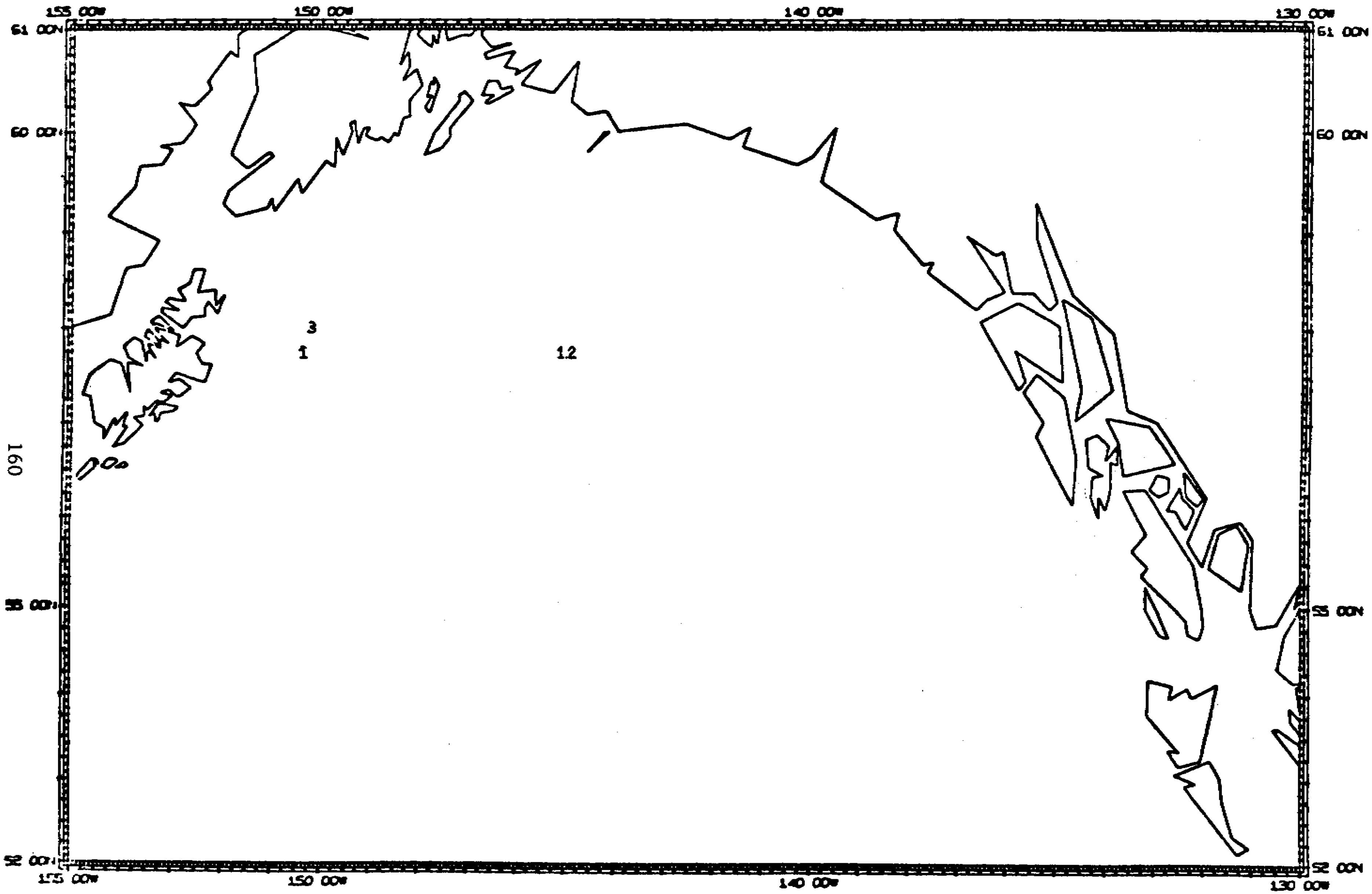

Figure A-78. Humpback whale, Megaptera novaengliae, sightings reported for August, 1958-1976.

Figure A-79. Humpback whale, Megaptera novaengliae, sightings reported for October, 1958-1976.

Figure A-80. North Pacific Whiteside Dolphin, Lagenorhynchus obliquidens, sightings reported for February, 1958-1976.

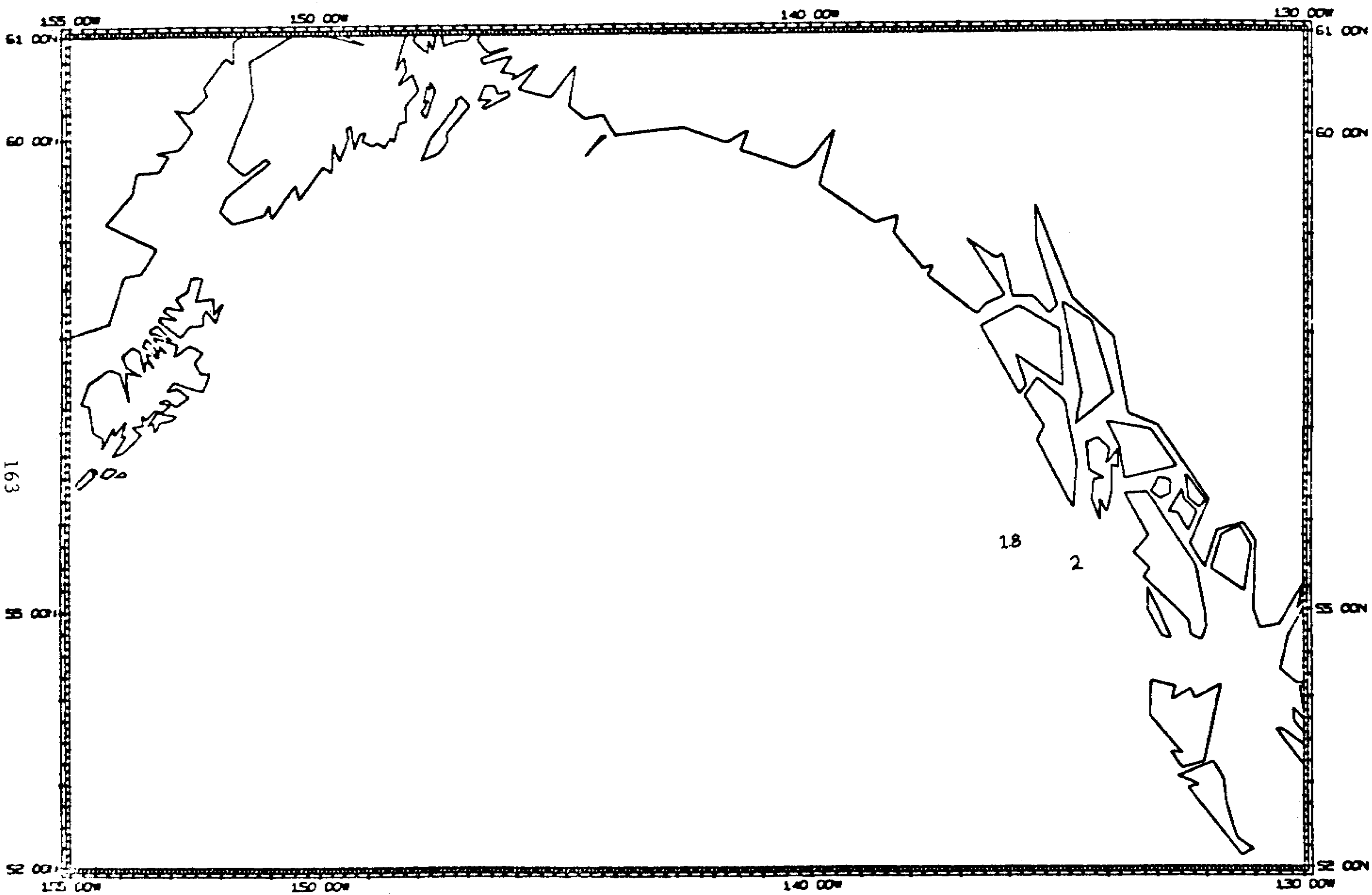

Figure A-81. North Pacific Whiteside Dolphin, Lagenorhynchus obliquidens, sightings reported for April, 1958-1976.

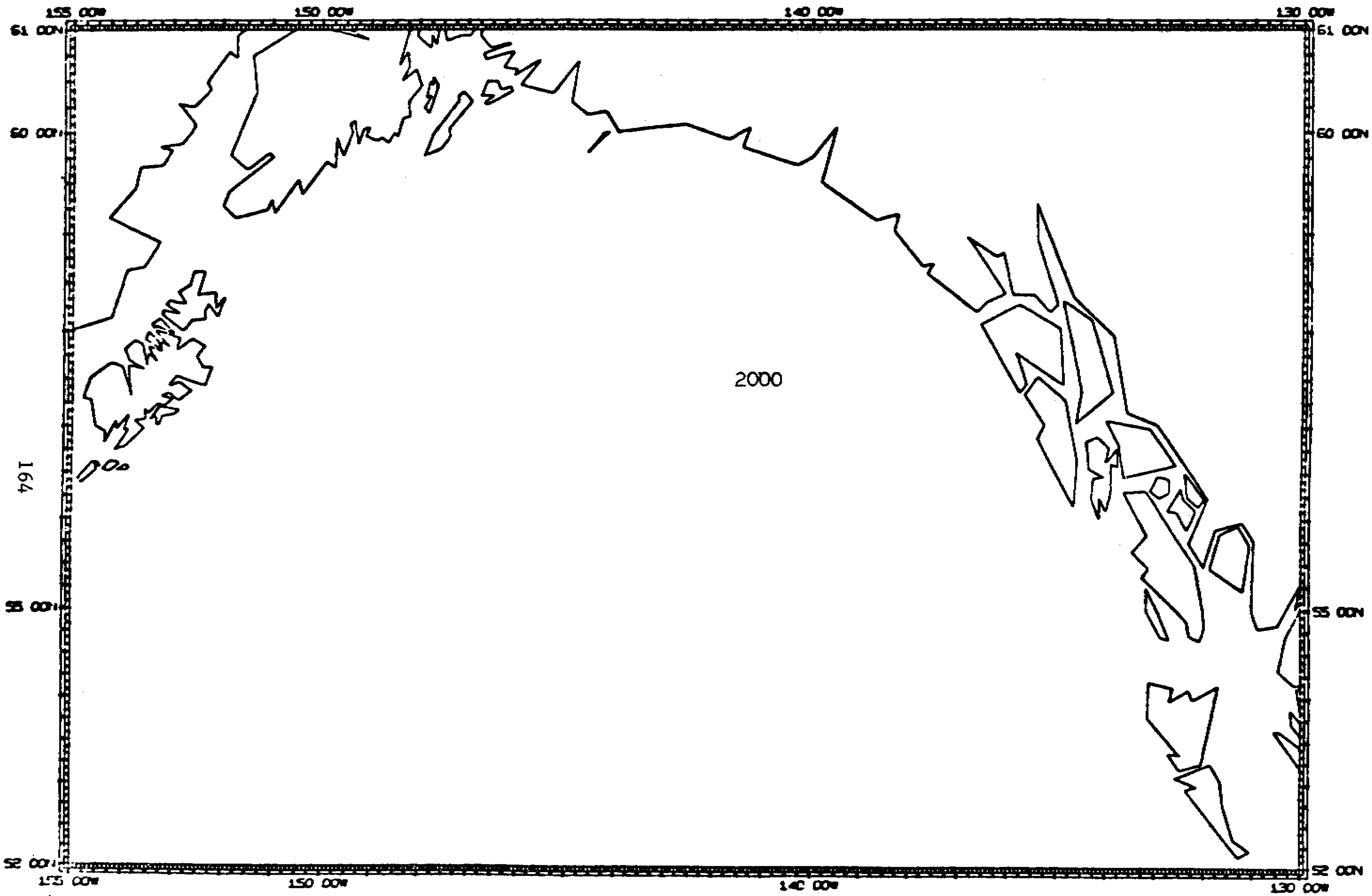

Figure A-82. North Pacific Whiteside Dolphin, Lagenorhynchus obliquidens, sightings reported for May, 1958-1976.

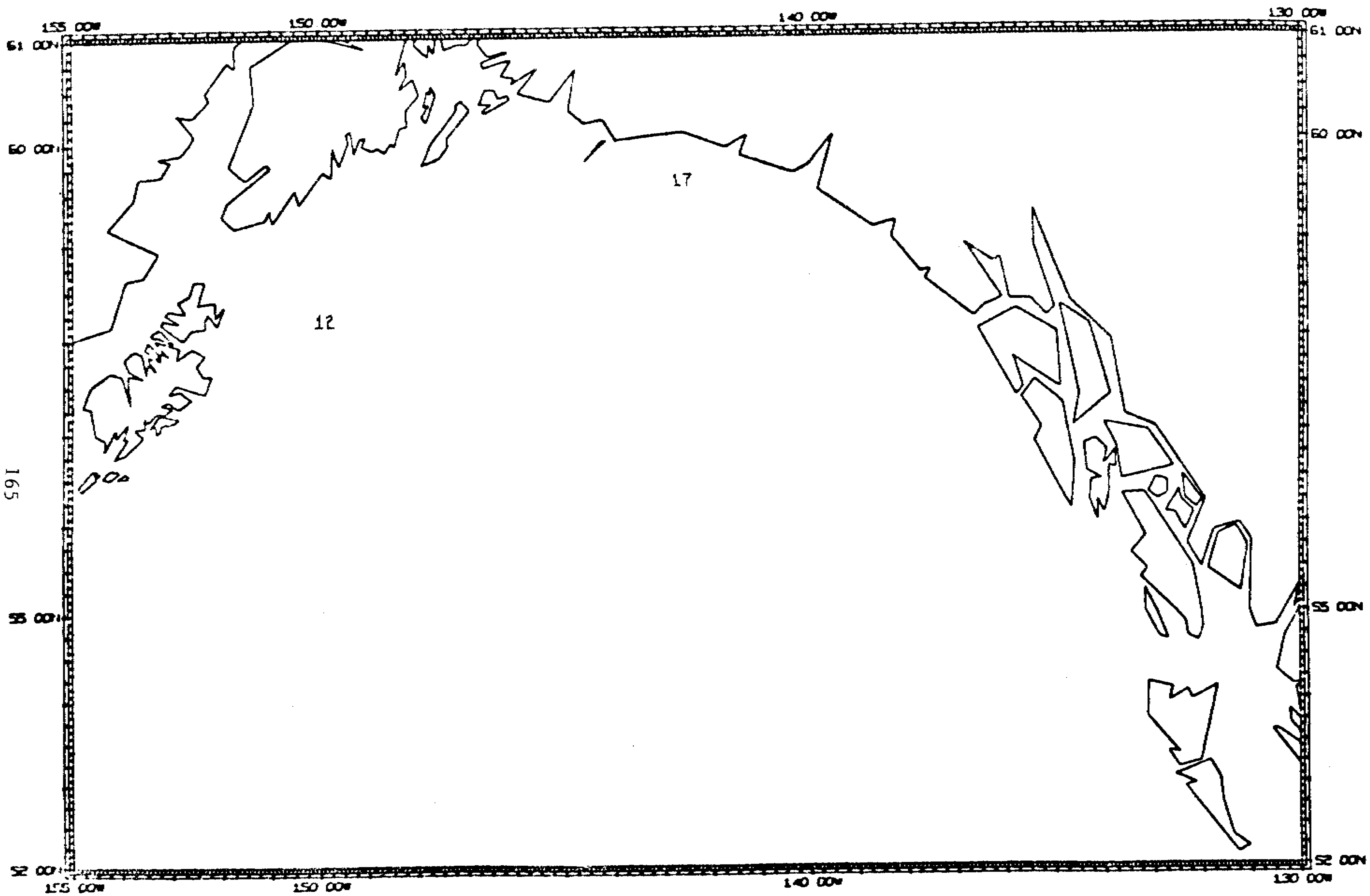

Figure A-83. North Pacific Whiteside Dolphin, Lagenorhynchus obliquidens, sightings reported for November, 1958-1976.

Figure A-84. Killer whale, Orcinus orca, sightings reported for January, 1958-1976.

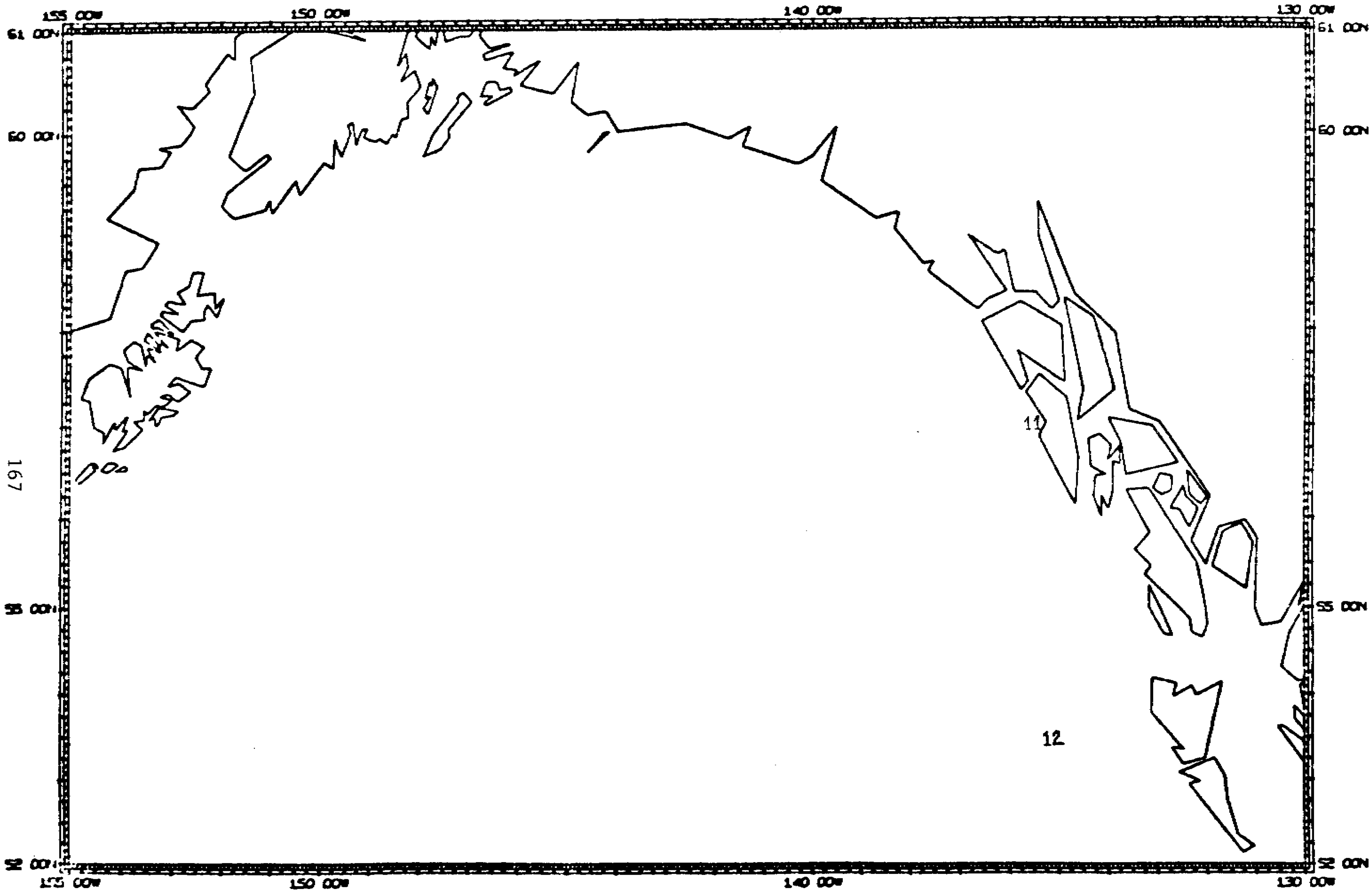

Figure A-85. Killer whale, Orcinus orca, sightings reported for March, 1958-1976.

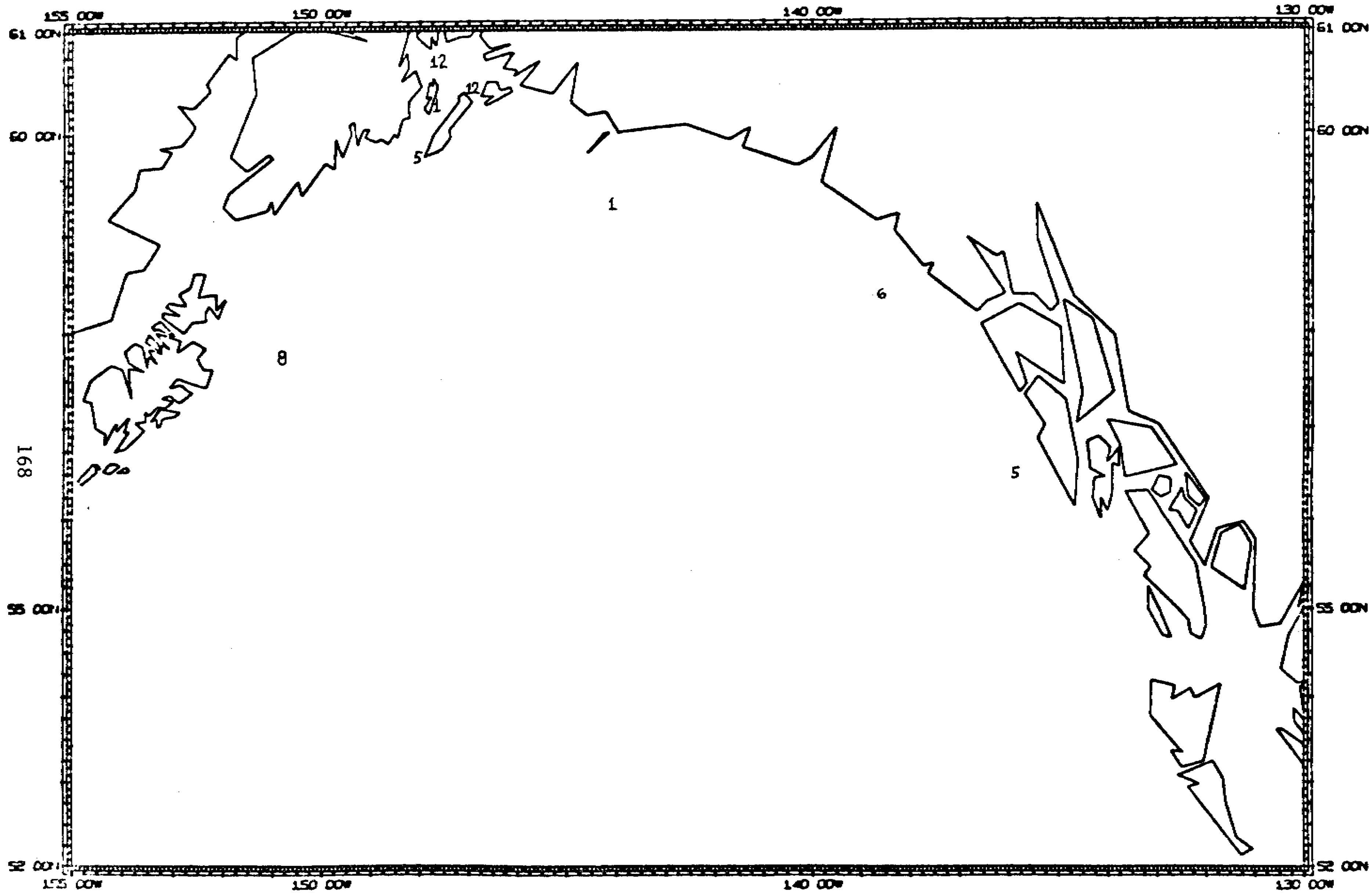

Figure A-86. Killer whale Orcinus orca, sightings reported for April, 1958-1976.

Figure A-87. Killer whale, Orcinus orca, sightings reported for May, 1958-1976.

Figure A-88. Killer whale, Orcinus orca, sightings reported for June, 1958-1976.

Figure A-89. Killer whale, Orcinus orca, sightings reported for August, 1958-1976.

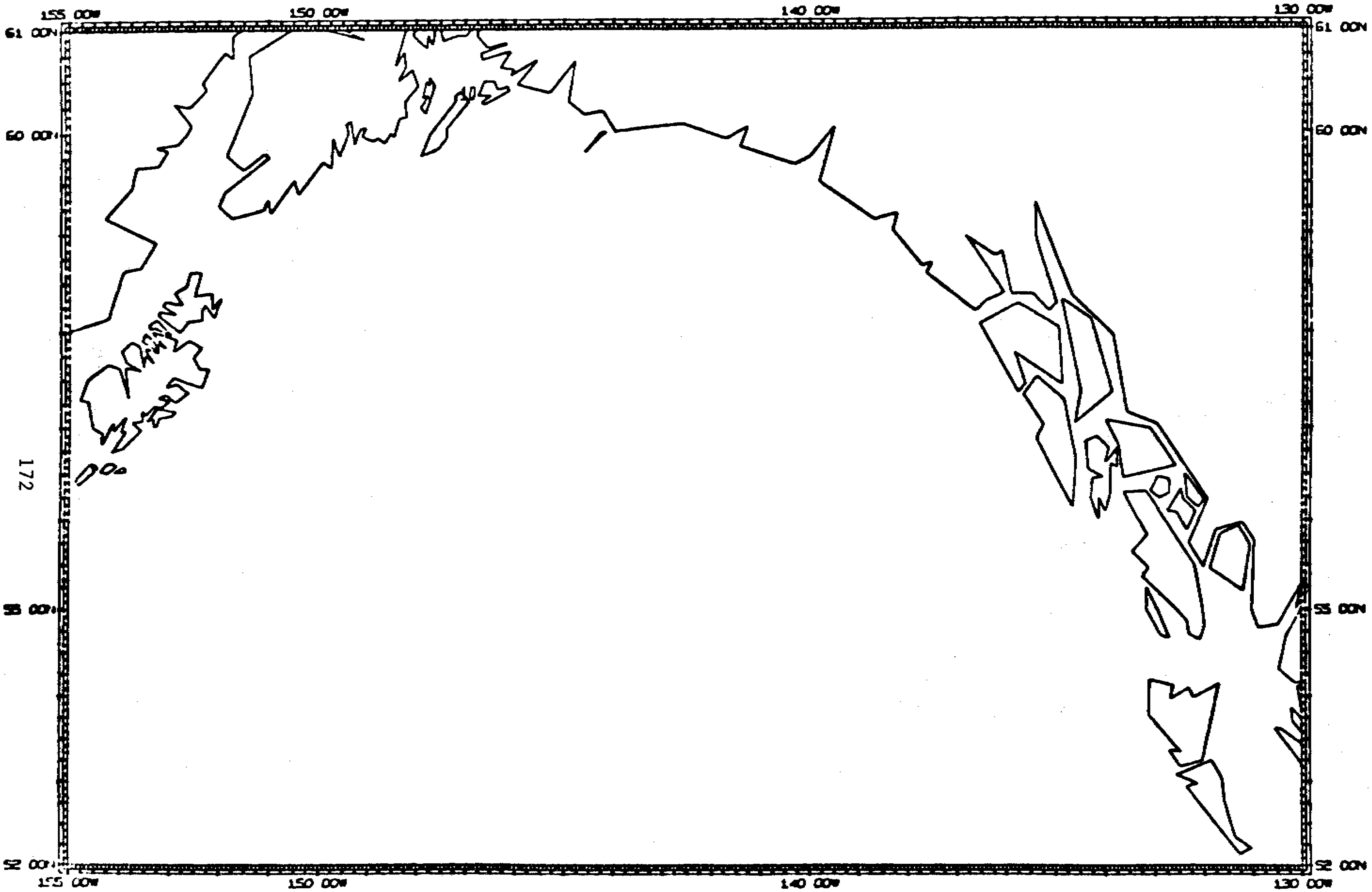

Figure A-90. Killer whale, Orcinus orca, sightings reported for September, 1958-1976.

Figure A-91. Killer whale, Orcinus orca, sightings reported for October, 1958-1976.

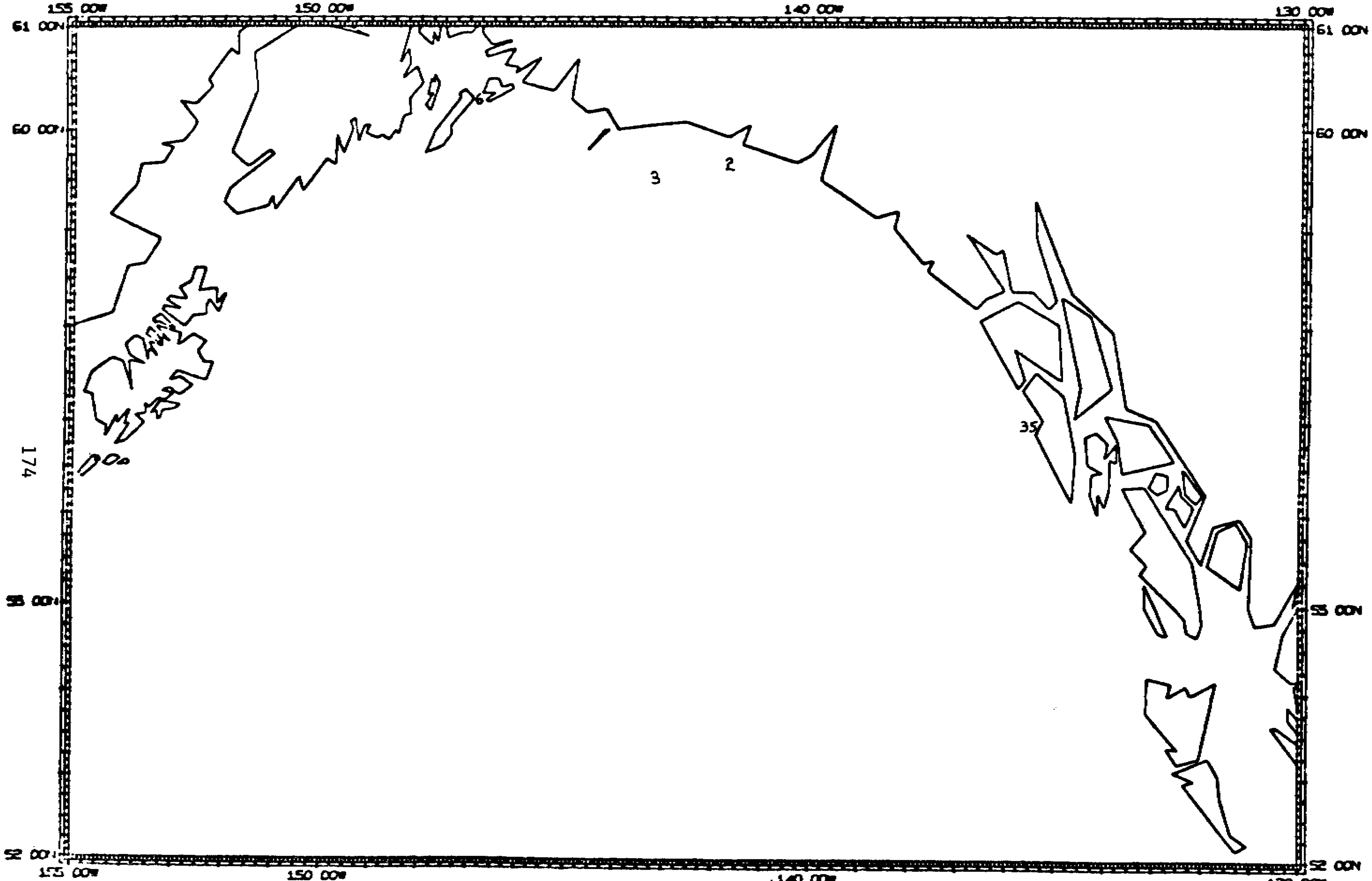

Figure A-92. Harbor porpoise, Phocoena phocoena, sightings reported for February, 1958-1976.

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Figure A-93. Harbor porpoise, Phocoena phocoena, sightings reported for March, 1958-1976.

Figure A-94. Harbor porpoise, Phocoena phocoena, sightings reported for April, 1958-1976.

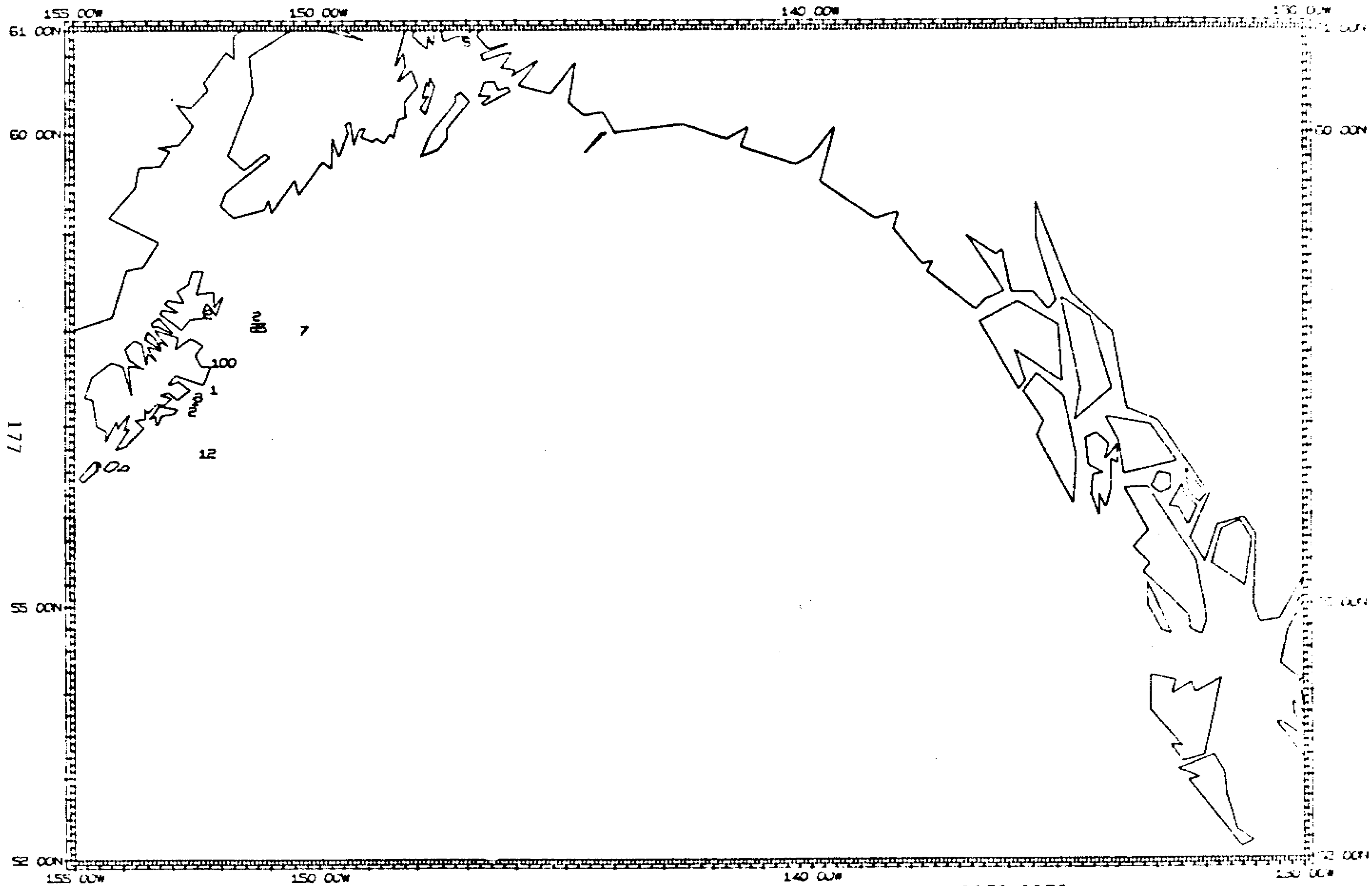

Figure A-95. Harbor porpoise, Phocoena phocoena, sightings reported for May, 1958-1976.

Figure A-96. Harbor porpoise, *Phocoena phocoena*, sightings reported for June, 1958-1976.

Figure A-97. Harbor porpoise, Phocoena phocoena, sightings reported for August, 1958-1976.

Figure A-98. Harbor porpoise, Phocoena phocoena, sightings reported for September, 1958-1976.

Figure A-99. Harbor porpoise, Phocoena phocoena, sightings reported for October, 1958-1976.

Figure A-100. Harbor porpoise, Phocoena phocoena, sightings reported for November, 1958-1976.

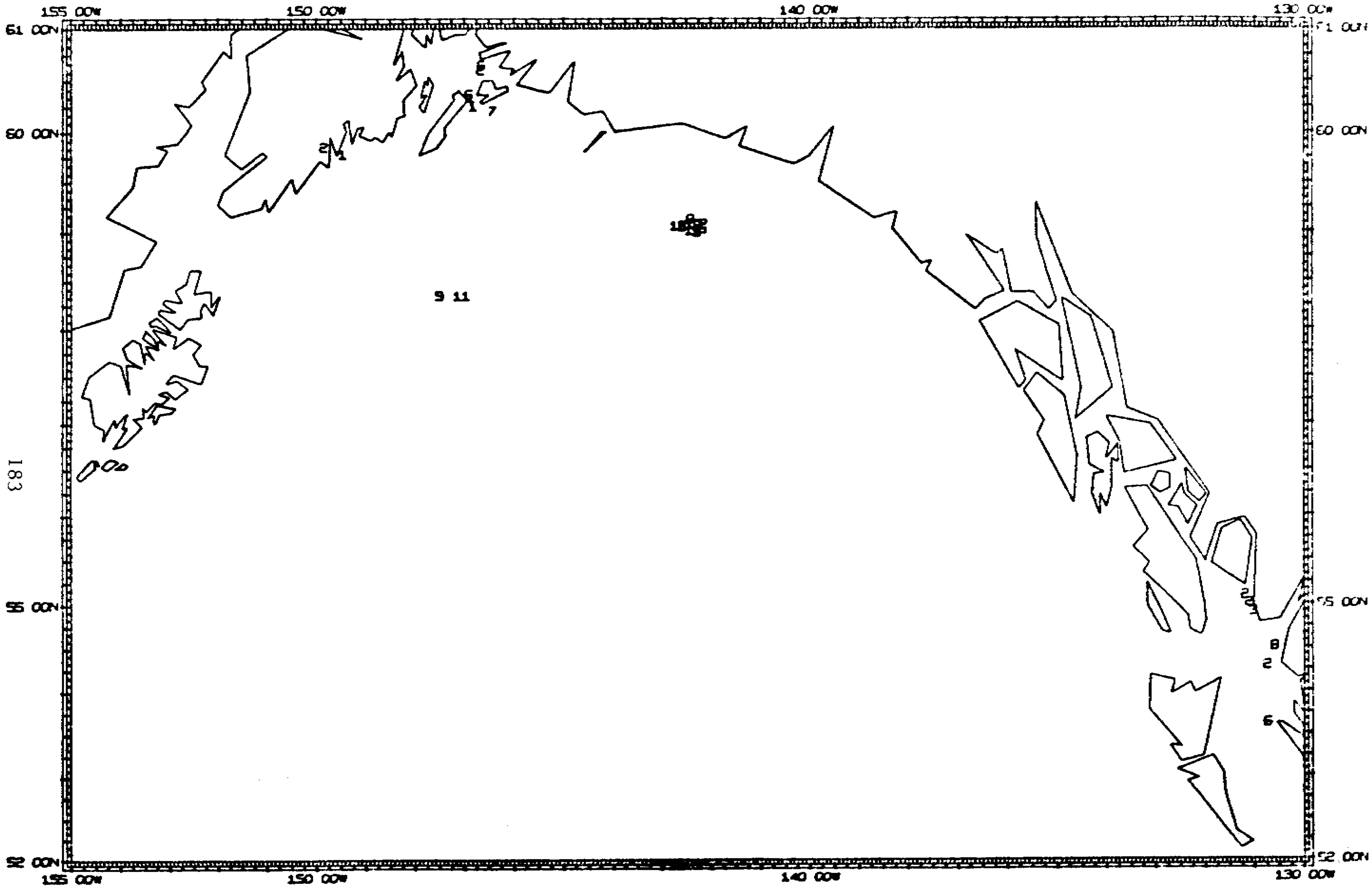

Figure A-101. Dall porpoise, *Phocoenoides dalli*, sightings reported for February, 1958-1976.

Figure A-102. Dall porpoise, Phocoenoides dalli, sightings reported for March, 1958-1976.

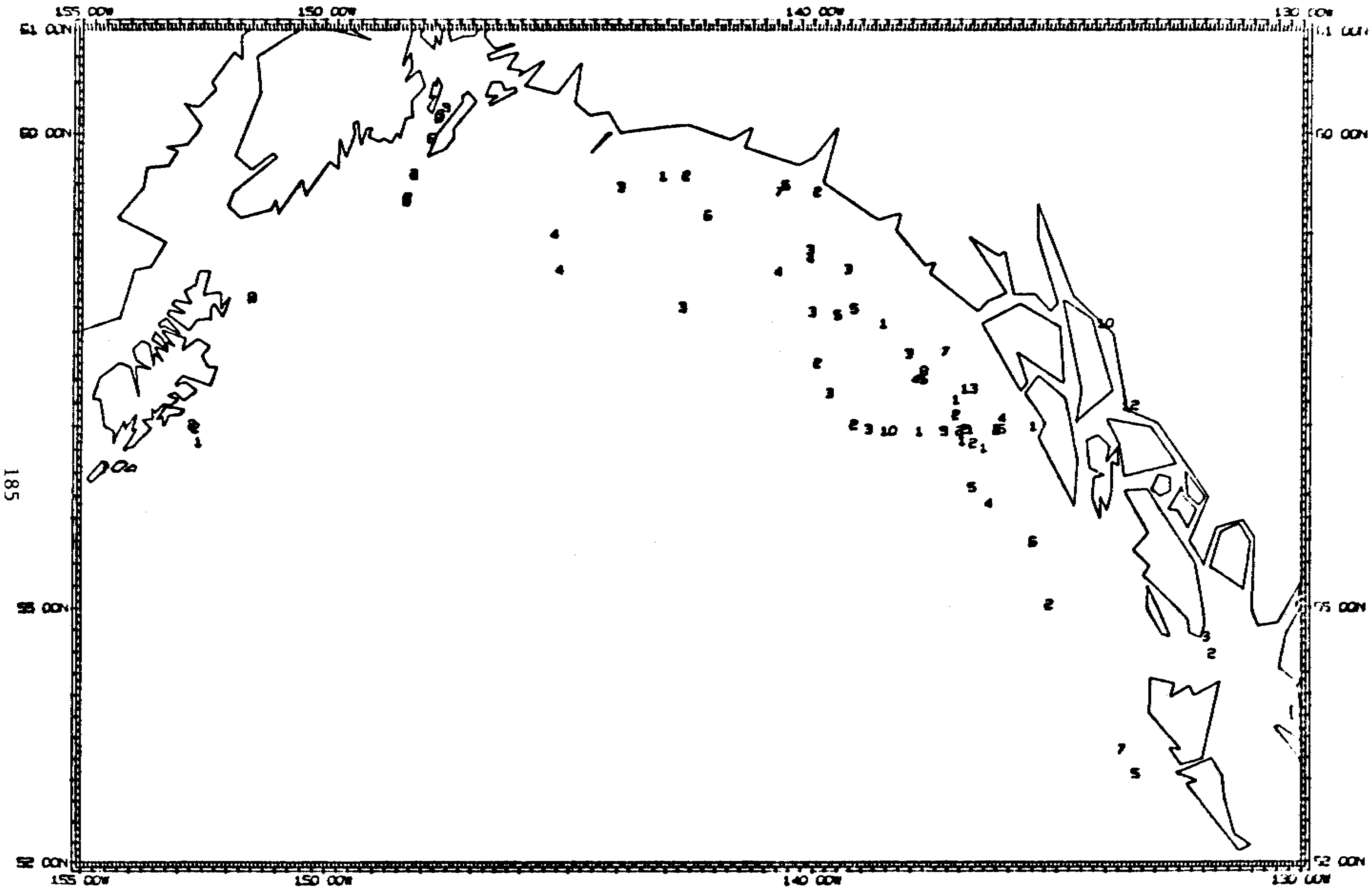

Figure A-103. Dall porpoise, Phocoenoides dalli, sightings reported for April, 1958-1976.

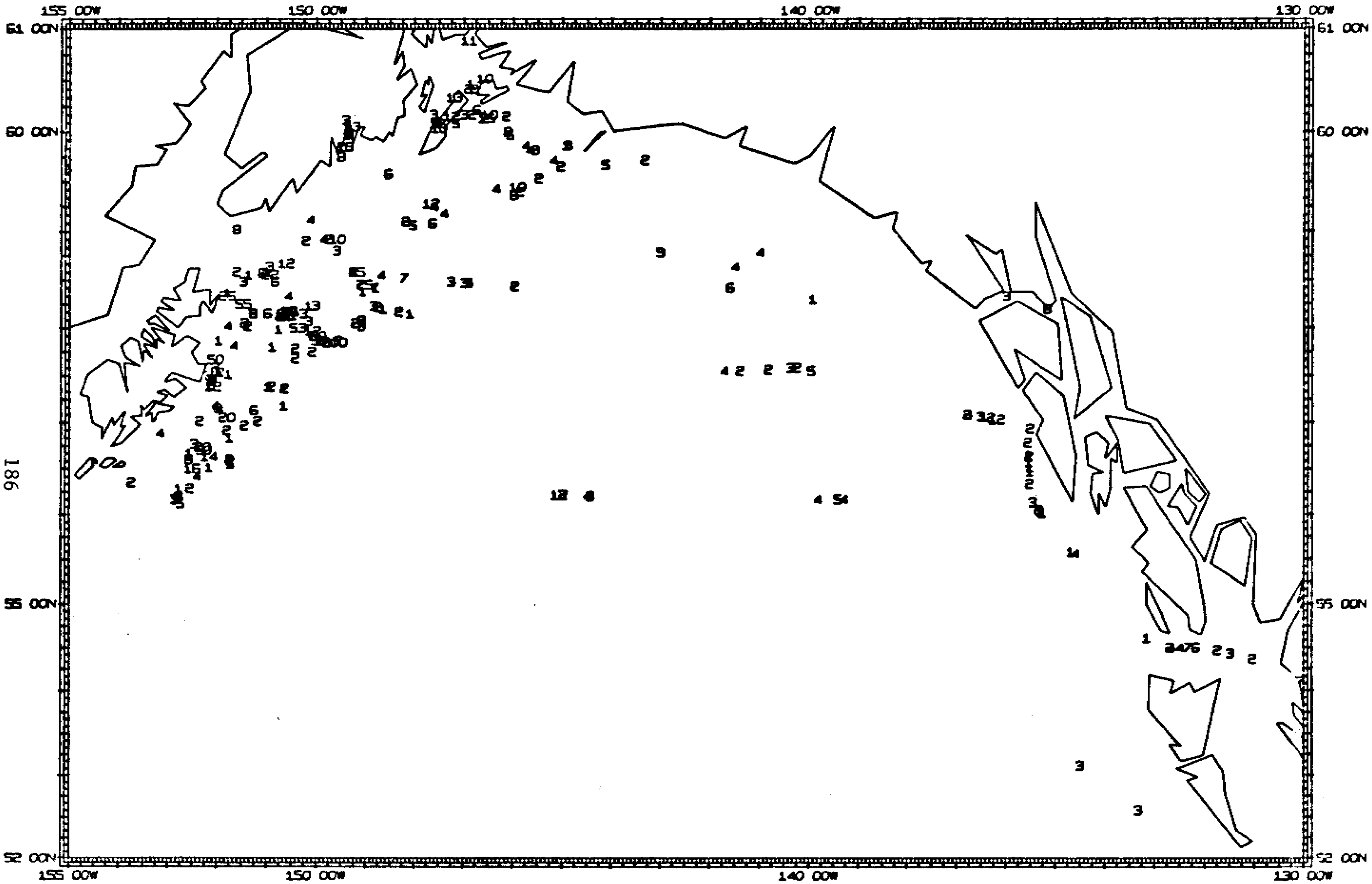

Figure A-104. Dall porpoise, Phocoenoides dalli, sightings reported for May, 1958-1976.

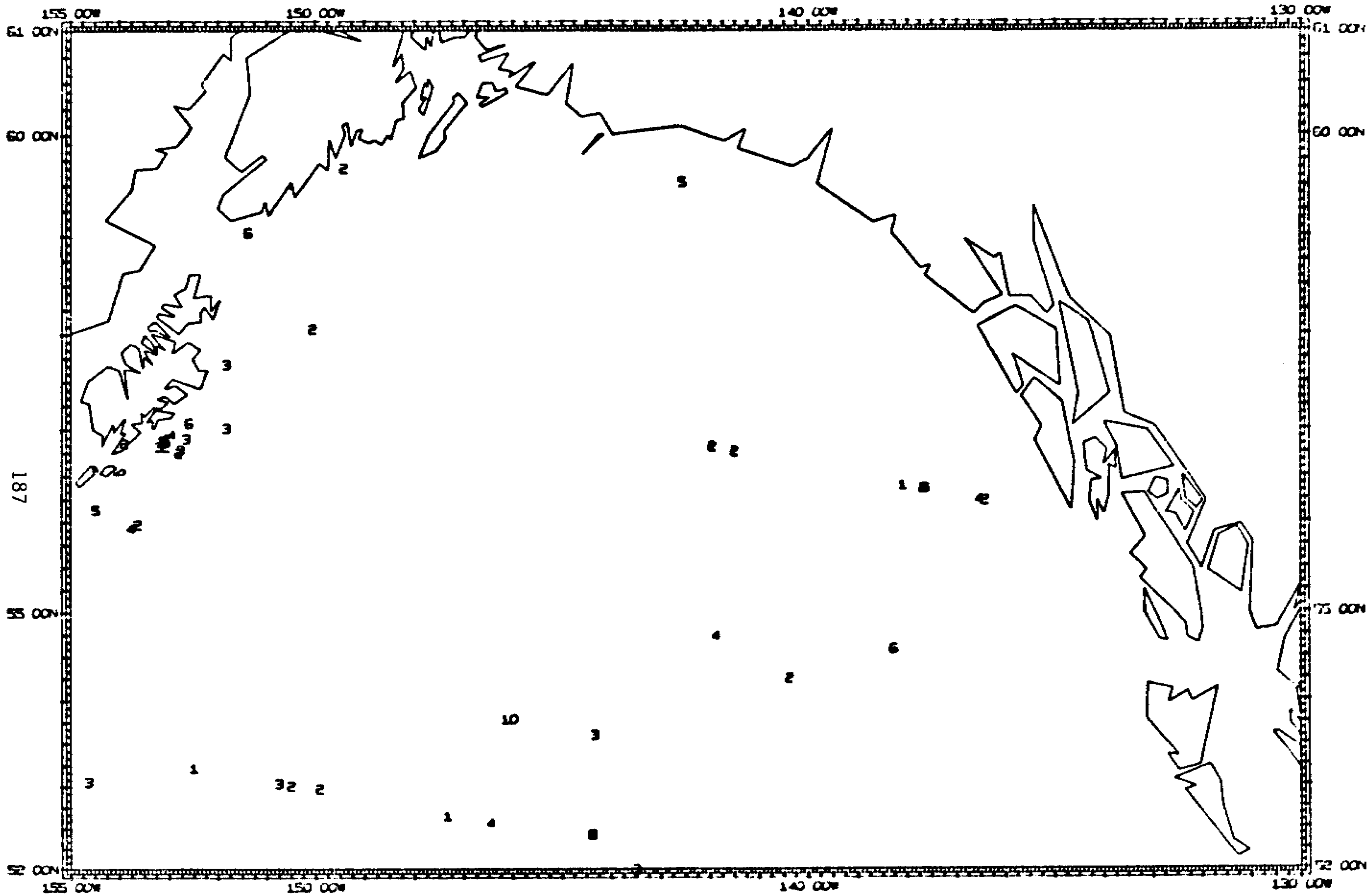

Figure A-105. Dall porpoise, Phocoenoides dalli, sightings reported for June, 1958-1976.

Figure A-106. Dall porpoise, Phocoenoides dalli, sightings reported for July, 1958-1976.

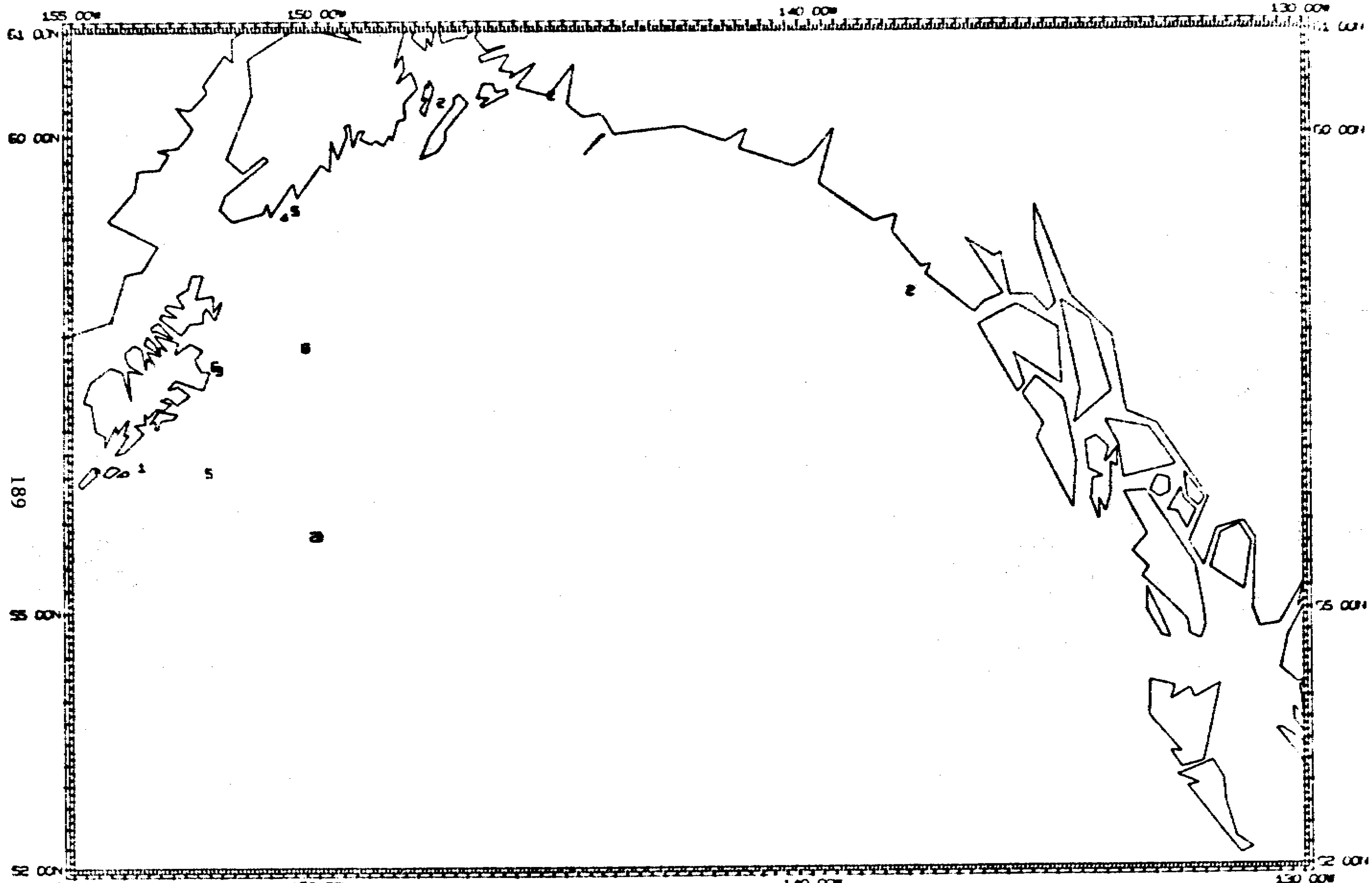

Figure A-107. Dall porpoise, Phocoenoides dalli, sightings reported for September, 1958-1976.

Figure A-108. Dall porpoise, Phocoenoides dalli, sightings reported for October, 1958-1976.

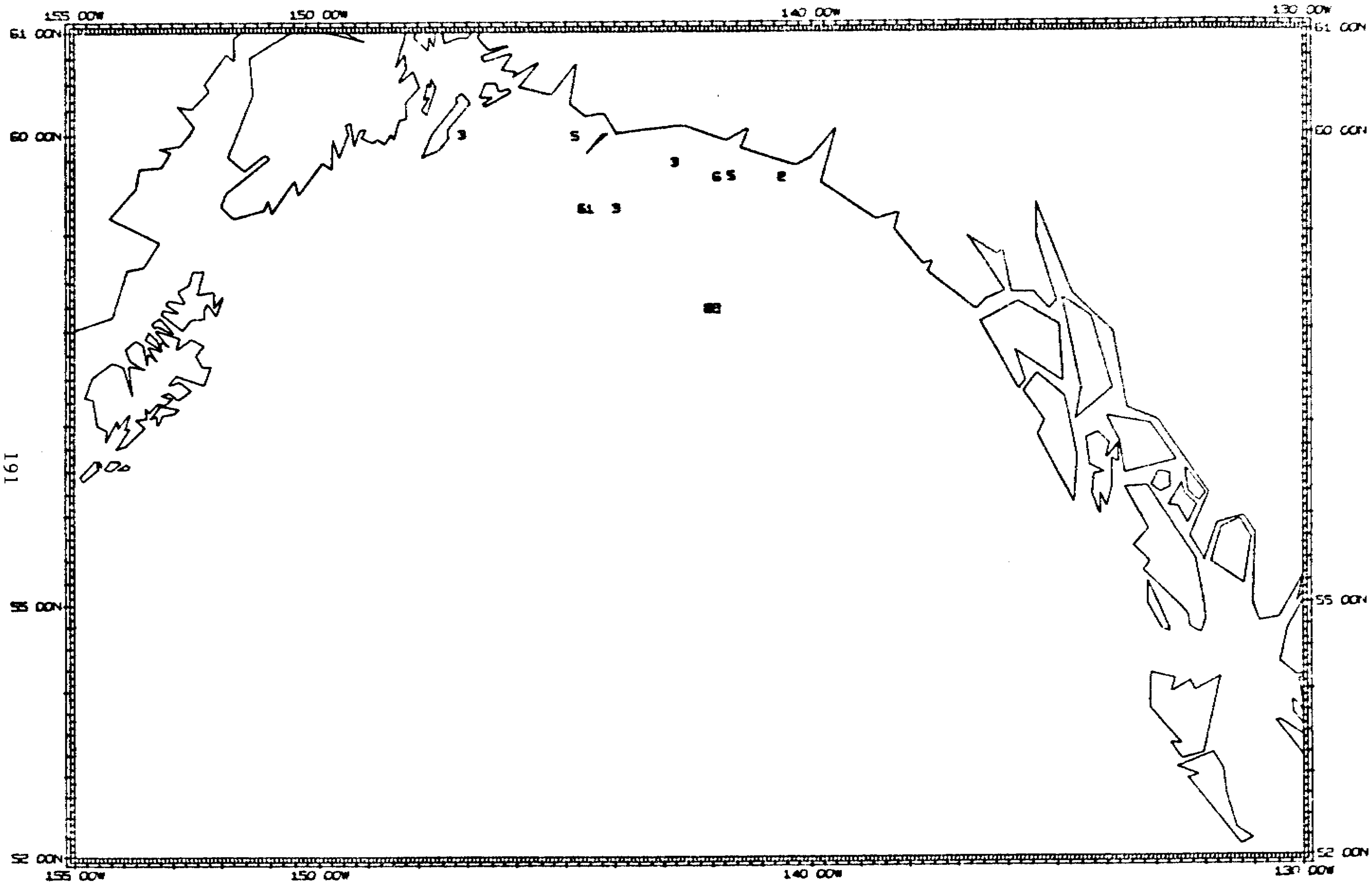

Figure A-109. Dall porpoise, Phocoenoides dalli, sightings reported for November, 1958-1976.

Figure A-110. Dall porpoise, Phocoenoides dalli, sightings reported for December, 1958-1976.

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Figure A-111. Beluga, Delphinapterus leucas, sightings reported for May, 1958-1976.

Figure A-112. Beluga, Delphinapterus leucas, sightings reported for June, 1958-1976.

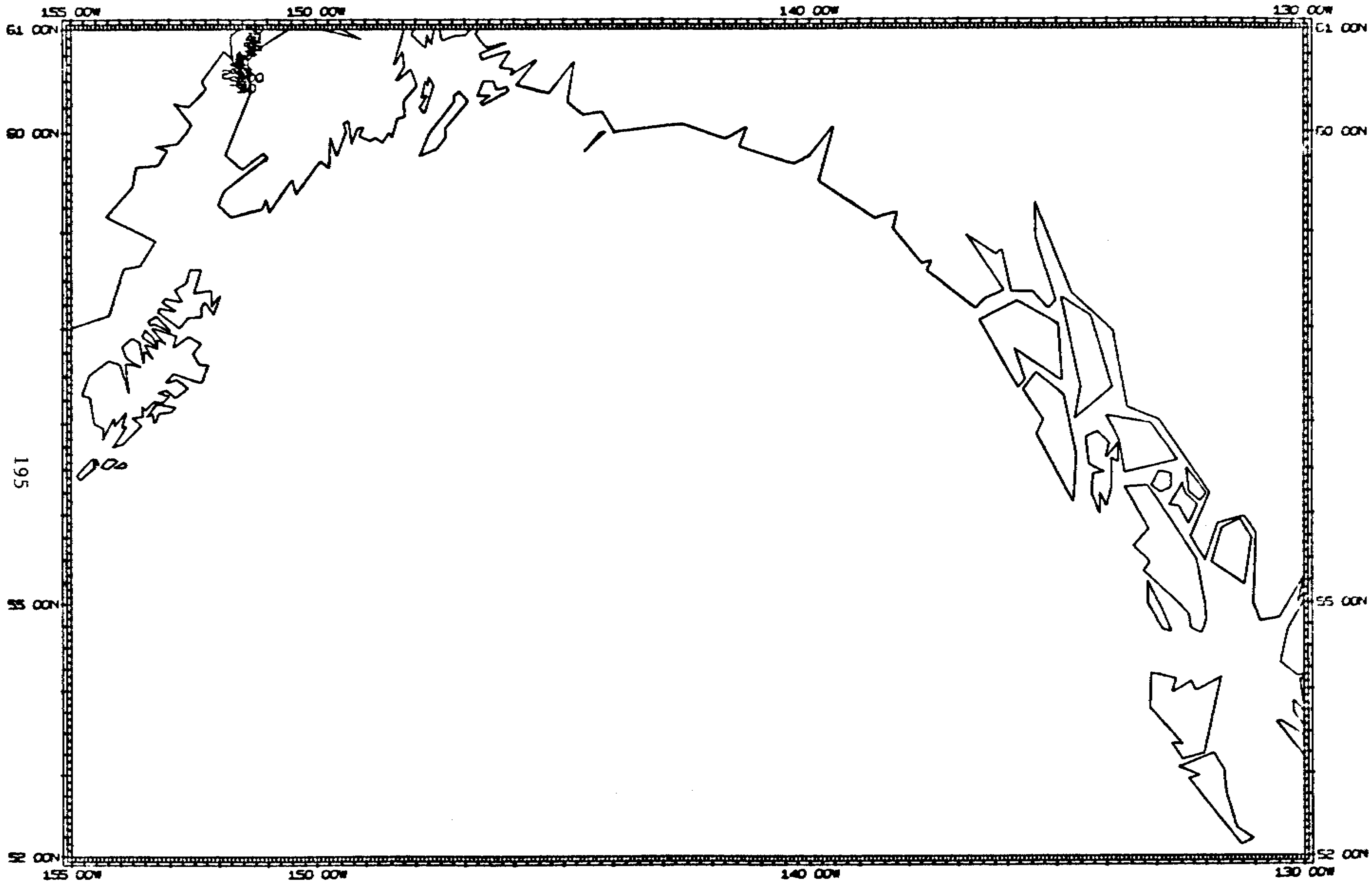

Figure A-113. Beluga, Delphinapterus leucas, sightings reported for July, 1958-1976.

Figure A-114. Beluga, Delphinapterus leucas, sightings reported for August, 1958-1976.

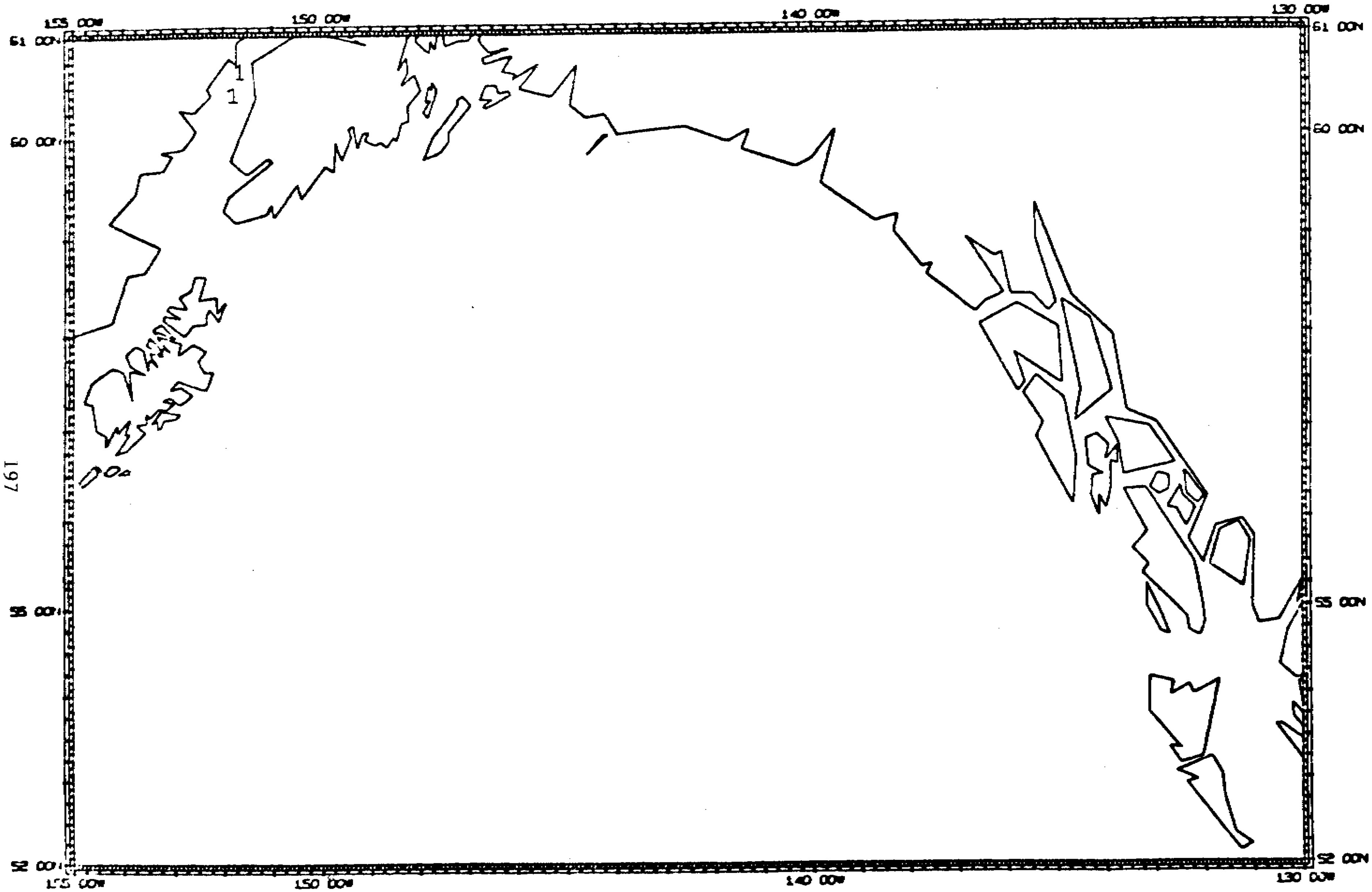

Figure A-115. Beluga, Delphinapterus leucas, sightings reported for September, 1958-1976.

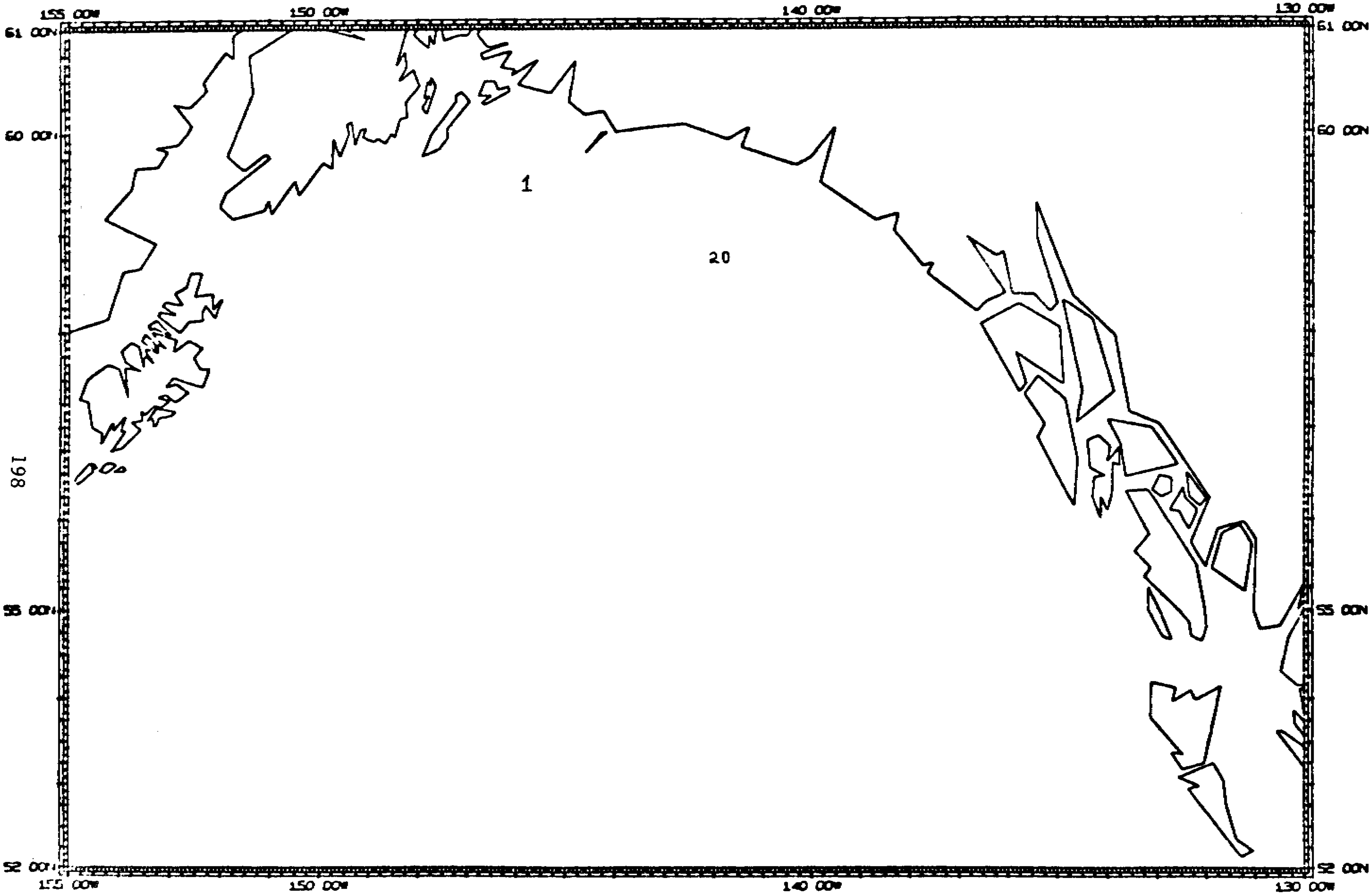

Figure A-116. Sperm whale, *Physeter macrocephalus*, sightings reported for May, 1958-1976.

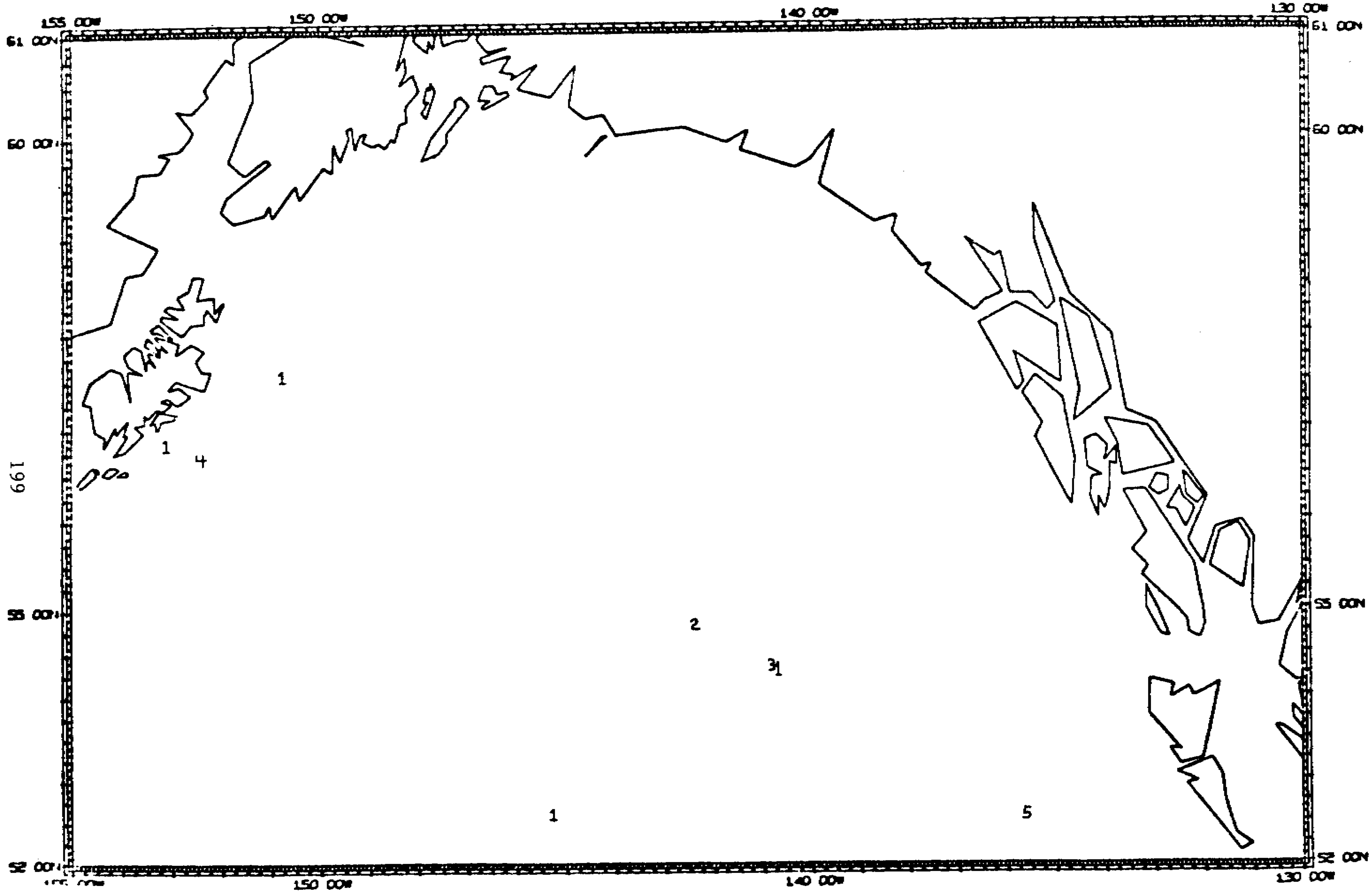

Figure A-117. Sperm whale, Physeter macrocephalus, sightings reported for June, 1958-1976.

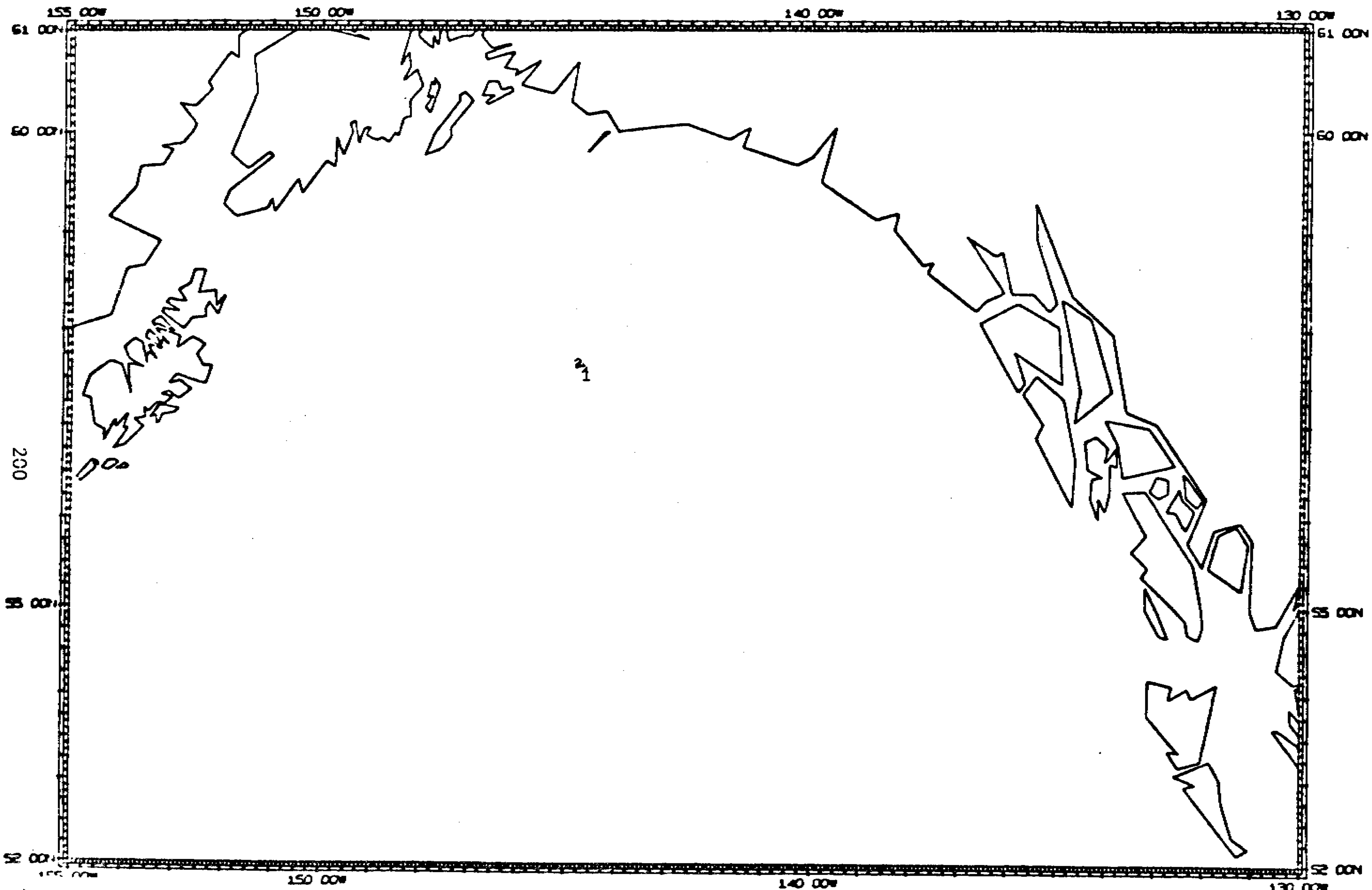

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Figure A-118. Sperm whale, Physeter macrocephalus, sightings reported for August, 1958-1976.

Figure A-119. Sperm whale, Physeter macrocephalus, sightings reported for November, 1958-1976.

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
23/ 2/58	3	57-00- N	135-30- W
24/ 2/58	1	57-00- N	135-30- W
9/ 3/58	2	57-00- N	135-30- W
1/ 4/58	1	57-32- N	137-05- W
8/ 4/58	3	54-55- N	134-05- W
8/ 4/58	1	55-20- N	134-25- W
8/ 4/58	1	55-37- N	135-10- W
8/ 4/58	2	55-37- N	135-10- W
17/ 4/58	1	57-06- N	136-19- W
20/ 4/58	1	58-40- N	139-36- W
21/ 4/58	1	58-58- N	140-48- W
21/ 4/58	1	59-20- N	140-50- W
21/ 4/58	2	59-18- N	140-55- W
21/ 4/58	2	59-22- N	140-47- W
22/ 4/58	1	58-31- N	139-53- W
27/ 4/58	7	56-58- N	136-16- W
2/ 5/58	1	58-19- N	149-48- W
2/ 5/58	1	58-20- N	149-20- W
2/ 5/58	1	58-15- N	149-55- W
3/ 5/58	1	57-51- N	150-26- W
3/ 5/58	6	58-08- N	150-30- W
3/ 5/58	3	57-56- N	150-28- W
3/ 5/58	1	58-10- N	150-32- W
3/ 5/58	1	57-51- N	150-26- W
3/ 5/58	1	57-45- N	150-24- W
4/ 5/58	1	58-06- N	151-06- W
7/ 5/58	1	58-20- N	150-52- W
7/ 5/58	1	58-20- N	150-42- W
7/ 5/58	2	58-20- N	150-44- W
7/ 5/58	8	58-20- N	150-49- W
7/ 5/58	1	58-20- N	150-46- W
11/ 5/58	1	58-30- N	139-03- W
13/ 5/58	1	59-24- N	146-07- W
14/ 5/58	1	59-26- N	146-21- W
14/ 5/58	1	59-26- N	146-21- W
16/ 5/58	1	59-52- N	146-13- W
16/ 5/58	2	59-46- N	147-57- W
17/ 5/58	35	59-46- N	147-57- W
17/ 5/58	50	59-46- N	147-57- W
19/ 5/58	1	59-10- N	147-51- W
22/ 5/58	50	59-51- N	147-20- W
22/ 5/58	1	60-06- N	146-28- W
23/ 5/58	1	59-37- N	144-56- W
25/ 5/58	1	59-37- N	144-52- W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
26/ 5/58	3	59-08-	N	148-49-	W
27/ 5/58	1	59-13-	N	147-04-	W
28/ 5/58	1	58-07-	N	149-04-	W
29/ 5/58	1	58-02-	N	149-55-	W
29/ 5/58	2	58-01-	N	149-14-	W
31/ 5/58	3	56-57-	N	151-35-	W
1/ 6/58	1	57-14-	N	151-49-	W
2/ 6/58	1	57-40-	N	151-35-	W
5/ 6/58	1	57-14-	N	152-15-	W
5/ 6/58	1	55-55-	N	154-52-	W
7/ 6/58	1	55-51-	N	155-49-	W
7/ 6/58	1	56-43-	N	153-03-	W
8/ 6/58	1	56-46-	N	151-35-	W
9/ 6/58	1	57-02-	N	152-00-	W
11/ 6/58	1	56-46-	N	152-20-	W
4/ 3/60	2	57-00-	N	135-30-	W
6/ 3/60	2	57-00-	N	135-30-	W
6/ 3/60	3	57-00-	N	135-30-	W
6/ 3/60	14	57-00-	N	135-30-	W
7/ 3/60	2	56-50-	N	135-30-	W
7/ 3/60	6	56-50-	N	135-30-	W
7/ 3/60	4	57-00-	N	135-30-	W
8/ 3/60	1	57-00-	N	135-30-	W
8/ 3/60	1	57-01-	N	135-21-	W
8/ 3/60	1	57-01-	N	135-21-	W
8/ 3/60	8	57-01-	N	135-21-	W
8/ 3/60	5	57-01-	N	135-21-	W
8/ 3/60	2	57-01-	N	135-21-	W
9/ 3/60	7	57-00-	N	135-30-	W
9/ 3/60	4	56-50-	N	135-30-	W
9/ 3/60	1	57-00-	N	135-30-	W
9/ 3/60	6	57-00-	N	135-30-	W
9/ 3/60	1	57-00-	N	135-30-	W
10/ 3/60	3	57-00-	N	135-30-	W
10/ 3/60	5	56-50-	N	135-30-	W
10/ 3/60	1	56-50-	N	135-30-	W
10/ 3/60	3	56-50-	N	135-30-	W
11/ 3/60	3	56-50-	N	135-30-	W
11/ 3/60	6	56-50-	N	135-30-	W
11/ 3/60	2	57-00-	N	135-30-	W
12/ 3/60	1	57-01-	N	135-21-	W
12/ 3/60	3	57-01-	N	135-21-	W
12/ 3/60	10	57-01-	N	135-21-	W
13/ 3/60	5	57-01-	N	135-21-	W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
13/ 3/60	7	57-01-	N	135-21-	W
14/ 3/60	5	57-00-	N	135-30-	W
15/ 3/60	7	57-00-	N	135-30-	W
15/ 3/60	2	56-50-	N	135-30-	W
15/ 3/60	1	57-00-	N	135-30-	W
15/ 3/60	1	56-50-	N	135-30-	W
17/ 3/60	2	57-00-	N	135-30-	W
17/ 3/60	3	57-00-	N	135-30-	W
17/ 3/60	1	57-00-	N	135-30-	W
17/ 3/60	10	57-00-	N	135-30-	W
18/ 3/60	2	56-50-	N	135-30-	W
18/ 3/60	1	56-50-	N	135-30-	W
18/ 3/60	1	56-50-	N	135-30-	W
18/ 3/60	4	56-50-	N	135-30-	W
19/ 3/60	6	57-00-	N	135-30-	W
19/ 3/60	5	57-00-	N	135-30-	W
19/ 3/60	1	56-50-	N	135-30-	W
22/ 3/60	1	57-02-	N	135-12-	W
22/ 3/60	1	57-02-	N	135-12-	W
22/ 3/60	1	57-02-	N	135-12-	W
22/ 3/60	2	57-02-	N	135-12-	W
22/ 3/60	6	56-50-	N	135-30-	W
23/ 3/60	2	57-02-	N	135-12-	W
23/ 3/60	2	57-02-	N	135-12-	W
23/ 3/60	10	57-02-	N	135-12-	W
24/ 3/60	1	56-50-	N	135-30-	W
26/ 3/60	1	56-50-	N	135-30-	W
26/ 3/60	3	56-50-	N	135-30-	W
26/ 3/60	8	56-50-	N	135-30-	W
26/ 3/60	3	56-50-	N	135-30-	W
28/ 3/60	1	56-50-	N	135-30-	W
28/ 3/60	1	56-50-	N	135-30-	W
29/ 3/60	1	57-01-	N	135-21-	W
30/ 3/60	1	56-50-	N	135-30-	W
30/ 3/60	1	56-50-	N	135-30-	W
31/ 3/60	12	57-13-	N	136-25-	W
31/ 3/60	1	57-20-	N	136-40-	W
2/ 4/60	1	57-43-	N	136-40-	W
2/ 4/60	1	57-47-	N	136-28-	W
2/ 4/60	1	57-50-	N	136-50-	W
3/ 4/60	2	58-08-	N	136-22-	W
4/ 4/60	1	58-36-	N	139-29-	W
5/ 4/60	1	59-35-	N	144-00-	W
5/ 4/60	1	59-35-	N	142-37-	W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
5/ 4/60	1	59-35-	N	142-37-	W
5/ 4/60	1	59-35-	N	142-37-	W
9/ 4/60	1	59-52-	N	147-47-	W
9/ 4/60	1	58-55-	N	148-38-	W
9/ 4/60	1	59-52-	N	147-47-	W
10/ 4/60	7	58-28-	N	149-19-	W
10/ 4/60	1	58-16-	N	149-34-	W
10/ 4/60	1	58-16-	N	149-34-	W
10/ 4/60	1	58-28-	N	149-19-	W
10/ 4/60	1	58-12-	N	149-42-	W
10/ 4/60	1	58-18-	N	149-29-	W
10/ 4/60	1	58-12-	N	149-42-	W
13/ 4/60	1	57-26-	N	152-09-	W
13/ 4/60	1	57-19-	N	152-18-	W
13/ 4/60	1	57-19-	N	152-18-	W
13/ 4/60	4	57-19-	N	152-18-	W
14/ 4/60	1	57-09-	N	151-10-	W
14/ 4/60	1	57-21-	N	150-48-	W
14/ 4/60	1	57-41-	N	150-10-	W
14/ 4/60	1	57-35-	N	150-21-	W
15/ 4/60	1	58-10-	N	150-18-	W
15/ 4/60	1	58-10-	N	150-18-	W
15/ 4/60	1	58-09-	N	149-58-	W
15/ 4/60	1	57-46-	N	149-53-	W
15/ 4/60	1	58-09-	N	149-58-	W
15/ 4/60	1	57-57-	N	150-13-	W
15/ 4/60	2	57-57-	N	150-13-	W
15/ 4/60	1	57-46-	N	149-53-	W
15/ 4/60	1	57-46-	N	149-53-	W
16/ 4/60	1	57-50-	N	150-25-	W
16/ 4/60	1	57-47-	N	150-43-	W
18/ 4/60	1	57-30-	N	152-00-	W
18/ 4/60	4	56-50-	N	151-39-	W
18/ 4/60	2	56-31-	N	152-18-	W
19/ 4/60	1	56-34-	N	152-24-	W
19/ 4/60	1	56-46-	N	152-31-	W
23/ 4/60	1	56-18-	N	135-29-	W
24/ 4/60	6	57-12-	N	152-53-	W
24/ 4/60	1	57-06-	N	152-48-	W
24/ 4/60	1	56-51-	N	152-33-	W
24/ 4/60	2	56-54-	N	152-35-	W
25/ 4/60	1	56-59-	N	152-39-	W
25/ 4/60	1	56-54-	N	152-39-	W
25/ 4/60	4	56-41-	N	152-36-	W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
25/ 4/60	6	56-43-	N	152-37-	W
26/ 4/60	3	56-44-	N	152-32-	W
27/ 4/60	40	56-45-	N	152-33-	W
28/ 4/60	1	56-59-	N	152-15-	W
28/ 4/60	1	58-50-	N	140-24-	W
28/ 4/60	1	58-57-	N	141-07-	W
29/ 4/60	1	59-37-	N	144-25-	W
1/ 5/60	1	59-28-	N	146-29-	W
1/ 5/60	2	59-26-	N	146-25-	W
3/ 5/60	4	57-03-	N	151-28-	W
3/ 5/60	2	59-18-	N	147-08-	W
4/ 5/60	1	58-16-	N	150-44-	W
4/ 5/60	1	58-23-	N	150-20-	W
4/ 5/60	1	58-06-	N	151-25-	W
4/ 5/60	1	58-03-	N	151-38-	W
4/ 5/60	1	58-03-	N	151-35-	W
4/ 5/60	200	57-02-	N	152-40-	W
4/ 5/60	1	58-47-	N	148-53-	W
4/ 5/60	1	58-27-	N	150-53-	W
5/ 5/60	9	56-37-	N	152-22-	W
8/ 5/60	1	58-02-	N	150-55-	W
8/ 5/60	1	58-15-	N	150-58-	W
8/ 5/60	1	58-13-	N	151-20-	W
8/ 5/60	1	58-12-	N	151-24-	W
8/ 5/60	1	58-14-	N	150-55-	W
8/ 5/60	3	58-03-	N	151-34-	W
8/ 5/60	1	58-14-	N	151-05-	W
8/ 5/60	1	58-13-	N	150-53-	W
8/ 5/60	1	57-37-	N	150-34-	W
8/ 5/60	2	58-09-	N	151-26-	W
8/ 5/60	2	58-03-	N	151-36-	W
8/ 5/60	3	58-14-	N	151-05-	W
9/ 5/60	1	58-09-	N	150-32-	W
9/ 5/60	4	57-43-	N	151-38-	W
9/ 5/60	2	57-20-	N	150-24-	W
9/ 5/60	2	57-31-	N	151-27-	W
9/ 5/60	1	57-20-	N	150-24-	W
10/ 5/60	2	56-55-	N	151-42-	W
10/ 5/60	4	56-55-	N	151-42-	W
10/ 5/60	2	56-55-	N	151-42-	W
10/ 5/60	2	56-55-	N	151-42-	W
10/ 5/60	2	56-55-	N	151-42-	W
10/ 5/60	1	56-55-	N	151-42-	W
11/ 5/60	1	58-35-	N	151-10-	W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
11/ 5/60	1	56-59-	N	151-39-	W
11/ 5/60	7	56-58-	N	151-40-	W
11/ 5/60	1	58-30-	N	151-24-	W
12/ 5/60	200	56-22-	N	153-03-	W
12/ 5/60	1	56-44-	N	152-34-	W
12/ 5/60	1	58-17-	N	150-10-	W
12/ 5/60	1	56-48-	N	152-28-	W
13/ 5/60	3	56-31-	N	153-07-	W
13/ 5/60	1	58-13-	N	150-23-	W
13/ 5/60	1	56-31-	N	153-07-	W
13/ 5/60	1	56-55-	N	153-17-	W
17/ 5/60	1	56-52-	N	151-50-	W
18/ 5/60	1	57-27-	N	152-17-	W
18/ 5/60	6	57-37-	N	152-05-	W
21/ 5/60	20	58-10-	N	152-15-	W
21/ 5/60	1	58-34-	N	151-02-	W
21/ 5/60	175	58-22-	N	151-47-	W
23/ 5/60	1	58-00-	N	151-23-	W
23/ 5/60	40	58-23-	N	151-47-	W
23/ 5/60	1	58-01-	N	151-27-	W
24/ 5/60	1	58-07-	N	150-32-	W
25/ 5/60	1	58-12-	N	150-37-	W
25/ 5/60	1	58-11-	N	150-36-	W
25/ 5/60	1	58-07-	N	150-49-	W
25/ 5/60	1	58-04-	N	150-45-	W
25/ 5/60	1	58-11-	N	150-40-	W
25/ 5/60	1	58-11-	N	150-40-	W
25/ 5/60	1	58-10-	N	150-37-	W
25/ 5/60	1	58-10-	N	150-37-	W
26/ 5/60	1	58-15-	N	151-15-	W
26/ 5/60	50	58-21-	N	151-44-	W
27/ 5/60	1	58-15-	N	151-35-	W
28/ 5/60	1	58-13-	N	151-15-	W
28/ 5/60	1	58-17-	N	151-38-	W
28/ 5/60	1	58-09-	N	151-16-	W
28/ 5/60	1	58-14-	N	151-13-	W
28/ 5/60	1	58-14-	N	151-10-	W
28/ 5/60	1	58-09-	N	151-16-	W
28/ 5/60	1	58-09-	N	151-16-	W
28/ 5/60	1	58-10-	N	151-22-	W
29/ 5/60	2	58-13-	N	151-38-	W
29/ 5/60	1	58-14-	N	151-39-	W
29/ 5/60	2	58-14-	N	151-39-	W
29/ 5/60	1	57-53-	N	151-53-	W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
31/ 5/60	5	57-37- N	152-05- W
31/ 5/60	1	57-32- N	151-54- W
1/ 6/60	1	57-41- N	152-10- W
2/ 6/60	1	56-21- N	153-50- W
2/ 6/60	1	56-33- N	153-27- W
31/ 1/61	2	53-57- N	130-58- W
1/ 3/61	1	53-56- N	130-30- W
5/ 3/61	1	55-13- N	133-05- W
12/ 3/61	75	52-47- N	131-16- W
13/ 3/61	1	52-04- N	130-53- W
5/ 5/62	1	56-04- N	134-34- W
12/ 5/62	1	56-09- N	154-15- W
12/ 5/62	1	55-46- N	155-26- W
12/ 5/62	1	55-47- N	155-24- W
12/ 5/62	1	56-30- N	153-43- W
12/ 5/62	2	56-24- N	153-45- W
12/ 5/62	1	56-23- N	153-45- W
12/ 5/62	2	56-16- N	153-47- W
11/ 9/63	1	57-55- N	150-47- W
19/ 5/68	1	55-58- N	135-12- W
19/ 5/68	1	56-11- N	135-31- W
19/ 5/68	1	55-28- N	134-12- W
19/ 5/68	2	56-20- N	135-32- W
19/ 5/68	1	55-30- N	134-20- W
19/ 5/68	1	56-17- N	135-32- W
19/ 5/68	2	56-36- N	135-33- W
19/ 5/68	1	56-41- N	135-34- W
20/ 5/68	1	57-00- N	135-50- W
20/ 5/68	1	57-07- N	137-01- W
23/ 5/68	1	57-54- N	149-30- W
25/ 5/68	1	57-31- N	151-53- W
27/ 5/68	1	56-19- N	152-48- W
28/ 5/68	1	56-32- N	152-05- W
28/ 5/68	1	56-32- N	152-03- W
29/ 5/68	1	57-07- N	151-22- W
31/ 5/68	1	56-54- N	152-36- W
31/ 5/68	50	57-30- N	152-14- W
31/ 5/68	150	57-32- N	152-12- W
1/ 6/68	1	55-59- N	153-37- W
1/ 6/68	1	56-48- N	152-44- W
1/ 6/68	9	56-03- N	153-30- W
1/ 6/68	1	56-02- N	153-34- W
1/ 6/68	1	56-26- N	153-02- W
1/ 6/68	1	56-47- N	152-46- W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
1/ 6/68	1	56-48- N	152-45- W
2/ 6/68	1	55-29- N	155-49- W
2/ 6/68	1	55-35- N	155-26- W
2/ 6/68	1	55-28- N	155-45- W
2/ 6/68	2	55-29- N	155-41- W
19/ 8/68	1	56-04- N	155-13- W
19/ 8/68	1	56-05- N	155-04- W
20/ 8/68	1	57-13- N	152-14- W
20/ 8/68	1	56-49- N	152-13- W
20/ 8/68	2	56-47- N	152-15- W
20/ 8/68	1	56-53- N	152-13- W
20/ 8/68	1	56-54- N	152-13- W
20/ 8/68	1	56-43- N	152-18- W
20/ 8/68	1	56-47- N	152-16- W
20/ 8/68	1	57-05- N	152-12- W
22/ 8/68	1	57-48- N	151-14- W
2/ 2/75	1	59-34- N	142-13- W
3/ 2/75	3	58-59- N	142-13- W
4/ 2/75	1	59-46- N	141-59- W
5/ 2/75	1	59-46- N	141-59- W
5/ 2/75	1 T	59-45- N	142-04- W
7/ 2/75	1	60-18- N	146-48- W
8/ 2/75	1	59-40- N	149-21- W
12/ 2/75	1	59-33- N	144-55- W
12/ 2/75	2	59-31- N	144-32- W
21/ 2/75	1	60-02- N	144-48- W
25/ 2/75	1	60-36- N	146-40- W
26/ 2/75	3	60-28- N	146-54- W
27/ 2/75	7	59-37- N	144-04- W
27/ 2/75	2	59-37- N	143-59- W
28/ 2/75	6	59-38- N	142-10- W
28/ 2/75	2 T	59-56- N	142-39- W
10/ 4/75	12	59-27- N	146-00- W
22/ 4/75	1	58-20- N	151-17- W
27/ 4/75	2	59-35-30N	143-38-00W
28/ 4/75	1	59-37- N	143-40- W
29/ 4/75	1 T	59-25- N	143-56- W
2/ 5/75	5	60-13- N	146-45- W
2/ 5/75	2	60-29- N	146-56- W
2/ 5/75	1	58-09- N	151-53- W
2/ 5/75	3	58-13- N	151-39- W
3/ 5/75	1	58-05-36N	151-26-30W
3/ 5/75	1	59-07- N	143-04- W
4/ 5/75	1	59-40- N	142-50- W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
4/ 5/75	1	58-00- N	150-45- W
5/ 5/75	1	57-49- N	151-23- W
6/ 5/75	1	59-01- N	151-36- W
6/ 5/75	2	58-25- N	148-10- W
6/ 5/75	2	58-25- N	148-10- W
7/ 5/75	1	59-51- N	149-31- W
7/ 5/75	1	59-51- N	149-31- W
7/ 5/75	1	59-51- N	149-31- W
7/ 5/75	6	58-25- N	148-08- W
8/ 5/75	1	60-10- N	147-38- W
9/ 5/75	1	59-11- N	146-30- W
10/ 5/75	1	59-46-36N	141-57-10W
10/ 5/75	1	59-45-48N	141-58- W
10/ 5/75	1	60-35- N	146-12- W
10/ 5/75	2	60-35- N	146-18- W
10/ 5/75	2	60-35- N	146-20- W
10/ 5/75	1	60-31- N	146-40- W
12/ 5/75	2	60-35- N	146-16- W
12/ 5/75	1	59-44- N	141-33- W
12/ 5/75	2	59-58- N	149-23- W
12/ 5/75	1	57-50- N	144-01- W
13/ 5/75	3	60-06-36N	147-29-30W
13/ 5/75	5	60-09-12N	147-27-00W
13/ 5/75	1	58-24-54N	151-18- W
15/ 5/75	2	58-20- N	151-44- W
15/ 5/75	1	58-31- N	151-30-30W
15/ 5/75	1	58-25-42N	151-33-12W
15/ 5/75	1	58-31-48N	151-14-12W
15/ 5/75	1	59-34- N	149-31- W
15/ 5/75	-0	60-20- N	146-50- W
16/ 5/75	1 T	60-32- N	146-34-30W
16/ 5/75	3	55-24- N	155-24- W
16/ 5/75	20	60-07- N	147-35- W
16/ 5/75	2	60-08- N	147-30- W
16/ 5/75	1	58-17- N	151-34-24W
18/ 5/75	1	58-39-12N	151-14- W
18/ 5/75	4	60-50- N	147-10- W
18/ 5/75	4	60-02-42N	147-08-30W
19/ 5/75	3	58-38-42N	151-07- W
19/ 5/75	2	58-33- N	151-20-48W
19/ 5/75	1	58-33- N	151-22- W
20/ 5/75	1	58-36-30N	150-51-48W
20/ 5/75	1	58-34- N	151-22- W
28/ 5/75	1	60-05- N	147-38- W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
28/ 5/75	1	60-04-00N	146-51-30W
28/ 5/75	1	59-58-30N	147-10- W
29/ 5/75	6	56-45- N	155-56- W
29/ 5/75	2	56-01- N	155-56- W
1/ 6/75	2	60-04-12N	147-38-00W
10/ 6/75	2	60-18-54N	150-47-30W
13/ 7/75	6	56-04- N	155-40- W
14/ 7/75	25	55-56- N	155-14- W
14/ 7/75	2	55-48- N	155-14- W
14/ 7/75	20	55-51- N	155-16- W
14/ 7/75	2	56-55- N	155-59- W
16/ 7/75	1	56-49- N	152-22- W
19/ 7/75	1	58-09- N	151-15- W
10/ 8/75	1	59-06- N	149-45- W
10/ 8/75	1	59-23- N	149-37- W
10/ 8/75	2	59-34- N	149-30- W
11/ 8/75	4	58-06- N	150-08- W
18/ 8/75	1	59-36- N	151-24- W
2/ 9/75	2	57-41- N	152-07- W
3/ 9/75	4	56-46- N	152-10- W
3/ 9/75	3	57-37- N	152-01- W
3/ 9/75	2	57-41- N	152-06- W
4/ 9/75	1	60-07- N	147-52- W
2/10/75	2	56-13- N	152-25-30W
15/10/75	1	58-17- N	151-24- W
24/10/75	1	59-12- N	147-39- W
25/10/75	1	59-11- N	147-36- W
25/10/75	1	59-11- N	147-36- W
2/11/75	6	59-43- N	144-36-18W
3/11/75	1	59-45- N	144-38- W
6/11/75	1	59-34- N	142-11- W
6/11/75	1	59-34- N	142-12- W
27/11/75	3	59-36- N	142-40- W
28/11/75	1	59-30- N	146-54- W
29/11/75	1	60-15- N	146-50- W
1/12/75	2	58-59- N	148-39- W
2/12/75	4	59-55- N	149-15- W
2/12/75	45	59-55- N	149-15- W
13/ 4/76	4	59-57-42N	147-49-48W
15/ 4/76	1	59-44-48N	149-25-12W
6/ 6/76	1	56-41-00N	153-28-48W
6/ 6/76	4	56-41-42N	153-27-30W
6/ 6/76	1	56-01-42N	155-05-00W
6/ 6/76	3	56-01-48N	155-04-00W

TABLE A- 1 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN SEA LION (EUMETOPIAS JUBATUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
6/ 6/76	1	56-01-54N	155-03-48W
6/ 6/76	1	56-02-00N	155-03-42W
6/ 6/76	1	56-01-12N	155-03-24W
6/ 6/76	3	56-01-12N	155-03-00W
6/ 6/76	1	56-03-18N	154-54-48W
6/ 6/76	3	56-03-24N	154-57-30W
6/ 6/76	1	56-04-24N	154-41-42W
6/ 6/76	1	57-38-24N	152-03-06W
19/ 6/76	2	56-01-00N	154-59-00W
20/ 6/76	4	56-55-12N	153-02-00W

TABLE A- 2 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN FUR SEAL (CALLORHINUS URSINUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
30/ 1/75	1 T	52-49- N	136-08- W
30/ 1/75	1	52-49- N	136-08- W
7/ 2/75	3 T	60-21- N	146-53- W
10/ 2/75	1	58-15- N	143-23- W
10/ 2/75	1	58-16- N	143-29- W
12/ 2/75	1	59-33- N	144-38- W
19/ 2/75	2 T	59-50- N	143-52- W
26/ 2/75	65 T	60-39- N	146-40- W
3/ 3/75	1	54-53- N	140-47- W
24/ 4/75	1	54-03- N	134-20- W
24/ 4/75	1	54-00- N	134-10- W
25/ 4/75	3	58-12- N	136-12- W
1/ 5/75	1	54-25- N	132-30- W
1/ 5/75	1 T	54-20- N	132-00- W
2/ 5/75	1	58-38- N	140-05- W
2/ 5/75	2	58-46- N	142-11- W
2/ 5/75	1	58-39- N	140-20- W
3/ 5/75	1 T	59-37-36N	148-07-42W
4/ 5/75	1	59-09- N	141-37-30W
4/ 5/75	3	59-00- N	142-14- W
5/ 5/75	2	59-09- N	145-36- W
5/ 5/75	2	59-11-30N	145-45- W
6/ 5/75	1 T	59-30- N	149-15- W
10/ 5/75	2 T	53-45- N	135-30- W
11/ 5/75	1	56-38- N	141-48- W
12/ 5/75	1	57-34- N	143-46- W
13/ 5/75	1	59-07- N	142-15- W
13/ 5/75	1	59-32- N	142-05- W
14/ 5/75	1	58-22- N	147-05- W
15/ 5/75	1	58-31- N	151-20-06W
15/ 5/75	1	58-31- N	151-30-30W
16/ 5/75	1	55-58- N	152-38- W
18/ 5/75	1	57-50- N	152-18- W
18/ 5/75	2	58-39-12N	151-14- W
19/ 5/75	1	58-33- N	151-20-48W
30/ 5/75	1	59-27- N	146-00- W
10/ 6/75	1 T	57-00- N	149-42- W
19/ 6/75	1 T	56-27- N	151-49- W
19/ 6/75	1 T	56-20- N	152-00- W
19/ 6/75	1 T	56-15- N	152-09- W
19/ 6/75	1 T	58-03- N	150-03- W
19/ 6/75	2	58-00- N	150-07- W
19/ 6/75	1 T	56-30- N	151-44- W
20/ 6/75	1	57-41- N	144-34- W

TABLE A- 2 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN FUR SEAL (CALLORHINUS URSINUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
20/ 6/75	2	59-01- N	147-34- W
20/ 6/75	1	59-05- N	147-35- W
22/ 6/75	1	52-18- N	133-56- W
22/ 6/75	1	52-44- N	134-44- W
13/ 7/75	2	56-03- N	155-40- W
13/ 7/75	1	56-13- N	155-30- W
21/ 7/75	1	57-51- N	151-30- W
8/ 8/75	1	54-22- N	138-07- W
11/ 8/75	1 T	57-58- N	150-11- W
24/ 8/75	1	55-10- N	137-00- W
22/10/75	3	59-50- N	149-31- W
3/12/75	1	57-33- N	142-24- W
4/12/75	1	56-40- N	141-05- W
9/ 4/76	1	59-27-30N	152-05-24W
20/ 4/76	2	58-54-12N	145-17-42W
20/ 4/76	2	59-02-12N	145-19-48W
20/ 4/76	2	59-04-42N	145-19-48W
20/ 4/76	2	59-09-24N	145-19-48W
20/ 4/76	2	59-10-18N	145-19-48W
21/ 4/76	2	59-11-30N	144-44-54W
21/ 4/76	1	59-09-18N	144-46-48W
21/ 4/76	1	59-05-24N	144-50-54W
21/ 4/76	1	58-53-12N	145-00-36W
19/ 6/76	1	54-01-48N	154-19-00W

TABLE A- 3 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
HARBOR SEAL (PHOCA VITULINA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
14/ 2/58	1	55-30- N	135-10- W
22/ 2/58	1	57-00- N	135-30- W
23/ 2/58	1	57-00- N	135-30- W
3/ 4/58	1	58-48- N	140-00- W
3/ 4/58	1	58-50- N	140-05- W
7/ 5/58	1	57-55- N	152-04- W
7/ 5/58	1	58-25- N	150-24- W
19/ 5/58	1	59-28- N	146-59- W
20/ 5/58	1	60-19- N	146-50- W
24/ 5/58	12	59-56- N	148-14- W
4/ 6/58	1	57-17- N	151-00- W
7/ 6/58	1	56-53- N	153-00- W
9/ 3/60	1	57-00- N	135-30- W
9/ 3/60	1	57-00- N	135-30- W
9/ 3/60	1	57-00- N	135-30- W
11/ 3/60	1	56-50- N	135-30- W
12/ 3/60	1	57-01- N	135-21- W
14/ 3/60	2	57-00- N	135-30- W
15/ 3/60	1	57-00- N	135-30- W
22/ 3/60	1	56-50- N	135-30- W
22/ 3/60	1	56-50- N	135-30- W
26/ 3/60	1	57-01- N	135-21- W
30/ 3/60	1	56-50- N	135-30- W
30/ 3/60	1	56-50- N	135-30- W
31/ 3/60	1	57-20- N	136-40- W
3/ 4/60	1	56-08- N	136-22- W
13/ 4/60	1	57-26- N	152-09- W
15/ 4/60	1	58-09- N	149-58- W
15/ 4/60	1	57-57- N	150-13- W
16/ 4/60	1	57-40- N	151-02- W
16/ 4/60	1	57-40- N	151-02- W
16/ 4/60	1	57-38- N	151-41- W
18/ 4/60	1	57-38- N	152-10- W
24/ 4/60	1	57-06- N	152-48- W
24/ 4/60	1	57-06- N	152-48- W
25/ 4/60	1	56-59- N	152-39- W
26/ 4/60	1	56-38- N	152-31- W
3/ 5/60	1	57-36- N	151-58- W
3/ 5/60	1	57-38- N	152-05- W
3/ 5/60	1	57-01- N	152-21- W
4/ 5/60	1	57-02- N	152-40- W
5/ 5/60	1	57-08- N	152-48- W
8/ 5/60	1	57-30- N	152-15- W
8/ 5/60	1	57-44- N	152-05- W

TABLE A- 3 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
HARBOR SEAL (PHOCA VITULINA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
8/ 5/60	1	57-30- N	152-15- W
8/ 5/60	1	58-00- N	151-05- W
12/ 5/60	1	56-22- N	153-03- W
13/ 5/60	1	56-55- N	153-17- W
13/ 5/60	1	56-55- N	153-17- W
13/ 5/60	1	56-20- N	153-04- W
17/ 5/60	2	57-13- N	153-02- W
17/ 5/60	2	57-03- N	153-18- W
17/ 5/60	2	57-03- N	153-18- W
17/ 5/60	1	56-55- N	153-21- W
17/ 5/60	1	56-55- N	153-21- W
17/ 5/60	1	56-53- N	153-10- W
17/ 5/60	1	56-55- N	153-21- W
21/ 5/60	2	58-10- N	152-15- W
24/ 5/60	1	58-45- N	150-49- W
26/ 5/60	1	58-15- N	151-28- W
27/ 5/60	1	58-14- N	151-16- W
28/ 5/60	1	58-10- N	151-22- W
29/ 5/60	1	58-06- N	151-12- W
11/ 2/61	1	53-52- N	130-53- W
5/ 3/61	1	55-13- N	133-05- W
12/ 5/62	1	56-28- N	153-43- W
12/ 5/62	1	56-30- N	153-43- W
10/ 9/63	1	56-55- N	155-56- W
19/ 5/68	1	56-56- N	135-32- W
25/ 5/68	1	57-25- N	152-08- W
25/ 5/68	1	57-21- N	152-11- W
25/ 5/68	1	57-23- N	152-09- W
31/ 5/68	1	57-23- N	152-20- W
31/ 5/68	3	57-19- N	152-26- W
31/ 5/68	1	57-17- N	152-29- W
31/ 5/68	1	57-18- N	152-28- W
31/ 5/68	1	57-17- N	152-30- W
31/ 5/68	1	57-05- N	152-34- W
31/ 5/68	1	57-16- N	152-30- W
31/ 5/68	1	57-15- N	152-31- W
31/ 5/68	1	57-09- N	152-34- W
13/ 5/75	35	60-15-42N	147-20-48W
19/ 5/75	6	58-20- N	152-10- W
7/ 8/75	1	60-24- N	152-10- W
23/ 8/75	1	59-35- N	151-25- W
8/ 9/75	1	58-15- N	137-10- W
2/10/75	1 T	56-13- N	152-25- W
14/10/75	1	58-54- N	152-53- W

TABLE A- 3 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
HARBOR SEAL (PHOCA VITULINA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
30/10/75	1	60-03- N	144-47- W
9/ 4/76	1	59-34-00N	151-34-00W
9/ 4/76	1	59-36-30N	151-19-00W

TABLE A- 4 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTHERN ELEPHANT SEAL (MIROUNGA ANGUSTIROSTRIS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
5/ 5/62	1	56-04- N	134-31- W
29/ 5/75	1	59-21-00N	145-51-24W

TABLE A- 5 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
GRAY WHALE (ESCHRICHTIUS ROBUSTUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
21/ 4/58	2	59-34- N	140-03- W
21/ 4/58	3	59-33- N	140-10- W
3/ 5/58	1	58-20- N	150-34- W
21/ 5/74	1 T	59-24- N	153-21- W
1/ 5/75	3 T	58-07- N	152-07- W
1/ 5/75	1 T	57-51- N	152-20- W
7/ 4/76	2	57-45-54N	152-10-00W
7/ 4/76	2	57-45-30N	152-03-00W

TABLE A- 6 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
MINKE WHALE (BALAENOPTERA ACUTOROSTRATA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
6/ 3/60	2	57-00- N	135-00- W
21/ 3/60	1	56-50- N	135-30- W
22/ 3/60	1	57-02- N	135-30- W
23/ 3/60	1	57-02- N	135-12- W
23/ 3/60	1	57-02- N	135-12- W
20/ 5/60	1	58-00- N	150-17- W
21/ 5/60	1	58-15- N	151-57- W
21/ 5/60	1	58-13- N	151-57- W
25/ 5/60	1	58-08- N	150-40- W
1/ 6/60	1	57-44- N	152-23- W
1/ 6/60	1	57-43- N	152-21- W
20/ 9/62	1	56-40- N	154-32- W
20/ 9/62	1	56-40- N	154-31- W
18/ 5/68	1	54-34- N	132-51- W
19/ 5/68	1	56-33- N	135-33- W
19/ 5/68	1	56-46- N	135-34- W
21/ 5/68	1	57-32- N	139-52- W
21/ 5/68	1	57-36- N	140-12- W
21/ 5/68	1	57-34- N	140-48- W
23/ 5/68	1	58-03- N	149-11- W
25/ 5/68	1	57-33- N	151-58- W
26/ 5/68	3	56-54- N	151-47- W
26/ 5/68	1	56-36- N	152-12- W
27/ 5/68	1	56-23- N	152-48- W
31/ 5/68	1	57-13- N	152-33- W
31/ 5/68	1	57-40- N	152-08- W
31/ 5/68	1	56-53- N	152-36- W
31/ 5/68	1	57-10- N	152-34- W
1/ 6/68	1	56-20- N	153-04- W
1/ 6/68	1	55-54- N	154-13- W
1/ 6/68	1	55-58- N	153-38- W
1/ 6/68	1	56-16- N	153-04- W
22/ 8/68	1	57-52- N	151-55- W
2/ 2/75	1	59-44- N	142-04- W
19/ 4/75	1 T	58-10-12N	151-05-48W
13/ 5/75	1	60-16- N	147-17- W
13/ 5/75	3 T	60-11-42N	147-23-42W
13/ 5/75	1	60-08-48N	147-27-30W
13/ 5/75	1	60-06-36N	147-29-30W
18/ 5/75	1	60-08- N	147-24- W
23/ 5/75	4	60-22-18N	147-13-48W
27/ 5/75	1	60-34-06N	146-37-36W
2/ 6/75	1	60-08-30N	147-25-06W
10/ 6/75	1	59-36-48N	152-14-00W

TABLE A- 6 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
MINKE WHALE (BALAENOPTERA ACUTOROSTRATA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
20/ 6/75	1	59-40- N	149-25- W
31/ 7/75	1 T	60-35- N	151-38- W
8/ 8/75	1	53-56- N	137-14- W
11/ 8/75	1	58-02- N	150-08- W
18/ 8/75	1	59-36- N	151-24- W
20/ 8/75	2 T	59-39- N	151-47- W
22/ 8/75	2	59-36- N	151-24- W
22/ 8/75	2	59-40- N	151-57- W
23/ 8/75	1	59-37- N	151-58- W
23/ 8/75	1 T	59-35- N	151-45- W
23/ 8/75	1	59-30-42N	151-48-36W
30/ 9/75	2	56-29- N	133-55-30W
27/11/75	7	59-27-12N	145-11-24W
17/ 4/76	1	60-21-54N	146-52-54W
22/ 4/76	1	59-14-36N	143-59-06W
29/ 4/76	1	58-22-30N	138-22-30W

TABLE A- 7 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
SEI WHALE (BALAENOPTERA BOREALIS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
4/ 4/58	2	57-30- N	137-55- W
17/ 4/58	1	56-58- N	135-44- W
5/ 6/58	2	55-57- N	154-37- W
5/ 6/58	4	56-02- N	154-08- W
18/ 4/60	1	57-15- N	151-50- W
23/ 5/60	1	57-44- N	152-14- W
6/ 5/62	2	56-10- N	140-38- W
7/ 5/62	4	56-13- N	145-32- W
12/ 5/62	1	55-45- N	155-29- W
26/ 5/68	6	56-29- N	151-59- W
15/ 5/75	2 T	60-25- N	146-55- W

TABLE A- 8 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
FIN WHALE (BALAENOPTERA PHYSALUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
9/ 3/58	1	57-00- N	135-30- W
4/ 4/58	1	58-15- N	138-40- W
5/ 4/58	3	57-30- N	137-55- W
6/ 4/58	1	55-42- N	135-55- W
7/ 4/58	2	55-05- N	135-10- W
19/ 4/58	2	58-26- N	139-00- W
19/ 4/58	1	58-10- N	139-15- W
1/ 5/58	2	58-26- N	145-11- W
1/ 5/58	1	58-29- N	147-05- W
18/ 5/58	2	58-55- N	149-52- W
18/ 5/58	1	58-55- N	149-52- W
18/ 5/58	1	58-55- N	149-45- W
8/ 6/58	3	56-42- N	152-16- W
8/ 5/60	2	57-30- N	152-15- W
8/ 5/60	1	56-55- N	151-42- W
10/ 5/60	1	56-55- N	151-42- W
11/ 5/60	3	58-15- N	151-58- W
12/ 5/60	1	58-09- N	150-27- W
19/ 5/60	1	58-06- N	150-47- W
21/ 5/60	2	58-33- N	151-05- W
21/ 5/60	1	58-37- N	151-13- W
24/ 5/60	3	58-08- N	150-31- W
25/ 5/60	2	58-06- N	150-44- W
25/ 5/60	3	58-10- N	150-37- W
25/ 5/60	4	58-10- N	150-37- W
25/ 5/60	1	58-08- N	150-40- W
25/ 5/60	1	58-12- N	150-37- W
26/ 5/60	2	58-15- N	151-38- W
27/ 5/60	1	58-15- N	151-35- W
27/ 5/60	1	58-14- N	151-16- W
29/ 5/60	2	58-06- N	151-12- W
29/ 5/60	1	57-31- N	151-40- W
1/ 6/60	1	57-39- N	151-56- W
7/ 5/62	1	56-13- N	145-35- W
7/ 5/62	1	56-13- N	145-12- W
11/10/62	1	56-28- N	148-39- W
18/ 5/68	2	54-33- N	132-49- W
25/ 5/68	1	57-26- N	150-22- W
11/ 5/74	2	57-31- N	147-00- W
11/ 5/74	4	57-28- N	146-36- W
11/ 5/74	3	57-42- N	147-30- W
14/ 5/75	3 T	59-58- N	145-55- W
15/ 5/75	2 T	60-25- N	146-55- W
14/ 7/75	1 T	60-06- N	152-03- W

TABLE A- 8 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
FIN WHALE (BALAENOPTERA PHYSALUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
14/ 7/75	1 T	59-45- N	152-00- W
14/ 7/75	1 T	59-43- N	152-01- W
14/ 7/75	1 T	59-34-36N	151-30-42W

TABLE A- 9 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
BLUE WHALE (BALAENOPTERA MUSCULUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
25/ 5/60	2	58-10- N	150-37- W
1/ 6/60	5	55-50- N	145-58- W

TABLE A-10 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
HUMPBACK WHALE (MEGAPTERA NOVAENGLIAE)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
14/ 5/58	5	59-26-	N	146-21-	W
17/ 5/58	2	59-46-	N	147-57-	W
18/ 5/58	1	59-17-	N	147-45-	W
19/ 3/60	1	57-00-	N	135-30-	W
18/ 4/60	2	56-31-	N	152-18-	W
19/ 4/60	1	56-36-	N	152-30-	W
19/ 4/60	1	56-38-	N	152-35-	W
19/ 4/60	3	56-47-	N	152-31-	W
25/ 4/60	1	56-43-	N	152-37-	W
25/ 4/60	3	56-40-	N	152-36-	W
25/ 4/60	1	56-43-	N	152-37-	W
26/ 4/60	2	56-46-	N	152-34-	W
26/ 4/60	1	56-47-	N	152-34-	W
26/ 4/60	1	56-46-	N	152-34-	W
26/ 4/60	1	56-45-	N	152-33-	W
27/ 4/60	12	56-45-	N	152-33-	W
5/ 5/60	2	57-00-	N	152-41-	W
5/ 5/60	2	56-31-	N	152-18-	W
5/ 5/60	1	56-40-	N	152-30-	W
6/ 5/60	1	57-08-	N	151-24-	W
10/ 5/60	1	56-55-	N	151-42-	W
10/ 5/60	4	56-55-	N	151-42-	W
10/ 5/60	3	56-55-	N	151-42-	W
10/ 5/60	2	56-55-	N	151-42-	W
11/ 5/60	3	56-56-	N	151-49-	W
13/ 5/60	1	56-20-	N	153-04-	W
17/ 5/60	1	56-52-	N	153-00-	W
17/ 5/60	2	56-47-	N	152-23-	W
17/ 5/60	2	56-52-	N	153-00-	W
17/ 5/60	4	56-52-	N	153-00-	W
17/ 5/60	1	56-52-	N	151-50-	W
17/ 5/60	2	56-42-	N	151-55-	W
17/ 5/60	2	56-35-	N	153-10-	W
18/ 5/60	3	57-11-	N	152-19-	W
18/ 5/60	1	57-48-	N	150-33-	W
18/ 5/60	3	57-30-	N	152-10-	W
21/ 5/60	2	58-34-	N	151-05-	W
23/ 5/60	2	58-07-	N	151-17-	W
23/ 5/60	1	58-22-	N	151-55-	W
24/ 5/60	1	58-24-	N	151-41-	W
25/ 5/60	2	58-10-	N	150-37-	W
25/ 5/60	1	58-10-	N	150-37-	W
26/ 5/60	5	58-15-	N	151-36-	W
27/ 5/60	2	58-15-	N	151-35-	W

TABLE A-10 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
HUMPBACK WHALE (MEGAPTERA NOVAENGLIAE)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
28/ 5/60	1	58-14- N	151-18- W
29/ 5/60	1	57-31- N	151-46- W
29/ 5/60	1	58-13- N	151-27- W
29/ 5/60	3	57-28- N	151-38- W
29/ 5/60	1	57-31- N	151-40- W
31/ 5/60	1	57-14- N	150-47- W
31/ 5/60	1	57-16- N	150-55- W
31/ 5/60	2	57-37- N	152-05- W
1/ 6/60	1	57-15- N	151-40- W
1/ 6/60	2	57-38- N	151-52- W
2/ 6/60	2	56-22- N	153-47- W
2/ 6/60	2	56-51- N	152-29- W
2/ 6/60	2	56-15- N	154-10- W
7/ 5/62	1	56-13- N	145-39- W
7/ 5/62	1	56-13- N	145-32- W
19/ 5/68	2	56-51- N	135-35- W
20/ 5/68	2	56-57- N	135-43- W
3/ 5/75	5	59-10- N	144-10- W
8/ 5/75	2	60-10- N	147-38- W
12/ 5/75	1 T	59-46-48N	141-33- W
13/ 5/75	4	60-22- N	147-14- W
14/ 5/75	1	59-55- N	143-00- W
15/ 5/75	2	60-25- N	146-55- W
15/ 5/75	10	60-25- N	146-55- W
15/ 5/75	3	60-25- N	146-55- W
15/ 5/75	1	60-25- N	146-55- W
16/ 5/75	1	60-28- N	146-46- W
21/ 5/75	1	60-08- N	147-30- W
28/ 5/75	2	60-22-48N	147-12-00W
31/ 5/75	1	60-07- N	147-31-43W
2/ 6/75	2	60-09-30N	147-42-00W
9/ 7/75	2	56-45- N	154-14- W
11/ 8/75	3 T	58-02- N	150-08- W
11/ 8/75	1 T	57-46- N	150-17- W
24/ 8/75	12	57-42- N	144-56- W
2/10/75	2	56-28-54N	132-56-06W
3/10/75	1	56-30- N	133-56-30W
6/10/75	1	56-29-24N	132-53- W
9/10/75	4	56-15- N	132-40- W
21/ 4/76	11	59-14-36N	143-59-06W
22/ 4/76	1	59-16-00N	143-58-00W

TABLE A-11 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
NORTH PACIFIC WHITESIDE DOLPHIN (LAGENORHYNCHUS OBLIQUIDENS)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
6/ 4/58	18	55-42-	N	135-55-	W
8/ 4/58	2	55-30-	N	134-35-	W
9/ 2/61	6	54-16-	N	130-28-	W
21/ 5/68	2000	57-34-	N	140-33-	W
27/11/75	17	59-36-	N	142-40-	W
30/11/75	12	58-09-	N	149-57-	W

TABLE A-12 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
FALSE KILLER WHALE (PSEUDORCA CRASSIDENS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
22/ 2/58	1	57-00- N	135-30- W
4/ 5/60	1	57-20- N	152-55- W
12/ 3/61	1	53-23- N	130-58- W

TABLE A-13 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
KILLER WHALE (ORCINUS ORCA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
9/ 3/58	5	57-00- N	135-30- W
13/ 3/58	3	57-00- N	135-30- W
9/ 4/58	5	56-30- N	135-50- W
10/ 5/58	1	58-15- N	137-15- W
14/ 5/58	1	59-26- N	146-21- W
18/ 5/58	10	58-58- N	149-26- W
20/ 5/58	1	59-52- N	147-11- W
9/ 3/60	3	57-00- N	135-30- W
11/ 4/60	8	57-21- N	150-41- W
9/ 5/60	4	57-55- N	151-45- W
18/ 5/60	3	57-17- N	152-37- W
29/ 1/61	2	53-47- N	130-34- W
4/ 3/61	1	54-41- N	132-36- W
24/ 5/68	5	58-04- N	150-18- W
20/ 8/68	2	57-45- N	152-10- W
3/ 3/75	12	53-22- N	135-14- W
2/ 5/75	1	58-09- N	151-53- W
2/ 5/75	6	60-14- N	146-48- W
4/ 5/75	6	55-30- N	132-01- W
7/ 5/75	2	59-51- N	149-31- W
8/ 5/75	5	60-15- N	146-56- W
12/ 5/75	5	59-42- N	141-12- W
14/ 5/75	2	60-08- N	146-30- W
14/ 5/75	4	60-07- N	146-25- W
14/ 5/75	2	60-01- N	146-03- W
14/ 5/75	3	60-01- N	146-03- W
14/ 5/75	1 T	60-01- N	146-03- W
15/ 5/75	2	60-06- N	149-27- W
15/ 5/75	1	60-06- N	149-27- W
28/ 5/75	6	60-05-00N	147-38-00W
29/ 5/75	20	59-30- N	146-15- W
1/ 6/75	5	60-04-12N	147-38-00W
7/ 6/75	7	60-00- N	147-55- W
20/ 6/75	1 T	59-12- N	147-55- W
20/ 6/75	1 T	59-40- N	149-05- W
27/ 6/75	20	56-25- N	154-19- W
4/ 8/75	1 T	59-34- N	151-22- W
8/ 8/75	1	53-58- N	137-22- W
10/ 8/75	2	59-28- N	149-35- W
24/ 8/75	6	56-39- N	139-24- W
5/ 9/75	10	60-17- N	147-03- W
8/10/75	2	57-40- N	152-05- W
12/ 4/76	12	60-41-12N	147-39-24W
12/ 4/76	1	60-26-00N	147-30-18W

TABLE A-13 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
KILLER WHALE (ORCINUS ORCA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
16/ 4/76	5	59-50-48N	148-05-36W
17/ 4/76	12	60-21-54N	146-52-54W
22/ 4/76	1	59-14-36N	143-59-06W
29/ 4/76	4	58-22-30N	138-22-30W
29/ 4/76	2	58-22-30N	138-21-06W
19/ 6/76	2	56-01-18N	154-55-12W

TABLE A-14 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
HARBOR PORPOISE (PHOCOENA PHOCOENA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
16/ 2/58	35	57-00- N	135-30- W
14/ 3/60	4	57-00- N	135-30- W
29/ 3/60	2	57-01- N	135-21- W
30/ 3/60	2	57-00- N	135-30- W
3/ 4/60	1	57-59- N	136-18- W
3/ 4/60	1	58-08- N	136-22- W
3/ 4/60	1	58-08- N	136-22- W
6/ 4/60	4	59-37- N	146-25- W
24/ 4/60	1	56-55- N	135-30- W
20/ 5/60	7	58-00- N	150-17- W
21/ 5/60	2	58-10- N	152-15- W
23/ 5/60	25	58-02- N	151-19- W
23/ 5/60	2	58-02- N	151-12- W
28/ 5/60	2	58-09- N	151-16- W
12/ 3/61	2	53-04- N	131-17- W
10/ 9/63	1	57-10- N	155-31- W
25/ 5/68	1	57-23- N	152-09- W
26/ 5/68	12	56-42- N	152-21- W
29/ 5/68	100	57-40- N	152-07- W
31/ 5/68	1	57-16- N	152-31- W
31/ 5/68	2	57-09- N	152-34- W
31/ 5/68	3	57-18- N	152-27- W
1/ 6/68	3	56-34- N	152-56- W
1/ 6/68	4	56-34- N	152-56- W
1/ 6/68	4	56-28- N	153-00- W
1/ 6/68	2	56-28- N	152-58- W
1/ 6/68	2	56-30- N	152-57- W
7/ 2/75	6 T	60-18- N	146-48- W
28/ 2/75	3 T	59-32- N	143-12- W
28/ 2/75	2 T	59-43- N	141-39- W
17/ 5/75	5	60-53- N	146-59- W
4/ 8/75	2	59-36- N	151-24- W
9/ 8/75	1 T	60-33- N	151-31- W
9/ 8/75	4	59-53- N	149-26- W
10/ 8/75	3 T	60-00- N	149-25- W
12/ 8/75	1	60-31- N	151-26- W
17/ 8/75	1	59-36- N	151-24- W
18/ 8/75	1	59-36- N	151-24- W
22/ 8/75	2	59-40- N	151-57- W
22/ 8/75	2	59-36- N	151-24- W
22/ 8/75	6	59-36- N	151-24- W
23/ 8/75	1	59-33- N	151-42- W
23/ 8/75	2	59-33- N	151-36- W
23/ 8/75	2	59-35- N	151-25- W

TABLE A-14 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
HARBOR PORPOISE (PHOCOENA PHOCOENA)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
25/ 8/75	1	59-30- N	151-53- W
3/ 9/75	4 T	59-52- N	148-19- W
29/ 9/75	2	55-26- N	131-49-24W
9/10/75	1	56-28- N	132-40- W
29/11/75	2	59-57- N	147-08- W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES CALLI)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
2/ 4/58	5	58-10-	N	139-30-	W
3/ 4/58	4	58-45-	N	140-05-	W
3/ 4/58	3 T	58-50-	N	140-05-	W
4/ 4/58	45	57-30-	N	137-55-	W
5/ 4/58	1	57-30-	N	137-45-	W
6/ 4/58	4	56-10-	N	136-25-	W
6/ 4/58	5	56-20-	N	136-45-	W
7/ 4/58	2	55-02-	N	135-10-	W
9/ 4/58	1	57-00-	N	135-30-	W
17/ 4/58	1	57-17-	N	137-05-	W
17/ 4/58	4	57-05-	N	136-09-	W
19/ 4/58	5	58-14-	N	139-10-	W
20/ 4/58	3	58-38-	N	139-18-	W
21/ 4/58	5	59-29-	N	140-35-	W
21/ 4/58	7	59-25-	N	140-42-	W
22/ 4/58	2	59-25-	N	139-56-	W
24/ 4/58	3	57-21-	N	139-40-	W
24/ 4/58	2	57-01-	N	139-10-	W
24/ 4/58	3	56-58-	N	138-52-	W
24/ 4/58	10	56-57-	N	138-32-	W
25/ 4/58	2	56-58-	N	136-54-	W
25/ 4/58	1	56-58-	N	136-15-	W
25/ 4/58	1	56-58-	N	136-47-	W
25/ 4/58	2	56-57-	N	137-00-	W
25/ 4/58	9	56-57-	N	137-20-	W
25/ 4/58	5	56-58-	N	136-09-	W
27/ 4/58	3	56-58-	N	136-16-	W
27/ 4/58	4	56-58-	N	136-16-	W
28/ 4/58	1	56-57-	N	137-50-	W
28/ 4/58	1	56-51-	N	136-57-	W
28/ 4/58	2	56-49-	N	136-44-	W
28/ 4/58	1	56-46-	N	136-31-	W
29/ 4/58	2	57-40-	N	139-55-	W
30/ 4/58	3	58-15-	N	142-41-	W
1/ 5/58	3	58-28-	N	146-54-	W
1/ 5/58	2	58-26-	N	145-56-	W
1/ 5/58	3	58-29-	N	147-15-	W
1/ 5/58	3	58-28-	N	146-59-	W
2/ 5/58	3	58-14-	N	150-01-	W
2/ 5/58	1	58-23-	N	149-04-	W
2/ 5/58	7	58-25-	N	148-48-	W
2/ 5/58	1	58-25-	N	148-48-	W
3/ 5/58	3	58-04-	N	150-10-	W
3/ 5/58	1	58-14-	N	150-10-	W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
3/ 5/58	4	58-20- N	150-34- W
4/ 5/58	1	57-52- N	151-58- W
7/ 5/58	4	58-01- N	151-47- W
8/ 5/58	2	58-35- N	149-16- W
8/ 5/58	4	58-35- N	149-16- W
8/ 5/58	35	58-35- N	149-16- W
8/ 5/58	1	58-35- N	149-16- W
10/ 5/58	2	58-27- N	149-07- W
10/ 5/58	75	58-27- N	149-07- W
12/ 5/58	4	58-47- N	141-00- W
13/ 5/58	2	59-24- N	145-52- W
14/ 5/58	4	59-26- N	146-21- W
15/ 5/58	2	59-32- N	145-29- W
16/ 5/58	4	59-49- N	145-40- W
16/ 5/58	3	59-49- N	145-33- W
16/ 5/58	4	59-07- N	150-08- W
16/ 5/58	2	58-54- N	150-13- W
16/ 5/58	3	58-38- N	150-57- W
18/ 5/58	4	58-55- N	149-52- W
18/ 5/58	12	59-17- N	147-45- W
18/ 5/58	2	59-06- N	148-11- W
18/ 5/58	10	58-55- N	149-40- W
18/ 5/58	2	58-55- N	149-45- W
19/ 5/58	4	59-15- N	147-36- W
20/ 5/58	2	60-25- N	146-47- W
20/ 5/58	32	60-10- N	147-00- W
20/ 5/58	5	60-05- N	147-10- W
22/ 5/58	8	60-00- N	146-07- W
22/ 5/58	4	59-52- N	145-45- W
22/ 5/58	5	59-58- N	146-04- W
23/ 5/58	4	59-43- N	145-11- W
23/ 5/58	6	59-35- N	148-32- W
23/ 5/58	2	59-39- N	145-02- W
27/ 5/58	4	59-11- N	147-24- W
27/ 5/58	5	59-04- N	148-02- W
28/ 5/58	4	58-33- N	148-41- W
28/ 5/58	4	58-33- N	148-41- W
29/ 5/58	3	58-01- N	149-06- W
1/ 6/58	3	57-01- N	151-49- W
1/ 6/58	3	57-41- N	151-49- W
3/ 3/60	4	55-26- N	131-38- W
3/ 3/60	6	55-37- N	132-16- W
5/ 4/60	2	59-35- N	142-37- W
5/ 4/60	1	59-35- N	143-05- W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
9/ 4/60	2	59-22-	N	148-18-	W
9/ 4/60	4	59-36-	N	148-11-	W
9/ 4/60	2	59-36-	N	148-11-	W
9/ 4/60	2	59-20-	N	148-20-	W
21/ 4/60	2	54-28-	N	131-51-	W
22/ 4/60	3	54-40-	N	131-58-	W
23/ 4/60	6	55-44-	N	135-30-	W
24/ 4/60	2	57-01-	N	152-43-	W
24/ 4/60	1	56-50-	N	152-35-	W
25/ 4/60	2	56-59-	N	152-39-	W
26/ 4/60	2	57-07-	N	137-05-	W
27/ 4/60	1	58-05-	N	138-34-	W
27/ 4/60	3	57-46-	N	138-03-	W
27/ 4/60	8	57-35-	N	137-44-	W
29/ 4/60	6	59-11-	N	142-10-	W
1/ 5/60	3	59-52-	N	144-54-	W
1/ 5/60	1	59-52-	N	144-56-	W
3/ 5/60	6	59-05-	N	147-38-	W
3/ 5/60	2	57-01-	N	152-21-	W
10/ 5/60	2	58-03-	N	151-27-	W
11/ 5/60	3	58-29-	N	151-28-	W
11/ 5/60	6	58-29-	N	150-50-	W
12/ 5/60	3	58-09-	N	150-16-	W
12/ 5/60	5	58-10-	N	150-27-	W
13/ 5/60	6	58-09-	N	150-59-	W
13/ 5/60	1	58-11-	N	150-25-	W
17/ 5/60	4	56-53-	N	153-10-	W
18/ 5/60	2	57-30-	N	152-10-	W
18/ 5/60	1	57-48-	N	150-54-	W
18/ 5/60	4	57-49-	N	151-40-	W
18/ 5/60	2	57-45-	N	150-05-	W
19/ 5/60	50	58-07-	N	150-42-	W
19/ 5/60	12	58-08-	N	150-40-	W
20/ 5/60	3	58-00-	N	150-17-	W
21/ 5/60	1	58-22-	N	151-47-	W
21/ 5/60	22	58-33-	N	151-01-	W
21/ 5/60	6	58-34-	N	151-05-	W
21/ 5/60	2	58-35-	N	151-36-	W
24/ 5/60	12	58-40-	N	150-42-	W
25/ 5/60	3	58-10-	N	150-37-	W
25/ 5/60	2	58-10-	N	150-37-	W
25/ 5/60	4	58-10-	N	150-37-	W
25/ 5/60	2	58-07-	N	150-45-	W
25/ 5/60	5	58-10-	N	150-37-	W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
25/ 5/60	2	58-10- N	150-37- W
25/ 5/60	10	58-11- N	150-40- W
25/ 5/60	6	58-09- N	150-43- W
26/ 5/60	55	58-15- N	151-33- W
28/ 5/60	5	58-09- N	151-16- W
28/ 5/60	3	58-09- N	151-16- W
28/ 5/60	1	58-01- N	151-23- W
28/ 5/60	2	58-01- N	151-23- W
28/ 5/60	2	58-09- N	151-16- W
29/ 5/60	1	57-31- N	151-46- W
31/ 5/60	1	57-11- N	150-40- W
2/ 6/60	6	57-04- N	152-35- W
2/ 6/60	5	56-08- N	154-29- W
2/ 6/60	4	54-44- N	141-53- W
2/ 6/60	2	54-15- N	140-23- W
6/ 2/61	6	53-38- N	130-44- W
6/ 2/61	2	55-06- N	131-12- W
6/ 2/61	2	55-01- N	131-07- W
6/ 2/61	3	54-55- N	131-02- W
9/ 2/61	8	54-31- N	130-36- W
9/ 2/61	2	54-18- N	130-45- W
3/ 3/61	5	54-42- N	132-30- W
4/ 3/61	3	54-40- N	132-38- W
5/ 3/61	3	55-22- N	133-27- W
5/ 3/61	10	55-09- N	132-02- W
5/ 3/61	2	55-06- N	132-57- W
5/ 3/61	5	55-00- N	132-50- W
6/ 5/62	5	56-10- N	139-25- W
6/ 5/62	4	56-10- N	139-18- W
6/ 5/62	4	56-10- N	139-50- W
7/ 5/62	1	56-13- N	145-09- W
7/ 5/62	3	56-13- N	145-00- W
7/ 5/62	2	56-13- N	144-58- W
7/ 5/62	4	56-12- N	144-30- W
7/ 5/62	3	56-12- N	144-26- W
12/ 5/62	2	56-21- N	153-45- W
20/ 9/62	1	56-37- N	153-36- W
11/10/62	1	56-30- N	150-17- W
11/10/62	3	56-30- N	149-23- W
11/10/62	3	56-30- N	150-15- W
24/ 6/63	3	52-00- N	143-30- W
25/ 6/63	4	52-34- N	146-28- W
25/ 6/63	1	52-39- N	147-20- W
26/ 6/63	2	53-00- N	150-30- W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
26/ 6/63	1	53-13- N	152-30- W
27/ 6/63	1	53-30- N	155-13- W
10/ 9/63	3	56-55- N	155-57- W
10/ 9/63	1	57-10- N	155-31- W
11/ 9/63	6	57-52- N	150-15- W
11/ 9/63	3	57-52- N	150-14- W
11/ 9/63	2	57-52- N	150-15- W
11/ 9/63	3	55-51- N	149-59- W
11/ 9/63	3	55-51- N	150-04- W
11/ 9/63	2	55-51- N	150-05- W
26/ 6/64	4	56-22- N	137-37- W
26/ 6/64	4	56-15- N	136-32- W
26/ 6/64	2	56-14- N	136-25- W
26/ 6/64	1	56-22- N	137-40- W
26/ 6/64	2	56-22- N	137-40- W
26/ 6/64	1	56-24- N	138-05- W
27/ 6/64	2	56-46- N	141-30- W
27/ 6/64	2	56-49- N	141-57- W
18/ 5/68	1	54-37- N	133-10- W
18/ 5/68	6	54-30- N	132-11- W
18/ 5/68	2	54-30- N	132-42- W
18/ 5/68	4	54-30- N	132-40- W
18/ 5/68	4	54-30- N	132-30- W
18/ 5/68	7	54-30- N	132-20- W
18/ 5/68	2	54-28- N	131-45- W
18/ 5/68	2	54-22- N	131-03- W
18/ 5/68	3	54-26- N	131-30- W
19/ 5/68	1	56-31- N	135-32- W
19/ 5/68	1	56-28- N	135-32- W
19/ 5/68	2	56-20- N	135-32- W
19/ 5/68	1	55-35- N	134-42- W
19/ 5/68	4	55-34- N	134-36- W
19/ 5/68	3	56-02- N	135-19- W
19/ 5/68	1	56-01- N	135-16- W
19/ 5/68	3	56-08- N	135-28- W
19/ 5/68	2	56-03- N	135-21- W
19/ 5/68	1	56-39- N	135-34- W
19/ 5/68	2	56-56- N	135-31- W
19/ 5/68	2	56-47- N	135-34- W
19/ 5/68	2	56-38- N	135-33- W
19/ 5/68	1	56-34- N	135-33- W
20/ 5/68	12	57-02- N	136-17- W
20/ 5/68	3	57-04- N	136-31- W
20/ 5/68	1	57-04- N	136-28- W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
20/ 5/68	2	57-03-	N	136-19-	W
20/ 5/68	3	57-05-	N	136-47-	W
20/ 5/68	2	57-05-	N	136-47-	W
21/ 5/68	4	57-33-	N	141-43-	W
21/ 5/68	3	57-35-	N	140-23-	W
21/ 5/68	2	57-34-	N	140-50-	W
21/ 5/68	5	57-33-	N	139-58-	W
21/ 5/68	2	57-35-	N	140-15-	W
21/ 5/68	2	57-33-	N	141-24-	W
22/ 5/68	1	58-09-	N	148-06-	W
22/ 5/68	2	58-10-	N	148-19-	W
22/ 5/68	2	58-13-	N	148-45-	W
22/ 5/68	1	58-12-	N	148-39-	W
22/ 5/68	3	58-14-	N	148-50-	W
23/ 5/68	3	58-05-	N	149-05-	W
23/ 5/68	2	58-03-	N	149-12-	W
23/ 5/68	500	57-51-	N	149-48-	W
23/ 5/68	2	58-03-	N	149-13-	W
23/ 5/68	8	57-52-	N	149-55-	W
23/ 5/68	2	57-52-	N	149-34-	W
23/ 5/68	3	57-51-	N	149-48-	W
24/ 5/68	6	57-55-	N	150-04-	W
24/ 5/68	12	57-58-	N	150-10-	W
24/ 5/68	2	57-41-	N	150-26-	W
24/ 5/68	5	58-00-	N	150-28-	W
24/ 5/68	2	57-47-	N	150-26-	W
24/ 5/68	20	57-55-	N	150-03-	W
24/ 5/68	50	57-52-	N	150-02-	W
24/ 5/68	1	58-08-	N	150-29-	W
25/ 5/68	5	57-24-	N	152-08-	W
25/ 5/68	12	57-23-	N	152-10-	W
25/ 5/68	2	57-23-	N	150-55-	W
25/ 5/68	1	57-23-	N	150-57-	W
25/ 5/68	4	57-11-	N	152-02-	W
25/ 5/68	2	57-22-	N	150-39-	W
25/ 5/68	1	57-23-	N	150-59-	W
25/ 5/68	1	57-22-	N	150-40-	W
25/ 5/68	2	57-09-	N	151-59-	W
25/ 5/68	4	57-08-	N	151-57-	W
25/ 5/68	20	57-03-	N	151-53-	W
25/ 5/68	1	57-27-	N	152-07-	W
25/ 5/68	2	57-32-	N	151-56-	W
25/ 5/68	2	57-35-	N	152-02-	W
25/ 5/68	1	57-33-	N	151-58-	W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
25/ 5/68	3	57-28-	N	152-05-	W
25/ 5/68	3	57-27-	N	152-07-	W
25/ 5/68	1	57-27-	N	152-06-	W
26/ 5/68	16	56-30-	N	152-35-	W
26/ 5/68	2	56-55-	N	151-48-	W
26/ 5/68	6	56-36-	N	152-34-	W
26/ 5/68	1	56-50-	N	151-45-	W
26/ 5/68	5	56-33-	N	151-44-	W
26/ 5/68	2	56-35-	N	151-44-	W
26/ 5/68	2	56-36-	N	151-45-	W
26/ 5/68	14	56-38-	N	152-15-	W
26/ 5/68	20	56-44-	N	152-23-	W
26/ 5/68	50	56-42-	N	152-21-	W
26/ 5/68	1	56-40-	N	152-34-	W
26/ 5/68	3	56-46-	N	152-28-	W
26/ 5/68	5	56-36-	N	152-34-	W
27/ 5/68	4	56-25-	N	152-25-	W
27/ 5/68	2	56-17-	N	152-33-	W
27/ 5/68	1	56-17-	N	152-47-	W
27/ 5/68	4	56-12-	N	152-46-	W
27/ 5/68	3	56-10-	N	152-52-	W
27/ 5/68	5	56-07-	N	152-45-	W
27/ 5/66	2	56-12-	N	152-46-	W
27/ 5/68	3	56-11-	N	152-48-	W
27/ 5/68	5	56-10-	N	152-50-	W
27/ 5/68	3	56-10-	N	152-50-	W
28/ 5/68	6	57-08-	N	151-15-	W
28/ 5/68	2	56-58-	N	151-27-	W
28/ 5/68	1	56-31-	N	152-10-	W
29/ 5/68	2	57-01-	N	151-11-	W
29/ 5/68	50	57-40-	N	152-07-	W
1/ 6/68	3	56-54-	N	152-39-	W
1/ 6/68	4	55-56-	N	153-46-	W
1/ 6/68	2	55-58-	N	153-38-	W
1/ 6/68	3	56-47-	N	152-46-	W
1/ 6/68	2	56-45-	N	152-48-	W
2/ 6/68	8	55-29-	N	155-41-	W
2/ 6/68	4	55-32-	N	155-35-	W
2/ 6/68	3	55-24-	N	155-59-	W
19/ 8/68	1	56-05-	N	155-04-	W
20/ 8/68	3	56-56-	N	152-14-	W
20/ 8/68	4	56-44-	N	152-18-	W
20/ 8/68	2	56-56-	N	152-14-	W
20/ 8/68	5	56-58-	N	152-13-	W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE		LONGITUDE	
20/ 8/68	1	57-12-	N	152-13-	W
22/ 8/68	2	57-52-	N	152-05-	W
22/ 8/68	2	57-52-	N	152-01-	W
22/ 8/68	6	57-52-	N	152-00-	W
22/ 8/68	2	57-52-	N	152-00-	W
22/ 8/68	3	57-45-	N	150-23-	W
22/ 8/68	3	57-52-	N	151-59-	W
22/ 8/68	2	57-44-	N	150-19-	W
22/ 8/68	1	57-42-	N	150-02-	W
22/ 8/68	1	57-44-	N	150-15-	W
22/ 8/68	1	57-40-	N	149-57-	W
22/ 8/68	4	57-39-	N	149-54-	W
23/ 8/68	1	57-24-	N	144-05-	W
23/ 8/68	3	57-23-	N	144-30-	W
23/ 8/68	2	57-27-	N	146-10-	W
23/ 8/68	3	57-26-	N	145-52-	W
23/ 8/68	1	57-22-	N	144-50-	W
24/ 8/68	2	57-13-	N	138-54-	W
24/ 8/68	2	57-16-	N	140-50-	W
24/ 8/68	3	57-16-	N	140-45-	W
24/ 8/68	2	57-13-	N	138-44-	W
24/ 8/68	2	57-13-	N	138-57-	W
24/ 8/68	7	57-16-	N	140-31-	W
24/ 8/68	3	57-16-	N	140-41-	W
24/ 8/68	4	57-13-	N	138-36-	W
13/ 6/70	3	53-03-	N	154-38-	W
14/ 6/70	3	53-02-	N	150-45-	W
14/ 6/70	2	52-58-	N	149-55-	W
15/ 6/70	5	52-25-	N	144-23-	W
15/ 6/70	2	52-25-	N	144-23-	W
15/ 6/70	8	52-25-	N	144-23-	W
3/ 2/75	3	59-04-	N	142-17-	W
3/ 2/75	8	59-08-	N	142-25-	W
3/ 2/75	12 T	59-05-	N	142-20-	W
4/ 2/75	10	59-05-	N	142-26-	W
4/ 2/75	12	59-04-	N	142-45-	W
5/ 2/75	9	59-00-	N	142-17-	W
5/ 2/75	5	59-02-	N	142-10-	W
5/ 2/75	5	59-03-	N	142-35-	W
5/ 2/75	11	59-01-	N	[illegible]	[illegible]
7/ 2/75	6	[illegible]	N	146-54-	W
7/ 2/75	7	60-12-	N	146-25-	W
7/ 2/75	1	60-20-	N	146-52-	W
7/ 2/75	1	60-15-	N	146-49-	W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE	LONGTITUDE
8/ 2/75	1	59-47- N	149-28- W
8/ 2/75	2	59-51- N	149-51- W
9/ 2/75	9	58-21- N	147-30- W
9/ 2/75	11	58-21- N	147-08- W
25/ 2/75	6	60-39- N	146-39- W
25/ 2/75	2	60-36- N	146-40- W
1/ 3/75	6	59-45- N	149-21- W
6/ 4/75	12	57-13- N	133-36- W
7/ 4/75	10	58-05- N	134-07- W
21/ 4/75	8	58-21- N	151-30- W
23/ 4/75	7	53-21- N	133-40- W
23/ 4/75	5	53-04-48N	133-24-24W
24/ 4/75	7	57-47- N	137-18- W
24/ 4/75	13 T	57-24- N	136-54- W
2/ 5/75	2	60-09- N	146-09-48W
2/ 5/75	6	60-13- N	146-44- W
2/ 5/75	9	58-47- N	143-00- W
4/ 5/75	1	57-59- N	150-46- W
4/ 5/75	8	58-12- N	135-10- W
5/ 5/75	1	58-18- N	139-56- W
5/ 5/75	3	58-20- N	136-00- W
5/ 5/75	7	58-31-30N	148-12- W
6/ 5/75	10	59-51- N	149-31- W
6/ 5/75	8	59-01- N	151-36- W
6/ 5/75	8	59-45- N	149-30- W
7/ 5/75	25	59-51- N	149-31- W
7/ 5/75	3	59-59-06N	149-21-30W
9/ 5/75	3	60-07- N	149-25- W
10/ 5/75	5	59-40- N	144-08- W
10/ 5/75	2	59-43- N	143-19- W
10/ 5/75	3 T	53-07- N	134-30- W
10/ 5/75	4	58-38- N	141-30- W
10/ 5/75	6	58-25- N	141-36- W
10/ 5/75	3	52-35- N	133-20- W
10/ 5/75	10	60-31- N	146-40- W
10/ 5/75	10	60-10- N	146-34- W
12/ 5/75	7	59-58- N	149-23- W
13/ 5/75	13	60-20- N	147-17- W
15/ 5/75	2 T	60-00- N	149-22- W
15/ 5/75	4	60-02- N	149-23- W
15/ 5/75	8 T	59-58- N	149-23- W
15/ 5/75	2 T	60-25- N	146-55- W
16/ 5/75	3	60-05- N	147-33- W
16/ 5/75	6	60-06- N	147-31- W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
16/ 5/75	3	58-48- N	149-35- W
17/ 5/75	11	60-53- N	146-59- W
18/ 5/75	1	60-28- N	146-52- W
19/ 5/75	1	58-33- N	151-22- W
19/ 5/75	25	58-20- N	151-53- W
20/ 5/75	1	58-35- N	151-00- W
21/ 5/75	3	60-10- N	147-37- W
23/ 5/75	12	60-09- N	147-20- W
27/ 5/75	13	60-03- N	149-23- W
28/ 5/75	12	60-05- N	147-38- W
29/ 5/75	10	60-02- N	147-35- W
29/ 5/75	6 T	59-22-30N	145-59- W
30/ 5/75	15	60-08- N	146-38- W
30/ 5/75	10	59-27- N	146-00- W
5/ 6/75	5 T	59-32-48N	142-33-30W
10/ 6/75	6	59-02-00N	151-23-00W
19/ 6/75	2	58-03- N	150-03- W
20/ 6/75	2	59-40- N	149-25- W
21/ 6/75	6 T	54-35- N	138-16- W
30/ 7/75	1	60-30- N	151-43- W
9/ 8/75	2	59-57- N	149-24- W
10/ 8/75	9	59-40- N	149-28- W
10/ 8/75	24	59-34- N	149-30- W
10/ 8/75	10	59-17- N	149-40- W
10/ 8/75	50	58-38- N	149-50- W
11/ 8/75	7	58-02- N	150-08- W
11/ 8/75	16	57-47- N	150-19- W
11/ 8/75	11	57-50- N	150-15- W
11/ 8/75	15	57-54- N	150-14- W
11/ 8/75	9	57-10- N	150-33- W
11/ 8/75	5	57-13- N	150-27- W
11/ 8/75	9	57-32- N	150-24- W
11/ 8/75	5	57-37- N	150-22- W
23/ 8/75	5	58-18- N	147-53- W
23/ 8/75	1	58-45- N	149-49-30W
23/ 8/75	1	59-33-30N	151-53-30W
23/ 8/75	4	57-54- N	146-00- W
23/ 8/75	7	58-12- N	147-08- W
23/ 8/75	4	58-13- N	147-13- W
23/ 8/75	12	58-15- N	147-43- W
24/ 8/75	4	57-47- N	145-27- W
24/ 8/75	2	56-38- N	139-21- W
24/ 8/75	2	57-37- N	144-30- W
24/ 8/75	4	55-34- N	137-55- W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
25/ 8/75	6	52-17- N	132-29- W
25/ 8/75	2	52-42- N	133-07- W
25/ 8/75	6	59-32- N	151-33- W
28/ 8/75	6	57-38- N	152-01- W
28/ 8/75	3	57-34- N	152-02- W
3/ 9/75	6	57-41- N	152-06- W
3/ 9/75	3	57-38- N	152-01- W
3/ 9/75	5	56-33- N	152-14- W
3/ 9/75	5	59-16- N	150-27- W
3/ 9/75	4	59-12- N	150-41- W
4/ 9/75	2	60-23- N	145-13- W
4/ 9/75	2	60-19- N	147-28- W
7/ 9/75	2	58-25- N	137-56- W
14/10/75	12	57-07- N	134-00- W
14/10/75	4	57-07- N	133-57- W
14/10/75	2	56-30- N	132-55- W
23/10/75	8	59-22-42N	149-06-12W
23/10/75	8	59-25- N	149-06- W
23/10/75	4	59-25- N	149-05- W
23/10/75	1	59-43-42N	149-18- W
25/10/75	2	59-11- N	147-36- W
25/10/75	5	59-11- N	147-36- W
28/10/75	5	60-10- N	146-43- W
28/10/75	5	60-26- N	146-48- W
28/10/75	6	60-30- N	146-45- W
28/10/75	8	60-20- N	146-48- W
29/10/75	8	60-03- N	144-47- W
30/10/75	2	60-03- N	144-47- W
30/10/75	8	60-03- N	144-47- W
30/10/75	3	60-03- N	144-47- W
2/11/75	6	59-15- N	144-40- W
2/11/75	11	59-15- N	144-40- W
3/11/75	3	59-15- N	143-58- W
3/11/75	5	59-59- N	144-48- W
4/11/75	3	59-43- N	142-46- W
7/11/75	5	59-35-30N	141-37- W
8/11/75	4	58-13- N	142-05- W
8/11/75	2	58-13- N	142-05- W
8/11/75	6	58-13- N	142-05- W
8/11/75	3	58-13- N	142-05- W
8/11/75	12	58-13- N	142-05- W
9/11/75	25	58-13- N	142-05- W
20/11/75	2	59-34- N	140-36- W
26/11/75	6	59-34- N	141-54- W

TABLE A-15 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
DALL PORPOISE (PHOCOENOIDES DALLI)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
29/11/75	3	60-00- N	147-06- W
3/12/75	4	57-42- N	142-43- W
3/12/75	3	56-32- N	140-50- W
3/12/75	15	57-27- N	142-10- W
3/12/75	5	56-40- N	141-05- W
13/ 4/76	6	59-57-42N	147-49-48W
13/ 4/76	9	60-15-30N	147-32-12W
13/ 4/76	8	60-09-36N	147-41-12W
13/ 4/76	5	60-11-54N	147-39-36W
20/ 4/76	4	59-00-36N	145-19-48W
20/ 4/76	4	58-38-12N	145-13-00W
21/ 4/76	3	59-28-00N	143-57-12W
21/ 4/76	3	59-28-00N	143-57-12W
28/ 4/76	4	58-37-24N	140-44-06W
29/ 4/76	3	58-12-42N	140-02-36W
20/ 6/76	1	56-55-12N	153-02-00W
20/ 6/76	2	56-49-30N	153-03-30W
20/ 6/76	3	56-53-42N	153-04-42W
20/ 6/76	4	56-57-12N	152-57-26W
20/ 6/76	5	56-53-00N	153-06-00W
20/ 6/76	2	56-52-30N	153-07-00W
20/ 6/76	2	56-51-18N	153-54-30W
20/ 6/76	3	56-49-30N	153-12-30W
20/ 6/76	3	53-36-42N	144-20-00W
20/ 6/76	10	53-47-30N	146-09-00W

TABLE A-16 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
BELUGA (DELPHINAPTERUS LEUCAS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
20/ 5/74	1	59-24- N	153-21- W
28/ 5/74	2	61-13- N	149-54- W
1/ 8/74	2	60-18- N	152-08- W
8/ 8/74	2	60-22- N	152-04- W
8/ 8/74	1	60-22- N	152-04- W
20/ 8/74	1	60-21- N	151-50- W
21/ 8/74	3	60-25- N	151-40- W
22/ 8/74	5	60-24- N	152-10- W
8/ 5/75	3	60-50-12N	151-20-00W
28/ 5/75	6	61-09-30N	150-17- W
30/ 5/75	30	61-12- N	150-32- W
3/ 6/75	3	61-02- N	151-13- W
10/ 6/75	11	61-12- N	150-30- W
11/ 6/75	1	60-35- N	151-47-18W
13/ 6/75	2	60-31- N	151-51- W
14/ 6/75	3	60-31- N	151-51- W
19/ 6/75	1	60-37- N	151-40- W
20/ 6/75	6	61-05- N	150-40- W
20/ 6/75	8	61-03-12N	150-54-30W
24/ 6/75	3	61-11- N	150-00- W
1/ 7/75	2	61-12- N	150-30- W
1/ 7/75	50	61-00- N	151-20- W
3/ 7/75	1	60-40- N	151-30- W
8/ 7/75	5	60-38- N	151-37- W
8/ 7/75	6	61-10- N	150-23-48W
9/ 7/75	1	61-06-12N	150-27-12W
9/ 7/75	1	61-08-12N	150-20-00W
9/ 7/75	40	60-55- N	151-23- W
11/ 7/75	1	60-53- N	151-15- W
12/ 7/75	11	60-36- N	151-32- W
12/ 7/75	10	60-45- N	151-33- W
12/ 7/75	15	60-50- N	151-22- W
13/ 7/75	17	60-34-30N	151-34-00W
15/ 7/75	50	60-30-30N	151-41- W
16/ 7/75	2	60-53-24N	151-14-24W
23/ 7/75	40	60-26- N	151-29- W
23/ 7/75	5	60-26- N	151-32- W
25/ 7/75	1	60-43-12N	151-34-06W
25/ 7/75	2	60-43-18N	151-34-12W
25/ 7/75	3	60-43-18N	151-34-12W
25/ 7/75	12	60-42-24N	151-42-30W
25/ 7/75	1	60-43-00N	151-34-06W
26/ 7/75	1	60-48-24N	151-16-54W
28/ 7/75	5	60-50-30N	151-24- W

TABLE A-16 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
BELUGA (DELPHINAPTERUS LEUCAS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
29/ 7/75	10	61-08-36N	150-38-30W
29/ 7/75	2	61-08-36N	150-38-30W
29/ 7/75	2	61-08-36N	150-36-30W
29/ 7/75	2	60-47-42N	151-19-30W
29/ 7/75	3	60-35- N	151-24- W
29/ 7/75	100	60-32- N	151-30- W
30/ 7/75	1	60-38- N	151-33- W
31/ 7/75	2	60-34- N	151-50- W
31/ 7/75	25	60-37- N	151-40- W
6/ 8/75	2	60-32- N	151-52- W
7/ 8/75	50	60-24- N	152-10- W
7/ 8/75	2	60-41- N	151-26- W
7/ 8/75	1	60-34- N	151-40- W
8/ 8/75	1	61-14-30N	149-53-06W
9/ 8/75	1	60-32- N	151-31- W
9/ 8/75	5	60-31- N	151-32- W
9/ 8/75	1	60-33- N	151-52- W
9/ 8/75	10	60-32- N	151-30- W
9/ 8/75	2	60-35- N	151-29- W
10/ 8/75	5	60-34- N	151-34- W
10/ 8/75	7	60-34- N	151-35- W
11/ 8/75	3	60-32- N	151-30- W
13/ 8/75	6	60-34- N	151-35- W
3/ 9/75	1	60-26- N	151-41- W
3/ 9/75	1	60-41- N	151-35- W

TABLE A-17 OBSERVATIONS OF MARINE MAMMALS IN THE GULF OF ALASKA
SPERM WHALE (PHYSETER MACROCEPHALUS)

DATE	NUMBER SEEN	LATITUDE	LONGITUDE
26/ 5/58	1	59-32- N	145-42- W
3/ 6/58	1	57-31- N	150-40- W
7/ 6/58	1	56-52- N	153-02- W
8/ 6/58	4	56-42- N	152-19- W
2/ 6/60	1	54-20- N	140-43- W
2/ 6/60	3	54-22- N	140-46- W
2/ 6/60	2	54-53- N	142-17- W
3/ 6/60	5	52-33- N	135-45- W
25/ 6/63	1	52-22- N	145-20- W
2/ 5/75	20	58-46- N	141-57- W
8/ 8/75	1	57-33- N	144-31- W
24/ 8/75	2	57-40- N	144-40- W
28/11/75	1 T	59-27- N	145-11- W

APPENDIX B

Annotated Bibliography

BERZIN, A.A. 1964. Opredelenic vozrastnogo sostava stada kashalotov Beringova morya i prilezhashchikh chastei Tikhogo okeana (Determination of age composition of the sperm whale stock of the Bering Sea and adjacent parts of the Pacific). Trv. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 52:267-270 (Transl. by Israel Program Sci. Transl. 1968. p. 263-266 in P.A. Moiseev (ed.), Soviet fisheries investigations in the northeast Pacific, Pt. 3, avail. Natl. Tech. Inf. Serv. Springfield, VA. as TT 67-51205.)

Pacific sperm whales are composed of two independent stocks: Asiatic and American. American stock said to migrate from California to Aleutian Islands and into the Bering Sea. Catch imformation in 1950-61 indicated that American stock was becoming younger because intensive whaling since 1954 removed older animals. 1. fig.

BERZIN, A.A. AND A.A. ROVNIN. 1966. Raspredelenie i, migratsii kitov v severo-vostochnoi chasti Tikhoga okeana, v Beringovom i Chukotskom moryakh (Distribution and migration of whales in the northeastern part of the Pacific Ocean, Bering and Chukchi Seas). Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 58: 179-207.

Information on sperm, humpback, finback, blue, gray, and Pacific right whales has been gathered by Russian research vessels and whaling fleets, and is presented here. Distribution charts for each species are included. Migration patterns are shown to be complex and therefore the traditional concept of "American" and "Asiatic" stocks of whales should be abandoned. Three oceanographic factors are discussed as they relate to whale distribution: (1) salinity of water, (2) cyclonic current systems, and (3) distribution of preferred food species. 8 fig.

BROOKS, J.W. 1957. Marine Mammals in relation to commercial fisheries in Alaska. Paper presented at the Eigth Alaskan Science Conf., Anchorage, Alaska, Sept. 10-13. 6 pp.

Of the 7 pinnipeds and more than 12 cetaceans common to Alaska, only the fur seal and the walrus are of major present commercial value; however, Eskimos utilize ringed seal, bearded seal, harbor seal, and ribbon seal, beluga, bowhead and gray whale on a smaller scale. Beluga whales, harbor seals, and northern sea lions are discussed as predators on commercial fish. Beluga whale research in estuaries of Bristol Bay was begun in 1954. Harbor seal control program by Alaska Dept. of Fish and Game is discussed.

Calkins, Donald G., Kenneth Pitcher, and Karl Schneider. 1975. Distribution and abundance of marine mammals in the Gulf of Alaska. Alaska Dept. of Fish and Game, Div. of Game, Anchorage, Alaska. 39 pp. 4 tab., 31 charts.

Report prepared under an OCSEAP contract to NOAA. Sea otters, northern sea lions, and harbor seals are discussed at length, as were the northern fur seal, black right whale, gray whale, minke whale, sei whale, fin whale, blue whale, humpback whale, north Pacific white-sided dolphin, killer whale, harbor porpoise, Dall porpoise, sperm whale, Bering Sea beaked whale, goose-beaked whale, northern right whale dolphin, short-finned pilot whale, belukha, and giant bottlenosed whale. Charts show sea lion and sea otter distribution; others show harbor seal density.

Clarke, Robert. 1957. Migration of marine mammals. Norsk Hvalfanget-tid. 46(1):609-630.

General review of migrations of the large whales and of a small number of small cetaceans, fur seals, phocid seals, and walruses. Paper notes lack of understanding of mechanisms of migration. 11 fig., 76 refs.

Cowan, Ian McTaggart. 1939. The sharp-headed finned whale of the eastern Pacific. J. Mammal. 20 (2):215-225.

Physical description of two specimens of *Balaenoptera acutorostrata* from waters off Vancouver Island, British Columbia, as well as museum specimens examined by the author. Morphometric comparison of Atlantic and Pacific forms is offered. Differences between forms do not justify taxonomic separation of species. 3 pl., 3 fig., 3 tab.

Fiscus, Clifford H., Dale W. Rice, and Ancel M. Johnson. 1969. New records of *Mesoplodon stejnegeri* and *Ziphius cavirostris* from Alaska. J. Mammal. 50 (1):127.

Floating carcass of *Mesoplodon stejnegeri* found 43 km west of Cape Edgecombe, Gulf of Alaska, at Lat. 57° 04' N., Long. 146° 32' W. Skull of *Z. cavirostris* found at Trident Bay, Akun Island, at Lat. 54° 09' N., Long. 165° 33'W.

Gilmore, Raymond, M. 1956. Rare right whale visits California. Pacific Discovery 9 (4):20-25.

Description of whale sighted along Southern California coast. Discussion of the history of the species. Data from California whalers shows only a handful of right whales taken. Map shows "original" distribution in North Pacific and Bering. Mentions Kodiak Gyre and Kodiak Ground. 3 photos + drawings.

Johnson, Murray L. and Gordon D. Alcorn. 1962. The return of the sea otter. Outdoor Calif. 23 (2):4-5.

Recounts history of exploitation since 1741. Present population is estimated as high as 40,000. Distribution includes Amchitka Island, Delarof, Andreanof and Fox Islands, Alaska Peninsula, Kodiak archipelago, and Kenai Peninsula to Cape St. Elias in Alaska, and the California coast.

Kasuya, Toshio. 1971. Consideration of distribution and migration of toothed whales off the Pacific coast of Japan based upon aerial sighting record. Sci. Rep. Whale Res. Inst. 23:37-60.

Reports odontocete sightings recorded during oceanographic aerial surveys 1959-1970, comprising 171,809 nautical miles flown. Describes conditions of observations. Mentions *Physeter*, *Berardius*, *Orcinus*, *Globicephala*, *Pseudorca*, *Grampus*, *Ziphius*, *Stenella attenuata*, *Stenella caeruleoalba*, *Tursiops*, *Lagenorhynchus*, *Phocoenoides*, and *Lissodelphis*.

Kellogg, Remington. 1931. Whaling statistics for the Pacific coast of North America. J. Mammal. 12 (1):73-77.

Catch data by species and location from 1919-1929. Species are blue, finback, humpback, sei, gray, and sperm whales, plus "miscellaneous" whales including beluga, bowhead, right, bottlenose, sharp-headed finback (minke), Bryde's whales. Locations described include: Alaska, British Columbia, Washington and California. Discussion mentions migration, numbers of whales, biology (lengths and maturity) and conservation.

Kenyon, Karl W. 1952. Diving depths of the Steller sea lion and Alaska fur seal. J. Mammal. 33 (2):245-246.

Sea lions and fur seals described at the mouth of Sitka Sound, off Crawfish Inlet, and off Kruzof Island, all within 40 miles of Sitka, Alaska. Based on a fisherman's observations, sea lions do not dive below 100 fathoms, and fur seals below 30 fathoms to feed.

Kenyon, Karl W. 1961. Cuvier beaked whales stranded in the Aleutian Islands. J. Mammal. 42 (1):71-76.

Two carcasses of Ziphius cavirostris found on Amchitka Island, apparently shot by rifle. Complete measurements given. 3 pl.

Kenyon, Karl W. and Ford Wilke. 1953. Migration of the northern fur seal, Callorhinus ursinus. J. Mammal. 34 (1):86-98.

Summary of existing knowledge. Three major breeding grounds are the Pribilof Islands and Commander Islands, and Robben Island. Fur seals migrate southward in winter as far as 34° N. Lat. off Japan. Monthly summary of known occurrences of the northern fur seal at sea is given. Effects of water temperature, food, and weather on distribution are evaluated. Arrival and departure schedule of the various age classes on Pribilof breeding grounds is summarized. Recoveries of tagged seals are summarized.

Klinkhart, Edward. 1966. The beluga whale in Alaska. Vol. VII, Project Report, Fed. Aid in Wildlife Restoration, Projects W-6-R and W-14-R. Alaska Dept. Fish. Game. 11 pp.

A general article which discusses knowledge of biology of beluga whales. Concentrations of belugas occur in shallow bays or estuaries of large rivers north of Lat. 40°N. (have been seen up to 60 miles upstream from the mouth of the Yukon River). Population in Bristol Bay is estimated at 1,000-1,500. Population in Cook Inlet is estimated at 300-400. Populations which winter in the Bering Sea may be those which summer in the western Canadian arctic and eastern Siberian arctic. Contains sections on abundance, range and movements, population dynamics, food habits, future research and management, and other topics.

Klinkhart, Edward G. 1967. Birth of a harbor seal pup. J. Mammal. 48(4):677.

On June 15, 1967, a female harbor seal gave birth at Tugidak Island, Alaska (Lat. 56° 33' N., Long. 155°20' W.). One half-hour of observation, from 12 minutes before the birth until 18 minutes afterward, is reported.

Klinkhart, Edward. 1969. The harbor seal in Alaska. Alaska Dept. of Fish and Game, Wildlife Notebook Series. 2 pp.

Both ice-and non-ice-inhabiting harbor seals are described. Natural history is given. Annual harvest in northern Alaska is given as 4,000; 30,000 in southern Alaska. A bounty was in effect from 1927 to 1967.

Klumov, S. K. 1962. Gladkiye (Yaponskiye) kity Tikhogo Okeana (The right whales in the Pacific Ocean). Trudy Inst. Okeanol., 58:202-297. English summary.

(Abstracted from English summary)
Whaling and research vessels conducted observations from 1952 to 1957 on the distribution of right whales in the northwest Pacific. The results of this work describe two stocks. The Pacific stock is larger than the Okhotsk stock and growth of the Pacific stock is faster. It is possible that puberty of females and males comes when they are 14-15 m long. Mating in right whales takes place in December and January; gestation is 11-12 months. Calves at birth are 5-6 m long. Weaning takes place after 6-7 months. All data are preliminary. The weight of adult whales is more than 100 tons at a length of 16-17 m. Analysis of food showed that right whales are stenophags. The main food of right whales in the Northern Hemisphere is Calanoida.

Lensinsk, Calvin J. 1960. Status and distribution of sea otters in Alaska. J. Mammal. 41(2):172-182.

A detailed report and review of census efforts from Cook Inlet to Amchitka Island from 1936 to 1957. "The present status of the otter is such that we can expect a rapid expansion in numbers from the Andreanof Islands eastward. West of the Andreanof Islands the habitat is limited and the population may already be near the carrying capacity. Here, sea otters are perhaps as abundant as they were before exploitation by the Russians. On Amchitka Island the evidence indicates that a high population has resulted in increased mortality and a lowered reproductive rate". - from author's summary. Estimates present Alaska population at 40,000. Includes distribution map.

Marine Mammal Biological Laboratory. Birds and mammals observed at sea, 1958-present. National Marine Fisheries Serv., Seattle, WA. (unpublished data listing).

An on-going compilation of marine mammal sightings from pelagic fur seal cruises, comprising 25 species. Sightings of each species are arranged by geographical area (e.g. Gulf of

Alaska, Bering Sea, British Columbia). Lat./Long., date, number and groups observed.

Mathisen, Ole A. 1959. Studies on Steller sea lion (Eumetopias jubata) in Alaska. Trans. 24th North American Wildl. Conf., March 2,3, and 4, 1959. p.346-356.

From 1953 to 1955, author explored use of aerial surveys.From March to December, 1956-58, surveys were made in the Gulf of Alaska, Aleutian Islands, and Bristol Bay. Counts given: Aleutian Islands - 73,090; Gulf of Alaska - 76,027; Bristol Bay - 147, including information from other sources. In 1958 the Chernabura Island (Shumagin Islands) rookeries were studied. Mating took place from 31 May - 10 June; births from 25 May - 27 June. Notes reluctance of animals to leave rookery during breeding season. 2 photos.

Mathisen, Ole A., Robert T. Baade and Ronald J. Lopp. 1962. Breeding habits, growth and stomach contents of the Steller sea lion in Alaska. J. Mammal. 43(4):469-477.

Rookery on Chernabura Island (Shumagin Islands) was observed from May 18 to July 25, 1958. Author's abstract: "Steller sea lions (Eumetopias jubata) were observed from May to July. Harem boundaries were indistinct, and the size of a harem varied from day to day as did the number of unattached males near a harem. Copulation was observed from 31 May to 10 July, parturition from 24 May to 27 June. A cow nursed only her own pup or yearling. Harem groups slowly disbanded as pups learned to swim. Lengths of pups, yearlings, cows and bulls are summarized. Only non-commercial fishes, with the exception of one pink salmon, were found in 114 stomachs. Invertebrates were more frequent than fishes".

Mathisen, Ole A. and Ron J. Lopp. 1963. Photographic census of the Steller sea lion herds in Alaska, 1956-58. (Contr. No. 83, College of Fisheries, U. Wash.) U. S. Fish Wildl. Serv. Spec. Sci. Rep.--Fisheries No. 424.

Author's abstract: "An aerial photographic technique for censusing herds of Steller sea lions (Eumetopias jubata) in Alaska is described. The minimum number of sea lions from Cape St. Elias to the Islands of the Four Mountains was estimated to be about 110,000 based on photographic censuses of rookeries and hauling grounds in 1957. The heaviest population density was recorded in an area between the entrance of Cook Inlet and Unimak Pass. Pronounced seasonal variations were

observed, with a partial peak population on the rookeries from July to September. A partial aerial photo census of the harbor seals (Phoca vitulina) in Alaska is discussed in the appendix". Surveys in the Kodiak Island District include three in 1956, five in 1957 and one in 1958.

Nasu, Keiji. 1963. Oceanography and whaling ground in the subarctic region of the Pacific Ocean. Sci. Rep. Whales Res. Inst. 17:105-155.

Data was obtained by whaling factory and whale marking boats in the North Pacific Ocean and Bering and Chukchi Seas. Extensive oceanographic data collected. Usual whaling grounds for blue, fin, humpback, sei, and sperm whales are discussed. Areas north and south of Unalaska are particularly productive for all species except perhaps blue. 51 fig.

Nasu, Keiji. 1966. Fishery oceanographic study on the baleen whaling grounds. Sci. Rep. Whales Res. Inst. 20:157-210.

Discusses the Bering Sea, northern North Pacific, and Gulf of Alaska "pelagic" grounds. In the subarctic Pacific, distribution of whaling grounds for blue, fin, sei, and humpback whales is roughly mapped. In the Gulf of Alaska, Japanese catch of baleen whales is tabulated for 1961-64, fin whale catch is mapped in detail. Section on whale movements includes fin whales in subarctic Pacific. 56 refs.

Nemoto, T. 1959. Food of baleen whales with reference to whale movements. Sci. Rep. Whales Res. Inst. 14:149-290.

Mentions blue, sei, Bryde's fin, right, Greenland, gray, humpback, and little piked whales. Data come from whales caught in three areas: northern North Pacific, waters adjacent to Japan, and Antarctica. In addition to food items found in stomachs of each species, author discusses: "feeding apparatus" in relation to food preference; hours of feeding; natural history of Euphausia superba; yearly fluctuations in abundance and location of foods in North Pacific; quantity of stomach contents; previous publications on feeding; "swallowing" and "skimming" types of feeding; congregation, diurnal migration and depth of food species; weights of stomach contents of fin and sei whales; distribution of whales in North Pacific (especially migrations of fin, sei, and Bryde's whales); results of marking research; "dispersive movements" of fin whales, and parasites found as related to whale migration. Appendix gives data on whale marks recovered from fin, sei,

and Bryde's whales in the North Pacific. One plate, picturing 17 food species. 43 tab., approximate 40 charts, 149 refs.

Nemoto, Takahisa. 1963. Some aspects of the distribution of _Calanus cristatus_ and _C. plumchrus_ in the Bering and its neighboring waters, with reference to the feeding of baleen whales. Sci. Rep. Whales Ref. Inst. 17:157-170.

Calanus cristatus spring and summer concentration coincides with fin whales' feeding grounds, and _C. plumchrus_ concentrations with sei whales. Distribution of the two _Calanus_ species was studied using whale stomach contents from 1952-1961, and plankton net studies. Total catches of fin and sei whales 1952-1961 are mapped. (Includes Gulf of Alaska).

Nemoto, Takahisa and Toshio Kasuya. 1965. Foods of baleen whales in the Gulf of Alaska of the North Pacific. Sci. Rep. Whales Res. Inst. 19:45-51.

Stomach contents were examined of blue, fin and sei whales caught in the Gulf of Alaska from 1961-1963. Catch distribution of 1963 are mapped. Right whales are mentioned in coastal waters of Kodiak Island.

Nikolaev, A. M. 1961. (The distribution, quantity and biology of the sea otter). Trudy Soveshchaniy Ikhtiologicheskoy Komissii, Vol. 12, p. 214-217. Translated by Division of Foreign Fisheries, National Marine Fisheries Service, NOAA. Trans. 520, 1970.

Tabulates population estimates for years 1912 to 1939 from Kuriles, Kamchatka, Aleutians and Alaska, and California. Otter habitat analyzed. Suggests possibility that sea otters give birth only once every two years.

Nishiwaki, Masahuru. 1966. Distribution and migration of marine mammals in the North Pacific area. Proc. Eleventh Pac. Sci. Congress, August 24, 1966.

Maps and short discussions on present knowledge of distribution of each species of marine mammal (excluding polar bear) found in the North Pacific, Bering Sea and waters north of Bering Strait. Thirteen pinnipeds, fifty-three cetaceans discussed.

Nishiwaki, Masahuru. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results. Pages 171-191, in K. S. Norris, ed. Whales, dolphins and porpoises. Univ. Calif. Press, Berkeley and Los Angeles.

Whaling catches reported for 1945-1962 for blue, fin, humpback, sei, Bryde's and sperm whales. Table and map for each species. Area includes North Pacific, Gulf of Alaska and Bering Sea. Catches are analyzed by 10° squares of area. Months of whaling activity are noted. Population estimates offered.

Ohsumi, Seiji. 1975. Incidental catch of cetaceans with salmon gillnet. J. Fish. Res. Board Can. 32(7):1229-1235.

Reports data from salmon research vessels, 1962-71. Species caught were Dall porpoise, True's porpoise, harbor porpoise, pilot whale and Baird's beaked whale. Many animals were not identified to species. The area fished included northern North Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan. 6 fig.

Okutani, Takashi and Takahisa Nemoto. 1964. Squids as the food of sperm whales in the Bering Sea and Alaskan Gulf. Sci. Rep. Whales Res. Inst., 18:111-122.

Seven genera of squid were found in stomachs of sperm whales from Aleutian Island waters, Bering Sea and Gulf of Alaska. Distribution of whales caught is mapped, according to whether they contained fish or squid, and what kind of squid they contained. Squids predominated over fish in the western part of the Aleutian chain, while fish predominated in the Gulf of Alaska. 5 pl., 5 fig.

Omura, Hideo. 1955. Whales in the northern part of the North Pacific. Norsk Hvalfangst-tid. 44(6):323-345; and 44(7): 395-405.

Described history of whaling in the North Pacific and compiles catch statistics since beginning of commerical whaling. Recent Japanese catches on each of 3 whaling grounds, (a) south of Commander Islands, (b) north of Akutan Is., and (c) south of Akutan, are analyzed for each species by sex, length, and sexual maturity. Pecularities of results are discussed. Also reports on 2 marking cruises. 17 tab., 18 fig.

Omura, Hideo. 1958. North Pacific Right Whale. Sci. Rep. Whale Res. Inst. 13:1-52.

Black right whales appear in the Bering Sea in June and stay all summer. Sightings from 1941-57 are mapped by months; April, May, June, and July-September. Numerous sightings occurred between Pribilof Islands and Aleutian Islands in July. In June and July a few were seen as far east as the Shumagin Island region. Whales sighted near the Aleutian Islands are thought perhaps to belong to a "Kodiak Ground" stock. Of all sightings, 68% were of single individuals. Largest group seen was four. 8 pls., 27 fig. including 25 photos.

Omura, Hideo and Seiji Ohsumi. 1964. A review of Japanese whale marking in the North Pacific to the end of 1962, with some information on marking in the Antarctic. Norsk Hval-fangst-tid. 53(4):90-112.

Reports on marking of blue, fin, humpback, sei (and Bryde's), and sperm whales from 1949 to 1962. Of 3,343 whales marked, 282 were recaptured, 80% of which were fin and sperm. Area included waters east of Japan to Long. 160°E., waters south of the Aleutian chain, the Gulf of Alaska and the Bering Sea. Maps show movements of recaptured whales summarized by species. Appendix gives sex, length, date and locations of marking and recapture of each whale. 12 tab., 5 maps.

Omura, Hideo, Seiji Ohsumi, Takahisa Nemoto, Keiji Nasu, and Toshio Kasuya. 1969. Black right whales in the North Pacific. Sci. Rep. Whales Res. Inst. 21:1-78.

Gives detailed anatomical descriptions of 13 black right whales, including two previously reported by Omura in 1958. Distribution is shown in maps, by month from April to September. Extensive comments made on movements in the Aleutian Islands area, Gulf of Alaska, and the Bering Sea. 27 fig., 18 pls.

Pike, Gordon C. 1962. Migration and feeding of the gray whale (_Eschrichtius gibbosus_). J. Fish. Res. Board Can. 19(5): 815-838.

Observations of gray whales from the coasts of British Columbia, Washington and Alaska are combined with published accounts in an effort to define the timing and route of the migration, and feeding areas in the Bering and Chukchi Seas. Uncertainty remains as to the route between British Columbia and the Bering Sea. Feeding observations, particularly around St. Lawrence Island, are given. 4 fig., 2 are maps.

Pike, G. C., and B. E. Maxwell. 1958. The abundance and distribution of Northern Sea Lions (Eumetopias jubata) on the coast of British Columbia. J. Fish. Board Can. 15(1):5-17.

Abundance and distribution of the northern sea lion in British Columbia waters are described based on aerial surveys in 1956-57. Compared to similar surveys in 1913, 1916, 1938, and 1955, the number of sea lions had not changed significantly. Estimated population in 1913 was 12,000-13,000. The 1956 estimate was 11,000-12,000. The major changes over this period were in distribution, and usage of different rookeries.

Pike, G. C., and I. B. MacAskie. 1969. Marine mammals of British Columbia. Bull. Fish. Res. Board Can., No. 171. 54 pp.

Records of cetaceans and pinnipeds in British Columbia and into the Gulf of Alaska up to 1967 were compiled from published and unpublished records. An account is given for each species with information on distribution, measurements, and incidental observations of interesting phenomena. A photograph or drawing is also given for each species. No abundance information is included except the occasional comment that a species is rare.

Pitcher, Kenneth W. 1975. Distribution and abundance of sea otters, Steller sea lions, and harbor seals in Prince William Sound, Alaska. Appendix A. in Donald G. Calkins, Kenneth W. Pitcher, and Karl Schneider, Distribution and abundance of marine mammals in the Gulf of Alaska. Alaska Dept. of Fish and Game report. 31 pp., 19 charts.

Report on two helicopter surveys, June 1973 and March 1974, and supplemental small plane and boat surveys. Sea otter: counts tabulated; history of occurrence discussed; census techniques evaluated; sexual segregation and shifts in distribution discussed; total population estimated at 5,000. Steller sea lion: habits, habitat, shifts in distribution, and decrease in population estimated at 6,500-7,500. Harbor seal: preferred types of hauling grounds and rookeries discussed; surveys are lacking; summer concentration sites are mentioned. Sightings of Dall porpoise, minke whale, humpback whale, killer whale and northern fur seal are reported. Charts show harbor seal and sea otter distribution.

Prasil, R. G. 1972. Distribution of sea mammals and associated land mammals found along the Katmai coast, Katmai National Monument. Science in Alaska, Proc. 22d. Sci. Conf. 8 pp.

Ten flights and 25 hours of observation from a boat were conducted by Park Service personnel from July, 1969 to June, 1971, along the coast of the Katmai Peninsula, surveying for marine mammals in the area. General seasonal distribution and maximum numbers observed are given for sea otter, sea lions, and hair seals. A brief description of the different habitat types available to each species is given by coastal zones.

Rice, D.W., and A. A. Wolman. 1971. Life history and ecology of the gray whale, Eschrichtius robustus. Amer. Soc. Mammal. Spec. Publ. No. 3. 142 pp.

Mongraphic account of existing knowledge, incorporating results of author's research, 1959-1970, which involved collection of 316 gray whales mostly from California. Offers good descriptions of methods currently used in biological research on large whales, with the exception of marking. Contents: Introduction; nomenclature; field and laboratory procedures, seasonal migratory cycle; food and feeding; age and growth; female reproductive cycle; male reproductive cycle; predators; parasites and epizoites; population; exploitation; summary. 48 tab., 38 fig., 172 refs.

Sandegren Finn. 1975. Sexual-agonistic signalling and territoriality in the Steller sea lion (Eumetopias jubatus). Pages 195-204, in K. Ronald and A.W. Mansfield, eds. Biology of the seal. Vol. 169.

About 3,000 hours of observation were carried out on Lewis Island, Gulf of Alaska, in summers of 1967- 69. Author describes reproductive "display" of the female, analyzing components of the display. Male response to display discussed. Functions of various components of display are considered; compared with other species of pinnipeds. Author hypothesizes that display serves to synchronize breeding cycles of male and female. 11 photos, 2 graphs.

Scammon, C. M. 1874. The Marine Mammals of the Northwestern coast of North America. John H. Carmany and Co., San Francisco and G. P. Putnam's Sons, New York. 319 pp.

The first major account of marine mammals in Alaska coupled with detailed descriptions of each species encountered. The book is written in three sections: I. Cetacea, II. Pinnipedia, and III. The American Whale-Fishery.

Scattergood, Leslie W. 1949. Notes on the little piked whale. Murrelet 30(1):3-16.

Summarizes knowledge of distribution, size, reproduction, food and taxonomy of Balaenoptera acutorostrata around the world, citing 62 authors. Discusses utilization in Norway, Siberia, Iceland, and Japan.

Scheffer, Victor B. 1949. The Dall porpoise, Phocoenoides dalli, in Alaska. J. Mammal. 30(2):116-121.

Reports on observations during two cruises in 1947 and 1948. Describes range in southern Bering Sea, Aleutian Island waters, Gulf of Alaska and southeast Alaska. No seasonality was observed. Anatomical measurements given for 5 specimens. 2 pls.

Scheffer, Victor B. 1973. Marine mammals in the Gulf of Alaska. Pages 175-207 in, Donald H. Rosenburg, ed. A review of the oceanography and renewable resources of the northern Gulf of Alaska. Institute of Marine Science, Univ. of Alaska, Fairbanks. 690 pp.

Discusses history of regulations and uses of marine mammals and threats to particular species. Population estimates in northwestern Gulf of Alaska (centered at Lat. 59°N. and Long. 150°W.) are tabulated. Large whale estimates are rough, the procedure used to arrive at them is explained. Smaller cetacean estimates come mainly from miscellaneous records. 66 refs.

Schiller, Everett L. and Robert Rausch. 1956. Mammals of the Katmai National Monument, Alaska. Arctic 9(3):191-201.

Occurrence and distribution of mammals obtained in the summer of 1953 at Katmai National Monument. Harbor seals were found to be common along the Shelikof Strait, especially in Kukak, Katmai, and Portage Bays. Includes map of Katmai area with collection localities marked.

Shurunov, N.A. 1970. Nekotorye gidrologicheskie kharakteristiki raionov kontsentratsii kitov v severo-vostochnoi chasti Tikhogo okeana, Beringovom i Chukotskom moryakh (Some hydrological characteristics of whale grounds in the northeastern Pacific and the Bering and Chukchi Seas.) Tr. Vses. Nauchno-issled.

Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72: 89-92. Transl. by Israel Program Sci. Transl., 1972, p. 83-86 <u>in</u> P.A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5, avail. Natl. Tech. Inf. Serv. Springfield, VA. as TT 71-50127.)

Surveys conducted on two vessels in 1972 along the Pacific coast of the Aleutian Islands east of 170°W. and the western part of the Gulf of Alaska to the Kenai Peninsula; the southeastern Bering Sea; the northern Bering Sea and the southern Chukchi Sea. It appears that whales form feeding concentrations in regions of contact between bodies of water of different characteristics. Hydrological information on the southeastern Bering Sea is from July; that on northern Bering and southern Chukchi is from July-August; In mid-March, 1961, finbacks and sperm whales arrived in the western Gulf of Alaska and eastern Aleutian Islands waters. In about June, Sei whales arrived. Concentrations of gray whales were noted in northern Bering Sea and southern Chukchi Sea.

Skaptason, Patricia Ann. 1971. The sea otter (<u>Enhydra lutris</u>). U. S. Dept. Int., Office of Library Services, Washington,D.C.

Bibliography of 194 references. Includes English language materials and translations from the Russian from 1950-1970, plus one 1897 publication. Index by subject and geographic area.

Taylor, F. H. C., M. Fujinaga and Ford Wilke. 1955. Distribution and food habits of the fur seals of the North Pacific ocean. Report of cooperative investigations by the governments of Canada, Japan, and the United States of America, February - July 1952. U. S. Dept. of the Int., Fish and Wildl. Serv. 86 pp.

Six vessels operated off the coast of northeastern Japan 19 February to 17 June, and off southern Hokkaido 6-17 June (2,329 seals were collected). One vessel operated off California, Oregon and Washington 8 February to 30 April. One vessel operated off Alaska 4 June to 13 July: 686 seals were collected off N. America; most work was done within 30 miles of shore. Location of winter concentrations of seals is noted; distribution by sex and age is discussed. Stomach contents are discussed area by area noting proportions comprised by commercial species. 50 fig., 30 tab., 9 appendices.

Thorsteinson, Fredrik V. and Calvin J. Lensink. 1962. Biological observations of Steller sea lions taken during an

experimental harvest. J. Wildl. Manag. 26(4):353-359.

Between 27 May and 15 July 1959, 464 sea lions, almost all breeding bulls, were harvested from five rookeries: Marmot Is., Chowiet Is., Atkins Is., Jude Is., and Ugamak Is. Sea lion harvest behavior, reproduction, growth, sex age composition of local populations, natural mortality of pups and food habits are discussed. 382 stomachs examined.

Vania, John and Edward Klinkhart. 1967. Marine mammal report. Vol. VIII, Annual Project Segment Report, Federal Aid in Wildlife Restoration. Alaska Dept. Fish and game, Juneau, Alaska. 24 pp.

Reproductive tracts of 11 adult female Steller sea lions collected in October 1966 were examined. Delayed implantation appears to last about 3 months. Molting at Lat. 58° - 59° N. Lat. lasts from the last week in July until beyond Oct. 25. Gulf of Alaska population discussed.

Thirty sea otters were transplanted from Prince William Sound to Klag Bay (Southeast Alaska) and Yakutat Bay.

Reports on studies of harbor seals at Tugidak Island and the Port Heiden - Port Moller area, primarily oriented towards commercial harvesting for pelts. Three hundred pups were tagged on Tugidak Island in 1966; 45 were recovered. Aerial surveys were carried out of Tugidak Island, Port Heiden-Port Moller, Sitkinak Is., Seal Is., and Cinder River.

Killer whale sounds in the 20-22,000cps frequency range were transmitted underwater in the Naknek River (Bristol Bay) and beluga whales moved away from the sound source. Four belugas were collected in the Kvichak River and measurements and stomach contents are given.

Vania, John, Edward Klinkhart and Karl Schneider. 1968. Marine Mammal Report. Vol. IX, Annual Project Segment Report, Federal Aid in Wildlife Restoration. Alaska Dept. of Fish and Game, Juneau, Alaska. 46 pp.

Harvesting activities on sea lions were monitored on Sugerloaf Island and Marmot Island where hunters took 4,855 sea lion pup pelts. Hunting activity caused a shift of several thousand sea lions from one area of the rookery to another.

Sightings of transplanted otters near Klag Bay are reported.

Examination of harbor seal pelage collected at 2-week intervals during 1966-67 indicated that molting begins in late August and is completed by late October. Eleven hundred and six pups were tagged at Tugidak Island (June 2-21), and 180 at Port Heiden (June 14-28). Pupping area on Tugidak Island, Port Heiden and Port Moller were surveyed by air during June, July and August. Results are tabulated for 1965-1967.

Belukha whales respond to killer whale sound playbacks at a distance of one mile.

Wilke, F. and K. W. Kenyon. 1954. Migration and food of the northern fur seal. Trans. 19th No. Amer. Wildl. Conf., pages 430-440.

Reviews history of pelagic studies of the northern fur seal. Summarizes U. S. pelagic research 1947-1952; animals were collected from south of the Pribilof Islands on both sides of the Aleutian Islands. Includes some findings of the joint research project carried out in the spring of 1952 by Canada, U. S. and Japan. Upon leaving the Pribilofs, those seals bound for the North American coast fan out southward and eastward into the eastern North Pacific and Gulf of Alaska. Migration differs in the winter distribution of various age classes; notes sites of winter concentrations.

Wilke, Ford, and Clifford H. Fiscus. 1961. Gray whale observations. J. Mammal. 42(1):108-109.

Reports observations off Washington, Gulf of Alaska, Kodiak Is., and in the Bering and Chukchi Seas. Includes thoughts on route of migration and feeding.

Quarterly Report

Contract No. R7120806
Research Unit 68
Period 1 October to
31 December 1976
Number of pages 6

SEASONAL DISTRIBUTION AND RELATIVE ABUNDANCE OF OFF-SHORE MARINE MAMMALS IN THE WESTERN GULF OF ALASKA: KODIAK ISLAND TO UMNAK ISLAND

Principal Investigators

Clifford Fiscus
Howard Braham
Roger Mercer

Research Assistants

Patrick McGuire
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National Marine Fisheries Service
Northwest and Alaska Fisheries Center
Marine Mammal Division
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Seattle, Washington 98115

28 December 1976

Research Unit 68

Sixth Quarterly Report, October-December, 1976

I. Task objectives.

Task objectives for FY77 are to synthesize the literature and collect sighting data on marine mammals at sea from Kodiak Island in the western Gulf of Alaska to south of Umnak Island in the western [illegible] Fox Islands: the latter area representing the Aleutian Shelf oil-lease site.

Sixth quarter objectives were to 1) conduct an intensive ship, helicopter and land survey of islands near the Aleutian Shelf oil-lease site to better understand pinniped distribution and abundance during the fall, as well as to collect sighting data on presumably migrating cetaceans in the area; and 2) transform data from several NOAA ship cruise reports into NODC format.

Data collected during FY76 in the Gulf of Alaska have been consolidated into the first of two final reports under RU68. This report was submitted to the Juneau Project Office on 17 December. The area covered in the final report included the Gulf from 150°W Longitude on the west, 130°W longitude on the east, 52°N Latitude to the south and the Alaskan coast to the north.

II. Field or laboratory activities.

A. Ship schedule. NOAA ship Surveyor, 18-29 October, 1976, western Gulf of Alaska to eastern Aleutian Islands; indlucing a helicopter survey (RU67) using the Bell 206B (N49593) from the Surveyor.

B. Scientific party.

Lt. Roger Mercer	all are employed by the
Robert Everitt	Marine Mammal Division
Bruce Krogman	
Carl Peterson	
David Rugh	

C. Methods. The October Surveyor cruise report, which was performed under both RU 67 and 68, has been presented as an Addendum in RU67 sixth quarterly report.

D. Sample localities/ship or aircraft tracklines. Approximately 147 man hours were spent watching for marine mammals from the flying bridge of the Surveyor covering over 828 nm of ships trackline. The general survey route is charted on Figure 1, and research sighting effort summarized in Table 1.

E. Data collected or analyzed.

1. Data collected during October 1976 Surveyor cruise are listed in the Addendum of RU67's sixth quarterly report.
2. The following NOAA ship cruise dates were analyzed in the laboratory for logging accuracy. Data from these cruises were finalized (formated) and are being prepared to be sent to the Juneau Project Office on computer cards (within two weeks):

	Cruise dates	NOAA ship	Lease areas
a)	12-30 April 1976	Surveyor	Kodiak-Brist. Bay
b)	15-19 July 1976	Discoverer	Gulf of Alaska
c)	4-27 August 1976	Moana Wave	Kodiak-Bering Sea
d)	7-17 September 1976	Surveyor	NEGOA

III. Results. Pelagic sighting data collected during the October Surveyor cruise are summarized in Table 2. Exact positions for each sighting have not been finalized but will be included in the annual report (1 April 1977).

IV. Preliminary interpretation of results. None

V. Problems encountered/recommended changes. None

VI. Estimate of funds expended.

Salaries/overtime	$1,100
Travel/per diem	420
Equipment/computer	200
	$1,720

VII. Revised data submission schedule. We have completed all 1975

OCSEAP cruise reports (n=15) and 6 or 18 1976 OCSEAP cruises. During the seventh quarter we expect to have the following cruises finalized onto NODC format and into the Juneau Project Office on computer cards:

	Cruise dates	NOAA ship	Area
1)	4 April- 9 June 1975	Surveyor	GOA
2)	24 February- 5 June 1976	Discoverer	GOA-Bering Sea
3)	9-13 March 1976	Surveyor	Seattle-Kodiak
4)	27 March- 30 May 1976	Miller Freeman	Kodiak-Bering Sea
5)	18-29 October 1976	Surveyor	Kodiak-Krenitzen Islands

VIII. Revised milestone (known activities for period 1 January - 1 April).

	Activity	Period of accomplishment
1)	Kodiak Shelf synthesis meeting preparation	1-13 January
2)	Log and computerize (carding) of cruises in VII.	January - March
3)	Miller Freeman Leg II in WGOA, 1 MMD employee	15 February - 10 March 1977
4)	Miller Freeman Leg III Bering Sea ice edge, 1MMD employee	14-25 March 1977
5)	Preparation of annual report	March

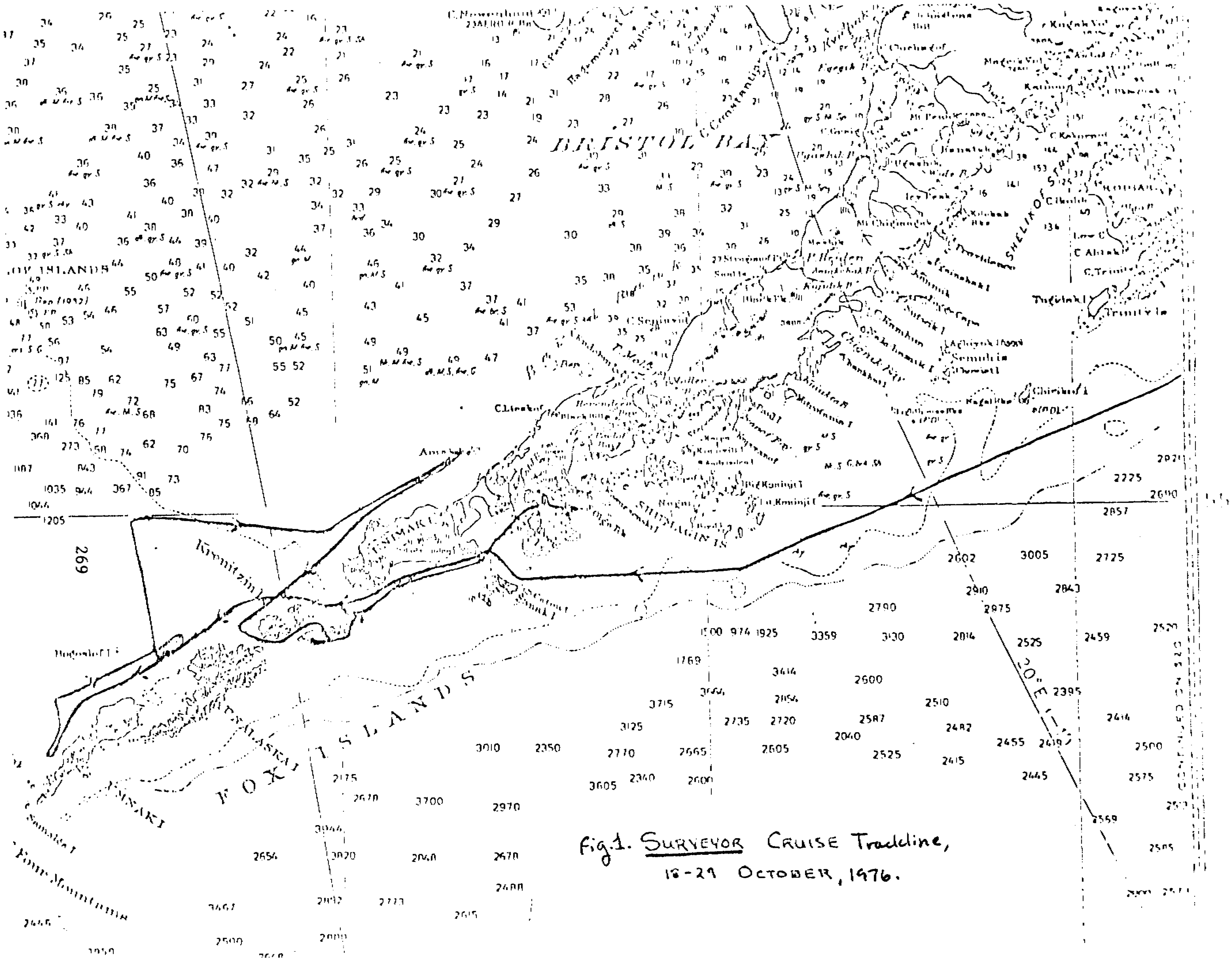

Fig. 1. SURVEYOR CRUISE Trackline, 18-29 OCTOBER, 1976.

Table 1.--Summary of research effort.

	Everitt	Krogman	Mercer	Peterson	Pugh	Total
Hours on bridge watch	22.3+	31.6+	24.3+	26.1+	42.4+	146.7+
No. of sightings from the bridge	7	7	16	19	25	74
Total nautical miles						270
Hours on land	9.6	15.1	16.7	14.8	15.3	71.5
Hours on aerial survey	15.8	7.9	5.8	5.0	6.5	41.0
Total aerial track miles						861
Total aerial data recordings						277

Table 2.--Number of animals seen from NOAA ship *Surveyor*, by day and by species, from 18 to 28 October 1976.

Species	Days										
	18	19	20	21	22	23	24	25	26	27	28
Enhydra lutris										1	
Phoca vitulina	3								20	1	1
Eumetopias jubatus											
(in the water)	1	1	20	45				5	43	8	11
(hauled out)									2020		1000
Callorhinus ursinus			1	16				1			
Unidentified pinniped	1		2								
Phocoenoides dalli		2	6	15					2	5	
Orcinus orca								3		1T *	
Balaenoptera acutorostrata				1T						1T	
Balaenoptera borealis										2T	
Balaenoptera physalus			1								
Megaptera novaeangliae		2									
Unidentified cetacean			2							1	1

* A "T" is placed after the number to indicate tentative identification.

RU# 68

Supplemental Reference

Fiscus, Clifford H., Braham, Howard, W., and Mercer, Roger W. 1976. Seasonal Distribution and Relative Abundance of Marine Mammals in the Gulf of Alaska. Northwest and Alaska Fisheries Center Processed Report, 238 pp.

Quarterly Report

Contract No. R7120807
Research Unit 69/70
Period 1 October 1976 to
31 December 1976
Number of pages 2

DISTRIBUTION AND ABUNDANCE OF BOWHEAD AND BELUKA WHALES IN THE BERING, CHUKCHI AND BEAUFORT SEAS

Principal Investigators

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Howard Braham
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28 December 1976

Research Unit 69/70

Sixth Quarterly Report, October-December, 1976

I. Task Objectives.

FY77 objectives under combined research units 69 and 70 are to identify migratory parameters and general ecological considerations of the bowhead (Balaena mysticetus) and beluga (Delphinapterus leucus) whales by assessing seasonal distribution and relative abundance in the northern Bering Sea and Arctic Ocean.

During the sixth quarter our specific plans were to 1) complete data management procedures for all data collected during FY76; and 2) begin the planning phase for FY77 spring season -- ice camps and aerial surveys.

II. Field or laboratory activities.

A. Field activities. None

B. Laboratory activities.

1. Ice station data logged and checked but not formatted for NODC.
2. FY76 aerial survey data computerized (NODC format).
3. Remaining RU 69/70 data prepared for EDS submission.

C. Methods.

1. Laboratory. Data were logged and checked by hand, while editing was finalized with the aid of computer programming (programs finalized this quarter); data were put onto computer cards in NODC/EDS format and will be sent to the Juneau Project Office within two weeks of this report.

III. Results. No new data results

IV. Preliminary interpretation of results. None

V. Problems encountered. Problems with computer programming and time available on a computer during the fifth quarter were resolved during the sixth quarter.

VI. Approximate funds expended.

Salaries/overtime	$5,100
Equipment, Misc.	400
Computer time	500
	$6,000

VII. Revised data submission schedule. All remaining RU69/70 aerial survey data collected during FY76 (19 days) will follow this report on computer cards. The completed survey days are: 30 April; 1, 3, 8, 9, 12, 15, 19, 20, 22, 24, 28, 31 May; and 1, 4, 5, 18, 19, 20 June, 1976.

VIII. Revised milestone (for period 1 January - 1 April).

Activity	Period of accomplishment
1) Logging and computerizing (NODC and analysis) of FY76 ice camp data	January-February
2) Detailed planning of FY77 ice camp and aerial surveys	January-March
3) Fall 1974 (non-OCSEAP), 1975 and 1976 aerial data	February
4) Preparation of annual report	March

QUARTERLY REPORT

Contract 03-5-022-56
Task Order No. 8
Quarter Ending -
31 December 1976
Number of Pages 48

R.U.#194 - MORBIDITY AND MORTALITY OF MARINE MAMMALS (BERING SEA)

Principal Investigator

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December 31, 1976

QUARTERLY REPORT

I. Task Objectives this quarter

A. To complete the laboratory analyses of materials obtained from necropsy of marine mammals in FY-76.

B. To complete the preparation of a selected bibliography of marine mammal mortality and pathology, relevant to the species and conditions occurring in the Alaskan OCS area.

II. Field and Laboratory Activities

A. Field Trip Schedule

(none)

B. Laboratory Activities

Histopathological materials and parasites, including some acquired prior to the OCSEAP, were prepared and studied further. Bibliographic references acquired to date were reviewed and sorted, and an annotated bibliography on mortality and pathology of Alaskan marine mammals was prepared and cross-indexed.

C. Methods

Tissue samples, including a backlog from pre-OCSEAP investigations of marine mammal diseases, were prepared by the paraffin embedding method, sectioned at 5 to 7 microns, mostly stained in hematoxylin-eosin (suspected micotic infections were stained also by the Gomori method), mounted on slides in Permount, and studied under a compound microscope, mainly by Associate Investigator R. Dieterich and the P.I. Endoparasitic helminths were dehydrated and stained in acetic carmine or, as appropriate, in methyl green-pyronin, mounted on slides in Permount, and compared with examples from various reference collections and literature sources principally by Biological Technician L.M. Shults. Identifications of acanthocephalans were confirmed or determined through consultation with specialist Dr. G.D. Schmidt (University of Northern Colorado, Greeley). Ectoparasites were studied whole in ethanol and in cleared specimens mounted in Permount, and compared with literature sources for identification by the P.I.

The literature search, utilizing a variety of sources, for published information on mortality and pathology of marine mammals was continued, and copies of pertinent papers were acquired via the University of Alaska's Bio-Medical Research Library. The 425 acquired to date were reviewed by L. Shults and the P.I., and those judged as relevant to the Alaskan OCS area were abstracted and cross-referenced.

III. Results

A. Tissue Sections

Micro-abcesses in the liver have been detected by us in 17 out of 18 spotted seals (*Phoca largha*) and 1/1 each of harbor seals (*P. richardsi*) and ribbon seals (*P. fasciata*). Nielsen (1976. Appendix 4, OCS Quart. Rep. R.U. #230, 30 Sept. 76) has reported them also in 1 of 7 bearded seals (*Erignathus barbatus*), 4 of 6 ringed seals (*P. hispida*), and 1 of 1 spotted seal. Tissue samples from 8 of our spotted seals were prepared and examined histologically, disclosing that the lesions are of two types: (1) parenchymatous focal necrosis with mainly eosinophilic invasion, and (2) micro-abcesses in the portal triads with mainly monocytic and polymorphonuclear invasion. The first is attributable to burrowing by minute parasitic helminths; the second appears to be due to primary infiltration via the circulatory system by a bacterial agent. Peripheral monocytic and polymorphonuclear aggregates in the parasitic lesions suggest the possibility that a bacterial agent may be exploiting those sites as well, on an opportunistic basis.

Sections of an enlarged spleen from one of the same spotted seals revealed an acute hemosiderosis and monocytosis, the large phagocytes being greatly distended with accumulations of hemosiderin granules. This condition was probably not associated with the foregoing; its cause was not apparent.

Three more cases of dermatomycosis were identified from study of sections obtained in previous years from the skin of walruses in the Bering Sea. As noted earlier (Quart. Re. R.U.#194, 30 June 76), this condition occurs commonly on the skin of the flippers of these animals (10/28 of those examined on the ZAGORIANY cruise), where it seems to be relatively benign. Less often (in 2/158) it is more widespread over the body surface, where it appears to cause much more of an inflammatory response.

B. Parasites

Representative samples of anopluran sucking lice, collected from the body surface of several pinnipeds, were identified as follows:

1. *Antarctophthirus microchir*, from 2 Steller sea lions,
2. *A. trichechi*, from 3 walruses
3. *Echinophthirius horridus*, from 2 spotted seals, 1 ringed seal, and 1 ribbon seal.

These were abundant only on the walruses, virtually all of which harbor large populations of these ectoparasites and experience some mild irritation as a result of their presence. They were least numerous on ribbon seals, occurring on only one of 23 examined during the ZAGORIANY cruise

Helminth parasites of the digestive tract of 43 pinnipeds of 6 species, examined prior to and during the course of this project, are shown in Tables 1 to 6. Apart from the nematodes *Phocanema* and *Contracaecum*, found in the stomach, none of these appeared to have any significant pathogenic effect on the hosts examined, although some are known to be pathogenic under stressful circumstances. In cases where the stomach nematodes were abundant and were attached to the lining in rosettes, damage to the mucosa and submucosa, and to some extent, to the underlying muscular layer was evident grossly. In a few of the spotted seals, local masses of scar tissue on the external surface of the stomach suggested that complete or nearly complete perforation of the stomach wall had occurred at some time in the past and subsequently healed.

Since these parasites are acquired by the seals through ingestion of fishes and other marine organisms in their normal diet, a series of 107 marine fishes, taken by otter trawl in the same areas where the seals were collected, were examined. Of especial concern were the larval stages of marine mammal parasites. The results of these examinations are shown in Table 7. All or most of these fishes are known or probable dietary items of the seals (cf. Quart. Repts. R.U.#232, 30 June, 31 Sept 76), and, as expected, the larvae that they harbored were mainly of Anasakid nematodes (probably mainly *Phocanema* and *Contracaecum*) and acanthocephalans of the genus *Corynosoma*.

C. Bibliography

The annotated bibliography of selected references on mortality and pathology of marine mammals of the Alaskan OCS area is presented in Appendix I of this report.

IV. Preliminary Interpretation of Results

No further interpretation is feasible at this time.

V. Problems Encountered/Recommended Changes

Progress in this quarter was hampered by non-receipt until 16 December of official notification from the OCSEAP Project Office of funds available for FY-77.

Table 1. Helminth parasites of Steller sea lion, Eumetopias jubatus.

Specimen number	Diplogonoporus tetrapterus	Anophryocephalus ochotensis	Diphyllobothrium sp.	Phocanema sp.	Contracaecum sp.	Filocapsularia sp.	Corynosoma villosum
42011	X			X			X
42012	X	X		X		X	X
42013		X		X		X	
42014			X			X	X
42015		X		X	X	X	X
42030		X					X
6 Hosts	2 (33%)	4 (66%)	1 (16%)	4 (66%)	1 (16%)	4 (66%)	5 (83%)

Table 2. Helminth parasites of bearded seals, Erignathus barbatus.

Specimen number	Pyramicocephala phocarum	Diphyllobothrium cordatum	Diphyllobothrium lanceolatum	Diphyllobothrium sp.	Phocanema sp.	Corynosoma semerme	Corynosoma validum
42028	X		X	X	X		
42039*	X	X	X				X
42040*		X	X	X			X
42041*		X	X	X		X	X
42059*	X	X	X				X
5 Hosts	3 (60%)	4 (80%)	5 (100%)	3 (60%)	1 (20%)	1 (20%)	4 (80%)

* Intestine only examined for helminths

Table 3. Helminth parasites of spotted seals, *Phoca largha*.

Specimen number	*Anophryocephalus ochotensis*	*Diplogonoporus tetrapterus*	*Phocitrema fusiforme*	*Phocanema* sp.	*Contracaecum* sp.	*Corynosoma strumosum*	*Corynosoma semerme*
42016	X		X				
42017				X		X	
42018		X		X		X	
42019	X			X	X	X	
42021				X		X	
42022	X					X	
42023	X			X			
42024	X				X	X	
42025	X				X	X	
42027				X		X	
42035		X				X	
42036	X				X	X	
42037	X				X	X	
42038						X	
42069	X			X	X	X	X
15 Hosts	9 (60%)	2 (13%)	1 (6%)	7 (46%)	6 (40%)	13 (86%)	1 (6%)

Table 4. Helminth parasites of harbor seals, *Phoca richardsi*.

Specimen number	*Anophryocephalus ochotensis*	*Diphyllobothrium* sp.	*Phocitrema fusiforme*	*Pricetrema* sp.	*Phocanema* sp.	*Contracaecum* sp.	*Filocapsularia* sp.	*Corynosoma strumosum*	*Corynosoma semerme*	*Corynosoma hadweni*
31090	X	X	X	X	X	X	X	X		X
38250					X	X		X	X	X
42020					X			X		
42026	X									
4 Hosts	2 (50%)	1 (25%)	1 (25%)	1 (25%)	3 (75%)	2 (50%)	1 (25%)	3 (75%)	1 (25%)	2 (50%)

Table 5. Helminth parasites of ribbon seals, *Phoca fasciata*.

Specimen number	*Anophryocephalus ochotensis*	*Diphyllobothrium* sp.	*Contracaecum* sp.	*Filocapsularia* sp.	*Corynosoma strumosum*	*Corynosoma villosum*
42029		X	X		X	
42031		X	X		X	X
42032	X				X	X
42033		X	X		X	X
42034		X	X	X	X	X
5 Hosts	1 (20%)	4 (80%)	4 (80%)	1 (20%)	5 (100%)	4 (80%)

Table 6. Helminth parasites of ringed seals, *Phoca hispida**.

Specimen number	*Diplogonoporus tetrapterus*	*Corynosoma strumosum*	*Corynosoma semerme*	*Corynosoma validum*
42042		X	X	
42043			X	
42044		X	X	
42060		X	X	
42061		X	X	
42066	X	X	X	X
42067	X	X	X	
42068	X	X	X	X
8 Hosts	3 (37%)	7 (87%)	8 (100%)	2 (25%)

*Intestine only examined for helminths.

Table 7. Larvae of marine mammal helminths found in marine fishes SURVEYOR cruise, March - April 1976, Bering Sea.

Host	Number examined	Number of specimens harboring larvae and frequency of occurrence (%)		
		Cestode	Nematode (Anisakidae)	Acanthocephala (*Corynosoma*)
Hemilepidotus jordani	9	0	2 (22)	4 (44)
Theragera chalcogramma	14	2* (14)	3 (21)	0
Gadus macrocephalus	2	0	2 (100)	0
Myoxocephalus polyacanthocephalus	21	0	20 (47)	0
Lepidopsetta bilineata	5	0	2 (40)	2 (40)
Podothecus acipenserinus	4	0	0	0
Icelus spatula	1	0	0	0
Dasycottus setiger	1	0	0	0
Raja kincadi	1	0	0	0
Pleuronichthys quadrituberculatus	3	0	2 (66)	0
Lycodes palearis	7	0	0	1 (14)
Lycodes diapterus	5	1 (20)	0	1 (20)
Limanda aspera	10	0	4 (40)	0
Thaleichthys pacificus	2	0	0	0
Reinhardtius hippoglossoides	3	0	1 (33)	0
Gymnoacanthus galeatus	6	2* (33)	5 (83)	4 (66)
Hippoglossoides elassodon	1	0	0	1 (100)
Lumpenus maculatus	2	0	0	0
Pleurogrammus monopterygius	1	0	0	0
Hippoglossus stenolepsis	4	0	0	0
Atheresthes stomias	5	0	0	0
Total	107	5 (4)	31 (28)	13 (12)

* Larvae of shark cestodes.

APPENDIX I

A SELECTED BIBLIOGRAPHY ON MORTALITY AND PATHOLOGY OF MARINE MAMMALS WITH PARTICULAR REFERENCE TO SPECIES INHABITING THE ALASKAN OUTER CONTINENTAL SHELF

Compiled by

L. M. Shults and F. H. Fay

The following list of 252 titles includes many of the recent publications pertaining to mortality, diseases, parasites, and other pathological conditions and causative agents of marine mammalian species known to occur in waters adjacent to Alaska. Several that refer to other species or to the same species in other parts of the world have been included, because the same or similar conditions can be expected to occur in the Alaskan OCS area. This is by no means an exhaustive bibliography. An equally large number of references on health and diseases of marine mammals in captivity and of wild cetaceans and pinnipeds other than those in the Alaskan area has been excluded from this list, and some publications pertinent to the Alaskan scene probably have been omitted by oversight. The search for and selection of these is continuing, and the list will be revised or ammended at a later time.

Appended to the list is a preliminary cross-reference system, designed to facilitate location by the user of those references pertaining to a particular species, pathological condition, or causative agent of concern.

Addison, R. F., S. R. Kerr, J. Dale and D. E. Sergeant. 1973. Variation of organochlorine residue levels with age in Gulf of St. Lawrence harp seals (*Pagophilus groenlandicus*). *J. Fish. Res. Bd. Can.* 30:595-600.

Rank correlation indicated that significant portions of the DDT and PCB variance could be assigned to increased residue levels with age.

Afanas'ev, V. P. 1941. Parasite fauna of harvested mammals of the Commander Islands. *Uch. Zap. LGU* 74(Biol. Ser. 18):93-117.

Includes description of parasites of fur seals and sea otters.

Akao, S. 1970. A new species of *Sarcocystis* parasitic in the whale *Balaenoptera borealis*. *J. Protozool.* 17:290-294.

Sarcocystis balaenopteralis n.sp. is described from muscle.

Akers, T. G., A. W. Smith, A. B. Latham and H. M. S. Watkins. 1974. Calicivirus antibodies in California Gray whales (*Eschrichtius robustus*) and Steller sea lions (*Eumetopias jupatus*). *Archiv f. gesamte Virusforsch.* 46:175-177.

Sera from 5 species of cetaceans and 6 species of pinnipeds were tested for antibodies to serotypes 1, 2, and 3 of San Miguel Sea Lion Virus. Positive results were obtained from California and Steller sea lions and California Gray whales. Sera from 10 sei, 22 fin, 12 sperm, and 1 belukha whale, and pooled sera from 45 northern fur seals, 14 Pacific walruses, and 7 bearded, 22 ringed, and 4 harbor seals were negative.

Anas, R. E. and A. J. Wilson, Jr. 1970. Organochlorine pesticides in nursing fur seal pups. *Pesticides Monitor J.* 4:114-116.

Nearly all samples of muscle, brain, liver, blubber, and ingested milk from five nursing fur seal pups from the Pribilof Islands contained DDE, DDD, and DDT. A few contained dieldrin, and trace amounts of PCB's were found in all but the brain tissues.

Anderson, R. C. 1959. The taxonomy of *Dipetalonema spirocauda* (Leidy, 1858) n. comb. (=*Skrjabinaria spirocauda*) and *Dirofilaria roemeri* (Linstow, 1905) n. comb. (=*Dipetalonema roemeri*). *Can. J. Zool.* 37:481-493.

Includes a description of nematodes taken from the testicular sheath of an Alaskan fur seal.

Arnold, P. W. and D. E. Gaskin. 1975. Lungworms (Metastrongyloidea: Pseudaliidae) of harbor porpoise *Phocoena phocoena* (L. 1758). *Can. J. Zool.* 53: 713-735.

Report of lungworms from 60 harbor porpoises, with a review of their occurrence and taxonomy in odontocete whales in general.

Babero, B. B. and L. J. Thomas. 1960. A record of *Pharurus oserkaiae* (Skrjabin, 1942) in an Alaskan whale. *J. Parasit.* 46:726.

Report of nematodes in the "head sinuses" of a belukha or white whale taken in Kotzebue Sound, Alaska, with discussion of their taxonomy.

Baker, R. C., F. Wilke and C. H. Baltzo. 1963. *The Northern Fur Seal.* U.S. Fish Wildl. Serv., Circular No. 169, 22 pp.

Mortality of pups 10 to 15% in first 5 months, mainly from hookworm infection, starvation, injuries, congenital defects, and bacterial infections. Little is known about the causes of death at sea.

Ball, G. H. 1930. An acanthocephalan, *Corynosoma strumosum* (Rudolphi), from the California harbor seal. *Univ. Calif. Publ. Zool.* 33:301-305.

Report of a heavily parasitized seal pup, whose weakened condition was attributed to the remarkable infestation by more than 1150 acanthocephalans.

Banks, N. 1910. New American mites (Arachnoidea, Acarina). *Proc. Entomol. Soc. Wash.* 12:2-12.

Includes a description of *Halarachne* (=*Orthohalarachne*) *attenuata* n.sp. from a fur seal pup at St. Paul Island.

Baylis, H. A. 1947. A redescription of *Uncinaria lucasi* Stiles, a hookworm of seals. *Parasitology* 38:160-162.

Detailed description of *U. lucasi* from Alaskan fur seals.

Beck, B. and A. W. Mansfield. 1969. Observations on the Greenland shark, *Somniosus microcephalus*, in northern Baffin Island. *J. Fish. Res. Bd. Can.* 26:143-145.

Report of predation on several narwhals and a belukha, while the latter were entangled in nets, with excellent illustrations of wounds inflicted by the sharks.

Berzin, A. A. 1971. *Kachalot.* Moscow:Pischevaia Promyshlennost. (Israel Prog. Sci. Transl., 1972, 394 pp.).

Describes "enemies, diseases, and parasites" (pp. 273-304). Attacks by predators seem to be rare, and parasites, although common, seem not to cause any major problems. Deformities of the lower jaw, with associated periostosis, various tumors, renal calculi, and dental caries are the most common damaging conditions.

Bigg, M. A. and F. J. Tarasoff. 1969. Death due to a bowel obstruction in a new-born harbour seal. *Murrelet* 50:8.

Death attributed to acute constipation by a 30 cm, compact mass of foetal hair firmly lodged in the lower colon.

Blessing, M. H. and W. Eickhoff. 1967. Nabelinfektion bei einem jungen Seehunde (*Phoca vitulina*). *Deutsch tierärztl. Wochenschr.* 74:364-365.

Report on an umbilical infection in a young harbor seal. Hemolysing *Streptococcus* was isolated as the causative agent.

Blessing, M. H. and R. Rummeld. 1969. Zur Morphologie der Bronchitis des Seehundes (*Phoca vitulina* L.). *Deutsch tierärztl. Wschr.* 76:457-459.

Histopathology of bronchopneumonia in a harbor seal.

Brooks, J. W. 1954. *A Contribution to the Life History and Ecology of the Pacific Walrus.* Alaska Coop. Wildl. Res. Unit Spec. Sci. Rept. No. 1, 103 pp.

Summary of all known inimical factors (pp. 61-68) affecting the welfare and survival of walruses, including parasites, diseases, accidents, weather, inter- and intra-specific strife, and harassment by man.

Brown, R. J., A. W. Smith and M. C. Keyes. 1974a. Sarcocystis in the northern fur seal. *J. Wildl. Dis.* 10:53.

Sarcosporidial cysts were found in the masseter muscle of one adolescent male fur seal among a group of 30 pups and two adults surveyed on St. Paul Island in the Pribilof Islands.

Brown, R. J., A. W. Smith and M. C. Keyes. 1975. Renal fibrosarcoma in the northern fur seal. *J. Wildl. Dis.* 11:23-25.

Description of a neoplasm in the right kidney of a 2-week old northern fur seal found dead on the Pribilof Islands.

Brown, R. J., A. W. Smith, M. C. Keyes, W. P. Trevethan and J. L. Kupper. 1974b. Lesions associated with fatal hookworm infections in the northern fur seal. *J. Am. Vet. Med. Assn.* 165:804-805.

Description of hemorrhagic enteritis caused by hookworms, *Uncinaria lucasi*, in 12 of 28 northern fur seal pups found dead on the rookeries of the Pribilof Islands.

Brown, S. G. 1975. Relation between stranding mortality and population abundance of smaller cetacea in the northeast Atlantic Ocean. *J. Fish. Res. Bd. Can.* 32:1095-1099.

Ratio of living specimens sighted to stranded specimens has been about 120:1 in recent years.

Brownell, R. L., Jr. and B. J. LeBoeuf. 1971. California sea lion mortality: natural or artifact? pp 287-306. *In* D. Straughan (ed.), *Biological and Oceanographical Survey of the Santa Barbara Channel Oil Spill, 1969-1970*, Vol. 1. Los Angeles: Univ. of So. California.

Report on possible association of pesticides and oil pollution on sickness and mortality in sea lions.

Buhler, D. R., R. R. Claeys and B. R. Mate. 1975. Heavy metal and chlorinated hydrocarbon residues in California sea lions (*Zalophus californianus californianus*). *J. Fish. Res. Bd. Can.* 32:2391-2397.

Assessment of the possible relationship between environmental pollutant burdens and *Leptospira* infections in healthy, sick, and dead sea lions collected along the central Oregon coast. No certain relationship was found.

Burns, J. J. 1965. *The Walrus in Alaska: Its Ecology and Management.* Juneau: Alaska Dept. Fish and Game. 48 pp.

Reports mass mortality of walruses on Punuk Islands, Bering Sea.

Ching, H. L. and E. S. Robinson. 1959. Two campulid trematodes from a new host, the harbor porpoise. *J. Parasit.* 45:181.

Hadwenias nipponicus from the stomach and *Campula oblonga* from the liver and bile ducts are reported for the first time from *Phocoena* in the North Pacific region.

Cockrill, W. R. 1960. Pathology of the Cetacea, a veterinary study on whales. *Brit. Vet. J.* 116:133-144, 175-190.

A thorough review of the etiology, course, and effect of all known pathological conditions especially in blue, fin, humback, and sperm whales of the southern hemisphere, with an extensive bibliography on pathology of all cetaceans. Parasitic diseases, tumors, abcesses, trauma, bacterial conditions, and malformations are considered.

Coyler, J. F. 1938. Dento-alveolar abscess in a grampus (*Orca gladiator* Bonn.). *Scottish Nat.* 230:52-55.

Report of a case of proliferative periodontitis in a killer whale.

Cooper, A. R. 1921. Trematodes and Cestodes of the Canadian Arctic Expedition, 1913-1918. *Rept. Can. Arctic Expedition 1913-1918.* 9(G-H):3-27.

List with supplementary description, including parasites identified from bearded seals and ringed seals collected in the eastern Beaufort Sea (Amundsen Gulf).

Cornwall, I. E. 1927. Some North Pacific whale barnacles. *Contrib. Can. Biol. Fish.* 3:503-520.

Taxonomic descriptions and habitat preferences of barnacles inhabiting the skin of whales taken in the eastern North Pacific.

Cowan, D. F. 1966. Pathology of the Pilot Whale *Globicephala melaena*: a comparative survey. *Arch. Path.* 82:178-189.

A systematic autopsy of 55 Pilot whales showed respiratory disease, mainly associated with lungworm infections, to be the most common and occasionally lethal condition. Other diseases included myocarditis, arteriosclerosis, sarcosporidiosis, glomerulitis, and colloid goiter.

Dahme, E. and E. Popp. 1963. Todesfälle bei Seelöwen (*Zalophus californianus* Lesson) verursacht durch eine bisher unbekannte Milbe (*Orthohalarachne letalis* Popp). *Berl. Münch. tierarztl. Wschr.* 76:441-443.

Death of two California sea lions, due to heavy mite infestations throughout the bronchial tree. Description of a new species of nasal mite and of the pathological lesions associated with its invasion.

Dailey, M. D. 1970. The transmission of *Parafilaroides decorus* (Nematoda: Metastrongyloidea) in the California sea lion (*Zalophus californianus*). *Proc. Helminthol. Soc. Wash.* 37:215-222.

Successful transmission via fishes of lungworms of a genus found in Alaskan pinnipeds.

Dailey, M. D. 1971. Distribution of Helminths in the Dall Porpoise (*Phocoenoides dalli* True). *J. Parasit.* 57:1348.

Report of helminths found in three specimens.

Dailey, M. D. and B. L. Hill. 1970. A survey of metazoan parasites infecting the California (*Zalophus californianus*) and Steller (*Eumetopias jubatus*) sea lion. *Bull. So. Calif. Acad. Sci.* 69:126-132.

Parasites of *Zalophus* and *Eumetopias* in central to southern California are similar.

Davey, J. T. 1971. A revision of the genus *Anisakis* Dujardin, 1845 (Nematoda: Ascaridata). *J. Helminthol.* 45:51-72.

Taxonomic revision of some stomach nematodes of marine mammals.

Davis, J. E. and S. S. Anderson. 1976. Effects of oil pollution on breeding grey seals. *Mar. Pollution Bull.* 7:115-118.

Oiling of pups did not appear to affect their survival.

Delyamure, S. L. 1952. Zoogeographical characteristics of the helminth fauna of pinnipeds and cetaceans. *Trudy Gelmintol. Lab. ANSSSR* 6:235-250.

A zoogeographical analysis of the helminths of pinnipeds and cetaceans of the world ocean.

Delyamure, S. L. 1953. Characteristic features of helminthofauna of pinnipeds and cetaceans in the light of their ecology and phylogeny, pp. 212-220. *In: Contrib. Helminthol., commem. 75th birthday K. I. Skrjabin.* Moscow: Akad. Nauk SSSR.

The author traces the evolutionary path of pinnipeds and cetaceans and their parasites by comparison with terrestrial mammals.

Delyamure, S. L. 1955. *Helminthofauna of Marine Mammals in the Light of Their Ecology and Phylogeny.* Moscow:Akad. Nauk SSSR. 517 pp.

Study of the parasites of marine mammals on a global scale, including host-parasite lists, zoogeographical considerations, and systematics.

Delyamure, S. L. 1961. Ecological-geographical survey of the helminth fauna of the fur seal. *Helminthologia* 3:73-80.

The helminth fauna of sub-populations of the northern fur seal and of northern and southern fur seal species differ, not so much as a consequence of genetic differences of the hosts, but more because of ecological and geographical differences and consequent exposure to different sources of infection. Pinnipeds of very different genetic makeup, but inhabiting the same area and utilizing the food sources, tend to have the same or very similar parasite fauna.

Delyamure, S. L. and V. N. Popov. 1975. Study of the helminth fauna of the bearded seals inhabiting Sakhalin Gulf. *Nauch. Dokl. Vysch. Shkol., Biol. Nauk* 10:7-10.

An investigation of the relationship between age of the host and the kind and degree of helminthic infections. The occurrence and abundance of most of the helminths were found to vary significantly with host age.

Delyamure, S. L., M. V. Yurakhno and V. N. Popov. 1975. Helminths parasitizing man and marine mammals, pp. 106-108. *In: Marine Mammals*. Materials 6th All-Union Conf., Part I. Kiev:Naukova Dumka.

Review of literature on this subject.

DeLong, R. L., W. G. Gilmartin and J. G. Simpson. 1973. Premature births in California sea lions: association with high organochlorine pollutant residue levels. *Science* 181:1168-1170.

Organochlorine and PCB levels were several times higher in premature than in normal term pregnancies.

De Smet, W. M. A. and J. Bultinck. 1972. A case of invasive acanthosis in the skin of the penis of a sperm-whale (*Physeter catodon* L.). *Acta Zool. Path. Antverp.* 55:91-102.

Description of the gross and histological characters of the lesions, with speculation that they may have been caused by temporary attachment by cirriped crustaceans or by exposure to petroleum tars or oils.

Doan, K. H. and C. W. Douglas. 1953. Beluga of the Churchill region of Hudson Bay. *Fish. Res. Bd. Can. Bull.* 98:1-27.

Reports very frequent occurrence of strogyloid nematodes in the eustachian canals and of anasakid nematodes in the stomach.

Doetschman, W. H. 1941. The occurrence of mites in pinnipeds, including a new species from the California sea-lion, *Zalophus californianus*. *J. Parasit.* 27(Suppl.):23. (Abstract)

Of 55 California sea lions, 6 Steller sea lions, 11 harbor seals, and 2 elephant seals examined at autopsy, 61 percent harbored mites in the lungs and 22 percent had them in the nasal passages.

Dougherty, E. C. and C. M. Herman. 1947. New species of the genus *Parafilaroides* Dougherty, 1946 (Nematoda:Metastrongylidae), from sea-lions, with a list of the lungworms of the Pinnipedia. *Proc. Helminthol. Soc. Wash.* 14:77-87.

Descriptions of three new species from California and Steller sea lions.

Duguy, R. and P. Babin. 1975. Intoxication aigue par les hydrocarbures observe chez un phoque veau-marin (*Phoca vitulina*). *Cons. int. Explor. Mer, Comite de Mammiferes Marins,* C. M. 1975/N:5.

Post mortem examination of a moribund harbor seal pup showed acute intoxication due to ingestion of "fuel oil".

Dunagan, T. T. 1957. Studies on the parasites of edible animals of Alaska. *Alaska Air Command Arctic Aeromed. Lab. Tech. Note* AAL-TN-57-14:1-18.

Includes record of a nematode of the middle ear cavity, *Otophocaenurus oserskoi*, from a Belukha at Pt. Lay, Alaska.

Dunlap, J. S., R. C. Piper and M. C. Keyes. 1976. Lesions associated with *Orthohalarachne attenuata* (Halarachnidae) in the northern fur seal (*Callorhinus ursinus*). *J. Wildl. Dis.* 12:42-44.

Virtually 100 percent infection rate of the nasoturbinates and nasopharynx in fur seals up to 4 years old. Description of gross and histopathology. Effects seem minor, except as a result of heavy injestation or under stressful conditions.

Eddie, B., W. J. L. Sladen, B. K. Sladen and K. F. Meyer. 1966. Serologic studies and isolation of *Bedsonia* agents from northern fur seals on the Pribilof Islands. *Am. J. Epidemiol.* 84:405-410.

Serum-antibodies for psittacosis-lymphogranuloma venereum (PLV) agents were present in significant amounts (CF titer 1:16 to 1:128) in 72 of 233 seals. Two moderately virulent agents belonging to the PLV group were isolated from the spleen of a pup and an adult female.

Fay, F. H. 1960. Carnivorous walrus and some arctic zoonoses. *Arctic* 13:111-122.

Review of available data on occurrence of *Trichinella spiralis* in arctic pinnipeds and modes of transmission.

Fay, F. H. 1968. Experimental transmission of *Trichinella spiralis* via marine amphipods. *Can. J. Zool.* 46:597-599.

Experimental confirmation of the possibility of this mode of infection of marine mammals with *Trichinella*.

Fay, F. H. and C. Ray. 1968. Influence of climate on the distribution of walruses, *Odobenus rosmarus* (Linnaeus). I. Evidence from thermoregulatory behavior. *Zoologica* 53:1-18.

Suggests that calves may be susceptible to chilling, especially in the first weeks or months after birth.

Ferris, G. F. 1916. Anoplura from sea-lions of the Pacific Ocean. *Entomol. News* 27:366-370.

Description of *Echinophthirius fluctus* n.sp. from a Steller sea lion and a report of *Antarctophthirus microchir* from California sea lions.

Ferris, G. F. 1925. On two species of the genus *Halarachne* (Acarina, Gamasidae). *Parasitology* 17:163-167.

Report of *Halarachne otariae* (=*Orthohalarachne zalophi*) from California harbor seals, and a description of a new species, *Halarachne miroungae*, from the northern Elephant seal.

Ferris, G. F. 1934. Contributions toward a monograph of the sucking lice, Part VII. *Stanford Univ. Publ. Biol. Sci.* 2:471-526.

Taxonomic review of the anopluran sucking lice, mainly those from pinnipeds.

Ferris, G. F. 1951. The sucking lice. *Mem. Pacific Coast Entomol. Soc.* 1:1-320.

Taxonomic review of the families, subfamilies, genera and species of anoplura, including those of the Pinnipedia.

Fisher, H. D. 1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. *Fish. Res. Bd. Can. Bull.* 93:1-58.

Includes brief resume of parasites, one case of apparent starvation, and one of lymphadenitis.

Fleischman, R. W. and R. A. Squire. 1970. Verminous pneumonia in the California sea lion (*Zalophus californianus*). *Path. Vet.* 7:89-101.

Description of the occurrence of verminous pneumonia caused by *Parafilaroides decorus*.

Freuchen, P. and F. Salomonsen. 1958. *The Arctic Year*. New York:Putmans. 438 pp.

Report (p. 53) of frostbite of the flippers in a walrus.

Furman, D. P. and A. W. Smith. 1973. *In vitro* development of two species of *Orthohalarachne* (Acarina: Halarachnidae) and adaptations of the life cycle for endoparasitism in mammals. *J. Med. Ent.* 10:415-416.

Discusses the developmental stages and concludes that transmission from host to host is accomplished by the active, hexapod larvae.

Geraci, J. R. and T. G. Smith. 1976. Direct and indirect effects of oil on ringed seals (*Phoca hispida*) of the Beaufort Sea. *J. Fish. Res. Bd. Can.* 33:1976-1984.

Brief contact with crude oil in open water may cause severe though transient eye problems; persistent contact, during the period of ice cover, may result in permanent eye damage. Oiling of newborn pups is expected to lead to mortality through toxic effects of ingestion and interference with thermoregulation.

Gilmartin, W. G., R. L. DeLong, A. W. Smith, J. C. Sweeney, B. W. DeLappe, R. W. Risebrough, L. A. Griner, M. D. Dailey and D. B. Peakall. 1976. Premature parturition in the California sea lion. *J. Wildl. Dis.* 12: 104-115.

Twenty percent of the California sea lion pups born on San Miguel Island die due to premature parturition. Specimens collected from premature-partus animals resulted in recovery of San Miguel Sea Lion Virus and *Leptospira pomona*. Environmental pollutant levels (DDE, PCB) also were higher, suggesting a close interrelationship between the disease agents and chemical contaminants.

Gol'tsev, V. N. 1968. Dynamics of coastal walrus herds in light of their distribution and numbers. *Izvestiia TINRO* 62:205-215.
Includes reports of mass mortality of walruses at several points on the Siberian coast.

Goto, S. and Y. Ozaki. 1930. Brief notes on new trematodes. III. *Jap. J. Zool.* 3:73-82.
Includes description of *Phocitrema fusiforme*, sp. nov., from the intestine of a ringed seal, *Phoca hispida*.

Golvan, Y. J. 1959. Acanthocephales de genre *Corynosoma* Lühe, 1904 parasites de mammiferes d'Alaska et de Midway. *Ann. Parasitol. Hum. Comp.* 34: 288-321.
Taxonomic review of *Corynosoma* including a key to species.

Greenwood, A. G., R. J. Harrison and H. W. Whitting. 1974. Functional and pathological aspects of the skin of marine mammals, pp. 73-110. *In* R. J. Harrison (ed.), *Functional Anatomy of Marine Mammals*, Vol. II. London:Academic Press. 366 pp.
A thorough review of pathological conditions in the skin of cetaceans and pinnipeds, including those resulting from trauma, viral, bacterial, and parasitic infections, and neoplasia.

Hadwen, S. 1922. Cyst-forming protozoa in reindeer and caribou, and a sarcosporidian parasite of the seal (*Phoca richardi*). *J. Am. Vet. Med. Assn.* 61:374-382.
Report of sarcosporidian cysts and eosinophilia in two harbor seals from the Bering Sea.

Hall, J. D., W. G. Gilmartin and J. L. Mattsson. 1971. Investigation of a Pacific pilot whale stranding on San Clemente Island. *J. Wildl. Dis.* 7:324-327.
Report of a mass stranding of 28 pilot whales on San Clemente Island, California. The lack of significant pathological evidence and presence of an abundant food supply (squid) in the adjacent waters suggested that the stranding was accidental, rather than precipitated by some disease condition.

Hall, N. R., R. D. Schimpff, J. R. Woodward, C. C. Carleton and R. T. Goldston. 1975. Neurologic disease in cetaceans. *Abstracts Conf. Biol. Cons. Mar. Mamm.* (Santa Cruz). p. 21.
Pathological findings in the brain implicate neurologic disease as a significant factor in cetacean mortality, especially in mass strandings.

Hanna, G. D. 1920. Mammals of the St. Matthew Islands, Bering Sea. *J. Mamm.* 1:118-122.
Includes necropsy findings in several walrus carcasses found stranded on the St. Matthew and Pribilof Islands, and concludes that they had been crushed by ice.

Hanna, G. D. 1923. Rare mammals of the Pribilof Islands, Alaska. *J. Mamm.* 4:209-215.
Report of three walruses, in which death had been caused by crushing of the body cavity.

Hashimoto, S., S. Dayton and J. C. Roberts, Jr. 1967. Aliphatic wax alcohols and other lipids in atheromata and arterial tissues of cetaceans. *Comp. Biochem. Physiol.* 20:975-986.
Comparative analysis of normal and atheromatous arterial tissues of sperm, pilot, and killer whales.

Heller, H. H. 1920. Etiology of acute gangrenous infections of animals: a discussion of blackleg, braxy, malignant edema and whale septicemia. *J. Inf. Dis.* 27:385-451.
A report on early work on anaerobic gas gangrenous bacteria, with a brief description of septicemia of whales due to contamination of wounds.

Heppleston, P. B. 1973. Organochlorines in British grey seals. *Mar. Pollution Bull.* 4:44-45.
High levels of PCB's compared with DDT and dieldrin, with greater concentrations in seals of the North Sea than elsewhere.

Hsu, C.-K., E. C. Melby, Jr. and N. H. Altman. 1974. *Eimeria phocae* sp.n. from the harbor seal (*Phoca vitulina concolor*). *J. Parasit.* 60:399-402.
Description of a coccidian from the colon of two young harbor seals and presumed to be specific in marine mammals, with a brief discussion of its pathogenicity.

Hsu, C.-K., E. C. Melby, Jr., N. H. Altman and J. D. Burek. 1974. Coccidiosis in harbor seals. *J. Am. Vet. Med. Assn.* 164:700-701.
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Ecology of *Antarctophthirus callorhini* and *Proechinophthirius fluctus*. About 92 percent of the Pribilof fur seals harbor one or both species. Transmission is mainly from mother to pup.

Kleinenberg, S. E., A. V. Yablokov, V. M. Bel'kovich and M. N. Tarasevich. 1964. *Belukha: Knowledge from a Monographic Investigation of the Species.* Moscow: Nauka. 456 pp.

Discusses enemies and parasites (pp. 370-394), including the pathology of parasitism. Anectodal records of attacks by killer whales and polar pears are cited. Parasitic infections of the kidneys by *Crassicauda giliakiana* and the stomach by *Anasakis kukenthalii* are regarded as the most damaging.

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LeBoeuf, B. J. 1971. Oil contamination and elephant seal mortality: a "negative" finding, pp. 277-285. *In* D. Straughan (ed.), *Biological and Oceanographical Survey of the Santa Barbara Channel Oil Spill, 1969-1970*, Vol. I. Los Angeles:Univ. So. California.

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Popov, V. N. and Yu. A. Bukhtiarov. 1975. Changes with age in the diet and helminth fauna of the larga of the Okhotsk Sea, pp. 62-64. *In: Marine Mammals, Materials 6th All-Union Conf.*, Part 2. Kiev:Naukova Dumka.

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Prato, C. M., T. G. Akers and A. W. Smith. 1974. Serological evidence of calicivirus transmission between marine and terrestrial mammals. *Nature* 249:255-256.

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Taxonomic revision of the genus, with discussion of intermediate and final host relationships in this parasite of Alaskan marine mammals.

Rausch, R. L. 1973. *Post Mortem Findings in Some Marine Mammals and Birds Following the Cannikin Test on Amchitka Island.* Las Vegas: U.S. Atomic Energy Comm., 86 pp.

Pathology in harbor seals and sea otters caused by explosive and implosive forces generated by an underground test of an atomic device.

Rausch, R., B. B. Babero, R. V. Rausch and E. L. Schiller. 1956. Studies on the helminth fauna of Alaska. XXVII. The occurrence of larvae of *Trichinella spiralis* in Alaskan mammals. *J. Parasit.* 42:259-271.

Reports of *Trichinella* in one bearded seal, *Erignathus barbatus* and *Phoca* sp.

Rausch, R. L. and F. H. Fay. 1966. Studies on the helminth fauna of Alaska XLIV. Revision of *Ogmogaster* Jägerskiöld, 1891, with a description of *O. pentalineatus* sp.n. (Trematoda: Notocotylidae). *J. Parasit.* 52:26-38.

A new species of intestinal helminth from a California gray whale taken near St. Lawrence Island, Bering Sea, is described and parasite-host relationships and other aspects of the biology of these and related marine mammal trematodes are discussed.

Rausch, R. and B. Locker. 1951. Studies on the helminth fauna of Alaska II. On some helminths parasitic in the Sea Otter, *Enhydra lutris* (L.). *Proc. Helminthol. Soc. Wash.* 18:77-81.

Description of five species of helminths, including an acanthocephalan and four trematodes, one of which was new to science.

Rausch, R. L. and D. W. Rice. 1970. *Ogmogaster trilineatus* sp.n. (Trematoda: Notocotylidae) from the Fin Whale, *Balaenoptera physalus* L. *Proc. Helminthol. Soc. Wash.* 37:196-200.

A new trematode from the rectum of two fin whales taken in the eastern North Pacific, with records of other related species in these and 14 other specimens of these whales.

Reed, R. E., G. Migaki and J. A. Cummings. 1976. Coccidioidomycosis in a California sea lion (*Zalophus californianus*). *J. Wildl. Dis.* 12:372-375.

Coccidioidal granuloma in an adult male California sea lion who lived for approximately 5 years in a zoo is described. Gross and histopathological findings are presented.

Reineck, M. 1962. Über die Aufzucht verlassener Säuglinge von *Phoca vitulina* und dabei beobachtete Krankheiten. *Nord. Vet.-Med.* 14(Suppl. 1):121-124.

Brief description of diseases and other causes of morbidity and death of harbor seal pups, separated prematurely from the mother by storms, human disturbance, etc.

Rewell, R. E. and R. A. Willis. 1949. Some tumors found in whales. *J. Path. Bact.* 61:454-456.

A papilloma of the tongue, a fibromyoma of the uterus, a mucinous cystadenoma of the ovary and three granulosa-cell tumours of the ovary in blue and fin whales are described.

Rewell, R. E. and R. A. Willis. 1950. Some tumours of wild animals. *J. Path. Bact.* 62:450-452.

Includes a report on a tumor, resembling a benign ganglioneuroma of man, situated in the anterior mediastinum of a blue whale.

Rice, D. W. 1963. Progress report on biological studies of the larger cetacea in the waters off California. *Norsk Hvalf.-Tidende* 52:181-187.

Includes report of parasites and pathological conditions in blue, fin, sei, humpack, gray, and giant bottlenose whales.

Rice, D. W. 1968. Stomach contents and feeding behavior of killer whales in the eastern North Pacific. *Norsk Hvalf.-Tidende* 57:35-38.

Describes predatory behavior of killer whales on other cetaceans and pinnipeds, with records of their occurrence in the stomach contents.

Rice, D. W. and A. A. Wolman. 1971. *The Life History and Ecology of the Gray Whale (Eschrichtius robustus)*. Am. Soc. Mamm., Spec. Pub. No. 3, 142 pp.

Includes review of predators, parasites, and epizoites (pp. 98-108). The killer whale is the only known predator; 18% of those examined had scars from this source. Other than one case of biliary inflammation, caused by the fluke *Lecithodesmus goliath*, and focal inflammation of the intestinal mucosa by an acanthocephalan of the genus *Bulbosoma*, parasites seemed to have little effect on their host.

Ridgway, S. H. 1966. Dall porpoise, *Phocoenoides dalli* (True): observations in captivity and at sea. *Norsk Hvalf.-Tidende* 55:97-110.

Report on behavior, physical characters, and acclimation to captivity, with descriptions of pathological findings due mainly to stress and parasitism.

Ridgway, S. H. 1972. Homeostasis in the aquatic environment, pp. 590-747. *In* S. H. Ridgway (ed.), *Mammals of the Sea: Biology and Medicine*. Springfield, Ill.:Chas. C. Thomas. 812 pp.

Though mainly confined to husbandry and care of marine mammals in captivity, includes numerous observations on characteristics of healthy and diseased animals applicable to wild specimens, plus a review of known diseases of both wild and captive animals and their diagnosis.

Ridgway, S. H. and M. D. Dailey. 1972. Cerebral and cerebellar involvement of trematode parasites in dolphins and their possible role in stranding. *J. Wildl. Dis.* 8:33-43.

Seven stranded dolphins (*Delphinus* sp.) in California were found to have severe liver damage and brain necrosis due to invasion by *Campula rochebruni*.

Ridgway, S. H. and D. G. Johnston. 1965. Two interesting disease cases in wild cetaceans. *Am. J. Vet. Res.* 26:771-775.

First report of helminth-associated cerebral and cerebellar abscesses in a porpoise.

Roberts, J. C., Jr., S. Hashimoto, S. Dayton, R. C. Boice and R. L. Brownell, Jr. 1964a. Morphological and biochemical studies of cetacean atheromata (P). *Circulation* 30(Suppl. III):25-26. (Abstract)

Coronary atheroma had lipid and fatty acid spectra nearly identical to those in plasma, but those in aorta had dissimilar composition and were more fibrous.

Roberts, J. C., Jr., R. C. Boice, D. H. Brown and R. L. Brownell, Jr. 1964b. Atherosclerosis in whales. *Circulation* 30(Suppl. III):25. (Abstract)

Examination of more than 90 whales of 12 species revealed lipid rich lesions in 3 of 13 striped dolphins, slight atheromata in 1 of 7 pilot whales, moderate to slight disease in 2 of 7 sperm whales and one pygmy sperm whale, and slight to severe disease, including thrombi in 2 killer whales. The lesions closely resembled those of human atherosclerosis.

Robson, F. D. and P. J. H. Van Bree. 1971. Some remarks on a mass stranding of sperm whales, *Physeter macrocephalus* Linnaeus, 1758, near Gisborne, New Zealand, on March 18, 1970. *Z. f. Säugetierk.* 36:55-60.

Report of 59 animals stranded, only one of which showed outward signs of disease, resembling "a severe kind of eczema".

Rodin, N. I., V. G. Lebedev, S. N. Nifontov, V. A. Protasov and L. A. Shkredova. 1970. On the disease of dolphins. *Veterinariya* (Moscow) 3:65-67.

The clinical picture in verminous pneumonia, gastric ulcers, erysipelis and various other diseases in *Tursiops, Delphinus*, and *Phocoena*.

Roppel, A. Y., A. M. Johnson, R. D. Bauer, D. G. Chapman and F. Wilke. 1963. Fur seal investigations, Pribilof Islands, Alaska, 1962. *U.S. Fish Wild. Serv., Spec. Sci. Rept. Fisheries* 454:1-101.

Includes discussion of mortality (pp. 34-40), primarily of pups, the main cause of which was starvation; enteritis, pneumonia, and louse infestations were regarded as the most frequent secondary causes.

Roth, H. 1949. Trichinosis in Arctic animals. *Nature* (London) 163:805-806.

Report of larvae of *T. spiralis* in one bearded seal.

Roth, H. and H. Madsen. 1953. Die Trichinose in Grönland, abschliessender Bericht der Jahre 1948-1953. *Proc. Intl. Cong. Zool.* 14:340-341.

Report of finding of *T. spiralis* larvae in walrus, and in ringed, harbor, and bearded seals in Greenland.

Schaffer, F. L. and M. E. Soergel. 1973. Biochemical and biophysical characterization of calicivirus isolates from pinnipeds. *Intervirology* 1:210-219.

Two virus isolates from California sea lions and one from an Alaskan fur seal, classified as caliciviruses based on their relationship to vesicular exanthema of swine virus, were examined for biochemical and biophysical properties.

Scheffer, V. B. 1939. Organisms collected from whales in the Aleutian Islands. *Murrelet* 20:67-69.

Record of two species of barnacles and one cyamid louse from humback whales and a stomach nematode from sperm whales taken in the vicinity of Akutan Island, Alaska.

Scheffer, V. B. and J. W. Slipp. 1944. The harbor seal in Washington State. *Am. Midl. Nat.* 32:373-416.

Includes reports of predation by sharks and killer whales and a brief resume of parasites.

Scherf, H. 1963. Ein Beitrag zur Kenntnis zweier Pinnipedierläuse (*Antarctophthirus trichechi* Boheman und *Echinophthirius horridus* Olfers). *Z. f. Parasitenk.* 23:16-44.

Contributions to knowledge of the morphology, ecology, and adaptations of the sucking lice of the walrus and phocine seals.

Schiller, E. L. 1954a. Studies on the helminth fauna of Alaska XVII. Notes on the intermediate stages of some helminth parasites of the sea otter. *Biol. Bull.* 106:107-121.

Report of observations on the life cycles and developmental characteristics of *Porrocaecum decipiens* and *Microphallus pirum*, pathogenic in the sea otter.

Schiller, E. L. 1954b. Unusual walrus mortality on St. Lawrence Island, Alaska. *J. Mamm.* 35:203-210.

Report of a mass stranding. Necropsy findings indicated that the animals had been killed by a "great and sudden external pressure," possibly from an "explosion".

Schiller, E. L. 1959. Observations on the morphology and life cycle of *Microphallus pirum* (Afanas'ev, 1941). *Trans. Am. Microsc. Soc.* 78: 65-76.

Results of experimental studies of the life cycle of this trematode, a known pathogenic agent in Alaskan sea otters.

Schmidt, G. D. and M. D. Dailey. 1971. A zoogeographic note on the acanthocephalan *Corynosoma bullosum* (Linstow, 1892). *Trans. Amer. Microsc. Soc.* 90:94-95.

Extension of the known geographic range of this parasite from seals of the Antarctic region to elephant seals in California. The California host occurs also in southern Alaska.

Schroeder, R. J., C. A. Delli Quadri, R. W. McIntyre and W. A. Walker. 1973. Marine mammal disease surveillance program in Los Angeles County. *J. Am. Vet. Med. Assn.* 163:580-581.

Considers the most important reasons for marine mammal strandings to be severe parasitism.

Sergeant, D. E. and F. A. J. Armstrong. 1973. Mercury in seals from eastern Canada. *J. Fish. Res. Bd. Can.* 30:843-846.

Mercury concentrations in the tissues of four species of seals from individual localities in eastern Canada were highest in liver and lowest in blubber. Concentrations also increased with age and appeared to vary with the position in the marine food web of the organisms which they eat.

Sheldrick, M. C. 1976. Trends in the strandings of cetacea on the British coasts, 1913-1972. *Mammal Rev.* 6:15-23.

Frequency of strandings appears to be correlated most often with high population densities attracted by abundant food fishes, though occasionally is correlated with high mortality due to scarcity of foods.

Shustov, A. P. 1969. Relative indices and possible causes of mortality of Bering Sea ribbon seals, pp. 83-92. *In* V. A. Arsen'ev, B. A. Zenkovich and K. K. Chapskii (eds.), *Marine Mammals*. Moscow:ANSSSR, Ichtiol. Comm.

Mortality rate of the population as a whole estimated to be 15 to 16 percent. Major causes of mortality suggested by observations and by gross examination of lesions are: (1) predation by sharks and killer whales, (2) attacks on the newborn by large gulls and, perhaps, eagles, (3) skin diseases (agent unknown) causing depilation and cracking of the skin, and (4) parasitism, especially ulceration of the stomach wall by anasakid nematodes. A list of parasites from 17 specimens.

Simpson, J. G. and M. B. Gardner. 1972. Comparative microscopic anatomy of selected marine mammals, pp. 298-418. *In* S. H. Ridgway (ed.), *Mammals of the Sea: Biology and Medicine*. Chas. C. Thomas, Springfield, Ill. 812 pp.

Observations on the comparative histology and histopathology of the respiratory, cardiovascular, digestive, integumentary, urinary, reproductive, and lymphatic systems and of the thyroid and adrenal glands in odontocete cetaceans and certain pinnipeds.

Skrjabin, A. S. 1958. Zoogeographical characteristics of the helminth fauna of marine mammals of the Boreo-Pacific sub-region. *Izv. Kryms. Pedag. Inst.* 31:5-45.

An analysis of the status and zoogeographical relationships of the helminth parasites of North Pacific marine mammals.

Skrjabin, A. S. 1965. Larval forms of helminths from marine mammals of far eastern seas, pp. 311-316. *In* E. N. Pavlovskii (ed.), *Marine Mammals*. Moscow:Science Publishers.

Morphological descriptions of larval helminths found in pinnipeds and cetaceans.

Skrjabin, A. S. 1969. A new species of trematode of the genus *Ogmogaster* (Notocotylidae), a parasite of baleen whales. *Zool. Zhur.* 48:1882-1885.

Description of a new helminth parasite from the colon of fin, sei, and blue whales.

Skrjabin, K. I. 1944. On trematodes of the genus *Odhneriella* Skrjabin, 1915, parasitic in sea mammals. *Dokl. Akad. Nauk SSSR* 44:302-303.

Re-description of the genus *Odhneriella* with a key to species found in walrus and belukha of the Bering and Chukchi Seas.

Skrjabin, K. I. 1947. *Oschmarinella sobolevi* n.gen. n.sp., a new trematode from the giant bottlenosed whale. *Dokl. Akad. Nauk SSSR* 57:857-859.

New trematode from the bite ducts of *Berardius* in the North Pacific region.

Skrjabin, K. I. and N. K. Andreewa. 1934. Un nouveau nematode: *Crassicauda giliakiana* n. sp. trouvé dans les reins de *Delphinoptera leucos*. *Annales Parasit.* 12:15-28.

Description of a new species of nematode from the kidneys of four belukhas taken in the Okhotsk Sea.

Smith, A. W., T. G. Akers, S. H. Madin and N. A. Vedros. 1973. San Miguel sea lion virus isolation, preliminary characterization and relationship to vesicular exanthema of swine virus. *Nature* 244:108-110.

First report of a virus from a marine mammal capable of producing disease in a terrestrial mammal. SMSV is currently indistinguishable from VESV.

Smith, A. W., T. G. Akers and C. Prato. 1975. Recent San Miguel sea lion virus isolations. *Abstr. Conf. Biol. Cons. Mar. Mamm.* (Santa Cruz). p. 59.

Report of isolation of two new SMSV serotypes from an aborted fetus of a California sea lion (SMSV-4) and a northern fur seal (SMSV-5). Serological evidence indicates that spread of SMS viruses from California to Bering Sea marine mammal populations takes about two years.

Smith, A. W., T. G. Akers, C. M. Prato and H. Bray. 1976. Prevalence and distribution of four serotypes of SMSV serum neutralizing antibodies in wild animal populations. *J. Wildl. Dis.* 12:326-334.

Serum neutralizing antibodies to four serotypes of SMSV were demonstrated in a variety of marine and terrestrial species. Results show a wide geographic distribution of SMS viruses in the marine environment and indicate infection of certain terrestrial mammals. Evidence is presented supporting the theory that unidentified submammalian marine species are a reservoir for SMSV.

Smith, A. W., R. J. Brown, D. E. Skilling and R. L. DeLong. 1974a. *Leptospira pomona* and reproductive failure in California sea lions. *J. Am. Vet. Med. Assn.* 165:996-998.

Pathology and isolation of *Leptospira pomona* from aborted sea lions and present evidence supporting its role as a cause of reproductive failure in *Zalophus californianus*.

Smith, A. W., C. M. Prato, W. G. Gilmartin, R. J. Brown and M. C. Keyes. 1974b. A preliminary report on potentially pathogenic microbiological agents recently isolated from pinnipeds. *J. Wildl. Dis.* 10:54-59.

Report of *Leptospira* and SMSV isolates from California sea lions and northern fur seals and of a mycotic agent, *Scopulariopsis*, from sea lions.

Smith, T. G. and J. R. Geraci. 1974. The effect of contact and ingestion of crude oil on ringed seals of the Beaufort Sea. Interim Rept. Beaufort Sea Proj. Study 45. 27 pp.

Exposure of ringed seals in sea water to Norman Wells crude oil for 24 hours did not cause permanent damage to healthy animals. Vulnerability was increased by other stresses.

Soergel, M. E., T. G. Akers and F. L. Schaffer. 1976. Amino acid composition of three immunological types of a calicivirus, San Miguel Sea Lion Virus. *Virology* 72:527-529.

Amino acid analyses revealed statistically significant differences in composition among three immunological types of San Miguel sea lion virus.

Soergel, M. E., A. W. Smith and F. L. Schaffer. 1975. Biophysical comparisons of calicivirus serotypes isolated from pinnipeds. *Intervirology* 5:239-244.

Biophysical properties of three new San Miguel sea lion virus isolates from pinnipeds were examined and compared with those of previously characterized serotypes.

Steding, E. 1923. Zur Anatomie und Histologie von *Halarachne otariae* n.sp. *Z. f. Wiss. Zool.* 121:442-493.

Description of a new species of nasal mite from the California sea lion.

Stolk, A. 1950. Tumours in whales. *Amsterdam Naturalist* 1:28-33.

Description of an ovarian carcinoma and uterine fibromyoma from a fin and blue whale, respectively.

Stolk, A. 1952. Some tumours in whales. *Proc. K. ned. Akad. Wet.* 55C:275-278.

A review of the occurrence and types of tumors found in cetaceans, with descriptions of five new records from a bottlenose dolphin and from sperm, fin, and humpback whales.

Stolk, A. 1953a. Some tumors in whales. II. *Proc. K. ned. Akad. Wet.* 56C:369-374.

Further review, with description of five additional records from sperm, fin, and humpback whales. All of the affected animals were adults. The tumors were for the most part histologically similar to their counterparts in man.

Stolk, A. 1953b. Some inflammations in whales. *Proc. K. ned. Akad. Wet.* 56C:364-368.

Report of tonsilitis in a sperm whale, and of colitis, inflammation of the cervical muscles, and inflammation of a flipper in blue whales. Causes are unknown.

Stolk, A. 1953c. Hepatic cirrhosis in the blue whale, *Balaenoptera musculus*. *Proc. K. ned. Akad. Wet.* 56C:375-378.

Description of a cirrhotic liver, structurally resembling the same condition in man, with speculation that it may have been caused by either hepatitis or more likely by nutritional deficiencies.

Stolk, A. 1954a. Some inflammations in whales. II. *Proc. K. ned. Akad. Wet.* 57C:254-257.

Description of fibropapillomatous proliferations of the pleura in a blue whale and inflammation with necrosis and calcification in the intercostal musculature of a fin whale.

Stolk, A. 1954b. A new case of hepatic cirrhosis in the blue whale, *Balaenoptera musculus* (L.). *Proc. K. ned. Akad. Wet.* 57C:258-260.

Description of a case in a female blue whale, attributed to hepatitis.

Stolk, A. 1962. Tumours in Whales. III. Granuloma malignum (Hodgkin's disease) in the fin whale (*Balaenoptera physalus*). *Proc. K. ned. Akad. Wet.* 65C:250-268.

Literature review and description of the first case of malignancy in a whale with involvement of the spleen, the para-aortal, paratracheal and retroperitoneal lymph glands, the lymph glands of the pelvic regions, the bone-marrow and the liver.

Stunkard, H. W. 1948. Pseudophyllidean cestodes from Alaskan pinnipeds. *J. Parasit.* 34:211-228.

Description and taxonomic discussion of four species of diphyllobothriid cestodes from the bearded seal, northern fur seal, and Steller sea lion from Bering Sea.

Stunkard, H. W. and H. W. Schoenborn. 1936. Notes on the structure, distribution, and synonomy of *Diphyllobothrium lanceolatum*. *Amer. Mus. Novit.* 880:1-9.

Additions are made to Zschokke's (1903) account of the structure of this species and to its taxonomy. A list of the diphyllobothriid cestodes of seals is given.

Sweeney, J. C. 1974. Common diseases of pinnipeds. *J. Am. Vet. Med. Assn.* 165:805-810.

Summary of disease patterns in wild and captive pinnipeds with brief descriptions of etiology, pathology, and treatment.

Sweeney, J. C. and W. G. Gilmartin. 1974. Survey of diseases in free-living California sea lions. *J. Wildl. Dis.* 10:370-376.

Necropsy findings in 51 moribund specimens that stranded in California. Respiratory disease, associated with lungworm infestation was most common.

Sweeney, J. C. and S. H. Ridgway. 1975. Common diseases of small cetaceans. *J. Am. Vet. Med. Assn.* 167:533-540.

Diagnosis and treatment of the more common diseases of small cetaceans in captivity.

Tarasoff, F. J. and J. Pierard. 1970. Ectrodactylism in the harbour seal, *Phoca vitulina* L. (Mammalia: Phocidae). *Can. J. Zool.* 48:1381-1384.

Description of a deformity in the hind limbs, probably of congenital origin.

Taylor, A. E. R., D. H. Brown, D. Heyneman and R. W. McIntyre. 1961. Biology of filarioid nematode *Dipetalonema spirocauda* (Leidy, 1858) from the heart of captive harbor seals and sea lions, together with pathology of the hosts. *J. Parasit.* 47:971-976.

Clinical symptoms of filariasis in both hosts and pathological findings at necropsy in the harbor seals.

Thorsteinson, F. V. and C. J. Lensink. 1962. Biological observations of Steller sea lions taken during an experimental harvest. *J. Wildl. Mgt.* 26:353-359.

About 10% of pups and an undisclosed proportion of adults were moribund or dead from natural causes.

Tikhomirov, E. A. 1959. The question of feeding of Steller sea lions on warm-blooded animals. *Izvestiia TINRO* 47:185-186.

Report of a case of predation on a ringed seal pup.

Tomes, C. S. 1873. On a case of abcess of the pulp in a grampus (*Orca gladiator*). *Trans. Odontol. Soc. Gr. Brit.* 5:39-46.

Description of a case of pulpitis in a killer whale.

Tomilin, A. G. and M. I. Smyshlyaev. 1968. On some mortality factors of whales. *Bull. Mosc. Soc. Nat.* (Sec. Biol.) 73:5-12.

Discussion of mortality factors, especially a disease of the baleen apparatus that has appeared in recent years and is thought to be due to excessive radiation.

Treschev, V. V. 1966a. A new species of Acanthocephala from a whale of the Chukchi Sea. *Trudy Ukrain. Respub. Nauch. Obsch. Parazit.* 5:112-115.

Description of a new species of acanthocephalan from the intestine of a gray whale taken in the Chukchi Sea.

Treschev, V. V. 1966b. A new species of the genus *Ogmogaster* Jägerskiöld, 1891, (*Ogmogaster delamurei* n.sp.), pp. 22-25. *In: Parazity promezhutochnye koziaeva i perenoschiki.* Kiev: A. N. Ukrain. SSR.

Description of *O. delamurei* (=*O. pentalineatus*) from the California gray whale taken in the Chukchi Sea.

Treschev, V. V., A. M. Serdiukov and M. V. Yurakhno. 1969. *Orthosplanchnus odobaeni* sp.nov. (Trematoda, Campulidae), a new trematode from the Pacific walrus. *Nauch. Dokl. Vysch. Shkol., Biol. Nauk* 8:7-9.

Diagnosis of a parasite, new to science, from the gall bladder of a walrus from the Chukchi Sea.

Truex, R. C., F. G. Nolan, R. C. Truex, Jr., H. P. Schneider and H. I. Perlmutter. 1961. Anatomy and pathology of the whale heart with special reference to the coronary circulation. *Anat. Rec.* 141:325-333.

Report on the results of study of 10 specimens, including sei, gray, and sperm whales. Findings included filariid nematodes in the right ventricle and cardiac veins of two sperm whales, a myocardial infarct in the interventricular septum of a sperm whale, and atheromatous plaques in the coronary arteries of four sperm whales.

Uys, C. J. and P. B. Best. 1966. Pathology of lesions observed in whales flensed at Saldanha Bay, South Africa. *J. Comp. Path.* 76:407-412.

The lesions observed in 21 of 2,000 sperm, blue, sei, and Brydes whales, including tumors, fibrous replacement of muscle and fat necrosis, renal and endometrial uterine necrosis, inflammation of testis and epididymis, ductal obstruction of mammary gland, and anal tonsils.

Van Bree, P. J. H. and R. Duguy. 1970. Sur quelques aberrations pathologiques chez les petits Cetacés. *Zool. Garten* 39:11-15.

Includes description of a harbor porpoise with a healed fracture of the distal part of one mandibular ramus and a record of an osteological anomaly (not described) in the cranium of a belukha.

Van Cleave, H. J. 1953a. A preliminary analysis of the acanthocephalan genus *Corynosoma* in mammals of North America. *J. Parasit.* 39:1-13.

Taxonomic revision, with diagnoses for most of Alaskan species.

Van Cleave, H. J. 1953b. Acanthocephala of North American mammals. *Biol. Monogr.* (Illinois) 23:1-179.

Monographic revision with detailed specific diagnoses for all known species of *Corynosoma* and *Bolbosoma* occurring in Alaskan marine mammals at publication time.

Van Pelt, R. W. and R. A. Dieterich. 1973. Staphylococcal infection and toxoplasmosis in a young harbor seal. *J. Wildl. Dis.* 9:258-261.

Generalized subcutaneous abscessation followed by acute systemic infection occurred 12 days post-capture. The causative agent, *S. aureus*, was isolated from several tissues, and *Toxoplasma gondi* was found associated with necrotic lesions in the liver. Both pathogens were presumably acquired prior to capture.

Vedros, N. A., D. G. Johnston and P. I. Warren. 1973. *Neisseria* species isolated from dolphins. *J. Wildl. Dis.* 9:241-244.

Report of isolates of commonly occurring bacterial agent in the respiratory tract of small cetaceans, resembling one in man that is frequently implicated in cases of bacterial pneumonia of children.

Vedros, N. A., A. W. Smith, J. Schonewald, G. Migaki and R. C. Hubbard. 1971. Leptospirosis epizootic among California sea lions. *Science* 172:1250-1251.

A *Leptospira* species is suspected of being the etiological agent in a recent epizootic among California sea lions. The disease was confined to subadult males. Pathology of 15 necropsied animals is presented.

Wardle, R. A., J. A. McLeod and I. E. Stewart. 1947. Lühe's *"Diphyllobothrium"* (Cestoda). *J. Parasit.* 33:319-330.

Host list and key to the genera of diphyllobothriid cestodes of pinnipeds.

Weber, N. A. 1950. A survey of the insects and related arthropods of Arctic Alaska. Part I. *Trans. Am. Entomol. Soc.* 76:147-206.

Includes report of sucking lice from a walrus and a ringed seal.

Wilson, T. M., A. D. Boothe and N. F. Cheville. 1972a. Sealpox field survey. *J. Wildl. Dis.* 8:158-160.
First evidence of a poxvirus skin infection in free-living California sea lions.

Wilson, T. M., N. F. Cheville and A. C. Boothe. 1972b. Sealpox questionnaire survey. *J. Wildl. Dis.* 8:155-157.
Sealpox was confirmed from skin biopsies by light and electron microscopy in five captive California sea lions, one free living Alaskan harbor seal and one South American sea lion.

Wolman, A. A. and A. J. Wilson, Jr. 1970. Occurrence of pesticides in whales. *Pesticides Monitor. J.* 4:8-10.
Organochlorine pesticides were found in tissue samples of brain, blubber, and liver from 6 of 23 gray whales, and in each of 6 sperm whales.

Young, P. C. and D. Lowe. 1969. Larval nematodes from fish of the subfamily anisakinae and gastro-intestinal lesions in mammals. *J. Comp. Pathol.* 79:301-313.
Pathology of nematode infections of the digestive tract of seals and porpoises. Description of eosinophilic granulomatous lesions of the stomach wall as inflammatory responses to the presence of the parasites.

Yurakhno, M. V. 1967. *Orthosplanchnus pygmaeus* sp.n. (Trematoda: Campulidae) a parasite of the whale. *Vestnik Zool.* 1967(3):79-82.
A new trematode from the intestine of a gray whale taken in the Chukchi Sea.

Yurakhno, M. V. 1968. A new trematode *Microphallus orientalis* sp.n. (Trematoda: Microphallidae), parasite of the Pacific walrus and bearded seal. *Zool. Zhur.* (Moscow) 47:630-631.
Description of a trematode, new to science, taken from intestines of walrus and bearded seals from the Bering and Chukchi Seas.

Yurakhno, M. V. 1969a. *Pricetrema erignathi* sp.n. (Trematoda: Heterophyidae), a parasite of the bearded seal. *Parazitologia* 3:354-356.
Description of parasite, new to science, in the intestine of Bering Sea bearded seals.

Yurakhno, M. V. 1969b. A new trematode, *Orthosplanchnus oculatus* sp.n. (Trematoda, Campulidae), parasite of the Pacific walrus. *Vestnik Zool.* 1969(4):29-31.
Description of a trematode, new to science, from the intestine of a walrus taken in the Chukchi Sea.

Yurakhno, M. V. 1973. A new species of cestoda - *Diphyllobothrium macroovatum* sp.n. (Cestoda, Diphyllobothriidae) - parasite of the gray whale. *Vestnik Zool.* 1973(6):25-30.
A parasite new to science from the intestines of two gray whales from the Bering Sea.

Yurakhno, M. V. and A. S. Skrjabin. 1971. *Parafilaroides krascheninnikovi* sp.n. parasite of the lungs of the ringed seal *Pusa hispida krascheninnikovi* Naumov et Smirnov. *Vestnik Zool.* 1971(1):32-36.

Description of a species of nematode new to science, from ringed seals of the Bering and Chukotsk Seas.

Yurakhno, M. V. and V. V. Treschev. 1972. An investigation of the helminth fauna of the Pacific walrus, pp. 280-283. *In* Abstracts of papers, 5th All-Union Conf. studies of marine mammals, Vol. II Makhachkala.

Preliminary results of examination of 95 walruses from the western Chukchi Sea, with a tabulation of the frequency of occurrence and intensity of infection for each of the 11 species found.

Zenkovich, B. A. 1938. On the grampus or killer whale, *Grampus orca* Linn. *Priroda* (Moscow) 1938(4):109-112.

Anecdotal accounts of predation on walruses and other marine mammals.

Key by Marine Mammal Species

CARNIVORES

Sea Otter (Enhydra lutris)

Afanas'ev (1941)
Kenyon (1969)
Kenyon et al (1965)
Neiland (1962)
Rausch (1953)
Rausch (1973)
Rausch & Locker (1951)
Schiller (1954a)
Schiller (1959)

SEALS, SEA LIONS and WALRUSES

Pinnipeds (general)

Delyamure (1952)
Delyamure (1953)
Delyamure (1955)
Dougherty & Herman (1941)
Ferris (1934)
Ferris (1951)
Greenwood et al (1974)
Jellison & Neiland (1965)
Johnson et al (1966)
Margolis (1954a)
Margolis (1955b)
Margolis (1956)
Margolis & Dailey (1972)
Markowski (1952)
Myers (1959)
Newell (1947)
Perry (1967)
Price (1932)
Ridgway (1972)
Scherf (1963)
Sergeant & Armstrong (1973)
Simpson & Gardner (1972)
Skrjabin (1958)
Skrjabin (1965)
Stunkard & Schoenborn (1936)
Sweeney (1974)
Wardle et al (1947)
Young & Lowe (1969)

Northern Fur Seal (Callorhinus ursinus)

Afanas'ev (1941)
Anas et al (1970)
Anderson (1959)
Baker et al (1963)
Banks (1910)
Baylis (1947)
Brown et al (1974a)
Brown et al (1974b)
Brown et al (1975)
Delyamure (1961)
Dunlap et al (1976)
Eddie et al (1966)
Jellison & Milner (1968)
Johnson (1968)
Keyes (1965)
Kim (1972)
Kim (1975)
Krotov & Delyamure (1952)
Lurochkin & Sobolewsky (1975)
Neiland (1961)
Olsen (1958)
Olsen & Lyons (1962)
Olsen & Lyons (1965)
Perry & Foster (1971)
Prato et al (1974)
Roppel et al (1963)
Smith et al (1974b)
Smith et al (1975)
Stunkard (1948)

Steller Sea Lion (Eumetopias jubatus)

Akers et al (1974)
Dailey & Hill (1970)
Dougherty & Herman (1947)
Ferris (1916)
Krotov & Dely.mure (1952)
Liu & Edward (1971)
Perry (1967)
Pike (1961)
Stunkard (1948)
Thorsteinsen & Lensink (1962)

California Sea Lion (Zalophus californianus)

Akers et al (1974)
Brownell & LeBoeuf (1971)
Buhler et al (1975)
Dahme & Popp (1963)
Dailey (1970)
Dailey & Hill (1970)
DeLong et al (1973)
Doetschman (1941)
Dougherty & Herman (1947)
Ferris (1916)
Fleischman & Squire (1970)
Gilmartin et al (1976)
Johnson & Ridgway (1969)
Le Boeuf & Bonnell (1971)
McIlhattan et al (1971)
Migaki et al (1971)
Morales & Helmboldt (1971)
Northway (1972)
Perry (1967)
Prato et al (1974)
Reed et al (1976)
Smith et al (1974a)
Smith et al (1974b)
Smith et al (1975)
Steding (1923)
Sweeney & Gilmartin (1974)
Taylor et al (1961)
Vedros et al (1971)
Wilson et al (1972a)
Wilson et al (1972b)

Walrus (Odobenus rosmarus)

Brooks (1954)
Burns (1965)
Fay (1960)
Fay & Ray (1968)
Freuchen & Salomonsen (1958)
Gol'tsev (1968)
Hanna (1920)
Hanna (1923)
Loughrey (1959)
Marks & Burns (1966)
Murie (1936)
Nikulin (1941)
Popov (1958)
Roth & Madsen (1953)
Schiller (1954b)
Skrjabin (1944)
Treschev et al (1969)
Weber (1950)
Yurakhno (1968)
Yurakhno (1969b)
Yurakhno & Treschev (1972)
Zenkovich (1938)

Northern Elephant Seal (Mirounga angustirostris)

Ferris (1925)
Johnston & Ridgway (1969)
LeBoeuf (1971)
Schmidt & Dailey (1971)

Bearded Seal (Erignathus barbatus)

Cooper (1921)
Delyamure & Popov (1975)
Kenyon (1962)
Krotov & Delyamure (1952)
Lyster (1940)
Myers (1957)
Rausch et al (1956)
Roth (1949)
Roth & Madsen (1953)
Stunkard (1948)
Yurakhno (1968)
Yurakhno (1969a)

Harbor and Spotted Seals (Phoca vitulina and P. largha)

Ball (1930)
Bigg & Tarasoff (1969)
Blessing & Eickhoff (1967)
Blessing & Rummeld (1969)
Duguy & Babin (1975)
Ferris (1925)
Fisher (1952)
Hadwen (1922)
Hsu et al (1974a)
Hsu et al (1974b)
Jacobsen (1966)
Lyster (1940)
Margolis (1956)
Popov (1975b)
Popov & Bukhtiarov (1975)
Rausch (1973)
Reineck (1962)
Roth & Madsen (1953)
Scheffer & Slipp (1944)
Tarasoff & Piérard (1970)
Taylor et al (1961)
VanPelt & Dieterich (1973)
Wilson et al (1972b)

Ringed Seal (Phoca hispida)

Cooper (1921)
Geraci & Smith (1976)
Goto & Ozaki (1930)
Kenyon (1962)
Krotov & Delyamure (1952)
Lyster (1940)
Myers (1957)
Roth & Madsen (1953)
Smith & Geraci (1974)
Tikhomirov (1959)
Weber (1950)
Yurakhno & Skrjabin (1971)

Ribbon Seal (Phoca fasciata)

Popov (1975a)
Shustov (1969)

WHALES AND PORPOISES

Cetacea (general)

Cockrill (1960)
Cornwall (1927)
Delyamure (1952)
Delyamure (1953)
Delyamure (1955)
Hall (1975)
Hashimoto et al (1967)
Heller (1920)
Jellison & Neiland (1965)
Kagei et al (1967)
Klumov (1963)
Leung (1965)
Leung (1967)
Margolis (1954a)
Margolis & Dailey (1972)
Margolis & Pike (1955)
Mosgovoi (1949)
Price (1933)
Roberts et al (1964)
Skrjabin (1958)
Skrjabin (1965)
Stolk (1952)
Stolk (1953a)
Tomilin & Smyshlyaev (1968)

Gray Whale (*Eschrichtius robustus*)

Akers *et al* (1974)
Kasuya & Rice (1970)
Rausch & Fay (1966)
Rice (1963)
Rice & Wolman (1971)
Treschev (1966a)
Treschev (1966b)
Truex *et al* (1961)
Wolman & Wilson (1970)
Yurakhno (1967)
Yurakhno (1973)

Humpback Whale (*Megaptera novaeangliae*)

Cockrill (1960)
Pilleri (1966)
Rice (1963)
Scheffer (1939)

Blue Whale (*Balaenoptera musculus*)

Cockrill (1960)
Rewell & Willis (1949)
Rewell & Willis (1950)
Rice (1963)
Skrjabin (1969)
Stolk (1950)
Stolk (1953b)
Stolk (1953c)
Stolk (1954a)
Stolk (1954b)
Uys & Best (1966)

Fin Whale (*Balaenoptera physalis*)

Cockrill (1960)
Pilleri (1968)
Rausch & Rice (1970)
Rewell & Willis (1949)
Rice (1963)
Skrjabin (1969)
Stolk (1950)
Stolk (1954a)
Stolk (1962)

Sei Whale (*Balaenoptera borealis*)

Akao (1970)
Rice (1963)
Skrjabin (1969)
Truex *et al* (1961)
Uys & Best (1966)

Minke Whale (*Balaenoptera acutorostrata*)

Margolis (1959)
Moore & Palmer (1955)

Toothed Whales (Odontocetes) general

Arnold & Gaskin (1975)
Brown (1975)
Greenwood *et al* (1974)
Johnston & Ridgway (1969)
Neiland *et al* (1970)
Ridgway (1972)
Ridgway & Johnston (1965)
Sheldrick (1976)
Simpson & Gardner (1972)
Sweeney & Ridgway (1975)
Vedros *et al* (1973)
Young & Lowe (1969)

Beaked Whales (*Ziphius*, *Mesoplodon*, *Berardius*)

Hubbs (1946)
Kenyon (1961)
Mitchell (1968)
Mitchell & Houck (1967)
Rice (1963)
Skrjabin (1947)

Pilot Whale (*Globicephala macrorhyncha*)

Cowan (1966)
Hall *et al* (1971)
Roberts *et al* (1964)

Killer Whale (*Orcinus orca*)

Colyer (1938)
Roberts *et al* (1964)
Tomes (1873)

Harbor Porpoise (*Phocoena phocoena*)

Arnold & Gaskin (1975)
Ching & Robinson (1959)
Rodin *et al* (1970)
Van Bree & Duguy (1970)

Dall Porpoise (*Phocoenoides dalli*)

Dailey (1971)
Machida (1974)
Migaki *et al* (1971)
Ridgway (1966)

Belukha (*Delphinapterus leucas*)

Babero & Thomas (1960)
Beck & Mansfield (1969)
Doan & Douglas (1953)
Dunagan (1957)
Kleinenberg *et al* (1964)
Krotov & Delyamure (1952)
Lyster (1940)
Neiland (1962)
Rausch *et al* (1956)
Skrjabin (1944)
Skrjabin & Andreeva (1934)
Van Bree & Duguy (1970

Narwhal (*Monodon monoceros*)

Beck & Mansfield (1969)

Sperm Whale (*Physeter catodon*)

Berzin (1971)
Cockrill (1960)
DeSmet & Bultinck (1972)
Owen & Kakulas (1968)
Roberts *et al* (1964)
Robson & Van Bree (1971)
Scheffer (1939)
Stolk (1953b)
Truex *et al* (1961)
Uys & Best (1966)
Wolman & Wilson (1970)

Key to Pathological Conditions

General Pathology and Mortality

Baker et al (1963
Berzin (1971)
Brooks (1954)
Cockrill (1960)
Cowan (1966)
Johnson (1968)
Johnston & Ridgway (1969)
Kenyon (1969)
Keyes (1965)
Loughrey (1959)
Migaki et al (1971)
Pike (1961)
Rausch (1953)
Reineck (1962)
Rice (1963)
Ridgway (1966)
Ridgway (1972)
Rodin et al (1970)
Simpson & Gardner (1972)
Sweeney (1974)
Sweeney & Gilmartin (1974)
Sweeney & Ridgway (1975)
Thorsteinsen & Lensink (196
Tomilin & Smyshlyaev (1968)
Uys & Best (1966)

Stranding and Mass Dying

Brown (1975)
Burns (1965)
Cowan (1966)
Gol'tsev (1968)
Hall et al (1971)
Hall et al (1975)
Hanna (1920)
Hanna (1923)
Kenyon (1961)
Kenyon (1969)
Mitchell (1968)
Mitchell & Houck (1967)
Murie (1936)
Ridgway & Dailey (1972)
Robson & Van Bree (1971)
Schiller (1954b)
Schroeder et al (1973)
Sheldrick (1976)

Miscellaneous Inflammatory Responses

Duguy & Babin (1975)
Geraci & Smith (1976)
Stolk (1953b)
Stolk (1954a)

Lymphadenitis

Fisher (1952)

Tumors

Rewell & Willis (1949)
Rewell & Willis (1950)
Stolk (1950)
Stolk (1952)
Stolk (1953a)
Stolk (1962)

Neurologic Disease

Hall et al (1975)
Pilleri (1966)
Pilleri (1968)
Ridgway & Dailey (1972)
Ridgway & Johnston (1965)

Congenital Deformities

Marks & Burns (1966)
Tarasoff & Pierard (1970)

Skin Lesions

DeSmet & Bultinck (1972)
Freuchen & Salomonsen (1958)
Greenwood et al (1974)
Hubbs (1946)
Mitchell & Houck (1967)
Nemoto (1955)
Pike (1951)
Shustov (1969)

Dental Lesions

Colyer (1938)
Tomes (1873)

Gastric Ulcers

Liu & Edward (1971)

Hepatic Cirrhosis

Stolk (1953c)
Stolk (1954b)

Hemorrhagic Enteritis

Brown et al (1974)

Bowel Obstruction

Bigg & Tarasoff (1969)

Starvation

Fisher (1952)
Roppel et al (1963)

Pneumonia

Blessing & Rummeld (1969)
Fleischman & Squire (1970)
Morales & Helmboldt (1971)

Cardiovascular Disease

Hashimoto et al (1967)
Roberts et al (1964a)
Roberts et al (1964b)
Truex et al (1961)

Renal Fibrosarcoma

Brown et al (1975)

Key to Pathogenic Agents

Chemical Pollutants / Toxicants

Addison et al (1973)
Anas et al (1970)
Brownell & Le Boeuf (1971)
Buhler et al (1975)
Davis & Anderson (1976)
DeLong et al (1973)
Duguy & Babin (1975)
Geraci & Smith (1976)
Gilmartin et al (1976)
Heppleston (1973)
Le Boeuf (1971)
Le Boeuf & Bonnell (1971)
Sergeant & Armstrong (1973)
Smith & Geraci (1974)
Tomilin & Smyshlyaev (1968)
Wolman & Wilson (1970)

Thermal Stress

Fay & Ray (1968)
Geraci & Smith (1976)

Trauma

Hanna (1920)
Hanna (1923)
Murie (1936)
Rausch (1973)
Schiller (1954b)
Van Bree & Duguy (1970)

Infectious Agents (Bacteria)

Blessing & Eickhoff (1967)
Gilmartin et al (1976)
Heller (1920)
Jellison & Milner (1958)
McIlhattan et al (1971)
Northway (1972)
Smith et al (1974a)
Smith et al (1974b)
Van Pelt & Dieterich (1973)
Vedros et al (1971)
Vedros et al (1973)

Infectious Agents (Virus)

Akers et al (1974)
Eddie et al (1966)
Madin et al (1976)
Prato et al (1974)
Schaffer & Soergel (1973)
Smith et al (1973)
Smith et al (1974b)
Smith et al (1975)
Smith et al (1976)
Soergel et al (1975)
Soergel et al (1976)
Wilson et al (1972a)
Wilson et al (1972b)

Protozoan Parasites

Akao (1970)
Brown et al (1974a)
Hadwen (1922)
Hsu et al (1974)
Owen & Kakulas (1968)
Reed et al (1976)
Van Pelt & Dieterich (1973)

Metazoan Parasites (general)

Afanas'ev (1941)
Cooper (1921)
Dailey (1971)
Dailey & Hill (1970)
Delyamure (1952)
Delyamure (1953)
Delyamure (1955)
Delyamure (1961)
Delyamure & Popov (1975)
Delyamure et al (1975)
Fisher (1952)
Jellison & Neiland (1965)
Johnson et al (1966)
Johnston & Ridgway (1969)
Kenyon (1962)
Klumov (1963)
Krotov & Delyamure (1952)
Lyster (1940)
Machida (1974)
Margolis (1954a)
Margolis (1956)
Margolis & Dailey (1972)
Margolis & Pike (1955)
Markowski (1952)
Popov (1975a)
Popov (1975b)
Popov & Bukhtiarov (1975)
Rausch (1953)
Rausch & Locker (1951)
Rice (1963)
Rice & Wolman (1971)
Scheffer & Slipp (1944)
Schroeder et al (1973)
Shustov (1969)
Skrjabin (1958)
Skrjabin (1965)
Yurakhno & Treschev (1972)

Trematodes

Ching & Robinson (1959)
Goto & Ozaki (1930)
Neiland (1961)
Neiland et al (1970)
Price (1932)
Rausch & Fay (1966)
Rausch & Rice (1970)
Ridgway & Dailey (1972)
Schiller (1954a)
Schiller (1959)
Skrjabin (1944)
Skrjabin (1947)
Skrjabin (1969)
Treschev (1966b)
Treschev et al (1969)
Yurakhno (1967)
Yurakhno (1968)
Yurakhno (1969a)
Yurakhno (1969b)

Cestodes

Rausch (1964)
Stunkard (1948)
Stunkard & Schoenborn (1936)
Wardle et al (1947)
Yurakhno (1973)

Nematodes

Anderson (1959)
Arnold & Gaskin (1975)
Babero & Thomas (1960)
Baylis (1947)
Brown et al (1974)
Dailey (1970)
Davey (1971)
Doan & Douglas (1953)
Dougherty & Herman (1947)
Dunagan (1957)
Fay (1960)
Fay (1968)
Fleischman & Squire (1970)
Kagei et al (1967)
Liu & Edward (1971)
Lukashenko et al (1971)
Morales & Helmboldt (1971)
Mosgovoi (1949)
Myers (1957)
Myers (1959)
Neiland (1961)
Olsen (1958)
Olsen & Lyons (1962)
Olsen & Lyons (1965)
Perry (1967)
Perry & Forrester (1971)
Rausch et al (1956)
Roth (1949)
Roth & Madsen (1953)
Scheffer (1939)
Schiller (1954a)
Skrjabin & Andreeva (1934)
Taylor et al (1961)
Young & Lowe (1970)
Yurakhno & Skrjabin (1971)

Acanthocephalans

Ball (1930)
Golvan (1959)
Margolis (1955b)
Neiland (1962)
Schmidt & Dailey (1971)
Treschev (1966a)
VanCleave (1953a)
VanCleave (1953b)

Ectoparasites

Cornwall (1927)
Ferris (1916)
Ferris (1934)
Ferris (1951)
Jacobsen (1966)
Kasuya & Rice (1970)
Kim (1972)
Kim (1975)
Leung (1965)
Leung (1967)
Margolis (1954b)
Margolis (1955a)
Margolis (1959)
McAtee (1923)
Osborn (1899)
Scheffer (1939)
Scherf (1963)
Steding (1923)
Weber (1950)

Nasal Mites

Banks (1910)
Dahme & Popp (1963)
Doetschman (1941)
Dunlap et al (1976)
Ferris (1925)
Furman & Smith (1973)
Kenyon et al (1965)
Lurochkin & Sobelewsky (1975)
Newell (1947)
Oudemans (1925)

Predators

Beck & Mansfield (1969)
Moore & Palmer (1955)
Nikulin (1941)
Popov (1958)
Rice (1968)
Scheffer & Slipp (1944)
Shustov (1969)
Tikhomirov (1959)
Zenkovich (1938)

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 8 R.U. NUMBER: 194

PRINCIPAL INVESTIGATOR: Dr. F. H. Fay

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1			
Alaska Peninsula	7/23/75	7/24/75	submitted			
Kotzebue Sound	7/17/75	7/20/75	submitted			
Kotzebue Sound	7/22/75	7/24/75	submitted			
St. Lawrence Is.	8/8/75	8/22/75	submitted			
Alaska Peninsula	Summer 1976		submitted			
Kotzebue Sound	Summer 1976		submitted			

All FY '76 data have been submitted

Note: 1 Data Management Plan has been approved by M. Pelto; we await approval by the Contract Officer.

QUARTERLY REPORT

Contract #03-5-022-69
Research Unit #229
Reporting Period Oct. 1 thru Dec. 31
Number of Pages - 9

Biology of the Harbor Seal, *Phoca vitulina richardi*, In the Gulf of Alaska

Principal Investigators:

Kenneth Pitcher, Marine Mammals Biologist

Donald Calkins, Marine Mammals Biologist

This project is investigating several phases of the biology and ecology of the harbor seal in the Gulf of Alaska which relate to oil and natural gas development in the area. Basic objectives include: (1) examination of food habits and trophic relationships, (2) investigation of population productivity with emphasis on determining age of sexual maturity and age specific reproductive rates and (3) examination of growth and body condition. Peripheral objectives include collection of data concerning seasonal distribution, use of critical habitat, effects of disturbance, population composition and collection of specimen materials for disease and environmental pollutant analyses.

Field activities conducted during the past quarter were centered in the western Gulf of Alaska. The NOAA ship Surveyor was used between 5-14 October to visit a number of sites around the Kodiak Archipelago, the Barren Islands, Semidi Islands and Chirikof Island. Eighteen harbor seals were collected on this cruise. From 3-10 November the Alaska Department of Fish and Game vessel Resolution was used for harbor seal collecting activities in the Kodiak area. A total of 35 seals were taken.

Laboratory activities conducted during the quarter included food habit analysis, tooth sectioning for age determination and reproductive tract analysis.

Department of Fish and Game employees participating in field and laboratory activities included: B. Ballenger, R. Smith, K. Schneider, C. Irvine, A. Franzmann, R. Aulabaugh, D. McAllister, F. Palmer and C. Lucier.

Methods

1. Harbor seals are being collected systematically from different areas and habitat types throughout the year. This is being done in order to detect variations in food habits with season, area and habitat type.

2. Weights and standard measurements are taken from each collected animal including: total weight, blubber weight, standard length, curvilinear length, axillary girth, maximal girth, hind flipper length and blubber thickness (Scheffer 1967). These data are being collected to establish growth rates, seasonal condition patterns and assist in making calculations of biomass.

3. Age determinations are being made. This is done by decalcifying a canine tooth from each animal, using a microtome to produce thin sections, staining the sections with hematoxylin and counting the annual growth rings with the aid of a microscope. Age determinations are necessary for development of growth rates and to determine population structure and productivity.

4. The ovaries and uterus are taken from each female seal and preserved in formalin. Standard laboratory techniques for reproductive analysis are used through which the presence of absence of a conceptus in the uterus is determined and a partial reproductive history is reconstructed by examination of ovarian structures. These data are necessary for estimating ages of sexual maturity and age specific reproductive rates, basic parameters required for population productivity calculations.

5. Testes and epididymides from each male seal are collected and preserved. A microscopic examination is made of epididymal fluid to determine whether sperm are present or not. These data are used for determination of age of sexual maturity and periods of seasonal potency in males.

6. Stomach contents from each seal are preserved in formalin. Weights and volumes are determined for all contents. Identifications of prey species are made by examination of recognizable individuals and skeletal materials of diagnostic value. Frequency of occurrence of prey species is then determined.

7. Intestinal contents from each seal are strained through mesh sieves to recover fish otoliths. Otoliths, which are diagnostic to species, are compared to a reference collection and identified.

8. Tissue samples are being collected and frozen so that baseline levels of heavy metals, pesticide residues and hydrocarbons can be determined.

9. Observations of harbor seals are recorded during collecting cruises and during aerial surveys conducted by other marine mammal and bird projects in the Gulf of Alaska. These data are being compiled and will eventually be of value in delineating areas with high harbor seal concentrations, patterns of seasonal distribution and critical habitat.

To date 154 harbor seals (Table 1) have been collected as part of RU-229. Reproductive analyses and age determinations have been completed for 42 of 72 females (Table 2). For males, reproductive analyses and age determinations have been completed for 56 of 82 animals (Tables 3 and 4).

Table 1. Locations, numbers and composition of collected harbor seals.

Location	No. of females	No. of males	Total
Kodiak area	38	40	78
Kenai coast	8	18	26
Prince William Sound	10	15	25
Icy Bay	9	4	13
Yakutat Bay	4	1	5
Middleton Island	3	2	5
Kayak Island	--	2	2
Total	72	82	154

Body measurements and weights have been recorded for each collected animal. When age determination are completed these data will be analyzed and presented in the annual report. Condition data, i.e. measurements of body fat, have been recorded and will also be analyzed and presented in the annual report.

Table 2. Productive maturity and age specific pregnancy rates for 42 female harbor seals from the Gulf of Alaska.

Age	Total Animals	No. Pregnant	Pregnancy Rate
0-12 months	2	0	0%
1 year	3	0	0%
2	1	0	0%
3	4	0	0%
4	3	1	33%
5	2	2	100%
6	4	4	100%
7	4	3	75%
8	1	1	100%
9	2	2	100%
10-20	14	11	79%
21-30	2	1	50%

A field party spent from mid-May through September on Tugidak Island which apparently has the single largest concentration of harbor seals in the world. They collected considerable data on numbers, seasonal use patterns, effects of disturbance and chronology of life history events. The completion report is now in preparation and will be appended to the annual report.

Table 3. Age of sexual maturity in 8 male harbor seals based on the presence of abundant epididymal sperm during the period 26-31 May.

(Years) Age	No. of Males	Epididymal Sperm No. Absent	Trace	Abundant	Mature %
2	1	1			0%
3	1	1			0%
5	1		1		0%
7	1			1	100%
8	2			2	100%
10	1			1	100%
13	1			1	100%

Observations of harbor seal concentrations were recorded during field activities of RU-3, RU-229 and RU-243 (Table 5). These cannot be considered complete and the estimated numbers do not in any way reflect true population values. However these data do increase our knowledge of seasonal distribution, relative abundance and identification of critical habitat.

Table 4. Seasonal potency in male harbor seals, 7 years and older.

Time Period	No. of Animals	Epididymal Sperm None	Trace	Abundant	Percent Potent
7-11 Feb.	2	2			0%
18-21 March	9	7	1	1	11%
15-24 April	15	2	1	12	80%
26-31 May	5			5	100%
29 Oct.-2 Nov.	6	5	1		0%

The preliminary stages of food habit analysis have been completed for all animals. This includes sorting, volumetric determination, enumeration and preliminary identification. Diagnostic skeletal materials have been forwarded to appropriate experts for final identification. These data are expected to be available for the annual report.

Table 5. Observations of harbor seal concentrations made during field activities of Ru-3, RU-229 and RU-243.

Date	Location	Est. No. of Seals
8 May 76	Dry Bay	93
29 May 76	Disenchantment Bay	331
30 May 76	Pt. Manby	50+

continued

Table 5. (continued) Observations of harbor seal concentrations made during field activities of RU-3, RU-229 and RU-243.

Date	Location	Est. No. of Seals
29 May 76	Pt. Riou	100+
28 May 76	Icy Bay	500+
28 May 76	Kaliakh River	200
26 May 76	Middleton I.	138
13 April 76	Harris Bay	75-125
15 April 76	Aialik Bay	150
24 August 76	Cape Fairfield	30
31 August 76	Calisto Head	70
31 August 76	Cheval I.	200
31 August 76	Aialik Cape	40
31 August 76	Home Cove	37
24 June 76	Taylor Bay	24
24 June 76	Rocky Bay	176
22 June 76	Fox River	45
3 October 76	Yukon I.	250
5 July 76	Iniskin Bay	57
30 Sept. 76	Augustine I.	1,175
5 Nov. 76	Zachar Bay	30
5 Nov. 76	Spiridon Bay	50
25 Sept. 76	Tugidak I.	13,000
2 Sept. 76	Sitkinak I.	800
2 Sept. 76	Geese I.	800
2 Sept. 76	Aiaktalik I.	600
9 Oct. 76	Ayakulik River	100
8 Oct. 76	Nagai Rocks	40
10 Nov. 76	Ugak Bay	250
1 March 76	Womens Bay	31
28 Feb. 76	Sitkalidak I.	35

Quarterly Report

Contract # 02-5-022-53
Research Unit #230
Reporting Period: October-December 1976
Number of Pages: 23

The natural history and ecology of the bearded seal (*Erignathus barbatus*) and the ringed seal (*Phoca* (*Pusa*) *hispida*)

Principal Investigators:

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I. Task Objectives

1. Summarization and evaluation of existing literature and available unpublished data on reproduction, distribution, abundance, food habits and human dependence on bearded and ringed seals in the Bering, Chukchi and Beaufort Seas.

2. Acquisition of large amounts of specimen material required for an understanding of food habits in these two species.

3. Acquisition of additional data on productivity and growth rates.

4. Acquisition of baseline data on mortality and morbidity (including parasitology, diseases, predation and human harvest) of ringed and bearded seals.

5. Determination of population structure of bearded and ringed seals as indicated by composition of harvest taken by Eskimo subsistence hunters.

6. Initial assessment of regional differences in density and distribution of ringed and bearded seals in relation to geographic areas and, to a lesser extent, in relation to major habitat condition.

7. Acquisition of additional information on seasonal migrations.

II. Field and Laboratory Activities

A. Schedule

Date	Location	Activity
October-December	Fairbanks	Analyses of seal specimens and data
September	R/V NATCHIK	Collection of seal specimens
October	R/V MILLER-FREEMAN	Collection of seal specimens
November	Nome	Collection of seal specimens
November	Stebbins	Collection of seal specimens

B. Scientific Party

Name	Affiliation	Role
John J. Burns	ADF&G	Principal Investigator
Thomas J. Eley	ADF&G	Principal Investigator
Kathryn Frost	ADF&G	Marine Mammals Biologist
Lloyd Lowry	ADF&G	Marine Mammals Biologist
Carol Nielsen	ADF&G	Game Biologist
David James	ADF&G	Marine Mammals Technician
Glenn Seaman	ADF&G	Marine Mammals Technician
Lynn Vaughan	ADF&G	Data Manager

C. Analytical Methods

From all specimens we endeavor to obtain weights, standard measurements, lower jaws, foreflipper claws, stomachs, reproductive tracts and intestines. We also obtained blubber, tissue, organ and blood samples as the situation permitted.

The ages of seals are determined by examination of claw annuli (for animals six years and younger) and dentine or cementum annuli (for animals over six years of age). Growth rates are based on weight and standard measurements correlated with specimen age, sex and date and locality of collection. Species productivity and parasite burden are determined, respectively, through laboratory examinations of reproductive tracts and various organs and correlation of these data with age, sex, and date and locality of collection of each specimen.

Regional differences in seal density and distribution were assessed through aerial surveys following the methods of Burns and Harbo (1972).

Analytical methods are discussed in detail in our Annual Report for FY-1976.

III-IV. Results and Preliminary Interpretation

A. Specimen Collections

During the October-December 1976 quarter our major efforts were devoted to laboratory analyses of specimens collected during field activities in previous quarters. However, seal specimens were obtained from Nome, Stebbins and Barrow (Table 1).

Table 1. Seal specimens obtained between October and December 1976.

Location	Male	Female	Total
Stebbins			
Ringed seal	1	1	2
Nome			
Ringed seal	2	3	5
Barrow			
Bearded seal	1	-	1
R/V MILLER FREEMAN			
Bearded seal	1	-	1

B. Ringed Seal

1. Distribution and Taxonomy

The ringed seal has a widespread northern, circumpolar distribution. Ringed seals have been recorded from the North Pole southward, in ice covered seas, to Finland, northern Iceland, southern Greenland, Labrador, Hudson Bay, southern Bering Sea, Sea of Okhotsk and northern Hokkaido. There are isolated ringed seal populations in the Gulfs of Bothnia and Finland, Lake Ladoga (USSR), Lake Saimaa (Finland) and in at least one lake on Baffin Island (Canada). Stragglers have been recorded in France, Scotland, southern Japan and at San Diego California. In Alaska, ringed seals inhabit the Bering, Chukchi and Beaufort Seas, and have been found in the Pribilof and Aleutian Islands.

Seven subspecies have been proposed for the ringed seal (Table 2) (Scheffer 1958 and Miller-Wille 1969). However. the ringed seal is a highly variable species and the subspecies are difficult to separate without examining a large number of specimens. Muller-Wille (1969) investigated the relationships of _P. h. botnica_, _P. h. ladogensis_, _P. h. saimensis_ and _P. h. pomororum_. These four subspecies were found to overlap in many traits but Muller-Wille concluded that they were significantly different enough to be classified as subspecies. The differences are attributed to the isolation of these populations for 8,000 to 12,000 years. The relationhsip between _P. h. pomororum_ and _P. h. hispida_ is unclear.

The population and taxonomic relationships between _P. h. hispida_, _P. h. kraschenínikovi_ and _P. h ochotensis_ are presently under investigation by Soviet and American biologists. _P. h. ochotensis_ appears to be a valid subspecies. The status of _P. h. krascheninikovi_ is unclear. Based on our observations, ringed seals move widely and Bering Strait is not a barrier. There is a net movement of ringed seals southward through the Strait in the fall with the formation of sea ice and conversely a net northward movement in the spring with breakup.

The Soviets have examined large numbers of ringed seal specimens from the Bering and Chukchi Seas and are finding that there are two morphos (which may be subspecies) of ringed seals. A larger morph found in the shorefast ice and a smaller morph in the drifting ice. However, not enough is known about the ecology and behavior of ringed seals to ascertain the relationships between the drifting and shorefast ice seals. Based on specimen material and collecting program, there appears to be age-specific, seasonal movements of seals between shorefast and drifting ice. In our future work we hope to delineate these movement patterns more clearly.

The Caspian seal (*Phoca caspica*) and the Baikal seal (*Phoca sibirica*), both found in land-locked water bodies (Caspian Sea and Lake Baikal), evolved from the ringed seal but are presently considered separate species.

2. Pelage

The color of ringed seals is quite variable, but the basic pattern is a gray back with black spots and a light belly. These black spots are ringed with light marks from which comes the seal's name. Several specimens have been examined which have the ringed pattern on back and belly and one adult specimen was observed to have the light coloration on both back and belly.

Pups are born with a white lanugo. The lanugo is shed when the pup is 2 to 6 weeks old. The first year pelage is quiet variable but it is generally light in coloration with faint spots and rings.

Ringed seals molt annually. During the period of molt they haul out on the sea ice on "warm," sunny days. Hauling out during the molt appears to be an important adaptation to the Arctic environment. Skin temperatures of ringed seals during immersion are generally within 3°C of water temperatures (which may be 2°C); upon hauling out the skin temperature may increase to 20°C or more. Epidermal cells of phocid seals in *in vitro* cultures were found to survive for 6 months at 4°C but required temperatures of at least 17° to 19°C for growth. The most rapid growth was at 37°C (Feltz and Fay 1966). Sleep or inactivity also may be a requirement for mitosis (Bullough 1962, Bullough and Rytomaa 1965). Therefore, growth and reparative functions of ringed seal skin may only be possible when the animal is hauled out and/or at rest.

The molt appears to begin in mid-May in the Bering Sea-Norton Sound and progressively later as one goes farther north; in Alaska the peak is in mid-June. Two adult ringed seals (BP-11-76, BP-12-76) collected at Barrow, Alaska in early August were just completing their molt.

3. Dentition

The dental formula of phocid seals varies according to the subfamily:

	Incisors	Canines	Postcanines	
Phocinae	1-2-3	1	1-2-3-4-5-(6)-0	= 34-36
	0-2-3	1	1-2-3-4-5-0-0	
Monachinae	0-2-3	1	1-2-3-4-5-(6)-0	= 32-34
	0-2-3	1	1-2-3-4-5-0-0	
Cystophorinae	0-2-3	1	1-2-3-4-(5)-(6)-0	= 26-34
	0-0-3	1	1-2-3-4-(5)-(6)-0	

The ringed seal follows the Phocinae pattern and typically has 34 teeth (lacks upper postcanine 6). Dental anomalies are not uncommon and those that we have found include:

a. Upper postcanine number 6 present
b. Upper postcanine numbers 4, 5 and/or 6 absent (never found)
c. Lower incisor number 1 present
d. Lower incisor number 3 absent
e. Supernumary lower incisor number 3
f. Supernumary lower canine

The incisors, canines and first postcanines are single rooted while postcanines (upper and lower) 25 are double rooted. One postcanine number 5 had 3 roots. The relative size of postcanines, in descending order, is 3-4-2-5-1. The postcanines are reticulated and are offset such that when the jaws are closed a net-like structure is formed, which is presumably used to assist in the retention of smaller invertebrates from the seawater.

Five early and mid-term fetuses (NP-14-76, STP-1-76, BS-11-70, BS-14-70, BS-15-70) had the deciduous dental formula:

$$i\ \frac{3}{2} \qquad c\ \frac{1}{1} \qquad pc\ \frac{3}{3} \qquad = \qquad 26$$

A mid-February fetus (N-2a-71) had a complete set of permanent teeth but they were not erupted. At birth, ringed seals have a complete set of fully erupted, permanent teeth.

Several cases of dental disease have been noted during examination of specimens. Two ringed seals were found to have caries in their second postcanines. The caries were situated in the pit of a tooth reticulation. One seal from Nome had grooves in the enamel of all teeth and the grooves resembled those of hypoplasia. Hypoplasia is a deficient formation of enamel due to injury or dysfunction of the ameloblasts (enamel-forming cells) during enamel formation.

Erosion of the teeth at the gingivolabial and buccal level has been noted in 30 ringed seals. The lesion is characterized by a smooth, highly polished notch in the tooth surface with no evidence of caries. Erosion appears to originate in the canine-postcanine 1 region and spreads anteriorly and posteriorly. The lesion appears to become progressively worse and ultimately the tooth erodes to a thin level and breaks. The etiologic factors responsible for this condition are unknown. In humans, erosion is caused by acid secretions from the labial or buccal glands and it is found in nervous individuals who are chronic worriers (Massler et al. 1958).

Another form of tooth wear, noted in several seals, appears to be a mechanical wearing away of the cusps. The cusps become flattened and the tooth takes on a peg shape. The abrasive action of invertebrate exoskeletons has been postulated as the etiologic factor.

4. Food Habits

See quarterly report of Research Unit 232.

5. Growth Rates and Productivity

Ringed seals are the smallest of all pinnipeds, with the largest adult female recorded for Alaska being 155 cm in length and the longest male 146 cm. The heaviest ringed seals examined thus far in this research were a 90.9 kg pregnant female, taken in November, and a 90.9 kg male, taken in January. However, the weight of an individual varies with age and season. Heaviest weights are achieved, by adults, in winter and early spring when the seal has a heavy layer of fat or blubber under the skin. This blubber is used for insulation and as an energy source during the breeding and pupping seasons. The weights of ringed seals decline with the decrease in feeding during the reproductive and molting season.

Fetal and Pup Development - The embryonic and fetal development of the ringed seals is one of the parameters that influences fertility. Embryological development is usually considered as a continuous process of growth and differentiation from the formation of the zvgote to parturition. Growth and differentiation appear continuous, albeit slow during the 3-1/2 month delay before implantation, but the factors that affect the rate of growth and differentiation are unknown.

Female ringed seals appear to be impregnated in mid to late April, soon after the birth of the pup. Impregnation is followed by a delay of up to 3-1/2 months before implantation, approximately in August. Additional seal specimens are required from August and September to demonstrate the precise period of implantation and to determine early fetal growth rates.

Thus far, 50 ringed seal fetuses (27 males and 23 females) have been examined and measured, yielding a fetal sex ratio of 1:1 (P 0.01). The fetal growth curve for length (Fig. 1) closely resembles that of ringed seals in Canada (McLaren 1958). The growth curve for weight (Fig. 2) is similar to those for most mammals. The relative growth of length and weight (L/W) (Fig. 3) is most rapid just after implantation, in August and September, with relative growth rates leveling off in late pregnancy. No differences between the growth rates of males and females were detected (P 0.05).

Pup Growth Rates - Weights of 55 ringed seal pups (21 males, 33 females and 1 sex unknown) have been obtained thus far, yielding a pup sex ratio of 1:1 (P 0.05). Ringed seal pups weigh about 4.0 kg at birth. A live pup two or three days old weighed 5.0 kg while the mean weight of 8 full-term fetuses was 3.4 kg.

Pup weights increase steadily from birth until weaning in late May or early June (Fig. 4). In late June and early July the weights of pups decrease somewhat as the pups adjust to life on their own. In mid and late July pups' weights increase steadily leveling off in August and September. The mean weights of male and female pups generally do not differ (P 0.05), however, there is more variation in the weights of males than in the weights of females.

Blubber thickness over the sternum increases from 0.5 cm or less at birth to an average of 2.6 cm in May and early June. During mid and late June and July, the blubber thickness decreases to a mean of 1.1 cm and this decrease in thickness is probably associated with the loss of weight immediately after weaning. By August mean blubber thickness has increased to 1.9 cm and then levels out at a mean of 3.0 cm from September to February. There appears to be no difference in blubber thickness between male and female pups (P 0.05 cm).

The lengths of pups increased steadily from birth and appeared to begin leveling out in August and September (Fig. 5). A significant decrease in length immediately after weaning was not noted. The mean lengths of males and females did not differ (P 0.05) and the variation in lengths was approximately equal in the two sexes.

Reproduction - The epididymides of 245 male ringed seals (representing all age classes and collected during all months) have been examined for the presence of sperm. Active spermatogenesis has been detected in essentially all males seven years old and older which were collected during the months of March, April, May and June (Table 3). Eight of 15 (53%) six year old males collected between March and May had abundant sperm in their epididymides. One five year old male taken in May had a trace of sperm in its epididymides. No geographic variation in spermatogenic activity has been detected thus far, however, our sample size from the Beaufort Sea is small.

The earliest date that sperm was found in male epididymides was mid-March and active spermatogenesis appears to continue until mid-June. Sperm remains on the epididymides of some males until mid-August. Most adult female ringed seals appear to ovulate in April and May therefore the males are physiologically capable of breeding well before and long after most females.

The reproductive tracts of 40 female ringed seals collected during 1975 and 1976 have been examined and a tabulation of their reproductive status is presented in Table 4. Two three-year-old females, one four-year-old and one five-year-old female had ovulated for the first time but they apparently did not conceive. Six of eight females (75%) six years old or older had ovulated but it could not be determined whether these females had conceived. A female 14 years old had cysts on both uterine horns. The cysts caused complete obstruction of the uterine horns and both ovaries had begun to atrophy. A 21-year-old female showed no follicular activity, whereas a 22-year-old female had ovulated but it could not be determined whether she had conceived.

6. Polar Bear Predation on Seals

During 1976, 25 seals killed by polar bears have been examined (Table 5). Ringed seals comprised 96 percent (24) of the seals killed and one bearded seal made up the remaining 4 percent. Two cases of bears feeding in garbage dumps near human habitation were noted and numerous observations were made of bears feeding on carrion, particularly on whale carcasses north of Barrow and on the beaches of St. Lawrence Island.

Of the 24 ringed seals examined, 14 (58%) were males and 10 (42%) were of undetermined sex. Thirteen (54%) of the ringed seals were adults (greater than 6 years old; had achieved sexual maturity); 2 (8%) of the seals were immature (older than pups yet less than 6 years old); and 9 (39%) seals were of undetermined age. The single bearded seal comprised the only pup and the only female in the sample.

Twenty (80%) seals were killed on moving pack ice and 5 (20%) seals were taken on shorefast ice. Most seals (88%) were killed by bears waiting at seal breathing holes. Bears were relatively unsuccessful in obtaining ringed seals from lairs in the drifting ice, as only 3 seals were killed out of 32 lairs excavated by bears.

At Cape Lisburne, polar bears were tracked for 3105 bear-kilometers, along which 20 seal carcasses were found. Bears killed on the average, at Cape Lisburne in the spring, 1 seal every 155.2 kilometers.

7. Density of Ringed Seals

Successful feeding and reproduction are tantamount to the survival of all species. Therefore the goal of seal management should be to protect these critical feeding and reproduction areas from unnecessary disturbance or disruption. These critical areas change temporally and spatially and, considering the dynamic state of the sea-ice ecosystem, there can be large spatial changes in the location of critical areas in a short period of time. Habitat selection by ice-inhabiting pinnipeds has been aptly discussed by Fay (1974) and Burns (1972), and the reader is referred to those papers for a fuller discussion. Breeding adult-ringed seals are found primarily (but not entirely) associated with shorefast ice, while the bearded seal is associated with many ice types and overlaps with all ice-associated pinnipeds in the study area.

Critical areas are ascertained first by determining seal densities in various locations and then by correlations of densities with observed or measured ice, behavioral, ecological or oceanographic conditions. In June, 1970, 1975 and 1976, ringed seal surveys were conducted by airplane over the shorefast ice from Barter Island to Point Lay. In addition, the 1976 survey was expanded to cover the shorefast ice from Pt. Hope to Cape Krusenstern and Kotzebue Sound. The results of these surveys are presented in Table 6. The areas of highest mean densities (Cape Krusenstern - Point Hope; Cape Lisburne - Pt. Lay; Wainwright - Barrow; Barrow - Lonely) are normally areas of very stable shorefast ice during late winter and spring. Within these larger areas there are variations in the density of ringed seals which appear to be dependent on the quality of shorefast ice. For example, between Cape Krusenstern and Point Hope the mean density was 2.3 ringed seals per square mile yet within this larger area the densities varied from 0.2 seals per square mile near Kivalina (early breakup of shorefast ice) to 3.8 seals per square mile near Cape Thompson (stable shorefast ice).

The most stable shorefast ice is found either along complex coasts or along coasts where the 10 fathom line lies far offshore. The edge of the shorefast ice tends to coincide with the 10 fathom curve. The higher densities in the Chukchi Sea are probably reflective of the better ice conditions together with higher overall biological productivity of the Chukchi as compared to the Beaufort Seas.

The total area of fast ice present during the 1975 and 1976 surveys is being calculated at this time from ERTS imagery. The total area of fast ice in each sector and the mean seal density for that sector will give a minimum estimate of the ringed seal population in each sector. However, this estimate will only reflect the seals on the ice. Not enough is known of ringed seal behavior to correct for animals in the water or otherwise not seen. This "population" analysis will be presented in our next report.

C. Bearded Seal

The major emphasis of work on bearded seals during this quarter involved laboratory preparation of teeth for age determination of the older seals, and the various aspects of data management including keypunching. Computer analysis of data was not possible due to problems of scheduling at the computer center.

Reproductive status of 77 female bearded seals obtained at hunting sites in the Bering, Chukchi and Beaufort seas was determined. Females in which one or both of the uterine horns had a thick and rugose appearance (indicating they had supported at least one fetus) and/or in which the ovaries contained a recent corpus albicaus or corpus luteum, were considered mature. As yet, the sample of ovaries has not been sectioned to determine the reproductive history of each female, or age-specific birth rates.

Based on this gross examination, 31 (40%) of the females were sexually immature (pup or adolescent) and 46 (60%) were mature. Previous studies (Burns, 1967 and unpublished) have suggested that there is a significant difference in the general age structure of samples obtained from the Bering Sea, as compared to those from the Chukchi and Beaufort Seas. In a sample of 391 bearded seals obtained from northern Bering Sea during the period 1964-1966, 209 (53%) were pup or adolescent seals (Burns, loc. cit.). Stirling, et al. (1975) found that in the eastern Beaufort Sea their samples included mainly adults. Pup and adolescent bearded seals comprised 29 percent of their 1974 sample (N = 31) and 18 percent of their 1975 sample (N = 51). These samples included both male and female seals.

Based only on the composition of females available from this study, there appears to be little difference between the samples we obtained in the Bering Sea and those acquired in areas further north. Our Bering Sea sample of 21 females included 9 (43%) sexually immature individuals. Of the Chukchi and Beaufort Sea specimens (N = 56), 22 (39%) were sexually immature.

The incidence of pregnancy in our sample of 46 sexually mature females was 87 percent. This is based on (1) indications of recent parturition in animals collected during April through mid-July, (2) the presence of an apparently active corpus luteum observed during this same period, or (3) presence of an implanted fetus in females collected after mid-July.

This incidence of pregnancy can be roughly compared to previously reported rates of ovulation. Stirling, et al. reported that all of nine adult females from the eastern Beaufort Sea, collected in 1974, had recently ovulated or were about to do so. The reported ovulation rate in their 1975 sample (N = 23) was .52. Burns (1967) reported an ovulation rate of .83 (N = 133) which is quite similar to the .87 found in this study.

Our objective during the current quarter of this study is to more clearly describe the actual age structure of our entire sample and to determine age specific birth rates, if possible.

V. Problems Encountered

Two problems have been encountered. First was the difficulty of obtaining specimens from the Beaufort Sea and the second is the continuing delay involved with computer services resulting from the needs of a large number of active programs. Neither can be immediately rectified.

VI. Estimated Funds Expended (since 1 July 1976)

100.	Salaries and wages	$46,829.27
200.	Travel	3,136.58
300.	Contractual	892.48
400.	Commodities	2,017.51
500.	Equipment	-0-

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Table 2. Distribution of currently accepted subspecies of the ringed seal.

Subspecies	Distribution
Phoca hispida hispida	Arctic Ocean, northern Eurasia, Greenland, northern North America and southward to Hudson and James Bays and Labrador
Phoca hispida krascheninikovi	Bering Straits southward throughout the Bering Sea and Bristol Bay to the southern Kuril Islands
Phoca hispida ochotensis	Sea of Okhotsk, northern Kuril Islands and south to Hokkaido
Phoca hispida botnica	Baltic Sea, Gulf of Bothnia and Gulf of Finland
Phoca hispida ladogensis	Lake Ladoga
Phoca hispida saimensis	Lake Saimaa and its series of interconnected lakes
Phoca hispida pomororum	White Sea and the coasts of the Kola Peninsula and Novaya Zemlya

Table 3. Seasonal variation in sperm presence in the epididymides of male ringed seals seven years old and older.

Month	Number Examined	Sperm Presence Abundant (Number)	Trace (Number)	None (Number)
January	3	-	-	3
February	1	-	-	1
March	9	9	-	-
April	15	15	-	-
May	24	23	-	1
June	36	21	5	10
July	21	1	1	19
August	5	-	2	3
September	1	-	-	1
October	2	-	-	2
November	11	-	-	11
December	12	-	-	12

Table 4. Reproductive status of 40 female ringed seals collected during 1976.

Number	Age (yrs)	Month of Collection	Pregnant Yes or No	Status	Comments
SHP-63-76	Pup	June	No	Nulliparous	No follicular activity
SHP-118-76	Pup	July	No	Nulliparous	No follicular activity
SHP-126-76	Pup	July	No	Nulliparous	No follicular activity
SHP-179-76	Pup	July	No	Nulliparous	No follicular activity
SHP-180-76	Pup	July	No	Nulliparous	No follicular activity
SHP-187-76	Pup	July	No	Nulliparous	No follicular activity
SHP-192-76	Pup	July	No	Nulliparous	No follicular activity
SHP-194-76	Pup	July	No	Nulliparous	No follicular activity
SHP-201-76	Pup	July	No	Nulliparous	No follicular activity
SHP-218-76	Pup	July	No	Nulliparous	No follicular activity
SHP-224-76	Pup	July	No	Nulliparous	No follicular activity
SHP-236-76	Pup	July	No	Nulliparous	No follicular activity
SHP-265-76	Pup	July	No	Nulliparous	No follicular activity
BP-15-76	Pup	July	No	Nulliparous	No follicular activity
WE-28-75	Pup	July	No	Nulliparous	No follicular activity
WS-39-75	Pup	July	No	Nulliparous	No follicular activity
WS-30-75	Pup	August	No	Nulliparous	No follicular activity
SHP-46-76	1	June	No	Nulliparous	No follicular activity
SHP-134-76	1	July	No	Nulliparous	No follicular activity
SHP-157-76	1	July	No	Nulliparous	No follicular activity
PHS-44-76	2	May	No	Nulliparous	No follicular activity
SHP-2-76	2	June	No	Nulliparous	No follicular activity
WS-43-75	2	August	No	Nulliparous	No follicular activity
PHP-41-76	3	May	No	Nulliparous	Ovulated apparently for first time
SHP-54-76	3	June	No	Nulliparous	Ovulated apparently for first time
SHP-58-76	3	June	No	Nulliparous	No follicular activity
PHP-40-76	4	May	No	Nulliparous	No follicular activity
SHP-77-76	4	July	No	Nulliparous	No follicular activity
SHP-83-76	4	July	No	Nulliparous	Ovulated apparently for first time
SHP-103-76	5	July	No	Nulliparous	Ovulated apparently for first time, degenerate corpus luteum
SHP-167-76	5	July	No	Nulliparous	No follicular activity
WS-24-76	5	July	No	Nulliparous	No follicular activity
SHP-190-76	6	July	Unk.	Nulliparous	No corpus albicantia, one corpus luteum
WS-27-76	6	July	Unk.	Primiparous	One corpus albicantia, one corpus luteum
SHP-202-76	8	July	Unk.	Primiparous	One corpus albicantia, one corpus luteum
SHP-144-76	8	July	Unk.	Multiparous	Two corpora albicantia, one corpus luteum

BP-12-76	11	August	Unk.	Multiparous	Two corpora albicantia, one corpus luteum
NP-1-76	14	January	No	Multiparous	Uterine cysts sealed both horns of uterus, ovaries atrophying
WS-61-76	21	August	No	Multiparous	Four corpora albicantia, no other follicular activity, had not ovulated this year.
BP-7-76	22	July	Unk.	Multiparous	Two corpus/albicantia, one corpus luteum

Table 5. Seals examined during 1976 which were killed by polar bears.

Location	Specimen Number	Species	Sex	Age (Years)	Ice Type	Habitat	Date
Cape Lisburne	CLP-1-76	Ringed Seal	Male	10+	Moving Pack	Breathing Hole	3/24/76
Cape Lisburne	CLP-2-76	Ringed Seal	Male	9+	Moving Pack	Breathing Hole	3/24/76
Cape Lisburne	CLP-3-76	Ringed Seal	Male	3	Moving Pack	Breathing Hole	3/25/76
Cape Lisburne	CLP-4-76	Ringed Seal	Male	11+	Moving Pack	Breathing Hole	3/25/76
Cape Lisburne	CLP-5-76	Ringed Seal	Male	11	Moving Pack	Breathing Hole	3/27/76
Cape Lisburne	CLP-6-76	Ringed Seal	Male	8	Shorefast Ice	Breathing Hole	3/31/76
Cape Lisburne	CLP-7-76	Ringed Seal	Male	10+	Moving Pack	Breathing Hole	4/1/76
Cape Lisburne	CLP-8-76	Ringed Seal	Male	8+	Moving Pack	Breathing Hole	4/1/76
Cape Lisburne	CLP-9-76	Ringed Seal	Unknown	Unknown	Moving Pack	Breathing Hole	4/7/76
Cape Lisburne	CLP-10-76	Ringed Seal	Unknown	Unknown	Moving Pack	Breathing Hole	4/10/76
Cape Lisburne	CLP-11-76	Ringed Seal	Male	9	Moving Pack	Breathing Hole	4/10/76
Cape Lisburne	CLP-12-76	Ringed Seal	Unknown	Unknown	Moving Pack	Lair	4/15/76
Cape Lisburne	CLP-13-76	Ringed Seal	Male	10	Shorefast Ice	Lair	4/16/76
Cape Lisburne	CLE-14-76	Bearded Seal	Female	Pup	Moving Pack	Breathing Hole	4/16/76
Cape Lisburne	CLP-15-76	Ringed Seal	Unknown	Unknown	Shorefast Ice	Breathing Hole	4/16/76
Cape Lisburne	CLP-16-76	Ringed Seal	Unknown	Unknown	Moving Pack	Breathing Hole	4/16/76
Cape Lisburne	CLP-17-76	Ringed Seal	Unknown	Unknown	Moving Pack	Breathing Hole	4/17/76
Cape Lisburne	CLP-18-76	Ringed Seal	Unknown	Unknown	Shorefast Ice	Lair	4/17/76
Cape Lisburne	CLP-19-76	Ringed Seal	Male	6	Moving Pack	Breathing Hole	4/17/76
Cape Lisburne	CLP-20-76	Ringed Seal	Male	7	Moving Pack	Breathing Hole	4/17/76
Barrow	BP-8-76	Ringed Seal	Male	8+	Moving Pack	Breathing Hole	3/23/76
Barrow	BP-9-76	Ringed Seal	Male	Unknown	Moving Pack	Breathing Hole	3/25/76
Barrow	BP-10-76	Ringed Seal	Unknown	4	Moving Pack	Breathing Hole	4/22/76
Barrow	BP-14-76	Ringed Seal	Unknown	Unknown	Moving Pack	Breathing Hole	4/22/76
Barter Island	BIP-6-76	Ringed Seal	Unknown	12	Shorefast Ice	Breathing Hole	7/27/76

Table 6. Ringed seal densities (observed seals/mi^2) calculated from 1970, 1975 and 1976 surveys.

Location	1970	1975	1976
Kotzebue Sound	-	-	0.7
Cape Krusenstern - Pt. Hope	-	-	2.3
Pt. Hope - Cape Lisburne	-	-	0.9
Cape Lisburne - Pt. Lay	-	-	4.9
Pt. Lay - Wainwright	5.4	2.9	1.9
Wainwright - Barrow	3.7	6.2	3.8
Barrow - Lonely	2.3	2.8	1.4
Lonely - Oliktok	1.0	1.4	1.1
Oliktok - Flaxman Island	1.4	1.0	1.4
Flaxman Island - Barter Island	2.4	1.8	0.4

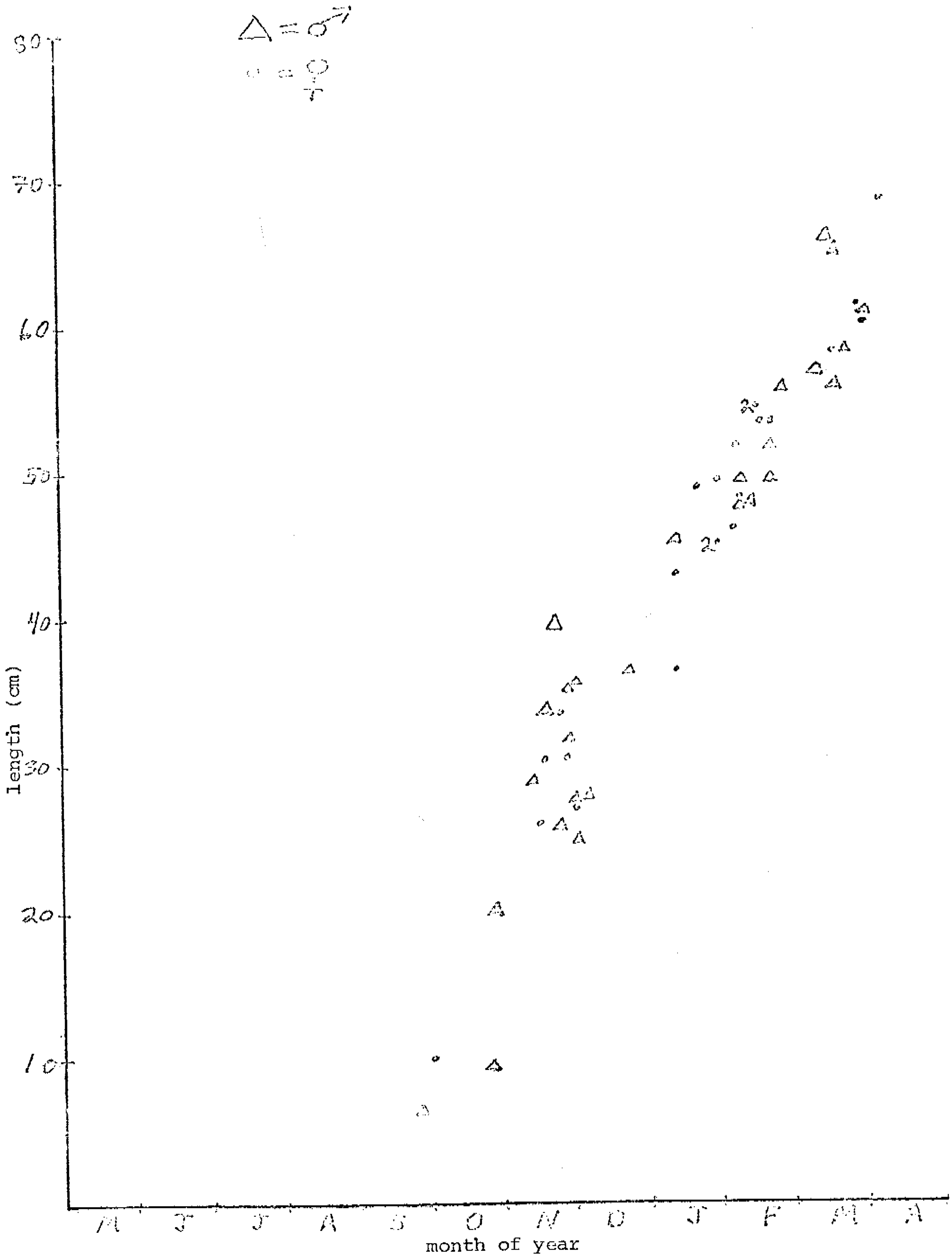

Figure 1. Fetal growth, length in relation to month of collection

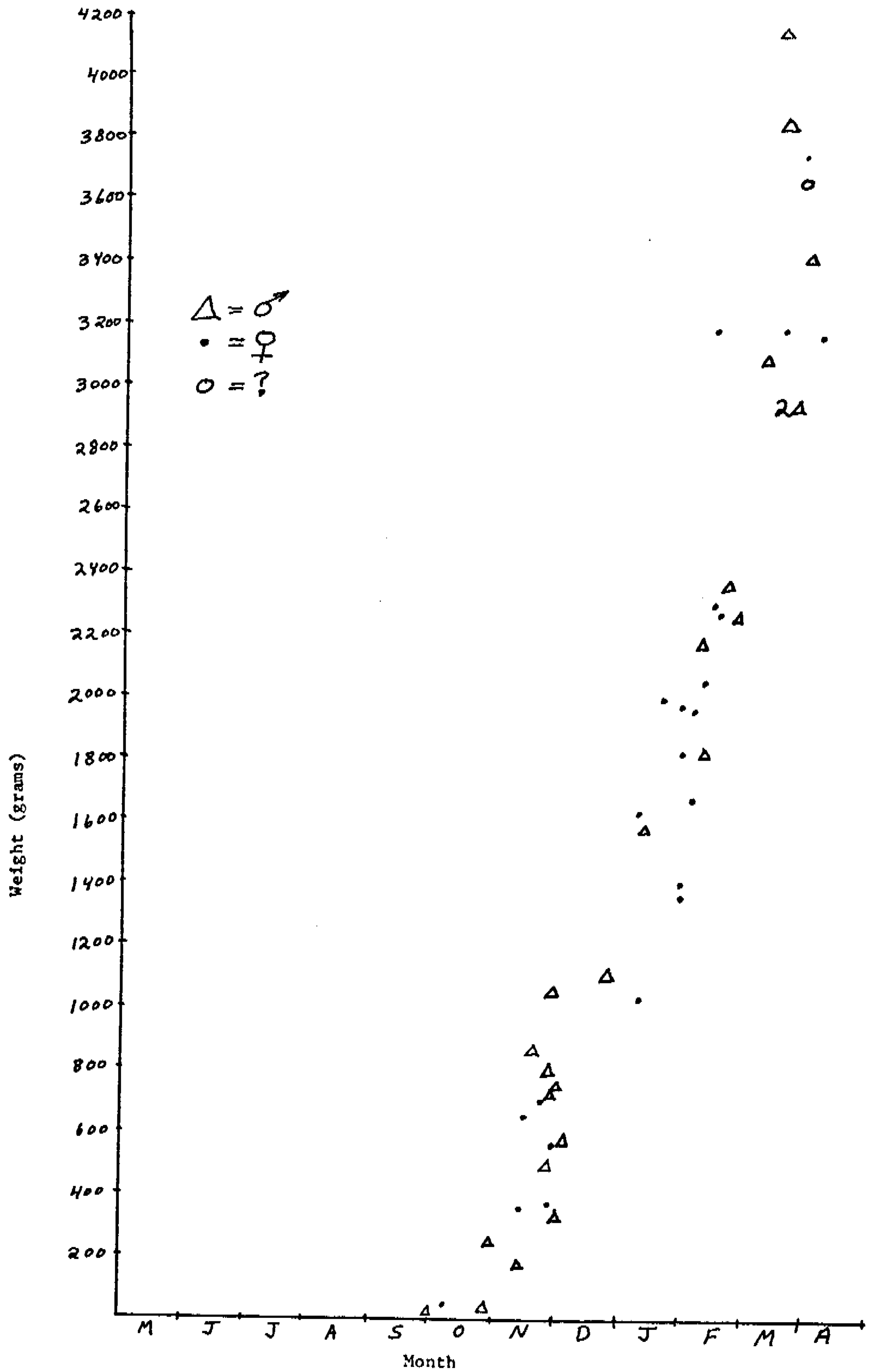

Figure 2. Fetal growth, weight in relation to month of collection.

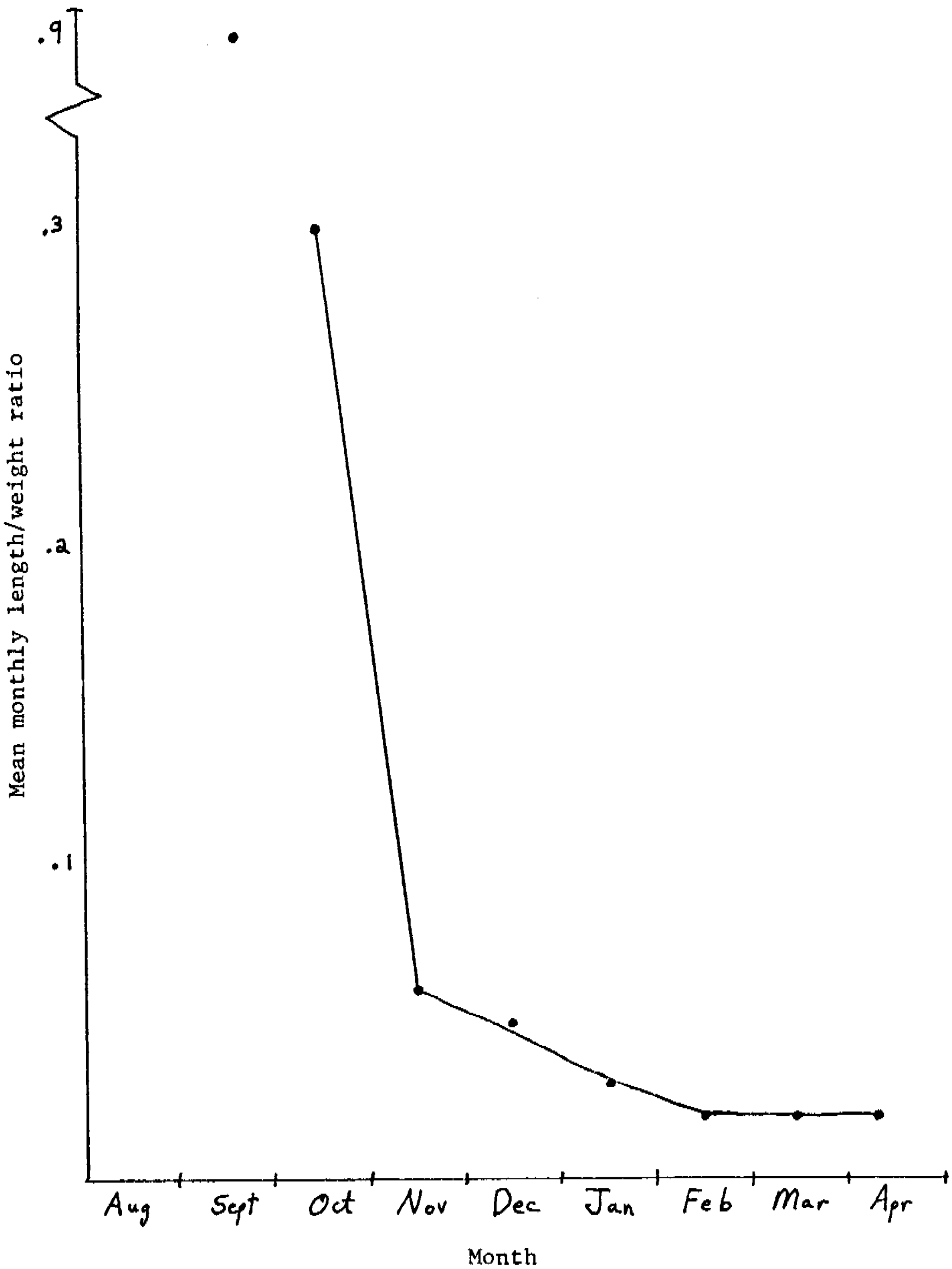

Figure 3. Fetal growth, length in relation to weight.

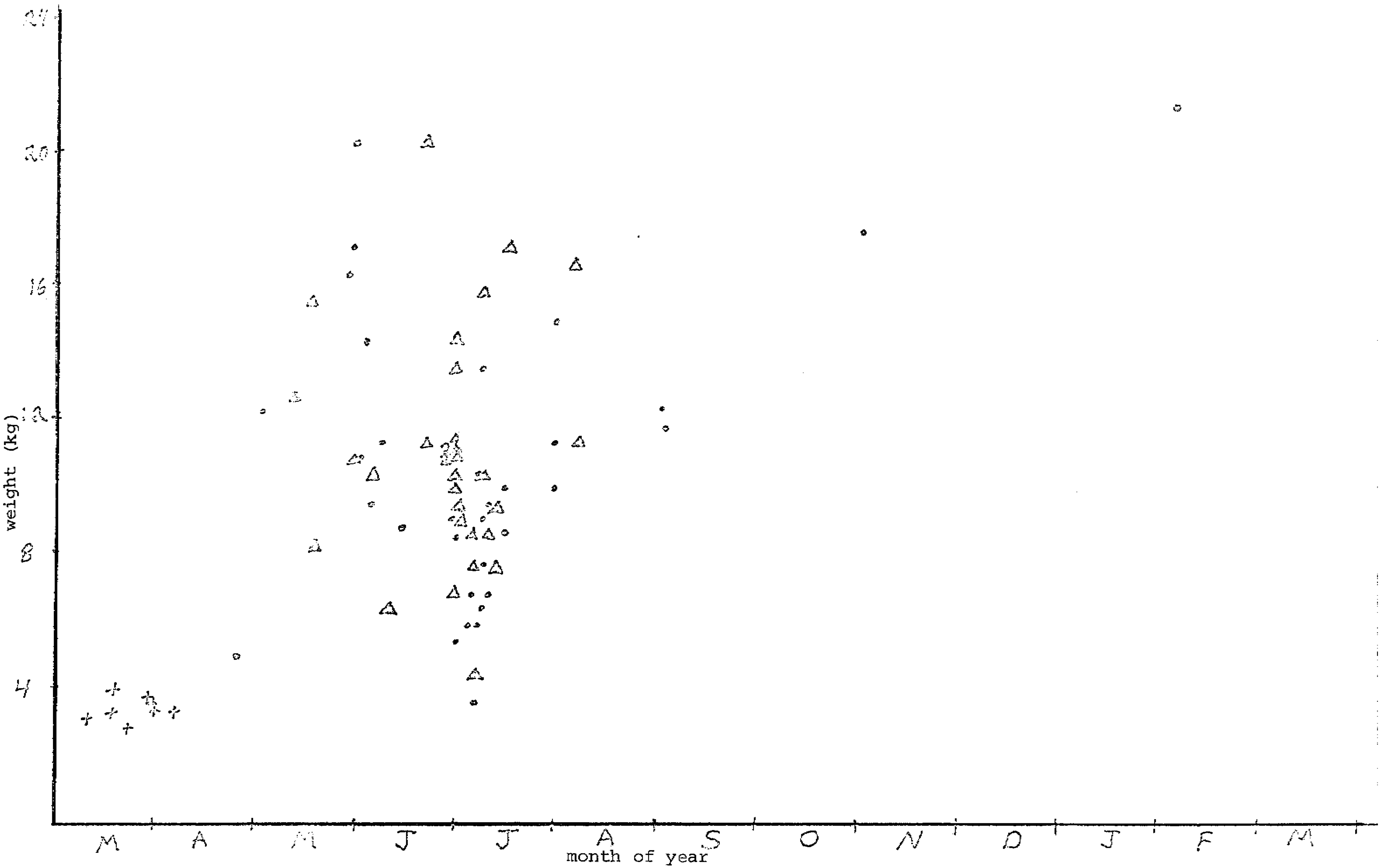

Figure 4. Pup growth, weight in relation to month of year

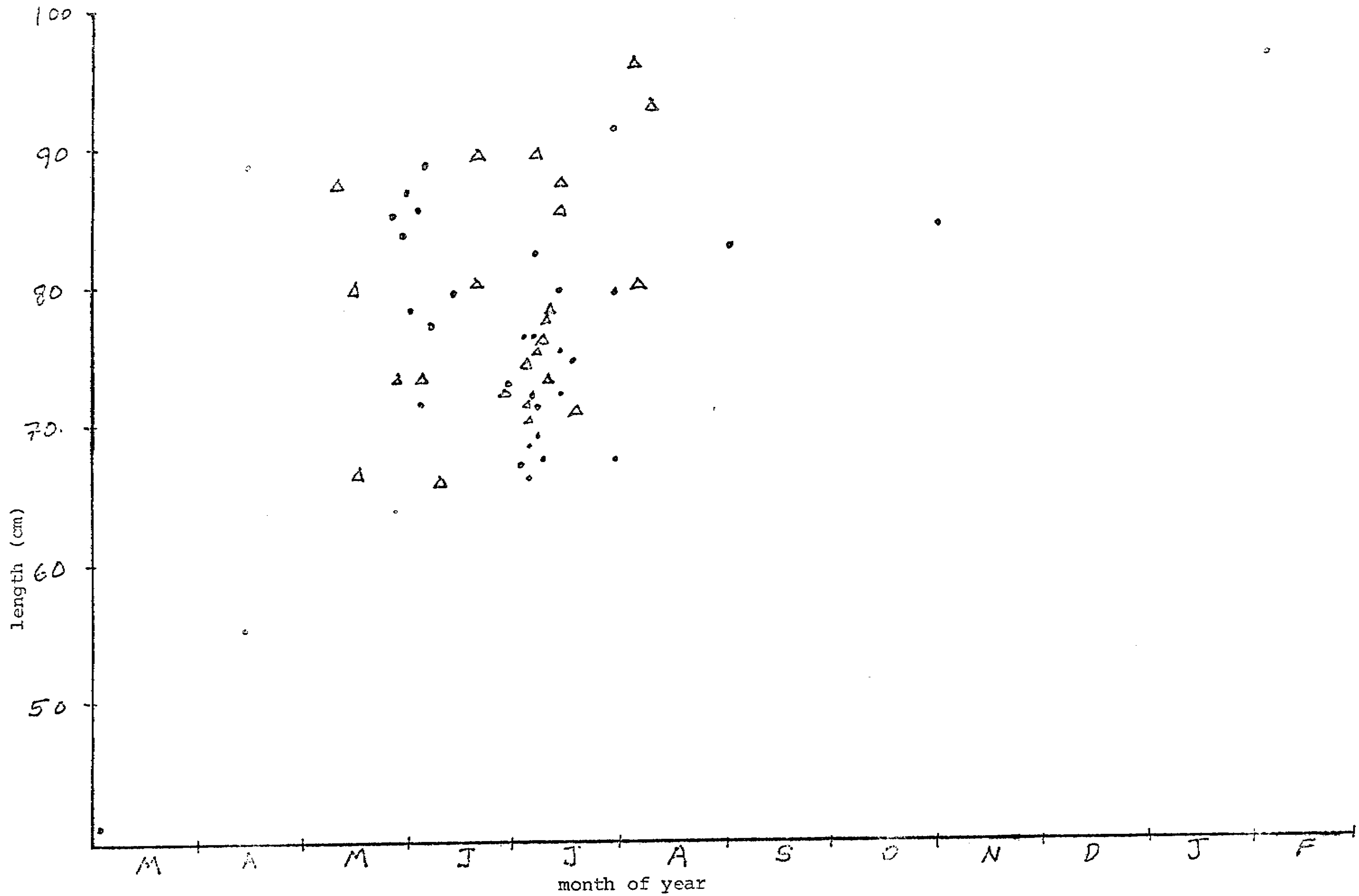

Figure 5. Pup growth, length in relation to month of collection

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Quarterly Report

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Trophic Relationships Among Ice Inhabiting Phocid Seals

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31 December 1976

I. Task Objectives

The investigation of trophic relationships among ice inhabiting phocids is addressed to the following task objectives:

1. Compilation of existing literature and unpublished data on food habits of ringed seals, bearded seals, spotted seals and ribbon seals. In addition, available information on distribution, abundance and natural history of potentially important prey species is being gathered.

2. Collection of sufficient specimen material (stomachs) for determination of the spectrum of prey items utilized by the seal species being studied throughout their geographic range and during all times of year. The contents of seal stomachs are sorted, identified and quantified. This information will be analyzed for geographical and temporal variability in prey utilization patterns as well as for species, sex and age related dietary differences.

3. Analysis of feeding patterns in relation to distribution, abundance and other life history parameters of key prey species. This involves determination of the degree of selectivity demonstrated by each species of seal as well as the availability and suitability of primary and alternative food sources. To whatever extent possible the effect of seal foraging activities on populations of prey species will be examined in light of observed rates of food consumption and foraging behavior. The accomplishment of this objective is largely dependent on information gathered by other OCSEAP projects involving benthic and planktonic organisms.

4. Analysis of trophic interactions among these species and other potential competitors such as walruses, whales, marine birds, fishes and humans. Input from other OCSEAP studies will be critical in this phase of the project.

With the understanding thus obtained of the trophic interrelationships of ice inhabiting phocids in the Bering-Chukchi and Beaufort marine systems, we will evaluate the probable kinds and magnitude of effects of OCS development on these species of seals. This will involve both direct effects such as disruption of habitat in critical feeding areas or alterations of populations of key prey species and indirect effects such as influence on populations of competitors for food resources.

II. Field and Laboratory Activities

Field activities during this past quarter were varied. Two people (Tom Eley and David James) spent two days on the NARL R/V NATCHIK attempting to collect seal specimens from the Beaufort Sea. One person (Kathy Frost) was aboard the OSS MILLER-FREEMAN to collect seal specimens and assess food availability as indicated by otter trawls. A specimen collection attempt at Nome was combined with a trip to arrange for and inspect field facilities. In late November, collections were made from village harvests at Nome and Stebbins. Locations of field collection sites are illustrated in Fig. 1.

Laboratory activities focused on processing of stomach samples. Development of reference collections of specimen material continued.

Data management progressed without major difficulties. Upon completion of laboratory analysis of specimens, data was transcribed, keypunched and transferred to magnetic tape for submission to NODC. Some progress was made on development of software for computer tabularization of data.

Table 1 provides a listing of field and laboratory activities during the past quarter. Dates and personnel are included.

Methods

Field collection procedures at coastal hunting villages and methods for laboratory analysis were as described in previous reports.

The NATCHIK, a 35 foot research boat belonging to the Naval Arctic Research Lab, was used in a final attempt to collect specimens from the Beaufort Sea. Two ADF&G personnel, a skipper and a crew member hunted in the ice north of Barrow to a distance of about 80 kilometers off shore.

On board the OSS MILLER-FREEMAN, a small boat was used to try to collect seals. Otter trawls were done and the specimens obtained were processed in conjunction with efforts of Northwest Fisheries Center and University of Alaska personnel. Trawls were of 30 minute duration using a modified eastern otter trawl with 83 foot headropes. Contents of trawls were sorted, identified and enumerated. Samples of selected species were weighed, measured and analyzed for stomach contents. Otoliths were removed from a number of fishes for reference purposes and determination of the correlation between otolith size and fish size. Representatives of certain species of fishes and invertebrates were retained for reference purposes.

Data Collected or Analyzed

The fall hunting period at coastal villages is shorter and less intense than that in the spring. Trips to Nome and Stebbins produced specimen material from seven ringed seals and one spotted seal. The trip to Stebbins, in eastern Norton Sound, indicated that a collection attempt at that locality in the spring might be fruitful. This would considerably increase our coverage of the

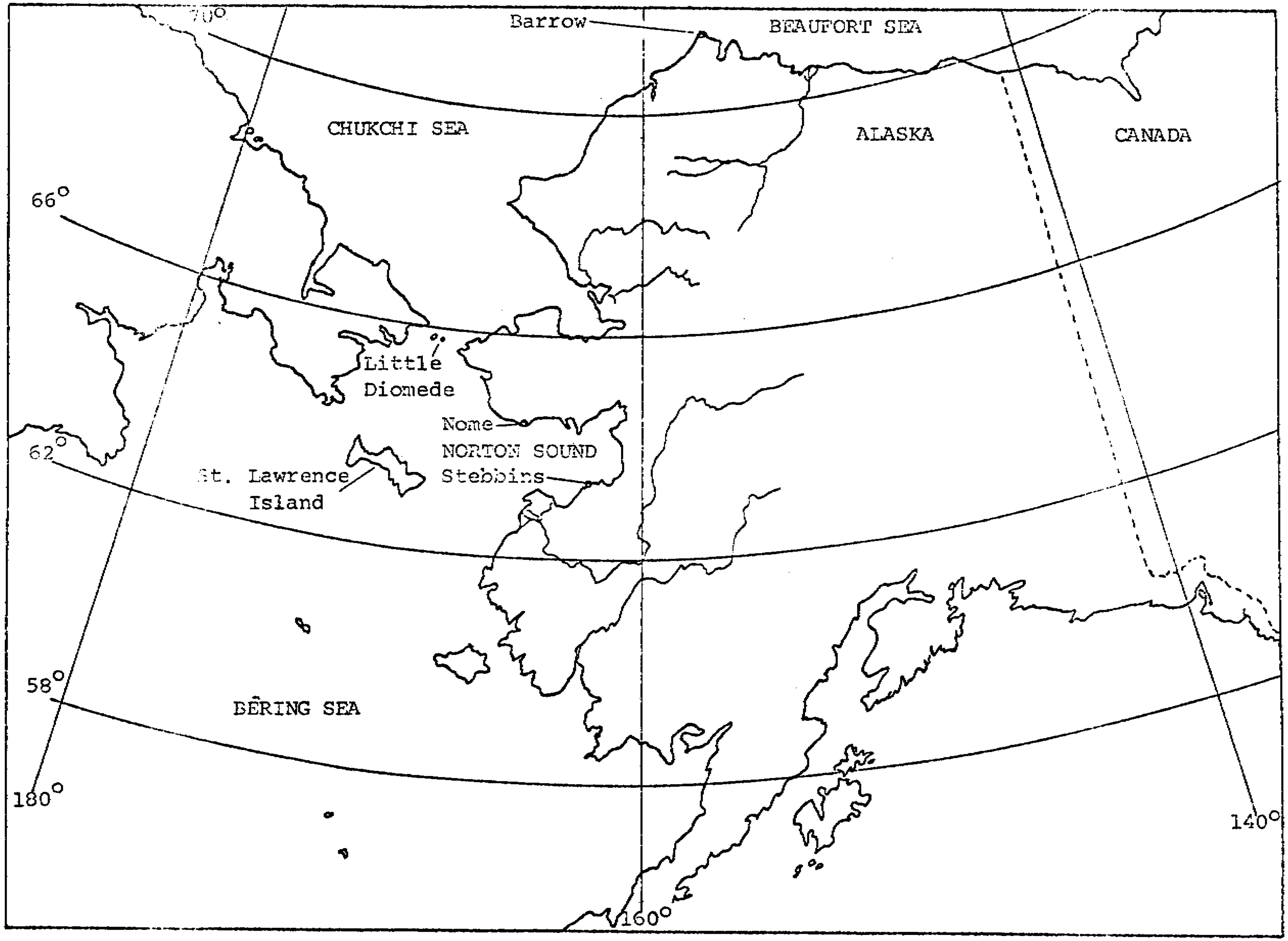

Figure 1. Locations mentioned in this report

Table 1. Field and laboratory activities from 27 September to 15 December 1976.

Activity	Date	Personnel
Specimen collection attempt on R/V NATCHIK-Beaufort Sea	27-30 September	T. Eley, D. James
Bering Sea/Norton Sound cruise on NOAA OSS MILLER-FREEMAN, collection of seal specimens and otter trawls	27 September - 13 October	K. Frost
Field facility inspection and specimen collection at Nome	12-18 October	L. Lowry, E. Muktoyuk
Specimen collection at Nome	18-24 November	L. Lowry, E. Muktoyuk, K. Frost
Specimen collection at Stebbins	19-21 November	K. Frost
Laboratory processing of specimen material-seal stomachs, invertebrate and fish material identifications, reference collections	Intermittent	K. Frost, L. Lowry, G. Seaman, L. Vaughan
Data management - transcription, keypunching and taping of data	Continuous	L. Vaughan, K. Frost
Compilation and analysis of data	Intermittent	L. Lowry, K. Frost
Preparation of Beaufort Sea final report	Intermittent	L. Lowry, K. Frost, J. Burns
Preparation of quarterly report		L. Lowry, K. Frost, J. Burns

Norton Sound lease area. One bearded seal was taken on the MILLER-FREEMAN, northeast of St. Lawrence Island. A breakdown of the specimens collected during the past quarter is given in Table 2.

Table 2. Seal stomachs collected during the period 27 September to 15 December 1976. Not all stomachs contained food.

Location	Phoca (Pusa) hispida	Erignathus barbatus	Phoca vitulina largha
MILLER-FREEMAN	-	1	-
Nome	5	-	1
Stebbins	2	-	-
Total	7	1	1

Seventy otter trawls conducted on the MILLER-FREEMAN were examined during the past quarter. Thirty of these were from Norton Sound. Thirty-six trawls were made between 5-80 miles north and east of St. Lawrence Island. The remaining four were 30-60 miles south of the Diomedes. Primary interest was in the fishes obtained from these trawls. Representatives of over 40 species of fishes were identified, length-frequencies determined and otoliths taken.

During the past quarter, a considerable amount of time was devoted to laboratory processing of specimens. The entire collection obtained previously from Shishmaref (105 ringed seals, 40 bearded seals and 3 spotted seals -- sample size includes only stomachs with recognizable contents), was processed. In addition the stomach contents of four bearded seals and one ringed seal taken at Diomede and one bearded seal collected on the MILLER-FREEMAN were analyzed. This represents by far the largest output of processed material of any quarter to date.

III. Results

Due to the large size of our sample at Shishmaref and the extensive compilation and analysis required we will report on only that sample in this report. Results of the Diomede and MILLER-FREEMAN collections will be reported on at a later date.

Spotted Seals

Only eight stomachs from spotted seals were collected, five of which were empty. The results of our analysis of the other three are presented in Table 3. The shrimp Crangon septemspinosa occurred in all 3 stomachs and accounted for 86.4 percent of the total volume. Fishes made up the remainder of the contents. The arctic flounder (Liopsetta glacialis) was the most commonly eaten fish species followed by saffron cod (Eleginus gracilus).

Ringed Seals

One hundred twenty-five ringed seal stomachs were collected, 105 of which contained recognizable food. The combined results for all ages and both sexes are given in Table 3. Invertebrates made up 58.5 percent of the total volume. Most of the invertebrate material was Crangon septemspinosa with mysids, amphipods, isopods and other shrimps found in much smaller quantities. Fishes made up 41.5 percent of the total contents. Of the recognizable fish remains (mostly otoliths), 92.5 percent of the individuals were saffron cod. Of the other fishes, 4.2 percent were arctic flounder and 1.1 percent were herring (Clupea harengus). Herring were all identified based on the presence of vertebrae. The heads of these relatively large fish are evidently not eaten. The number of herring is therefore probably underestimated, relative to the other species which were enumerated by otoliths.

Table 4 gives a breakdown of foods of ringed seals by age classes. Data are separated into pups (approximately 4 months old) and animals older than pups (over 1 year old). In pups, almost 68 percent of the volume was fish remains; almost all of it from saffron cod. Invertebrates which were identified were almost entirely shrimps with smaller amounts of isopods. Amphipods and mysids were found in a high percentage of the stomachs examined but amounted to only trace percentages of the total volume. In animals older than pups, invertebrates were the most common food making up 60.6 percent of the contents volume. Shrimp were again the most common food item. Amphipods, isopods and mysids were more abundant than in pups. Fishes made up about 40 percent of the contents in the older animals. Again saffron cod were eaten most frequently. Herring and flatfishes (Pleuronectidae), which were not found at all in pups, made up about 10 percent of the fishes in the older ringed seals. The mean volume of contents in seals older than pups was 2.8 times greater than that in pups.

Table 5 presents the foods of ringed seals obtained at Shishmaref, separated by sex of the seal from which the stomach was taken. As pups appear to forage somewhat differently than adults, only animals older than pups are included in this table. The same items appear in the stomachs of both male and female ringed seals. Fishes were somewhat more abundant in females than males. Saffron cod made up a higher percentage of the identified fish in

Table 3. Food items identified from 3 spotted seal, 105 ringed seal and 40 bearded seal stomachs collected at Shishmaref 4 June - 12 July, 1976. Data are expressed in part A as the percent of the total volume of contents comprised by each species or group and as frequency of occurrence.[1] Part B indicates the species composition of fishes expressed as the percentage of the total number of fishes identified and the frequen:y of occurrence.

Food Item	Spotted Seals % Vol/#	Spotted Seals % Freq	Ringed Seals % Vol/#	Ringed Seals % Freq	Bearded Seals % Vol/#	Bearded Seals % Freq
A. Amphipods Total	*	33.3	2.3	55.2	*	25.0
<u>Gammarus wilkitzkii</u>	*	33.3	1.3	45.7		
Other amphipods			1.0	10.5	*	25.0
Mysids Total			4.3	60.0	*	20.0
<u>Neomysis rayii</u>			4.1	51.4	*	15.0
Other mysids			0.2	21.0	*	5.0
Bivalves Total					15.8	60.0
<u>Serripes</u> sp.					9.6	35.0
<u>Clinocardium</u> sp.					5.5	40.0
Others					*	25.0
Hermit Crabs Total					1.4	45.0
Brachyuran Crabs Total					19.2	80.0
<u>Telmessus cheiragonus</u>					16.0	62.5
<u>Chionoecetes</u> sp.					1.3	32.5
<u>Hyas coarctatus</u>					1.9	15.0
Shrimp Total	86.4	100.0	46.6	91.4	50.9	100.0
<u>Crangon septemspinosa</u>	86.4	100.0	40.9	75.2	33.2	80.0
<u>Argis lar</u>	*	33.3	1.2	4.8	17.2	55.0
<u>Eualus gaimardii</u>			1.4	20.0	*	20.0
<u>Pandalus goniurus</u>			3.3	31.4	*	22.5
Others			*	1.9	*	15.0
Isopods Total			3.6	22.9	3.6	50.0
<u>Saduria entomon</u>			3.6	22.9	3.6	50.0
Others					*	2.5
Other Invertebrates			1.7	10.5	5.5	67.5
Invertebrates Total	86.4	100.0	58.5	95.2	96.6	100.0
Fishes Total	12.6	100.0	41.5	85.7	2.8	92.5

Table 3. Food items identified (continued).

Food Item	Spotted Seals % Vol/#	Spotted Seals % Freq	Ringed Seals % Vol/#	Ringed Seals % Freq	Bearded Seals % Vol/#	Bearded Seals % Freq
B. Fishes						
Clupea harengus			1.1	9.5		
Eleginus gracilus	38.5	100.0	92.5	73.3	14.8	62.5
Boreogadus saida			*	11.4	3.8	2.5
Family Pleuronectidae	3.8	33.3	*	7.6	46.6	65.0
Liopsetta glacialis	61.5	66.7	4.2	13.3	4.8	20.0
Pleuronectes quadrituberculatus			*	1.0	2.5	10.0
Family Cottidae			*	1.9	10.5	40.0
Myoxocephalus sp.			*	10.5	3.0	15.0
Lumpenus sp.			*	1.0	6.0	17.5
Ammodytes hexapterus					6.8	12.5
Other fishes			*	3.8	1.2	12.5
Total number of fishes identified	26		3285		601	
Mean volume of contents	402.9		97.5		415.2	

1 Frequency of occurrence = $\frac{\text{number of times found}}{\text{number of stomachs examined}} \times 100$

* Indicates food items which constituted less than 1 percent of the total volume.

Table 4. Food items identified from ringed seal stomachs obtained at Shishmaref. Data are expressed in the same manner as in Table 3.

Food Item	Pups N = 19 % Vol/#	Pups N = 19 % Freq	Non-Pups N = 86 % Vol/#	Non-Pups N = 86 % Freq
A. Amphipods Total	*	52.6	2.5	55.8
Gammarus wilkitzkii	*	52.6	1.4	44.2
Other amphipods	*	21.0	1.1	15.2
Mysids Total	*	36.8	4.6	64.0
Neomysis rayii	*	26.3	4.4	56.9
Other mysids	*	10.5	0.2	23.3
Shrimp Total	28.6	73.7	48.0	95.3
Eualus gaimardii	1.5	15.8	1.1	20.9
Pandalus goniurus	4.4	21.1	3.3	33.7
Crangon septemspinosa	22.7	63.2	42.3	77.9
Argis lar			1.3	5.8
Other shrimps			*	2.3
Saduria entomon	1.7	31.6	3.8	21.0
Other Invertebrates	*	15.8	1.8	9.3
Invertebrates Total	32.1	84.2	60.6	97.6
Fishes Total	67.8	73.7	39.4	88.3
B. *Eleginus gracilus*	99.6	47.4	88.6	79.1
Clupea harengus			1.7	11.6
Liopsetta glacialis			6.6	16.3
Family Pleuronectidae			1.4	9.3
Other Fishes	*	26.3	1.7	26.7
Total number of fishes identified	1179		2106	
Mean volume contents (ml)	39.9		110.2	

Table 5. Food items of male and female ringed seals from Shishmaref. Only animals older than pups are included. Data are expressed in the same manner as in Table 3.

Food Item	Males N = 36 % Vol/#	Males N = 36 % Freq	Females N = 49 % Vol/#	Females N = 49 % Freq
A. Amphipods Total	2.6	55.6	2.5	57.1
Gammarus wilkitzkii	*	47.2	2.2	44.9
Anonyx nugax	1.9	8.3	*	6.1
Other amphipods	*	16.7	*	14.3
Mysids Total	2.8	58.3	4.4	67.3
Neomysis rayii	2.6	55.5	4.3	55.1
Other mysids	*	22.2	*	18.4
Shrimp Total	57.1	91.7	41.9	98.0
Eualus gaimardii	*	13.9	1.5	24.5
Pandalus goniurus	6.3	38.9	1.0	28.6
Crangon septemspinosa	50.3	72.2	37.1	81.6
Argis lar	*	2.8	2.2	8.2
Other shrimps			*	4.1
Saduria entomon	3.4	30.6	4.2	20.4
Other Invertebrates	*	11.1	1.0	8.2
Invertebrates Total	66.7	97.2	55.4	98.0
Fishes Total	33.2	91.7	44.6	89.8
B. *Eleginus gracilus*	77.9	80.6	91.8	77.6
Boreogadus saida	1.4	13.9	*	8.2
Clupea harengus	2.0	8.3	1.6	14.3
Liopsetta glacialis	15.4	25.0	4.0	10.2
Family Pleuronectidae	1.2	8.3	1.5	10.2
Other Fishes	2.0	22.2	*	16.3
Total number of fishes identified	483		1612	
Mean volume of contents	110.9		109.9	

females. Shrimp were relatively more abundant in males. Amphipods, mysids and isopods were found in similar quantities in seals of both sexes. The mean volumes of contents were essentially identical.

Bearded Seals

Forty-nine bearded seal stomachs were collected of which 40 contained food. The combined results for all ages and both sexes of seals are presented in Table 3. Shrimps (mostly Crangon septemspinosa and Argis lar) were the most common type of food eaten, accounting for over 50 percent of the total volume. Brachyuran crabs (mostly Telmessus cheiragonus) accounted for about 20 percent of the contents and bivalves (Serripes sp. and Clinocardium sp.), 15.8 percent. As has been the case in previous samples, usually only foot portions of clams and abdomens of crabs were found. Fishes made up only 2.8 percent of the food volume in bearded seals. The types of fishes most commonly eaten were flatfishes, sculpins (Cottidae), saffron cod, sand lance (Ammodytes hexapterus) and pricklebacks (Lumpenus fabricii).

Table 6 shows the foods of bearded seals in relation to age classes of the seals. Frequency of occurrence is not given due to small sample sizes. Bearded seal pups ate almost entirely shrimps. Bivalves, crabs, isopods and fishes were eaten in small amounts. Of the fishes, flatfishes were most commonly eaten followed by sculpins, saffron cod and pricklebacks.

Yearling seals had eaten large amounts of bivalves, shrimps and crabs. Fishes eaten were mostly sand lance followed by flatfishes, sculpins, saffron cod and pricklebacks.

Bearded seals two years old or older ate 44.4 percent shrimps, 23.6 percent brachyuran crabs and 17.2 percent bivalves. Isopods and other invertebrates occurred in small amounts. Flatfishes were the predominant type of fish eaten followed by gadids (saffron and polar cod), sculpins, sand lance and pricklebacks. The mean volumes of contents found in pups, yearlings and older seals were fairly comparable.

Table 7 shows the food items of bearded seals two or more years old, broken down by sex of the seal. Shrimps, brachyuran crabs and bivalve molluscs were the main food items for both sexes. Flatfishes were the most common fishes eaten followed by gadids (saffron and polar cod), sculpins and sand lance.

IV. Discussion of Results

The feeding pattern of seals taken at Shishmaref is generally consistent with our observations elsewhere. However, it is somewhat unusual in that a single prey species appeared very commonly in all three species of seals.

Table 6. Food items utilized by bearded seal pups, yearlings and animals older than one year. Only animals of known age and sex are included. Data are expressed in the same manner as in Table 3.

Food Item	Pups N = 10 % Vol/#	Yearlings N = 4 % Vol/#	Over 1 year N = 21 % Vol/#
A. Bivalves Total	1.7	41.7	17.2
Serripes sp.	*	22.0	10.4
Clinocardium sp.	1.4	18.8	5.9
Siliqua sp.	*		
Others	*	1.2	*
Hermit Crabs Total	*	2.5	1.4
Brachyuran Crabs Total	3.8	25.1	23.6
Telmessus cheiragonus	1.6	23.1	20.1
Chionoecetes sp.	*	2.0	1.9
Hyas coarctatus	2.0		1.6
Shrimp Total	82.5	28.5	44.4
Crangon septemspinosa	61.0	23.1	26.8
Crangon dalli	*	1.7	
Argis lar	21.0	3.7	17.3
Others	*	*	*
Isopods Total	3.7		3.8
Saduria entomon	3.7		3.8
Others	*		
Other Invertebrates	1.5	*	7.1
Invertebrates Total	93.7	98.6	97.4
Milk	1.7		
Fishes Total	4.1	1.0	2.5
B. *Eleginus gracilus*	11.7	6.7	13.8
Boreogadus saida			7.4
Family Pleuronectidae	66.0	18.7	53.2
Liopsetta glacialis	4.3	6.7	6.6
Pleuronectes quadrituberculatus			3.5
Family Cottidae	8.5	18.7	9.0
Gymnocanthus sp.		2.7	
Myoxocephalus sp.	6.4		2.9
Lumpenus sp.	3.2	5.3	0.6
Ammodytes hexapterus		41.3	2.3
Other fishes			0.6
Total number of fishes	94	75	310
Mean volume of contents	375.4	448.4	426.3

Table 7. Comparison of foods of male and female bearded seals. Data include only animals two or more years old. Data are expressed in the same manner as in Table 3.

Food Item	Males N = 5 % Vol/#	Females N = 16 % Vol/#
A. Bivalves Total	14.5	17.8
Serripes sp.	*	12.4
Clinocardium sp.	11.9	4.8
Siliqua sp.	1.2	*
Others	*	*
Hermit Crabs Total	1.6	1.4
Brachyuran Crabs Total	16.9	24.9
Telmessus cheiragonus	16.2	20.9
Chionoecetes sp.	*	2.1
Hyas coarctatus		1.9
Shrimp Total	39.7	45.3
Crangon septemspinosa	38.6	24.3
Crangon dalli		
Argis lar	*	20.6
Others	*	*
Isopods Total	10.5	2.5
Saduria entomon	10.5	2.5
Others		
Other Invertebrates	10.4	6.4
Invertebrates Total	93.5	98.2
Fishes Total	6.4	1.7
B. *Eleginus gracilus*	19.6	12.7
Boreogadus saida		8.9
Family Pleuronectidae	51.0	53.3
Limanda proboscidea	2.0	
Liopsetta glacialis	3.9	6.9
Pleuronectes quadrituberculatus	9.8	2.3
Family Cottidae	7.8	8.9
Myoxocephalus sp.	5.9	2.3
Lumpenus sp.		
Ammodytes hexapterus		2.7
Other fishes		2.0
Total number of fishes identified	51	259
Mean volume of contents	368.8	467.3

The shrimp Crangon septemspinosa was, overall, the most important prey item consumed by spotted, ringed and bearded seals. Percentage of the total volume of stomach contents made up by this species ranged from a high of 86.4 percent in spotted seals to a low of 22.7 percent in ringed seal pups. In our samples of seal stomachs and otter trawls, C. septemspinosa has occurred at only one other locality other than near Shishmaref; that being in two otter trawls taken less than a kilometer offshore from Nome on June 21, 1976. Rathbun (1904) states that the species is found along the Alaskan coast from Eschscholtz Bay in Kotzebue Sound to the Shumagin Islands. All collection sites noted by Rathbun are in shallow water, most less than 8 fathoms (about 15 meters) deep. Squires (1965) notes that in the Canadian arctic this species is commonly found in shallow sandy areas where eelgrass is present. These shrimp probably move away from shore in winter. Apparently C. septemspinosa was by far the most common shrimp near Shishmaref in June and July 1976. Argis lar occurred in stomachs of all three seal species, but was most common in bearded seals. The shrimps Eualus gaimardii and Pandalus goniurus occurred in trace amounts in bearded seals and were slightly more common in ringed seals.

Spotted seals ate flatfishes, mostly arctic flounder, and saffron cod in addition to C. septemspinosa. Unfortunately, our sample consists of only three stomachs which contained food. This small sample is a result of the relatively few spotted seals taken by hunters at Shishmaref and the high percentage (5 out of 8) of the stomachs which were empty. A larger sample would be desirable. However, it appears likely that C. septemspinosa would remain the major food item in a larger sample.

Amphipods, mysids, isopods and several kinds of fishes, in addition to Crangon septemspinosa were found in ringed seal stomachs. Overall, fishes made up 41.5 percent of the food volume in stomachs of these seals. By far the majority of fishes eaten were saffron cod. Arctic flounder and herring occurred less commonly. The numerical estimates given fishes in the tables are based on number of individuals identified by otoliths, characteristic bones, or whole specimens. This provides something of a temporal summation of recently eaten fishes as otoliths and perhaps bones are retained in the stomach for some time after the rest of the fish is digested. Unfortunately how long they are retained is, as yet, unknown. Fish remains other than otoliths and bones were separated as well as possible by species and the volume of each identified component. On a volume basis, herring was the predominant food fish followed by saffron cod and arctic flounder.

Food items found in ringed seal pups were similar to those found in older animals but the proportions of the various items in the diet differed. Pups ate considerably more fish than older ringed seals. Essentially all fish eaten by pups were saffron cod. No evidence of flatfishes or herring was found. Evidently saffron cod are readily captured by ringed seal pups; perhaps a dive to the bottom is not required as it would be if feeding were on shrimps or flatfishes.

Feeding habits of male and female ringed seals were generally similar. Shrimp and flatfishes were slightly more abundant in the males and saffron cod were more abundant in females. If the composition of the diet of pups is compared to that of older seals of both sexes, it appears that pups feed more like older females than like older males. The mean volumes of contents in older males and females were similar while the volume of contents in pups was less than half that in older animals.

As we have found at other areas, bearded seals at Shishmaref fed on a variety of benthic crustaceans and molluscs. Bearded seal pups ate almost entirely shrimps. Animals two or more years old ate substantial quantities of bivalves and brachyuran crabs in addition to shrimps. Bivalves and crabs made up over 40 percent of the total contents in animals 2 or more years old as compared to less than 5 percent in pups.

As we have noted previously when bivalves are eaten usually only the foot portions occur in the stomachs. When crabs are eaten, frequently only abdominal portions are found. Many of the abdomens are of ovigerious females (those carrying eggs). Perhaps feeding on clams and crabs involves a behavioral pattern which is not yet well developed in pups. Apparently yearling animals have developed this pattern, in fact bivalves and crabs were more common in our small sample of yearlings than in older animals.

Comparison of foods of male and female bearded seals two or more years old showed a very similar feeding pattern. Males had eaten slightly more fishes while females had eaten more clams, crabs and shrimp. Again these differences are perhaps not real and are attributable to small sample sizes. Fishes eaten by all age classes and both sexes were predominantly demersal forms; flatfishes and sculpins. Saffron cod were regularly eaten. Sand lance, polar cod and pricklebacks occurred occasionally. The mean volume of contents in male seals appears lower than that in females.

V. Problems Encountered/Recommended Changes

The only major problem encountered this past quarter has been the backlog of data to be keypunched and analyzed by computer. As an alternative the time required for manual compilation and analysis of large amounts of data was significant. We are presently endeavoring to develop means for using the data management system more effectively in order to provide us with computer assistance.

VI. Estimate of Funds Expended

As of November 30 we have expended approximately the following amounts during FY 77:

Salaries and benefits	-	$ 9,500
Travel and per diem	-	1,500
Contractual services	-	500
Commodities	-	500
Total Expenditures	-	$12,000

VII. Literature Cited

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FINAL REPORT

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Assessment of the Distribution and Abundance of Sea Otters Along the Kenai Peninsula, Kamishak Bay and the Kodiak Archipelago

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December 1, 1976

I. Summary

Sea otters are the most vulnerable of all marine mammals to the effects of environmental oil spills. Many populations have not recovered from the period of excessive exploitation during the 18th and 19th centuries. Relatively small oil spills could not only kill large numbers of sea otters but could virtually eliminate small isolated populations or retard range expansion into unpopulated former sea otter habitat. OCS devèlopment currently poses the most significant threat to the complete recovery of sea otters. As sea otters may be a "keystone" species, altered sea otter abundance could have a profound effect on the structure of nearshore communities.

The current distribution and relative abundance of sea otters along the Kenai Peninsula, Kamishak Bay and the Kodiak Archipelago were determined through aerial and boat surveys and miscellaneous observations. These data were compared to previously existing information to determine the history of population growth, present status, probable future trends and to identify critical areas.

The outer Kenai Peninsula coast was repopulated in the 1960's. Most of the available habitat south and east of Port Graham is presently occupied and range expansion into Kachemak Bay and lower Cook Inlet is occurring. Another population has occupied Kamishak Bay for many years and has recently expanded its range southwestward along the Alaska Peninsula. Both of these populations currently occupy, and are expanding into, habitat that lies within or adjacent to the proposed lower Cook Inlet OCS lease area. There is a potential for oil spills to kill large

numbers of sea otters and perhaps seriously retard repopulation of former sea otter habitat in lower Cook Inlet.

The Barren Islands were completely repopulated by sea otters in the 1950's. Although this population may have played a major role in repopulation of the Kenai Peninsula in the 1960's it does not appear to be contributing significantly to the repopulation process at this time. Most of the population occupies a small area and could be vulnerable to relatively small oil spills or other localized impacts.

A remnant population of sea otters survived north of Shuyak Island. This group has increased in numbers and is rapidly expanding its range around both sides of Afognak Island. This expansion is expected to continue until all of Kodiak Island is repopulated. Although this population is likely large enough to survive even major oil spills, repopulation of Kodiak could be seriously retarded by OCS related activities.

Another population of unknown size inhabits the extensive area of shallow water between the southwestern end of Kodiak Island and Chirikof Island. The potential for growth of this population appears high, however, much of its habitat lies within the proposed western Gulf of Alaska OCS lease area. More information on the status of this population is needed.

Several other populations outside of the study area appear threatened by proposed OCS development and should be studied in greater detail.

II. Introduction

Sea otters were reduced to very low numbers by commercial hunting between 1742 and 1911. A number of small nucleus populations did survive, however, and many have steadily grown and expanded their ranges. For the past 20 years the pattern of repopulation of former sea otter habitat has been monitored by the U. S. Fish and Wildlife Service and the Alaska Department of Fish and Game through a series of surveys (Lensink 1960, Kenyon 1969, Schneider unpublished data). In recent years survey techniques have been refined to permit more realistic estimates of abundance, although we are still unable to census sea otters with a high degree of confidence over large areas (Schneider 1971, Estes and Smith 1973).

Most of these efforts were directed at populations in the Aleutian Islands where rapid range expansion was taking place. Through a combination of extensive aerial surveys and intensive boat and shore counts it was possible to assess the status and trends of sea otter populations, identify critical areas, predict patterns of range expansion and evaluate the impacts both natural and unnatural catastrophic events.

Sea otter populations in the Gulf of Alaska have generally been smaller and attracted less attention from scientists. The status of these populations has been monitored through a haphazard series of fragmentary surveys and reported sightings. Calkins et al. (1975) summarized most of the pertinent available data. Even though the basic distribution of sea otters was known and some rough estimates of abundance had been made

(A.D.F.& G. 1973) it was clear that the basis for assessment of changes in distribution and abundance was poor.

Concern for the potential effects of the Trans-Alaska oil pipeline terminal, the proposed Trans-Alaska gas pipeline terminal and associated tanker traffic on marine mammals in general and sea otters in particular caused scientists to turn their attention to the Prince William Sound area. The Alaska Department of Fish and Game conducted two helicopter surveys (Pitcher 1975) and cooperated with the U. S. Fish and Wildlife Service in a supportive boat survey. The U. S. Fish and Wildlife Service then initiated more intensive studies adjacent to tanker routes and terminal sites. Proposals for expanded human activities in the marine environment, particularly those associated with OCS development, have increased the need to update information on sea otter distribution and abundance in other areas.

Sea otters are probably the most vulnerable of all marine mammals to the direct effects of oil. Unlike most marine mammals they have no thick blubber layer. They rely on air trapped in their dense fur for conservation of body heat and buoyancy. When clean, this mat of fur is waterproof and the skin over most of the body remains dry. If the fur is soiled it loses its water repellency and insulative qualities. If this is not corrected quickly the animal will die of hypothermia. Although little information is available on the quantities and types of petroleum products necessary to kill a sea otter, it appears that relatively small amounts of both refined fuels and crude oil will cause death (Kenyon no date, Schneider unpublished data). Kenyon (1969) cited cases where massive kills may have occurred near shipwrecks.

Long-term effects of chronic pollution on all high trophic-level species are possible if one or more of the links in the food chain are affected. Sea otters require very large quantities of food (20 to 25 percent of their own body weight per day) to support their high metabolic rate. The main factor limiting most sea otter populations appears to be food availability.

Sea otters in most areas appear to be relatively sedentary and feed on relatively sessile organisms. Therefore they may be exceptionally sensitive to changes in the food chain and any such effects would tend to be site specific.

All of the sea otter populations bordering the Gulf of Alaska are still recovering from the period of commercial exploitation, and are expanding their range into unpopulated or sparsely populated habitat. The range of some of these populations is extremely limited. Very localized effects of human activity could endanger some of these populations and seriously retard the process of repopulation of former sea otter habitat.

Sea otters exert a profound influence on nearshore plant and animal communities and have been described as a keystone species (Faro 1969, Estes and Palmisano 1974, and others). A knowledge of the history of sea otter occupancy of an area is necessary for studies of changes in those communities.

The objectives of this project were to map the present range of sea otters around the Kenai Peninsula, Kamishak Bay and the Kodiak Archipelago; to determine the relative abundance of sea otters throughout their present range; to determine recent patterns of change in distribution and abundance providing a basis for predicting future changes; and to identify areas critical to the survival and continued growth of sea otter populations. It is anticipated that this information will be useful for making decisions on the regulation of human activities in the marine environment so as to minimize adverse impacts on sea otters. The information should also be useful to ecologists studying changes in nearshore communities.

III. Current State of Knowledge

Calkins et al. (1975) provided the most up to date summary of available information on sea otter distribution and abundance in the study areas prior to the initiation of this project. The following discussion is adapted from that report.

Kenai Peninsula

Prior to 1967, only scattered observations of sea otters had been reported from Cape Puget to Port Graham on the Kenai Peninsula. Lensink (1960) reported a sighting of 15 animals near Elizabeth Island in 1953, and Kenyon (1969) felt that no significant population of otters occupied the area by the mid-1960's. In 1967 large numbers of otters began to be sighted regularly on the southern tip of the Kenai Peninsula in the area from Koyoktolik Bay to Chugach Bay. On a 1968 survey of this area 400 otters were seen. The apparent movement of large numbers of otters to the southern tip of the Kenai Peninsula, probably from the Barren Islands, and subsequent expansion up the southeast side of the Kenai Peninsula probably occurred in the years 1966 to 1968. At the same time, otters from Prince William Sound probably contributed to the repopulation of the area east of Gore Point.

Our most recent information from surveys conducted in 1970 confirmed there were concentrations of otters on the tip of the Kenai Peninsula with scattered groups along the coast to Cape Puget (Table 1). It is important to realize that data presented in Table 1 originated from a series of surveys conducted by different observers under varying conditions from various fixed-wing aircraft. The large variability between surveys renders them useless for comparative purposes. This information should only be used to indicate the presence of animals and can in no way be extrapolated to give total numbers. Reports from the public in the early 1970's indicated that up to 200 otters were regularly seen in Port Graham and that small numbers were straying into Kachemak Bay. Sightings from north of Kachemak Bay as far as Ninilchik were increasing.

Kamishak Bay

The Kamishak Bay area including Augustine Island, Shaw Island and Cape Douglas has been partially surveyed on numerous occasions. Lensink (1962) reported that approximately 50 otters were seen near Augustine Island in 1948 and that Spencer counted 40 at Augustine Island and one

Table 1. SEA OTTERS COUNTED ON AERIAL SURVEYS OF KENAI PENINSULA
June, 1970 - January, 1971

AREA	JUNE 5 & 9	JULY 15-20	AUG. 14	OCT. 12	NOV. 12	JAN. 12
C. Junken-C. Resurrection	5	30	42	27	10	30
Resurrection Bay	2	2	0	4	2	NS
Aialik Bay	1	20	5	8	0	21
Harris Bay	8	18	7	5	3	* 25
Nuka Bay	106	56	NS	31	28	27
Port Dick	0	11	NS	NS	3	23
Rocky Bay-Port Chatham	121	125	NS	NS	9	26
Koyuktolik Bay-Port Graham	0	0	NS	NS	0	NS
Total	243	262	54	75	55	152

* 38 Sea otters counted from shore and skiff 11/20/70.

at Shaw Island in 1957. Lensink counted 52 on Augustine in 1959, but he considered it a poor count. In 1965 Kenyon counted 18 around Augustine Island and 101 in the Shaw Island-Cape Douglas area. In 1969 Alaska Department of Fish and Game biologists tallied 62 and 130 animals in the Augustine Island area on different counts. In 1971 Alaska Department of Fish and Game biologists counted 150 otters between Augustine Island and Tignagvik Point. Also in 1971 Prasil (1971) counted 60 otters between Augustine and Shaw Islands. A 1970 survey by Schneider indicated that this population had expanded its range southwestward to the vicinity of Shakun Island. Prasil (1971) subsequently counted up to 443 sea otters around the Shakun Island and 92 at Douglas Reef on a series of aerial surveys made in 1970 and 1971.

Kodiak Archipelago

Sea otter habitat in the Barren Islands is separated from that in the rest of the Kodiak Archipelago by approximately 15 km of deep water. This probably limits movements between the island groups. Sea otter sightings in the Barren Islands date back to 1931, when two otters were seen near Sud Island. Otters have been observed regularly in the Barren Islands since then. The highest count prior to 1970 was 325 animals seen in 1957 (Lensink 1960). Kenyon (1969) reported seeing 272 otters in the Barren Islands during a 1959 survey and estimated a population of 363 animals.

In June 1970 Schneider flew as the only observer in a Grumman Goose during a survey of the Barren Islands. Offshore coverage was poor although conditions and visibility were good and a complete count of the Barren Islands was made with a total count of 307.

Portions of the Kodiak-Shuyak-Afognak area, including the Trinity Islands and Chirikof Island, contain good sea otter habitat. Kodiak was an important hunting area during the period of Russian exploitation, but the population was never completely extirpated.

Reports from the Kodiak area are fragmentary and incomplete; no complete surveys have been attempted. We knew that a relatively large population has existed for many years at the north end of the group and a population of unknown size occurred at the south end.

In 1948 Refuge Manager Beals reported three otters off Shuyak Island and in 1951 Chapados and Spencer saw 15 on Sea Otter Island and 67 at Latax Rocks (Lensink 1960). In 1957 Lensink saw 14 in the Trinity Islands and 281 around the Shuyak area. In 1964 E. Klinkhart counted 63 sea otters at Latax rocks, 13 at Seal Island and one at Marmot Island.

Sightings at areas other than the north and south ends included five sighted by James Faro at Uyak Bay and three near the south end of Chirikof sighted by the crew of the MV "Teal." Occasional individuals were reported from Marmot and Chiniak Bays.

The most recent survey information came from Schneider (1970, unpub. report) who saw 18 between Ban Island and Shuyak Strait, 6 in Pernosa Bay, 3 at Marmot Island, 121 in the area of Sea Otter Island, 33 on the west side of Shuyak Island and 26 in the area of Latax Rocks and Dark Island for a total of 207. On a separate flight six were seen midway between Tugidak and Chirikof Islands. Reports of small numbers and the incidence of beach-dead animals on Tugidak Island indicated that at least moderate numbers occur there.

Reports since 1970 suggested that range expansion was occurring along both sides of Afognak Island. B. Ballanger sighted 15 south of Marmot Strait and 10 at Outlet Cape in 1975 and reported an increase in sightings near the town of Kodiak. Lensink (1960) estimated the total sea otter population of the Kodiak Archipelago including the Barren Islands at 800-1,500, while Kenyon (1969) indicated that the Kodiak area had not been repopulated to a significant degree with a total estimate of 1,118 otters. Based on more recent information ADF&G (1973) estimated the population at 4,000 sea otters.

IV. Study Area

The study area included the shoreline, all offshore rocks and islets and floating glacial and sea ice pans and adjacent waters less than 80 m in depth in the following areas.

1. The Kenai Peninsula from Cape Puget to the mouth of the Kenai River including the Chugach Islands.

2. The west side of lower Cook Inlet from Tuxedni Bay to Cape Douglas including Augustine Island.

3. The entire Kodiak Archipelago including the Barren Islands, Shuyak Island, Afognak Island, Marmot Island, Kodiak Island, the Trinity Islands and Chirikof Island.

V. Methods of Data Collection

Between 1 October and 7 October 1975 a helicopter survey was made of the Kenai Peninsula and the northern part of the Kodiak Archipelago. A Bell 206B "Jet Ranger" II helicopter (N90217) was flown along the survey trackline at altitudes of 50 to 70 m and an average airspeed of 70 knots (130 km/hr). Both altitude and airspeed were varied according to counting conditions. A forward observer sat in the left front seat and counted animals directly in front and to the left of the helicopter, an offshore observer sat in the right rear seat and counted on the right side, and a recorder sat in the left rear seat and recorded all observations and photographed concentrations of marine mammals. Both the pilot and recorder assisted the observers by pointing out animals. Personnel were Vernon Lofstedt - pilot, Karl Schneider - forward observer, Donald Calkins - recorder, Warren Ballard - right observer on the Kenai P eninsula, and Kenneth Pitcher - right observer on Afognak Island. This survey required a total of 38.4 hours of flying time including 25.1 hours of actual survey time.

Sea otters were counted visually. Large pods of sea otters were photographed and the number of individuals was determined from projected 35mm slides.

Between 3 February and 11 February 1976 counts of sea otters were made from skiffs along portions of the Kodiak Archipelago. Three observers jointly counted numbers of pups and numbers of adults as the skiff paralleled the shoreline and circled offshore rocks. Binoculars were used to aid counts offshore and to identify pups.

Sightings and partial counts of sea otters were made on the following aerial surveys of sea lions conducted under RU #243.

12 March - 14 March 1976 - covering portions of the Kenai Peninsula and Kodiak Archipelago.

20 May 1976 - covering portions of the Barren Islands.

8 June - 10 June 1976 - covering portions of the Kenai Peninsula, Barren Islands and the Kodiak Archipelago.

The trackline on these surveys normally covered only small portions of sea otter habitat. The observer placement in the aircraft was such that few sea otters on the left side of the aircraft were seen. Therefore, the number of sea otters counted was generally low.

The trackline was modified to cover selected areas of sea otter habitat more thoroughly when survey conditions were suitable. Emphasis was placed on the fringes of expanding populations and areas that had not been surveyed previously.

The scientific party included:

Karl Schneider - Alaska Department Fish and Game - Principal Investigator and observer 12 - 14 March, 20 May, 8 - 10 June.

Donald Calkins - Alaska Department Fish and Game - Principal Investigator RU #243 and observer 12 - 14 March, 20 May, 8 - 10 June.

Charles Irvine - Alaska Department Fish and Game - Observer - recorder 12 - 14 March.

Roger Aulabaugh - Alaska Department Fish and Game - Observer - recorder 8 - 10 June 1976.

A Grumman Super Widgeon flown by Ken Bunch was used on all of these surveys.

On 1 April, 1976 a systematic survey of Kamishak Bay and portions of Kachemak Bay was made from a Grumman Turbo Goose.

Tracklines were flown over open water in shallow areas believed to support sea otters. The aircraft was flown along east and west tracklines spaced 2 minutes of longitude apart. Navigation was aided by The Global Navigation System (GNS 500). One observer counted sea otters out of each side of the aircraft. A limited track width was not used as the objective of the survey was to determine distribution and relative abundance rather than to estimate numbers. The effective track width for individual animals was probably no more than 400 m, however.

Survey conditions which influence the sightability of sea otters were classified on all of the above surveys according to the following system.

Code

1 Excellent - surface of water calm, usually a high overcast sky with no sun glare. Sea otters appear dark against a uniformly light gray background of the water's surface. Individuals easily distinguished at a distance.

2 Very good - may be light ripple on water's surface or slightly uneven lighting but still relatively easy to distinguish individuals at a distance.

3 Good - may be light chop, some sun glare or shadows. Individuals at a distance may be difficult to distinguish but individuals nearby and small groups at a distance are readily identified.

4 Fair - usually choppy waves and strong sun glare or dark shadows in part of the survey track. Individuals in kelp beds, in the lee of rocks, or near the observer and most pods readily identified but most individuals and some pods in areas of poor lighting or at a distance difficult to distinguish.

5 Poor - individuals difficult to distinguish unless very close and some pods at a distance may be missed, however, conditions still good enough to give a very rough impression of the distribution of animals.

6 Unacceptable - heavy chop with many whitecaps, lighting poor or large waves breaking on rocks. No surveys should be conducted under these conditions but occasionally a sighting of significance may be made in the course of other activities.

Conditions may vary within a single count area. Therefore, the classification may represent the average conditions encountered.

Tracklines of all the above surveys are presented in the RESULTS section of this report.

Significant sightings made by other biologists from both federal and state agencies were collected. Those made by personnel working on RU #3/4, 229 and 243 were particularly useful.

Pertinent information on past distribution and abundance was extracted from the literature and Alaska Department of Fish and Game files.

Results

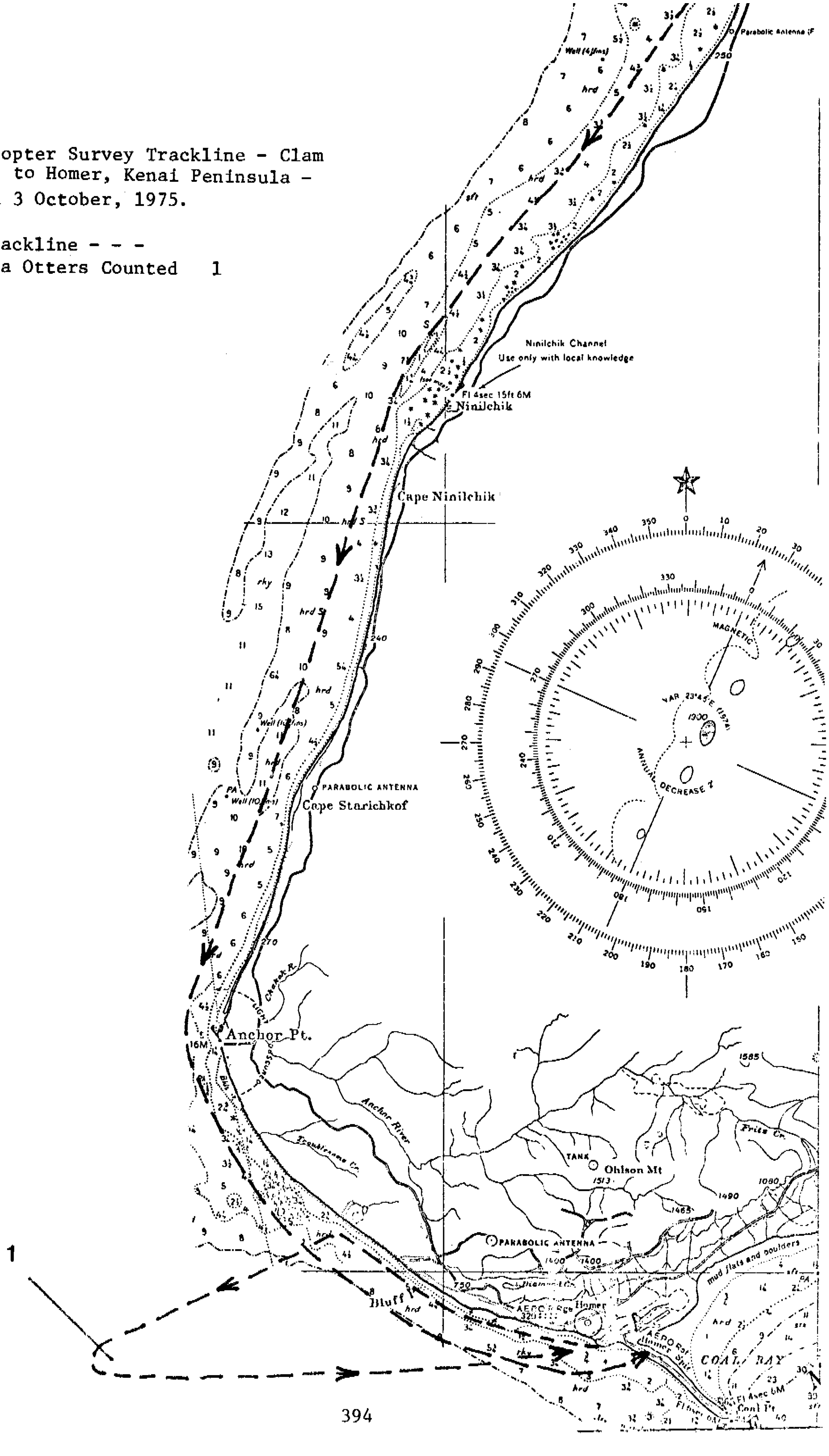
Results of the October helicopter survey are presented in Table 2 and Figs. 1-6, the February boat survey in Table 3 and Figs. 7-8, the March

Table 2. Results of helicopter sea otter survey of portions of the Kenai Peninsula and the Kodiak Archipelago, 1-7 October 1975.

Area	Date	Sea Otters Counted	Survey Conditions	Completeness of Coverage
Kenai Peninsula				
Kenai-Clam Gulch	10/1/75	0	Fair	Incomplete
Clam Gulch-Ninilchik	"	0	"	"
Ninilchik-Anchor Pt.	"	0	"	"
Anchor Pt-Coal Pt.	"	0	"	"
Coal Bay	"	0	Very Good	Complete
Bear Cove	"	5	Good	"
Halibut Cove	"	1	"	"
Tutka-Sadie	"	1	"	"
Seldovia	"	4	"	"
Port Graham	"	16	Fair	"
Port Chatham	"	54	Poor	"
Chugach Bay	10/2/75	66	"	"
Rocky Bay	"	90	Fair	"
Port Dick	"	15	"	"
Nuka Passage	"	32	"	"
West Nuka	"	20	Poor	Incomplete
McCarty Arm	Not Surveyed			
East Arm Nuka	10/3-4/75	26	Poor	Incomplete
Pye Reef-Two Arm	10/4/75	1	"	Complete
Harris Bay	"	92	Very Good	"
Aialik Bay	"	36	"	"
Resurrection Bay	10/4-5/75	29	Fair	Incomplete
Day Harbor	10/5/75	13	"	Complete
Whidbey-Johnstone	"	15	"	"
Puget Bay	"	25	Good	"
Kodiak Archipelago				
Ouzinki	10/6/75	0	Poor	Incomplete
Afognak Bay	"	6	Fair	"
Kazakof Bay	"	0	Poor	"
Duck Bay	"	1	"	"
Izhut Bay (West)	"	1	"	"
Izhut Bay (East)	"	0	"	"
King Cove	10/7/75	16	Fair	"
Marmot I.	"	529	"	Complete
Tonki Cape	"	134	Good	"
Tonki Bay	"	32	"	"
Seal Bay (East)	"	164	"	"
Seal Bay (West)	"	342	"	"
Perenosa Bay (South)	"	290	Excellent	"
Perenosa Bay (North)	"	58	"	"
Shuyak (East)	"	10	Good	"
Sea Otter I.	"	156	Fair	Incomplete
Point Banks	"	9	Very Good	Complete
Shuyak (North)	"	14	"	Incomplete
Latax Rocks	"	59	"	Complete
Shuyak (West)	"	12	"	Incomplete
Shuyak Strait	"	2	"	"
Bluefox Bay	"	81	"	"
Foul Bay	"	61	"	"

Fig. 1 Helicopter Survey Trackline - Clam Gulch to Homer, Kenai Peninsula - 1 and 3 October, 1975.

Trackline - - -
Sea Otters Counted 1



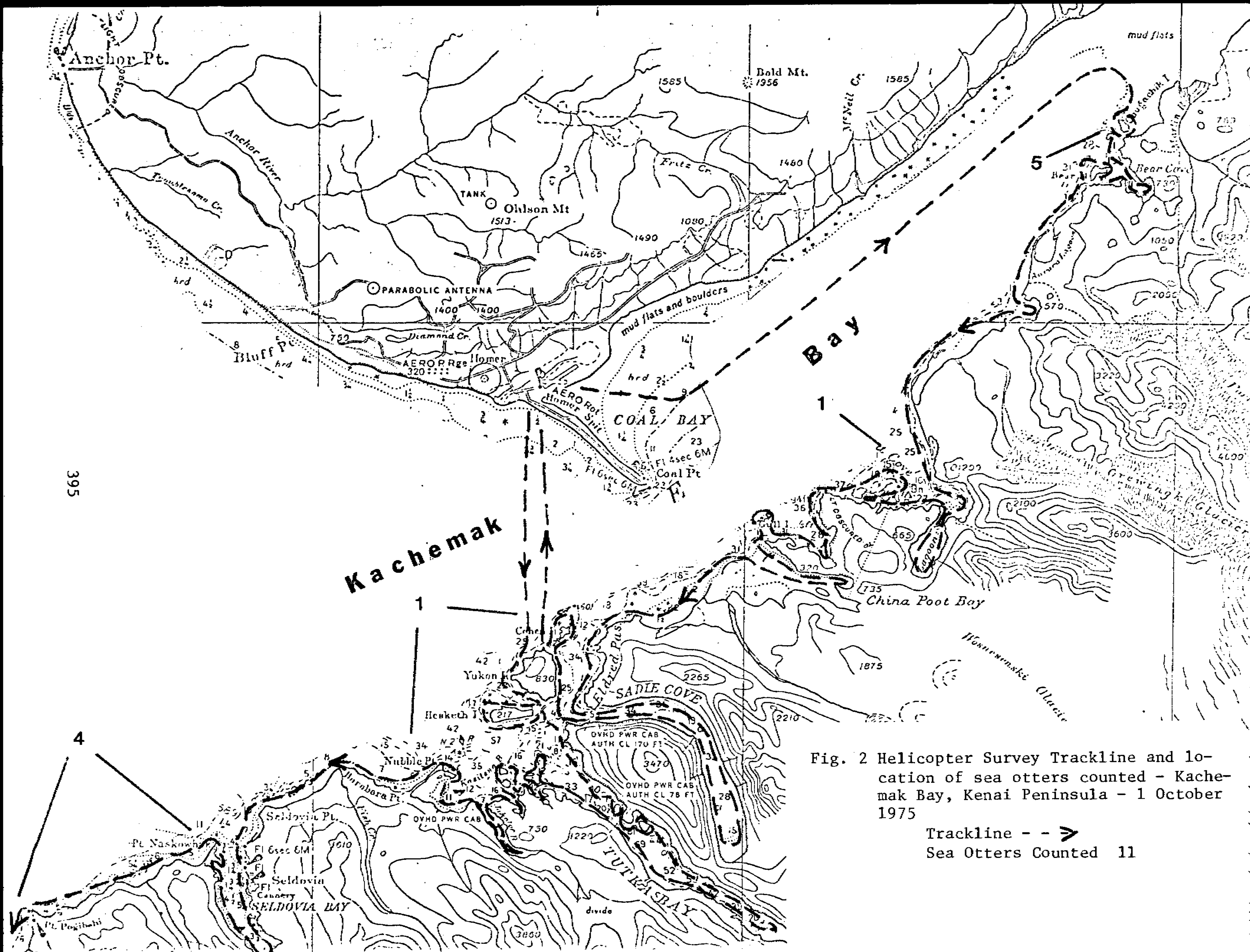
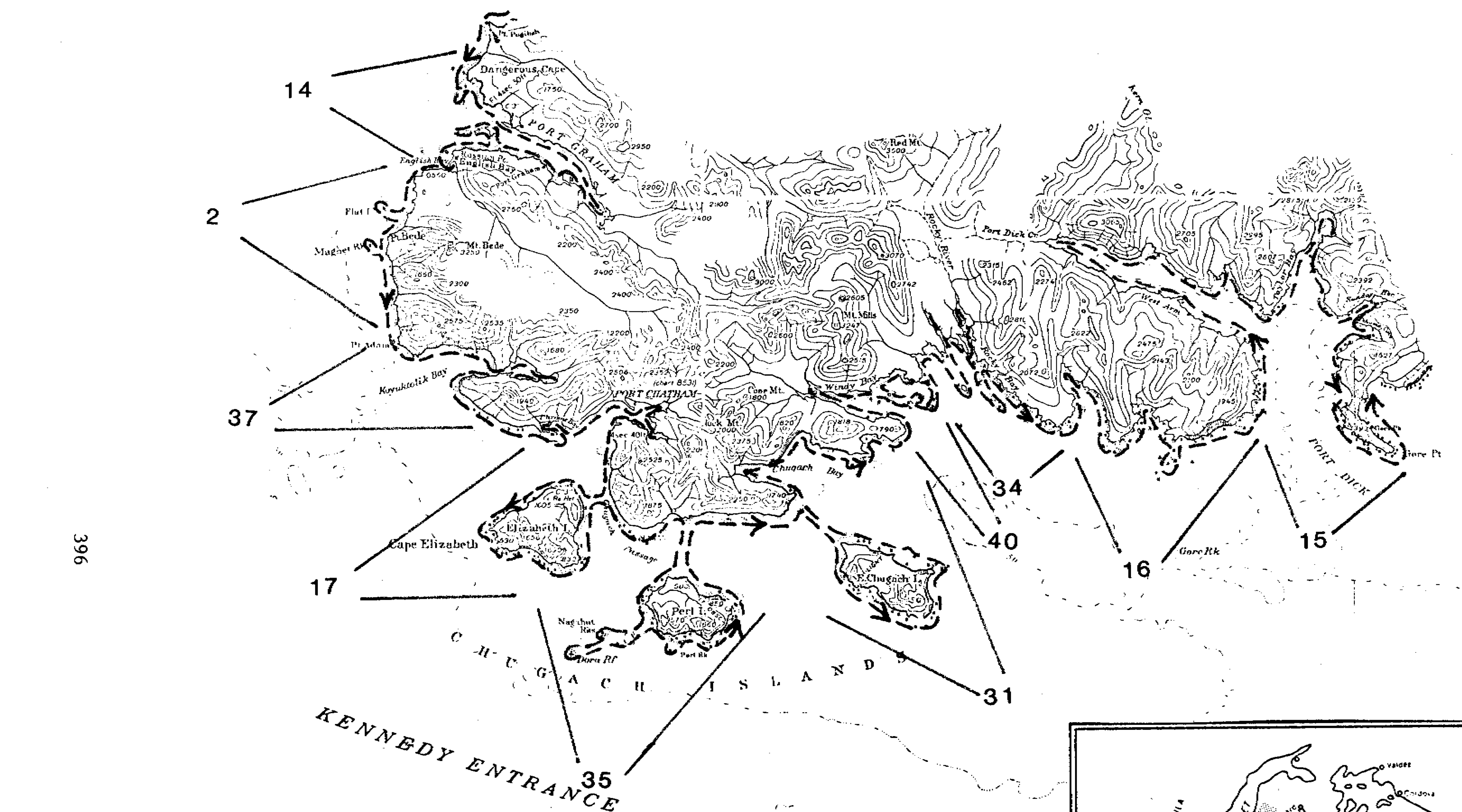


Fig. 2 Helicopter Survey Trackline and location of sea otters counted - Kachemak Bay, Kenai Peninsula - 1 October 1975

Trackline - - >

Sea Otters Counted 11



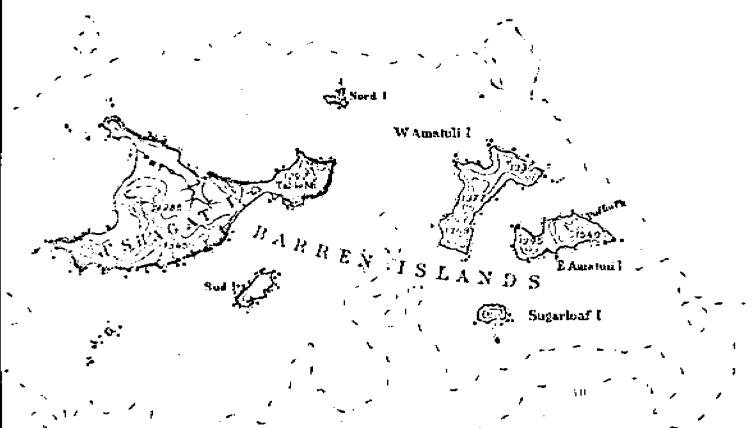
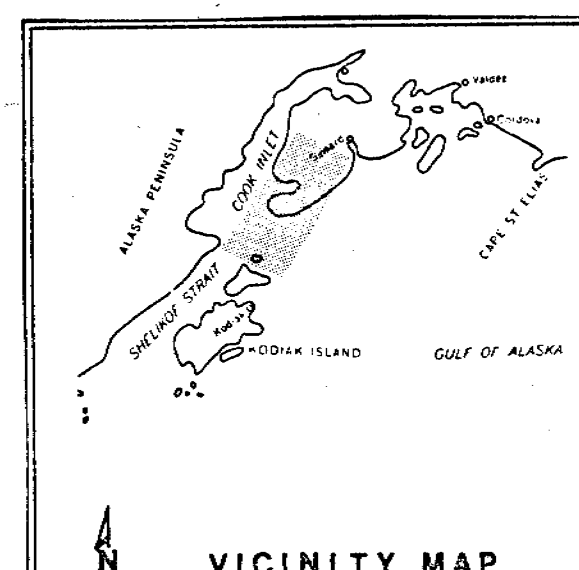
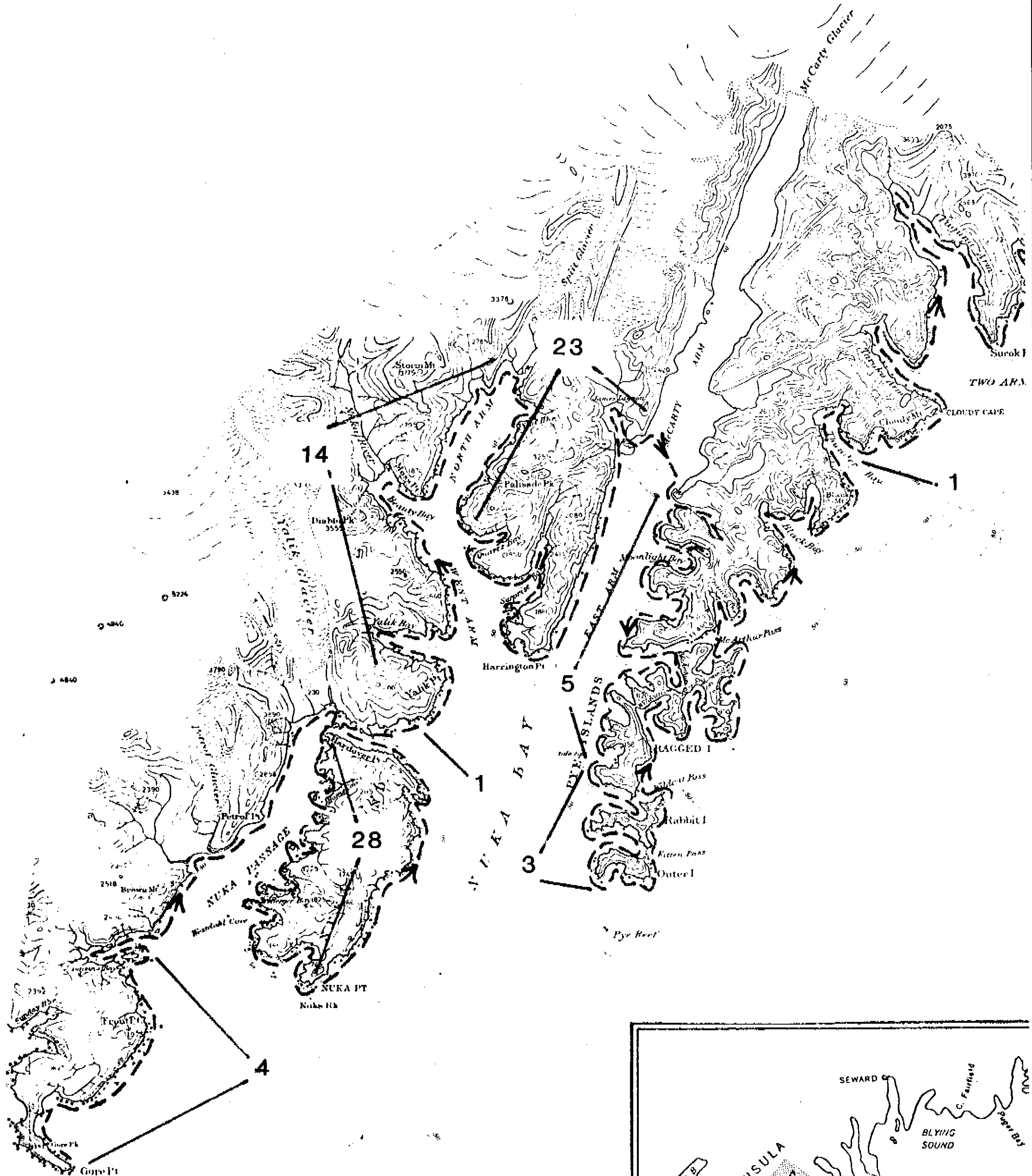


Fig. 3 Helicopter Survey Trackline and location of sea otters counted - Dangerous Cape to Gore Point, Kenai Peninsula - 1-2 October 1975.

Trackline - - >

Sea Otters Counted 241





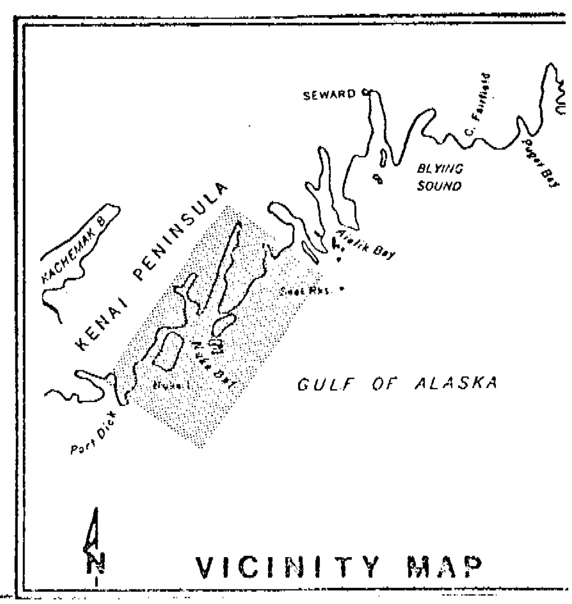
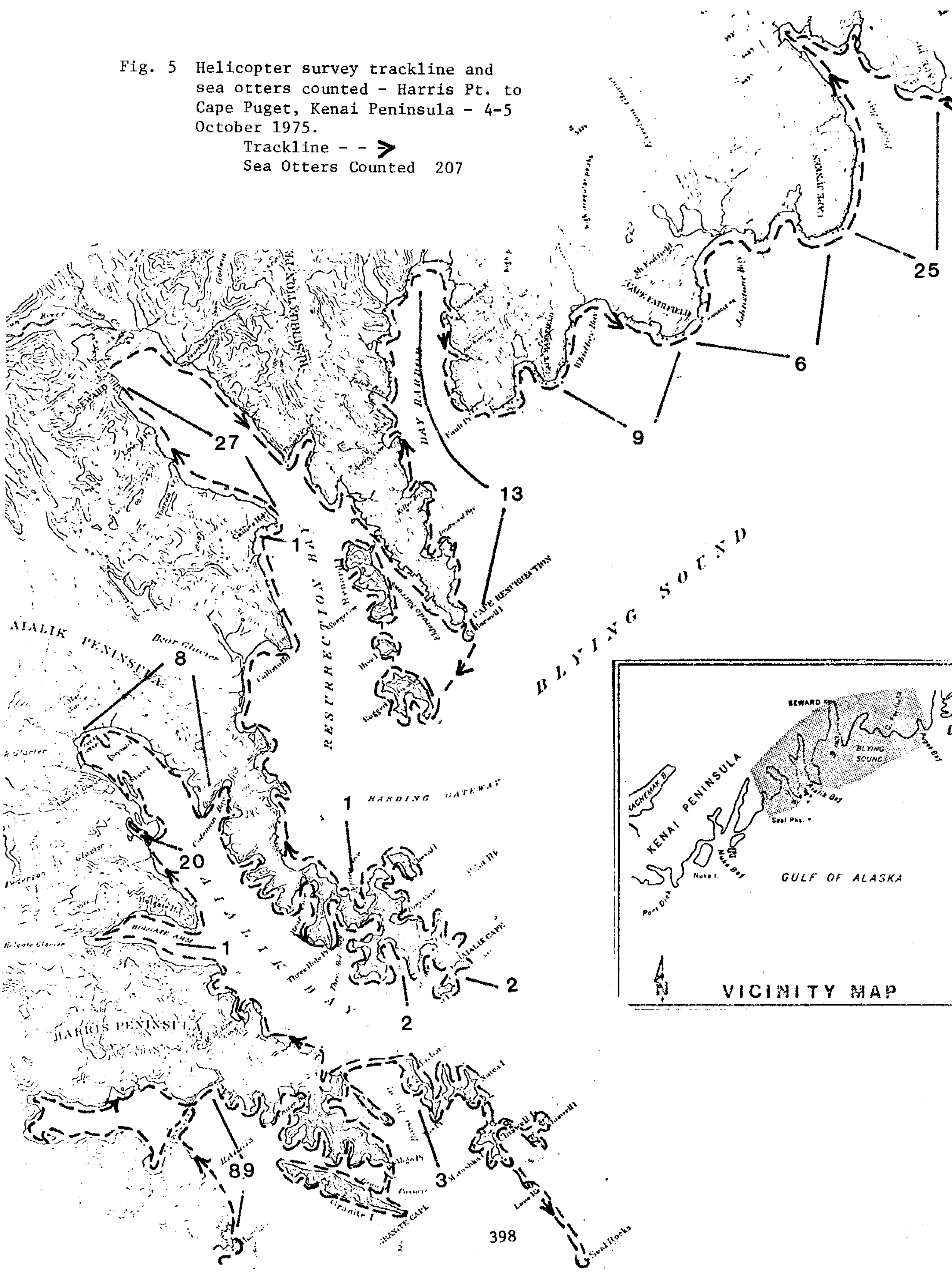


Fig. 4 Helicopter survey trackline and location of sea otters counted - Gore Pt. to Harris Pt., Kenai Peninsula - 2, 3, 4 October 1975.
Trackline - - >
Sea Otters Counted 82

Fig. 5 Helicopter survey trackline and sea otters counted - Harris Pt. to Cape Puget, Kenai Peninsula - 4-5 October 1975.

Trackline - - >

Sea Otters Counted 207



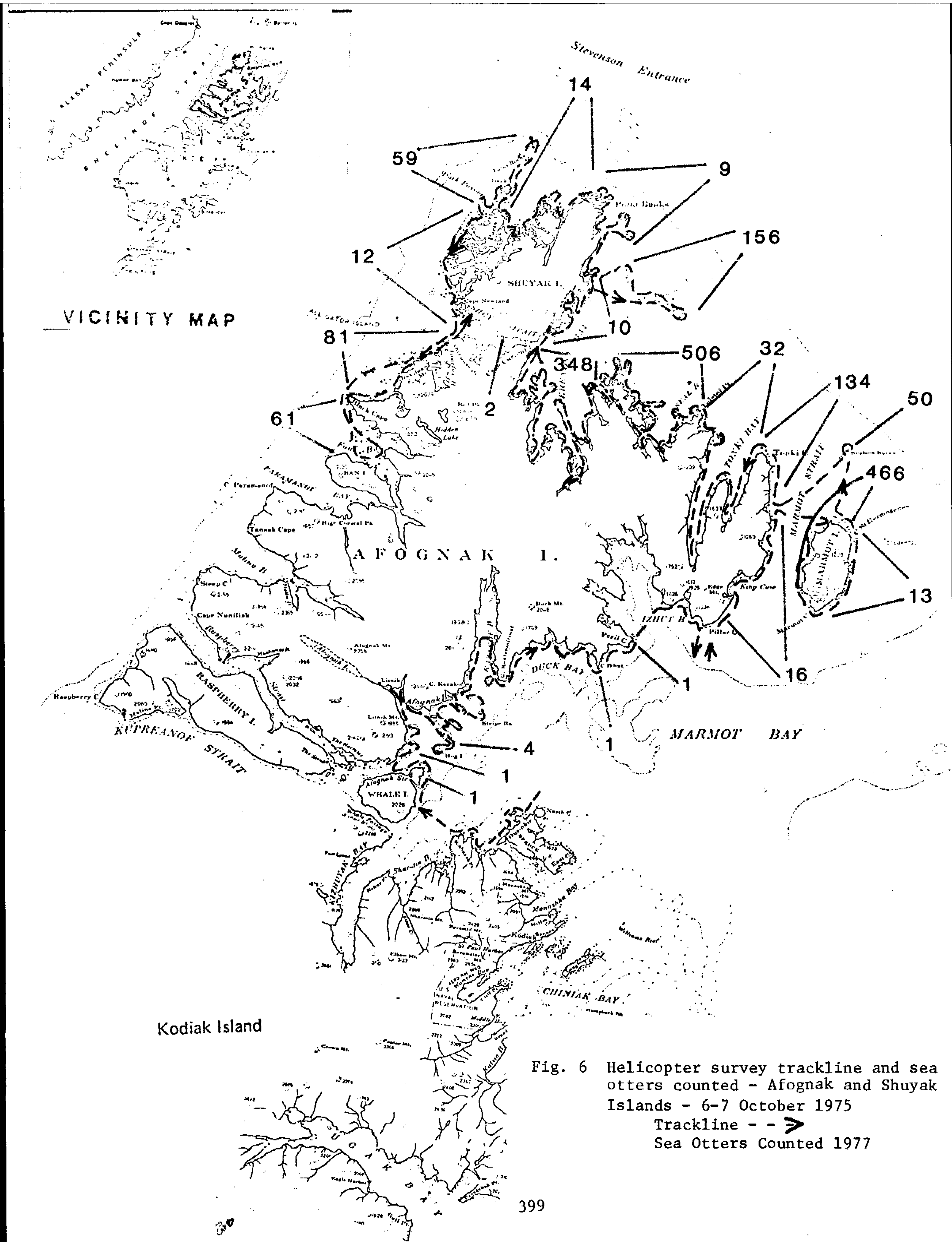


Fig. 6 Helicopter survey trackline and sea otters counted - Afognak and Shuyak Islands - 6-7 October 1975
Trackline - - >
Sea Otters Counted 1977

Table 3. Results of boat sea otter survey of portions of the Kodiak Archipelago, 3-11 February 1976.

Area	Date	Sea Otters Counted	Survey Conditions	Completeness of Coverage
Kupreanof Strait	2/3/76	1	Poor	Incomplete
Paramanof Bay	2/4/76	15	Fair	"
Foul Bay	"	60	Poor	"
Bluefox Bay	"	32	Fair	"
Shuyak Strait	"	14	"	"
Shuyak (West)	2/5/76	272	Poor	"
Uganik Passage	2/10/76	37	Excellent	"
Cape Ugat	"	1	Fair	"
Uyak Bay (East)	2/11/76	1	"	"
Uyak Bay (South)	"	0	Very Good	"
Kodiak	2/9/76	0	Fair	"

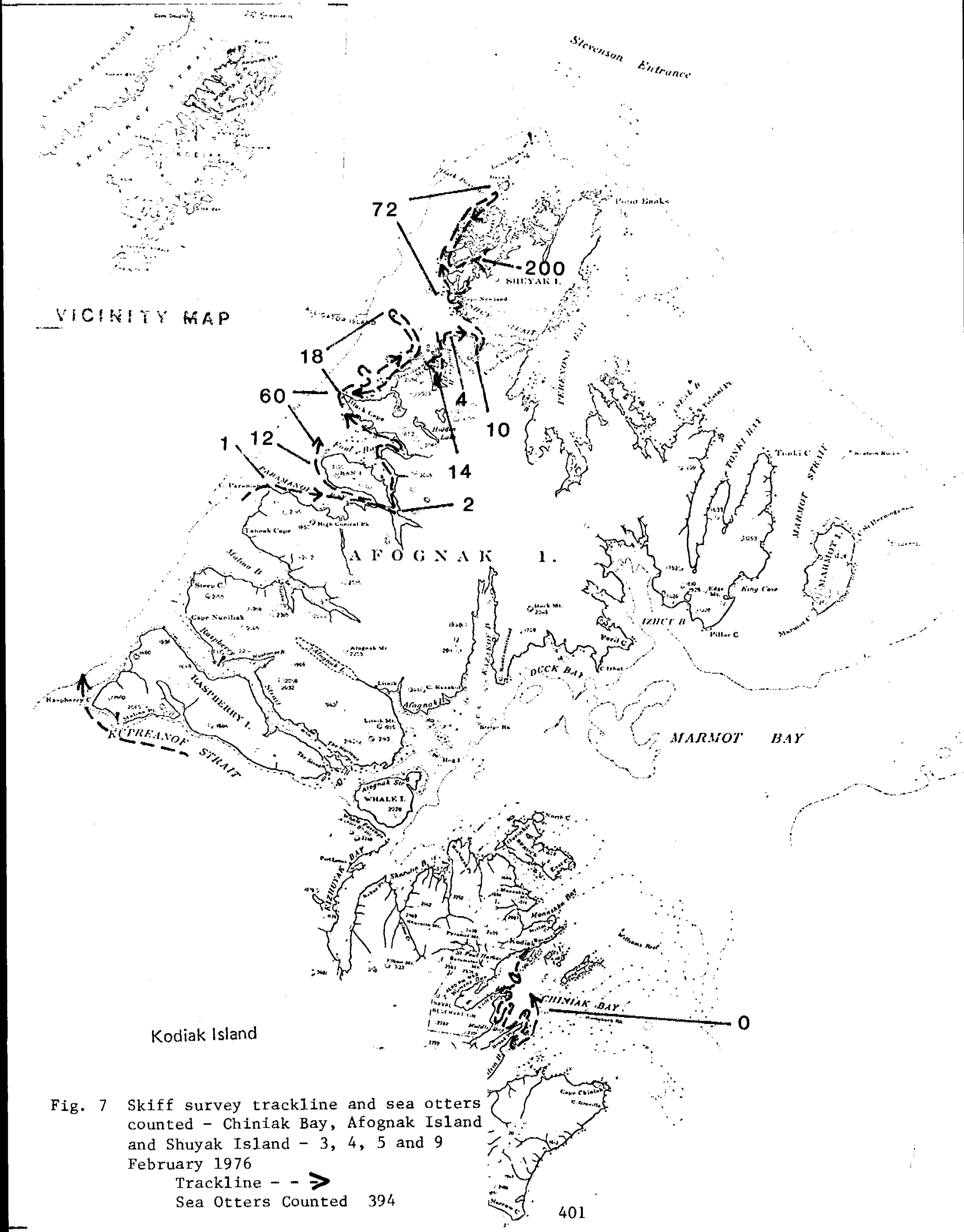


Fig. 7 Skiff survey trackline and sea otters counted - Chiniak Bay, Afognak Island and Shuyak Island - 3, 4, 5 and 9 February 1976

Trackline - - >

Sea Otters Counted 394

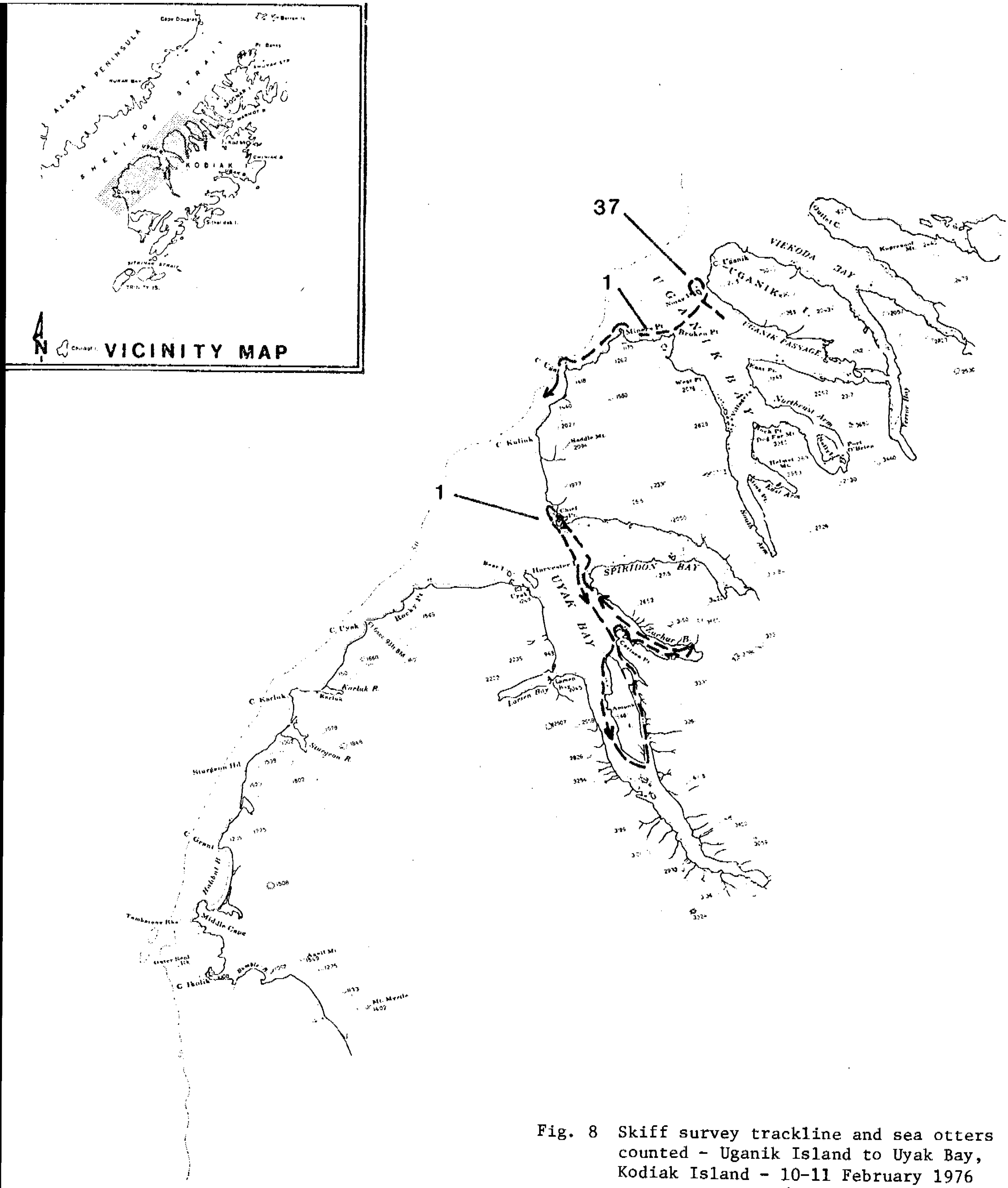


Fig. 8 Skiff survey trackline and sea otters counted - Uganik Island to Uyak Bay, Kodiak Island - 10-11 February 1976

Trackline - - >

Sea Otters Counted 39

fixed-wing survey in Table 4 and Figs. 9-13, the April aerial strip survey in Table 5 and Figs. 14-15, the May fixed-wing survey in Table 6 and Fig. 16 and the June fixed-wing survey in Table 7 and Figs. 17-21. Survey tracklines are shown in Figs. 1-21. Counts presented in Tables 2-4 and 6-7 are grouped into standardized count areas to facilitate comparison.

Sea otter observations made by personnel conducting three aerial surveys of birds under RU #3/4 are presented in Figs. 22-28. All three surveys include the area within 400 m of shore along the entire shoreline from Gore Point to the East Foreland. Sea otters offshore were not counted and at times otters inside the survey strip were ignored if many birds were present.

Sightings made in various parts of the Kodiak Archipelago from helicopters and boats by personnel working on RU #229 and 243 in October and November 1976 are presented in Figs. 29-32. These observations often were made under poor conditions and reflect only the presence or absence of sea otters close to shore.

Recent significant sightings from other sources are presented in Table 8.

VII. Discussion

The effectiveness of surveys of the type used in this project can be highly variable. The results should be interpreted carefully with consideration of the survey conditions and the completeness of coverage.

Table 4. Sea Otter sightings made during aerial survey of sea lions around the Kodiak Archipelago, 13-14 March 1976.

Area	Date	Sea Otters Counted	Survey Conditions	Completeness of Coverage
Kodiak Archipelago				
Izhut Bay (East)	3/13/76	0	Fair	Incomplete
Duck Bay	"	6	"	"
Cape Chiniak	"	0	"	"
Kodiak	"	0	"	"
Sequel Pt.	"	1	Good	"
Ugak I.	"	0	Poor	"
Ugak Bay	"	0	"	"
Dangerous Cape	"	0	"	"
Sitkalidak I. (South)	"	0	"	"
Twoheaded I.	"	0	"	"
Aiaktalik I.	"	0	"	"
Sitkinak I. (South)	"	1	Fair	"
Tugidak I. (South)	"	21	Good	"
Tugidak-Chirikof	"	1	"	"
Chirikof	"	10	Very Good	"
Tugidak I. (North)	"	1	Fair	"
Alitak Bay	"	0	"	"
Ayakulik	"	0	"	"
Halibut Bay	3/14/76	1	Good	Complete
Karluk	"	0	"	"
Rocky Point	"	0	"	"
Uyak Bay (West)	"	5	Very Good	Incomplete
Cape Ugat	"	0	Fair	Complete
Uganik Passage	"	12	Poor	Incomplete
Viekoda Bay	"	1	Very Good	Incomplete
Kupreanof Strait	"	20	Good	"
Raspberry Strait	"	20	"	"
Malina Bay	"	31	Fair	"

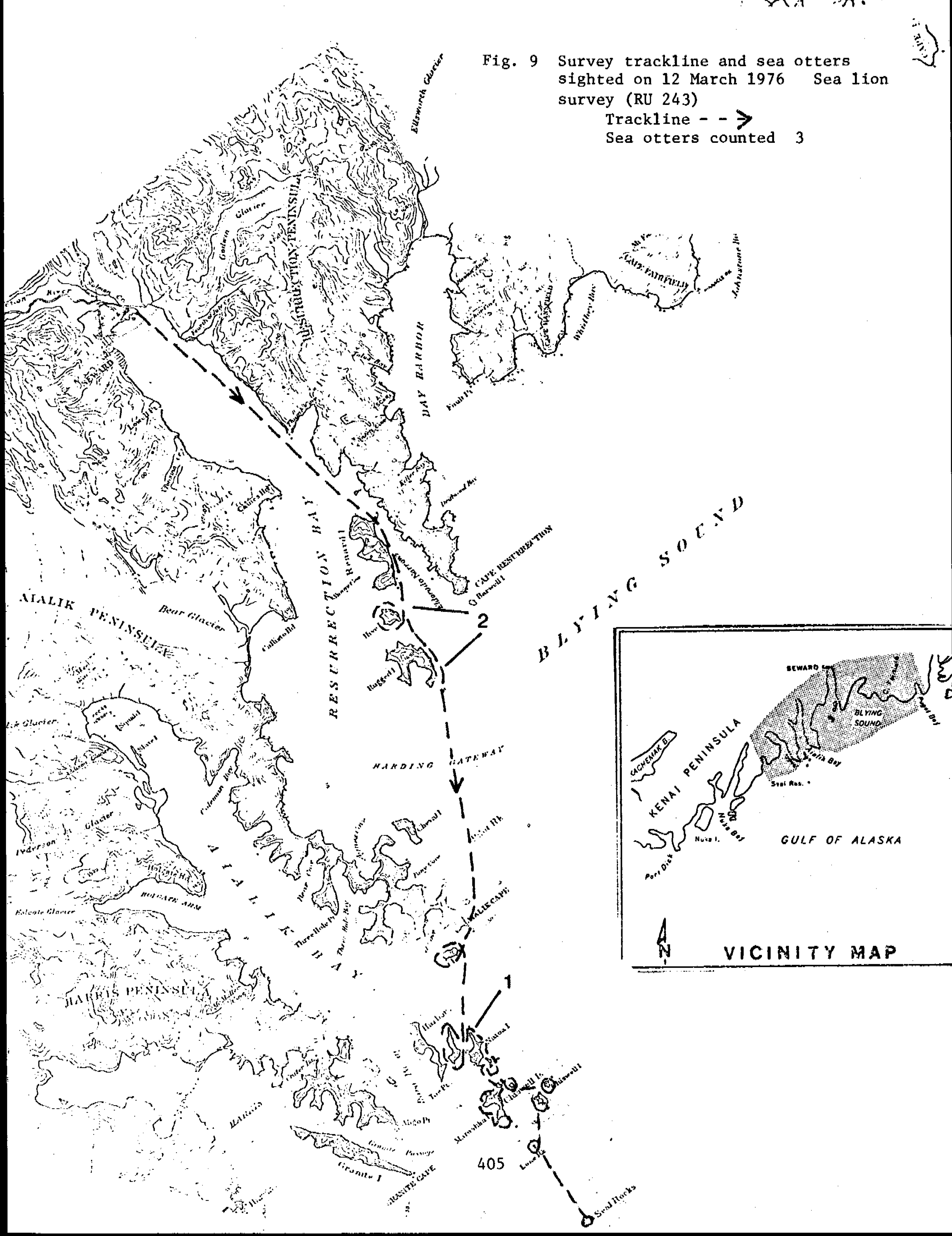


Fig. 9 Survey trackline and sea otters sighted on 12 March 1976 Sea lion survey (RU 243)
Trackline - - >
Sea otters counted 3

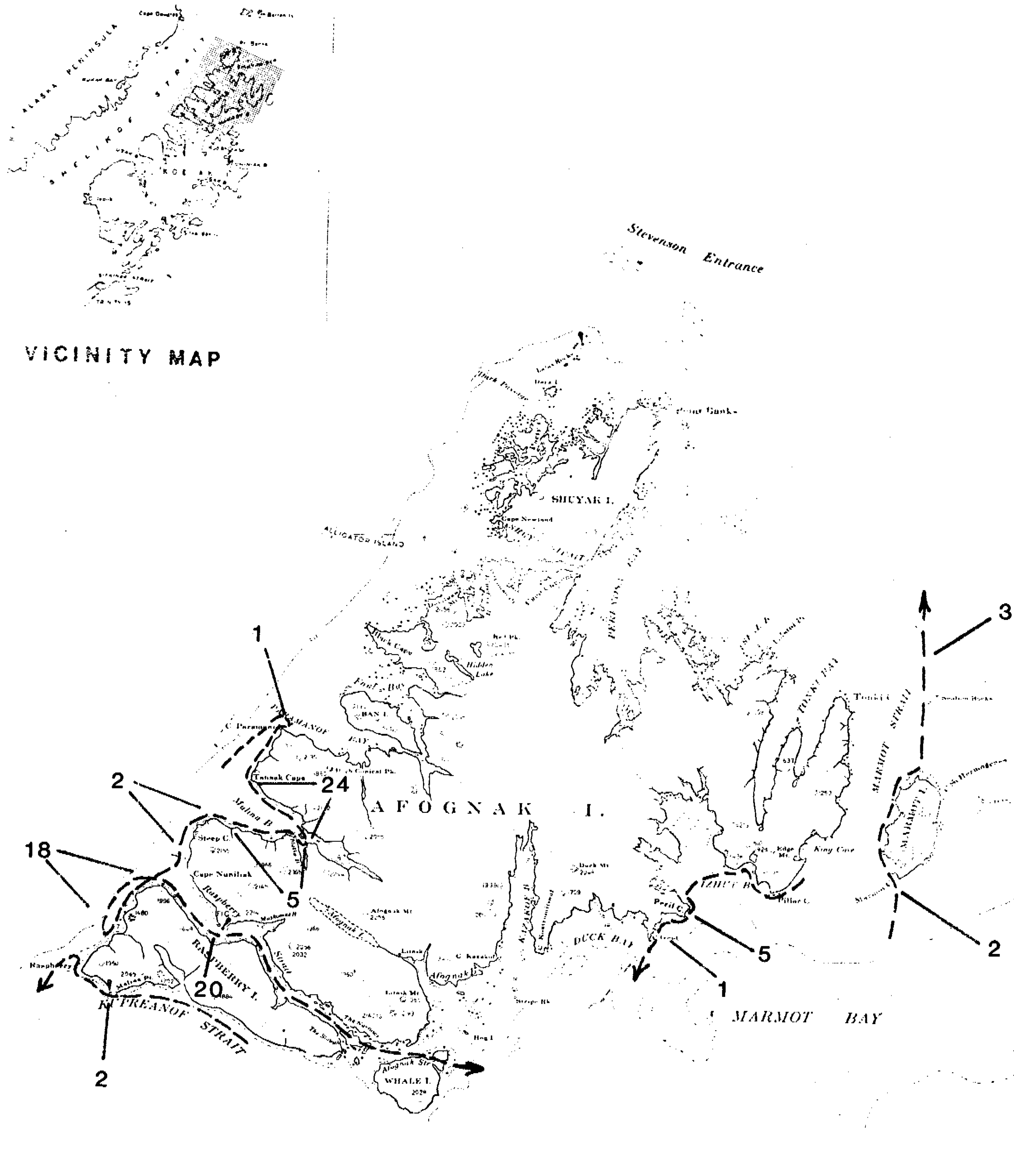


Fig. 10 Survey trackline and sea otters sighted on 13-14 March 1976 Sea lion survey (RU 243)
Trackline - - >
Sea otters counted 83

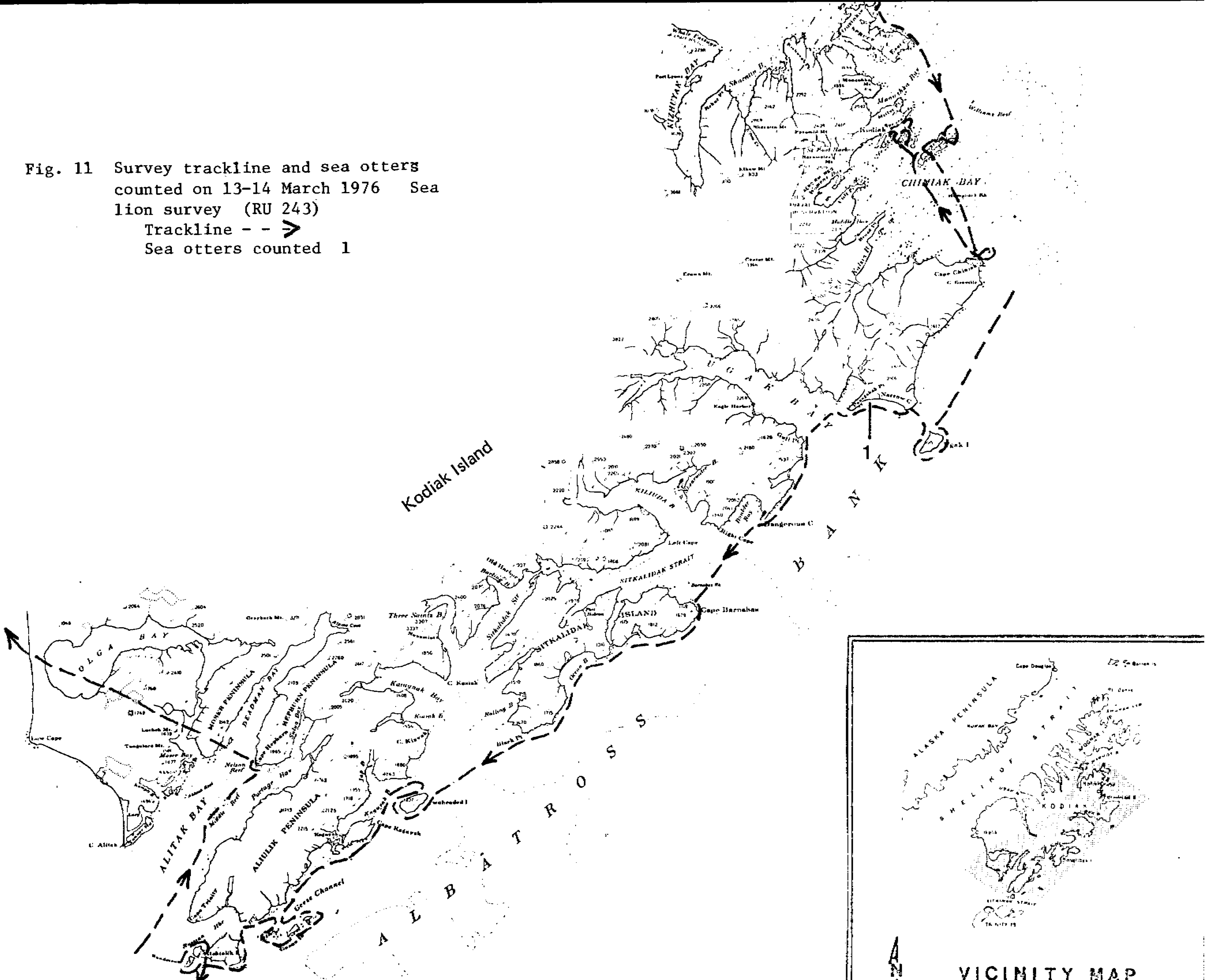
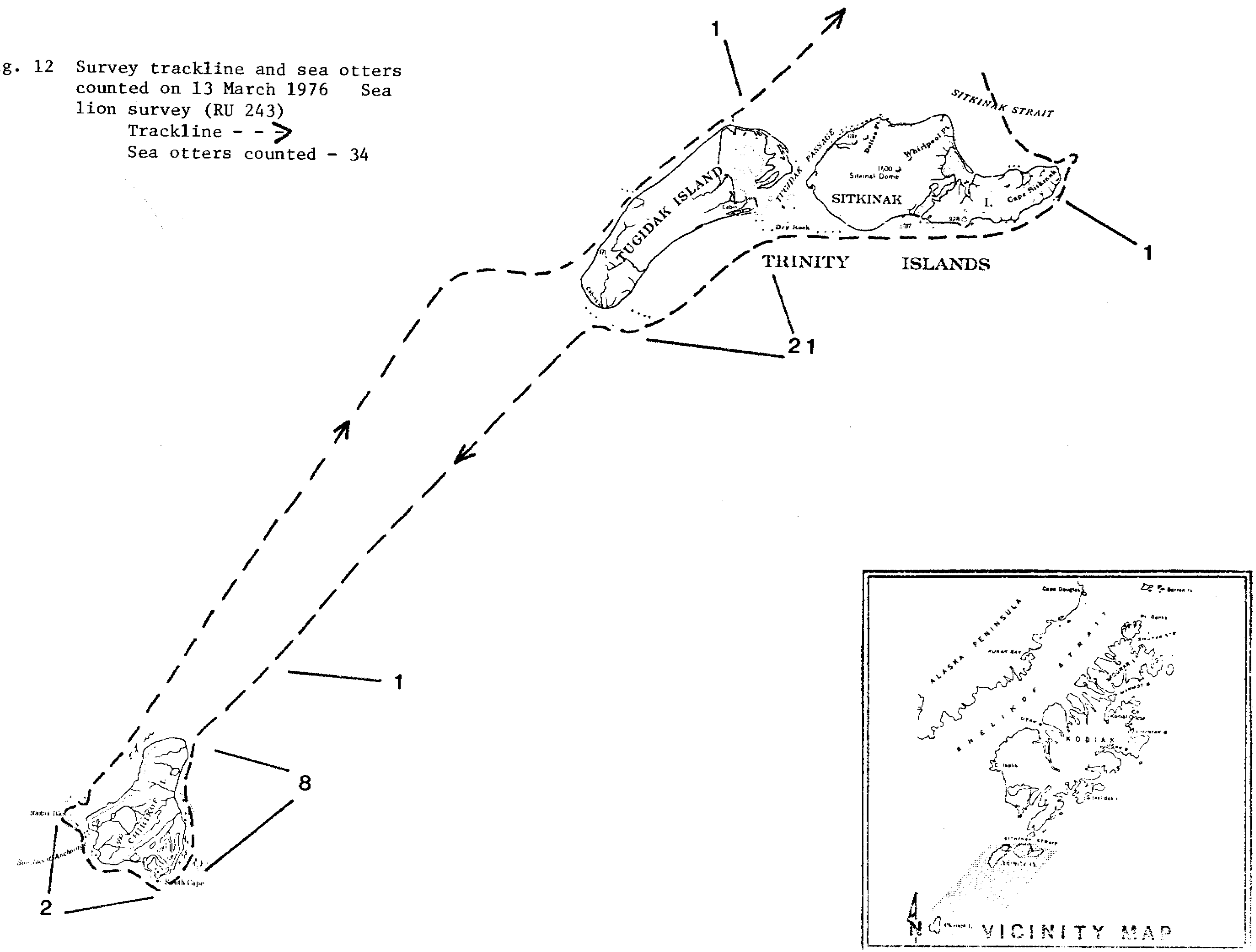


Fig. 11 Survey trackline and sea otters counted on 13-14 March 1976 Sea lion survey (RU 243)
Trackline - - >
Sea otters counted 1

Fig. 12 Survey trackline and sea otters counted on 13 March 1976 Sea lion survey (RU 243)
Trackline - - >
Sea otters counted - 34



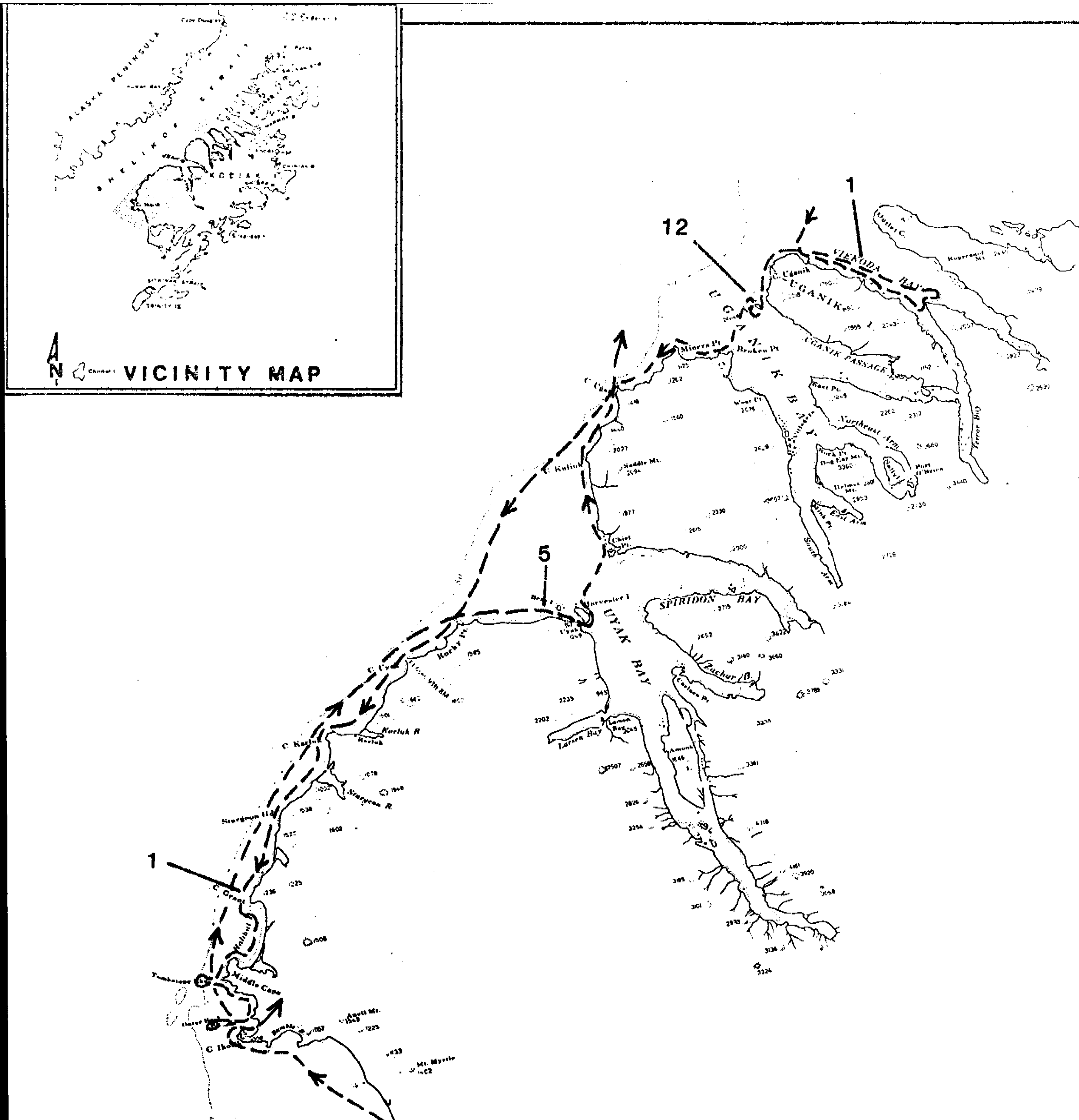


Fig. 13 Survey trackline and sea otters counted on 13-14 March 1976 Sea lion survey (RU 243)
Trackline - - >
Sea otters counted 19

Table 5. Sea otter sightings made on unlimited-width strip transect survey in Kamishak Bay and Kachemak Bay, 1 April 1976.

Kamishak Bay

Tracklines - Even minutes of latitude extending from the shore of Kamishak Bay to;

153° 00' W Long between 59° 36' N Lat and 59° 20' N Lat
153° 10' " " " 59° 18' " " 59° 08' " "
153° 15' " " " 59° 06' " " " 59° 04' " "

and shoreline from Shaw I. to C. Douglas

Sighting Latitude	Sighting Longitude	Number of Sea Otters Sighted	Survey Conditions
59°32' N	153°22' W	1	Very Good
59 32	153 26	1	"
59 26	153 40	1	"
59 26	153 39	4	"
59 26	153 37	2	"
59 26	153 29	1	"
59 26	153 28	34	"
59 22	153 57	1	"
59 22	154 00	4	"
59 21	153 56	1	"
59 21	153 54	2	"
59 21	153 52	1	"
59 21	153 50	1	"
59 22	153 45	1	"
59 23	153 22	1	"
59 19	153 29	1	"
59 19	153 28	1	"
59 20	153 34	2	"
59 20	154 00	1	"
59 18	154 02	1	"
59 16	154 03	1	"
59 16	154 04	1	Good
59 12	153 57	1	"
59 12	154 04	1	"
59 12	154 07	2	"
58 54	153 18	1	"
58 52	153 18	3	"
58 50	153 19	1	"

Table 5 (Cont.) Sea otter sightings made on unlimited-width strip transect survey in Kamishak Bay and Kachemak Bay, 1 April 1976.

Kachemak Bay

Tracklines - Even minutes of latitude extending from the shore of The Kenai Peninsula to 152° 10' W Long between 59° 34' N. Lat and 59° 48' N Lat.

Sighting Latitude	Sighting Longitude	Number of Sea Otters Sighted	Survey Conditions
59°34' N	151°30' W	1	Very Good
59 34	151 33	1	"
59 34	152 03	4	"
59 34	152 05	1	"
59 36	151 59	1	"
59 36	151 45	1	"
59 36	151 34	1	"
59 38	151 51	1	"
59 38	151 54	1	"
59 38	151 56	1	"
59 38	151 57	1	"
59 38	152 02	1	"
59 38	152 06	1	"
59 40	152 04	1	"
59 40	151 57	1	"
59 40	151 55	2	"
59 40	151 52	5	"
59 40	151 48	2	"
59 40	151 47	2	"
59 42	151 50	4	"
59 42	151 45	1	"
59 42	151 58	3	"
59 42	151 59	2	"
59 42	152 01	1	"
59 44	152 06	2	"
59 44	152 03	1	"
59 46	152 06	3	"
59 48	152 06	1	"
59 48	151 59	1	"
59 48	151 58	1	"

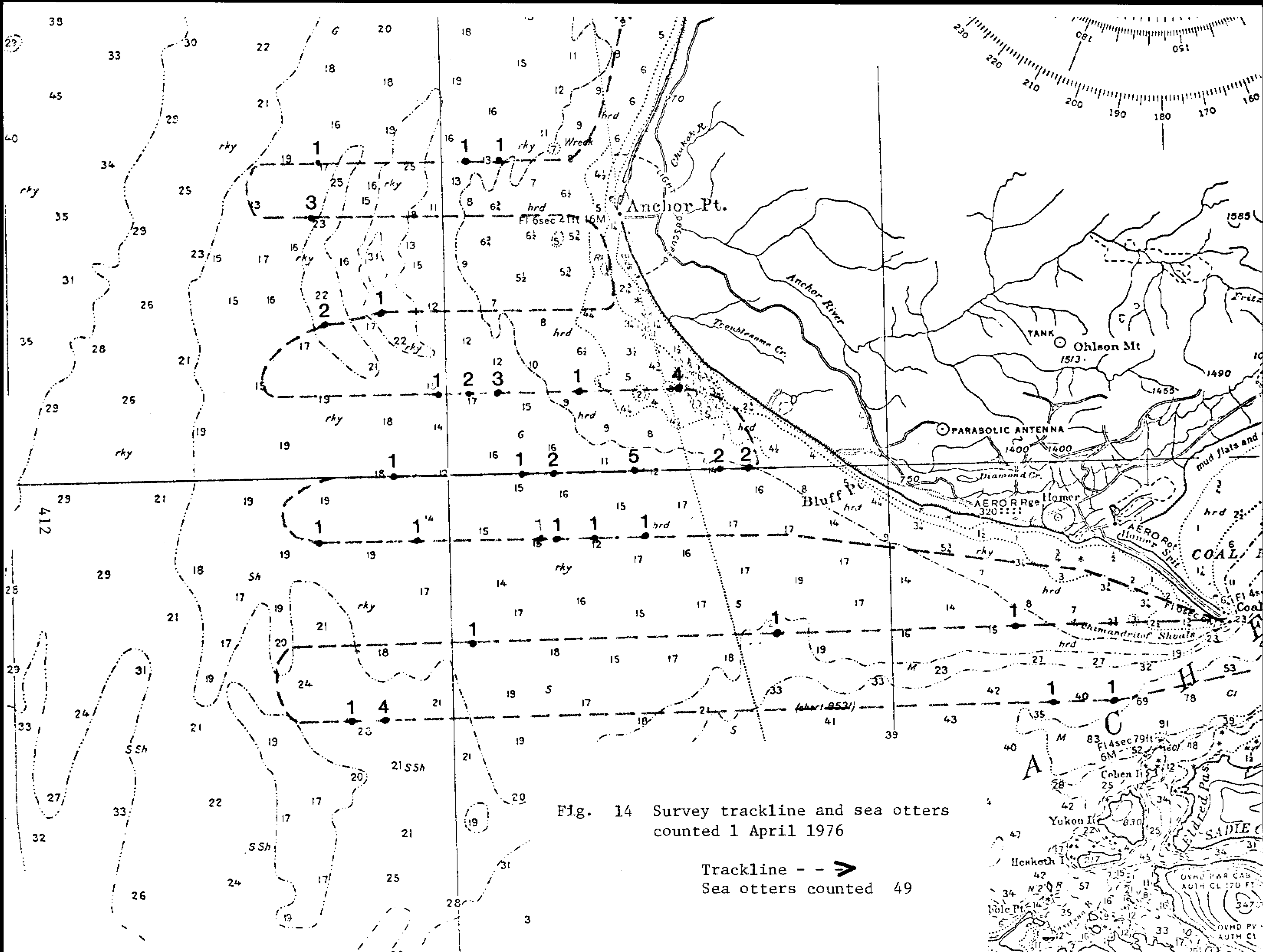


Fig. 14 Survey trackline and sea otters counted 1 April 1976

Trackline - - >
Sea otters counted 49

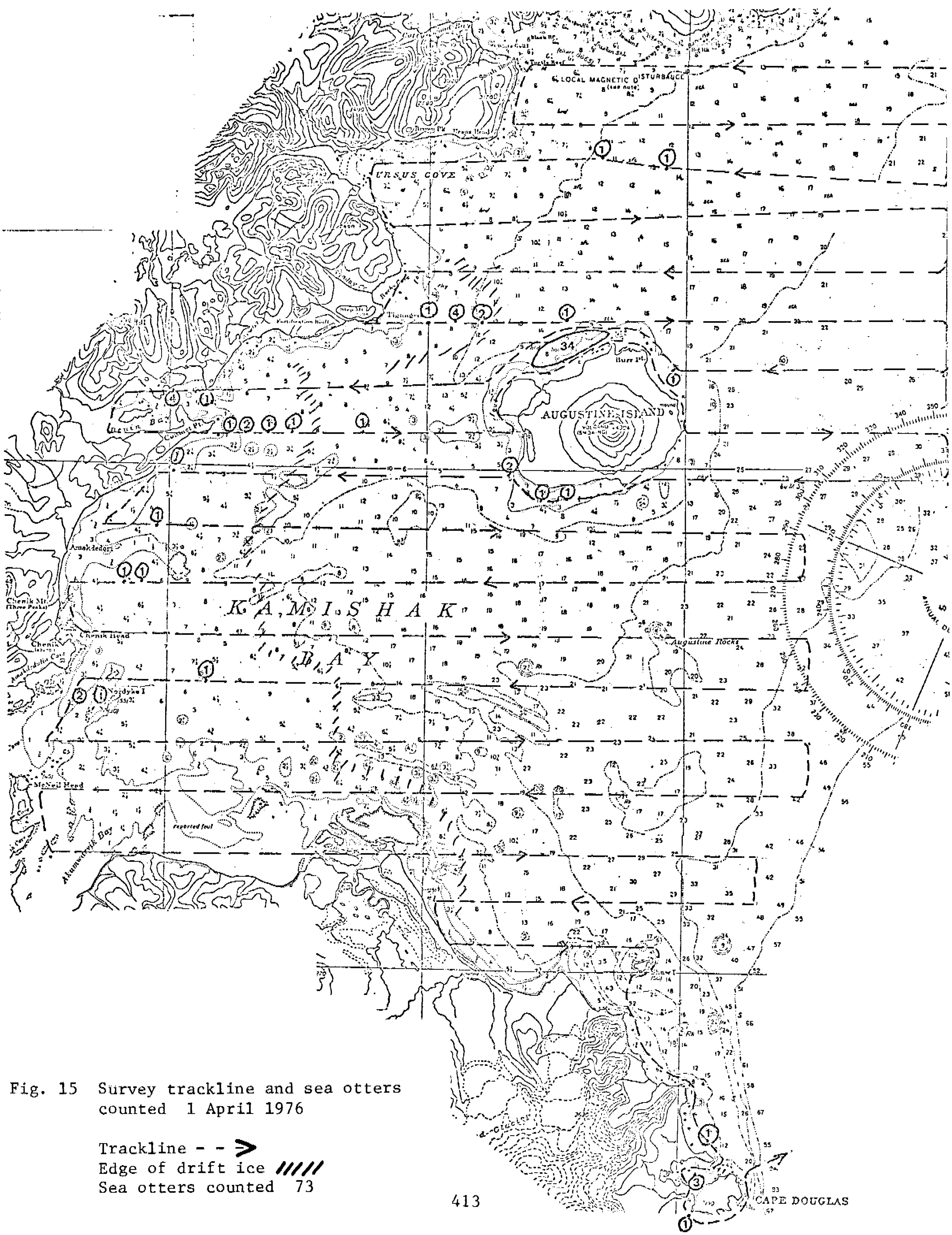


Fig. 15 Survey trackline and sea otters counted 1 April 1976

Trackline - - >
Edge of drift ice /////
Sea otters counted 73

Table 6. Sea otter sightings made during aerial survey of sea lions around the Barren Islands, 20 May 1976.

Area	Date	Sea Otters Counted	Survey Conditions	Completeness of Coverage
West Amatuli I.	5/20/76	8	Poor	Incomplete
N. side Ushagat I.	"	10	"	"
S. side Ushagat I.	"	40	"	"
Sud I.	"	33	"	"
Carl I.	"	60	"	"

Table 7. Sea otter sightings made during aerial survey of sea lions around the Kodiak Archipelago including the Barren Islands, 10 June 1976.

Area	Date	Sea Otters Counted	Survey Conditions	Completeness of Coverage
Kodiak Island				
Low Cape	6/10/76	2	Fair	Incomplete
Kodiak	"	1	Excellent	"
Barren Islands				
Sugarloaf Island	"	1	Fair	Complete
E Amatuli I.	"	0	"	"
W. Amatuli I.	"	2	"	"
Nord I.	"	0	"	"
N. side Ushagat I.	"	8	"	"
S. side Ushagat I.	"	35	"	"
Sud I.	"	15	"	"
Carl I.	"	50	"	Incomplete

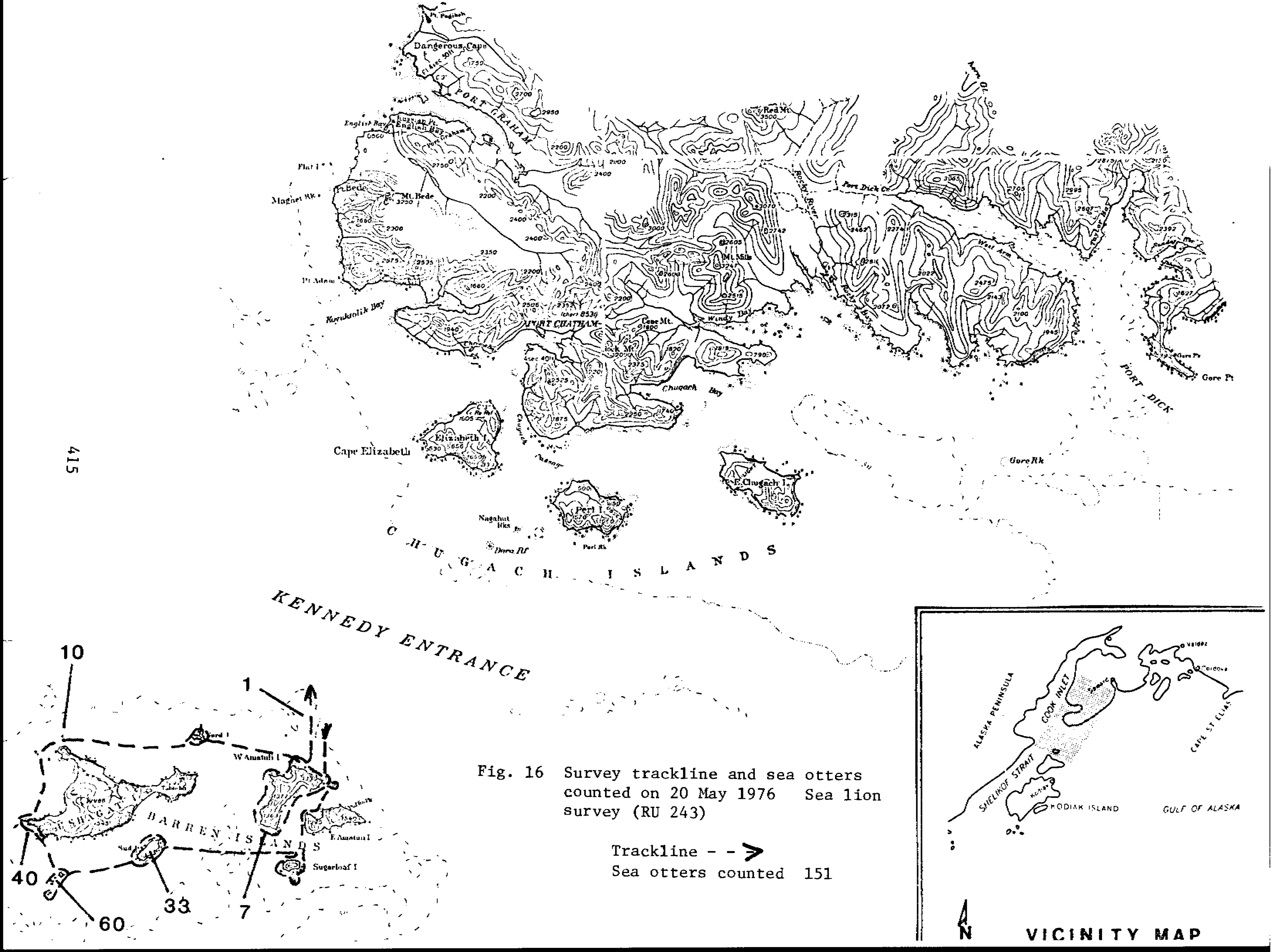


Fig. 16 Survey trackline and sea otters counted on 20 May 1976 Sea lion survey (RU 243)

Trackline - - >
Sea otters counted 151

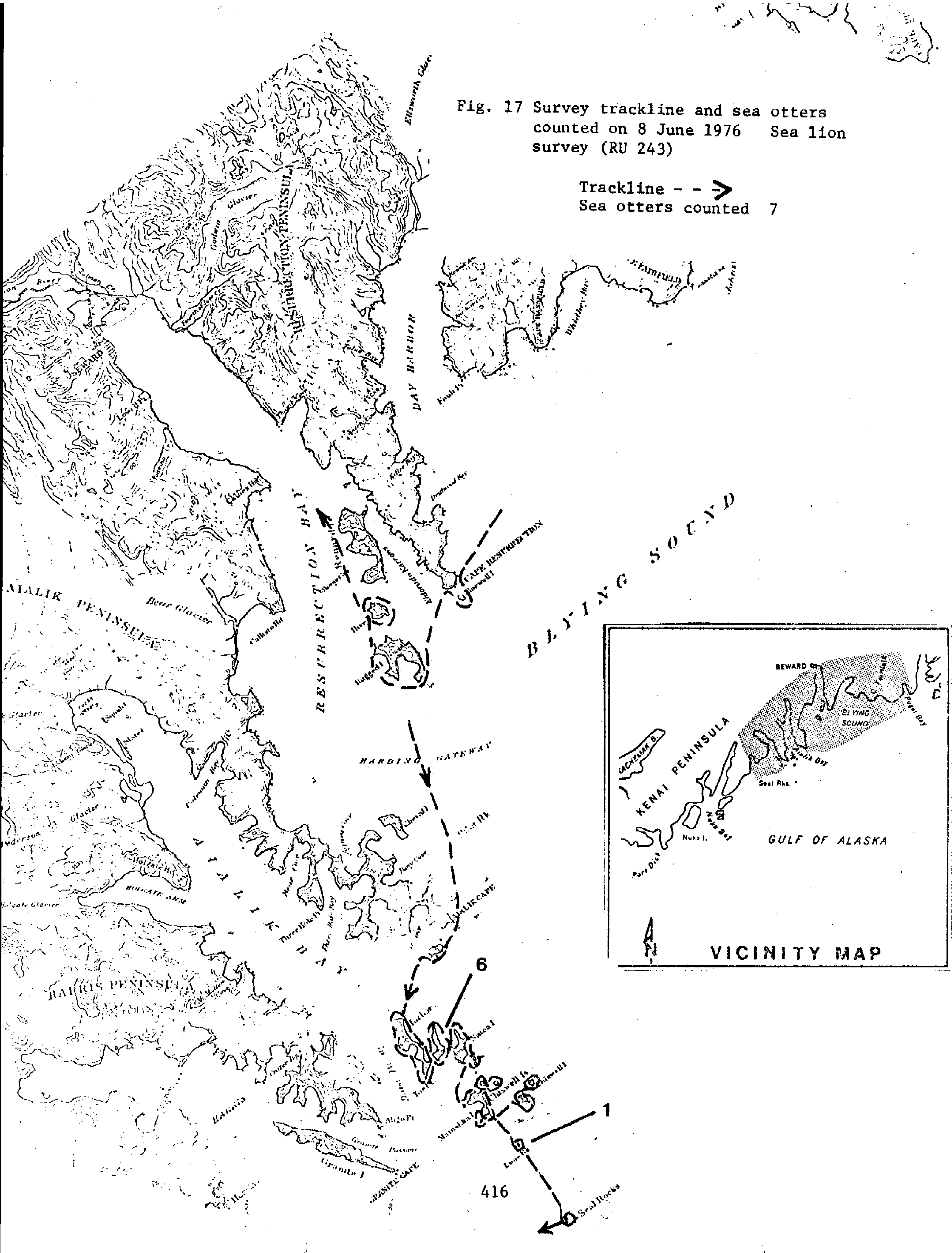


Fig. 17 Survey trackline and sea otters counted on 8 June 1976 Sea lion survey (RU 243)

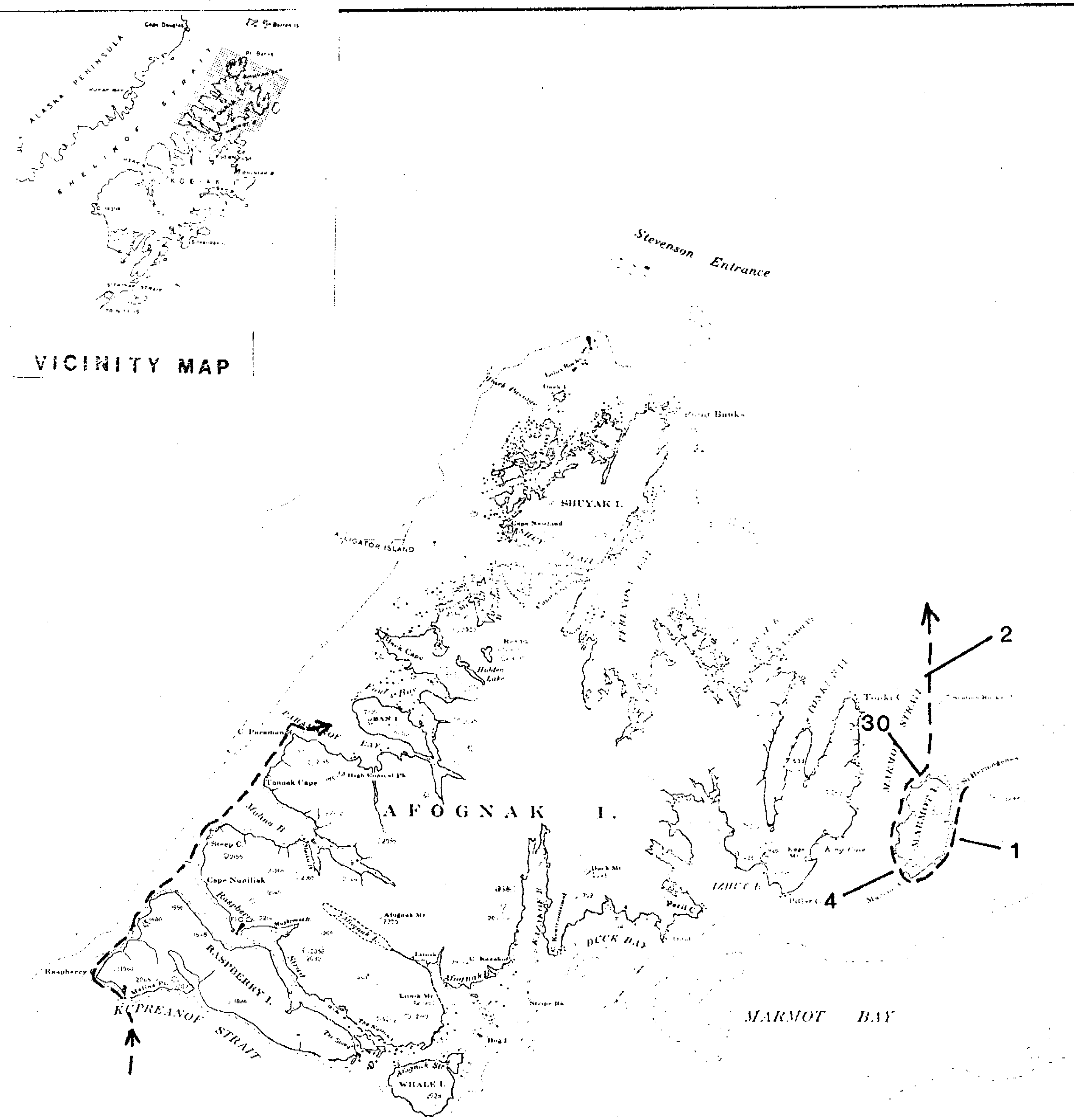


Fig. 18 Survey trackline and sea otters counted on 8 and 10 June 1976 sea lion survey (RU 243)

Trackline - - >
Sea otters counted 37

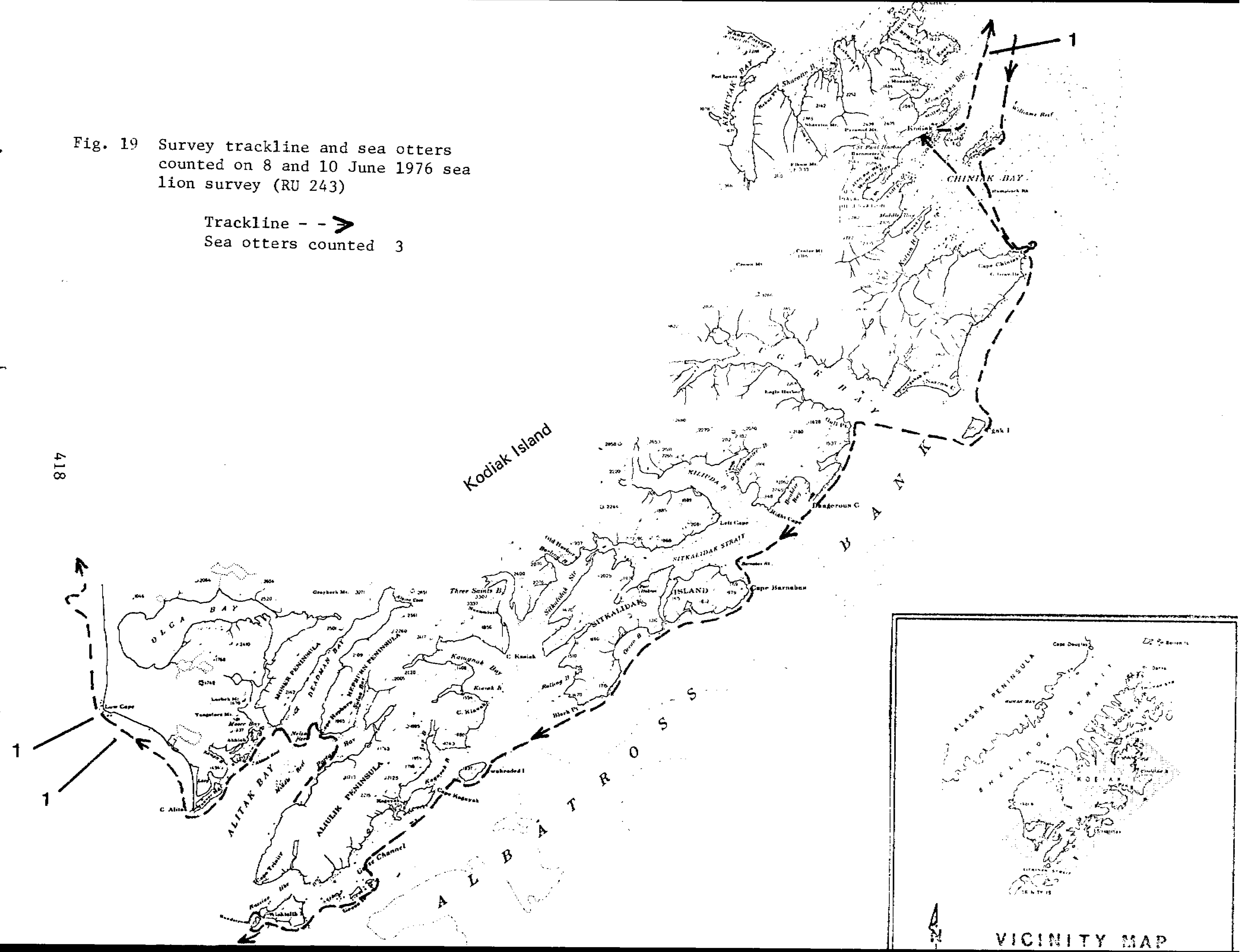


Fig. 19 Survey trackline and sea otters counted on 8 and 10 June 1976 sea lion survey (RU 243)

Trackline - - >
Sea otters counted 3

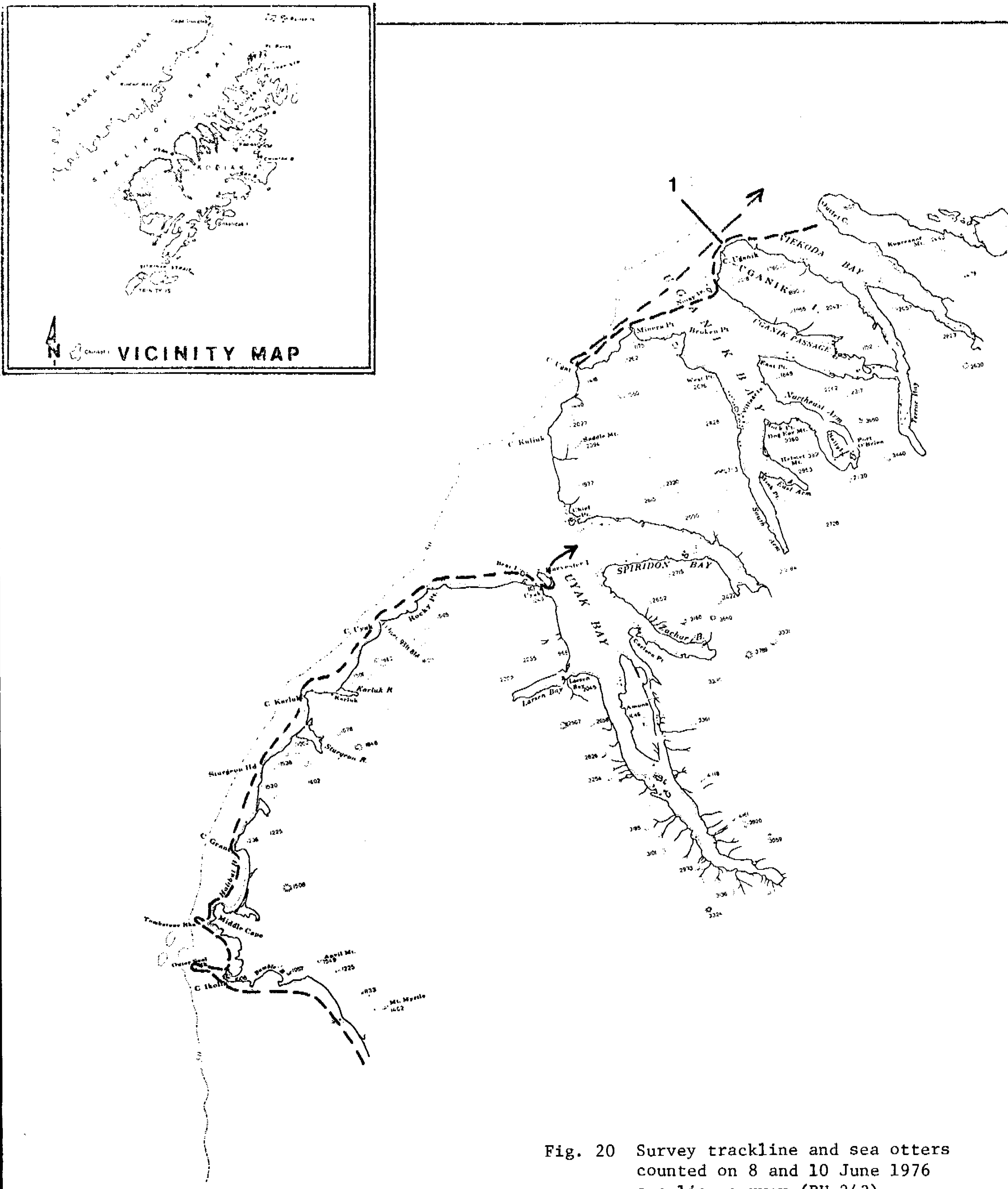


Fig. 20 Survey trackline and sea otters counted on 8 and 10 June 1976 sea lion survey (RU 243)

Trackline - - >
Sea otters counted 1

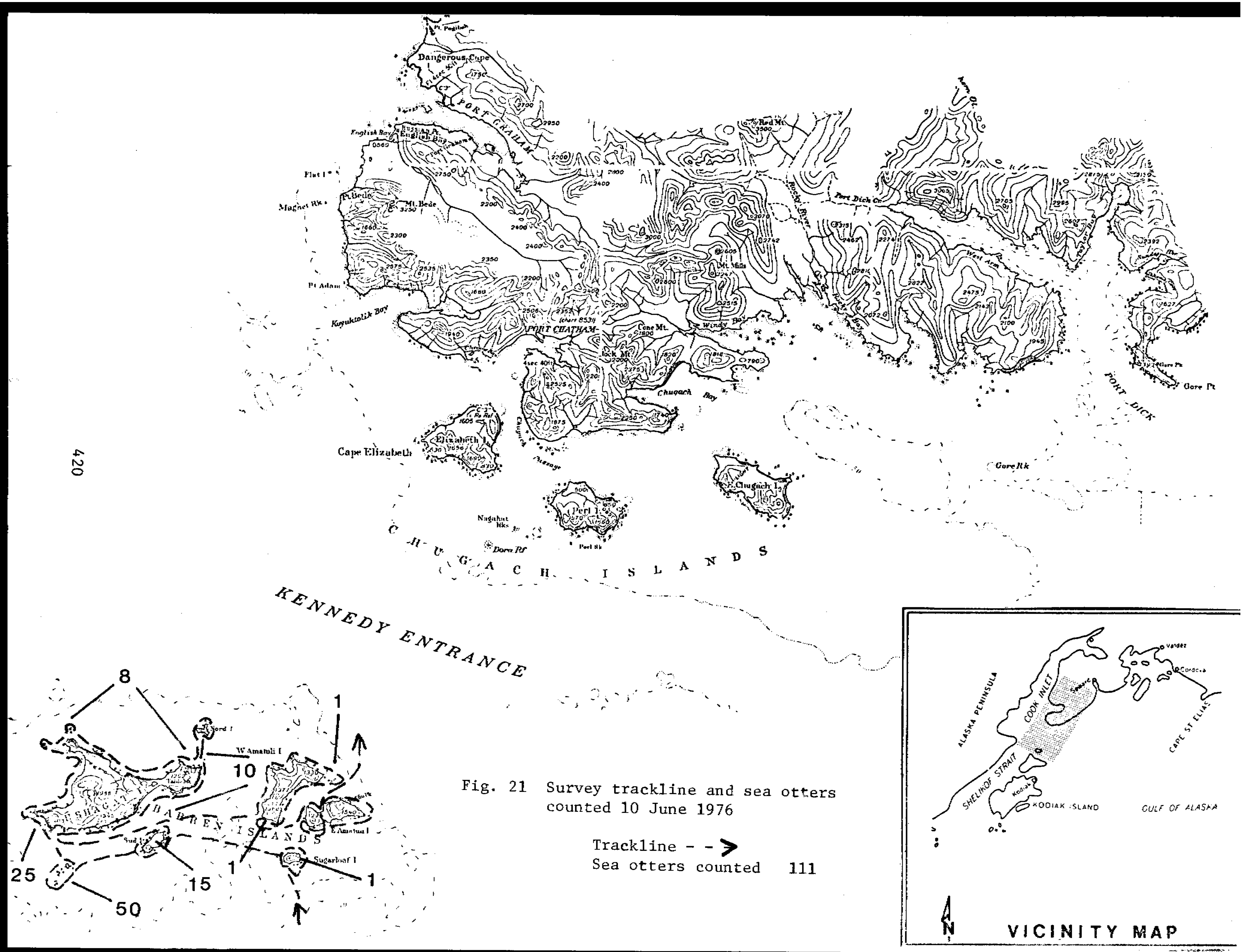


Fig. 21 Survey trackline and sea otters counted 10 June 1976

Trackline - - >
Sea otters counted 111

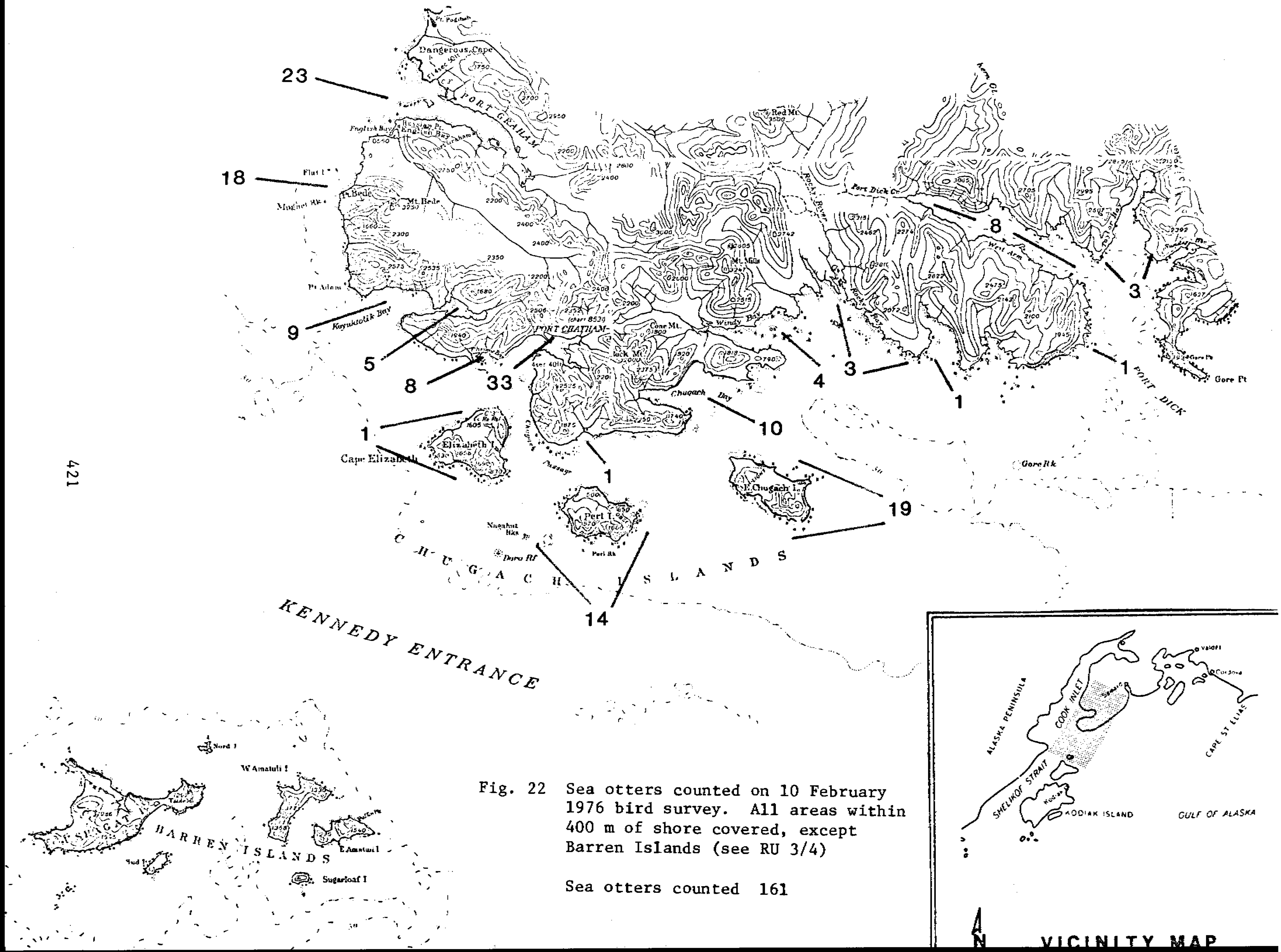


Fig. 22 Sea otters counted on 10 February 1976 bird survey. All areas within 400 m of shore covered, except Barren Islands (see RU 3/4)

Sea otters counted 161

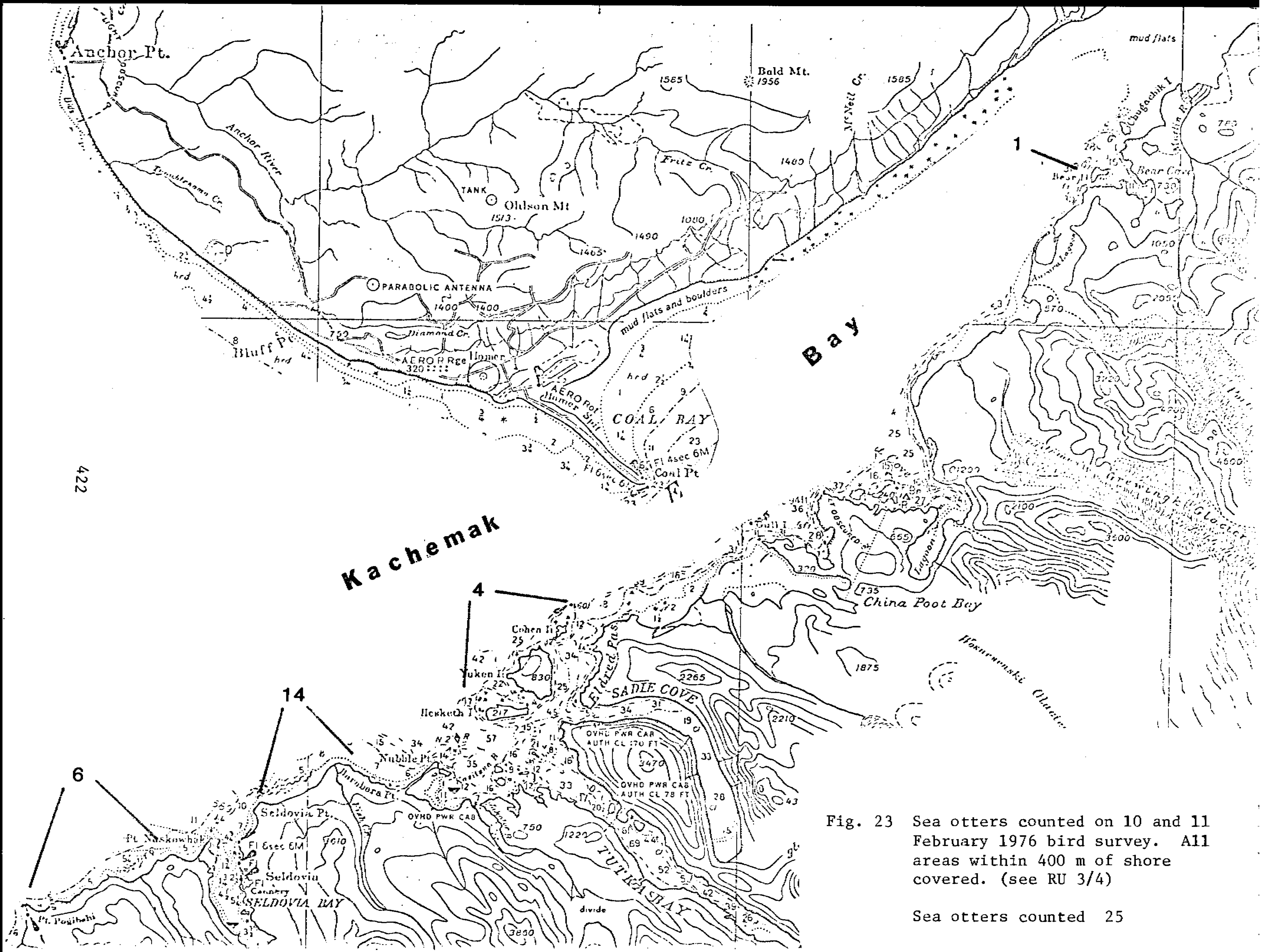


Fig. 23 Sea otters counted on 10 and 11 February 1976 bird survey. All areas within 400 m of shore covered. (see RU 3/4)

Sea otters counted 25

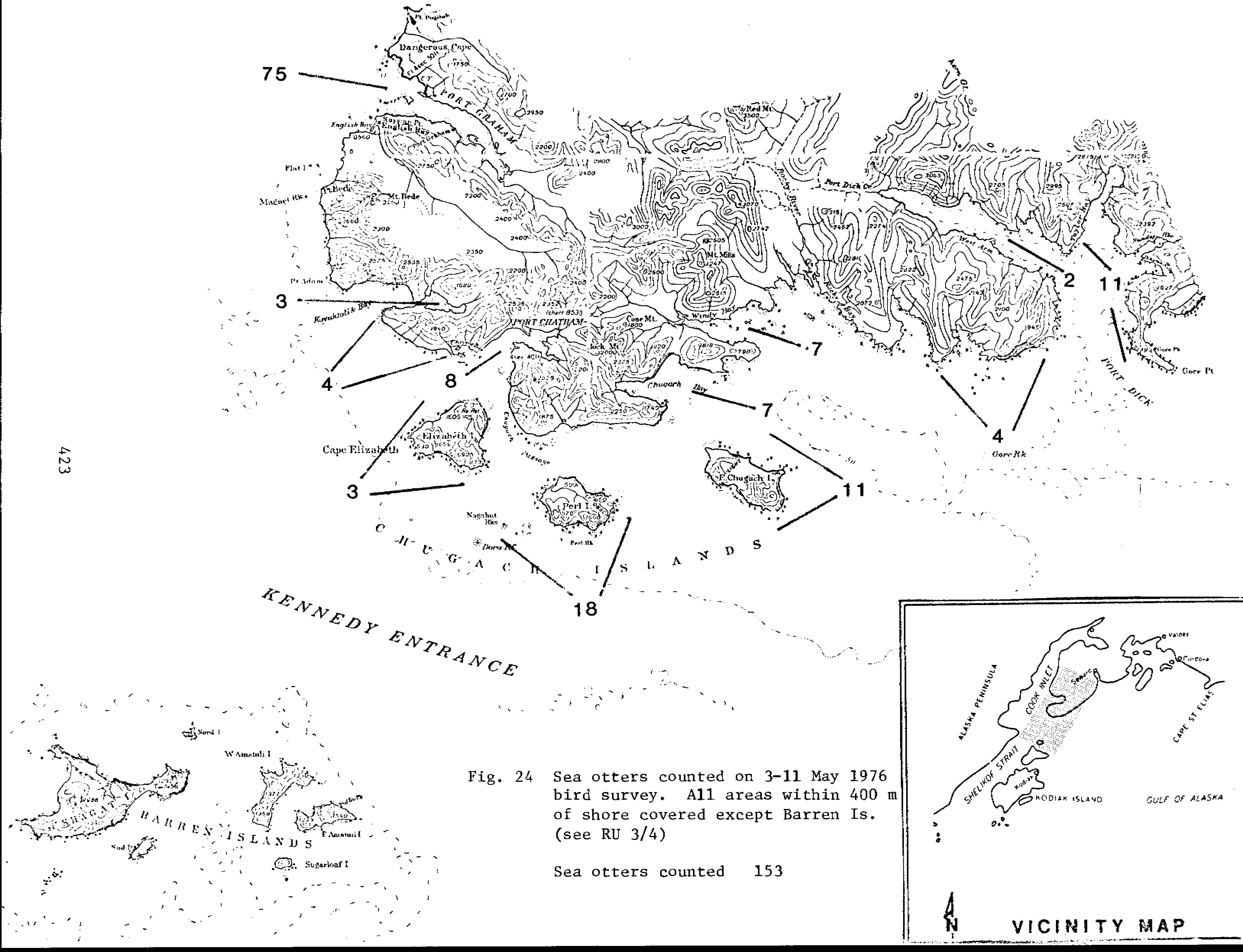


Fig. 24 Sea otters counted on 3-11 May 1976 bird survey. All areas within 400 m of shore covered except Barren Is. (see RU 3/4)

Sea otters counted 153

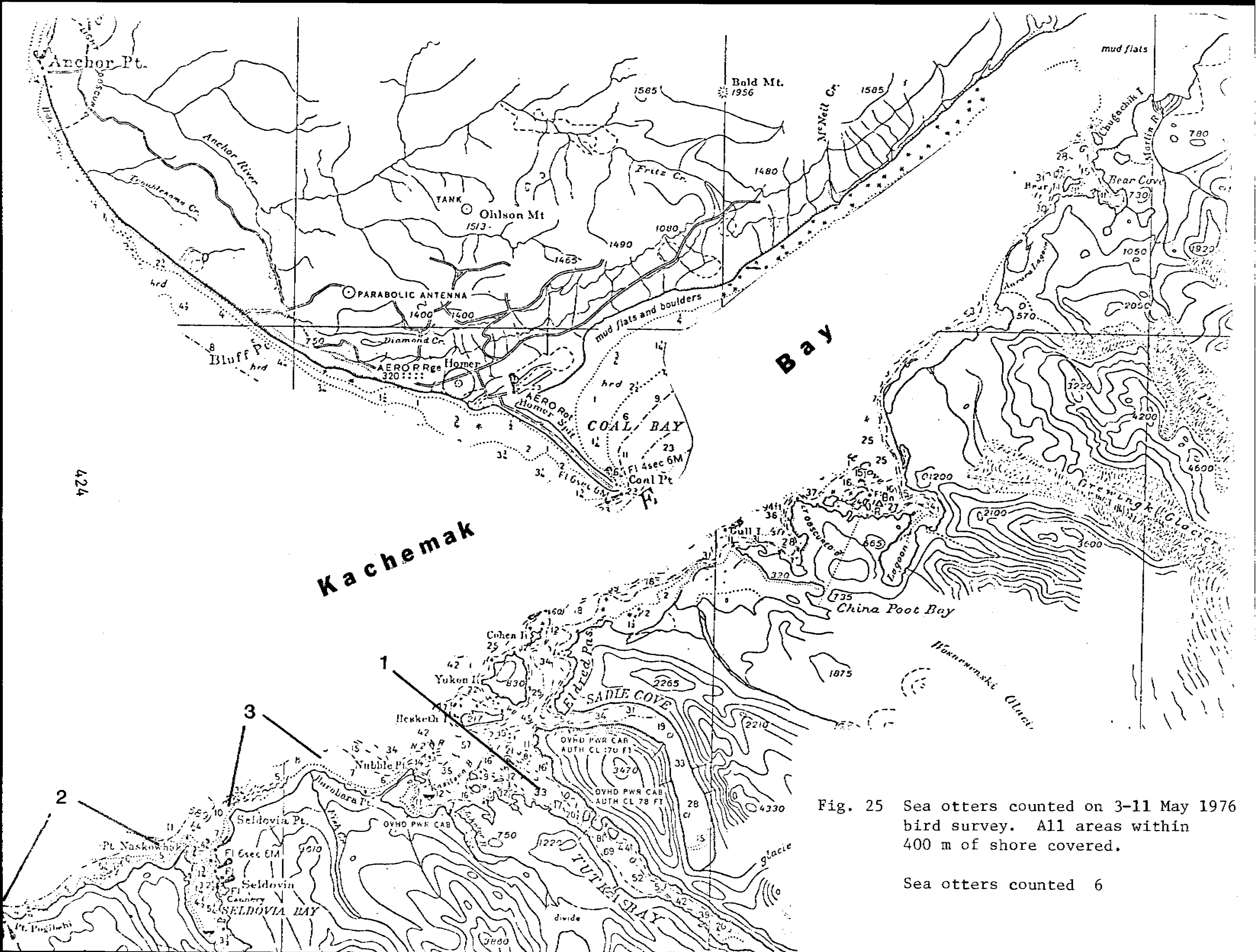


Fig. 25 Sea otters counted on 3-11 May 1976 bird survey. All areas within 400 m of shore covered.

Sea otters counted 6

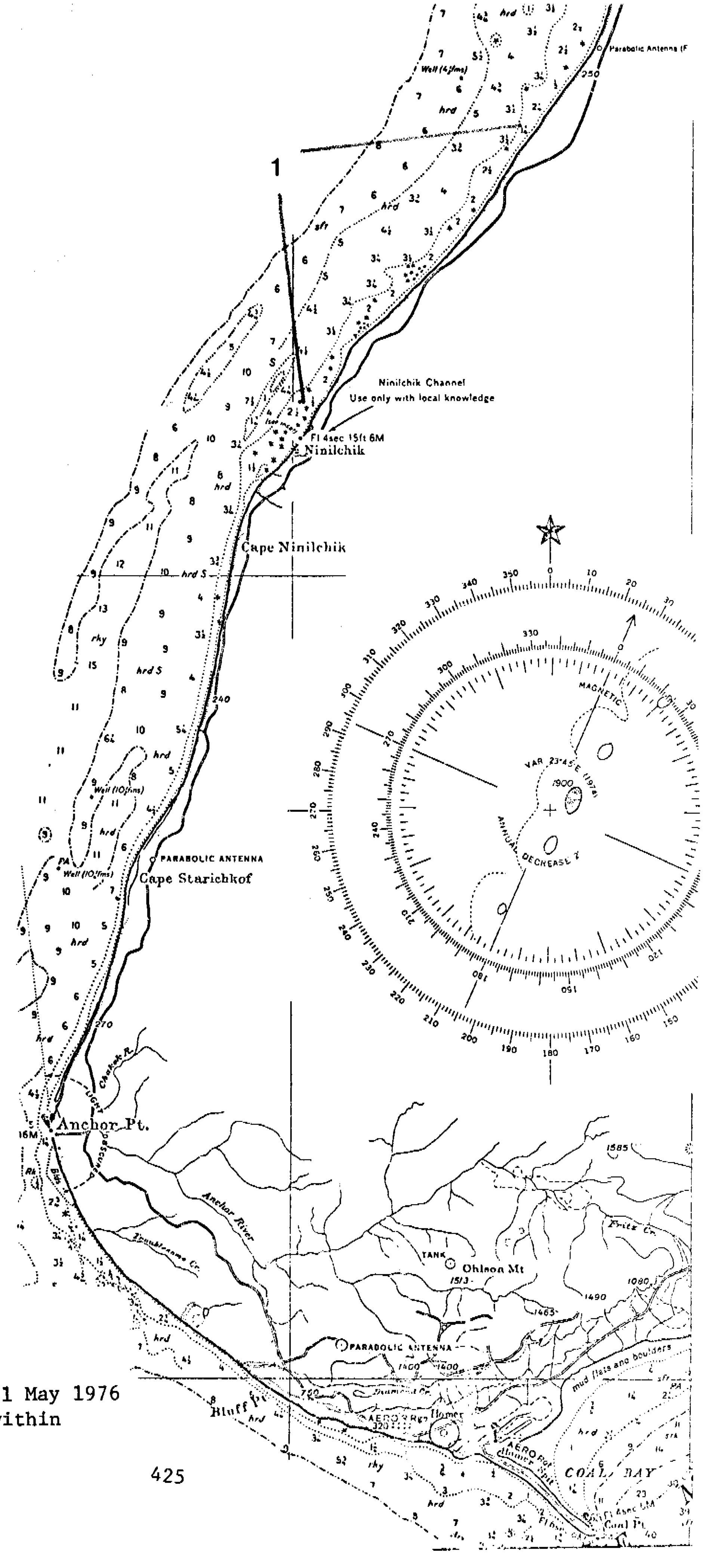


Fig. 26 Sea otters counted on 3-11 May 1976 bird survey. All areas within 400 m of shore covered.

Sea otters counted 1

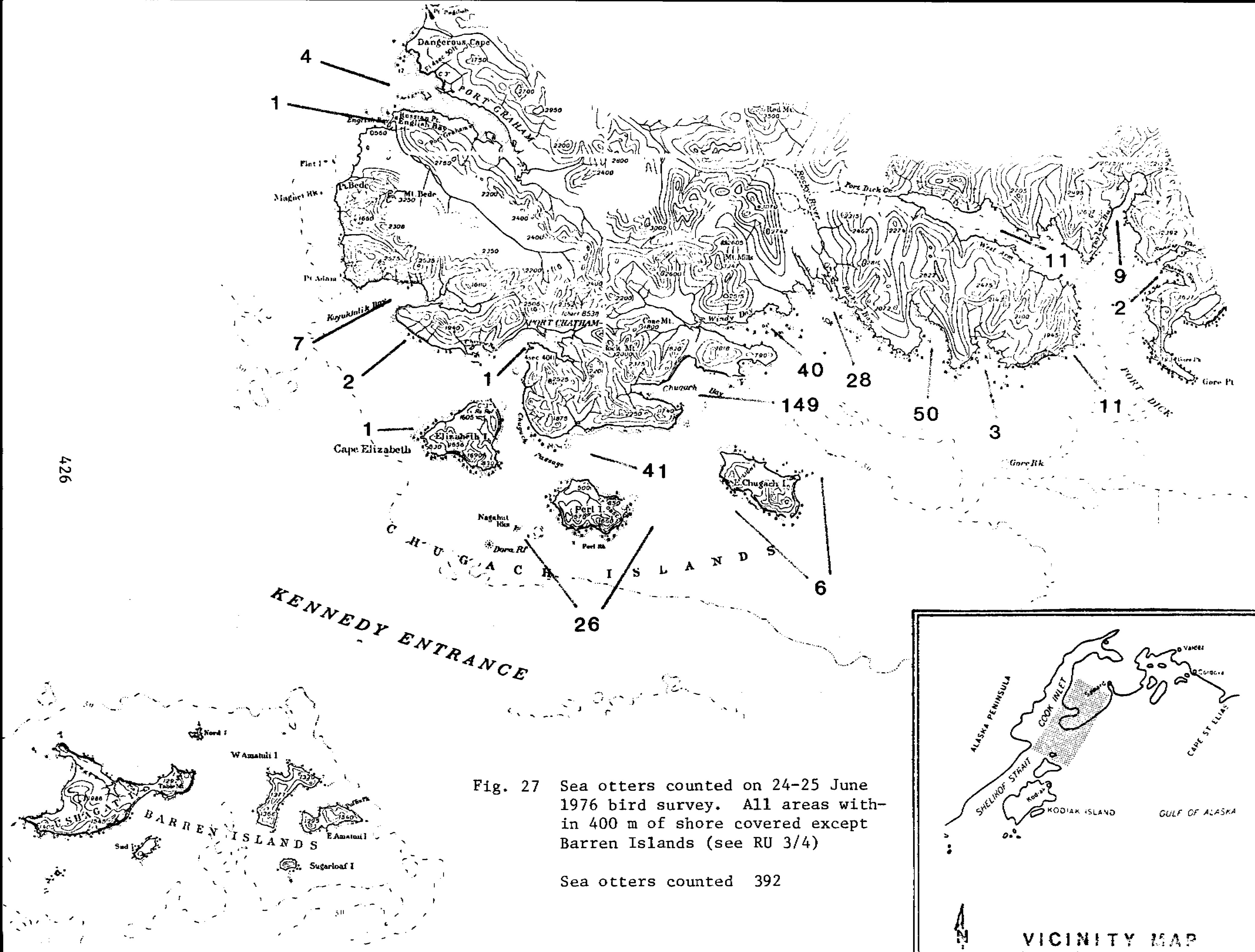


Fig. 27 Sea otters counted on 24-25 June 1976 bird survey. All areas within 400 m of shore covered except Barren Islands (see RU 3/4)

Sea otters counted 392

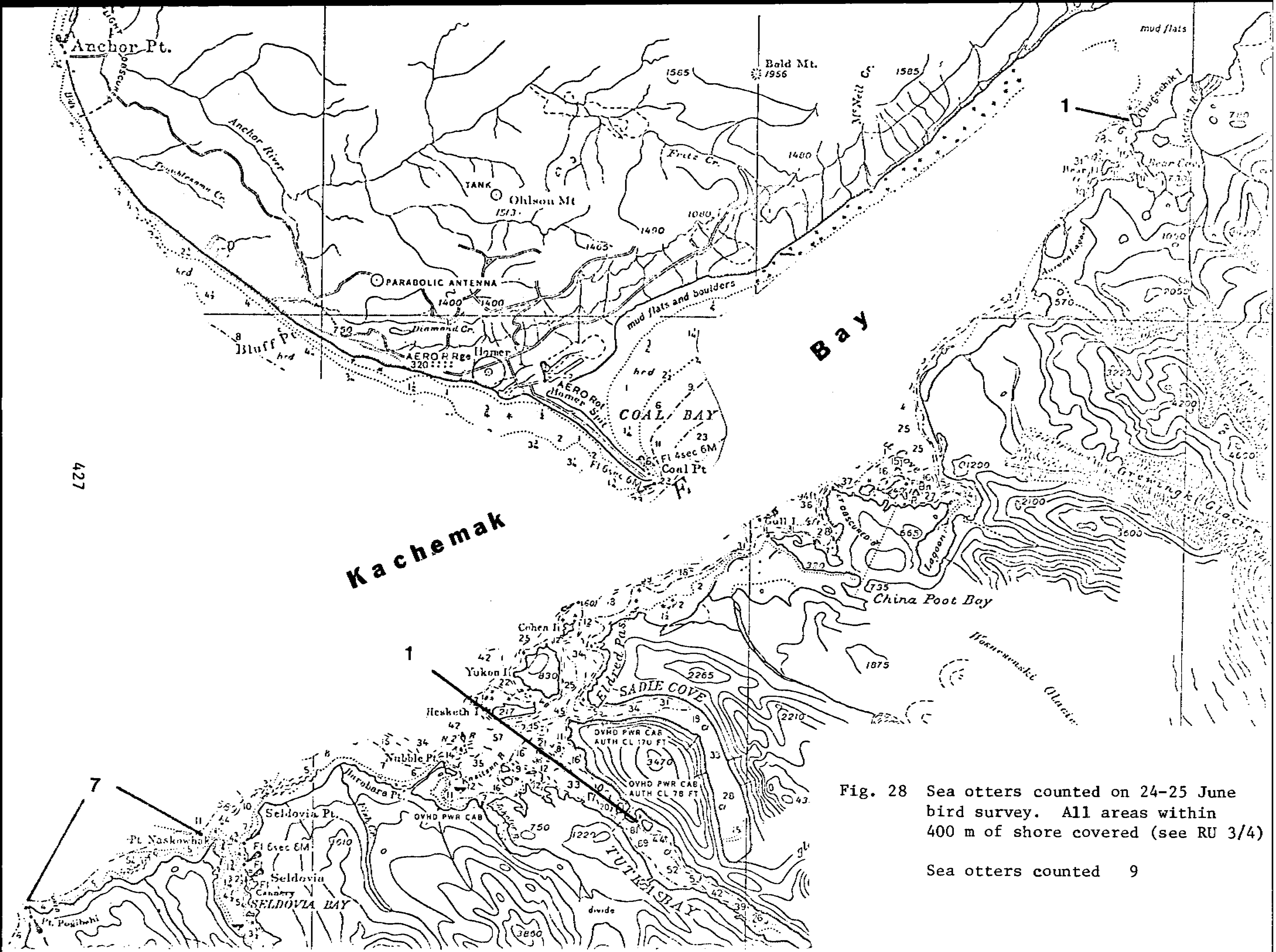


Fig. 28 Sea otters counted on 24-25 June bird survey. All areas within 400 m of shore covered (see RU 3/4)

Sea otters counted 9

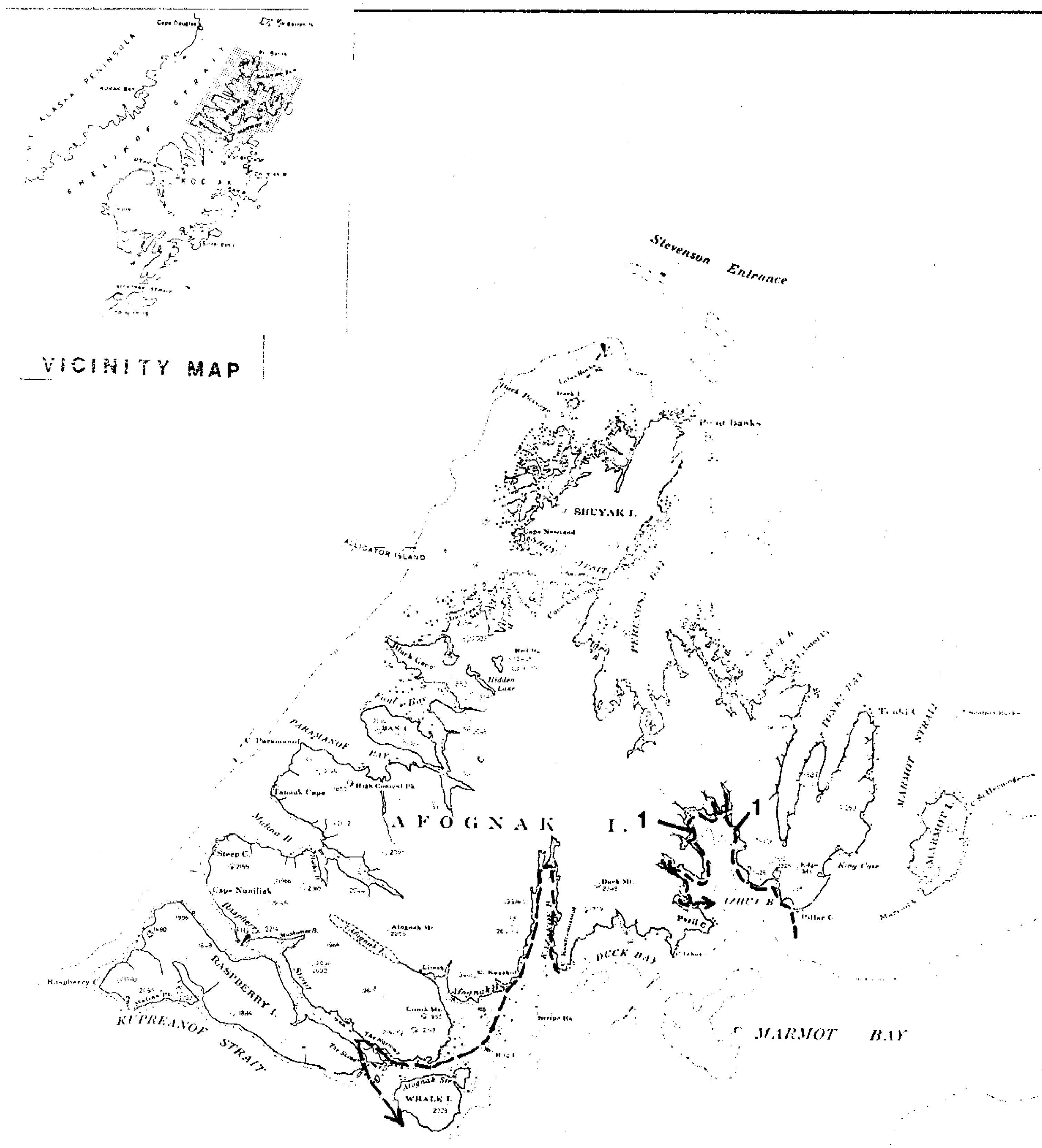
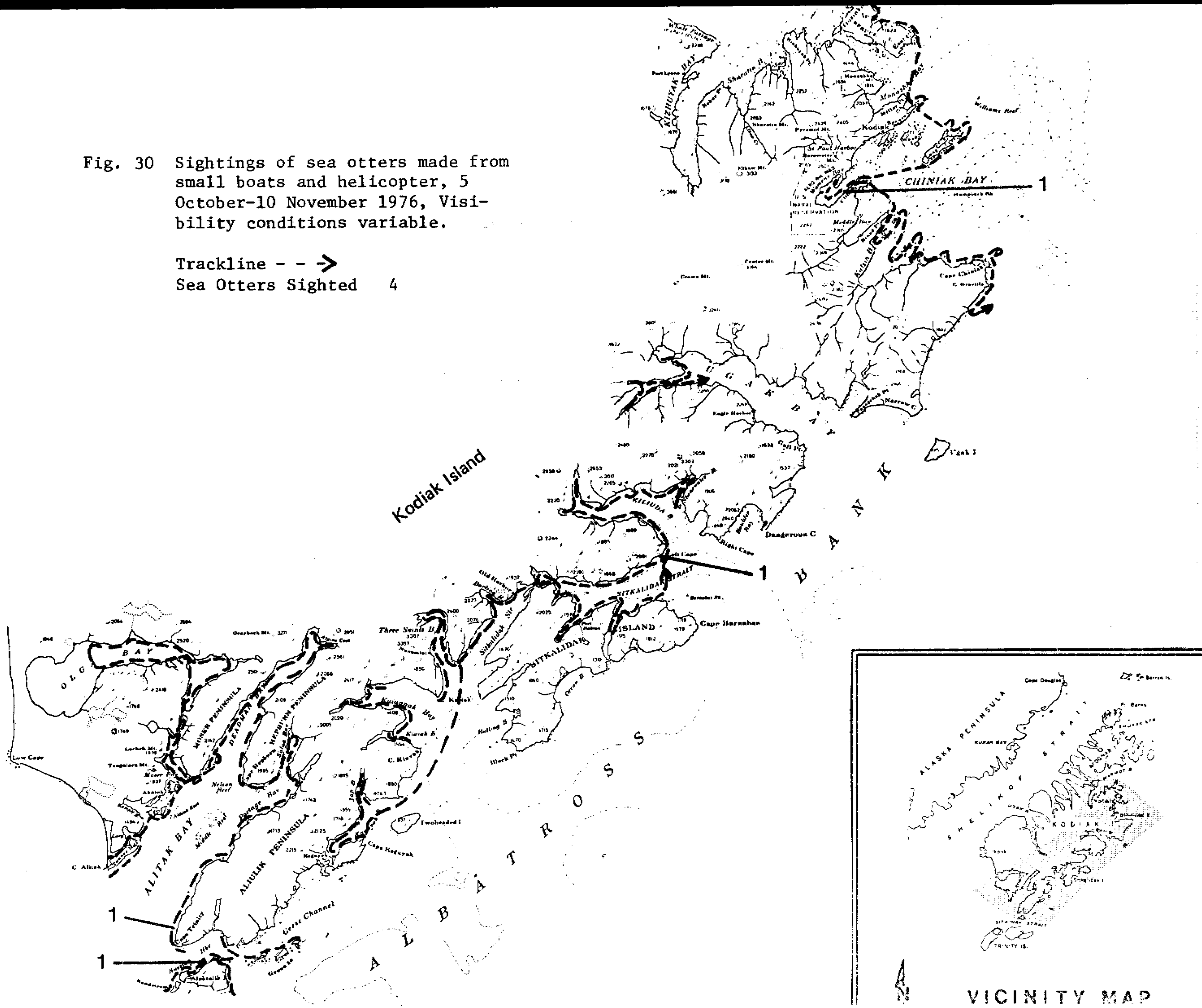


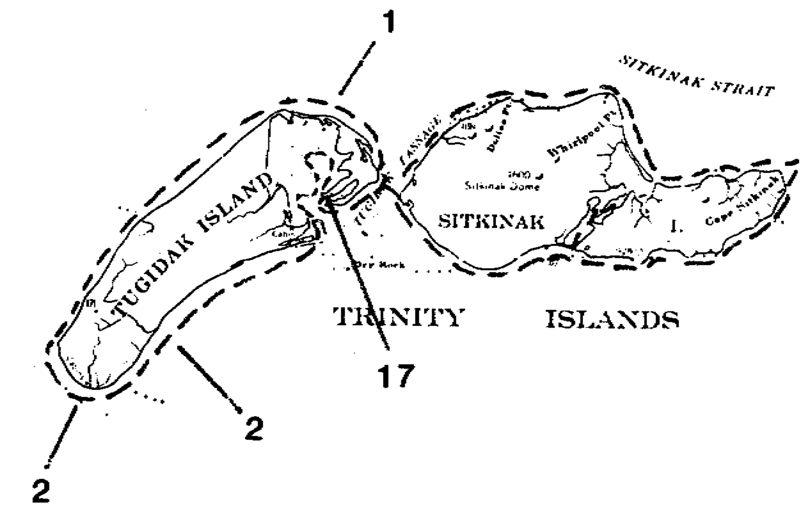
Fig. 29 Sightings of sea otters made from small boats October 1976. Visibility conditions variable.

Trackline - - →
Sea Otters Sighted 2

Fig. 30 Sightings of sea otters made from small boats and helicopter, 5 October-10 November 1976, Visibility conditions variable.

Trackline - - →
Sea Otters Sighted 4





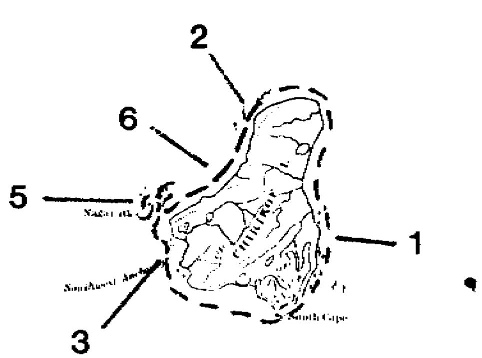


Fig. 31 Sightings of sea otters made from helicopter, 8-9 October 1976. Visibility conditions poor.

Sea Otters Sighted 39

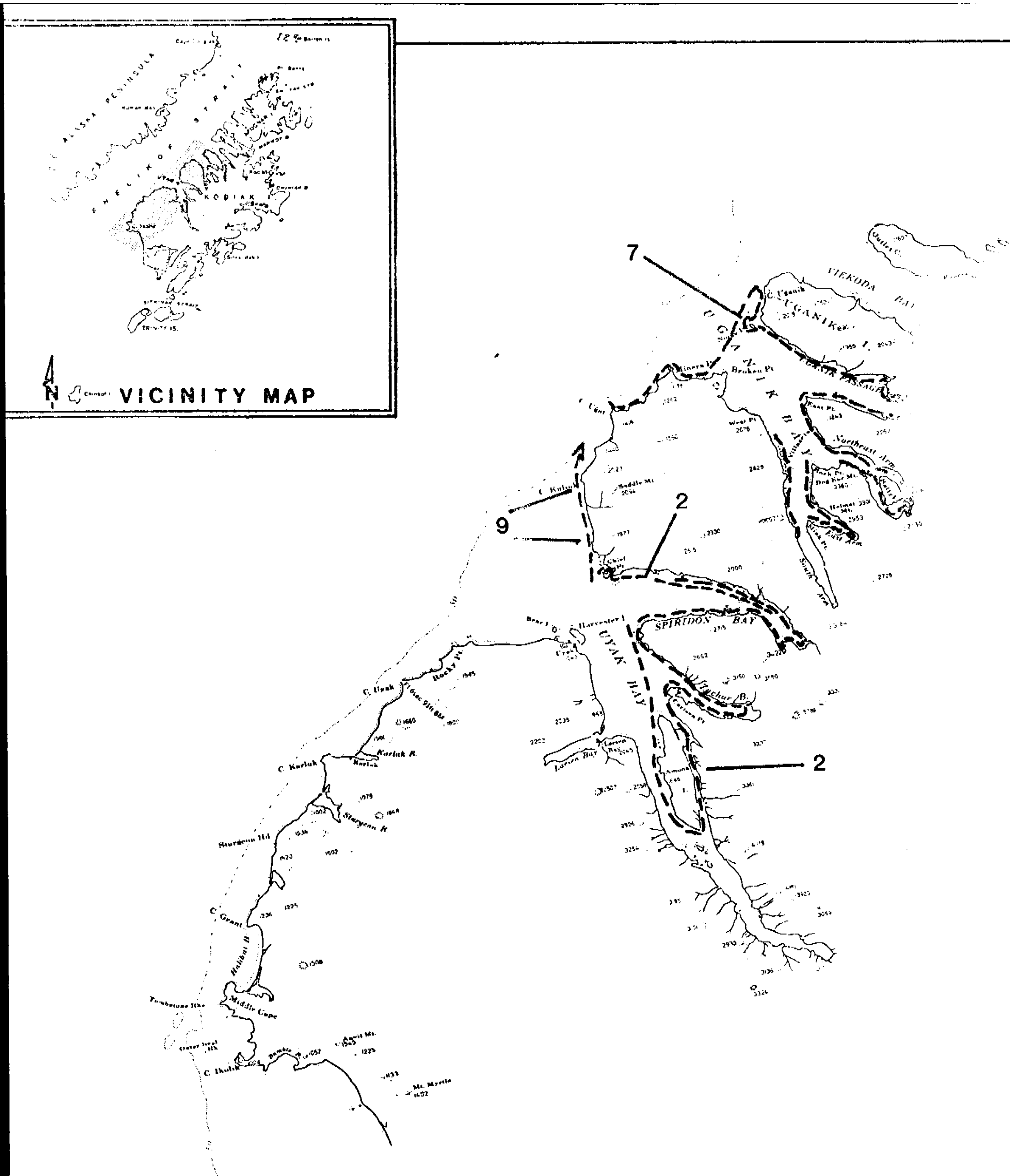


Fig. 32 Sightings of sea otters made from small boats and helicopter, 10 October-10 November 1976. Visibility conditions variable.

Trackline - - ➤
Sea Otters Sighted 20

Table 8. Recent significant sightings of sea otters.

Location	Date	Number of Sea Otters	Observer
Kachemak Bay			
Bear Cove	Spring 1973	1	M. McBride
Peterson Bay	Spring 1973	1	M. McBride
Glacier Spit	1 June 1975	1	Bill McDermitt
Sadie Cove	4 May 1975	2	Merle Wolford
Tutka Bay	April-May 1975 (daily)	1	T. Kronin
Homer Spit	Spring-Summer 1976 (died Aug. 1976)	1	Numerous
26.7 Naut. Mi. Transect Homer Spit west along 59°35'54" N Lat.	30 March 1976	30	D. Erickson
Yukon Island	17 March 1976	2	Ballard & Erickson
Bluff Point	13 March 1976	27	Ballard
Outer Kenai Coast			
Quartz Bay (Nuka Bay)	2 May 1975	50	S. Linderman
Chugach Passage	1 April 1975	"Hundreds"	T. Edwards
Port Graham	13 June 1975	40-50	K. Kyle
Harris Bay	31 August 1976	100	P. Arneson
East Arm Nuka Bay	31 August 1976	5	P. Arneson
West Arm Nuka Bay	31 August 1976	45	P. Arneson
Kamishak Bay & Cook Inlet			
Augustine Island	5 March 1976	50 hauled out	Ballard-Erickson
59°26'N 152°52'W	10 May 1976	1	Erickson
59°28'N 152°00'W	10 May 1976	1	Erickson
59°29'N 152°22'W	30 Sept 1976	2	Erickson & Kurhajec
Kalgin Island	9 June 1975	2	USFWS-Briggs
Kodiak			
Malina Pt. Raspberry I.	Spring 1975	20	"A Pilot"(B. Ballenger)
South of Marmot Strait	July 1975	25	B. Ballenger
Raspberry Strait	1975	1	B. Ballenger
Spruce Cape	"frequently" 1975	1-2	G. Hadju
Outlet Cape	22 April 1975	10	B. Ballenger
Gull Point	28 February 1976	2	P. Arneson
Foul Bay	22 March 1976	48	P. Arneson
Kupreanof Strait	22 March 1976	1	P. Arneson
Deadman Bay	5 March 1976	2	P. Arneson
Tugidak I.(Northwest side)	30 June 1976	1 dead	B. and P. Johnson
Tugidak	8 July 1976	1 dead	B. and P. Johnson
Tugidak	10 July 1976	1 dead	B. and P. Johnson
Tugidak	23 July 1976	1 dead	B. and P. Johnson
Tugidak	25 July 1976	1	B. and P. Johnson
Tugidak	29 July 1976	2 (1 pup)	B. and P. Johnson
Tugidak	1 August 1976	1 dead	B. and P. Johnson

Table 8 (Cont'd.) Recent significant sightings of sea otters.

Location	Date	Number of Sea Otters	Observer
Tugidak	9 August 1976	3 (1 pup)	B. and P. Johnson
Tugidak	27 August 1976	1 dead	B. and P. Johnson
Tugidak	31 August 1976	1	B. and P. Johnson
Tugidak	13 September 1976	1	B. and P. Johnson
Marmot Bay			
58°08'N, 152°01' W	22 May 1976	2	USFWS-Bartonek
58°09'N, 152°00' W	16 July 1975	1	USFWS-Cline
58°07'N, 152°00' W	16 July 1975	2	USFWS-Cline

The probability of sighting a sea otter is influenced by the speed and altitude of the platform, distance from the trackline, lighting conditions, sea state, activity of the animal, group size and presence of birds, other marine mammals, kelp etc. Experience indicates that many otters are missed even under ideal conditions and ideal conditions rarely occur along Alaska's coast. Some success has been achieved in attempts to census sea otters through intensive use of combinations of air and ground counts over small areas and at considerable cost. These indicate that there may be 1.5 to 4 times as many sea otters as are seen from a helicopter and perhaps 4 to 10 times as many as seen from a fixed wing aircraft, but it has never been possible to measure all variables. Therefore, the counts presented in this report should not be considered total counts. They indicate distribution and relative abundance and permit only rough estimates of population size.

KENAI PENINSULA

A summary of significant counts of sea otters around the Kenai Peninsula is presented in Table 9. All counts are arranged by standardized count areas to facilitate comparison. Locations are the approximate midpoints of each count area. These counts were conducted by different individuals using different survey platforms under varying conditions of visibility. All possible sea otter habitat was rarely covered. Changes in numbers seen in each count area are often due to differences in surveys rather than actual changes in numbers of sea otters present. When considered with reports from residents of the area and biologists frequently visiting the area certain patterns are evident, however.

Table 9. Summary of significant counts of sea otters around the Kenai Peninsula.

Area	Location: Latitude	Location: Longitude	1951-* 1953	1967-* 1968	1970-** 1971	Oct 1975 Helicopter Survey	Feb 1976 Bird Survey	Apr 1976 Strip Census	May 1976 Bird Survey	June 1976 Bird Survey	Jun-*** July 1976 Boat Survey	Aug 1976 Mapping Flight
Puget Bay	59° 58' N	148° 31' W	No significant population	Few sightings	NS	25						
Whidbey-Johnstone	59° 55'	148° 50'			22	15						
Day Harbor	59° 58'	149° 10'			8	13						
Resurrection Bay	59° 58'	149° 23'			2	29					9	
Aialik Bay	59° 45'	149° 42'			20	36					36	
Harris Bay	59° 43'	149° 53'			38	92					72	100
Pye Reef-Two Arm	59° 30'	150° 14'			1	1					16	
East Arm-Nuka	59° 27'	150° 25'			85	26					35	5
McCarty Arm	59° 38'	150° 18'			8	NS						
West Nuka	59° 28'	150° 34'			41	20					127	45
Nuka Passage	59° 20'	150° 48'			10	32					56	2
Port Dick	59° 14'	151° 03'	1		23	13	12		13	33	134	
Rocky Bay	59° 12'	151° 20'			4	90	8		11	121		
Chugach Bay	59° 10'	151° 35'	15	400+	76	66	44		36	222	260	
Port Chatham	59° 12'	151° 50'			50	54	56		16	11		
Port Graham	59° 22'	151° 55'	No significant population		0	16	41		75	5		
Seldovia	59° 27'	151° 44'		Few sightings	Few sightings	4	20		5	7		
Tutka-Sadie	59° 30'	151° 30'				1	4		1	1		
Halibut Cove	59° 36'	151° 15'				1	0		0	0		
Bear Cove	59° 43'	151° 06'				5	1		0	1		
Coal Bay	59° 42'	151° 14'				0	0		0	0		
Coal Pt-Anchor Pt	59° 40'	151° 45'				0	0	400 est.	0	0		
Anchor Pt-Ninilchik	59° 55'	151° 47'				0	0	0	0	0		
Ninilchik-Clam Gulch	60° 09'	151° 30'				0	0	0	1	0		
Clam Gulch-Kenai	60° 22'	151° 20'				0	0	0	0	0		

* From Lensink (1962)

** Composite of highest counts from several surveys

*** Bailey 1976

History

Sea otters probably were eliminated from the Kenai Peninsula by the early 1900's. It appears that remnant populations may have survived in southwestern Prince William Sound, the northern Kodiak Archipelago and Kamishak Bay. Small numbers were occasionally reported between the Chugach Islands and Cape Puget in the 1950's and early 1960's but Kenyon (1969) concluded that no significant population occurred in the area. Reports increased steadily through the mid-1960's and in 1967 several hundred and perhaps over 1,000 abruptly appeared in the vicinity of Port Graham and Chugach Bay. This concentration diminished over the next few years, perhaps as the result of dispersal to the east.

By 1970 sea otters were distributed in small numbers along the entire peninsula from Cape Puget to Port Graham. Rare sightings occurred in Kachemak Bay. It appeared that repopulation was the result of range expansion by the Prince William Sound population and large scale immigration from another area, perhaps the Barren Islands. Between 1970 and early 1975 no major changes were reported although sightings in Kachemak Bay increased and sea otters became a common sight near Seward.

Present Status

Survey conditions around the Kenai Peninsula during October 1975 helicopter survey were less than ideal. The percentage of sea otters recorded was probably in the lower range for helicopter surveys. There may be three or more times as many as counted. Results of the June 1976 bird survey, Bailey's (1976) boat counts and other sightings (Tables 8 and 9) tend to support this view. The survey did delineate the distribution of the population and provide good information on the relative abundance of sea otters occupying various parts of the area. These were the primary objectives of the survey. Bailey's (1976) boat counts (Table 9) probably provide the best information on distribution and abundance within the area he covered. The technique he employed would tend to give more uniform results in areas where extensive offshore shallow areas do not exist. His counts should still be considered minimal especially in the area west of Gore Point.

The October helicopter survey and recent sightings indicate that the distribution of sea otters along the outer Kenai coast is essentially the same as in 1970. Some range expansion into Kachemak Bay has occurred. The distribution and relative densities of sea otters between Port Graham and Cape Puget generally seem to conform to the distribution of suitable habitat. This indicates that no major range expansion is occurring in that area and it is unlikely that significant changes will occur in the future, although densities may increase. Sea otters appear established in the area from Port Graham to Seldovia but their densities are low. Scattered otters occur along the entire south side of Kachemak Bay but no groups of breeding animals have become established there.

There have been occasional sightings of sea otters near Homer and as far north as Deep Creek since the late 1960's. These appeared to be stray animals and were usually old males. In 1975 there was an increase in sightings of sea otters in offshore areas west of the area between Homer and Anchor Point indicating recent range expansion. The 1 April 1976 strip transect survey confirmed that a substantial number of sea otters were dispersed over a large area. A reliable population estimate is not possible from these data, however, it would appear that over 400 sea otters occupy the area surveyed and their numbers are increasing. No pups have been reported in this area suggesting that this group is composed of sexually inactive animals probably mostly "surplus" males. Such animals are usually the first colonizers of vacant habitat. Their numbers increase through immigration from adjacent areas of high density rather than through reproduction in the recently populated area. It may take several years for a significant level of reproduction to develop in this area.

The survey did not cover all of the presently occupied habitat as sea otters were seen near the ends of the tracklines and on both the first and last tracklines. General observations indicate that there are few north of Anchor Point, however. The first recent observation of a sea otter north of Ninilchik was made in May (Fig. 26). An unusual characteristic of this population is its offshore distribution which is similar to that found north of Unimak Island and the Alaska Peninsula (see RU 241).

Future

Kenyon (1969) described a common pattern of range expansion for sea otters. Concentrations often build up at the fringes of a population then abruptly disperse into adjacent habitat only when competition for food arises. This abrupt movement is often preceded by an increase in the occurrence of stray transient animals. This pattern appears to be occurring in the lower Cook Inlet-Kachemak Bay area today. High densities built up in the area between Rocky Bay and Port Graham in the late 1960's and early 1970's. Stray animals in Kachemak Bay increased then an abrupt shift to the area northwest of Homer occurred. At the same time there appears to have been a decrease near Port Graham where frequent unconfirmed reports of over 200 were received in the early 1970's. Some immigration from Kamishak Bay might also have occurred. This pattern of range expansion should continue for several years. We can expect continued movement of animals from the outer Kenai Peninsula into Kachemak Bay and northward up Cook Inlet.

Kachemak Bay, particularly the south side, should eventually support relatively high sea otter densities. Opportunities for the general public to view sea otters in Alaska are extremely limited. Kachemak Bay will probably eventually be the most accessible sea otter viewing area in Alaska. Therefore, the importance of the bay and the sea otter population that will repopulate it is increased.

The potential for range expansion north of Kachemak Bay is less certain. Sea otters are capable of feeding in waters 80 m deep and in rare cases more than 100 m deep although most normally remain in water 60 m deep or less. Therefore, potential sea otter habitat extends across Cook Inlet and this population may become contiguous with that in Kamishak Bay. Food availability and perhaps the occurrence of sea ice will probably determine the eventual northern limit of this population. At this time it is difficult to predict what the northern limit will be. A recent sighting near Kalgin Island (Table 8) suggests that at least stray individuals may eventually occur throughout lower Cook Inlet.

Critical Areas

The potential for adverse impacts of OCS development on sea otters inhabiting the waters around the Kenai Peninsula appears high. Presently occupied or potential sea otter habitat lies in and adjacent to proposed lease areas and sites for onshore activities. Oil spills, in particular, could greatly reduce sea otter numbers and retard the process of repopulation of former habitat. Impacts in some areas would have greater detrimental effects than those in other areas.

Densities of sea otters between Gore point and Cape Puget are low. The area consists of deep, steep-sided fiords. Waters of suitable depths for sea otter foraging are limited to a narrow band along the shores and a few scattered submerged glacial moraines and shallow lagoons. The observed distribution of sea otters generally coincided with the distribution of shallow water. Most concentrations were inside the major bays. Very few sea otters were seen near exposed capes. Areas with a direct southeast exposure to the Gulf of Alaska are generally precipitous and wave scoured and offer little habitat for sea otters.

The combination of topography of the area and distribution of sea otters would probably limit the impact of offshore oil spills in this area. Sea otters east of Gore Point are probably contributing less to repopulation of new areas than those west of Gore Point. If a short-term impact such as an oil spill reduced sea otter numbers east of Gore Point, recovery could be rapid provided the relatively dense populations in Prince William Sound and west of Gore Point remained unaffected. Perhaps the greatest loss in human terms would be a loss of opportunity to view sea otters should a reduction occur in Resurrection Bay.

The situation west of Gore Point is quite different. Concentrations of sea otters near the fringes of expanding populations appear to be important to the repopulation process. Animals toward the center of the population probably contribute less to repopulation than those near the fringes. From this standpoint the area from Port Graham to Rocky Bay may be critical. A reduction in sea otter densities in that area could seriously retard repopulation of Kachemak Bay and Lower Cook Inlet. Kachemak Bay and all waters of lower Cook Inlet less than 60 m deep, at least as far north as Ninilchik, should also be considered critical because of their potential as sea otter habitat.

KAMISHAK BAY

History

The history of sea otters in Kamishak Bay is vague. Most surveys of the area have included only the shoreline of Augustine Island and perhaps Shaw Island and Cape Douglas. Occasional sightings of large numbers offshore and dramatic fluctuations in shoreline counts suggested that considerable movement occurred and that much of the occupied habitat lay outside of the area surveyed. The 1 April 1976 survey was the first attempt to locate sea otters in all potential habitat in Kamishak Bay. Table 10 presents the most significant counts made in Kamishak Bay and adjacent areas. These counts were made under variable conditions and should be compared with caution.

It appears that a small remnant population of sea otters remained in Kamishak Bay in the early 1900's. This population, centered around Augustine Island, probably grew throughout the 1940's and 1950's although no growth is evident in the counts. By 1965 some range expansion to the south had occurred. Counts made between 1969 and 1971 indicated that there may have been an increase in numbers around Augustine Island and the waters immediatedly to the north and west and that there had been a substantial movement around Cape Douglas to the vicinity of Shakun Rocks. The relatively high numbers seen by Prasil (1971) southwest of Cape Douglas suggest that the population within Kamishak Bay proper had reached a much higher level in the early 1960's than indicated by the counts.

Most likely, densities in the bay increased steadily through the 1960's then stabilized or declined slightly as animals emigrated to the southwest and possibly to the east across Cook Inlet. There is also a possibility that periodic oil spills influenced numbers although no'direct evidence of oil related mortality is available from that area.

Present Status

The available information indicates that the range of the population extends from northern Kamishak Bay to Cape Nukshak. Otters may occur

Table 10. Summary of significant counts of sea otters in Kamishak Bay and adjacent waters.

	1948[1]	1957[1]	1959[1]	1965[2]	1969	1970	1970-71[3]	1971	Apr 1976[4]	Jun 1976
North of Chinitna Pt	Reports									
Augustine I. shoreline	50	40	52	18	132			24	40	
Chinitna Pt-Douglas R. (including offshore areas)	Reports						60	100-150	28	
Douglas R-C. Douglas		1		71		0			5	
C. Douglas-Kiukpalik I.		0	0	30		0	92			
Kiukpalik I.-C. Chiniak		0	0	0		71	443			
C. Chiniak-C. Nukshak		0	0	0		0	0			
C. Nukshak-C. Kubugakli		0	0	1		0	0			0
C. Kubugakli-C. Unalishagvak		0	0	0		7				35

1 Lensink (1962)
2 Kenyon (1969)
3 Highest counts from Prasil (1971)
4 Partial coverage, see fig. 15

throughout the shallow waters of Kamishak Bay and often range far from shore. The distribution observed on 1 April 1976 (Fig. 15) seemed to be influenced by the distribution of sea ice. Many sea otters were associated with patches of drift ice and 17 were hauled out on ice. The sea otters appear to be relatively mobile in this area and major shifts may occur periodically. Concentrations usually occur around Augustine Island, particularly the north side; in the waters west of Augustine Island; around Shaw Island and Cape Douglas; at Douglas Reef; and at Shakun Rocks. Observed numbers in each of these areas have fluctuated widely, however.

Sea otters inhabiting the Alaska Peninsula coast between Cape Douglas and Cape Chiniak should be considered part of the Kamishak population. Those sighted near Puale Bay in 1970 and 1976 are probably at the extreme fringe of the large population that is centered near Kujulik and Amber Bays. Therefore, the Kamishak population and the Kujulik population are expanding their ranges toward each other and should eventually become contiguous. A superficial survey of the area between Cape Nukshak and Puale Bay in June 1976 indicated that little expansion of range has occurred since 1970 but the pattern of range expansion is clear.

Although a reliable population estimate cannot be derived from data collected on 1 April 1976, crude estimates indicate that there might be between 500 and 1,000 in Kamishak Bay. The number southwest of Cape Douglas probably equals or exceeds that number.

Future

The population should continue to expand its range to the southwest. Eventually some range expansion to the north should occur. The range of this population could become continuous with that of the Kenai Peninsula. Recent sightings in the middle of lower Cook Inlet (Table 8) indicate that some interchange already occurs. At this time it is not possible to predict how far up Cook Inlet either population will expand.

Critical Areas

At the present time the area around Augustine Island and northern Kamishak Bay should be considered most critical to the process of repopulation of former sea otter range. The concentration inhabiting the Shakun Rocks area is also expected to contribute significantly to the repopulation of vacant habitat and is highly vulnerable. However, the presence of the large and rapidly expanding Kujulik Bay population to the southwest makes survival and growth of the Shakun Rocks group less critical.

KODIAK ARCHIPELAGO

Three separate population centers of sea otters exist in the Kodiak Archipelago. These are: (1) the Barren Islands, (2) Shuyak-Afognak and (3) Trinity Islands-Chirikof Island. Each will be discussed separately.

1. Barren Islands

History

Significant counts of sea otters made in the Barren Islands are presented in Table 11. These counts were made under different conditions and may not be directly comparable.

No real change in numbers is apparent after 1957. All of the lower counts including those made in 1976 were made under poor conditions or were incomplete. The difference between the 1951 and 1957 counts is not easy to explain. Either a substantial nucleus population was present in 1951 but was missed on the survey, or a group emigrated from the Shuyak Island area. In either case the island group was fully repopulated by 1957. Lensink (1962) speculated that regular movements occurred between Shuyak and the Barren Islands. The fluctuations in counts which lead him to suggest this were more likely caused by scattering of animals offshore but some major movements may have occurred.

The group of several hundred sea otters that appeared on the Kenai Peninsula in 1967 may have come from the Barren Islands. If this is the case there may have been substantial fluctuations in the number of sea otters occupying the Barren Islands that are not evident in the counts.

Present Status

At the present time this population can be considered at or near the carrying capacity of the habitat. Densities are highest in the shallow

Table 11. Summary of significant counts of sea otters around the Barren Islands.

Area	Latitude	Longitude	1951*	1957*	1957*	1959*	1964	1966	1970	1974**	1975**	May 1976	June 1976
Sugarloaf I.	58° 53' N	152° 02' W							0		6		1
E. Amatuli I.	58° 55'	151° 59'							0		5		0
W. Amatuli I.	58° 56'	152° 03'							2		21	8	2
Nord I.	58° 58'	152° 09'							0		12		0
N. side Ushagat	58° 57'	152° 15'							75	150 (N. and S. side Ushagat)	21	10	8
S. side Ushagat	58° 54'	152° 15'						150+ (S. side Ushagat, Sud I., Carl I.)	1		20	40	35
Sud I.	58° 54'	152° 13'							29	120	71	33	15
Carl I.	58° 53'	152° 19'							200		70	60	50
Total			0	325	234	272	81		307		226	151	111

* Lensink 1962

** Bailey 1975

waters south of Ushagat Island including those around Carl Island and Sud Island. Low densities are usually found throughout the remainder of the island group. This distribution has been evident in most counts and probably reflects the quality of the habitat.

Future

Little change is expected in the status of sea otters in the Barren Islands. Numbers may fluctuate but the distribution should remain similar to that observed in recent years. Occasionally sea otters might immigrate to the Kenai Peninsula or Shuyak Island but such movements will be difficult to detect. The Barren Island population is no longer playing an important role in the process of repopulation of vacant sea otter habitat.

Critical Areas

Complete elimination of the Barren Island population would have relatively little impact on other areas. Therefore, consideration of critical areas can only be based on survival of the population as a separate entity. Perhaps two-thirds of the population regularly inhabits the relatively small area around the south side of Ushagat Island, Carl Island and Sud Island. Most reproductive activity probably occurs there. Therefore, this area is critical to the survival of the Barren Island population.

Because that area is small, the population is highly vulnerable and could be severely reduced by a minor oil spill. Repopulation of the

Barren Island group would eventually occur through immigration from the Kenai Peninsula or Shuyak Island, but this could take many years.

2. Shuyak-Afognak

History

Significant counts of sea otters around the area between Shuyak Island and Chirikof Island are summarized in Table 12.

A remnant population survived in the vicinity of Latax Rocks and Sea Otter Island. By the 1950's this population was well established and appeared to be growing rapidly, expanding its range to Afognak Island in the vicinity of Seal Bay.

Little change was evident in the 1960's. The range of the population remained the same although stray individuals were seen around Kodiak Island. No increase in numbers was evident. There may be several reasons for this apparent lack of growth. First, sea otter populations often increase in numbers without expanding their range for several years. Traditional survey techniques are not always sensitive enough to detect increases in densities. Counts made during the 1960's were incomplete and often not directed specifically at sea otters. Second, immigration to the Barren Islands and eventually to the Kenai Peninsula may have occurred. This would explain the lack of a major reduction of the Barren Island population when several hundred sea otters appeared on the Kenai Peninsula in the mid-1960's. Third, oil, probably from tanker

Table 12. Summary of significant counts of sea otters around the Kodiak Archipelago

			1951*	1957*	1957*	1958*	1959*	1964	1966	Sightings 1964-1971	1970	Sightings 1975	Heli-copter 1975	Boat 1976	Air March 1976	Misc 1976
Cape Chiniak	57° 38'N	152° 15'W														
Kodiak	57° 45'	152° 20'								1					0	
Spruce I.	57° 55'	152° 23'								2		Few		0	0	1,1
Ouzinki	57° 57'	152° 30'														
Sharatin Bay	57° 53'	152° 41'											0			
Kizhuyak Bay	57° 49'	152° 52'														
Whale Passage	57° 56'	152° 50'														
Afognak Bay	58° 02'	152° 43'										1				
Kazakof Bay	58° 08'	152° 35'											6			
Duck Bay	58° 07'	152° 27'											0			
Izhut Bay (West)	58° 11'	152° 17'											1		6	
Izhut Bay (East)	58° 11'	152° 12'										Few	1			1
King Cove	58° 12'	152° 00'											0		0	1
Marmot I.	58° 13'	151° 50'						1					16			
Tonki Cape	58° 21'	151° 59'									3	25	529			
Tonki Bay	58° 18	152° 08'								3			134			
Seal Bay (East)	58° 22'	152° 10'											32			
Seal Bay (West)	58° 23'	152° 16'						13		Many			164			
Perenosa Bay (South)	58° 22'	152° 25'											342			
Perenosa Bay (North)	58° 27'	152° 28'									2		290			
Shuyak (East)	58° 31'	152° 23'		5	12	581	365				4		58			
Sea Otter I.	58° 31'	152° 12'	15		75				150+				10			
Point Banks	58° 38'	152° 19'			75				100+		121		136			
Shuyak (North)	58° 36'	152° 28'		89	119								9			
Latax Rocks	58° 40'	152° 31'	67					63					14			
Shuyak (West)	58° 34'	152° 39'									26		59			
Shuyak Strait	58° 29'	152° 35'									33		12	272		
Bluefox Bay	58° 27'	152° 44'									0		2	14		
Foul Bay	58° 21'	152° 50'									18		81	32		
Paramanof Bay	58° 18'	152° 56'											61	60		48
Malina Bay	58° 13'	153° 05'												15		
Raspberry Strait	58° 06'	153° 06'													31	3
Kupreanof Strait	57° 59'	153° 10'													20	
Viekoda Bay	57° 54'	153° 14'										10, 20		1	20	1
Uganik Passage	57° 51'	153° 24'													1	
Uganik Bay	57° 48'	153° 30'												37	12	7
Cape Ugat	57° 52'	153° 51'														
Uyak Bay (East)	57° 39'	153° 50'												1	0	9
Uyak Bay (South)	57° 25'	153° 59'								5				1		2
Uyak Bay (West)	57° 36'	153° 58'												0	5	2

Table 12 (Cont.) Summary of significant counts of sea otters around the Kodiak Archipelago

			1951*	1957*	1957*	1958*	1959*	1964	1966	Sightings 1964-1971	1970	Sightings 1975	Heli-copter 1975	Boat 1976	Air March 1976	Misc 1976
Rocky Point	57° 40'N	154° 12'W													0	
Karluk	57° 35'	154° 30'													0	
Halibut Bay	57° 25'	154° 43'													1	
Ayakulik	57° 10'	154° 35'													0	
Low Cape	56° 55'	154° 20'														2
Alitak Bay	56° 55'	154° 05'													0	1
Deadman Bay	57° 04'	153° 57'														2
Olga Bay	57° 08'	154° 15'														
Tugidak I. (North)	56° 35'	154° 35'	0	0						Beach Deads					1	1
Tugidak I. (South)	56° 25'	154° 35'	0	0						Annually					21	21
Sitkinak I. (South)	56° 30'	154° 10'	0	0	15					Present					1	
Sitkinak I. (North)	56° 38'	154° 05'	0	0												
Tugidak-Chirikof	56° 00'	155° 30'								6					1	
Chirikof I.	55° 50'	155° 40'	0							4					10	17
Aiaktalik I.	56° 43'	154° 00'													0	1
Twoheaded I.	56° 53'	153° 37'								1					0	
Three Saints Bay	57° 09'	153° 28'														
Sitkalidak I. (West)	57° 04'	153° 25'														
Sitkalidak I. (South)	57° 05'	153° 05'													0	
Sitkalidak I. (North)	57° 12'	153° 05'														1
Kiliuda Bay	57° 19'	153° 00'														
Dangerous Cape	57° 19'	152° 38'													0	2
Ugak Bay	57° 27'	152° 40'													1	
Ugak Island	57° 23'	152° 15'													0	
Sequel Point	57° 31'	152° 15'													0	

* Lensink (1962)

ballast, has periodically killed many sea birds in this area. Some mortality of sea otters might have occurred.

The 1970 survey and increased sightings around Afognak Island and northern Kodiak Island indicated that range expansion along the northern and western sides of Afognak Island had finally started. The 1975 and 1976 surveys indicate that the rate of range expansion has accelerated and that the size of the population has, in fact, increased substantially.

The population has gone through the classic pattern of growth described by Kenyon (1969). It remained concentrated in a small area, built to high densities, then abruptly expanded its range into adjacent vacant habitat. Whether expansion to the south was retarded by immigration to the north or by mortality from oil spills is uncertain. The population has overcome whatever limiting influences that might have existed and has entered a period of rapid range expansion.

Present Status

Survey conditions were generally good around the north side of Afognak and Shuyak Islands during the October 1975 helicopter survey. Many sea otters were resting in pods increasing their sightability. The percentage of sea otters seen was probably much higher than that seen around the Kenai Peninsula at the same time. We were forced to terminate the helicopter survey before we could clearly delineate the southwestern fringe of the population. The February 1976 skiff survey and March 1976 aerial survey corrected this one flaw and provided some information on shifts in distribution and sex segregation. Although Kodiak Island was not systematically surveyed most of its shoreline was visited during 1976. The data collected provide an excellent picture of the present distribution of the population (Figs. 6, 7, 8, 10 and 13).

The primary range of the population currently extends from Shuyak Island south to Raspberry Island on the west side of the archipelago and to Marmot Island on the east side. The area between Ban Island and Marmot Island supports sea otter densities comparable to those anywhere in the world. High proportions of females with pups were observed throughout this area. Most of the groups south of Malina Bay and Marmot Strait are probably composed of reproductively inactive animals. Scattered individuals and occasional small groups occur along the entire coast of Kodiak Island. Those between Uganik Bay and Low Cape on the northwest side and between Cape Chiniak and Two Headed Island on the southeast side probably do not represent established groups.

This distribution is typical of rapidly expanding populations, a central area of high density with well defined boundaries or "fronts" of expansion, occasional groups of nonbreeding animals ahead of the "fronts" in areas of good habitat and occasional stray animals far ahead of the "fronts." The "front" on the western side of the archipelago is less well defined than that on the eastern side, probably because areas of high quality habitat on the west side of Kodiak Island are widely separated encouraging greater dispersal.

Future

Range expansion southward along both sides of the archipelago should continue at a rapid rate over the next few years. This will be most noticeable in Marmot and Chiniak Bays which appear to contain large areas of suitable sea otter habitat. The timing of this expansion is difficult to predict but it seems reasonable to expect moderate to high densities to build up in those areas in the next 5 to 10 years. Abrupt movements of several hundred animals from Marmot Strait to such areas as Hog Island, Williams Reef and Cape Chiniak could occur at any time.

Eventually the population should become continuous with the Trinity Island population. Potential sea otter habitat on the northwest side of Kodiak Island north of Cape Ikolik appears limited and should require less time to become fully repopulated than the remainder of the island. We can expect a relatively sparse distribution of sea otters with a few small concentrations in areas such as the Noisy Islands, Chief Point and Harvester Island. The area south of Cape Ikolik is discussed under the Trinity Island population.

The southeast side of Kodiak Island has a number of large shallow areas that will probably support large numbers of sea otters. The number of stray individuals and small groups in the area should increase over the next few years. Eventually large numbers of sea otters should move into the area, primarily frcm the north but also from the Trinity Islands. It may take many years for sea otters to reach carrying capacity throughout the entire area.

Critical Areas

Virtually all reproduction in the Shuyak-Afognak population presently occurs around Shuyak Island and the northern half of Afognak Island. Rapid repopulation of Kodiak Island depends on maintenance of a high rate of reproduction in this area. Even when Kodiak Island is fully repopulated the area should remain one of the most important pieces of sea otter habitat in southcentral Alaska.

Marmot and Chiniak Bays will also be critical to the process of repopulation of the extensive areas of potential habitat along the east side of Kodiak Island for many years.

Many areas southwest of Cape Chiniak will become critical in the future. Quality of the habitat in that area should be maintained even though short-term impacts would have little effect until Chiniak Bay becomes densely populated.

3. Trinity Islands-Chirikof Island

History

An extensive area of almost 10,000 km^2 of water shallow enough to support sea otters lies between Kodiak Island and Chirikof Island. Small numbers were present in the Trinity Island area in the 1950's although no significant population could be found (Lensink 1962). This group probably represented a remnant population but could have formed from animals straying from

Shuyak Island. During the 1960's sightings around the Trinity Islands and Chirikof Island increased (Table 12). Beach dead animals were found on Tugidak Island each year by seal biologists but live otters were rarely seen from shore. In 1971 a survey of the area between Tugidak Island and Chirikof Island was attempted but poor conditions and fog interfered. Six sea otters were seen midway between Tugidak and Chirikof Islands. This suggested that the range of the population was extensive and that the population was larger than suspected.

Present Status

No funds were available to survey this area under this research unit and the area remains to be properly surveyed. The observations made during activities funded under RU 243 (Figs. 11, 12, 19, 30 and 31) provide some information on distribution of the population.

There appears to be a concentration of sea otters south of Tugidak and Sitkinak Islands. Potential sea otter habitat extends over 20 km from shore in this area. A much larger area of potential sea otter habitat exists north of the Trinity Islands. Only occasional sightings have been made in this area, however, the incidence of beach dead animals on the northwest shore of Tugidak Island (Table 8) indicates that significant numbers occur there. These animals probably tend to remain well offshore and are missed on nearshore surveys.

Another concentration occurs near Chirikof Island. Again there is a large area of potential habitat offshore and there may be many more sea otters than indicated by the limited observations presented in this report. The potential sea otter habitat around Chirikof is continuous with that around the Trinity Islands. Sea otters have been seen between the islands indicating some use of this area. Densities appear lower there than they are closer to the islands, however.

Alitak Bay was reasonably well surveyed during 1976. Occasional stray sea otters occur there but no established groups were found. Similarly, densities around the Aliulik Peninsula are low even though habitat there appears excellent. This suggests that densities around the Trinity Islands and Chirikof Island are below carrying capacity and there has been little incentive for major range expansion.

The number of sightings in the area and along the south shore of Kodiak has increased steadily, however, indicating steady population growth.

Future

This population can be expected to grow for many years. Eventually the entire area within the 80 m depth contour may support moderate to high densities. The population should expand its range into Alitak Bay and northward along both sides of Kodiak Island until its range becomes continuous with that of the northern Kodiak population. Some interchange of stray animals may have already occurred.

Critical Areas

Until more information is available, all waters less than 80 m deep southwest of Kodiak should be considered critical to this population.

VIII. Conclusions

The outer Kenai Peninsula was repopulated by sea otters emigrating from Prince William Sound and perhaps the Barren Islands. The present population is contiguous with that in Prince William Sound. All of the habitat south and east of Port Graham is presently occupied. The population is currently expanding its range into Kachemak Bay and lower Cook Inlet. The potential for significant impacts of oil and gas development on sea otters appears greatest in the area between Rocky Bay and Ninilchik.

A separate population inhabits Kamishak Bay. This population has grown and expanded its range southwestward along the Alaska Peninsula. Potential sea otter habitat in Kamishak Bay is contiguous with habitat on the Kenai Peninsula. The two populations may become continuous and it is possible that some exchange is occurring at present. Both populations should expand northward until some factor such as food availability or seasonal sea ice limits further expansion.

The Barren Islands population appears to be near carrying capacity. Little change is expected in the future.

The Shuyak-Afognak population of sea otters is rapidly expanding its range on both sides of the Kodiak Archipelago. Densities around Kodiak Island remain low but should increase dramatically as sea otters emigrate from Afognak Island. The population appears large enough to survive a major oil spill; however, such an event could seriously retard repopulation of Kodiak Island.

A separate population occupies the shallow waters between Kodiak and Chirikof Islands. This population appears to be well established and growing, however, data on distribution and abundance are inadequate.

The present distribution of sea otters in the study area and patterns of range expansion are shown in Figs. 33 and 34.

Several areas appear to be critical to the survival of healthy sea otter populations or to the process of repopulation of former sea otter habitat. These areas are shown in Figs. 35 and 36.

As sea otters expand their range into new areas significant changes in nearshore communities can be expected. Many areas currently supporting high densities of sea otters are probably rapidly changing. The history of sea otter occupancy of an area should be considered by individuals attempting to understand those communities.

IX. Needs for Further Study

Coverage of most of the study area was adequate to meet the objectives of the study. The main deficiency was in the area around the south end

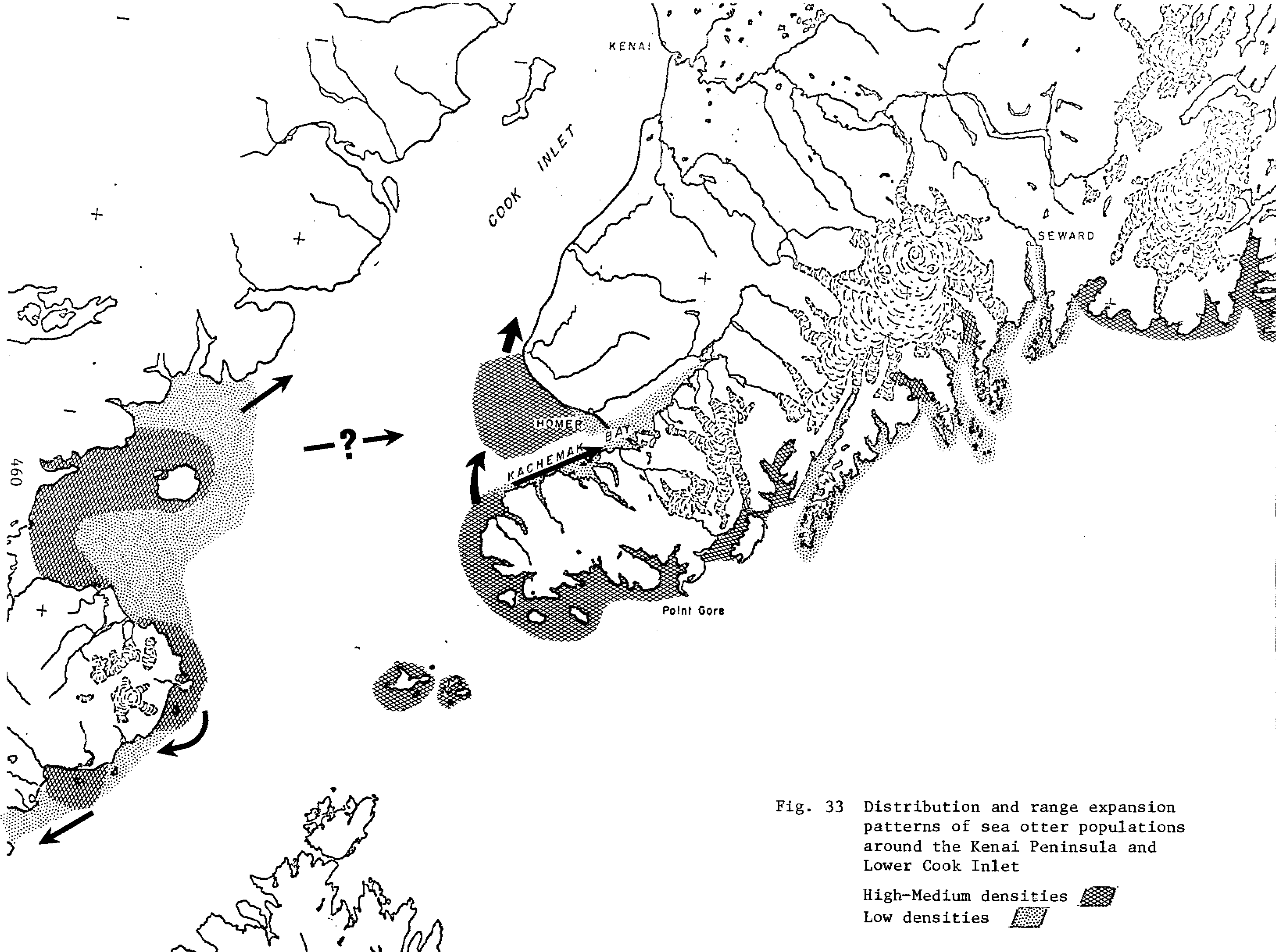


Fig. 33 Distribution and range expansion patterns of sea otter populations around the Kenai Peninsula and Lower Cook Inlet

High-Medium densities

Low densities

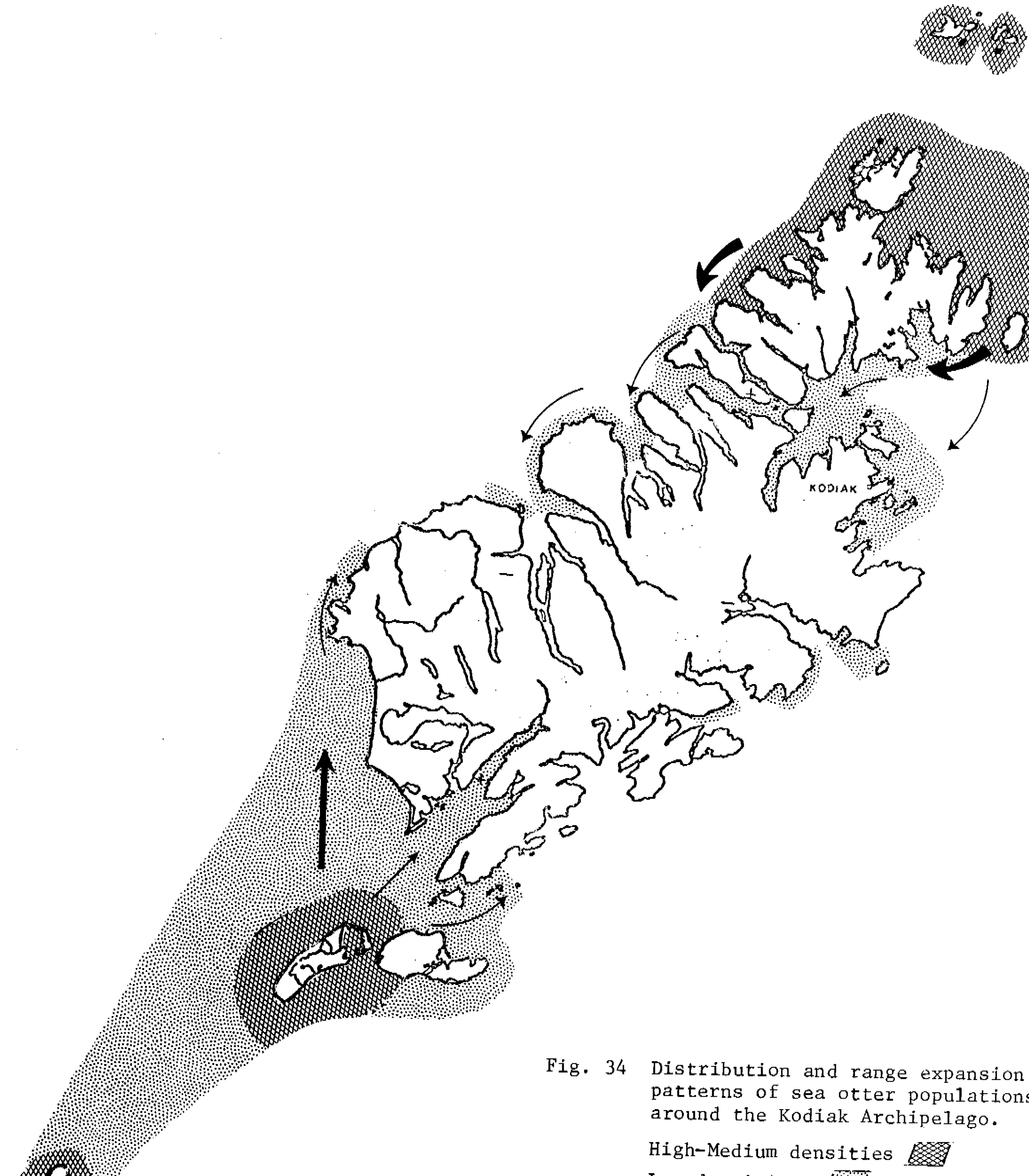


Fig. 34 Distribution and range expansion patterns of sea otter populations around the Kodiak Archipelago.

High-Medium densities

Low densities

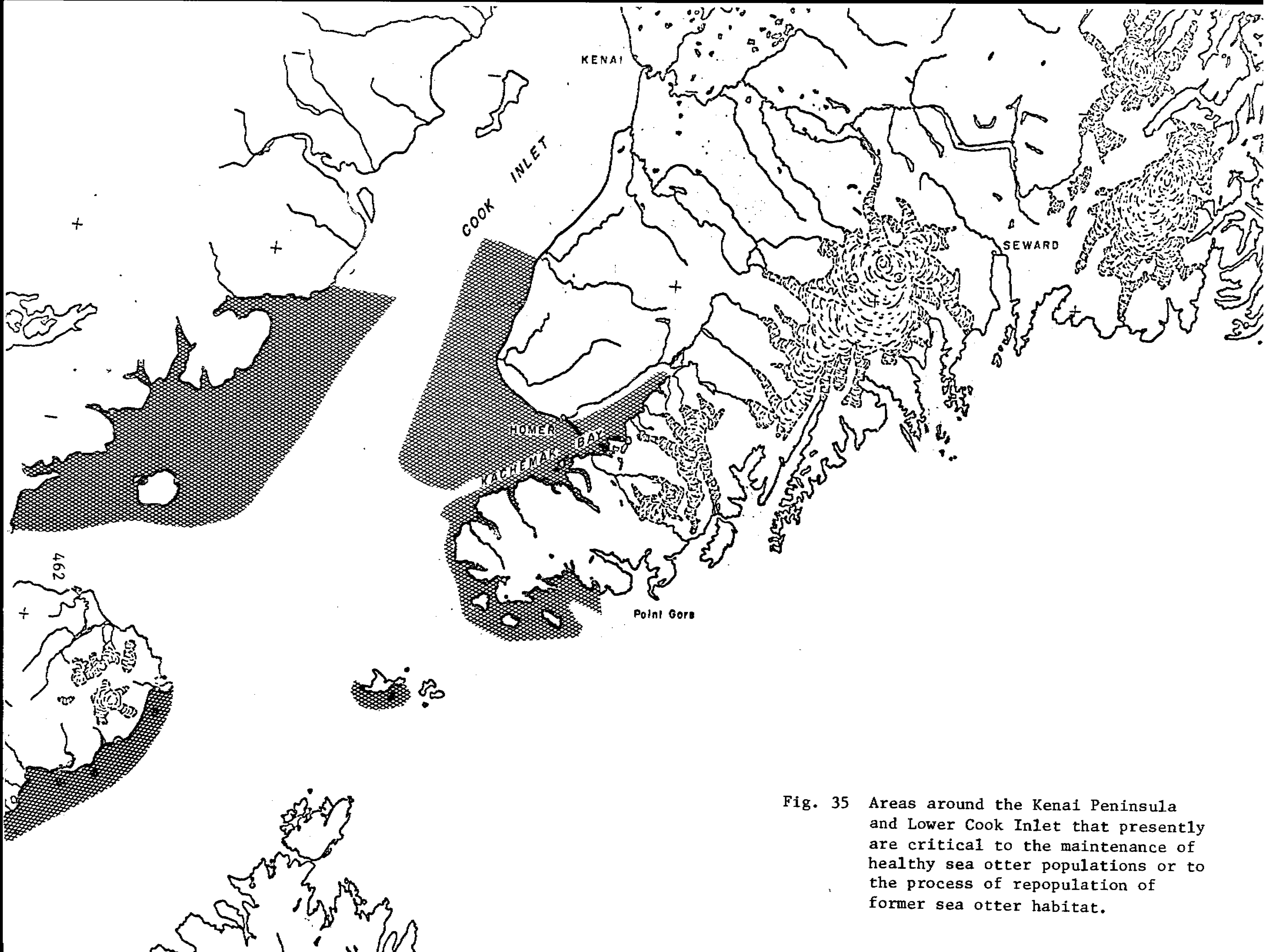


Fig. 35 Areas around the Kenai Peninsula and Lower Cook Inlet that presently are critical to the maintenance of healthy sea otter populations or to the process of repopulation of former sea otter habitat.

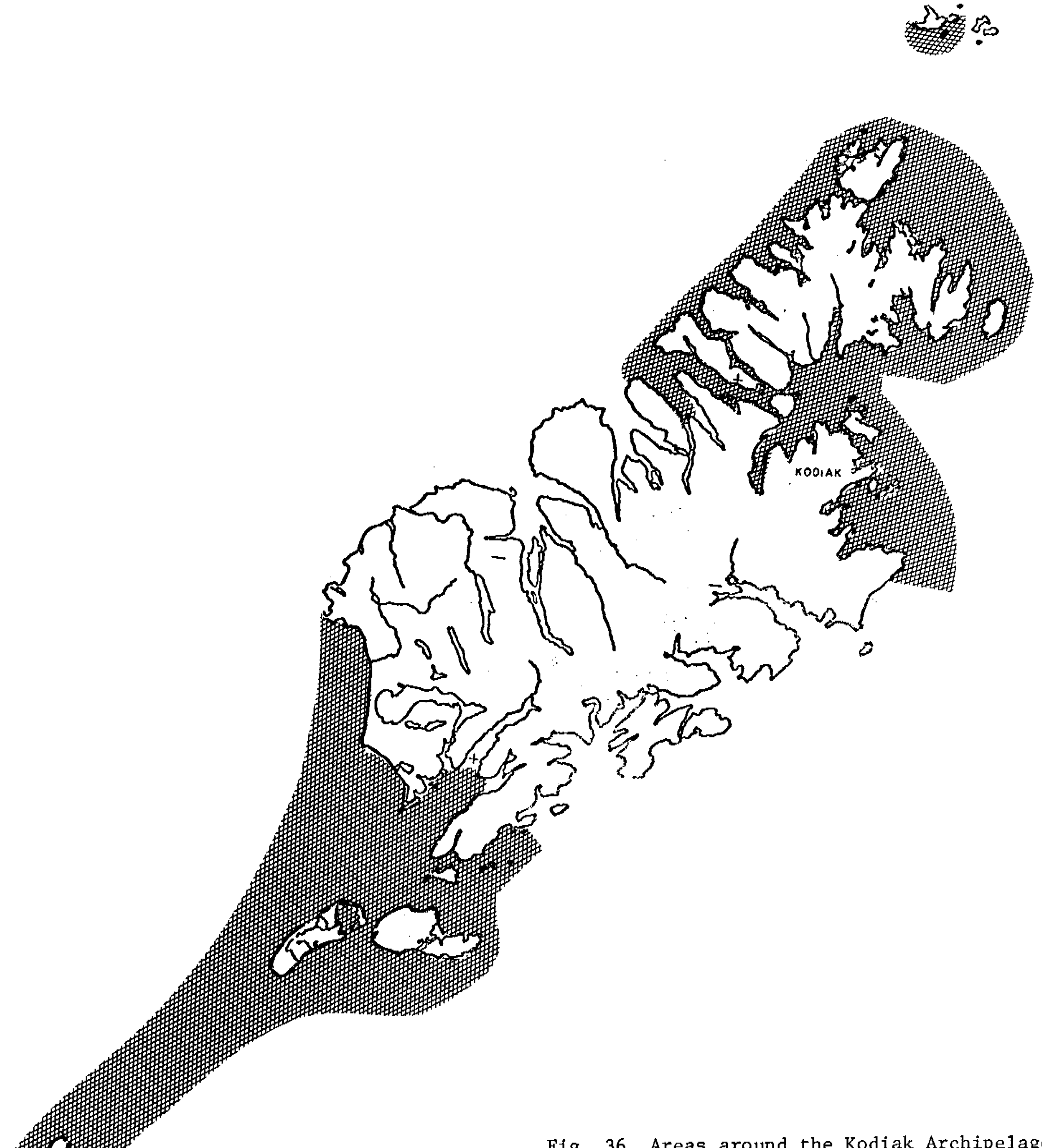


Fig. 36 Areas around the Kodiak Archipelago that presently are critical to the maintenance of healthy sea otter populations or to the process of repopulation of former sea otter habitat.

of Kodiak Island, the Trinity Islands and Chirikof Island. Shoreline surveys were not adequate in extensive shallow areas where sea otters may be scattered over hundreds of square miles. Over 9,000 km^2 of potential sea otter habitat exists southwest of Kodiak Island. Much of this lies within the proposed western Gulf of Alaska lease area. The limited observations available indicate that sea otters already inhabit much of this area. This area should be able to support several thousand sea otters. A systematic survey of the entire area should be conducted to determine the present status of the population and to delineate areas of concentrations.

Changes in sea otter distribution and abundance throughout the remainder of the study area should be monitored. This could be done in conjunction with other activities at no additional operational cost for a few years. It might be necessary to survey selected areas where range expansion is rapid in 3 to 4 years.

There are several areas of concern outside of the study area. These include:

1. Northeast Gulf of Alaska coast - The outer coast of the northeast Gulf of Alaska has generally been considered to be devoid of sea otters. Earlier surveys indicate substantial numbers south of Hinchinbrook Island and small numbers around Kayak Island (Pitcher 1975). In 1966, 10 were transplanted to Yakutat Bay. Recent observations indicate that increasing numbers of sea otters are occurring around the Copper River Delta and that small groups now occur at Icy Bay and along the outer

coast between Yakutat and Cape Fairweather. This suggests that natural repopulation of this extensive area has begun. Little of this area has been surveyed for sea otters. If the status of these groups is as tenuous as believed, it would take little to stop the repopulation of the gulf coast. The status of sea otters should be determined before extensive offshore drilling, or onshore site construction occurs. The role of the Hinchinbrook Island population should be assessed before areas west of Kayak Island are leased.

2. Southern Alaska Peninsula - Several sea otter populations occur along the south side of the Alaska Peninsula including the Semidi Islands, Shumagin Islands, Sanak Island and the Sandman Reefs. Some of these populations could be impacted by OCS development although they are more removed from proposed lease areas. Most of these populations have not been surveyed since 1970. The status of each could be determined by reviewing existing data and making additional observations during work on other research units.

3. Fox and Krenitzin Islands - The Fox and Krenitzin Islands contain large areas of vacant, former sea otter habitat. There are currently four distinct populations of sea otters and a few other small groups and scattered individuals in the area. Some of these populations have verged on extinction for many years but have recently started to grow rapidly. All are concentrated within a few km^2 and all are adjacent to the proposed Aleutian Shelf lease area. A very small oil spill could eliminate any one of these populations. Reasonably good information exists on these populations, the most recent gathered under RU #67 in

1975. This information should be summarized and additional information could be gathered during the course of other activities at little additional cost.

4. Pribilof Islands - Sea otters were once common in the Pribilof Islands but were completely exterminated. Several transplants have been made in attempts to reestablish the population. Recent surveys by National Marine Fisheries Service biologists indicate very small numbers surviving there. However, all surveys have been made during summer while fur seals were present complicating identification of sea otters. A survey, probably by boat, should be conducted while fur seals are absent. Also the possibility of larger numbers existing in shallow offshore areas should be investigated.

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FINAL REPORT

Contract #03-5-022-69

Research Unit #241

Reporting Period 1 July 1975-
30 September 1976

Number of Pages: 57

Distribution and Abundance of Sea Otters in Southwestern Bristol Bay

Karl Schneider

Alaska Department of Fish and Game

October 1, 1976

I. Summary

A systematic aerial strip transect census of sea otters was conducted north of Unimak Island and the Alaska Peninsula. The main range of the population extended from Cape Mordvinof to Cape Lieskof including Bechevin Bay, Izembek Lagoon and Moffet Lagoon. Portions of the population range over 40 km from shore. Small numbers are believed to be scattered to the west and northeast particularly near Port Moller. This range was greatly reduced from that observed in 1970 as a result of mortality caused by extreme sea ice conditions in 1971, 1972 and 1974. No range expansion has been observed since 1972; however, repopulation of former habitat between Cape Lieskof and Port Heiden should occur in the absence of severe sea ice conditions.

Survey results were expanded to indicate a total population of over 17,000 sea otters. The present population appears below the 1970 level and within the carrying capacity of the present range. Distribution within the range was influenced by water depth and perhaps weather. Observed densities averaged 3.1 sea otters/km^2 in waters 0 to 20 m deep, 5.8/km^2 in water 20-40 m deep, 0.5/km^2 in water 40-60 m deep and 0.03/km^2 in water over 60 m deep. Previous surveys indicate that at times higher densities occupy waters between 40 and 80 m deep. Few animals stray beyond the 80 m depth contour. The area between Cape Mordvinof and Cape Lieskof from shore to the 60 m contour including Bechevin Bay should be considered critical to the survival of this population.

II. Introduction

A large, and in many respects unique, population of sea otters occupies the shallow waters of southwestern Bristol Bay north of the Alaska Peninsula and Unimak Island. Most sea otter populations reside close to shore, concentrating in areas with offshore rocks and kelp beds. In contrast, otters in this population range widely in offshore waters. While at times they concentrate within a few kilometers of the adjacent sandy beaches, they frequently scatter to the vicinity of the 80 m depth contour, 50 km or more from shore.

Sea otters are probably the most vulnerable of all marine mammals to the direct effects of oil. Unlike most marine mammals they have no thick blubber layer. They rely on air trapped in their dense fur for conservation of body heat and buoyancy. When clean, this mat of fur is waterproof and the skin over most of the body remains dry. If the fur is soiled it loses its water repellency and its insulative quality. If this is not corrected quickly the animal will die of hypothermia. While little information is available on the quantities and types of petroleum products necessary to kill a sea otter it appears that relatively small amounts of both refined fuels and crude oil will cause death (Kenyon no date, Schneider unpublished data). Kenyon (1969) cited cases where massive kills may have occurred near shipwrecks.

Long-term secondary effects of chronic pollution on all high trophic level species are possible if one or more of the links in the food chain are affected. Sea otters require large quantities of food (20 to 25 percent of their own body weight per day) to support a high metabolic rate. The main factor limiting most sea otter populations appears to be food availability. Sea otters in most areas appear to feed on relatively sessile organisms. Therefore, they may be exceptionally sensitive to changes in the food chain and any effects would tend to be site specific.

The southwestern Bristol Bay sea otter population appears to be vulnerable to oil spills. It is bounded by the proposed Bristol Bay OCS lease area and by Unimak Pass, a potential hazard area for tankers. The population periodically concentrates, making it possible for a small spill to directly kill large numbers of otters. This population appears to be a likely source of otters that will repopulate the Fox and Krenitzin Islands. These island groups contain some of the largest areas of unpopulated sea otter habitat remaining in Alaska and, at present, support only a few tenuously established groups of sea otters. A severe reduction of the Unimak-Alaska Peninsula population could delay repopulation of these islands for many years.

The range and distribution of the Bristol Bay population have fluctuated in recent years, partly as a result of periodic formation of sea ice (Schneider and Faro 1975). There appear to have been some fluctuations in numbers but no reliable estimates have been made.

The objectives of this project were to:

1. Determine the current range of the population.

2. Determine the distribution of sea otters within that range.

3. Identify areas of potentially critical habitat.

4. Estimate the size of the population.

Of particular interest were the offshore limits of distribution, distribution in relationship to water depth, characteristics of the northeastern fringe of the range of the main population, which can be expected to change in the future, and the precise locations of high densities of sea otters that might indicate areas of abundant food organisms.

III. Current State of Knowledge

A number of fixed-wing aerial surveys of the study area have been flown since 1957 by U. S. Fish and Wildlife Service and Alaska Department of Fish and Game personnel. The most significant counts are summarized in Table 1. None of these surveys systematically covered the entire area and the numbers of sea otters counted varied greatly. A general pattern of changes in distribution is evident however.

A remnant population probably survived the period of commercial exploitation prior to 1911. This population was concentrated north of Unimak Island

Table 1. Significant sightings of sea otters along the north side of the Alaska Peninsula and Unimak Island.

	1957	1958	1962	1965	1969	1970	March 1971	Oct. 1971	March 1972	May 1972	Oct. 1972 to June 1973	June 1975	Aug. 1975
Cape Chichagof to Cape Greig										0	4	0	0
Cape Greig to Reindeer Creek				0				4		0		0	0
Reindeer Creek to Cape Kutuzof				0			5	40		0	3	0	0
Cape Kutuzof to Cape Lieskof				39			74	60	18	1		2	0
Cape Lieskof to Moffet Point				20			38	24	1	2		24	0
Moffet Point to Otter Point	786		811	2765	330	2157	20	273	400-600	79		198	2585
Otter Point to Cape Mordvinof				58	152							1	19
Cape Mordvinof to Cape Sarichef				10	0							0	1
Cape Sarichef to Scotch Cap		75										0	0
Total	786	75	811	2892	482	2157	137	401	-	82	7	223	2605

1957-1965 from USFWS reports by Kenyon and Lensink.
1975 Surveys conducted under RU 67 Outer Continental Shelf Environmental Assessment Program.
None of these surveys covered the entire area. The primary purpose of this table is to demonstrate changes in distribution and relative abundance in some area.

and Izembek Lagoon. During the early 1960's it expanded its range to the vicinity of Port Moller although the largest numbers remained north of Izembek Lagoon (Kenyon 1969). By 1970 sea otters were common as far northeastward as Port Heiden and occasional individuals were seen near Ugashik and Egegik Bays. In 1971, 1972 and 1974 sea ice, which normally forms only to the vicinity of Port Heiden, advanced to Unimak Island. Many sea otters were killed and others were forced southwestward (Schneider and Faro 1975). The cumulative effects of the 3 years of ice formation appeared to severely restrict the range of this population to the area west of Cape Lieskof. Occasional sea otters have been sighted to the northeast of that point particularly near Port Moller; however, no established groups have been located and no evidence of expansion of the main population into formerly occupied habitat northeast of Cape Lieskof has been found since 1972 (Fig. 1).

The effects of the sea ice on numbers of sea otters were less evident. Mortality of several hundred sea otters was observed in 1971 and 1972 and the possibility that several thousand died existed. The lack of range expansion suggests that densities of sea otters west of Cape Lieskof are lower than those in the 1960's when considerable range expansion occurred. This suggests that a significant reduction in numbers did occur.

Because potential range of the population covers over 10,000 km^2 of open water, traditional survey methods have not been adequate to estimate the size of the population. Kenyon (1969) estimated that the population was over 3,800 in 1965 but more recent information indicates that his

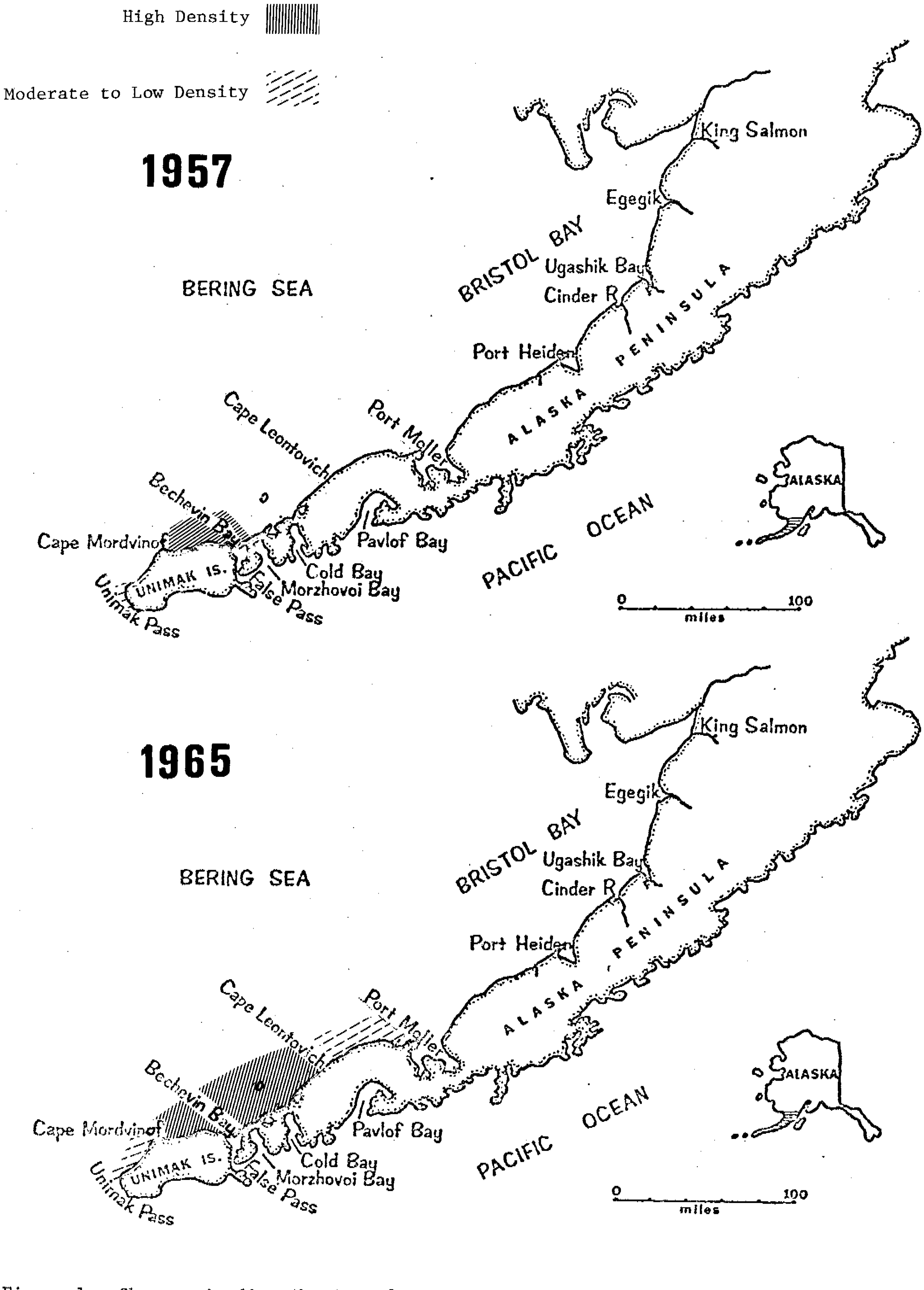


Figure 1. Changes in distribution of sea otters north of the Alaska Peninsula and Unimak Island 1957-1965.

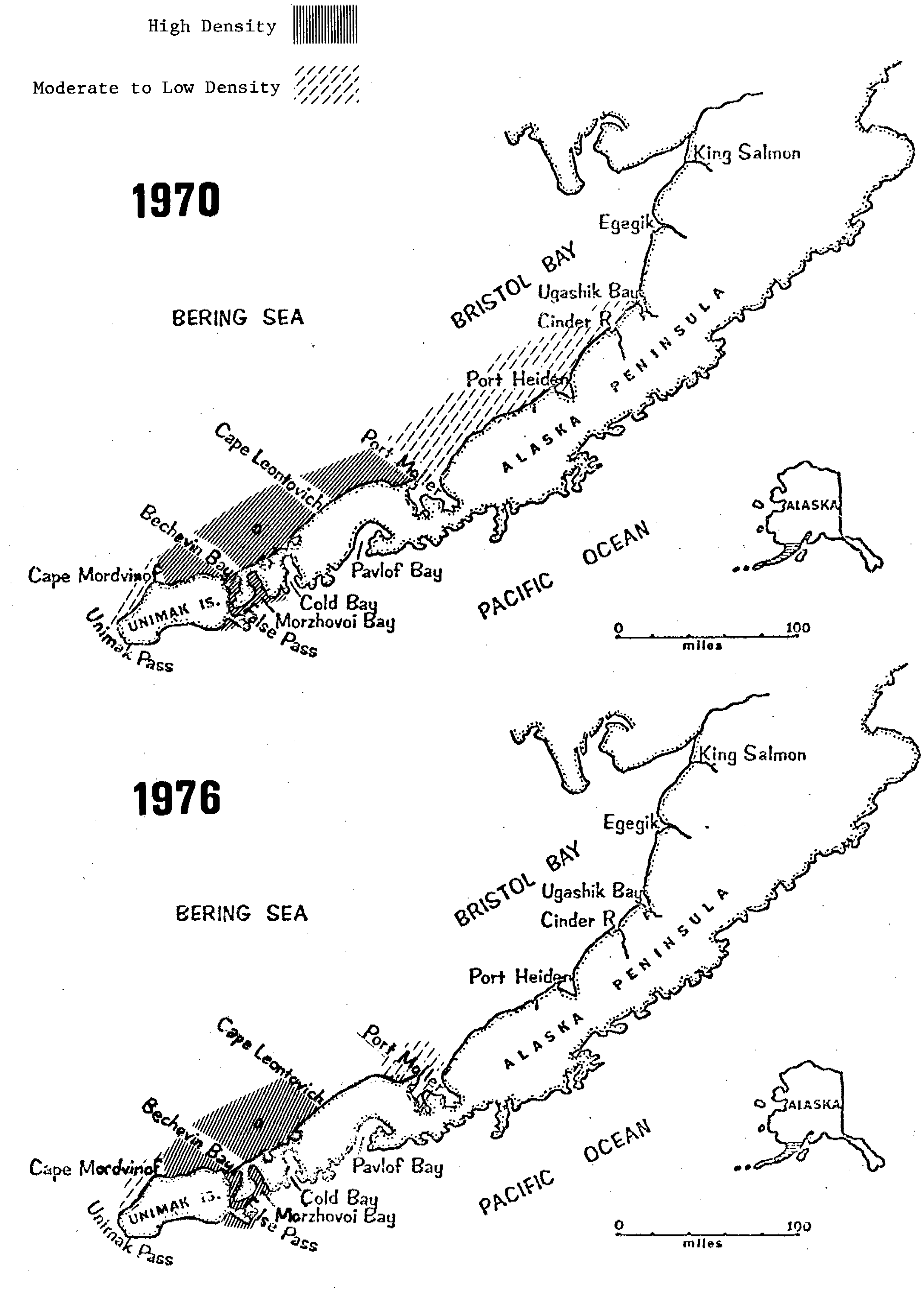


Figure 1.(cont'd.) Changes in distribution of sea otters north of the Alaska Peninsula and Unimak Island 1970-1976.

survey did not cover the entire range of the population and that considerable population growth occurred after that time. In 1970 a total of 2,157 sea otters was counted in photographs of several pods clustered southeast of Amak Island. One of these pods was the largest ever recorded, containing over 1,000 sea otters. No pups were visible in the photographs, indicating that all segments of the population were not represented. Crude estimates made from aerial surveys conducted prior to 1970 indicated that this population contained on the order of 8,000 to 10,000 sea otters (Alaska Department of Fish and Game 1973). These estimates would not stand up to statistical scrutiny however.

IV. Study Area

At one time or another parts of this population have been observed in the waters north of Unimak Island and the Alaska Peninsula from Scotch Cap to Egegik Bay (Fig. 1). They have occupied Bechevin Bay, Izembek Lagoon and Port Moller frequently and probably at least small numbers have used all of the bays and lagoons in the area. Surveys indicate that large numbers may occasionally move offshore to the vicinity of the 80 m depth contour north of Unimak Island and Izembek Lagoon. Some otters have been sighted 50 km from shore and one moribund animal was found over 100 km from shore (T. Newby, pers. comm.). The potential study area delineated by these observations is over 10,000 km^2.

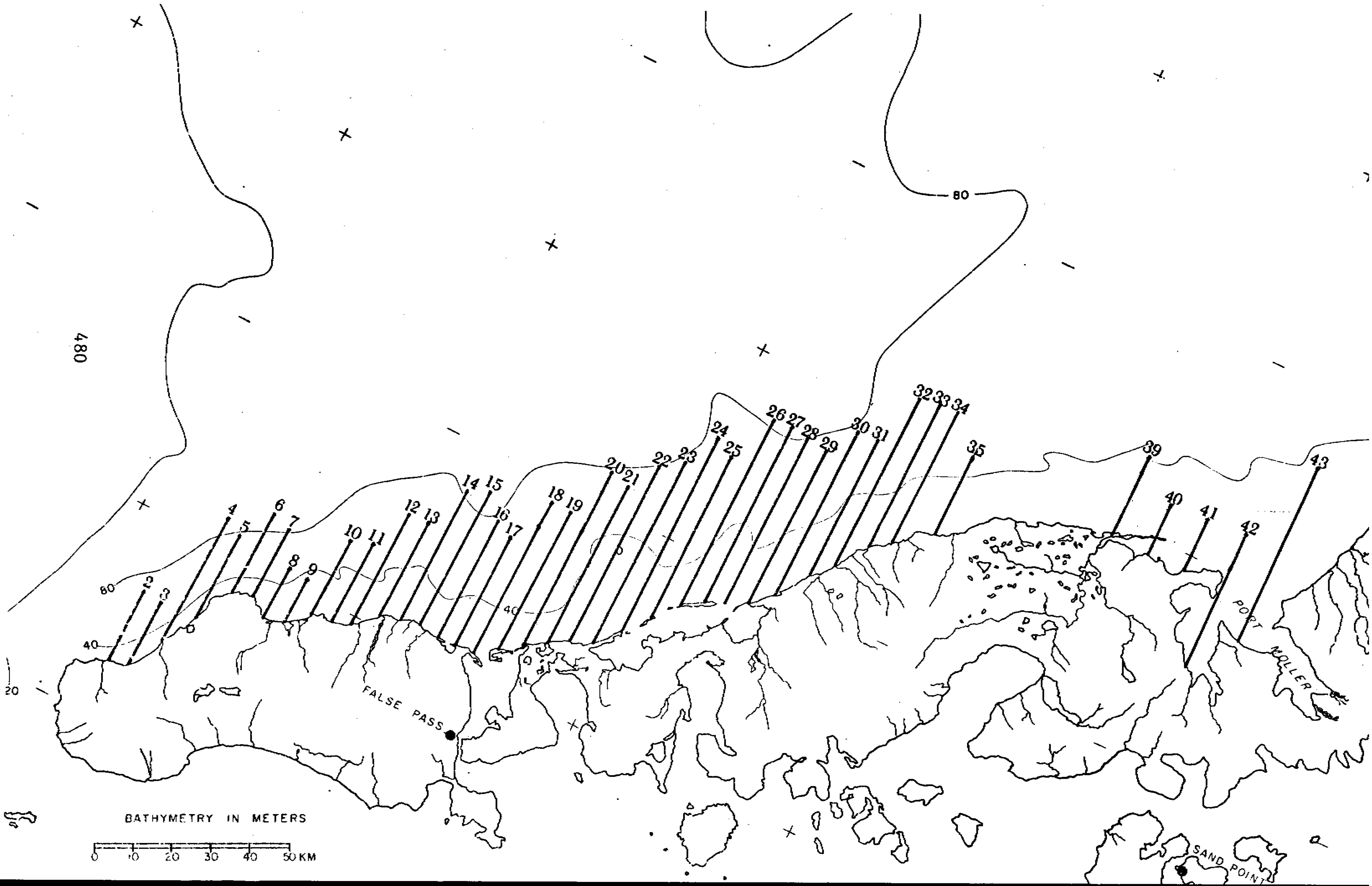
Although information was gathered throughout the entire area during the contract period, most of the effort was directed at the area from Cape Sarichef to Port Moller.

V. Methods

Information on the distribution of the population was gathered on aerial surveys conducted under RU 67 in June and August 1975 and RU 243 in June 1976. These surveys were made from a Grumman Super Widgeon flown in an irregular pattern over concentrations of marine mammals. All sea otters sighted were counted visually or photographed with motor-driven 35 mm cameras.

On 30 and 31 July 1976 a systematic aerial survey of the main population's range was made. The survey platform was the U. S. Department of Interior, Office of Aircraft Services turbo Goose N780. The aircraft was flown along predetermined tracklines which generally extended along north-south lines extending from shore to the vicinity of the 80 m depth contour. Navigation was aided by the Global Navigation System (GNS 500). Corrected flightlines are shown in Fig. 2. The aircraft was maintained at a constant altitude of 200 feet (61 m) and a constant airspeed of 120 knots (222 km/hr). Two observers counted all sea otters seen within 0.1 nautical mile (185 m) strips on either side of the aircraft. Strip width was determined with the aid of an inclinometer specifically designed for the survey. Allowance was made for a strip directly under the aircraft that was not visible to the observers. All observations were transmitted over a portable intercom system to a third individual who recorded them on standardized data sheets. For each group of sea otters the time of the observation, group size, side of the aircraft and whether they were resting or active were recorded.

Figure 2. Strip Transects flown on 30-31 July 1976 sea otter survey.



Two other observers sat in the rear of the aircraft and recorded all sea otters seen regardless of distance from the aircraft. Particular attention was paid to the occurrence of large pods outside of the limited strip transects. While these observers counted "unlimited" width strips, their range was limited by a variety of conditions and no duplication occurred on consective transects. One of the observers recorded observations for both rear observers.

Both recorders synchronized stop watches at the start of each transect and recorded the times of observations to the nearest second. The recorder for the limited strip survey also periodically recorded latitude and longitude indicated by the GNS 500. This procedure permitted fairly precise determination of the location of each observation and facilitated comparison of observations between the limited and unlimited strip surveys.

An irregular flight pattern was used in Bechevin Bay as past surveys indicated that sea otters tended to concentrate in specific parts of the bay making a strip census inappropriate. A direct count was made of this area.

Visibility conditions were classified for each transect according to the following system:

Code

1 Excellent - surface of water calm, usually a high overcast sky with no sun glare. Sea otters appear dark against a uniformly light gray background of the water's surface. Individuals easily distinguished at a distance.

2 Very good - May be light ripple on water's surface or slightly uneven lighting but still relatively easy to distinguish individuals at a distance.

3 Good - may be light chop, some sun glare or shadows. Individuals at a distance may be difficult to distinguish but individuals nearby and small groups at a distance are readily identified.

4 Fair - usually choppy waves and strong sun glare or dark shadows in part of the survey track. Individuals in kelp beds, in the lee of rocks, or near the observer and most pods readily identified but most individuals and some pods in areas of poor lighting or at a distance difficult to distinguish.

5 Poor - individuals difficult to distinguish unless very close and some pods at a distance may be missed, however, conditions still good enough to give a very rough impression of the distribution of animals.

6 Unacceptable - heavy chop with many whitecaps, lighting poor or large waves breaking on rocks. No surveys should be conducted under these conditions but occasionally a sighting of significance may be made in the course of other activities.

This system differs somewhat from that used by Estes and Smith (1973), but is similar to that used by Kenyon (1969).

Personnel participating in the 30-31 July survey were Herman Reuss - pilot, John Sasso - co-pilot, Karl Schneider and Kenneth Pitcher - limited strip observers, Roger Aulabaugh - recorder, Donald Calkins and James Faro - unlimited strip observers. Paul Arneson conducted a survey of birds under RU 3/4 from the rear of the aircraft. Distances were expressed in nautical miles because this unit's relationship to latitude and the speed of the aircraft facilitated the plotting of observations.

VI. Results

Results of the survey are presented in Tables 2 and 3. Each transect was broken into 2 nautical mile (3.7 km) long segments. Segment A extended from shore to 2 nm (3.7 km) from shore, segment B from 2 nm (3.7 km) to 4 nm (7.4 km) from shore, etc. Each segment in the limited width strip survey would represent two parallel rectangles 2 nm (3.7 km) long and 0.1 nm (0.185 km) wide separated by approximately 50 m. The total area surveyed in each limited width segment was 0.4 nm^2 (1.37 km^2). Each segment also represents approximately 1.0 minute of survey time. The data have been grouped into these segments for convenience.

Table 2. Results of sea otter transect survey north of the Alaska Peninsula and Unimak Island - 30 and 31 July 1976.

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day	Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm²)	Ratio Unlimited/ 0.2nm Track *
2 A	164° 50'	31	1221	6	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
3 A	164° 45'	31	1214	2	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
4 A	164° 40'	31	1202	2	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
5 A	164° 35'	31	1153	2	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	1	0	+
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
6 A	164° 30'	31	1143	2	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
7 A	164° 25'	31	1136	3	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day	Hour Min.	Visi-bility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm^2)	Ratio* Unlimited/ 0.2nm Track
8 A	164° 20'	31	1128	6	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
9 A	164° 15'	31	1122	6	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
10 A	164° 10'	31	1112	1	2	0	0	2	4	11	10.0	2.8
B					13	0	2	6	21	27	52.5	1.3
C					0	0	6	0	6	26	15.0	4.3
D					0	1	0	0	1	13	7.5	13.0
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	3	0	+
G					0	0	0	0	0	0	0	
11 A	164° 05'	31	1103	1	0	0	0	0	0	0	0	
B					7	0	0	0	7	46	17.5	6.6
C					0	0	15	2	17	50	42.5	2.9
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
12 A	164° 00'	31	1053	2	1	0	0	0	1	4	2.5	4
B					21	0	0	7	28	44	70.0	1.6
C					1	1	0	1	3	3	7.5	1.0
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	2	0	+
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
13 A	163° 55'	31	1044	1	2	2	11	0	15	19	37.5	1.3
B					0	0	0	5	5	4	12.5	0.8
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	1	0	+
E					0	0	0	0	0	1	0	+
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day	Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm^2)	Ratio * Unlimited/ 0.2nm Track
14 A	163° 50'	31	1032	1	4	0	0	0	4	8	10.0	2.0
B					9	0	0	26	35	171	87.5	4.9
C					0	0	0	0	0	3	0	+
D					0	0	0	1	1	0	2.5	0
E					0	0	0	0	0	0	0	
F					0	0	0	1	1	0	2.5	0
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
15 A	163° 45'	31	1020	1	1	1	0	2	4	8	10.0	2.0
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	4	0	+
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
G					0	0	0	1	1	1	2.5	1.0
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	1	0	+
16 A	163° 40'	30	1720	1	3	0	0	0	3	29	7.5	9.6
B					97	0	5	42	144	246	360.0	1.7
C					0	0	4	0	4	17	10.0	4.25
D					3	0	1	0	4	5	10.0	1.25
E					0	0	1	0	1	2	2.5	2.0
F					0	0	0	0	0	2	0	+
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
17 A	163° 35'	30	1711	2	2	1	0	0	3	6	7.5	2.0
B					0	0	0	1	1	1	2.5	1.0
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	2	0	+
E					0	0	0	0	0	1	0	+
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
18 A	163° 30'	30	1658	2	0	0	2	1	3	2	7.5	0.7
B					0	0	2	0	2	1	5.0	0.5
C					0	0	0	0	0	2	0	+

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day	Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm^2)	Ratio * Unlimited/ 0.2nm Track
18 D					0	0	0	0	0	0	0	
E					1	2	1	2	6	2	15	0.3
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
H					0	0	0	2	2	2	5.0	1.0
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
K					1	0	0	0	1	1	2.5	1.0
L					0	0	0	0	0	0	0	
19 A	163° 25'	30	1644	2	0	0	0	0	0	0	0	
B					0	0	0	0	0	44	0	+
C					0	0	0	7	7	2	17.5	0.3
D					0	0	1	1	2	3	5.0	1.5
E					0	2	0	0	2	1	5.0	0.5
F					0	0	0	0	0	0	0	
G					0	1	1	0	2	0	5.0	0
H					0	0	0	0	0	0	0	
I					2	0	0	0	2	1	5.0	0.5
J					0	0	0	0	0	0	0	
K					0	0	0	0	0	0	0	
20 A	163° 20'	30	1320	1	13	2	0	0	15	25	37.5	1.7
B					0	0	0	0	0	2	0	+
C					0	0	0	0	0	0	0	
D					0	0	1	0	1	3	2.5	3.0
E					0	0	0	0	0	0	0	
F					0	0	0	1	1	1	2.5	1.0
G					0	1	0	0	1	0	2.5	0
H					0	0	1	1	2	4	5.0	2.0
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	1	0	+
K					1	0	0	0	1	0	2.5	0
L					0	0	0	0	0	0	0	
M					0	0	0	0	0	0	0	
21 A	163° 15'	30	1307	1	0	0	1	1	2	1	5.0	0.5
B					0	0	0	0	0	1	0	+
C					0	0	0	0	0	3	0	+
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day	Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm^2)	Ratio * Unlimited/ 0.2nm Track
21 G					0	0	0	0	0	1	0	+
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	2	0	+
J					0	0	0	0	0	0	0	
K					0	0	0	0	0	0	0	
22 A	163° 10'	30	1250	1	0	1	0	1	2	0	5.0	0
B					100	0	0	0	100	50	250.0	0.5
C					0	0	1	0	1	5	2.5	5.0
D					1	0	0	0	1	2	2.5	2.0
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
K					1	0	0	0	1	1	2.5	1.0
L					0	0	0	0	0	0	0	
M					0	0	0	0	0	0	0	
N					0	0	0	0	0	0	0	
23 A	163° 05'	30	1235	2	0	0	9	0	9	129	22.5	14.3
B					1	1	0	0	2	33	5.0	16.5
C					0	0	1	0	1	20	2.5	20.0
D					2	0	0	0	2	122	5.0	61.0
E					0	0	0	1	1	0	2.5	0
F					0	0	0	1	1	0	2.5	0
G					2	0	0	0	2	1	5.0	0.5
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
K					0	0	1	0	1	0	2.5	0
L					0	0	0	0	0	0	0	
M					0	0	0	0	0	2	0	
N					0	0	0	0	0	0	0	
O					0	0	0	0	0	2	0	+
24 A	163° 00'	30	1218	2	0	0	0	0	0	0	0	
B					1	3	1	0	5	3	12.5	0.6
C					0	0	0	0	0	1	0	+
D					0	0	0	0	0	0	0	

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm²)	Ratio * Unlimited/ 0.2nm Track
24 E				0	0	0	0	0	2	0	+
F				0	0	0	0	0	0	0	
G				0	0	0	0	0	0	0	
H				0	0	0	0	0	0	0	
I				0	0	1	0	1	0	2.5	0
J				0	0	0	0	0	0	0	
K				1	0	0	0	1	1	2.5	1.0
L				0	0	0	0	0	0	0	
M				0	0	0	0	0	0	0	
N				0	0	0	0	0	0	0	
O				0	0	0	0	0	0	0	
P				0	0	0	0	0	2	0	+
25 A	162° 55'	30 1203	1	0	0	0	0	0	0	0	
B				0	0	0	0	0	1	0	+
C				0	0	1	0	1	0	2.5	0
D				2	0	0	0	2	0	5.0	0
E				0	0	0	0	0	3	0	+
F				0	0	0	0	0	0	0	
G				0	0	0	0	0	0	0	
H				0	0	0	0	0	0	0	
I				0	0	0	0	0	0	0	
J				0	0	0	0	0	0	0	
K				0	0	0	0	0	0	0	
L				0	0	0	0	0	0	0	
26 A	162° 50'	30 1146	1	0	0	0	0	0	0	0	
B				0	2	0	0	2	0	5.0	0
C				0	0	0	1	1	2	2.5	2.0
D				2	0	0	0	2	3	5.0	1.5
E				0	0	0	0	0	0	0	
F				0	0	1	0	1	0	2.5	0
G				0	0	0	0	0	1	0	+
H				0	0	0	0	0	0	0	
I				0	0	0	0	0	0	0	
J				0	0	0	0	0	0	0	
K				0	0	0	0	0	0	0	
L				0	0	0	0	0	0	0	
M				0	0	0	0	0	0	0	
N				0	0	0	0	0	0	0	
O				0	0	0	0	0	0	0	

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day	Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm^2)	Ratio * Unlimited/ 0.2nm Track
27 A	162° 45'	30	1130	1	1	0	0	0	1	1	2.5	1.0
B					0	2	0	2	4	39	10.0	9.8
C					10	4	22	0	36	52	90.0	1.4
D					0	0	0	0	0	0	0	
E					1	0	0	0	1	2	2.5	2.0
F					0	0	0	1	1	1	7.5	1.0
G					0	0	0	0	0	0	0	
H					0	0	1	0	1	2	2.5	2.0
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
K					0	0	0	0	0	0	0	
L					0	0	0	0	0	0	0	
M					0	0	0	0	0	0	0	
28 A	162° 40'	30	1115	1	0	0	0	0	0	1	0	+
B					0	0	0	1	1	38	2.5	38
C					2	1	3	15	21	29	52.5	1.4
D					8	3	2	4	17	19	42.5	1.1
E					3	2	1	8	14	40	35.0	2.9
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
H					1	1	0	0	2	0	5.0	0
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
K					0	0	0	0	0	0	0	
L					0	0	0	0	0	4	0	+
M					0	0	0	0	0	0	0	
29 A	162° 35'	30	1100	1	0	0	0	0	0	0	0	
B					0	0	2	1	3	0	7.5	0
C					0	0	25	0	25	23	62.5	0.9
D					1	3	1	0	5	87	12.5	17.4
E					4	4	0	0	8	3	20.0	0.4
F					6	3	1	1	11	7	27.5	0.6
G					1	0	0	0	1	68	2.5	68.0
H					0	0	4	0	4	29	10.0	7.3
I					0	0	0	0	0	4	0	+
J					0	0	0	0	0	0	0	
K					0	0	0	0	0	0	0	

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm^2)	Ratio * Unlimited/ 0.2nm Track
30 A	162° 30'	30 1454	1	1	0	0	0	1	0	2.5	0
B				2	0	0	0	2	9	5.0	4.5
C				2	0	0	0	2	3	5.0	1.5
D				0	0	0	0	0	0	0	
E				0	0	50	0	50	60	125	1.2
F				0	6	0	0	6	42	15	7.0
G				0	0	0	0	0	2	0	+
H				0	0	0	2	2	3	5.0	1.5
I				0	0	0	3	3	8	7.5	2.7
J				0	0	0	0	0	0	0	
K				0	0	0	0	0	3	0	+
L				0	0	0	0	0	0	0	
M				0	0	0	0	0	0	0	
31 A	162° 25'	30 1509	1	1	0	0	14	15	2	37.5	0.13
B				0	2	3	0	5	3	12.5	0.6
C				35	1	0	0	36	29	90.0	0.8
D				0	0	0	0	0	15	0	+
E				0	0	0	1	1	1	2.5	1.0
F				3	0	0	0	3	1	7.5	0.3
G				0	0	0	0	0	0	0	
H				0	0	0	0	0	0	0	
I				0	0	0	0	0	0	0	
J				0	0	0	0	0	0	0	
K				0	0	0	0	0	0	0	
32 A	162° 20'	30 1518	1	0	0	2	0	2	2	5.0	1.0
B				0	1	0	0	1	0	2.5	0
C				0	0	0	0	0	0	0	
D				0	0	0	1	1	0	2.5	0
E				0	0	0	0	0	0	0	
F				0	0	0	0	0	0	0	
G				0	0	0	0	0	1	0	+
H				0	0	0	0	0	0	0	
I				0	0	0	0	0	0	0	
J				0	0	0	0	0	0	0	
K				0	0	0	0	0	0	0	
L				0	0	0	0	0	0	0	
M				0	0	0	0	0	0	0	
33 A	162° 15'	30 1537	1	0	1	0	0	1	1	2.5	1.0
B				0	0	0	2	2	10	5.0	5.0

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day	Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm²)	Ratio* Unlimited/ 0.2nm Track
33 C					4	2	2	0	8	4	20.0	0.5
D					6	2	0	0	8	0	20.0	0
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
K					0	0	0	0	0	0	0	
L					0	0	0	0	0	0	0	
34 A	162° 10'	30	1555	1	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
K					0	0	0	0	0	0	0	
35 A	162° 00'	30	1612	3	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
39 A	161° 20'	31	1421	2	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
40 A	161° 10'	31	1430	1	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	

Table 2. (cont'd)

Transect Number	Trackline Deg. Min. Longitude	Start Date/Time ADT Day	Hour Min.	Visibility Code	Sea Otters Counted: Left Track (0.1nm) Resting	Left Track (0.1nm) Active	Right Track (0.1nm) Resting	Right Track (0.1nm) Active	Total 0.2nm Track	Total Unlim. Track	Density 0.2nm Track (Otters/nm^2)	Ratio * Unlimited/ 0.2nm Track
41 A	161° 00'	31	1438	1	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
42 A	160° 50'	31	1445	1	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
43 A	160° 40'	31	1502	1	0	0	0	0	0	0	0	
B					0	0	0	0	0	0	0	
C					0	0	0	0	0	0	0	
D					0	0	0	0	0	0	0	
E					0	0	0	0	0	0	0	
F					0	0	0	0	0	0	0	
G					0	0	0	0	0	0	0	
H					0	0	0	0	0	0	0	
I					0	0	0	0	0	0	0	
J					0	0	0	0	0	0	0	
K					0	0	0	0	0	0	0	
L					0	0	0	0	0	0	0	
M					0	0	0	0	0	0	0	
Bechevin Bay		30	1732	5						186		

* + = Infinity

Table 3. Sizes of sea otter groups sighted on 30-31 July 1976 transect survey.

Transect	Track width	Frequency of Occurance of Group Size 1	2	3	4	5	Sizes of Larger Pods
5 D	0.2 nm						
	Unlimited	1					
10 A	0.2 nm	2	1				
	Unlimited	3	2		1		
B	0.2 nm	2		3			10
	Unlimited	3	2	1			7, 10
C	0.2 nm	1	1	1			
	Unlimited		3			1	6, 9
D	0.2 nm	1					
	Unlimited	2					11
F	0.2 nm						
	Unlimited			1			
11 B	0.2 nm	2	1	1			
	Unlimited	2			1		20, 20
C	0.2 nm	2					15
	Unlimited		2		1		14, 20, 8
12 A	0.2 nm	1					
	Unlimited	1		1			
B	0.2 nm	2	1				6, 7, 11
	Unlimited			2		1	6, 27
C	0.2 nm	3					
	Unlimited	3					
F	0.2 nm						
	Unlimited		1				
13 A	0.2 nm	5	5				
	Unlimited	4	2	2		1	
B	0.2 nm	3	1				
	Unlimited	1		1			
D	0.2 nm						
	Unlimited	1					
E	0.2 nm						
	Unlimited	1					
14 A	0.2 nm	2	1				
	Unlimited	3					
B	0.2 nm	2	1			1	7, 11, 13
	Unlimited				1		80, 20, 30, 20, 17
C	0.2 nm						
	Unlimited	1	1				
D	0.2 nm	1					
	Unlimited						
F	0.2 nm	1					
	Unlimited						

Table 3. (cont.) Sizes of sea otter groups sighted on 30-31 July 1976 transect survey.

		Frequency of Occurance of Group Size					Sizes of
Transect	Track width	1	2	3	4	5	Larger Pods
15 A	0.2 nm	2	1				
	Unlimited	2	3				
C	0.2 nm						
	Unlimited	2	1				
G	0.2 nm	1					
	Unlimited	1					
J	0.2 nm						
	Unlimited	1					
16 A	0.2 nm	1	1				
	Unlimited	1	1	1			23
B	0.2 nm	7	6				35, 60, 30
	Unlimited		5				100, 40, 8, 9, 50, 17, 12
C	0.2 nm	1		1			
	Unlimited				1		6, 7
D	0.2 nm	4					
	Unlimited	1	2				
E	0.2 nm	1					
	Unlimited	2					
F	0.2 nm						
	Unlimited	2					
17 A	0.2 nm	1	1				
	Unlimited	4	1				
B	0.2 nm	1					
	Unlimited	1					
D	0.2 nm						
	Unlimited	2					
E	0.2 nm						
	Unlimited	1					
18 A	0.2 nm	1	1				
	Unlimited		1				
B	0.2 nm		1				
	Unlimited	1					
C	0.2 nm						
	Unlimited		1				
E	0.2 nm	4	1				
	Unlimited	2					
H	0.2 nm		1				
	Unlimited		1				
K	0.2 nm	1					
	Unlimited	1					

Table 3. (cont.) Sizes of sea otter groups sighted on 30-31 July 1976 transect survey.

Transect	Track width	Frequency of Occurance of Group Size 1	2	3	4	5	Sizes of Larger Pods
19 B	0.2 nm						
	Unlimited						9, 35
C	0.2 nm		1				5
	Unlimited	2					
D	0.2 nm	2					
	Unlimited	1	1				
E	0.2 nm	2					
	Unlimited	1					
G	0.2 nm	2					
	Unlimited						
I	0.2 nm		1				
	Unlimited	1					
20 A	0.2 nm	2			1		9
	Unlimited	1		1			6, 7, 8
B	0.2 nm						
	Unlimited	2					
D	0.2 nm	1					
	Unlimited			1			
F	0.2 nm	1					
	Unlimited	1					
G	0.2 nm	1					
	Unlimited						
H	0.2 nm	2					
	Unlimited	2	1				
J	0.2 nm						
	Unlimited	1					
K	0.2 nm	1					
	Unlimited						
21 A	0.2 nm	2					
	Unlimited	1					
B	0.2 nm						
	Unlimited	1					
C	0.2 nm						
	Unlimited	1	1				
G	0.2 nm						
	Unlimited	1					
I	0.2 nm						
	Unlimited		1				
22 A	0.2 nm	2					
	Unlimited						
B	0.2 nm						100
	Unlimited						50
C	0.2 nm	1					
	Unlimited					1	
D	0.2 nm	1					
	Unlimited	2					
K	0.2 nm	1					
	Unlimited	1					

Table 3. (cont.) Sizes of sea otter groups sighted on 30-31 July 1976 transect survey.

Transect	Track width	Frequency of Occurance of Group Size 1	2	3	4	5	Sizes of Larger Pods
23 A	0.2 nm	1					8
	Unlimited						50, 50, 15, 14
B	0.2 nm	2					
	Unlimited	1	1				30
C	0.2 nm	1					
	Unlimited	1					9, 10
D	0.2 nm		1				
	Unlimited	2					20, 100
E	0.2 nm	1					
	Unlimited						
F	0.2 nm	1					
	Unlimited						
G	0.2 nm		1				
	Unlimited	1					
K	0.2 nm	1					
	Unlimited						
M	0.2 nm						
	Unlimited		1				
O	0.2 nm						
	Unlimited		1				
24 B	0.2 nm	2		1			
	Unlimited	1	1				
C	0.2 nm						
	Unlimited	1					
E	0.2 nm						
	Unlimited	2					
I	0.2 nm	1					
	Unlimited						
K	0.2 nm	1					
	Unlimited	1					
P	0.2 nm						
	Unlimited		1				
25 B	0.2 nm						
	Unlimited	1					
C	0.2 nm	1					
	Unlimited						
D	0.2 nm		1				
	Unlimited						
E	0.2 nm						
	Unlimited	1	1				
26 B	0.2 nm	2					
	Unlimited						
C	0.2 nm	1					
	Unlimited	2					
D	0.2 nm		1				
	Unlimited	1	1				
F	0.2 nm	1					
	Unlimited						
G	0.2 nm						
	Unlimited	1					

Table 3. (cont.) Sizes of sea otter groups sighted on 30-31 July 1976 transect survey.

Transect	Track width	Frequency of Occurance of Group Size 1	2	3	4	5	Sizes of Larger Pods
27 A	0.2 nm	1					
	Unlimited	1					
B	0.2 nm	2	1				
	Unlimited	3					16, 20
C	0.2 nm	6	1	1			8, 17
	Unlimited	2		2	1		7, 7, 10, 16
E	0.2 nm	1					
	Unlimited	2					
F	0.2 nm	1					
	Unlimited	1					
H	0.2 nm	1					
	Unlimited		1				
28 A	0.2 nm						
	Unlimited	1					
B	0.2 nm	1					
	Unlimited						30, 8
C	0.2 nm	4	1				15
	Unlimited	1		1			9, 16
D	0.2 nm	5	2	1		1	
	Unlimited	6	1	1	2		
E	0.2 nm	3	1	1			6
	Unlimited	2	1		2		16, 12
H	0.2 nm	2					
	Unlimited						
L	0.2 nm						
	Unlimited		2				
29 B	0.2 nm	1	1				
	Unlimited						
C	0.2 nm						25
	Unlimited	2	1				19
D	0.2 nm	5					
	Unlimited	1					25, 50, 11
E	0.2 nm				2		
	Unlimited	3					
F	0.2 nm	4	1			1	
	Unlimited	1					6
G	0.2 nm	1					
	Unlimited	1		2		1	6, 50
H	0.2 nm	1		1			
	Unlimited		1	1			10, 14
I	0.2 nm						
	Unlimited	1		1			

Table 3. (cont.) Sizes of sea otter groups sighted on 30-31 July 1976 transect survey.

Transect	Track width	Frequency of Occurance of Group Size 1	2	3	4	5	Sizes of Larger Pods
30 A	0.2 nm	1					
	Unlimited						
B	0.2 nm		1				
	Unlimited	3	1		1		
C	0.2 nm		1				
	Unlimited	1	1				
E	0.2 nm						50
	Unlimited				2		12, 40
F	0.2 nm						6
	Unlimited						11, 10, 21
G	0.2 nm						
	Unlimited		1				
H	0.2 nm		1				
	Unlimited			1			
I	0.2 nm	3					
	Unlimited	2	1		1		
K	0.2 nm						
	Unlimited			1			
31 A	0.2 nm	1	1				12
	Unlimited		1				
B	0.2 nm	3	1				
	Unlimited	1	1				
C	0.2 nm	3				1	28
	Unlimited	1			1		24
D	0.2 nm						
	Unlimited						15
E	0.2 nm	1					
	Unlimited	1					
F	0.2 nm			1			
	Unlimited	1					
32 A	0.2 nm	2					
	Unlimited		1				
B	0.2 nm	1					
	Unlimited						
D	0.2 nm	1					
	Unlimited						
G	0.2 nm						
	Unlimited	1					
33 A	0.2 nm	1					
	Unlimited	1					
B	0.2 nm		1				
	Unlimited	1	1	1	1		
C	0.2 nm	1	2	1			
	Unlimited				1		
D	0.2 nm		1				6

In some cases a partial segment beyond those indicated was surveyed. No sea otters were seen in these partial segments and they have been ommitted from the tables to prevent confusion. Flightlines and distribution of sea otters counted in Bechevin Bay are shown in Fig. 3.

VII. Discussion

Although the 30-31 July survey was considered highly successful there are a number of limitations that should be considered before interpreting the data. The time available for preparation of this report did not allow detailed analysis of all aspects of the survey. Therefore, this discussion will cover factors influencing the survey and the most important conclusions drawn from it. A more detailed analysis might be necessary for comparison with any subsequent surveys.

Strip transects were chosen over line transects because measurement of radial angles, radial distances or right angle distances for each sighting would have been impossible given the speed of the aircraft, number of observations and short distances of observation.

A systematic arrangement of transects was chosen over a random distribution because major objectives of the survey involved determining the distribution of sea otters throughout the entire area. Use of a systematic survey greatly complicates estimation of variance in the population estimate as neither the transects or the sea otters were randomly distributed. This problem could have been overcome by repetetive surveys but, given

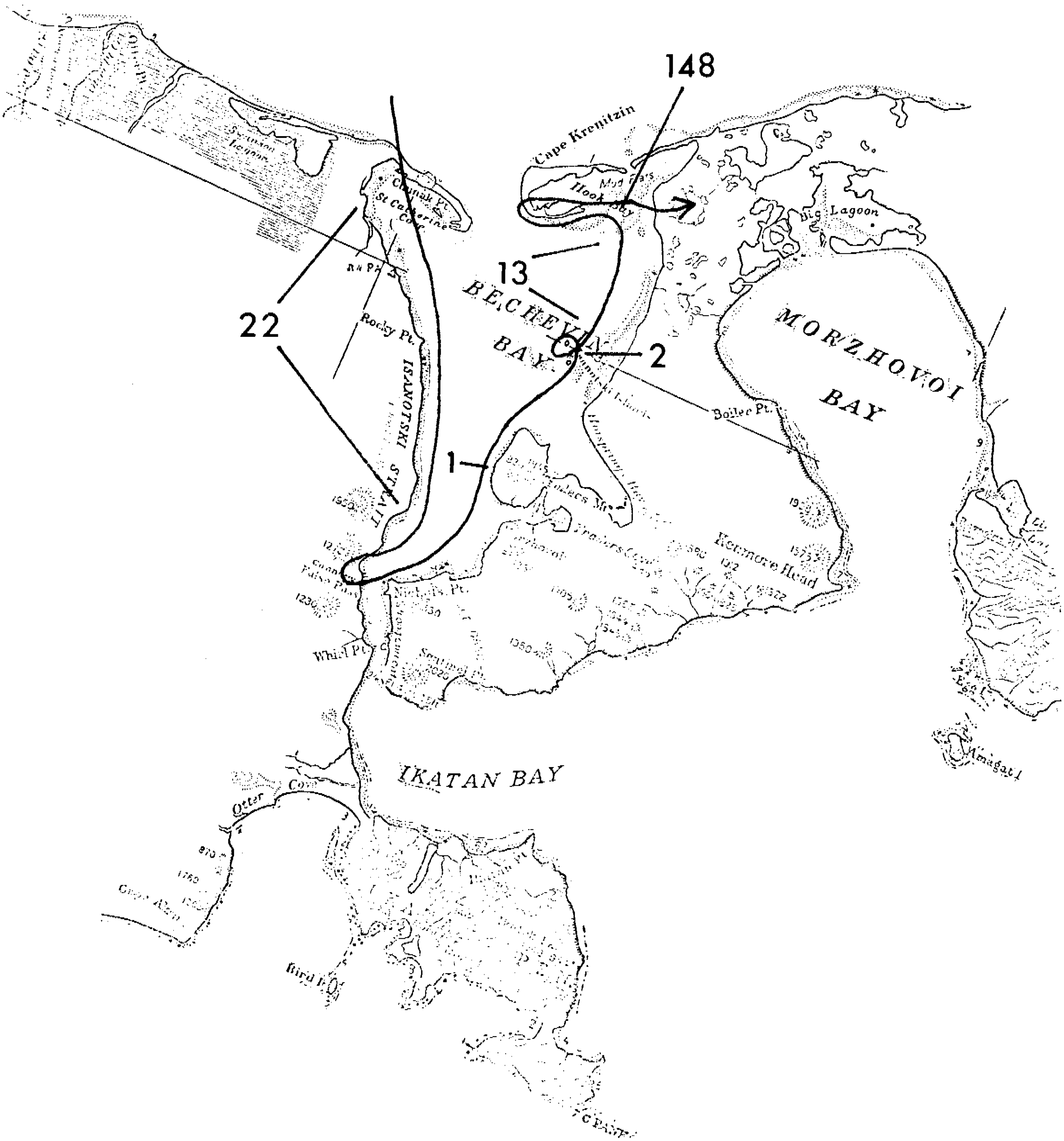


Figure 3. Survey Trackline and locations of sea otters counted in Bechevin Bay on 30 July 1976.

limited funding, several less intensive and perhaps less accurate surveys might have introduced more variability while providing the means to estimate that variability. Systematic sampling can produce estimates that compare favorably with stratified random samples provided no periodicity occurs in the population (Cochran 1963). No known periodicity that would cause bias in the present survey exists.

Effect of Pods

A major problem anticipated in this survey was the distribution of the sea otters in relation to each other. During past surveys distribution has varied from most individuals being widely scattered to the occurrence of large pods of up to 1,000 with a few scattered individuals nearby. The occurrence of large pods could strongly influence estimates of densities depending on whether a pod fell within a count area or not. This was a major reason for conducting an unlimited width strip survey at the same time as the limited width strip survey. It provided information useful in evaluating the influence of large pods. It also increased the possibility of detecting low densities of sea otters.

The occurrence of pods does not appear to have been a serious problem in this survey. No pods of over 100 individuals were seen. Most pods were of moderate size and a number of pods usually occurred within an area so some fell within the limited width strips (Table 3).

A total of 1,901 sea otters was counted in the unlimited transects while 811 were counted in the 0.2 nm transects for a ratio of 2.3. The ratio of the number of pods containing over 10 individuals was 50:15 or 3.2. This might indicate that too few pods were seen in the 0.2 nm transect; however, the effective width of the unlimited width counts would be greater for pods than for individuals since sightability increases with group size. This is evident when the numbers of single animals sighted are compared. Fewer single animals were seen in the unlimited width transects than in the 0.2 nm transects (126:149, ratio 0.85) and a higher percentage of all animals seen were in pods over 10 (71 percent vs. 53 percent). Therefore the effective width of the unlimited width transects was greater for pods than for individuals and the higher ratio of pods sighted between the two surveys would be expected.

The ratio of the number of sea otters in pods was similar to the ratio of the number of pods (3.1 vs 3.2) indicating that pod size had little influence for pods over 10.

This does not rule out the possibility that the occurrence of pods biased the counts. Some bias probably did occur, at least within small areas. Large pods may have occurred between transects out of view of all of the observers. The unlimited width transect observers probably sampled less than half the area even for large pods. Therefore, while no bias resulting from the occurrence of pods could be readily identified, some could have occurred.

Effect of Diving Animals

A major assumption made with most strip transect surveys is that all animals in the strip are counted. This assumption is seldom justified and it certainly isn't in the case of diving mammals. There have been several attempts to estimate the percentage of time a sea otter spends under water. Estes and Smith (1973) estimated that at Amchitka Island 30 percent of the population is under water at any given instant even during periods of minimum feeding activity. The proportion decreases with time, however. If we assume that the observers on the present survey could view a 0.2 nm long strip at any instant, any given point would remain in his field of view for only 6 seconds. The decrease in number of sea otters on the surface would be insignificant during that time. In reality the time the observer could devote to effectively watching one spot is considerably less than 6 seconds.

Estimates by Estes and Smith (1973) were based on observations made in quite different habitat and generally shallower depths (less than 30 m). No suitable data are available for the area north of Unimak Island and the Alaska Peninsula. Water depths are generally greater requiring considerably more time to dive to the bottom. At extreme depths the sea otter would be forced to rest longer between dives however. Food items might be more abundant in that area requiring less time to locate them.

Many sea otters reacted to the aircraft by diving. Observers frequently saw sea otters dive just as they came into view and occasionally saw splashes that could not be positively identified. Observers counting in unlimited width strips sat in the rear of the aircraft and had poorer forward vision than those counting in the limited strips. Many sea otters were under water by the time their location came into view.

While no reliable adjustment can be made for the effect of diving animals on the present survey, Estes and Smith (1973) estimated that 30 percent under water could probably be used as a conservative figure.

Sightability of Animals on the Surface

Experience has shown that not all sea otters on the surface of the water are seen during aerial surveys. Many factors influence the sightability of an individual sea otter. These include:

1. Visibility conditions - Many factors influence the visibility of sea otters in the water. These factors often influence each other providing a wide array of conditions. Often conditions change rapidly. Among the more common factors are sea state and lighting conditions. Any type of wave will reduce visibility. Sharp, choppy waves are worse than large swells so wind velocity and direction at the time of the survey are major factors. Lighting conditions often magnify the effect of sea state. Sun glare on the water's surface, reflection on the windshield of an aircraft, low light intensity because of clouds or time of day and the wave lengths of light reflected from the water's surface strongly influence visibility. Since the angle of incidence of light is important,

visibility on one side of the observer may be significantly different from that on the other side.

The visibility code assigned to each transect was an attempt to classify all of these factors (Table 2). Conditions encountered on this survey were the best ever encountered in this area during a survey. This greatly reduced the effects of visibility conditions on the counts. Only on transects 8 and 9 and in Bechevin Bay did visibility conditions seriously interfere with the survey. A 13 August 1975 survey indicated that substantial numbers of sea otters existed in the area of both transects 8 and 9 although few were found west of there. Some correction should be made for these two transects. Allowing half the number seen on transect 10 for transect 9 (16) and half of that (8) for transect 8 would seem to be a conservative approach.

Visibility conditions probably also reduced the Bechevin Bay count significantly. On 13 August 1975 a total of 444 sea otters was counted in the bay under slightly better conditions. Since sea otters may move in and out of the bay no reliable correction factor can be suggested.

2. Presence of confusing objects - The presence of other species of marine mammals, birds, certain types of kelp, drift or any object that appears similar to the target species will distract the observer and reduce his ability to identify the target species.

There was little kelp or drift in the area. Visibility conditions made identification of other marine mammals and birds relatively easy. The only serious interference was from several million shearwaters in dense flocks. Flocks on the water resembled pods of sea otters at a distance. This tended to distract the unlimited width strip observers and reduced their ability to identify pods at a distance. As the aircraft approached flocks of shearwaters they would take off and fly back and forth over the count area. This created a "screen" effect making it extremely difficult to identify sea otters under them. Fortunately the area of highest shearwater concentrations appeared to lie offshore from the area of highest sea otter density. Some sea otters were probably missed as a result of the presence of birds, however.

3. Behavior - The way animals react to the survey platform, their activity and posture in the water, and their distribution in relation to each other and in relation to geographical features have a strong influence on sightability. Distribution of individuals has an effect that often overrides the effects of all other factors. When most animals are resting on the surface of the water in large groups, counts are almost always high. When they are widely scattered, counts will be low unless other conditions are ideal.

Generally, sea otters are most visible when they are resting on their backs and in groups and least visible when alone and upright in the water. Some movements will enhance sightability, particularly swimming on their backs. Many factors influence behavior including time of day, presence of the aircraft, present weather conditions and even weather conditions of the past few days.

Group size and whether the animals were resting or active were recorded for each sighting in the hope that some comparison of these factors between areas could be made. It would appear that the two limited width strip observers used slightly different definitions of resting and active. The left observer classed as active only those animals that were moving in such a way as to hinder identification. Only 13 percent fell into this catagory. The right observer used a somewhat broader definition and classified 48 percent as active. The difference probably represents animals beginning to react to the aircraft but not diving or upright in the water.

Even when all of the above factors are ideal some animals will be missed. The human eye can not sweep an area giving equal attention to all areas. It tends to focus on points and rapidly move from point to point. The less time available to search a given area and the more distant the area the less efficient the observer. The aircraft used on this survey was relatively fast, giving the observer only a few seconds to locate, identify and count sea otters. There was no way to increase the time of observation without changing the survey platform. This would have been at the expense of coverage or safety.

A relatively narrow strip width was selected to at least partially overcome the problems of aircraft speed and other factors that reduce sightability. It is certain that some sea otters were missed throughout the survey. The bird observer in the rear of the aircraft counted birds in a 100 m strip and noticed some sea otters missed by the left observer. These were not included in the counts.

Observer ability can strongly influence counts. All observers were experienced and all except one of the unlimited width strip observers had participated in intensive sea otter counts in the past year. The left observer counted 55 percent of the sea otters recorded in the 0.2 nm wide strips; however, he saw only 51 percent of the singles and pairs. This suggests that both observers had similar ability and the difference was due to the size of a few larger groups.

All of the factors discussed above tend to reduce the percentage of sea otters on the surface that are seen. Unfortunately without some form of ground truth it is impossible to quantify these factors. It was not logistically or economically feasible to attempt to gather ground truth information on this survey.

Comparisons of aerial counts with shore counts or boat counts have been attempted in other areas. All indicate that a significant percentage of sea otters are missed in aerial counts. However, these comparisons have never included strip counts over open water. Therefore, there is no reliable way to estimate the percentage of sea otters on the surface that are missed. One must simply recognize that the counts and any estimates derived from the counts are low.

Sea Otters Outside of the Survey Area

The available information indicates that most of the population was in the area surveyed but that small numbers may have been outside the area. Only one sighting of sea otters south of Cape Sarichef has been recorded (Table 1). Seventy-five sea otters sighted there in 1958 may have been a transient group as none have been reported from there since and none were seen on two surveys in 1975. The 1975 surveys indicated that few sea otters were west of Cape Mordvinof, perhaps even fewer than in 1965 when Kenyon (1969) counted 10. Results of the present survey seemed to confirm this (Table 2).

We encountered fog and were unable to complete transects 36-38. No sea otters were sighted on transects 34 or 35 and none were seen in the Port Moller area. A total of six survey tracklines paralleling the shore at various distances from shore have been flown in this area since June 1975. The last of these was made under excellent conditions the morning of the first day of this survey. On all of these surveys only two sightings of sea otters, both near the western side of the entrance to Port Moller and Herendeen Bay, have been made. Reports from biologists in the area indicate that very few sea otters remain northeast of Cape Lieskof. Therefore, it appears that scattered individuals and perhaps a few very small groups were northeast of Cape Lieskof. We were not able to survey intensively enough to estimate their numbers. They probably compose only a fraction of a percent of the population.

Sea otters have frequently been seen in water over 60 m deep, especially in the area surveyed, but only occasional individuals have been seen in water over 80 m deep. There are several records of sea otters caught in crab pots nearly 100 m deep and resting animals have been seen in water over 200 m deep, however, those regularly feeding in water over 80 m deep would appear to be unique and are usually adult males. Therefore, the 80 m depth contour was selected as the outer boundary of the survey area. Problems with the GNS 500 navigation aid caused us to underestimate or overestimate our distance from shore. Therefore, not all areas within the 80 m contour were surveyed (Fig. 2). Sea otters were seen in the northern-most segment of three transects (15, 23, 24). Estimated depths near these sightings ranged from 70 to 80 m. Transects 10, 11, 12, 13, 16, 17, 18 and 19 were probably cut too short although the number of sea otters that would have been seen had they been extended would have been small. Transects 8 and 9 were cut short purposely because of visibility conditions. There is also a possibility that a small number of otters were beyond the 80 m depth contour.

Izembek and Moffet Lagoons were not specifically surveyed, however, the aircraft was flown over most parts of the lagoons likely to contain sea otters during refueling trips. No sea otters were seen there. We might have missed scattered individuals, however.

A line opposite the False Pass cannery was arbitrarily selected as the southern boundary of the population. Substantial numbers of sea otters exist along the south shore of Unimak Island and the Alaska Peninsula between Cape Lazaref and Cold Bay. There is a strong possibility that many of the animals repopulating this area in the late 1960's immigrated from the Bering Sea through Isanotski Strait. Small numbers are seen in the strait today and movement through the strait has been observed during periods of extremely heavy sea ice formation (Schneider and Faro 1975). Some interbreeding between sea otters in the Bering Sea and those from the Sandman Reefs and Sanak Island probably occurs. Therefore the population being discussed here is not entirely discrete. Isanotski Straits appears to be the point at which interchange is most restricted but the Bering Sea population could periodically gain or lose animals through this interchange.

In summary, small numbers of sea otters were probably farther offshore than the transects extended, northeast of the survey area or in Izembek and Moffet Lagoons. There is no evidence that inclusion of these animals would significantly increase the population estimate, however.

Population Estimate

The due date of this report limited the time available for analysis of the data. As indicated above, there were many factors influencing the survey that could not be quantified. Therefore, only a simple expansion of the data for a population estimate will be presented with no estimate of variance. It is anticipated that with additional time a more refined estimate could be produced.

An area of approximately 7175 km^2 was sampled. Of that area 506.3 km^2 fell within the limited width strip transects. A total of 811 sea otters was counted in the strips. If we expand this to the entire area we get:

	11,495
Add Bechevin Bay count	186
Unadjusted estimate	11,681

If we compensate for the poor visibility conditions along transects 8 and 9 by assuming that a total of 24 sea otters would have been seen if visibility conditions and the transect lengths were the same as transect 10 we would have an adjusted estimate of:

11,681 + 340 = 12,021

This would be an estimate of the number of sea otters that would have been counted if the entire area had been surveyed.

An unknown proportion of the population would have been under water at the time of the survey. If we use Estes and Smith's (1973) estimate of 30 percent, recognizing that this may not apply to this particular area we get:

12,021 on surface + 5,152 diving = 17,173

This estimate assumes that:

1. All sea otters on the surface in the strip transects were counted.

2. All sea otters on the surface in Bechevin Bay were counted.

3. All sea otters were within the area sampled.

4. No sampling error occurred.

5. 30 percent of the sea otters were not on the surface.

From the previous discussion of factors influencing the survey it is evident that assumptions 1-3 are incorrect and would tend to yield an underestimate of numbers. Assumption 4 could yield an overestimate or an underestimate although no gross errors were immediately obvious. Assumption 5 could yield an overestimate or an underestimate, however, it fails to consider diving in reaction to the aircraft which would tend to produce an underestimate. Therefore, the overall estimate would tend to be conservative unless sampling error was great.

The above estimate indicates a density of 2.3 sea otters/km^2. If we exclude those areas west of Cape Mordvinof and east of Cape Leontovich the overall density would be 3.0 sea otters/km^2. This is a modest density for a sea otter population when compared to those observed in other areas (Kenyon 1969, Estes and Smith 1973); however, most other estimates have assumed that sea otter habitat did not extend beyond the 60 m depth contour. The observed density within the 60 m depth contour in the primary range of the population (between transects 10 and 33) was 2.7 sea otters/km^2 or with the 30 percent correction for diving animals 3.9/km^2, still a moderate density.

There is reason to believe that both the total population and the densities of sea otters in the area surveyed were lower than in the 1960's. During the 1960's the range of the population expanded rapidly. By 1970 substantial numbers had reached Port Heiden and there was evidence of expansion to the south side of the Alaska Peninsula and Unimak Island. Such expansion usually indicates that sea otter densities have become too high in relation to food availability. Sea ice conditions in the early 1970's reduced the range of the population (Schneider and Faro 1975). Since 1972 no repopulation of former habitat to the northeast has been observed. Fragmentary surveys indicate little change in the range of sea otters on the south side of Unimak Island and fewer sea otters inhabit the area west of Cape Mordvinof. Residents of Cold Bay have observed a reduction in the number of sea otters using Izembek Lagoon (Robert Jones, USFWS, pers. comm.). These factors indicate that competition for food and hence the need to expand range have been reduced. This is probably the result of lower densities.

If this is the case, the population can be expected to increase in numbers unless some factor increases mortality or limits the food supply.

Range

The main range of the population presently extends from the vicinity of Cape Mordvinof to Cape Lieskof and includes Bechevin Bay. Izembek and Moffet Lagoons are used to a lesser extent. Small numbers may occur west of Cape Mordvinof; however, less offshore habitat exists in that area. Small numbers appear to persist near Port Moller and it is possible that scattered individuals may stray as far to the northeast as Egegik. Those animals presently northeast of Cape Lieskof are probably not contributing significantly to the growth of the population.

The population should again expand its range as its numbers increase as long as severe sea ice conditions similar to those in 1971 and 1972 do not occur. Range expansion to the northeast will probably be rapid once it begins. It is not possible to predict how long it will take for the population to reoccupy all of its 1970 range. If sea ice conditions remain moderate it should take less than 10 years, however.

When assessing the possible impacts of both offshore and onshore activities on sea otters, the potential range of the population should be considered. This extends to the Port Heiden area. Sea otters have occurred farther to the northeast in the past and will in the future, however, average sea ice conditions would eliminate most of those animals. Densities of sea otters between Port Heiden and Port Moller will probably fluctuate dramatically as sea ice conditions vary. In rare, extreme cases the range may be restricted to its present distribution.

Distribution

Sea otters were not distributed uniformly within the present range of the population. Small areas of extremely high densities were evident. The range was stratified into high, medium and low density areas on the basis of the unlimited width strip count (Table 4, Fig. 4). No attempt was made to delineate small areas of concentration although it appears

Table 4. Approximate water depth, sea otter density stratum and number of sea otters counted in 0.2 nm strip for each transect segment surveyed between Urilia Bay and Cape Lieskof.

Transect Number	Depth (m)	Density	Number of Sea Otters Counted
10 A	20-40	H	4
B	"	H	21
C	"	H	6
D	40-60	H	1
E	"	M	0
F	"	M	0
G	60+	L	0
11 A	0-20	M	0
B	20-40	H	7
C	"	H	17
D	"	H	0
E	40-60	M	0
F	"	M	0
12 A	0-20	M	1
B	"	H	28
C	20-40	H	3
D	40-60	M	0
E	"	M	0
F	"	M	0
G	"	L	0
H	"	L	0
13 A	0-20	H	15
B	20-40	H	5
C	"	H	0
D	"	M	0
E	40-60	M	0
F	"	M	0
G	"	L	0
14 A	0-20	H	4
B	20-40	H	35
C	"	H	0
D	"	H	1
E	40-60	M	0
F	"	M	1
G	"	L	0
H	60+	L	0
I	"	L	0
J	"	L	0
15 A	20-40	H	4
B	"	H	0
C	40-60	H	0
D	"	H	0
E	"	M	0
F	"	M	0
G	60+	L	1
H	"	L	0
I	"	L	0
J	"	L	0
16 A	0-20	H	3
B	20-40	H	144
C	"	H	4
D	40-60	H	4
E	"	M	1
F	"	M	0
G	"	M	0
H	"	L	0
I	60+	L	0
17 A	0-20	H	3
B	20-40	H	1
C	"	H	0
D	"	M	0
E	40-60	M	0
F	"	M	0
G	"	M	0
18 A	0-20	H	3
B	20-40	H	2
C	"	H	0
D	"	M	0
E	40-60	M	6
F	"	M	0
G	"	M	0
H	"	M	2
I	"	M	0
J	"	L	0
K	60+	L	1
L	"	L	0
19 A	0-20	H	0
B	20-40	H	0
C	"	H	7
D	40-60	M	2
E	"	M	2
F	"	M	0
G	"	M	2
H	"	M	0
I	"	M	2
J	"	M	0
K	60+	L	0
20 A	0-20	H	15
B	20-40	H	0
C	"	M	0
D	"	M	1
E	40-60	M	0
F	"	M	1
G	"	M	1
H	"	M	2
I	"	M	0

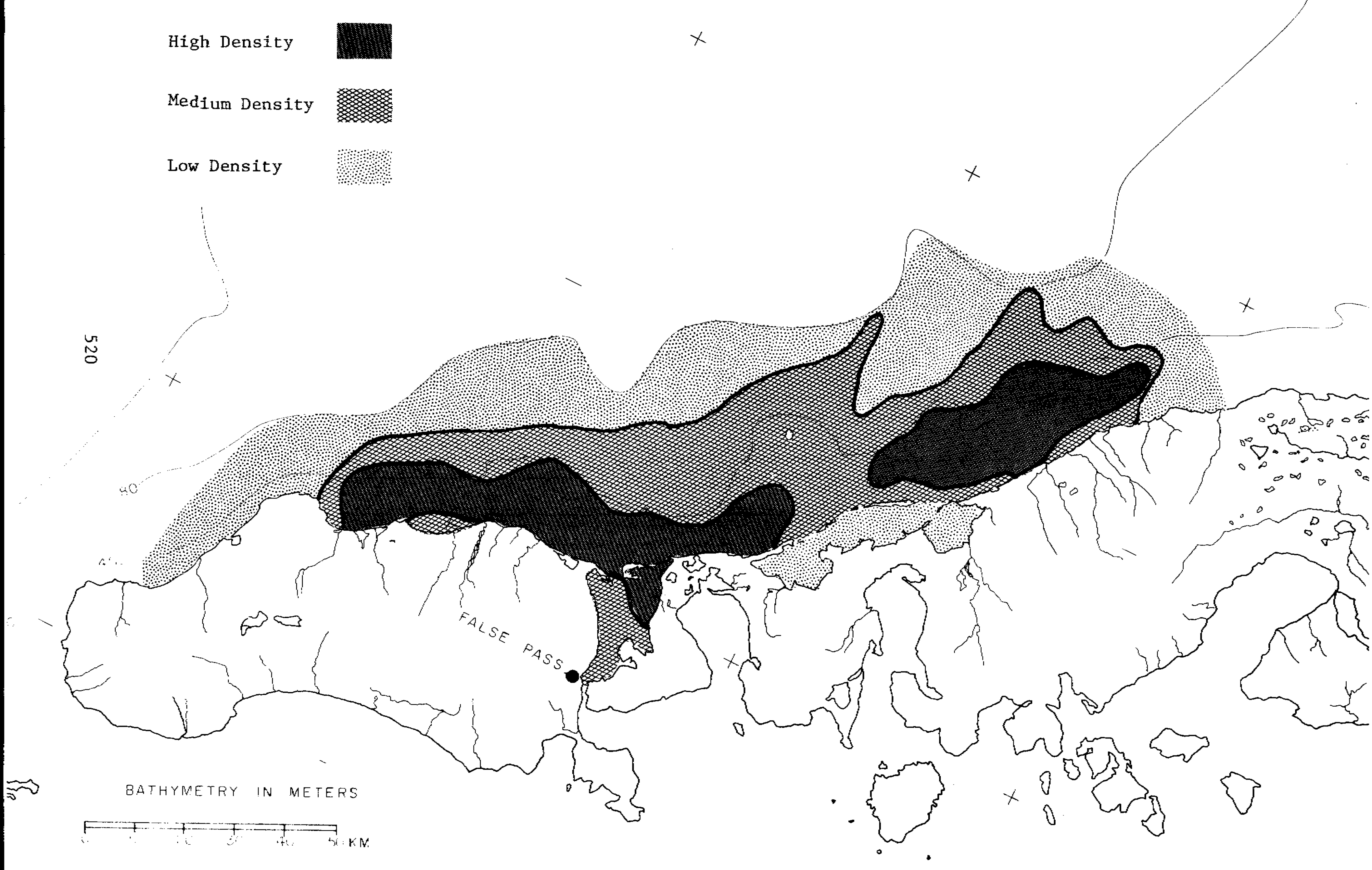
Table 4. (cont.) Approximate water depth, sea otter density stratum and number of sea otters counted in 0.2 nm strip for each transect segment surveyed between Urilia Bay and Cape Lieskof.

Transect Number	Depth (m)	Density	Number of Sea Otters Counted
20 J	40-60	M	0
K	"	L	1
L	60+	L	0
M	"	L	0
21 A	0-20	H	2
B	20-40	H	0
C	"	M	0
D	"	M	0
E	40-60	M	0
F	"	M	0
G	"	M	0
H	"	M	0
I	"	M	0
J	"	M	0
K	60+	L	0
22 A	0-20	H	2
B	20-40	H	100
C	"	H	1
D	"	H	1
E	"	M	0
F	"	M	0
G	"	M	0
H	"	M	0
I	40-60	M	0
J	"	M	0
K	"	M	1
L	60+	M	0
M	"	L	0
N	"	L	0
23 A	0-20	H	9
B	20-40	H	2
C	"	H	1
D	"	H	2
E	"	M	1
F	"	M	1
G	40-60	M	2
H	"	M	0
I	"	M	0
J	"	M	0
K	"	M	1
L	60+	M	0
M	"	M	0
N	"	M	0
O	"	M	0
24 A	0-20	M	0
B	20-40	M	5
C	"	M	0
D	"	M	0
24 E	40-60	M	0
F	"	M	0
G	"	M	0
H	"	M	0
I	"	L	1
J	"	L	0
K	"	L	1
L	"	L	0
M	60+	L	0
N	"	L	0
O	"	L	0
P	"	L	0
25 A	0-20	M	0
B	"	M	0
C	20-40	M	1
D	"	M	2
E	40-60	M	0
F	"	M	0
G	"	M	0
H	"	M	0
I	"	L	0
J	"	L	0
K	"	L	0
L	60+	L	0
26 A	0-20	M	0
B	"	H	2
C	20-40	H	1
D	"	H	2
E	"	M	0
F	"	M	1
G	40-60	M	0
H	"	L	0
I	"	L	0
J	"	L	0
K	60+	L	0
L	"	L	0
M	"	L	0
N	"	L	0
O	"	L	0
27 A	0-20	M	1
B	20-40	H	4
C	"	H	36
D	"	H	0
E	"	H	1
F	"	H	1
G	40-60	M	0
H	"	M	1
I	"	M	0

Table 4. (cont.) Approximate water depth, sea otter density stratum and number of sea otters counted in 0.2 nm strip for each transect segment surveyed between Urilia Bay and Cape Lieskof.

Transect Number	Depth (m)	Density	Number of Sea Otters Counted
27 J	40-60	L	0
K	"	L	0
L	60+	L	0
M	"	L	0
28 A	0-20	M	0
B	20-40	H	1
C	"	H	21
D	"	H	17
E	"	H	14
F	40-60	H	0
G	"	M	0
H	"	M	2
I	"	M	0
J	"	M	0
K	"	M	0
L	60+	M	0
M	"	M	0
29 A	0-20	M	0
B	20-40	H	3
C	"	H	25
D	"	H	5
E	40-60	H	8
F	"	H	11
G	"	H	1
H	"	H	4
I	"	H	0
J	"	M	0
K	60+	M	0
30 A	0-20	M	1
B	20-40	H	2
C	"	H	2
D	"	H	0
E	"	H	50
F	40-60	H	6
G	"	H	0
H	"	H	2
I	"	M	3
J	"	M	0
K	60+	M	0
L	"	L	0
M	"	L	0
31 A	0-20	H	15
B	"	H	5
C	20-40	H	36
D	"	H	0
E	"	H	1
F	"	H	3
31 G	40-60	M	0
H	"	M	0
I	"	M	0
J	60+	L	0
K	"	L	0
32 A	0-20	M	2
B	"	M	1
C	20-40	H	0
D	"	H	1
E	"	H	0
F	40-60	M	0
G	"	M	0
H	"	L	0
I	60+	L	0
J	"	L	0
K	"	L	0
L	"	L	0
M	"	L	0
33 A	0-20	M	1
B	20-40	H	2
C	"	H	8
D	"	H	8
E	40-60	M	0
F	"	L	0
G	"	L	0
H	60+	L	0
I	"	L	0
J	"	L	0
K	"	L	0
L	"	L	0

Figure 4. Distribution of sea otters north of the Alaska Peninsula and Unimak Island on 30-31 July 1976.



that such areas exist. Observed densities within the 0.2 nm strips averaged 6.5 sea otters/km^2 in high, 0.3/km^2 in medium and 0.06/km^2 in low density areas.

This distribution is only representative of the situation on 30 and 31 July 1976. Somewhat different distributions have been observed on previous surveys. This population is more mobile than those occupying typical, rocky, sea otter habitat. Differences have generally been in the degree of dispersal offshore. At times large numbers have been concentrated near shore while at other times low densities were found near shore and high densities occurred 15 to 30 km from shore. The 30-31 July 1976 distribution appears intermediate between those extremes and may be more typical. There appeared to be at least two separate areas of high density roughly separated by a line between Amak Island and Cold Bay. This separation has been observed on past surveys and may reflect varying quality of habitat.

Configuration of shoreline, offshore islands and rocks appears to strongly influence the distribution of sea otters in most populations. Many animals seek sheltered areas to rest. There is relatively little relationship between these features and distribution in this area except in Bechevin Bay. Occasionally small pods have been seen near Amak Island but that is usually not a high density area.

Water depth seems to influence distribution more than the shoreline. Each segment of transects 10-33 was classified by depth. Throughout much of the area the outer edge of "high" density areas closely conformed to the 40 m depth contour and the edge of the "medium" density conformed to the 60 m depth contour. Sea otters northeast of Amak Island were distributed slightly farther offshore with medium densities extending to the 80 m contour in one area and high densities extending to areas 50 m deep.

Densities observed in the 0.2 nm strips averaged 3.1 sea otters/km^2 in water 0 to 20 m deep, 5.8/km^2 in water 20 to 40 m deep, 0.5/km^2 in water 40 to 60 m deep and 0.03/km^2 in water over 60 m deep. True densities would have been higher because diving animals weren't counted. The observed densities in water over 60 m deep may be low. Only 0.25 percent of the sea otters counted in the limited width strips were beyond the 60 m depth contour while 0.84 percent counted in the unlimited width strips were beyond the 60 m countour. In either case only a small percentage of the population was in water deeper than 60 m. During a survey of the area west of Amak Island made on April 1969 most of the sea otters seen were in water deeper than 40 m and many were beyond the 60 m depth contour. Sea otters observed in deep areas have usually been widely scattered. Large pods usually occur in water less than 40 m deep.

Weather seems to play a role in determining offshore distribution. Concentrations near shore frequently follow severe storms while animals tend to be farther offshore and widely dispersed after several days of calm weather. The 30-31 July 1976 survey followed a period of moderately rough weather with winds reaching 35 knots.

Deep areas are probably not available for foraging by all segments of the population and they may not be available to those segments that do use them all of the time. Most observations of sea otters in deep water have involved adult males. Young animals and females with pups prefer shallower water. Competition for food is probably greatest in waters less than 40 m deep and this may limit the size of the population even when food in deeper water remains abundant.

It is probably safe to consider the 80 m depth contour the outer limit of the range of the population in the area west of Cape Lieskof although some animals will stray farther. The 80 m depth contour swings far offshore in the vicinity of Port Moller and no deeper water occurs in Bristol Bay proper. The outer limits of potential sea otter habitat northeast of Port Moller are not known. Presumably sea ice would keep offshore densities low throughout most of the area. Without that limitation much of Bristol Bay and the northern Bering sea could be potential sea otter habitat.

Critical Areas

Those areas indicated as high density in Fig. 4 should probably be considered critical to this population. Possibly the area should be extended to the 30 fm curve and include all of Bechevin Bay. This area supported most of the population even in 1970. Most reproductive activity, rearing of young and most competion for food occurs there. Had this area not been available in 1972 the population would be virtually extinct today. Even during the most extreme sea ice conditions enough open water persisted in this area to permit survival of many healthy adult animals. No such area exists to the northeast except for limited areas near Port Moller.

The area from Cape Lieskof to Port Moller is critical for range expansion although not to the survival of the population.

VIII. Conclusions

A remnant sea otter population survived in the shallow waters north of Unimak Island and the Izembek area of the Alaska Peninsula. This population grew and expanded its range through the 1950's and 1960's. By 1970 substantial numbers had reached Port Heiden and scattered individuals occurred at Egegik. Expansion to the Pacific Ocean through Isanotski Strait had started. Most animals remained between Cape Mordvinof and Cape Lieskof, however. Extreme sea ice conditions in 1971, 1972 and 1974 restricted the range of the population to the area between Cape Mordvinof and Cape Lieskof with only small numbers to the southwest and in the vicinity of Port Moller. The size of the population was probably reduced substantially and little expansion of range has occurred in recent years. The present population probably exceeds 17,000 animals.

All waters less than 80 m deep are potential sea otter habitat, however, most of the population remains in waters less than 60 m deep. These waters extend far from shore throughout the area.

The population should grow and expand its range as far northeastward as Port Heiden in the absence of severe sea ice conditions.

All waters less than 60 m deep between Cape Lieskof and Cape Mordvinof, including Bechevin Bay, should be considered critical to the survival of this population.

IX. Needs for further study

Studies of activity patterns and movements of sea otters in the study area would greatly enhance our ability to evaluate the census. The cost of such studies probably exceeds their value to the OCSEAP program, however. Little is known about the food habits of this population and the relationship between concentrations of sea otters and the distribution of potential food species has not been examined.

The distribution of this population should be monitored to determine future patterns of range expansion. The northeastern fringe of the population should be of particular concern.

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QUARTERLY REPORT

Contract #03-5-022-69
Research Unit #243
Reporting Period Oct. 1 thru Dec. 31
Number of Pages - 10

Population Assessment, Ecology and Trophic Relationships of Steller Sea Lions in the Gulf of Alaska

Principal Investigators:

Donald G. Calkins, Alaska Department of Fish and Game
Kenneth W. Pitcher, Alaska Department of Fish and Game

December 31, 1976

I. Task Objectives

To determine numbers and biomass of Steller sea lions in the Gulf of Alaska. To establish sex and age composition of groups of sea lions utilizing the various rookeries and hauling grounds. To determine patterns of animal movement, population identity and population discreteness of sea lions in the Gulf. To determine changes in seasonal distribution.

To investigate population productivity and growth rates of Steller sea lions in the Gulf of Alaska with emphasis on determining; age of sexual maturity, overall birth rates, duration of reproductive activity and survival rates for various sex and age classes.

To determine food habits of Steller sea lions in the Gulf of Alaska with emphasis on variation with season and habitat type. An effort will be made to relate food habits with prey abundance and distribution. Effects of sea lion predation on prey populations will be examined.

To incidentally collect information on pathology, environmental contaminant loads, critical habitat and fishery depredations.

II. Field or Laboratory Activities

A. Ship schedule

1. NOAA Ship Surveyor

   a. Oct. 5 through Oct. 14

2. M.V. Resolution ADF&G charter vessel

   a. Nov. 3 through Nov. 10

B. Scientific Parties

1. Oct. 5 through Oct. 14

   a. Donald G. Calkins, Alaska Dept. of Fish & Game
      Principal Investigator

   b. Kenneth Pitcher, Alaska Dept. of Fish & Game
      Co-Principal Investigator

   c. Karl Schneider, Alaska Dept. of Fish & Game
      Collecting and survey crew

   d. Albert Franzmann, Alaska Dept. of Fish & Game
      Collecting and survey crew

   e. Roger Smith, Alaska Dept. of Fish & Game
      Collecting and survey crew

   f. Ben Ballenger, Alaska Dept. of Fish & Game
      Collecting and survey crew

g. Charles Irvine, Alaska Dept. of Fish & Game
   Collecting and survey crew

h. Roger Aulabaugh, Alaska Dept. of Fish & Game
   Collecting and survey crew

i. Dennis McAllister, Alaska Dept. of Fish & Game
   Collecting and survey crew

2. Nov. 3 - Nov. 10

a. Donald Calkins, Alaska Dept. of Fish & Game
   Principal Investigator

b. Kenneth Pitcher, Alaska Dept. of Fish & Game
   Co-Principal Investigator

c. Roger Aulabaugh, Alaska Dept. of Fish & Game
   Collecting crew

d. Dennis McAllister, Alaska Dept. of Fish & Game
   Collecting crew

D. Methods

1. Sex and age composition counts - each hauling area which was accessible by helicopter was visited. A ground party was landed on the area and counts were made of the animals in the area, separating them by sex and age class where possible.

2. Search for branded animals - while the animals were being counted, they were inspected for brands.

3. Collection of samples - sea lions are collected from the rookery or hauling areas by the use of helicopters or from the water by skiffs working off a larger vessel. Collection of animals during this quarter was biased toward younger females to facilitate reproduction studies.

4. Analysis of food habits was accomplished by collection of stomachs and intestinal tracts which were analyzed for identification, volume and occurrence frequency of prey species.

5. Population productivity is being studied through the analysis of reproductive tracts from collected animals.

E. Sample localities

1. Data and samples have been collected from sea lion rookeries and hauling areas in the Semidi Islands, Chirikof Island, Kodiak, Afognak and Shuyak Islands and the Barren Islands.

F. Data collected or analyzed

1. Partial or complete sex and age composition counts were made at the following hauling areas or rookeries:

Cape Chiniak	Cape Ugat
Cape Barnabas	Sea Otter Island
Twoheaded Island	Marmot Island
Chowiet Island	Sugarloaf Island
Chirikof Island	

2. Reproductive tract analyses have been completed for all animals (both male and female) collected to date. These data will be analyzed to examine age of sexual maturity and age specific reproductive rates when age determinations are completed and will be presented in the annual report.

3. The preliminary stages of food habit analyses have been completed for all animals. This includes sorting, volumetric determination, enumeration and preliminary identification. Diagnostic skeletal materials have been forwarded to appropriate experts for final identification. These data should be available for the annual report.

4. A total of 23 sea lions were collected. Tentative ages for those sea lions have been determined.

III. Results

A. Results for age analysis of the sea lions collected during the quarter are given in Table I.

B. Sex and age composition of the hauling areas determined to date is shown in Table II.

C. Branded animals were sighted as follows:

Loc. Sighted	Date Sighted	No. Sighted	Brand
Cape Chiniak	Oct. 5, 1976	1	x left shoulder
Cape Chiniak	Oct. 5, 1976	1	o left shoulder
Nagai Rks.	Oct. 8, 1976	1	x left shoulder
Marmot I.	Oct. 12, 1976	3	x left shoulder
Marmot I.	Oct. 12, 1976	15	o left shoulder
Marmot I.	Oct. 12, 1976	numerous	T right shoulder
Sugarloaf I.	Oct. 13, 1976	numerous	x right shoulder
Sugarloaf I.	Oct. 13, 1976	2	x left shoulder

Table I. Tentative ages for sea lions collected between Oct. 1, 1976 and Dec. 31, 1976.

Field No.	Date Coll.	Loc. Coll.	Sex	Tentative Age
SL-46-76	10/7/76	Chowiet I.	FF	5 yrs 4 mo
SL-47-76	10/11/76	Sea Otter I.	FF	1 yr 4 mo
SL-48-76	10/8/76	Chirikof I.	FF	11 yrs 4 mo
SL-49-76	10/8/76	Chirikof I.	FF	5 yrs 4 mo
SL-50-76	10/8/76	Chirikof I.	FF	19 yrs 4 mo
SL-51-76	10/8/76	Nagai Rks.	FF	1 yr 4 mo
SL-52-76	10/8/76	Nagai Rks.	MM	1 yr 4 mo
SL-53-76	10/11/76	Sea Otter I.	FF	8 yrs 4 mo
SL-54-76	10/12/76	Marmot I.	FF	14 yrs 4 mo
SL-55-76	10/12/76	Marmot I.	FF	11 yrs 4 mo
SL-56-76	10/12/76	Marmot I.	MM	1 yr 4 mo
SL-57-76	10/12/76	Marmot I.	FF	8 yrs 4 mo
SL-58-76	10/12/76	Marmot I.	MM	3 yrs 4 mo
SL-59-76	10/12/76	Marmot I.	FF	4 yrs 4 mo
SL-60-76	10/13/76	Sugarloaf I.	FF	4 yrs 4 mo
SL-61-76	10/13/76	Sea Otter I.	FF	1 yr 4 mo
SL-62-76	10/14/76	Marmot I.	FF	13 yrs 4 mo
SL-63-76	10/14/76	Marmot I.	FF	14 yrs 4 mo
SL-64-76	10/14/76	Marmot I.	FF	4 yrs 4 mo
SL-65-76	10/14/76	Marmot I.	MM	1 yr 4 mo
SL-66-76	10/14/76	Marmot I.	FF	1 yr 4 mo
SL-67-76	11/5/76	Spiridon Pt.	MM	9 yrs 5 mo

Table II. Sex and age composition of selected hauling areas and rookeries as determined in Oct. and Nov. 1976. X indicates animals were present.

Location	Adult FF	Adult MM	Subadult FF	Subadult MM	Yearlings	Pups
Cape Chiniak	X	X	X	X	X	X
Cape Barnabas		X		X	X	
Twoheaded Island	X	X	X	X	X	X
Chowiet Island	X	X	X	X	X	X
Chirikof I.	X	X	X	X	X	X
Sea Otter Island	X	X	X	X	X	X
Marmot Island	X	X	X	X	X	X
Sugarloaf Island	X	X	X	X	X	X
Cape Ugat		X		X		

IV. Preliminary Interpretation of Results

Sex and age composition for many of the rookeries and hauling areas has been determined for the late fall as shown in Table II. We can see that Chowiet Island, Two Headed Island, Chirikof Island, Marmot Island, and Sugarloaf Island have all age classes and both sexes. These areas are breeding rookeries of extreme importance to the sea lion population in the Kodiak area. Some of these areas are vacated by the majority of the animals in favor of more protected waters in the winter. Winter sex and age composition may be completely different in many areas. Cape Barnabas and Cape Ugat were used primarily by males.

Sightings of branded animals during this quarter shows that young animals disperse to the south of Sugarloaf and Marmot Islands as well as to the north. Animals which were branded on Sugarloaf Island in July 1975 were sighted this quarter on Cape Chiniak, Nagai Rocks near Chirikof Island, Marmot Island, and on Sugarloaf Island. Very few branded yearlings were sighted on Sugarloaf Island. Animals branded on Marmot Island in July 1975 were sighted at Cape Chiniak and on Marmot Island. Those pups which were branded in 1976 were sighted only in the areas where they were born and branded.

V. Problems encountered - none.

VI. Estimate of funds expended:

A. Funds Expended to Dec. 31

1.	Salaries and benefits	$12,000
2.	Collecting trips	$ 2,000
4.	Commodities (Lab supplies, photo supplies, etc.)	$ 2,000
5.	Travel and Per diem	$ 2,500
	Total	$18,500

Quarterly Report

Contract # 03-5-022-55
Research Unit #248/249
Reporting Period: 1 October - 31 December 1976
Number of Pages: 3

The Relationships of Marine Mammal Distributions, Densities and Activities to Sea Ice Conditions in the Bering and Chukchi Seas

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January 15, 1977

I. Task Objectives:

The major objectives of this project are:

1. To determine the extent and distribution of regularly occurring ice-dominated marine mammal habitats in the Bering and Chukchi Seas;

2. to describe and delineate these habitats;

3. to determine the physical environmental factors which produce these habitats;

4. to determine the distribution and densities of the various marine mammal species in different ice habitats; and

5. to determine how the dynamic changes in quality, quantity and distribution of sea ice relates to major biological events in the lives of marine mammals (e.g., birth, nurture of young, mating, molt and migrations).

II. Field and Laboratory Activities:

A. Field Activities:

Field activities during this quarter were very limited and restricted to observations of ice conditions reported by investigators working on other projects, in the Norton Sound area.

General observations of sea ice conditions are useful for verification of satellite imagery. Field activities of cooperators were as follows:

Activity	Date	Location	Personnel
Surface ice observations	18-24 Nov.	Nome	L. Lowry
Surface ice observations	19-21 Nov.	Stebbins	K. Frost
Surface ice observations	30 Oct-31 Dec.	Nome	E. Muktoyuk

B. Laboratory Activities:

During this quarter the major activities of the principal investigators involved: A) data compilation; B) data coding; C) development of a computer program; D) mapping of several years data concerning walrus distributions and E) the organization of all NOAA and Landsat imagery useful to this study. One of the principal investigators (L. S.) was also involved in correlating records of polar bear sightings and captures with sea ice conditions as determined from Landsat imagery.

III. Results:

A. Compilation of data about mammal distribution from field notes of previous years as well as observations recorded during this project was continued and has essentially been completed. Some of this information is of a general, qualitative nature (i.e. general comments about time, location and abundance of migrating marine mammals), and although useful and informative, is not sufficiently detailed to warrent coding or statistical analysis.

B. All detailed surface or near surface observations of marine mammals and sea ice conditions obtained during 1975 and 1976 have now been coded and keypunched. The results of intensive ice and mammal surveys conducted in the study areas during 1970 were also coded during this quarter and await availability of keypunching services. In view of the observed annual variation in sea ice conditions, data from 1970 will be included for purposes of comparison with more recent information.

A system for coding large scale features of the sea ice cover, as determined from NOAA satellite imagery was also developed. These data have been coded and are currently in the process of being keypunched. It will be analyzed to describe, on an annual basis, the spatial and temporal variation of selected marine mammal habitats.

C. A computer program which will enable the plotting of a variety of different kinds of data in appropriate OCSEAP format was initially developed during the previous quarter. This program required some modification and testing, and is now operational.

D. Observations relating to the seasonal distribution of walrus within the sea ice cover, acquired by F. H. Fay over a period of more than 20 years, have now been mapped.

E. In view of the variety of ice habitats which seem to be of significant importance to different species of marine mammals, it became necessary to organize a "catalog" of the NOAA and Landsat images which show features of particular interest. This task has been partially completed.

IV. Preliminary Interpretation of Results:

None. It is anticipated that considerable analysis and interpretation of results can be accomplished during the next two quarters of this project.

V. Problems Encounterd:

The only significant problem encountered during this past quarter has been due to the backlog of data, from several projects, which awaits keypunching and computer analysis. It appears that this may be less of a problem during the next quarter.

VI. Estimate of Funds Expended:

$10,000.00

RECEPTORS (BIOTA)

MARINE BIRDS

RECEPTORS (BIOTA)

BIRDS

RECEPTORS (BIOTA)

BIRDS

RECEPTORS (BIOTA)

BIRDS

QUARTERLY REPORT

Contract #03-5-022-69

Research Unit #3

Reporting Period October 1, 1976-

December 30, 1976

Pages 17

Indentification, Documentation and Delineation of Coastal Migratory Bird Habitat in Alaska.

Paul D. Arneson

Alaska Department of Fish and Game

December 30, 1976

I. Task Objectives

1. Summarize and evaluate existing literature and unpublished data on the distribution, abundance, behavior, and food dependencies of birds associated with littoral and estuarine habitat in the Gulf of Alaska, Bristol Bay, and Aleutian Shelf.

2. Determine seasonal density distribution, critical habitats, migratory routes, and breeding locales for principal bird species in littoral and estuarine habitat in the Gulf of Alaska, Bristol Bay, and Aleutian Shelf. Identify critical species particularly in regard to possible effects of oil and gas development.

III. Field Activities

A. Field trip schedule

1. On September 30, 1976 eight aerial pelagic transects were conducted in Lower Cook Inlet utilizing a State of Alaska Grumman Goose.

2. Shoreline bird surveys were conducted in Lower Cook Inlet from September 30 to October 2, 1976 in a Kachemak Air Service DeHavilland Beaver. Concurrently, habitat mapping along the shoreline was completed.

3. A Peninsula Airways Cessna 180 was used for shoreline bird surveys along the north side of the Alaska Peninsula from October 13-16, 1976 and for habitat mapping from the mouth of the Naknek River around the Peninsula through False Pass to Cape Tolstoi at Pavlof Bay.

4. From October 25 to 27, 1976, most of the Aleutian Islands from Unimak to Samalga were mapped for coastal habitat in a Peninsula Airways Grumman Widgeon.

B. Scientific Party

1. For the Lower Cook Inlet pelagic and shoreline surveys, the bird observers were David Kurhajec, ADFG, Anchorage and David Erikson, ADFG, Homer. David Trudgen, ADFG, Anchorage concurrently mapped the shoreline.

2. Bird observers and mappers for the Alaska Peninsula and Aleutian Shelf surveys were Paul Arneson and Dave Kurhajec, ADFG, Anchorage. Mike Vivion, USFWS, Cold Bay, also made observations on a portion of the Aleutian Shelf survey.

C. Methods

As in past reports, the technique used for shoreline bird surveys was flying in single-engine, high-wing aircraft at an altitude of approximately 30-45 meters and speed of 160 kilometers per hour. Observers were used on both sides of the aircraft with the shoreside observer covering the area to the high tide line and the oceanside observer enumerated all birds within 200 meters of the aircraft. In estuarine habitat and where upland vegetation was inundated by storm tides, a total count of birds was attempted. This entailed flying back and forth over the estuaries or coastal floodplain at close enough intervals to get "total" coverage. These techniques were used for both the Lower Cook Inlet and Alaska Peninsula surveys.

The pelagic transects were conducted in twin-engine aircraft 30 meters off the water at 193 kilometers per hour. Observers enumerated birds within 100 meters on both sides of the aircraft.

All observations were recorded on cassette-type tape recorders. Information recorded was: bird identification to lowest taxon possible (order, family, genus, species); bird numbers, habitat type in which the bird was found and other information including activities, sex, color phase, etc., as outlined in the data processing format. Weather observations were recorded at the start of each flight and a coded survey conditions number was noted as often as conditions change. Time was recorded each time a new station was started and ended.

Habitat mapping was conducted from both single and twin engine aircraft while flying at an altitude of 90-120 meters along the coastline. Information was color-coded onto USGS 1;63,360 maps.

D. Localities

See attached maps (Figures 1-3).

E. Data Collected

In Lower Cook Inlet approximately 1300 kilometers of shoreline were surveyed for birds covering 178 stations and recording 2779 parameters. Pelagic surveys covered 464 kilometers of open water in eight transects with 96 parameters recorded.

Over 620 kilometers of shoreline were surveyed on the Alaska Peninsula including 38 stations, and an estimated 1700 parameters were recorded. In addition 2500 kilometers of shoreline were mapped for habitat types on the Alaska Peninsula and 1500 kilometers on Fox and Krenitzin Islands. Inclement weather precluded completion of habitat mapping of the islands in the Aleutian Shelf lease area.

Figure 1. Trackline of eight aerial transects for birds in Lower Cook Inlet September 30, 1976.

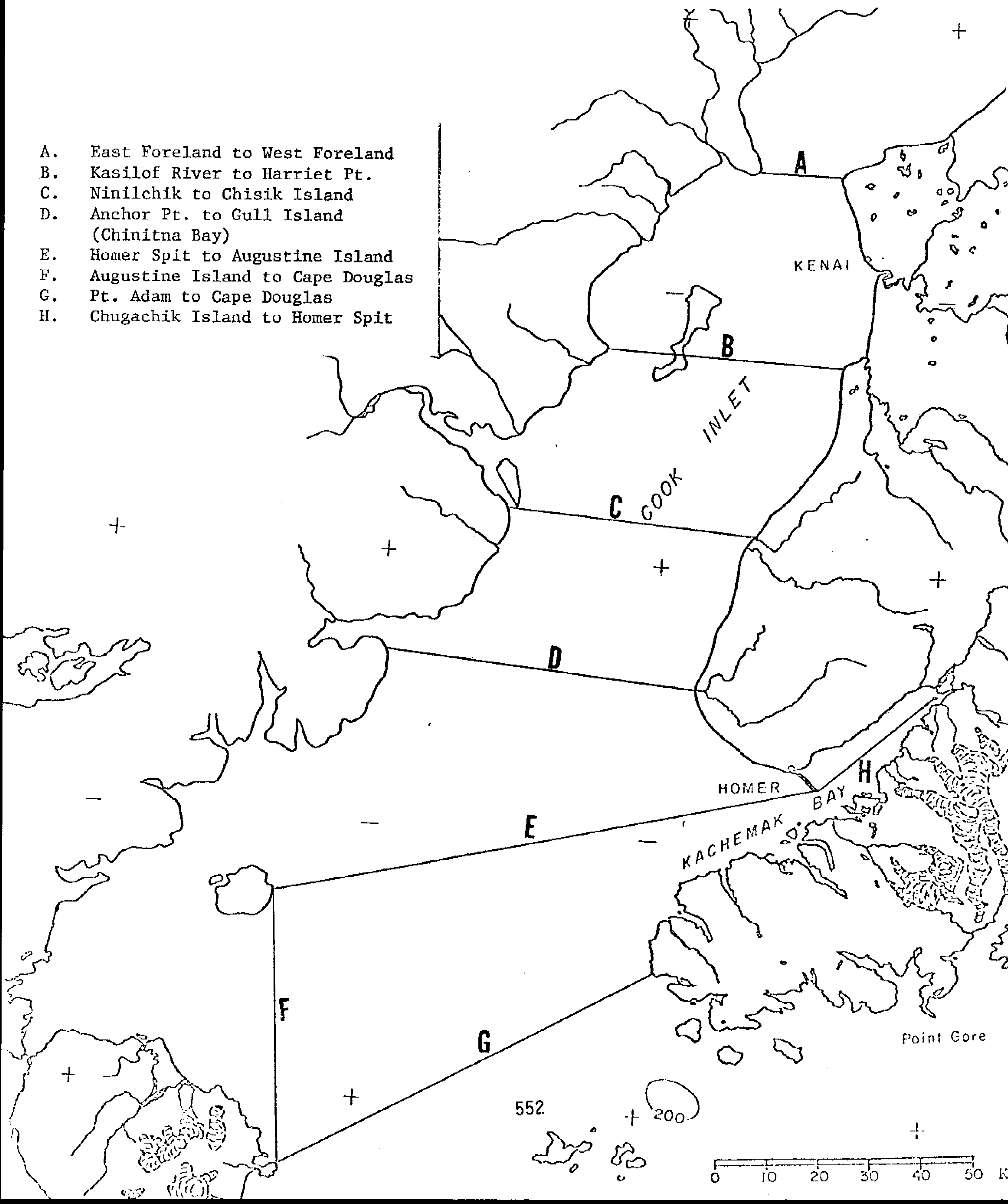


Figure 2. Trackline of aerial bird surveys and habitat mapping in Lower Cook Inlet September 30-October 2, 1976.

Figure 3. Trackline of aerial habitat mapping in Bristol Bay and Aleutian Shelf lease areas, October 13-27, 1976.

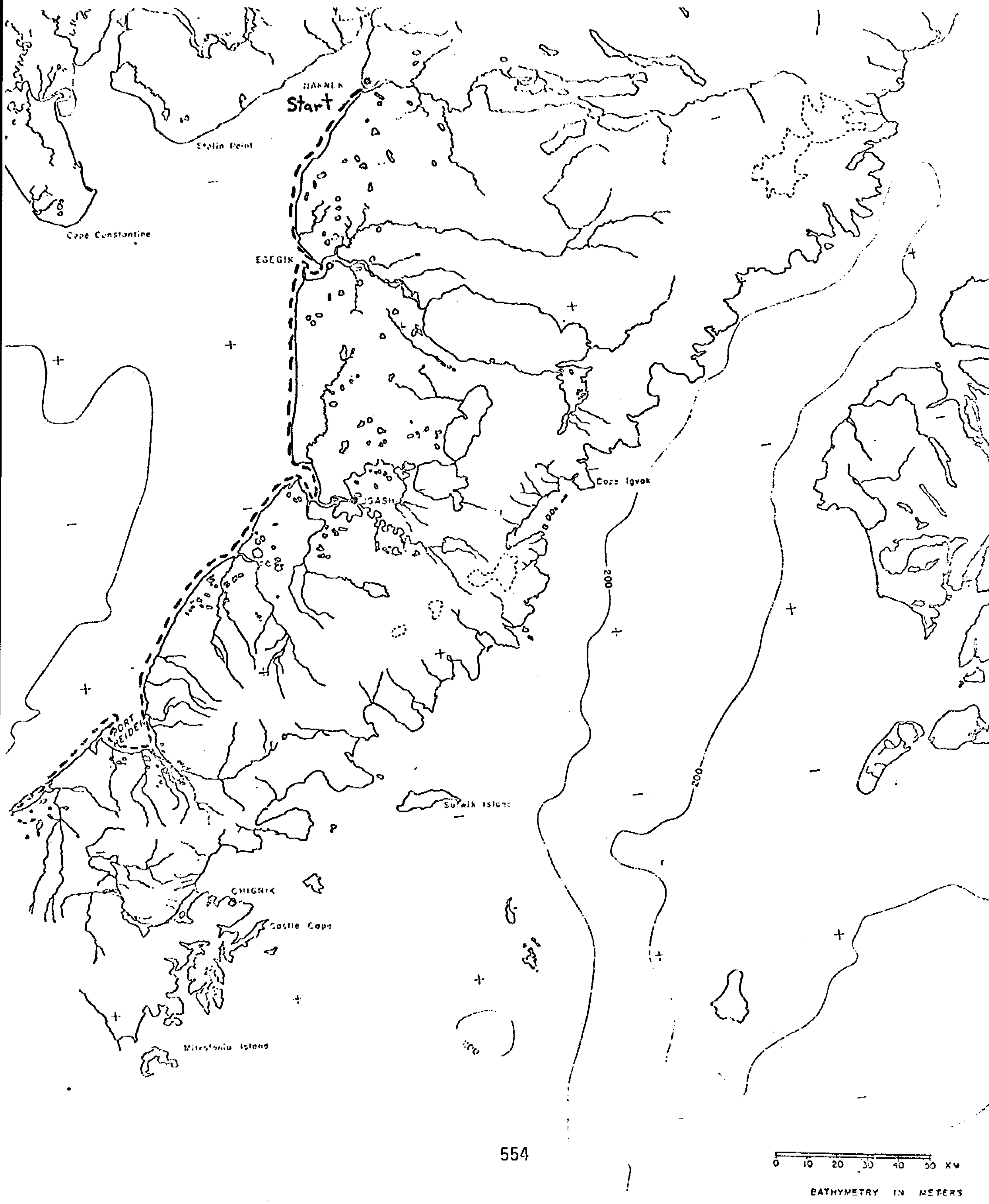


Figure 3. (continued)

Figure 3. (continued)

III. Results

All bird surveys completed thus far in RU #3 have been keypunched, verified and are presently in final data processing stages. Fifteen surveys were completed in FY 76 including eight in Lower Cook Inlet, three on the north side of the Alaska Peninsula, two in NEGOA and one each on Kodiak and the north side of Bristol Bay. Two completed so far in FY 77 were in Lower Cook Inlet and the north side of the Alaska Peninsula.

Data analysis has been stymied by the unavailability of the ADFG computer programmer. It is anticipated that much analysis will be completed for the annual report, April 1, 1977. Data from the four seasonal shoreline and pelagic flights in Lower Cook Inlet are presently being summarized for an ADFG, Habitat Protection Section report. No attempt will be made to summarize that data in this report.

A preliminary summarization of birds in the estuaries of the north side of the Alaska Peninsula are shown in Table 1. In addition, miscellaneous bird observations were made on habitat mapping flights (Table 2). Mike Vivion, USFWS, Cold Bay made most observations from Unimak to Unalaska Islands.

An atlas of USGS 1:63,360 maps and another of 1:250,000 maps containing all habitat information collected to date from aerial surveys has been completed. Information included on the maps is shown in Table 3. The information is color-coded making reproduction difficult. Until the format for final disposition of this information is decided upon, the

Table 1. Summary of bird observations in estuaries of the Alaska Peninsula, aerial surveys, October 13-16, 1976.

	Ugashik	Cinder R. Hook Lagoon	Port Heiden	Seal Is.	Mud Bay	Nelson Lagoon	Izembek Lagoon
Loons (unid)	1						1
Large loon	2	2	1			15	18
Small loon			1	5			2
Grebe (unid)	1	1	1			8	6
R.N. Grebe		1				3	2
Cormorants (unid)		10	2				26
Swans	4	59	98	6			2
Geese (Dark)	35		230	250	175		
Canada	11,774	10,744	4,791	1,364	80	41	29,733
Brant			14				99,349
Emperor	422	3,601	4,073	10,102	3,418	14,220	5,507
Snow	545	2,250					2
Duck (unid)	77	808		114		3	931
Dabbler Ducks (unid)	6,046	2,371	5,667	812	135	1,418	462
Mallard	581	126	60	483		14	552
Pintail	259	1,718	834	5,966	959	495	2,068
G-W Teal	80	3	99				
Am. Wigeon	41	6		3			10
Diving Ducks	173	76	75	6			
Scaup	17	11				1	136
Goldeneye	52		3				
Bufflehead		3	5	5			
Sea Ducks (unid)	28	512	12,017	1,801	218	10,316	4,816
Oldsquaw	1		85	75		72	20
Harlequin							4
Eiders (mixed)			76		1	84	1,690
Steller's		249	460	943	3,011	17,294	15,532
Large eider (unid)	4	31	73			637	55
Common		1	195	25		80	4
Scoter (unid)	1,367	5	10,817	108	102	782	1,232
W-W scoter	45	3	51	1		23	18
Surf scoter		12	5			25	
Common scoter	38	99	320	2	372	1,447	123
Merganser (unid)	4						1
R-B Merganser	20						
Eagles (Q-ad, M-im)	2-M	1-Q,1-M	4-Q,2M	3-Q,3-M			6-Q,6-M
Gyrfalcon			1				
Ptarmigan	46						
Large shorebirds	85		503				20
Yellowlegs	7						
Medium shorebirds	907	1,858	3,559	841	3,700	2,651	4,908
Small shorebirds	1,375	15,805	3,466	1,860		19,148	4,346
Mixed shorebirds	1,113	1,500		1,500			3,800
Jaeger (parasitic)				2			
Gulls (unid)	285	1,769	337	2,000	1,500	652	529
Large gulls (unid)	18	70	305	92		9	
Glaucous-winged	161	625	190	1,579	385	3,656	4,055
Herring	3						
Small gull	175	1	2	40		132	546
Mew	209	7	157	10		46	59
Bonaparte's	16		31	1			62
Kittiwake	123	1	55	200		359	977
Sabines	1	15					
Murre						3	
Small alcid						2	1
Pigeon guillemot			1				
Raven	2	2	5	2			14
Passerine - small	7	132	65			8	
Snow bunting		35		25		50	4

Table 2. Miscellaneous bird observations on habitat mapping flights on Alaska Peninsula and Aleutian Shelf, October 1976.

Alaska Peninsula October 16	Em Go	Bl Br	Ca Go	Eide	Scot	Dabb	Lari	Shor	Corm	Murr	ShWa	Fulm	SmAl
Bechevin Bay													
Hook Bay	117	2900											
St. Catherine Cove	151	10	5175			3000		300	25				
Hotsprings Bay	715												
Traders Cove	515		825			125							
Nichols Point							6000		75				
Isanotski Straits							5500						
Morzhovoi Bay	465	3125									10K's		
Thinpoint Cove	35												
Old Man's Lagoon	50		1250										
Kinzarof Lagoon	595	2400	1400										
Lenard Harbor	70												
Belkofski Bay							2400						
Bear Bay	55												
Volcano Bay							230						
Duschkin Bay	180												
Long John Lagoon	95				150								
Long Beach							65						
Black Point	91												
Chinaman Lagoon	65					50							
Jackson Lagoon	270						55	350					
Canoe Bay	306												
Deer Island	106												
Aleutian Islands October 25-27													
Unimak				74	108				10				
Ugamak							250						
Round	20												
Kaligagan	75												
Tigalda	50												
Avantanak	5												
Akun							40						
Akutan Pass										Pres	Pres	Pres	Pres
Unalga									50				
Egg	60												
Unalaska	810				15					25			
Umnak	936			238	26			1185		Pres			
Adugak	35												
Samalga	695							350					

Key to abbreviations:

Em Go	Emperor Goose	Lari	Larids	SmAl	Small alcids
Bl Br	Black Brant	Shor	Shorebirds	10 K's	Tens of thousands
Ca Go	Canada Goose	Corm	Cormorants	Pres	Present
Eide	Eiders-mixed	Murr	Murres		
Scot	Scoters-mixed	ShWa	Shearwaters		
Dabb	Dabblers-mixed	Fulm	Fulmars		

Table 3. Color-coded habitat mapping system for coastal zone from Cape Fairweather to Cape Newenham.

Substrate: Color Code

Dk. Blue	Mud	
Yellow	Sand	
Red	Gravel	
Black	Rock	
Dk. Blue & Yellow	Mud and Sand	Many more combinations exist
Red & Yellow	Gravel with Sand	
Black & Red	Rock with Gravel (Rubble)	
Green	Vegetation - Mixed grasses, sedges, forbs	
Purple	Vegetation - Beach Rye	
Orange	Vegetation - Eelgrass	
Pink	Algae - Kelp	
Brown	Stormtide line	
Lt. Blue	Changed water course	

Slope of Bank

1	Flat	0-20°
2	Slight	20-40°
3	Moderate	40-60°
4	Steep	60-80°
5	Vertical	80-100°

Height of Bank

A	0-3 m	0-10 ft.
B	3-6 m	10-20 ft.
C	6-12 m	20-40 ft.
D	12-30 m	40-100 ft.
E	30+ m	100+ ft.

bound atlases are available for perusal in the Anchorage ADFG office. As more information is gathered on subsequent flights, it will be added to the atlases. Quantities of each habitat type have not yet been summarized.

IV. Intrepretation of Results

Due to the large volume of data collected on each survey, analysis is difficult until a program is completed for computer analysis. General impressions and "gut feelings" are all that is available for interpretation of the data.

Timing of this year's flight along the north side of the Alaska Peninsula coincided with that of last fall. Several differences were noted in species abundance although quantitative results are not directly comparable since the flight last year was the first under this project and slightly different techniques were used. However, it appeared that in the Ugashik-Cinder River/Hook Lagoon areas more Canada geese, snow geese and shorebirds were observed in 1976. Although many Canada geese apparently were still on the Yukon-Kuskokwim River Delta and many snow geese had already passed through the area, we were able to catch more of the peak of migration. Almost 12,000 Canadas and over 500 snows were seen on Ugashik and almost 11,000 Canadas and 2,250 snows on Cinder River/Hook Lagoon. It appeared that the species composition and numbers utilizing these two estuarine complexes were quite similar.

Port Heiden and Seal Islands contained a somewhat different species composition and abundance than the previously mentioned estuaries, yet between themselves were similar. Fewer Canada geese and shorebirds, and virtually no snow geese were observed, while more emperor geese and sea ducks were found. Comparable numbers of dabblers and larids were found among all these estuaries.

Large numbers of emperor geese but few Canada geese and dabblers used the Nelson Lagoon/Mud Bay area and food availability studies would likely reveal why. This area was used heavily by sea ducks and shorebirds also. Species diversity appeared to be somewhat less than the other estuaries.

Richest of all in species diversity and abundance of birds is the Izembek-Moffett Lagoon area. Large numbers of Canada geese, black brant, emperor geese, dabblers, sea ducks, shorebirds and larids are found there, but relative abundance can vary from year to year with the possible exception of black brant. Although many more brant were observed in 1975 than 1976, it was felt this was due to observer error rather than a change in population size. Brant were the most difficult bird to aerial census since they frequently flushed long before the plane approached, were often in tight three-dimensional masses and often flew back to areas that had already been censused or returned to the census area to be counted more than once. The total of 99, 349 enumerated this year, plus those seen in other bays in the vicinity, likely represent a relatively accurate estimate of the total population of black brant.

Many fewer Canada and emperor geese were observed in Izembek this year than last year. Apparently the Canadas simply bypassed Izembek for staging in 1976. They staged for longer periods on the Y-K Delta and simply flew directly south with favorable winds. Emperors also may have been staging farther up the Peninsula or farther north and had not yet arrived at Izembek at the time of the survey. Fewer dabblers than expected were observed, but the usual large number of sea ducks were seen. Most shorebirds had already passed through this region.

No noteworthy bird observations were made during the mapping flights of the Aleutian Shelf. The emperor goose migration out the Chain was well underway since this species was well distributed throughout all islands as far out as we went. Most surprising was how faunistically rich per unit area that Samalga Island was.

V. Problems

Increasing costs with decreased funding will greatly decrease the amount of data gathered during this fiscal year. Nine of the 17 surveys completed to date (those in lower Cook Inlet) were funded by the Alaska Department of Fish and Game, Habitat Protection Section. Two others were conducted concurrently with OCS marine mammal surveys. Also, all data processing costs including keypunching and programming are to be born by project funds this fiscal year. Therefore, it is anticipated that only three or possibly four aerial surveys will be conducted during the present fiscal year.

VI. Funds Expended

Salaries	$11,250
Travel/per diem	1,250
Logistics	
(air charter, etc.)	5,345
Commodities	100
Equipment	0
Total	$17,945

Quarterly Report

Contract # 03-5-022-69
Research Unit # 3/4
Report Period: 1 October-31 December
Number of Pages: 6

Identification, Documentation and Delineation of Coastal Migratory Bird Habitat in Alaska

George J. Divoky
Principal Investigator

Alaska Department of Fish and Game
1300 College Road
Fairbanks, AK 99701

1 January 1977

I. Task Objectives

Task A-5--Determine the seasonal density distribution, critical habitats, migratory routes, and breeding locales for principal marine bird species in the study areas. Identify critical species particularly in regard to possible effects of oil and gas development.

Task A-6--Describe dynamics and trophic relationships of selected species at offshore and coastal study sites.

A. Ship and field trip schedule and scientific parties.

The following list of data gathering units includes all field work conducted as part of R.U. 3/4. Abbreviations used are:

Type of study
- AC - aerial census
- HC - habitat census
- MW - migrant watch

Personnel
- BB - Bob Boekelheide
- BC - Beth Chiodo
- KD - Kate Darling
- GD - George Divoky
- DF - Doug Forsell
- DG - Dan Gibson
- EG - Ed Good
- TH - Tom Harvey
- KH - Katie Hirsch
- SM - Steve MacDonald
- KO - Karen Oakley
- MP - Mark Phillips
- KW - Ken Wilson
- DW - Doug Woodby

An explanation of file identification number is given at the end of the list.

File ID	Date	Location	Type of Study	Personnel
2BW576	6 May-3 June	Barrow Whale Camp	MW	DW
2A1576	15 May	Barrow to Icy Cape and return	AC	DW
2A2576	19 May	Barrow to Pt. Hope	AC	DW
3A1676	4 June	Northeast of Barrow	AC	KD, TH, DW
1WL676	4-7 June	Wales	MW, HC	SM
2A1676	5 June	Barrow to Wainwright and return	AC	KD, TH
3OK676	7-15 June	Oliktok and vicinity	HC	KD, TH
2PH676	9-13 June	Pt. Hope	MW, HC	SM

2A2676	10 June	Barrow to Icy Cape and return	AC	DW, KW, BC
2A3676	11 June	Chukchi Sea	AC	BB
2A2676	12 June	Barrow to Halkett and return	AC	KH, KW
1WA676	12-18 June	Wales	MW	DG
2A4676	18-19 June	Wales to Pt. Lay	AC	DG
3C0676	16 June	Cooper Island	HC, MW	BB, BC, KH, TH, EG
3C0776 3C0876 3C0976	16 September	Beaufort Sea		
2PD676	17-21 June	Peard Bay and vicinity	HC	KD, KW
2A5676	17 June	Barrow to Pt. Lay and return	AC	GD, KH
3A3676	17 June	Barrow to Pt. McIntyre and return	AC	TH, DW
2A6676	19 June	Barrow to Lisburne and return	AC	DW
2A7676	21 June	Barrow to Icy Cape	AC	TH, KH
2IC676	21-29 June 15 July	Icy Cape and vicinity	HC	TH, KH
3BR676	22-23 June	Barter Island	HC	GD, EG
2KL676	23-28 June	Kasegaluk Lagoon (Pt. Lay - s)	HC	DG, SM
3BL676	23 June - 3 July	Beaufort Lagoon to Demarcation Bay and return	HC	GD, EG
2CL676	25-28 June	Cape Lisburne and vicinity	HC	KD, KW
2WR676	28 June- 6 July	Wainwright and vicinity	HC	KD, KW
3A1776	1 July	Barrow to Barter Island and return	AC	TH
2KL676	6-20 July	Kasegaluk Lagoon (Pt. Lay to Icy Cape)	HC	BK, DG, SM
2A1776	6 July	Barrow to Wainwright and return	AC	TH
3A2776	7 July	Barrow to Prudhoe Bay and return	AC	EG, TH
2A2776	8 July	Barrow to Pt. Lay and return	AC	EG, TH, KW
3PP776	8-12 July	Pitt Point and vicinity	HC	KD, DW
2CB776	12-16 July	Southern Kasegaluk Lagoon to Cape Beaufort	HC	GC, EG
3CR776	13-15 July	Colville Delta	HC	KD, KW
3BR776	13-14 July	Barter Island and vicinity	HC	KO, KH
3A3776	15 July	Barrow to Barter Island and return	AC	TH, DW
2A3776	16 July	Barrow to Cape Beaufort and return	AC	TH, KO
3OK776	16-19 July	Oliktok and vicinity	HC	KD, KW
2BW776	18-19 July	Barrow to Walakpa Bay	HC	BC, KO

3A4776	20 July	Barrow to Demarcation Point and return	AC	KO, EG
3BB776	20-26 July	Bullen to Brownlow	HC	KD, KW
2KL776	22-29 July	Icy Cape to Wainwright	HC	DG, SM, KO
2A4776	25 July	Barrow to Icy Cape	AC	TH, EG
2UP776	25-26 July	Islands next to Utukok Pass	HC	GD, EG
3A5776	28 July	Barrow to Demarcation Point and return	AC	GD, EG, TH
3A6776	30 July	Barrow to Lonely	AC	TH, DW
2WR776	30 July-6 August	Wainwright to Peard Bay	HC	KD, KW
2PD776	30 July-6 August	Peard Bay	HC	EG
3PI776	31 July-5 August	Plover Islands	HC	TH, KH
2AI876	6 August	Barrow to Cape Lisburne and return	AC	TH, KH, DW
2IC876	6-16 August	Icy Cape	MW	DG
2IC876	7-13 August	Icy Cape and vicinity	HC	KD, KW
3A1876	12 August	Barrow to Demarcation Point and return	AC	DF, EG, TH, KO
3PB876	12-19 August	Pingok to Bullen	HC	TH, KO
2CL876	13-20 August	Cape Lisburne and vicinity	HC	KD, KW
3A2876	19 August	Bullen to Barrow	AC	TH, KO
3AL876	19-31 August	Barrow to Barter Island, R.V. ALUMIAC	PC	DF, EG
3A3876	20 August	Barrow to Cape Lisburne	AC	TH, KO
3PP876	30 August-1 September	Pitt Point and vicinity	HC	KD, KW
3BR876	31 August-8 September	Barter Island	HC	GD, EG
3OK976	4-7 September	Oliktok	HC	KD, KW
3A1976	7 September	Barrow to Demarcation Point and return	AC	GD, KO, DW, KH
2IC976	9-12 September	Icy Cape	HC	KD
2A1976	11 September	Barrow to Cape Lisburne and return	AC	KO, KH, KW
2PD976	13-15 Sept.	Peard Bay	HC	KD
2WR976	13-14 Sept.	Wainwright and vicinity	HC	KW
2B2076		Barrow	MW	--
3PB076		Prudhoe Bay	HC	--
3A2976	18 September	Barrow to Cape Halkett and return	AC	EG, KW, GD, BB
2A2976	20 September	Barrow to Cape Lisburne and return	AC	BB, KW, DF, KO
2CL976	20-26 Sept.	Cape Lisburne	MW	KO
3A3976	23 September	Barrow to Prudhoe Bay and return	AC	BB, TH, KD
2A3976	23 September	Barrow to Pt. Lay and return	AC	KW

2A4976	28 September	Barrow to Cape Lisburne and return	AC	BB, DW
3A1A76	4 October	Barrow to Barter Island and return	AC	DW, EG
2A1A76	13 October	Barrow to Icy Cape and return	AC	GD, DW
3A2A76	13 October	Plover Islands	AC	GD, DW
2A1B76	6 November	Chukchi Sea	AC	DW, EG

Explanation of File Identification Numbers

All data gathered as part of this research unit has been partitioned into "files." Each file includes one data gathering unit such as a cruise, flight, field trip, etc. Each file is given a unique six-digit number. These numbers are used by OCS project offices and the NODC for identification of data.

First Digit

1 - Bering Sea
2 - Chukchi Sea
3 - Beaufort Sea

When more than one sea is surveyed the sea with the largest coverage is used.

Second and Third Digit

Vessel abbreviation if cruise.

AL - ALUMIAC
BI - BURTON ISLAND
DI - DISCOVERER
GL - GLACIER
SR - SURVEYOR

Abbreviation for geographic point if land based.

WA and WL - Wales
PH - Point Hope
CL - Cape Lisburne
CB - Cape Beaufort
KL - Kasegaluk Lagoon
IC - Icy Cape
WR - Wainwright
PD - Peard Bay
BW - Barrow
CO - Cooper Island
PP - Pitt Point
CR - Colville River (Helmrich's)
OK - Oliktok Point
PB - Prudhoe Bay
BB - Brownlow Point
BR - Barter Island
BL - Beaufort Lagoon

If aerial census "A" followed by the number of the census for that sea for that month, i.e. 2A5676 is the fifth Chukchi flight for June 1976.

Fourth, Fifth and Sixth Digit
The number of the month and year the field work started. October is "A" and November is "B." An "O" is used if data was gathered for a number of months on an irregular basis.

Coding

All of the above data has been coded and is currently being punched at the AEIDC in Anchorage.

II. Aerial censusing - Aerial censusing was the primary means of obtaining information on bird use of coastal waters. Observations were made from both sides of a Twin Otter flying at 150 feet. In general, flights were over the barrier islands for the first half of the flight and mid-lagoon or mainland beach on the return. Information on ice and habitat was mapped during the flight. The species, number, activity and habitat of all birds seen were noted. Birds were mapped on U.S. Coast and Geodetic Charts after each flight.

Habitat censusing (foot) - Transects along the coast were walked in order to determine numbers and activities of species using inshore waters, adjacent beach and tundra. Information on breeding birds was obtained whenever possible. Birds per distance walked in each habitat were computed. Most areas were visited three times during the summer in order to obtain information on breeding, post breeding and fall migration densities. At the same time, information was gathered on the species and numbers of migrating birds in each area.

Migration watches - In addition to migration data gathered during the course of other work some stationary migraton watches were conducted at appropriate points on the coast. This provided information on the number of birds passing per unit time.

Breeding birds - Whenever nests were encountered information on clutch size, stage of nesting and habitat was recorded.

Specimen collecting - Specimens were collected during the course of a number of field trips in order to obtain information on food items and fat and molt condition of the birds. Whenever possible plankton tows were conducted when birds were collected.

III. Methods

Data Collected

The following data has been collected since the last quarterly report was submitted.

File Id	Minutes of Observation	km of trackline
3A2976	60	192
2A2976	280	871
2CL976	1140	-
3A3976	259	865
2A3976	240	638
2A4876	202	752
3A1A76	290	1116
2A1A76	70	265
3A2A76	19	75
2A1B76	110	350

IV. Results

A final report for R. U. 3/4 is being prepared.

V. Problems encountered and recommended changes

An error in computation led Fish and Game and the Arctic Project Office to believe that this project had enough funds to continue work during this quarter without additional funding. On 15 November it was discovered the project had no more funds and all temporary assistants were terminated. This has resulted in a few minor problems but a Final Report should still be finished in early 1977.

VI. Estimate of funds expended

The following funds were expended from 1 October to 20 December.

Salaries	$ 9,958
Travel	1,269
Contractual	776
Commodities	69
Total	$12,072

APPENDIX

Quarterly Report: 1 January 1977
Research Unit: 3/4

George J. Divoky
ADF&G

In order to determine species abundance in coastal habitsts, transects were walked at a number of locations on the Beaufort and Chukchi Sea coasts. Whenever possible two or three visits were made to a given location in order to observe seasonal changes. Land based work of this sort provides detailed information that is impossible to obtain from aerial surveys.

Tables Q, R and S show data obtained on the three visits made to Oliktok Point. Twenty five other trips will be presented in the final report. The " index of abundance" used to show bird numbers refers to the number of birds encountered per kilometer of habitat walked. It is a birds per linear distance figure and not a density. Habitat abbreviations on the tables are as follows:

WT - wet tundra
MT - moist tundra
MTWP - moist tundra with ponds
BT - brackish tundra
RD - river delta
RM - river mouth
Bea - beach
S&B - spits and bars
Lag - lagoon
Bay - bay
Oce - ocean

Table Q shows that in mid-June birds were abundant in small patches of wet tundra. Moist tundra had good numbers of birds but less than wet tundra. The beach was snow covered and received no bird use. Bird use of the ocean was surprisingly high since the only open water was present in a narrow moat between the beach and the grounded nearshore ice.

Table R shows that by mid-July less birds are present on the wet tundra but that moist tundra has numbers comparable to mid-June levels. Three habitats not censused on the first visit (brackish tundra, river delta, and river mouth) have large numbers of Black Brant and good numbers of a number of other species. The beach now has some birds but in low numbers. Bird use of the ocean is comparable to mid-June levels.

Table S shows that by early September species diversity in the Oliktok area is less compared to earlier vists and that all habitats except the ocean have high bird use. The most common species on the wet tundra is the Long-billed Dowitcher. This species is only a migrant in the Oliktok area and does not breed. Use of the ocean adjacent to the shore has dropped since the pack ice has melted and provided more open water in areas away from shore.

Table Q. Indices of abundance of species encountered in the vicinity of Oliktok from 12 June to 15 June. See Figure for exact location.

Habitat	WT	MT	MTWP	BT	RD	RM	Bea	S&B	Lag	Bay	Oce
Km per habitat	4.3	55.6					34.0				34.0
Min. per habitat	210	1870					1150				1150
Species											
Arctic Loon	-	-					-				2.9
Red-throated Loon	-	0.1*					-				-
Whistling Swan	0.2*	-					-				-
Black Brant	-	-					-				0.2*
White-fronted Goose	11.9	0.9					-				-
Pintail	0.2*	0.1*					-				-
Oldsquaw	9.1	1.3					-				2.8
Common Eider	-	-					-				0.1
King Eider	10.2	0.6					-				4.5
Spectaded Eider	0.2*	-					-				0.3
Unid. Ptarmigan	-	0.2					-				-
American Golden Plover	0.2*	0.7					-				-
Semipalmated Sandpiper	2.8	1.6					-				-
Baird's Sandpiper	-	0.2					-				-
Pectoral Sandpiper	0.2*	0.1*					-				-
Dunlin	2.6	0.6					-				-
Stilt Sandpiper	0.2*	-					-				-
Red Phalarope	6.7	0.1					-				-
Northern Phalarope	1.2	-					-				-
Pomarine Jaeger	0.7	0.3					-				-
Parasitic Jaeger	-	0.1					-				-
Long-tailed Jaeger	-	0.1					-				-
Glaucous Gull	0.4	0.1					-				0.2
Sabine's Gull	0.9	-					-				-
Arctic Tern	0.7	-					-				-
Snowy Owl	-	0.1*					-				-

Short-eared Owl	0.2*	-	-	-
Hoary Redpoll	-	0.1	-	-
Savannah Sparrow	-	0.1	-	-
Lapland Longspur	6.0	3.0	-	-
Snow Bunting	-	1.1	-	-

*Denotes single sighting.

Table R. Indices of abundance of species encountered in the vicinity of Oliktok from 16 July to 19 July. See Figure for exact location.

Habitat	WT	MT	MTWP	BT	RD	RM	Bea	S&B	Lag	Bay	Oce
Km per habitat	4.3	55.5		12.0	5.1	13.8	31.9				16.1
Min. per habitat	165	1740		320	180	365	910				490
Species											
Yellow-billed Loon	-	-		-	-	-	-				0.3
Arctic Loon	0.7	0.1		-	0.4	-	-				0.8
Red-throated Loon	-	0.1		-	-	-	-				-
Gavia sp.	-	-		-	-	-	-				0.5
Whistling Swan	-	0.1		-	-	-	0.1				0.1*
Black Brant	-	0.5		36.2	5.4	38.8	1.9				6.9
White-fronted Goose	1.4*	0.1*		-	-	0.3	-				-
Snow Goose	-	0.1*		-	-	-	-				-
Pintail	-	-		-	-	2.7	-				-
Greater Scaup	-	-		-	-	-	-				0.4*
Oldsquaw	0.7	0.2		-	-	2.7	-				0.7
Common Eider	-	-		-	-	-	-				0.1
King Eider	-	0.1*		-	1.2	-	-				0.4
Unid. Eider	0.7	0.1*		-	-	-	-				1.6
Red-breasted Merganser	-	-		-	-	-	-				0.1*
Willow Ptarmigan	-	0.1		-	-	-	-				-
American Golden Plover	-	0.8		0.3	-	-	-				-
Black-bellied Plover	-	0.1		-	-	-	-				-
Ruddy Turnstone	0.7	0.1		-	-	-	-				-
Semipalmated Sandpiper	5.8	1.8		0.8	-	2.7	0.1*				-
Western Sandpiper	-	0.1		-	-	-	-				-
Baird's Sandpiper	-	0.3		0.2	-	0.1*	0.1*				-
Pectoral Sandpiper	2.8	0.6		1.8*	-	-	-				-
Dunlin	1.9	0.8		0.2	-	-	0.1*				-
Long-billed Dowitcher	0.2*	-		-	-	-	-				-

Stilt Sandpiper	0.6	-	-	-	-	-	-
Whimbrel	-	0.1*	-	-	-	-	-
Red Phalarope	3.0	0.7	0.2	-	0.2	-	-
Northern Phalarope	0.5	0.1	-	-	-	-	-
Pomarine Jaeger	-	0.1	-	-	-	-	-
Parasitic Jaeger	0.2*	0.2	-	-	-	-	-
Long-tailed Jaeger	0.5	0.1	-	-	-	-	-
Glaucous Gull	-	0.1	-	1.6	1.3	1.5	3.2
Sabine's Gull	2.3*	0.1	-	-	-	-	-
Arctic Tern	1.6	0.2	-	-	0.1*	-	-
Snowy Owl	-	0.1	-	-	-	-	-
Common Raven	-	0.1*	-	-	-	-	-
Hoary Redpoll	-	0.1*	-	-	-	-	-
Savannah Sparrow	-	0.2	-	-	-	-	-
Lapland Longspur	1.4	3.9	1.6	-	-	0.1*	-
Snow Bunting	-	0.3	-	-	-	0.1	-

*Denotes single sighting.

Table S. Indices of abundance of species encountered in the vicinity of Oliktok from 4 September to 6 September. See Figure for exact location.

Habitat	WT	MT	MTWP	BT	RD	RM	Bea	S&B	Lag	Bay	Oce
Km per habitat	5.2	17.6	9.9	4.6	6.0	7.6	15.4				15.4
Min. per habitat	175	490	255	85	190	215	370				370
Species											
Arctic Loon	0.2	0.1	1.2	-	3	0.8	-				0.2
Red-throated Loon	0.2	-	0.5	-	0.2*	-	-				-
Gavia sp.	-	-	-	-	0.2*	-	-				-
Whistling Swan	-	-	-	-	0.2*	-	-				-
Black Brant	-	-	-	3.7	-	8.7	2.1*				-
Pintail	-	0.1	-	-	-	-	-				-
Gyrfalcon	-	0.1*	-	-	-	-	-				-
American Golden Plover	0.2*	0.1	-	-	-	-	-				-
Black-bellied Plover	0.9	0.6	0.4	-	-	0.1*	-				-
Western Sandpiper	-	-	-	-	0.3	-	0.1*				-
Pectoral Sandpiper	1.3	-	0.2	-	-	0.5	-				-
Dunlin	2.7	2.1	2.6	0.1*	2.5	3.0	1.6				-
Sanderling	-	-	-	-	-	-	0.9				-
Long-billed Dowitcher	3.0	0.2	1.9	-	-	0.3*	0.2				-
Red Phalarope	-	-	0.7	-	-	-	3.1				-
Parasitic Jaeger	0.4	-	-	-	-	-	-				-
Glaucous Gull	0.4	-	0.2	-	16.5	2.6	0.5				-
Arctic Tern	-	-	-	-	-	-	0.5				1.5
Snowy Owl	0.2*	0.2	-	-	-	-	-				-
White-crowned Sparrow	-	0.1*	-	-	-	-	-				-
Lapland Longspur	0.6	3.0	0.6	0.4	0.3	-	-				-
Snow Bunting	-	0.5	0.2	-	-	-	1.3				-

*Denotes single sighting.

RU# 38

NO REPORT WAS RECEIVED

A final report is expected next quarter

Quarterly Report

Contract # 03-5-022-72
Research Unit 83
Reporting Period
1 October - 31 December 1976

Reproductive Ecology of Pribilof Island Seabirds

George L. Hunt, Jr.

Department of Ecology and
Evolutionary Biology
University of California
Irvine, California 92717

1 January 1977

During the period 1 October - 31 December 1976 the staff returned from field work in the Pribilof Islands and we have begun analysis of the 1976 data. Two summer employees left the payroll as of 30 September and we are left with a staff of three - the principal investigator, a full-time employee and a part-time employee.

George Hunt, Molly Hunt and Barbara Mayer all attended the NOAA-OCSEP meeting in Anchorage (19-22 October) of researchers from NOAA-sponsored field studies of seabirds and shorebirds in Alaska. All of us felt that the meeting was useful, informative, very well conducted, and gave everyone there some perspective on the goals and problems of their own projects.

Overall we felt that the 1976 field season was a successful one in terms of being able to accomplish the goals we set and the quality of the data we were able to obtain with a minimum of difficulties. Motorcycle maintenance and minor problems associated with transportation were the only problems.

I. Task Objectives

The task objectives for the 7th quarter were:

A. To analyze data on reproductive success, growth rates and phenology collected during the 1976 season.

B. To begin sorting and identification of food samples collected during the 1976 field season.

C. To begin analysis of data on the distribution of seabirds around the Pribilof Islands taken on two cruises on the R/V Moana Wave in June and July of 1976.

D. To begin coding of the data collected above, and to complete coding of 1975 data.

E. To design new data forms for 1977 such that data in the field may be taken directly into code.

II. Field Activities

A. Field trip schedule

19-22 October	G. Hunt, M. Hunt and B. Mayer to Anchorage for NOAA seabird research meeting
25-29 October	B. Mayer to Fairbanks to the Marine Sorting Center
10 December	B. Mayer to Allan Hancock Foundation, University of Southern California
16 December	B. Mayer to California Department of Fish and Game, Long Beach, California

B. Scientific party

George L. Hunt, Jr., Associate Professor, University of California, Irvine, Principal Investigator

Molly Warner Hunt, Assistant Specialist, University of California, Irvine, Project Leader, St. George Island

Barbara Mayer, Assistant Specialist, Unitersity of California, Irvine, Project Leader, St. Paul Island

C. Methods

For Task Objectives a-c please see Annual Report 1975.

b. To learn techinques for identification of food items used by seabirds, B. Mayer spent five days at the Marine Sorting Center in Fairbanks, Alaska. In addition she has visited the Allan Hancock Foundation of the University of Southern California to consult a shrimp taxonomist and the California Department of Fish and Game in Long Beach, California, to learn techniques for identifying fish otoliths.

E. Data analyzed

For number of samples taken, see 6th Quarterly Report.

1. Reproductive success, phenology, and growth rates, 1976 season. Analyses of these data have been completed. Results will be presented in the 1 April 1977 report.

2. Food samples. To date 150 of the 550 samples collected in 1976 have been sorted and all crustaceans contained in them have been identified. Otoliths found in the samples have been separated for subsequent identification. Sorting is expected to be completed by the end of February 1977.

3. Ship transects. A patchwork of xeroxed copies of the smooth plots of the ship tracks arrived in November. Analysis has begun of the densities of seabirds found in each ten-minute sections of latitude and longitude through which the ship passed on the two cruises. This work is expected to be completed by the end of January 1977.

4. Coding of data. Coding of the 1975 at-sea data taken on the cruise of the Discoverer has been completed and sent to Michael Crane, the EDS Liason Officer, in Anchorage to be punched. Coding of the 1975 colony data is nearly completed, awaiting only the confirmation of several new codes before it can be finished and submitted. Michael Crane visited U.C. Irvine on 15 November, 1976, and during that meeting said that with minor annotations our 1976 çolony data can be punched directly from xeroxed copies of the original data sheets. This will save us many hours of labor and increase accuracy by eliminating a step in transcribing data. With his help we began redesigning all of our data acquisition forms such that most data in 1977 can be taken in the field directly in code. The revision of these forms has been completed and they have been sent to Michael Crane for comment.

III. Results

Results of data from the 1976 season will be reported on in the Annual Report due 1 April 1977.

V. Problems encountered/recommended changes

A. When B. Mayer departed from St. Paul Island on 22 September, none of the three Harley Davidson motorcycles that NOAA purchased at the beginning of the 1975 field season were running. During the 1976 season a maximum of two of the three bikes were working at any given time, with the third machine being used as a source of parts for the other two. We feel that we can get at least two of the bikes working again, but it is not clear that they will last very long, given the difficulty of finding replacement parts for these discontinued models. When the new contract was negotiated in August and September of 1976, we obtained money for the purchase and shipping of a Honda Three-wheeler (ATC-90) for St. Paul Island in 1977 with the assumption that one of the Harley-Davidsons would be sent over to St. George. We now feel that in order to provide reliable transportation on St. George it may be necessary to purchase a small Honda CT-90 motorcycle for use on St. George Island in addition to the three-wheeler needed on St. Paul. To that end we are examining the costs of various transportation options. Transportation on St. George presented a minor problem in 1976. While Molly Hunt was sharing facilities with Lance Craighead and Ron Squibb on Joe Hickey's research project she was able to use a truck which they had rented from the National Marine Fisheries Service for an astronomical $27/day, a financial burden that our project could not have borne. For six weeks after their departure she was able to get transporation to the study sites first by hitching rides and later by borrowing a truck after most of the NMFS fur seal researchers had left. NMFS will not have vehicles available for borrowing during their peak season (July and August) and it is clear that a small investment in a motorcycle would be more economical for our project than renting a pickup from NMFS at the rates they have been charging.

Estimate of Funds Expended
as of 30 November 1976

Category		Appropriated	Expended	Balance
Salaries		$60,597.00	$33,884.22	$26,712.78
Fringe benefits		6,812.00	1,967.23	4,844.27
Supplies and expenses		10,669.47	6,966.15	3,703.32
Equipment		8,477.79	7,409.93	1,067.86
Travel		23,566.00	16,101.98	7,464.02
Other		6,882.74	766.26	6,116.48
	1975-76	60,332.00		
	1976-77	56,673.00		
	Total	$117,005.00	$67,095.77	$49,909.23

PROJECT: PRIBILOF ISLAND SEABIRDS — PRINCIPAL INVESTIGATOR: GEORGE L. HUNT JR — DATE:

MILESTONE: COMPLETED Δ
ACTIVITY: START — END

MAJOR MILESTONES/ACTIVITIES

FY 1976 → 1976 JAN. 3, APR. 4, JUL. 5 — FY 1977 → OCT. 1, 1977 JAN. 2, APR. 3, JUL. 4 — FY 1978 → OCT. 1, 1978 JAN. 2

1	FIELD WORK - ST. PAUL ISLAND 1976
2	FIELD WORK - ST. GEORGE ISLAND 1976
3	ANALYSIS OF 1976 DATA - REPRODUCTION, PHENOLOGY, GROWTH
4	CODING - REPRODUCTION, PHENOLOGY, GROWTH 1976
5	SUBMISSION OF CODED DATA (#4 ABOVE)
6	ANALYSIS OF 1976 AT-SEA SURVEYS OF SEABIRDS
7	CODING OF AT-SEA DATA - 1976
8	SUBMISSION OF CODED DATA (#7 ABOVE)
9	ANALYSIS OF FOOD SAMPLES - 1976
10	CODING OF FOOD SAMPLES
11	SUBMISSION OF CODED DATA (# 10 ABOVE)
12	CODING OF ALL 1975 DATA
13	SUBMISSION OF CODED 1975 DATA
14	7TH QUARTERLY REPORT
15	ANNUAL REPORT - 1976 SEASON
16	FIELD WORK - ST. PAUL ISLAND 1977
17	FIELD WORK - ST. GEORGE ISLAND 1977
18	ANALYSIS OF 1977 DATA - REPRO., PHENOLOGY + GROWTH
19	CODING - REPRODUCTION, PHENOLOGY + GROWTH 1977
20	SUBMISSION OF CODED DATA (# 19 ABOVE)
21	ANALYSIS OF 1977 AT-SEA SURVEYS OF SEABIRDS
22	CODING OF AT-SEA DATA - 1977
23	SUBMISSION OF CODED DATA (# 22 ABOVE)
24	ANALYSIS OF FOOD SAMPLES - 1977
25	CODING OF FOODS - 1977
26	SUBMISSION OF CODED DATA (# 25 ABOVE)
27	FINAL REPORT
28	
29	

RU# 108

NO REPORT WAS RECEIVED

QUARTERLY REPORT

Contract No. 03-5-022-84
Research Unit #172
Reporting Period: 1 Oct - 31 Dec 1976
Number of Pages: 3

Shorebird Dependence on Arctic Littoral Habitats

Research Coordinator: Peter G. Connors
Bodega Marine Laboratory
University of California
Bodega Bay, California 94923

Principal Investigator: R. W. Risebrough

Date of Report: January 1, 1977

I. Task Objectives

The ultimate objective of this study is the assessment of the degree and nature of dependence of each shorebird species on Arctic habitats which may be susceptible to perturbation from offshore oil development activities. The approach entails three major areas of investigation:

1. Seasonal occurrence of shorebirds by species, in a variety of arctic littoral and near-littoral habitats.

2. Foraging habitat preferences of shorebirds within the littoral zone, by species.

3. Diets of shorebirds in the arctic littoral zone, by species, as these change through the season.

II. Field and Laboratory Activities

A. No field work during this quarter.

B. Scientific Party

Research coordinator: Peter G. Connors

C. Methods - Data Analysis:

Preliminary analysis of census results included compilation of all census data to allow computer plotting of species populations for all transects by 5-day periods. This allowed comparisons of (1) different species, age, and sex classes. (2) single species in different habitats, tundra vs. littoral, and (3) single species habitat use patterns between seasons 1975 and 1976. Interpretations of these analyses are discussed briefly in Results section.

D. Not applicable

E. Data Analyzed:

The results of approximately 500 littoral zone transect censuses and 200 tundra transect censuses were tabulated by species and 5-day census period. Computer plots (total ≈ 35) of population changes throughout the season were constructed for 13 species.

All transect census data were entered on coding sheets (Format 034) and submitted to Ray Hadley, Univ. of Alaska, for card punching. Entries totaled 4680 cards.

Quarterly Report

Contract # 03-5-022-69
Research Unit 196
Report Period: 1 October-31 December 1976
Number of Pages: 5

The Distribution, Abundance and Feeding Ecology of Birds Associated with Pack Ice

George J. Divoky
Principal Investigator

Alaska Department of Fish and Game
1300 College Road
Fairbanks, AK 9970

January 1, 1976

III, IV. Results and Preliminary Interpretation

No change in preliminary interpretations included in the previous quarterly report.

In this report we present a table tentatively classifying the 10 most common shorebird species near Barrow with respect to susceptibility to potential oil-development-related disturbances in the littoral zone. This classification is based on interpretation of our data and observations, with reference to any available relevant literature. The required information falls into areas of distribution, habitat use, social systems ecology, behavior, and trophic studies.

Potential susceptibility of selected shorebirds to offshore oil development disturbances in the arctic littoral zone.

High	Medium	Low
Red Phalarope	Baird Sandpiper	Golden Plover
Sanderling	Dunlin	Pectoral Sandpiper
Ruddy Turnstone	Long-billed Dowitcher	
Western Sandpiper		
Semipalmated Sandpiper		

V. Problems: None

VI. Estimate of Funds Expended

Funds expended from April 15, 1975 through November 30, 1976 totaled approximately $57,000.

I. Task Objectives

Task A-5--Determine the seasonal density distribution, critical habitats, migratory routes and breeding locales for principal marine bird species in the study areas. Identify critical species particularly in regard to possible effects of oil and gas development.

Task A-6--Describe dynamics and trophic relationships of selected species at offshore and coastal study sites.

Task A-31--Determine the relationship of living resources to the ice environment (including the edge of drifting ice, land fast ice and inner pack ice) on a seasonal basis in the Bering, Chukchi and Beaufort Seas.

II. Ship and field trip schedule and scientific parties.

File Id	Ship or Plane	Area	Dates	Personnel
2BI776	BURTON ISLAND	Chukchi	22-28 July	Woodby
2GL876	GLACIER	Chukchi and Beaufort	6 Aug-3 Sept	Woodby and Phillips
3AL876	ALUMIAC	Beaufort	19-31 Aug	Good and Forsell
3GL976	GLACIER	Beaufort	5-17 Sept	Forsell
1DI976	DISCOVERER	Chukchi	10-24 Sept	Woodby
2GL976	GLACIER	Chukchi	20 Sept-2 Oct	Good
2GLA76	GLACIER	Chukchi	6-12 Oct	Harvey and Wilson

Explanation of File Identification Numbers

All data gathered as part of this research unit has been partioned into "files." Each file includes one data gathering unit such as a cruise, flight, field trip, etc. Each file is given a unique six-digit number. These numbers are used by OCS project offices and the NODC for identification of data.

First Digit

1 - Bering Sea
2 - Chukchi Sea
3 - Beaufort Sea

When more than one sea is surveyed the sea with the largest coverage is used.

Second and Third Digit

Vessel abbreviation if cruise

AL - ALUMIAC
BI - BURTON ISLAND
DI - DISCOVERER
GL - GLACIER
SR - SURVEYOR

Abbreviation for geographic point if land based

WA and WL - Wales
PH - Point Hope
CL - Cape Lisburne
CB - Cape Beaufort
KL - Kasegaluk Lagoon
IC - Icy Cape
WR - Wainwright
PD - Peard Bay
BW - Barrow
CO - Cooper Island
PP - Pitt Point
CR - Colville River (Helmrich's)
OK - Oliktok Point
PB - Prudhoe Bay
BB - Brownlow Point
BR - Barter Island
BL - Beaufort Lagoon

If aerial census "A" followed by the number of the census for that sea for that month, i.e. 2A5676 is the fifth Chukchi flight for June 1976.

Fourth, Fifth and Sixth Digit

The number of the month and year the field work started. October is "A" and November is "B." An "O" is used if data was gathered for a number of months on an irregular basis.

III. Methods

Observations

Observations are made from the flying bridge while the ship is steaming. All birds seen within 300 meters of one side of the ship are recorded. Each observation period is 15 minutes long. Ship followers are counted at least once during an observation period. Bird densities per square kilometer are computed from transect observations. Migrants and ship followers are ignored when computing densities.

Station observations are made by counting all birds in the vicinity of the ship. Station counts do not provide density information.

Collecting

Specimens are collected for stomach contents analysis. Information on molt, weight, fat and gonad size are also recorded. Stomach contents analysis is currently being done.

IV. Data Collected

Data totals for each cruise are given below:

File Id	15 minute Transects	Station Observations in hours	Specimens Collected
2BI776	32	14	--
2GL876	282	8	76
3AL876	135	--	60
3GL976	124	2	--
1DI976	300	--	9
2GL976	177	--	--
2GLA76	34	--	--

In addition to the above cruises the foot and aerial censusing conducted as part of R.U. 3/4 will provide information on bird ice relationships in inshore waters.

V. Results

Data gathered on all cruises have been coded and are currently being keypunched. Cruise tracks have been plotted by hand on USGS charts and densities on a birds/km^2 basis have been computed for transect observations. Preliminary results for each cruise are given below.

Northern Chukchi Sea, late July (2BI776) - Heavy ice conditions prevented steaming faster than 2-3 knots and the ship frequently had to back and ram. This meant that transect observations capable of producing density figures were rarely obtained. As is usually the case in heavy ice, birds were attracted to the ship due to prey items brought to the surface by the ship's screws. Good information was obtained on relative numbers of gull and jaeger species and age ratios. Continuous daylight allowed information to be gathered on patterns of activity throughout the 24-hour cycle.

Northern Chukchi and Beaufort Seas, August (2GL876) - Observations aboard the GLACIER showed bird densities to be highest in ice areas with coverage of less than two oktas. The largest numbers of birds were seen off Barrow. Lesser numbers of birds were seen in the Chukchi while extremely low densities were found in the heavy offshore ice in the Beaufort.

The most abundant birds seen in the ice were immature Red Phalaropes, adult Glaucous Gulls and immature Black-legged Kittiwakes. In open water in the Chukchi Sea, Thick-billed Murres were the most commonly encountered species.

Beaufort Sea, August (3AL876) - The cruise of the ALUMIAC in the nearshore waters of the Beaufort Sea provided important information on densities and migration in an area where little information is available. Icebreakers cannot come closer to shore than the 10 fathom contour. Thus the area between the 10 fathom contour and shore-based observers has never been studied from a vessel. Observations made on this cruise show that habitat use of this area is not extensive. Few large concentrations of waterfowl were found. Visits to barrier islands showed large numbers of Red Phalaropes and Sabine's Gulls were present on and near the island beaches.

Beaufort Sea, mid-September (3GL976) - Heavy fog during the cruise made systematic observations difficult. Good information was obtained on the seaward extent of typical shoreline migrants and on the timing of migration for a number of species. Two typical Bering Sea species, short-tailed Shearwater and Crested Auklet were seen north of Barrow.

Bering and Southern Chukchi Seas, September (1DI976) - Birds were most abundant in the Bering Strait and surrounding waters. The shallow waters of Norton and Kotzebue Sounds had low numbers of birds.

Shearwaters were the most frequently encountered birds. Their area of greatest concentration stretched from the southernmost station below the Bering Strait, at $62^{o}30'$N, through the strait to the 67th parallel. No shearwaters were seen in either Norton or Kotzebue Sounds. The net movement of these long distance migrants was north and northeast, into the wind.

Black-legged Kittiwakes were the second most common birds in the deep water areas, and were the most common birds in the shallow sounds. Almost all individuals of this small species of gull were identified as adults in breeding plumage.

As a group, Alcids were the next most common birds. This includes Common and Thick-billed Murres, Horned and Tufted Puffins, Crested, Least and Parakeet Auklets, and Kittlitz's Murrelet. These birds were in greatest numbers near summer nesting sites, such as the Diomede Islands and Cape Lisburne. Fair numbers of the smaller Alcids were seen far north of their known breeding ranges, suggesting a post-breeding migration to the north.

A significant number of migrating loons were seen passing southwest around Cape Lisburne from nesting areas on the North Slope. The most commonly seen species were Arctic Loons, many of which were still in breeding plumage. Fair numbers of these migrants were encountered in Norton and Kotzebue Sounds as well.

Northern Chukchi Sea, mid-September (2GL976) - The GLACIER cruised in both open water and ice areas and provided good information on densities and species composition in the two habitats. Work in the area of Katie's Floeberg showed that "pagophilic" species remain near the floeberg after the ice edge has moved far to the north.

Chukchi Sea, mid-October (2GLA76) - Low densities of all species were found as winter conditions were beginning in the Chukchi. Ross' Gulls, usually considered a "pagophilic" species were seen in the southern Chukchi far from any ice.

VI. Problems encountered and recommended changes.

None.

VII. Estimate of funds expended.

The following funds were expended between 1 October and 20 December.

Salaries	$ 7,292
Travel	669
Contractual	140
Commodities	54
	$ 8,155

APPENDIX

Quarterly Report: 1 January 1977
Research Unit: 196

George J. Divoky
ADF&G

Rough sorting of specimens collected in the Bering Sea in March and April 1976 is now complete. Tables 1 and 2 show the frequency of occurrence of prey items found in the bird stomachs. Frequency of occurrence is the percent of stomachs examined that contained a particular item. Prey items in stomachs are currently being counted and their length and volume measured.

The primary prey item found in stomachs of birds collected at the ice edge was pollock. It is interesting that pollock were found in surface feeders, such as gulls, as well as in diving birds, such as murres. Pollock was the only identifiable fish found in stomachs collected in April. In March, however, capelin was found in 41 percent of the Common Murre stomachs and one of the two Black-legged Kittiwakes.

Parathemisto sp. and euphausiids were the most common invertebrates and were found primarily in murre stomachs. It is surprising that three of the four Ivory Gull's examined contained shrimp (Pandalus sp.). Ivory Gull's feed only at the waters surface and the shrimp found in the stomachs may have been obtained by pirating and scavenging in feeding flocks of murres.

Table 1. Frequency of occurrence of prey items in seabird stomachs in the Bering Sea in March.

	Number of Stomachs	*Parathemisto* sp.	Euphausiid	*Pandalus* sp.	Pollock	Capelin
Black-legged Kittiwake	2		100%			50%
Ivory Gull	6				100%	
Common Murre	17	24%		6%	100%	41%
Thick-billed	2	100%				

Table 2. Frequency of occurrence of prey items in seabird stomachs in the Bering Sea in April

	Number of Stomachs	*Parathemisto* sp.	Euphausiid	*Pandalus* sp.	Squid	Pollock	Unid Fish
Northern Fulmar	1				100%		100%
Glaucous Gull	3					100%	
Ivory Gull	4			75%		100%	
Black-legged Kittiwake	1					100%	
Common Murre	14	43%	57%			43%	
Thick-billed Murre	9	11%			11%	78%	23%

RU# 215

NO REPORT WAS RECEIVED

A final report is expected next quarter

ERRATA for RU# 215

Figures 4, 5, 6, 8, 9, and 10 listed on pages 421, 422, 423, 426, 428, 429 in Volume 1, July - September, 1976 of the PI Quarterly Reports are incorrect. The "y" axis reads "number of birds, hundreds". It should read "number of birds".

TO: NOAA Environmental Research Laboratories, Boulder, Colorado; OCSEA Project Offices, Juneau and Fairbanks, Alaska.

FROM: Principal Investigator, William H. Drury
Organization: College of the Atlantic
Eden Street
Bar Harbor, Maine 04609

Report prepared by: William H. Drury
Benjamin Steele

SUBJECT: Quarterly report on work for 1976
Contract 03-5-022-77 Tasks # 237
Period: 1 October 1976 - 31 December 1976

TITLE: Birds of Coastal Habitat on the South Shore of Seward Peninsula, Alaska.

I. Task Objectives

A. Studies of populations, community structure and ecology of Marine birds at Bluff Cliffs and Sledge Island.

1. To determine the number and distribution of each species relative to other species, to periods of the breeding season, and to characteristics of available habitat within the colony or study area.
2. To provide estimates of nesting success of principal species.
3. To establish and describe sampling areas which may be utilized in subsequent years or by other persons for monitoring the status of populations.
4. To determine the amount and kinds of foods utilized by the principal species, and to describe daily foraging patterns; when possible to determine the relationship of food selected to that available.
5. To describe the chronology and phenology of events in the biology of breeding birds, including changes in population from the beginning of site occupation in the spring through departure in the fall.
6. To provide comparison of current data with recent historical data.

B. Survey of the use of coastal habitats by waterfowl and shorebirds.

1. To determine the number and distribution of principal species at spring arrival, during breeding season and in fall gatherings, as there are related to characteristics of available habitat within the area.
2. To provide estimates of production or nesting success of principal species for which estimates can be made from the air.

3. To establish and describe sampling areas which may be used in later years or by others for monitoring the status of populations.
4. To describe the chronology and phenology of events in the use of coastal habitats by waterfowl: changes in populations from arrival in spring through departure in fall.
5. To provide a comparison of current data with recent historical data.

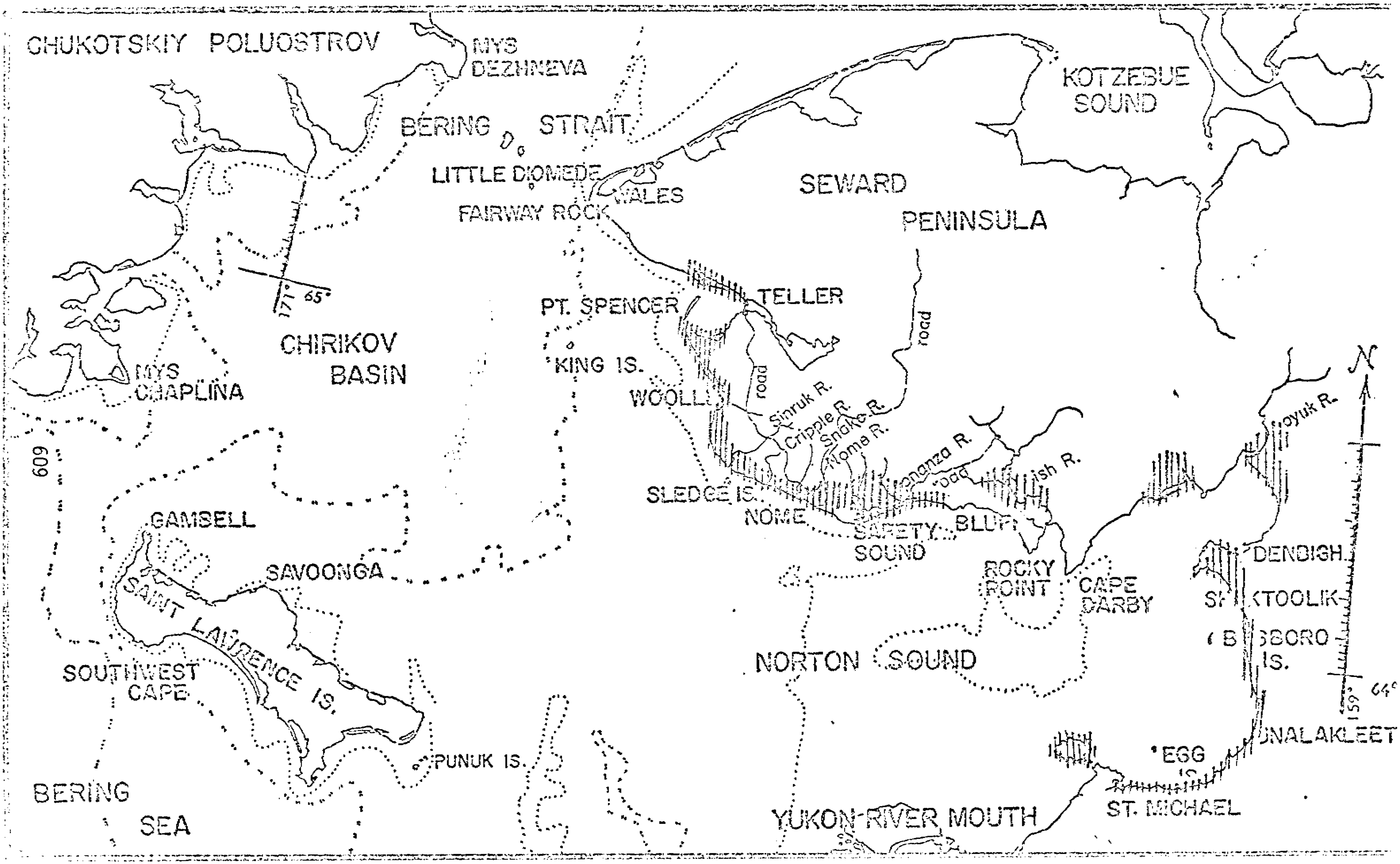
II. Activities

A. Field activities

1. During this quarter field operations were ended, the last party returning from Nome on October 16. The field party left the colony at Bluff on October 11, after documenting the departure of Murres, Kittiwakes, and Puffins from the cliffs. Observations and counts were made from established study sites every other day during the period of departure. Also sea watches were made twice a day to determine presence of migrating birds and lingering flocks of seabirds. Murres left the cliff gradually. All chicks jumped by September 16 and a few adults stayed on the cliff until September 18. Kittiwakes had all left the cliff by September 25, but flocks were seen over the water near the cliffs until October 6. Horned Puffins were present in large numbers on the cliff until September 18, after which none were seen. Glaucous Gulls and Pelagic Cormorants were still loafing on and near the cliff when the field party left on October 11.
2. During September and October four aerial surveys for migratory waterfowl were flown. These were done by flying over coastal lagoons, marshes and ponds in a small Cessna at about 100 mph and at an altitude of 100 to 200 feet. Type of habitat, species present, and numbers were recorded during transects between recognizable land marks.
   Approximately 950 miles were flown over coastal areas in September and October. The areas that were covered by aerial surveys during the whole summer are shown in figure 1 by cross hatching.
   Areas that contained tha largest concentrations of waterfowl in September and October were: 1) Point Spencer, 2) Safety Sound, 3) the mouth of the Fish River, 4) the mouth of the Koyuk River, and 5) the mouth of the Kwik River (half way between the Fish and Koyuk Rivers.)

B. Other Activities

1. During this quarter two meetings were attended, at Salishan Lodge, Oregon, and at the Ramada Inn, Anchorage, Alaska. Comments on these meetings were prepared, including their relevance to the goals of OCSEAP.


CHUKOTSKIY POLUOSTROV
MYS DEZHNEVA
BERING STRAIT
KOTZEBUE SOUND
LITTLE DIOMEDE
WALES
SEWARD
PENINSULA
FAIRWAY ROCK
171°
65°
TELLER
PT. SPENCER
road
CHIRIKOV
BASIN
KING IS.
MYS CHAPLINA
Sinruk R.
Cripple R.
Snake R.
Nome R.
SLEDGE IS.
NOME
SAFETY
SOUND
GAMSELL
SAVOONGA
ROCKY POINT
CAPE DARBY
SAINT LAURENCE IS.
SOUTHWEST CAPE
NORTON SOUND
PUNUK IS.
EGG IS.
BERING
SEA
YUKON RIVER MOUTH
ST. MICHAEL
64°
159°
N

2. The majority of office time was spent preparing data for computer archiving. Preliminary formats were reviewed by Mike Crane, and several additions to formats and to codes were requested. Estimates were made of the total number of cards needed to record the data, and the total amount of work required to code the data and put it on punched cards. This work will be continued in the next quarterly period.
3. To aid in George Hunt's analysis of the Kittiwake reproductive failure this year, data on reproductive success at 7 colonies were summarized. These are shown in Table 1. They show a very poor reproductive year in 1976 compared to 1975. They also indicate better reproduction at the eastern end of Norton Sound than in other areas. A further discussion of this will be included in the annual report.
4. In response to a specific data request we plotted our aerial waterfowl survey on USGS maps. These surveys are described above. Further analysis of this will occur in the annual report.
5. Planning was begun for the 1977 field season. Employment applications are being reviewed and logistics have been requested from NOAA. Six months reports have been sent to the Bering Strait Native Corporation and the White Mountain Village Council. A letter has been written to the White Mountain Village Council asking for permission to work at the Bluff Cliffs in 1977.
6. Laboratory work on food specimens was begun. Fish that were collected during the field season have been sorted and are awaiting identification. This work will be completed in the next quarter.

III. Accounting

Full accountings of the field season have been submitted to the accounting office in Boulder, Colorado.

1976 Kittiwake Reproductive Success in Norton Sound

Colony	Total Kittiwake Numbers	Number of Nests Sampled	% Nests with Incubating Adults*	Chicks Fledged per Nest	Egg Laying Dates	Egg Hatching Dates	Fledging Dates
Bluff 75 mi. east of Nome	3500-6100	2244		0.02	6/25-7/13	7/22-8/9	8/30-
Bluff (from boat)		2123	0.16 0.29**				
Square Rock 78 mi. east of Nome	575	121		0.02			
Sledge Island 25 mi. west of Nome	1300	204	0.04 0.15***				
King Island 80 mi. west of Nome	3000-6000	72	0.28***				
Cape Denbeigh N. eastern Norton Sound	1200	765	0.27				
Cape Denbeigh S. eastern Norton Sound	650	588	0.27				
Egg Island eastern Norton Sound	525	92	0.38				
			1975				
Bluff stakes	4250-7250	226	0.7-0.8	0.42			8/31-
Bluff (from photo)		1281		0.48			
Sledge Island	950-1500	233		0.35			
Cape Denbeigh	600-1000	470		0.50			

* Except where noted, these numbers were obtained from a small boat below the cliff in mid August

** This figure was obtained from observations from study stakes throughout the summer. It is higher than the data taken from the boat because a lot of the eggs had disappeared by mid August

*** These numbers were obtained from one days observations from the top of the cliffs. At Sledge, they were obtained about two weeks before the data taken from the boat.

RU# 239

NO REPORT WAS RECEIVED

A final report is expected next quarter

QUARTERLY REPORT

Contract: 01-5-022-2538
Research Unit: RU-337
Reporting Period: October 1, 1976 to
December 31, 1976
Number of Pages: i + 8

SEASONAL DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS
PART I. SHIPBOARD SURVEYS

Calvin J. Lensink
James C. Bartonek
Co-principal Investigators

and

Patrick J. Gould
Craig S. Harrison
Gerald A. Sanger
Susan B. Matthews
Co-investigators

U.S. Fish and Wildlife Service
Office of Biological Services - Coastal Ecosystems
800 A Street - Suite 110
Anchorage, Alaska 99501

January 1, 1977

This report describes activities by U.S. Fish and Wildlife Service personnel related to shipboard surveys of marine birds in Alaskan waters during the quarter from 1 October through 31 December 1976. Observations of marine birds from aircraft are summarized in the companion report titled, "Seasonal distribution and abundance of marine birds: Part II. Aerial surveys."

Nearly 50 days of shipboard surveys were conducted by FWS personnel on four NOAA-operated cruises during this quarter (Table 1).

Field Operation FW76089

Patrick Gould conducted seabird observations along 77 transects in Kodiak Basin, Alaska Peninsula South, St. George Basin, East Central Bering Sea and Bristol Bay Basin, from 20 September to 1 October 1976 on board the R/V *Moana Wave*. Forty-four of those transects were completed in the St. George Basin where bird densities ranged from 1 to 3,873 birds per km^2, with a mean of 117 birds per km^2. The high density was the result of a large feeding flock of short-tailed shearwaters just outside of Dutch Harbor. Short-tailed shearwaters composed 84% of the total birds recorded in this area. Fifteen transects in the Bristol Bay Basin region averaged 13 birds per km^2, with shearwaters (35%), northern fulmars (28%), and murres (19%) dominating the avifauna.

Field Operation FW76092

Arthur Sowls conducted seabird observations aboard the R/V *Moana Wave* from 18 to 29 October, surveying the Lower Cook Inlet lease area and portions of the Northwest Gulf of Alaska adjacent to the Barren Islands. Of the 73 transects conducted, shearwaters were very common around the Barrens, but by far the richest area for wintering birds was Kachemak Bay, which abounded with fork-tailed petrels, murres, murrelets and scoters.

Field Operation FW76092

Gerry Sanger participated with Dennis Heinemann, Oregon State University in a 3-day cruise aboard the R/V *Surveyor* in the Gulf of Alaska. They were able to study closely a dense concentration of 50,000 to 100,000 sooty and short-tailed shearwaters which had remained in Perenosa Bay, Afognak Island, for a week. They collected specimens of the two species, affording an excellent opportunity for a comparison of feeding habits. All data were given to Dennis Heinemann for his use in the OCSEAP project RU#108.

Field Operation FW76094

Patrick Gould participated on a research cruise in the little studied oceanic area between the Alaska Peninsula and Hawaii along the 158°W longitude line. Observations were conducted on board the R/V Moana Wave from 22 October to 7 November, in cooperation with Wayne Hoffman of Oregon State University (RU#108) and Terry Wahl of Bellingham, Washington.

Seabird density and distribution were determined by 112 standardized transects and many random observations. There were three major goals of this investigation: 1) to determine southward dispersal patterns of Alaskan seabirds; 2) to relate the density and distribution of seabirds to physical oceanographic condition; and 3) to gain a perspective on the avifauna of an almost unknown but critical transitional area of the North Pacific Ocean. The trip was highly successful and the results will be presented at the Pacific Seabird Group meeting in early January.

Seabird density averaged about 45 birds/km^2 over the Alaskan Shelf at 54.7°N, dropped to a level of 6-10 birds/km^2 from 52°N to 41°N, and then dropped to a level of 0.4-1.5 birds/km^2 from 39°N to 23°N. The birds tended to occur in one of three discernible distribution patterns: 1) species present throughout the area (e.g., black-footed and laysan albatross); 2) arctic species dispersing south to about the subarctic beginning at the subarctic convergence and continuing southward. Over 45 species were identified. Significant new information on distribution included the following: The scaled petrel was common from just off Chirikof Island south to 40°N; the red phalarope was common and perhaps in residence at 41°N; Kermadec and Herald petrels were sighted from 41°N southward; the red-legged kittiwake was observed at 45°N; the Phoenix Island petrel was found north to 24°N; and the red-tailed tropicbird was sighted north to 36°N.

A detailed analysis of these data is currently being conducted and the results will be published as soon as the analysis is completed. The findings are also being prepared for presentation at the Pacific Seabird Group's annual meeting in January 1977.

Field Operation FW76095

Pat Baird was aboard the R/V Miller Freeman 4-23 November conducting marine bird censuses in the Gulf of Alaska and the Kodiak Island area. Seventy-six 10-minute transects were conducted during Leg IV of the ship's cruise. Twenty-one species of birds were sighted, with a mean density of 37.05 birds per km^2. Generally, birds were extremely dispersed, but two large concentrations were encountered. Near the Barren Islands, the largest seabird colony in the Gulf, black-legged kittiwakes, common murres, and horned and tufted puffins were observed in the hundreds. Slightly southwest of Kodiak Island concentrations of thousands of murres, kittiwakes, and tufted puffins were found in a shallow (18 fathom) area, perhaps attracted by an upwelling of food sources. To further the feeding ecology studies (RU#341/342), specimens were collected in Resurrection Bay (near Seward), near Kayak Island (NEGOA) and in Molina Bay (near Glacier Bay).

Data Status

Under the direction of Susan (Bates) Matthews all of the 1975 shipboard and aerial census data collected with OCSEAP funds were transcribed onto computer forms; a majority has been keypunched; and seven batches submitted to OCSEAP (Table 2). Shipboard and aerial census data acquired early in 1976 remains on the old format but will be transcribed early in the next quarter. Margaret Petersen, Anthony DeGange, Allen Moe, Dave Nysewander, Kevin Powers, Pat Baird, Colleen Handel and Craig Harrison have done most of the recent transcription of data.

Susan Bates Matthews has resigned from her permanent position as Computer Analyst. Sue will continue working with us on an intermittent basis until a replacement can be found.

More than 1-man month has been spent by Gerald A. Sanger and Partick Gould in the preliminary analyses of shipboard and aerial survey data, as requested by NOAA, for presentation at the Lower Cook Inlet (November) and NWGOA (January 1977) synthesis meetings and attendance at the Southern Bering Sea workshop (October).

Efforts for Next Quarter

Efforts during the forthcoming quarter will be (1) directed towards reducing the backlog of data that must be submitted to OCSEAP, (2) continuation of shipboard surveys of opportunity, and (3) participation in OCSEAP synthesis meetings.

Table 1. Log of U. S. Fish and Wildlife Service, Office of Biological Services-Coastal Ecosystems' field operations for the study of marine birds, 1 October to 31 December 1976.

Date	Field Operations Number	Platform or Type of Study	Location	Personnel
16 May - 15 Oct, 15 Nov - 23 Nov	76056	Field camp	Nelson Lagoon	Robert Gill, Anthony DeGange, & Paul Jorgensen
1 Jun - 4 Oct 8 Nov to date	76069	Field camp	Kodiak Island	Matthew Dick and Jay Nelson
17-27 Aug*	76086*	Aerial survey, Grumman Goose N780*	Arctic Ocean & NE Bering Sea*	Craig Harrison, Colleen Handel, Arthur Sowls, & Radike (NMFS)*
20 Sep - 3 Oct	76089	MOANA WAVE	Bering Sea	Patrick Gould
15 Sep - 22 Oct	76091	Field Camp	Unimak Pass	Jay Nelson
18-29 Oct	76092	MILLER FREEMAN	Lower Cook Inlet	Arthur Sowls
4-15 Oct	76093	Aerial survey	Chukchi Sea, E. Bering Sea, Bristol Bay, St. George Basin, Unimak	Craig Harrison, Colleen Handel, Arthur Sowls
21 Oct - 11 Nov	76094	MOANA WAVE	Kodiak to Hawaii	Patrick Gould
4-23 Nov	76095	MILLER FREEMAN	Leg IV	Patricia Baird

*This field operation from previous quarter is included for reporting convenience.

Table 2. Log of data processing for U. S. Fish and Wildlife Service's field operations, 1975-76.

Field Operation Number	Data Edited	Keypunching				Date Tape Created	Date Tape Submitted to OCSEAP
		Batch #	Number of Sheets	Date Submitted	Date Returned		
FW5001							
FW5002							
FW5003							
FW5004	15 Sep 76	6-10	882	22 Sep 76	12 Oct 76	22 Dec 76	23 Dec 76
FW5005							
FW5006							
FW5007							
FW5008	1 Oct 76	23	92	14 Oct 76			
FW5009	15 Sep 76	5	72	21 Sep 76	12 Oct 76	22 Dec 76	23 Dec 76
FW5010	5 Nov 76	34	253	23 Dec 76			
FW5011	1 Oct 76	22	265	14 Oct 76			
FW5012	15 Nov 76	35	172	6 Dec 76			
FW5013	15 Sep 76	12	278	22 Sep 76	12 Oct 76	22 Dec 76	23 Dec 76
FW5014	1 Dec 76	36	274	23 Dec 76			
FW5015	3 Dec 76	37	500+	23 Dec 76			
FW5016	13 Oct 76	32-33	276	23 Dec 76			
FW5017							
FW5018	15 Sep 76	4	334	21 Sep 76	12 Oct 76	22 Dec 76	23 Dec 76
FW5019							
FW5020	1 Dec 76	39	205	23 Dec 76			
FW5021	1 Dec 76	40	335	23 Dec 76			
FW5022							
FW5023	1 Sep 76	3	200	20 Sep 76	12 Oct 76	22 Dec 76	23 Dec 76
FW5024	1 Sep 76	1	99	15 Sep 76	12 Oct 76	22 Dec 76	23 Dec 76
FW5025	1 Dec 76	41	221	23 Dec 76			
FW5026	1 Dec 76	42	135	23 Dec 76			
FW5027	1 Dec 76	43	108	23 Dec 76			
FW5028		00				1 Jul 76	15 Jul 76
FW5029	1 Dec 76	44	73	23 Dec 76			
FW5030		2	89	15 Sep 76	12 Oct 76	22 Dec 76	23 Dec 76

(Table continued)

Table 2. Continued.

Field Operation Number	Data Edited	Keypunching				Date Tape Created	Date Tape Submitted to OCSEAP
		Batch #	Number of Sheets	Date Submitted	Date Returned		
FW5031	1 Dec 76	45	44	23 Dec 76			
FW5032	15 Sep 76	11	88	22 Sep 76	10 Dec 76	22 Dec 76	23 Dec 76
FW5033	20 Nov 76	46	121	Dec 76			
FW5034	20 Nov 76	47	95	23 Dec 76			
FW5035	20 Nov 76	48	13	Dec 76			
FW6001							
FW6002							
FW6003							
FW6004							
FW6005							
FW6006							
FW6007							
FW6008		30	52	14 Oct 76			
FW6009							
FW6010							
FW6011							
FW6012							
FW6013							
FW6014							
FW6015							
FW6016							
FW6017		18	106	30 Sep 76			
FW6018		49					
FW6019	22 Sep 76	26-27	384	14 Oct 76			
FW6020	15 Oct 76						
FW6021		29	188	14 Oct 76			
FW6022							
FW6023							
FW6024							
FW6025							
FW6026							

(Table continued).

Table 2. Continued.

Field Operation Number	Data Edited	Keypunching				Date Tape Created	Date Tape Submitted to OCSEAP
		Batch #	Number of Sheets	Date Submitted	Date Returned		
FW6027							
FW6028							
FW6050	23 Sep 76	30	67	14 Oct 76			
FW6051	23 Sep 76	31	95	14 Oct 76			
FW6052	23 Sep 76	25	209	14 Oct 76			
FW6053							
FW6054							
FW6056							
FW6057	23 Sep 76	28	239	14 Oct 76			
FW6058							
FW6059							
FW6060							
FW6061							
FW6062							
FW6063		38	1000+	23 Dec 76			
FW6064							
FW6065							
FW6066							
FW6067							
FW6068							
FW6069	23 Sep 76	50	108	23 Dec 76			
FW6070							
FW6071							
FW6072							
FW6073							
FW6074							
FW6075							
FW6076							
FW6077							
FW6078							
FW6079							

(Table continued).

Table 2. Continued.

		Keypunching					
Field Operation Number	Data Edited	Batch #	Number of Sheets	Date Submitted	Date Returned	Date Tape Created	Date Tape Submitted to OCSEAP
FW6080							
FW6081							
FW6082							
FW6083		24	119	14 Oct 76			
FW6085							
FW6086							
FW6087							
FW6088							
FW6089							
FW6090	(Data given to Dennis Heineman RU#108)						
FW6091							
FW6092							
FW6093							
FW6094							
FW6095							

QUARTERLY REPORT

Contract: 01-5-022-2538
Research Unit: RU-337
Reporting Period: October 1, 1976 to
December 31, 1976
Number of pages: ii + 10

SEASONAL DISTRIBUTION AND ABUNDANCE OF MARING BIRDS: PART II. AERIAL SURVEYS

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and

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January 1, 1977

Abstract. Aerial surveys were conducted in the Beaufort Sea, the Chukchi Sea and the Bering Sea in August and October of 1976 by U. S. Fish and Wildlife Service personnel. Data were obtained from two mission reports. In total, 1762 quadrats or units of information were collected.

Summaries of bird population data in August and October are presented in 4 maps.

Distributional data from aerial transects are deemed insufficient in quantity to adequately measure potential impacts of OCS leasing on avifauna in most regions in any but the summer months.

INTRODUCTION

This report considers the seasonal density and distribution of marine birds and the identification of critical species and areas with regard to possible effects of oil and gas development. Emphasis is on the pelagic environment and not on species generally confined to littoral habitats. Furthermore, this report does not directly address the distribution of pelagic species when they occupy shoreline habitats during the breeding season. With a large enough data base, an evaluation of the use of any geographical area by species can be made. Key areas can then be identified and seasonal patterns of distribution by species will indicate which populations would be adversely impacted by outer continental shelf oil and gas development.

CURRENT STATE OF KNOWLEDGE

See Annual Report, RU-337, April 1, 1976 and Quarterly Report, RU-337, July 1, 1976.

STUDY AREA

Aerial observations of seabirds have been made during this reporting period within 8 of 32 oceanographic regions that were subjectively delineated by us so as to, in part, encompass sedimentary basins identified by the U.S. Department of the Interior for leasing and, in part, in consideration of political boundaries or oceanographic characteristics (see Annual Report, RU#337, 1 April 1976). Specific locations are reported in the Results section, but in general the boundaries for this reporting period have been the 141°30'W meridian to the east in the Beaufort Sea, the 72°N latitude to the north in the Beaufort Sea, the 171°W meridian to the west in the Bering Sea and the 52°30'N latitude to the south in the Gulf of Alaska. Areas in which surveys were flown correspond to those which we believe are most lacking in information at critical times of the year. Other areas have been omitted due to reduction of funding for this activity.

METHODS

See Annual Report, RU-337, April 1, 1976.

RESULTS

Table 1 is a log of field reports prepared by U.S. Fish and Wildlife personnel, contractees and collaborators covering their shipboard, aerial and ground surveys during the period 1 October to 31 December 1976. Data from field reports 76086 and 76093 comprise the basis for this report.

Table 2 summarizes the distribution of effort for aerial censuses. Densities of birds (all species combined) are mapped for the months of August and October (Maps lab and 2ab).

DISCUSSION

Maps lab illustrate seabird distribution and densities for the Beaufort Sea, Chukchi Sea and Northern Bering Sea during the period 17-27 August 1976. This synoptic view, obtained from 17-27 August, fills a major gap in our knowledge for this area at a time when the breeding cycle for most birds is almost completed and feeding in preparation for migration is occurring. The packice habitat in the Beaufort Sea in August appears to be of limited importance for a few species of birds. Jaegers, kittiwakes and arctic terns occasionally were observed over the ice, but their biomass would be so small that it is effectively negligible. The inshore ice-free areas of the Beaufort Sea proved to be of great importance to migrating eiders, oldsquaw, loons and phalaropes and measures must be taken in offshore oil development in this area to mitigate the disturbance of this flyway.

The waters of the northeastern Chukchi Sea appeared to be of comparatively limited importance for seabirds among the August survey period, perhaps due to the distance from any breeding sites. The central and southern Chukchi, on the other hand, did have sizeable concentrations of murres, phalaropes, fulmars and small alcids. Much of Kotzebue Sound did not support sizeable seabird communities although cormorants are found in the area, but the waters offshore from Cape Espenberg proved to be very important for sea ducks and Eschscholtz Bay had mudflats which were of great importance to waterfowl and shorebirds.

The surveys in the northern Bering Sea showed the largest concentrations of seabirds to be associated with the Diomede Islands, King Island and the Gambel area of St. Lawrence Island. These areas must be protected from the effects of oil spills at all costs. Least, crested and parakeet auklets were the dominant species, and they are all very vulnerable to oil spills. Norton Sound surprisingly had very few seabirds, except for the area immediately adjacent to Cape Denbigh. The most important areas of the Eastern Central Bering Sea proved to be the southern coastline of Nunivak Island and the mudflats of the Yukon delta which supported large populations of pintails and shorebirds.

Maps 2ab illustrate seabird distribution and densities for the Chukchi Sea, the northern Bering Sea and the southern Bering Sea during the period 4-15 October 1976. There was a general evacuation of birds from the Chukchi and Northern Bering in comparation to the August survey, but murres and kittiwakes were still in the Cape Lisburne area and large numbers of shearwaters had moved from the Bering Sea up into the southern Chukchi. The large concentrations of birds associated with the Diomedes, King Island and Gambel had disappeared; but shearwaters were feeding in large numbers in some areas. Oldsquaw had moved into Kotzebue Sound, a species which had not been present in August. Norton Sound again appeared to be of limited importance to seabirds. The nearshore waters, however, were likely to have been of greater importance, but the survey transects did not adequately cover this area.

Bristol Bay had small populations of seabirds except in the areas immediately adjacent to the shoreline where scoters and loons were found in considerable numbers. Especially large concentrations of sea ducks were observed in the Bechevin Bay-Unimak Island area. The southern Bering Sea had substantial numbers of fulmars, murres, tufted puffins, small alcids, kittiwakes and glaucous-winged gulls in all areas surveyed. There were especially large concentrations of these species and migrating phalaropes in the vicinity of Akutan Pass. Very large rafts of murres were observed to the north of St. Paul Island, apparently an important feeding area. Near the 100-f curve of the southern Bering Sea Japanese and Russian bottom fish operations produce tons offal and we found large numbers of fulmar, kittiwakes and glaucous-winged gulls associated with these ships.

CONCLUSIONS

The 1762 quadrats surveyed during this quarter have supplied much-needed information on the abundance and distribution of marine birds during fall in the Beaufort, Chukchi and Bering Seas. Areas which stand out as deserving protection due to seabird resources as determined by these surveys are the flyway just offshore along the entire Beaufort Sea, Eschscholtz Bay, the Diomede Islands, King Island, northwest St. Lawrence Island, the Pribilof Islands, Akutan Pass and the coastline of the Alaska Peninsula. In these areas alcids and sea ducks are concentrated in large numbers and would be especially vulnerable to oil and gas development.

NEEDS FOR FURTHER STUDY

Aerial censuses have provided information of substantial value to understanding distribution patterns of marine birds. However, survey data are not available for some geographic areas (South Central Bering Sea, Navarin Basin and Western Gulf of Alaska); and seasonal data is inadequate for all areas, with the winter period most poorly represented. Similarly, replication of surveys in all areas and seasons is considered essential for evaluating annual changes in distribution which may result from various climatic or oceanographic factors, changes in populations, or in distribution of food resources.

Aerial censuses provide the only internally consistent means for evaluating distribution and abundance of birds over large areas or within short periods of time, and on termination of the OCSEAP program will likely provide the only available means for monitoring populations in a consistent manner. The importance of aerial survey data indicates that additional emphasis should be placed on this phase of the program, particularly as current data from shipboard censuses are available for comparing and evaluating both techniques.

WORK SCHEDULED FOR FOLLOWING QUARTER

Complete surveys of Kodiak and the Western Gulf of Alaska to Akutan and including Unimak Pass area of southern Bering Sea. March-April.

Summarize census data for all years, seasons and areas for inclusion in annual report.

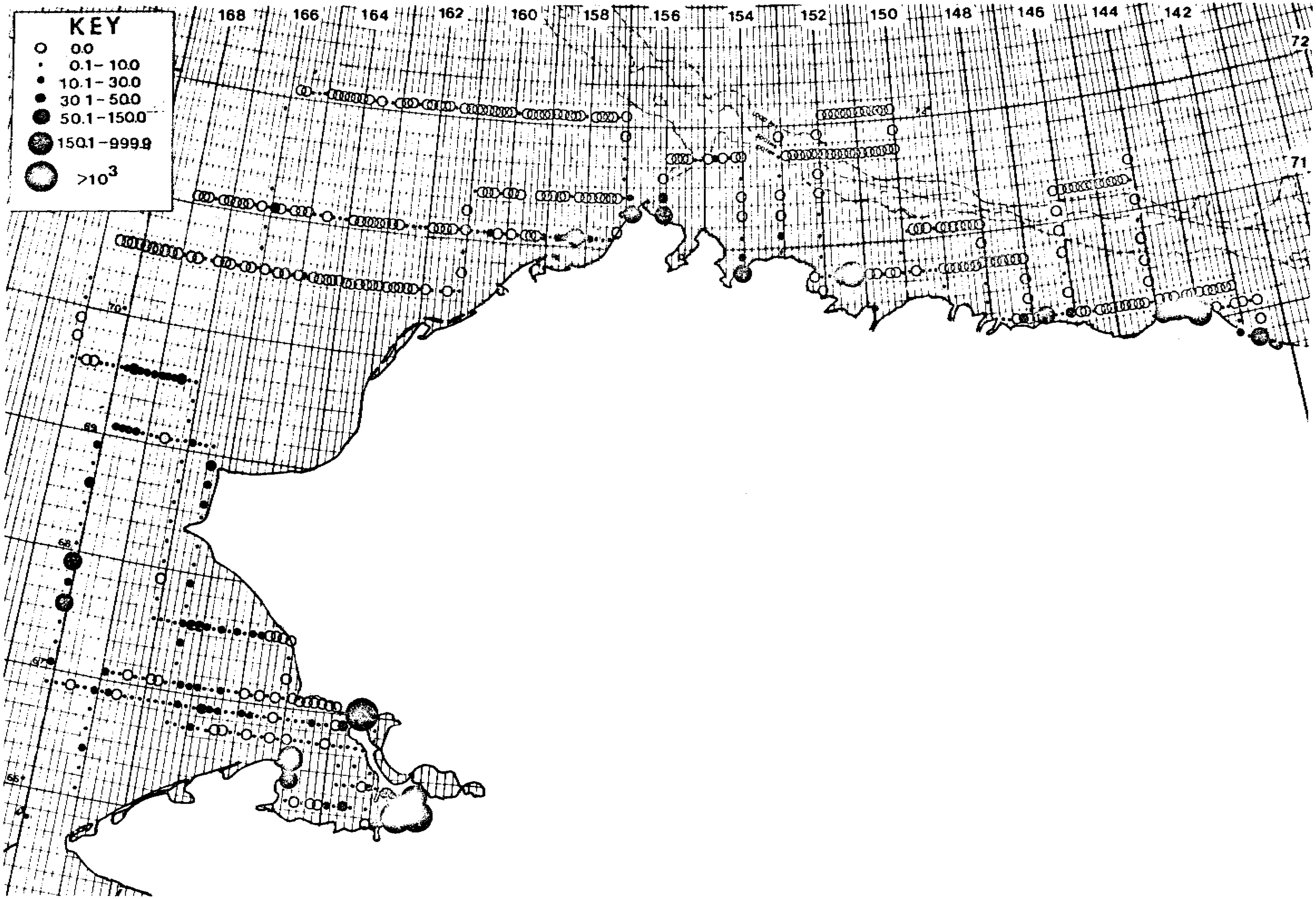
Table 1. Log of U. S. Fish and Wildlife Service, Office of Biological Services-Coastal Ecosystems' field operations for the study of marine birds, 1 October to 31 December 1976.

Date	Field Operations Number	Platform or Type of Study	Location	Personnel
16 May - 15 Oct, 15 Nov - 23 Nov	76056	Field camp	Nelson Lagoon	Robert Gill, Anthony DeGange, & Paul Jorgensen
1 Jun - 4 Oct 8 Nov to date	76069	Field camp	Kodiak Island	Matthew Dick and Jay Nelson
17-27 Aug*	76086*	Aerial survey, Grumman Goose N780*	Arctic Ocean & NE Bering Sea*	Craig Harrison, Colleen Handel, Arthur Sowls, & Radike (NMFS)*
20 Sep - 3 Oct	76089	MOANA WAVE	Bering Sea	Patrick Gould
15 Sep - 22 Oct	76091	Field Camp	Unimak Pass	Jay Nelson
18-29 Oct	76092	MILLER FREEMAN	Lower Cook Inlet	Arthur Sowls
4-15 Oct	76093	Aerial survey	Chukchi Sea, E. Bering Sea, Bristol Bay, St. George Basin, Unimak	Craig Harrison, Colleen Handel, Arthur Sowls
21 Oct - 11 Nov	76094	MOANA WAVE	Kodiak to Hawaii	Patrick Gould
4-23 Nov	76095	MILLER FREEMAN	Leg IV	Patricia Baird

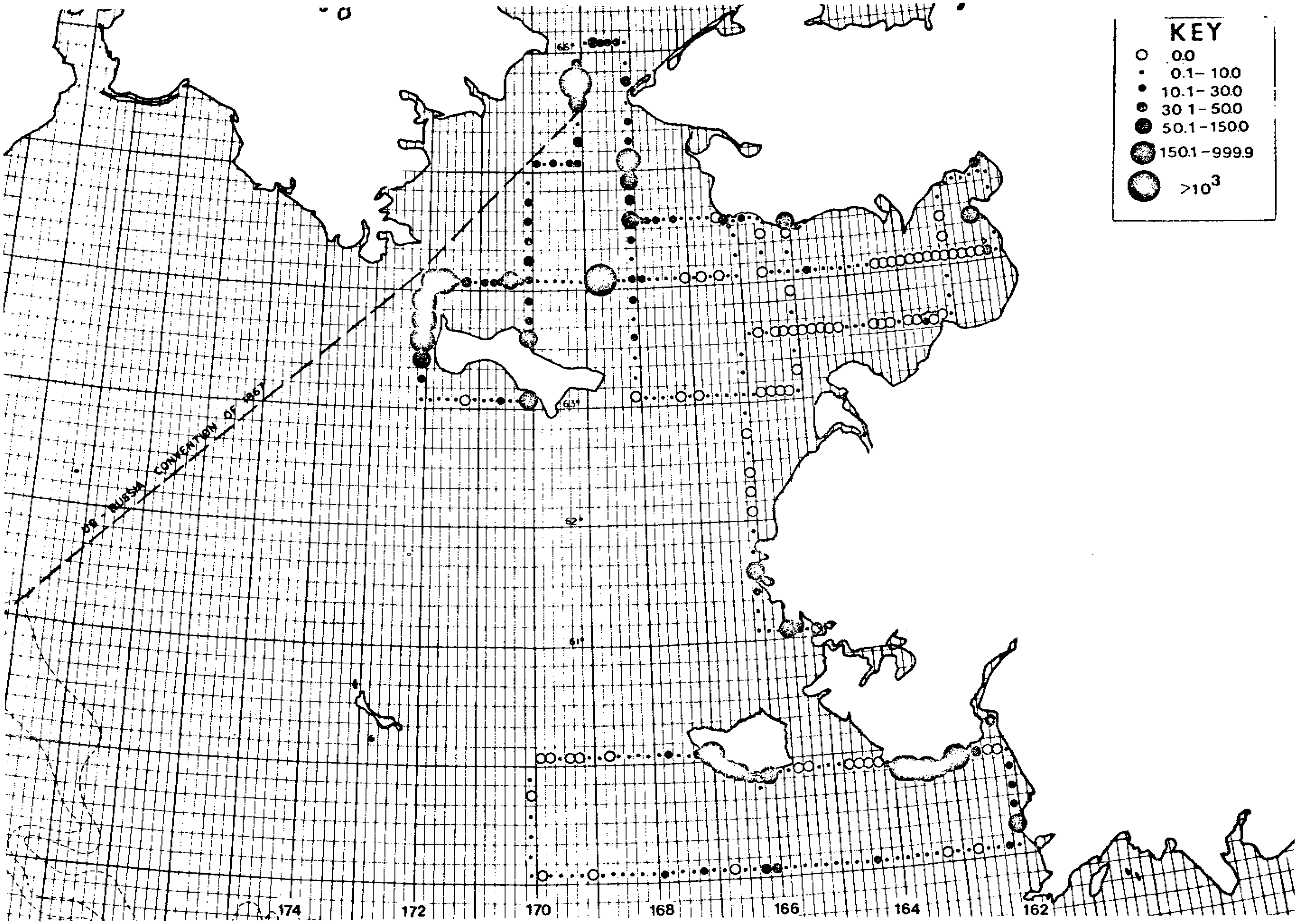
*This field operation from previous quarter is included for reporting convenience.

Table 2. Distribution of effort for censusing marine birds by the aerial transect method, July-December, 1976.

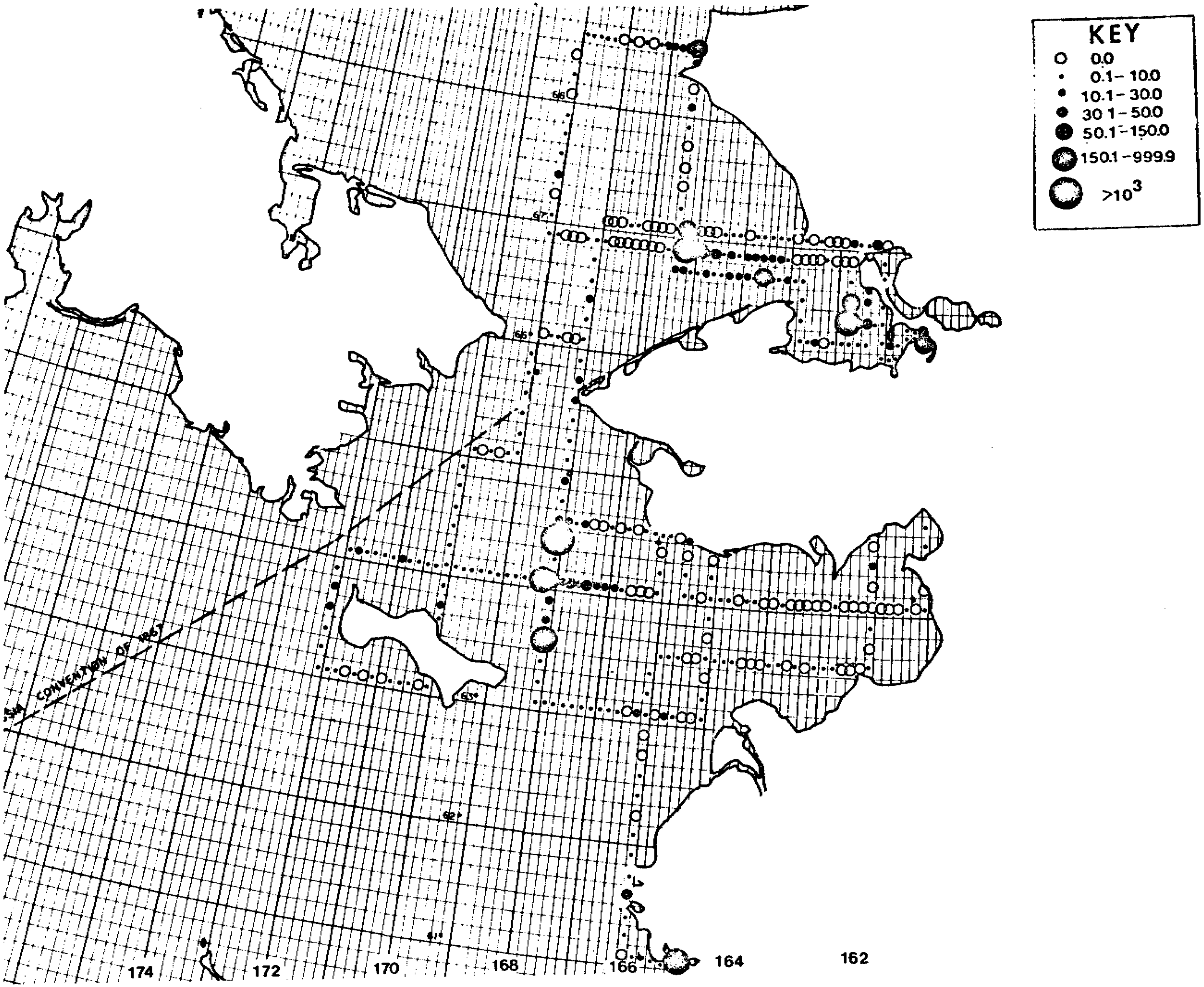
Region	Region Abbre-viation	August	October	Total
Beaufort Basin	BFT	206	0	206
Bristol Bay	BB	0	122	122
Eastern Central Bering Sea	ECB	119	23	142
Hope Basin	HB	480	173	653
Navarin Basin	NAV	6	6	12
Norton Basin	NB	210	210	420
St. George Basin	SGB	0	151	151
Umnak Basin	UMB	0	56	56
Total		1021	741	1762



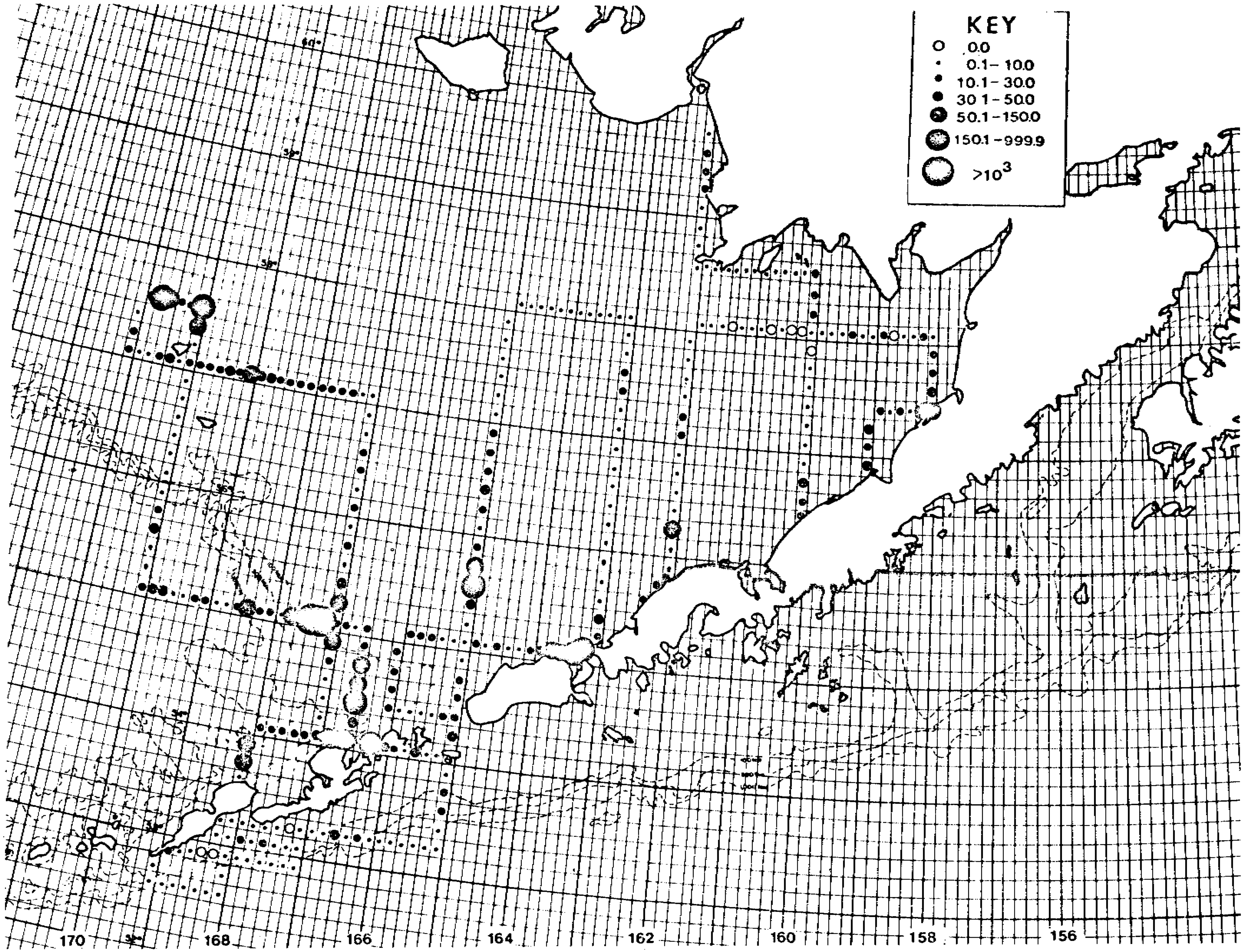
Map 1a. Aerial transects showing density of birds per Km^2 for all areas surveyed in August, 1976.



Map 1b. Aerial transects showing density of birds per Km^2 for all areas surveyed in August, 1976.



Map 2a. Aerial transects showing density of birds per Km^2 for all areas surveyed in October, 1976.



Map 2b. Aerial transects showing density of birds per Km^2 for all areas surveyed in October, 1976.

QUARTERLY REPORT

Contract: 01-5-022-2538/
01-06-022-11437
Research Unit: RU-338/343
Reporting Period: October 1, 1976 to
December 31, 1976
Number of Pages: i + 2

PRELIMINARY CATALOG OF SEABIRD COLONIES

AND

PHOTOGRAPHIC MAPPING OF SEABIRD COLONIES

Calvin J. Lensink
James C. Bartonek
Co-principal Investigators

and

Arthur L. Sowls
Susan C. Bates
Co-investigators

U.S.Fish and Wildlife Service
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January 1, 1977

INTRODUCTION

This report contains a summary of activities during the quarter from 1 October through 30 December, 1976,on Research Units # 338 and 343.

The objectives of the two research units are to catalog seabird colonies, provide information about their location, composition, size and amount of land occupied, and to obtain a photographic record of the colonies.

STUDY AREA

Since colonies are abandoned this time of year, active field work for colony censusing was not done during this quarter. Observations of many colony sites were done opportunistically during aerial and shipboard pelagic transects, with only cormorants found still on the sites and they were presumably only roosting.

Data gathering on the Arctic Ocean, Bering Sea and Aleutian Islands was begun by a literature search and consolidation of various U.S. Fish and Wildlife Service reports. Updating existing data on the Gulf of Alaska and Bristol Bay continued.

METHODS

Methods are described in our annual report of 1 April 1976.

RESULTS AND DISCUSSION

Summarization of colony data for areas not previously reported would be premature, because the bulk of the data acquisition has not been completed.

Meetings were held on requirements for the computerization of colony data with Rod Stein and Mike Crane of NOAA's Environmental Data Service. Data for the computer will be limited to posiiton, number of birds, and nests of each species composing the colony, date, disturbance factors, land ownership, data quality, island size, marine mammals present and data source. This format will allow for:

1. Analysis of pelagic observation of seabirds in relationship to size and location of colonies or groups of colonies.

2. Provide a ready source of data for use in trajectory and risk analysis for predicting the effect of oil spills and other environmental hazards.

3. Facilitate identification of critical habitats.

4. Analysis of nesting distribution of individual species.

Data that does not contribute substantially to meeting these primary goals was excluded from the computerized format, because both the printed catalog and the open file on each colony will provide more flexible and accessable formats for obtaining detailed information on individual colonies. Also the cost of computerization and archival will be substantially less.

Efforts during the next quarter will be directed towards transcription of data onto computer format; keypunching that data; submission of taped data to OCSEAP; and seeking and adding new information to the open file.

QUARTERLY REPORT

Contract: 01-6-022-11437
Research Unit: RU-339
Reporting Period: October 1, 1976 to
December 31, 1976
Number of Pages: i + 1

REVIEW AND ANALYSIS OF LITERATURE AND UNPUBLISHED DATA ON MARINE BIRDS

Calvin J. Lensink

and

James C. Bartonek

Co-principal Investigators

U.S. Fish and Wildlife Service
Office of Biological Services - Coastal Ecosystems
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January 1, 1977

INTRODUCTION

The objectives of this research unit are to provide an annotated bibliography of Alaskan marine birds and an analysis of the current status of information on marine birds of relevance to evaluating potential impacts from proposed developments of the outer continental shelf.

PROJECT ACCOMPLISHMENTS

During this quarter we finalized our efforts to examine source documents for the comprehensive bibliography. More than 800 titles of published and unpublished references to birds of coastal Alaska and adjacent waters have been assembled. An additional 200 titles of either general references to marine biology or references to oil contamination of birds and their habitats are to be included in the final report.

In addition to examining key references and journals, several data bases were queried for relevant titles. They included NTIS (1964-76), BioAbstracts (1972-76), Oceanic Abstracts (1964-76), Oceanic Abstracts (1964-76), Dissertation Abstracts (1861-1976), and Fish and Wildlife Reference Service (Alaska Federal Aid in Wildlife Restoration reports only). In all cases, these data bases were deficient in titles that were known to us. We do not known whether or not the deficiency was attribuitable to our inadequate selection of key words, the inadequate coding of the reference, the reference may not have been accessioned into the base, or a combination of all.

The final report will be completed for inclusion with the Annual Report.

QUARTERLY REPORT

Contract: 01-6-022-11437
Research Unit: RU-340
Reporting Period: October 1, 1976 to
December 31, 1976
Number of Pages: i + 1

MIGRATION OF BIRDS IN ALASKA COASTAL AND MARINE HABITATS SUBJECT TO INFLUENCE BY OCS DEVELOPMENT

Calvin J. Lensink
James C. Bartonek
Co-principal Investigators

and

Susan Bates Matthews
Robert E. Gill, Jr.
Patrick J. Gould
Scott A. Hatch
Robert D. Jones, Jr.
David R. Nysewander
Gerald A. Sanger
Co-investigators

U.S. Fish and Wildlife Service
Office of Biological Services - Coastal Ecosystems
800 A Street - Suite 110
Anchorage, Alaska 99501

January 1, 1977

This report summarizes efforts by U.S. Fish and Wildlife Service (FWS) personnel, our contractees, and our collaborators during the quarter from 1 October through 31 December 1976 to characterize migration of birds in those waters subject to petroleum development of the outer continental shelf.

Data that had been collected from spring through fall at various FWS field camps were either transcribed or edited and are, at the end of this quarter, awaiting keypunching. Problems related to contracting keypunching were partly resolved this quarter. NOAA-EDS's keypunching service is an important asset, which should facilitate future processing of "Sea Watch" data for analyses and for submission to the Juneau Project Office. Processing shipboard transect data (RU#337) was given priority, at the expense of this and other research units' data, because of various users' needs.

Susan (Bates) Matthews wrote a program to accommodate both band recovery data and "Sea Watch" data, with displays by species and by month of the numbers and percentages of birds found at different blocks of latitude and longitude. David R. Nysewander is currently analyzing the data from the 20,158 banded birds that were banded or recovered in Alaska (see Annual Report RU#340, 1 April 1976) and will incorporate "Sea Watch" data into the analyses when it becomes available for automatic data processing. Sets of these band-report data are also being used for analyses of both migration and mortality by Robert D. Jones, Jr., for black brant, and by James G. King and John I. Hodges, Jr. for white-fronted geese and other waterfowl of the North Slope.

Banding schedules covering 4268 birds banded by OCSEAP investigators during 1976 have been submitted to FWS Bird Banding Laboratory. Additional banding schedules have yet to be submitted. Several additional reportings of banded glaucous-winged gulls were received during this quarter, and all supported the conclusion regarding their migration as stated in the Quarterly Report RU#340, 1 July 1976.

QUARTERLY REPORT

Contract: 01-022-2538
Research Unit: RU-341, RU-342
Reporting Period: October 1, 1976 to
December 31, 1976
Number of pages: i + 5

FEEDING ECOLOGY AND TROPHIC RELATIONSHIPS OF ALASKAN MARINE BIRD (RU-341)

AND

POPULATION DYNAMICS OF MARINE BIRDS (RU-342)

Calvin J. Lensink
James C. Bartonek
Co--principal Investigators

and

Susan B. Matthews
Robert E. Gill, Jr.
Patrick J. Gould
Scott A. Hatch
Robert D. Jones, Jr.
David R. Nysewander
Gerald A. Sanger
Arthur L. Sowls
Co-investigators

U.S. Fish and Wildlife Service
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Anchorage, Alaska 99501

January 1, 1977

INTRODUCTION

Research Units RU#341 and 342 were designed to help satisfy the objectives of OCSEAP Task A-6 which are to describe the trophic relationships and the population dynamics of selected species at offshore and coastal study sites. Since personnel, coastal study sites, and ships, involved in RU#341 are largely identical with those involved in RU#342, the two research units are treated together in this report. This report summarized our activities related to these research units during the quarter from 1 October to 31 December 1976.

STUDY AREAS

Activities under this contract are largely restricted to the Gulf of Alaska and the southeastern Bering Sea. The Annual Report (1 April 1976) and the Quarterly Reports (1 July and 1 September 1976) describe the location of the study sites and regions where birds have been collected for food studies.

METHODS

See our Annual Reports for RU#341 and 342 of 1 April 1976.

RESULTS AND DISCUSSION

Field Activities

Only 3 of the 14 field camps operated during the summer were in operation during this quarter, and they were Unimak Pass, Nelson Lagoon and Kodiak (Table 1).

Unimak Pass: From 17 September to 22 October Jay Nelson was stationed at the Cape Sarichef U. S. Coast Guard LORAN "C" Station on the southwest tip of Unimak Island monitoring movements of birds and mammals through the pass. Although over 45 species of birds were recorded, their migration patterns varied in steadiness and intensity. The most steady migrants were the cormorants and black-legged kittiwakes, whereas the shearwaters and murres were much more intermittent in their movements. In mid-October 3,400 murres per hour passed through Unimak Pass. There were 16,000 shearwaters per hour moving through on 29 September; 550 arctic loons per hour on 9 October; and 350 red-faced and pelagic cormorants per hour on 6 October. The kittiwakes, with a peak of 2,000 per hour on 14 October, heavily used en route a tidal rip feeding area one-half mile to one mile offshore.

The most unusual sighting was that of several flocks of pine siskins which have never before been recorded in the Aleutian Islands. They have been reported regularly on Kodiak Island and at the base of the Alaska Peninsula, and twice at Sand Point in the early 1940's, over 150 miles to the east. The siskins were actively feeding along the beach, gradually moving south.

Ten peregrine falcons and several gyrfalcons and bald eagles were observed moving south along the coast.

Migration of marine mammals had not started, although one gray, one fin and two killer whales were observed. The expected gray whale migration had not yet occurred by 22 October.

Less than a sixth of the pass can be observed from Cape Sarichef, and certainly less than half of those pelagic birds moving through the pass are countable.

Unimak study site is providing some unexpected but significant information about Aleutian Canada geese migrations. Jay Nelson observed nine Aleutian Canada geese at Sennet Point on 22 September. He identified the geese by the stubby neck and the white band at the base of the neck. He also saw more than 100 other Canada geese but did not believe them to be of the endangered race. Wayne Hoffman, from Oregon State University, reported to us the sighting of 34 "small" Canada geese (probably Aleutians) flying east along the south shore of East Unalga on 7 September. This information was relayed to Vernon Byrd, USFWS at Adak, who is in charge of the national recovery program for this endangered race.

Nelson Lagoon : Robert Gill and Anthony DeGange were at the Nelson Lagoon camp through 15 October when they returned to Anchorage to participate in the OCSEAP bird workshop. Bob and Tony returned to Nelson Lagoon for the period 15 to 23 November to continue monitoring the movements of waterfowl and shorebirds through aerial and ground surveys and seawatches. A total of 80,000 waterfowl (15 species) were observed, with 21,500 emperor geese, 21,800 black scoters, 16,000 Steller's eiders, and 9,000 oldsquaws. Rock sandpipers and sanderlings were present in low numbers, totalling about 1,000 birds. A handful of northern and red phalaropes were sighted. No significant Gray whale migration was observed and individuals were still present in the lagoon when the camp was closed.

Kodiak: Matthew Dick returned from the Kodiak study area on 4 October to work up the data he and Jay Nelson collected this summer and to participate in the OCSEAP bird workshop. Matt returned to Kodiak in early November where he is working as an intermittent employee of FWS continuing the bird studies. In Chiniak Bay in November, common goldeneyes, scaup, buffleheads, mallards, common mergansers, red-breasted mergansers, harlequins, white-winged scoters, black scoters, surf scoters and common eiders were common. Both red-throated and arctic loons were present. The Afognak double-crested cormorants appeared to have moved into Chiniak Bay.

Matt is systematically collecting birds for food analyses throughout the winter. His collection includes alcids, larids and waterfowl.

Matt wrote a popular article titled "The birds around us" for The Kodiak Fish Wrapper (Vol. 2, Issue 11, p. 1-7, November 1976) which characterized the birds of the Kodiak area and brought attention to the OCSEAP bird studies and the OCS program in general.

Laboratory and Office Activities

A majority of the effort for this research unit was spent preparing interim reports, manuscripts, and presentations covering field activities of the past summer; participating in OCSEAP-sponsored workshops and meetings; processing birds for food analyses; and working with various aspects of data management.

Progress reports covering the diverse studies at the 14 FWS field camps were being prepared during this quarter. (See Quarterly Reports RU#341/342, July 1 and October 1, 1976 for location and personnel at these camps.) The progress reports will be included in the Annual Report for 1977.

Several papers covering aspects of this research unit were prepared for presentation at the Pacific Seabird Group meeting at Pacific Grove, California in January. Abstracts of those papers will be included in the Annual Report for 1977.

Allen Moe, Margaret Petersen, and Sally Fullerton, under Gerald Sanger's direction, logged in 156 specimens into the collection of bird stomachs, bringing the total logged to 613 specimens. Additional specimens are on hand and will be processed next quarter. Approximately 125 contents from stomachs were rough sorted, but there was no effort to make final sortings, which will wait until OCSEAP-paperwork requirements have subsided. Gerald Sanger and Patricia Baird completed rough sorting of stomachs from all sooty and short-tailed shearwaters in our possession. Pat has also been building a reference collection to facilitate sorting and identification of food organisms.

A majority of the OBS/CE staff participated in the OCSEAP-sponsored meeting of investigators that were conducting bird studies in coastal Alaska. Robert Gill and Anthony DeGange flew in from the Nelson Lagoon field camp to attend the meeting; Lora Leschner and Dave Manuwal from Seattle; Marshall Howe from Washington, D.C.; and Scott Hatch, Duff Wehle, Bob Day and contractees Pete Mickelson, Bud Lehnhusen and Sue Quinlan from Fairbanks. The meeting was held in Anchorage from 20 to 22 October.

About 5 weeks of Gerald Sanger's time during the quarter was spent in preparing for and attending OCSEAP data synthesis meeting and preparing related evaluation and technical reports. The first synthesis meeting was on the eastern Bering Sea, held 3-6 October at Salishan Lodge, Gleneden Beach, Oregon; and the second meeting was on Lower Cook Inlet and held 16-18 November in Anchorage.

Considerable time was spent during the quarter finalizing a comprehensive ADP system for field and laboratory data from marine bird feeding studies. Gerald Sanger and Susan Bates Matthews working with the staff and soliciting advice from other OCSEAP investigators developed a system that is quite flexible and which is designed to accommodate data from pelagic and shore-based studies. The system is capable of storing and analyzing data from cursory analyses of stomach contents as well as more detailed analyses which may emphasize numbers and sizes of prey and record taxonomically and meristically useful information on prey part sizes. When a sufficient quantity of the latter kinds of data have been accumulated, indices of original prey sizes can be developed.

Susan Matthews met with Robert Stein and Michael Crane NODC-EDS in November data formatting differences and the kinds of data to be archived by OCSEAP.

Little data from this research unit has been processed for ADP (see Quarterly Report RU#337, Table 2, 1 January 1977) because of formatting differences with NODS-EDS and priority request by OCSEAP for shipboard survey information (RU#337).

NEXT QUARTER ACTIVITIES

Effort will be directed towards completion of reports for inclusion into the Annual Report which is due 1 April 1977, reduction of data to be processed for ADP and archival by OCSEAP, and preparation of manuscripts for publication.

Field activities will include continued operation of the Kodiak field study, intermittent operation of both the Nelson Lagoon and Cape Sarichef field studies, and collection of birds for food studies from NOAA-operated vessels of opportunity.

Preparation for field activities during the 1977 field season will be continuing throughout the next quarter. Cleaning, repairing and replacement of equipment and supplies. Contract agreements for operating a vessel must be finalized.

Table 1. Log of U. S. Fish and Wildlife Service, Office of Biological Services-Coastal Ecosystems' field operations for the study of marine birds, 1 October to 31 December 1976.

Date	Field Operations Number	Platform or Type of Study	Location	Personnel
16 May - 15 Oct, 15 Nov - 23 Nov	76056	Field camp	Nelson Lagoon	Robert Gill, Anthony DeGange, & Paul Jorgensen
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21 Oct - 11 Nov	76094	MOANA WAVE	Kodiak to Hawaii	Patrick Gould
4-23 Nov	76095	MILLER FREEMAN	Leg IV	Patricia Baird

*This field operation from previous quarter is included for reporting convenience.

RU# 428

NO REPORT WAS RECEIVED

A final report is expected next quarter

QUARTERLY REPORT

Contract #03-5-022-56
Research Unit #441
Task Order #27
1 October - 31 December 1976
Number of Pages 67

Avian Community Ecology at Two Sites on Espenberg Peninsula in Kotzebue Sound, Alaska. A Composite Study of: 1) Habitat Utilization and Breeding Ecology of Waterbirds, 2) Habitat Utilization and Breeding Ecology of Shorebirds and Non-Waterbird Species, and 3) Habitat Utilization, Breeding Ecology, and Feeding Ecology of Predators of Birds.

Principal Investigator: P. G. Mickelson, Institute of Arctic Biology

Report Prepared By: Douglas Schamel, Institute of Arctic Biology
Diane Tracy, Institute of Arctic Biology
Anne Ionson, Institute of Arctic Biology
Peter G. Mickelson, Institute of Arctic Biology

31 December 1976

I. Task Objectives

1. To determine phenology of events from spring arrival through departure of birds,
2. to determine the distribution and abundance of birds and their predators,
3. to describe habitat utilization of birds and their predators during migration, the nesting season, and the brood rearing season,
4. to estimate production of all avian species nesting on the Espenberg Peninsula;
5. to determine the abundance of small mammals which are utilized by avian and mammalian predators,
6. to describe availability of food and utilization by shorebirds,
7. to determine distribution and abundance of sea mammals,
8. to provide recommendations to lesson the impact of developments on the avian community and avian habitat at the Espenberg Peninsula, and
9. to establish baseline study plots to evaluate the impact of developments on the avian community and avian habitat at the Espenberg Peninsula.

II. Field Activities

A. Field trip schedule

None

B. Scientific Party

Name	affiliation	role
Peter Mickelson	Institute of Arctic Biology	principal investigator
Douglas Schamel	Institute of Arctic Biology	research associate
Diane Tracy	Institute of Arctic Biology	research associate
Anne Ionson	Institute of Arctic Biology	graduate student

C. Methods

Please refer to the September Quarterly Report for a detailed outline of methods used in the various sub-projects reported here.

D. Sample localities

The locations of nesting plots, census transects, and the beach survey area are shown in Figure 1. The locations of base camp, intertidal invertebrate sampling areas, the island mudflats, and the South Mudflats are given in Figure 2.

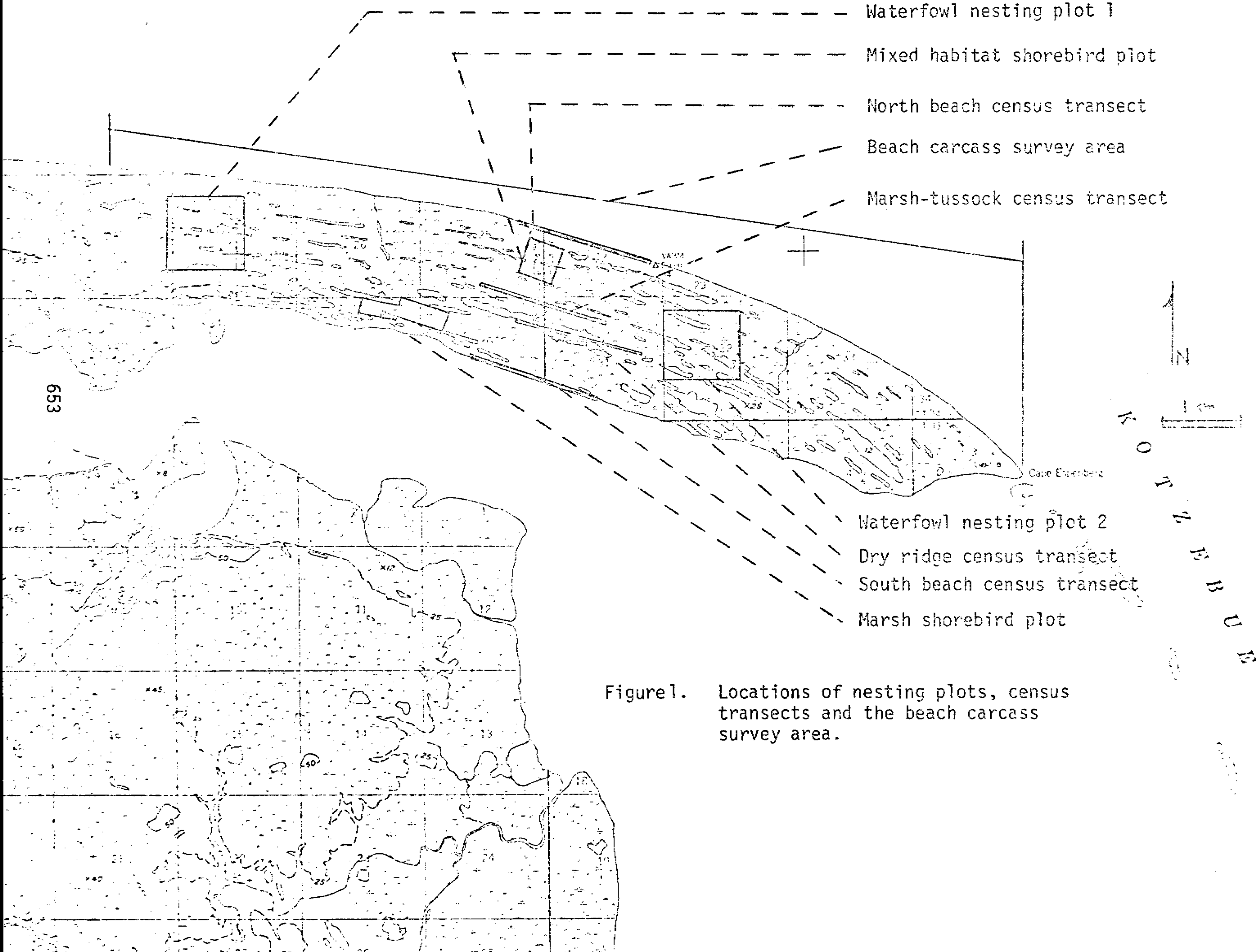

Figure 1. Locations of nesting plots, census transects and the beach carcass survey area.

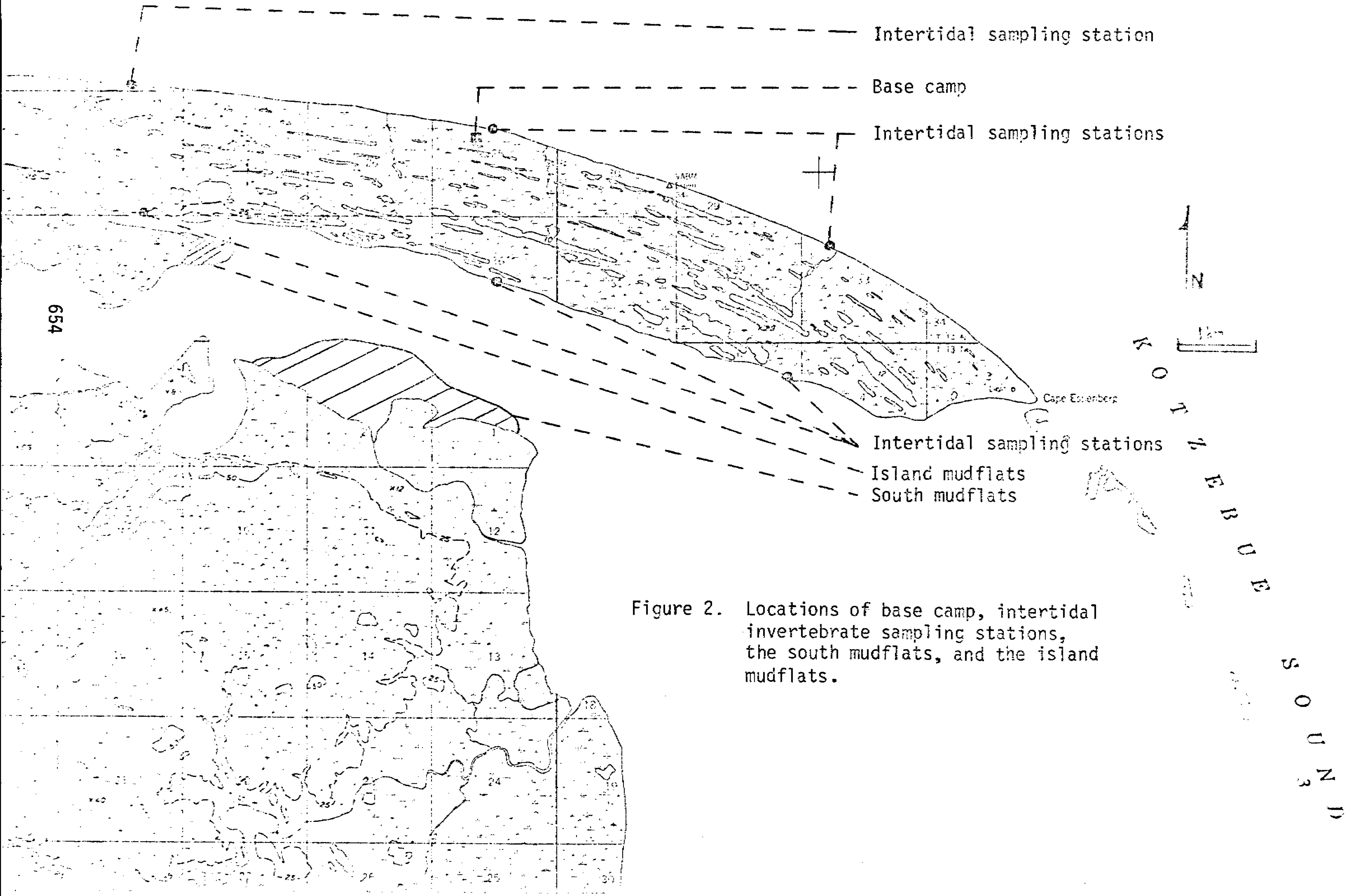

Figure 2. Locations of base camp, intertidal invertebrate sampling stations, the south mudflats, and the island mudflats.

III. Results

A. Nest initiation and termination

Nest initiation and termination dates for selected shorebirds, Arctic Terns and Sabine's Gulls are given in Figure 3.

Cape Espenberg (66.3°N) is located about midway between the Kolomak River (61°N) and Barrow (71°N), two locations where breeding Dunlins were intensively studied by Holmes (1971). Laying dates from Espenberg fall between the dates he gives for those two localities and correspond closely with data given by Norton et al. (1975) at Prudhoe Bay (70°N).

Espenberg Western Sandpipers began laying about two weeks later than Kolomak River birds, in some years (Holmes 1972), but both populations ceased laying on about the same date.

Laying dates for Semipalmated Sandpipers at Espenberg are very similar to Prudhoe Bay birds (Norton et al. 1975).

Nest initiation dates for Northern Phalaropes at Espenberg began a week earlier and lasted several days longer than at Prudhoe Bay (Norton et al. 1975). The clumped distribution of nests at the beginning of the nesting period at Espenberg suggests that, in a phenologically earlier year than 1976, birds may begin laying even earlier.

Red Phalaropes began laying at Espenberg about the same date as noted at Prudhoe Bay (Norton et al 1975), but 3-4 days earlier than at Barrow (Schamel, unpubl.). Nest initiation at Espenberg ceased by 23 June, but commonly continued through 1 July at both Barrow (Schamel, unpubl.) and Prudhoe Bay (Norton et al. 1975).

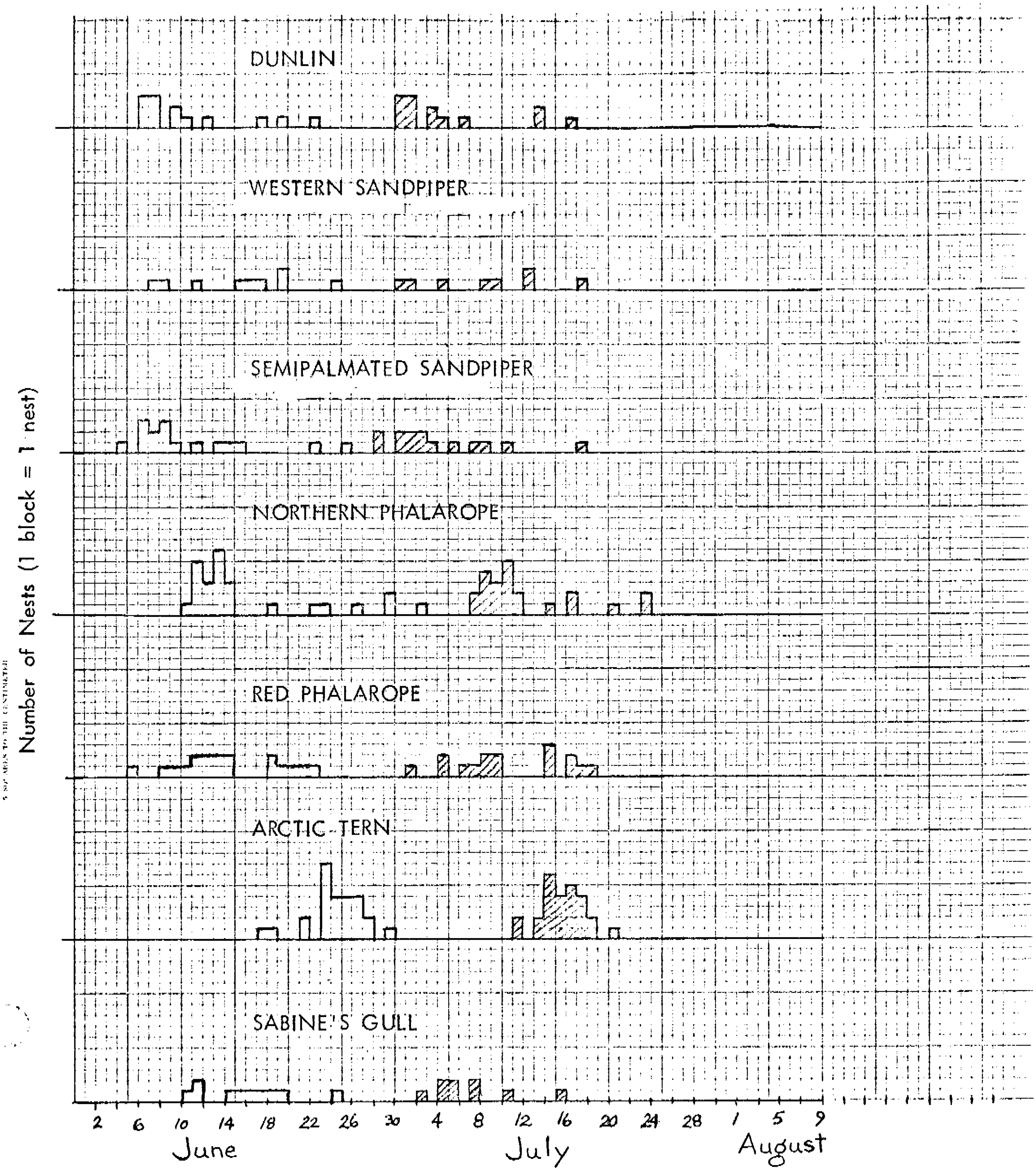

Fig. 3. Dates of nest initiation (unshaded) and termination (shaded) of selected shorebirds, Arctic Tern and Sabine's Gull. Cape Espenberg, Alaska. 1976.

At present, we have no comparative nest initiation data for Arctic Terns and Sabine's Gulls in Alaska.

B. Chick growth rate and mortality

Arctic Tern - Weight development in Arctic Tern chicks at Cape Espenberg (66.3°N) (Fig. 4) was very comparable to that reported from the Finnish archipelago (60.6°N) (Lemmetyinen 1973). Arctic Tern chicks from Spitsbergen (78.9°N) gained weight at a slower rate (Lemmetyinen 1972).

Two additional growth parameters were considered: bill length and wing length (Fig. 5 and 6). We have been unable, to date, to find comparative data in the literature. Of the three measurements, wing length appears to have the least scatter of data points and may be the best single criterion for determining the age of tern chicks.

Six of 45 banded chicks (13.3%) were found dead on the tundra. All had apparently died of starvation. Five of the chicks (83.3%) had been the second to hatch at a nest. The only first-hatched chick to succomb to starvation died 2 days after its nest mate. Five of the deaths occurred in the period 26 to 29 July. The other death occurred on 17 July. Age at death ranged from 5 to 11 days. Lemmetyinen (1972) found that second-hatched chicks died first. Bengtson (1971) reported that most mortality in tern chicks came in their first week.

At least some chicks were lost to predators, including red foxes. Both Lemmetyinen (1972) and Bengtson (1971) felt that predation losses were unimportant on Spitsbergen.

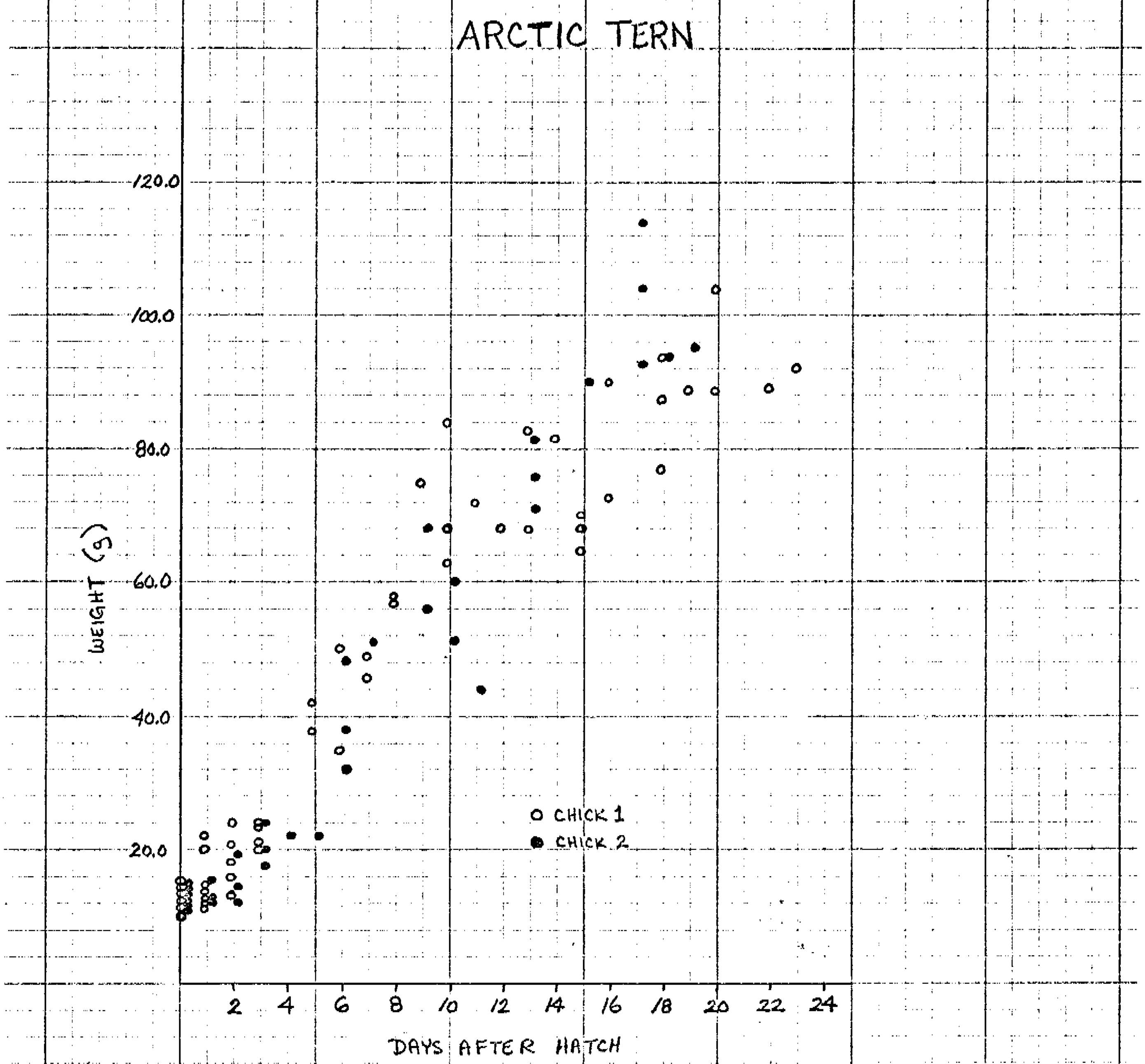

Figure 4. Growth rate (weight) of Arctic Tern chicks. Cape Espenberg, Alaska. 1976.

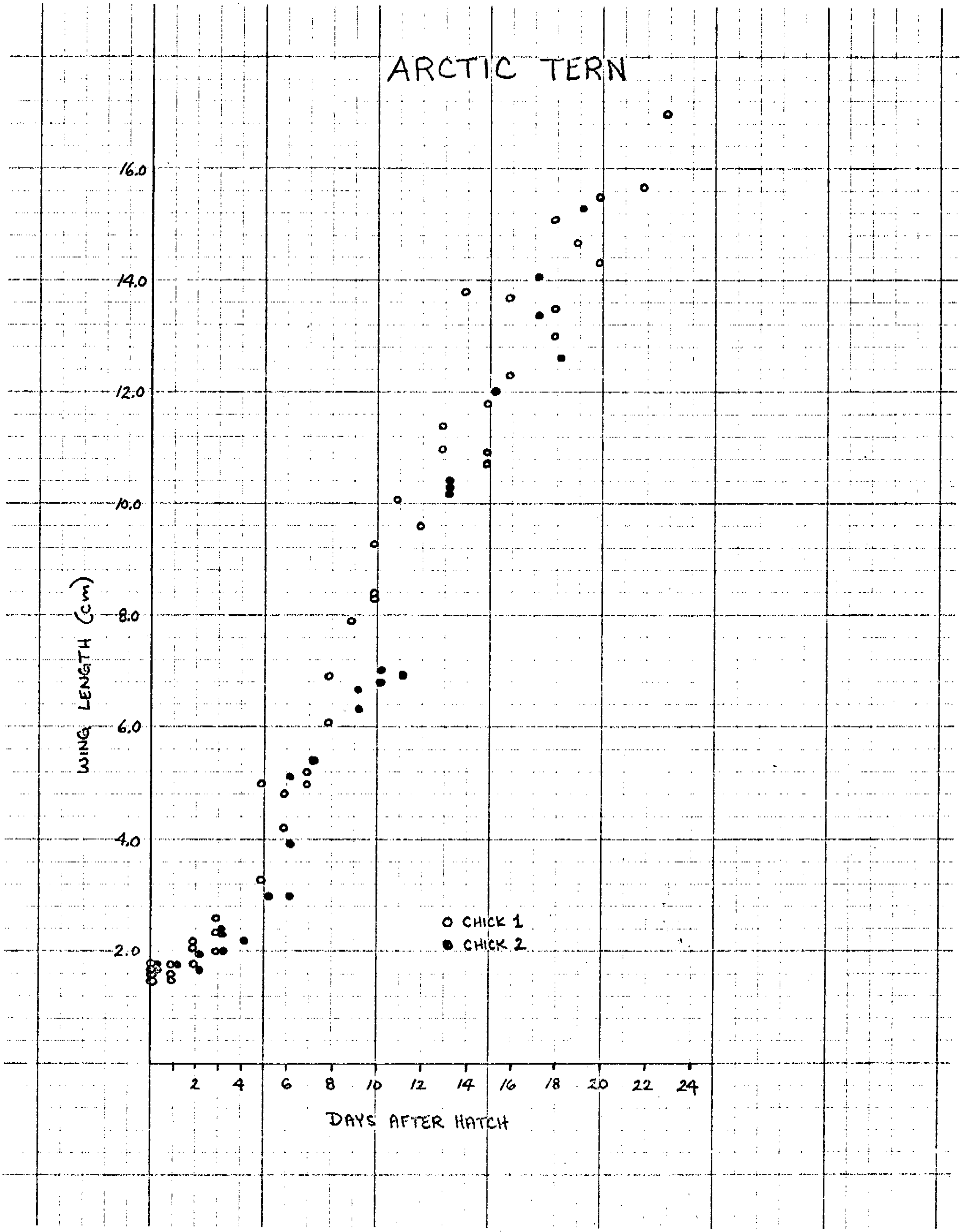

Figure 5. Growth rate (wing length) of Arctic Tern chicks. Cape Espenberg, Alaska. 1976.

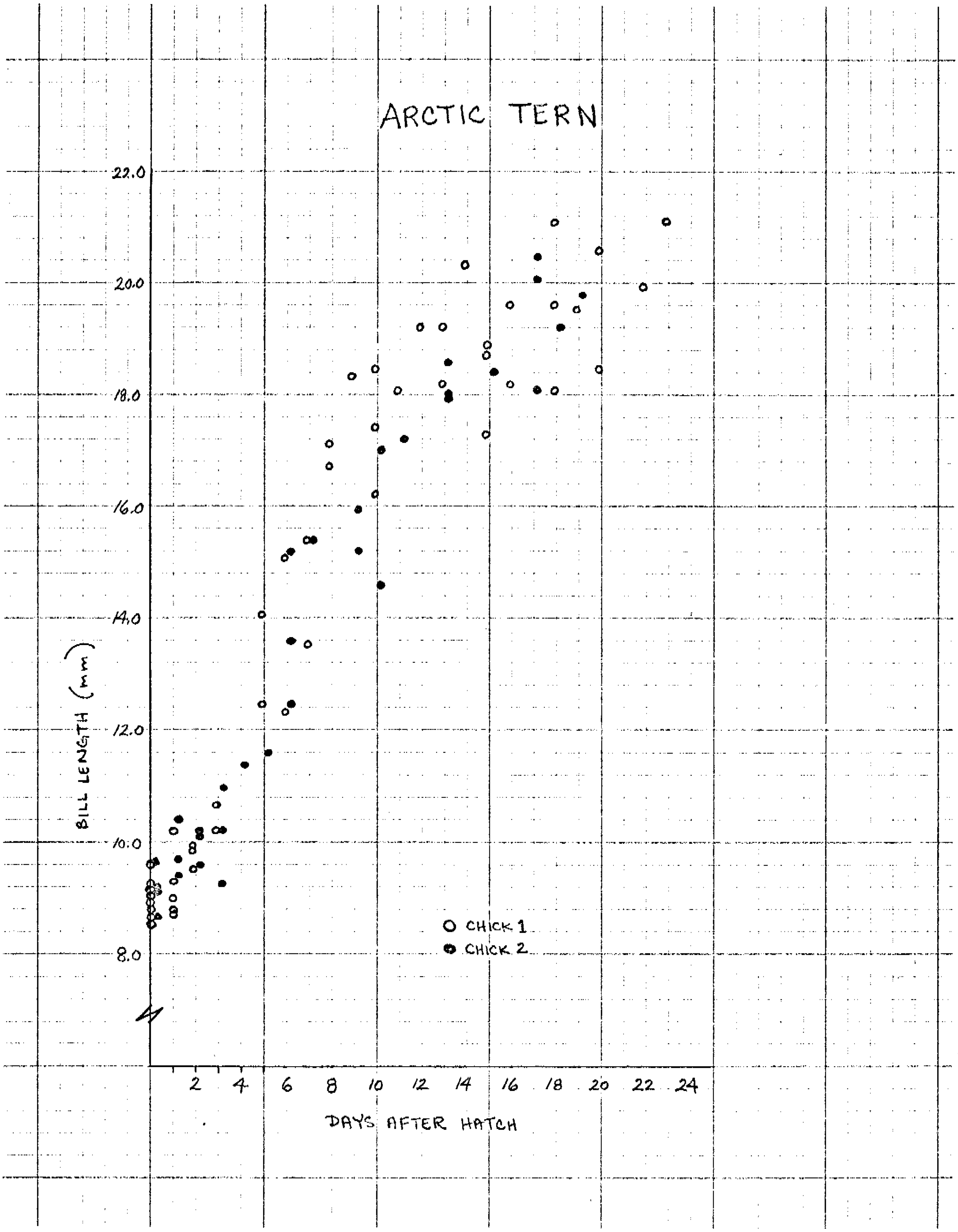

Figure 6. Growth rate (bill) of Arctic Tern chicks. Cape Espenberg, Alaska. 1976.

Tern chicks at Espenberg were able to fly by 23 days. One chick was probably flying at age 19 days. According to Witherby et al. (1944), Arctic Terns fly at about 3 weeks of age.

Sabine's Gull - To date, we have been unable to find comparative data on growth rates of Sabine's Gull chicks. According to Witherby et al. (1944), details of the fledging period of these birds is unknown. Our findings on growth rate appear in Figures 7, 8 and 9.

As found in tern chicks, wing length (Fig. 8) may be the best single criterion for age determination.

Only one dead (unbanded) Sabine's chick was found on the tundra, away from the nest site. Two dead chicks were found at nests. Each was the third chick to hatch at three-egg clutches. These were the only three-egg clutches in our study area.

Sabine's Gull chicks were able to fly at 20 days.

C. Census Transects

The results of the census transects are given in Figures 10 to 27.

Loons - Of the two species of loons commonly found on Espenberg, the Red-throated Loon clearly outnumbered the Arctic Loon (see Table 3 of the September quarterly report). Red-throated Loons were also more common in our censuses than were Arctic Loons. Although both species were found to feed in the shallow waters of the Chukchi coast (Fig. 10 and 11), only Red-throated Loons frequented the bay (Fig 10). Flocking of Red-throated Loons began in early August and continued into early September. In September, these loons were found in flocks of up to 80 birds in the bay, primarily in the evening (after 2000 hours). Arctic Loon numbers increased in early September.

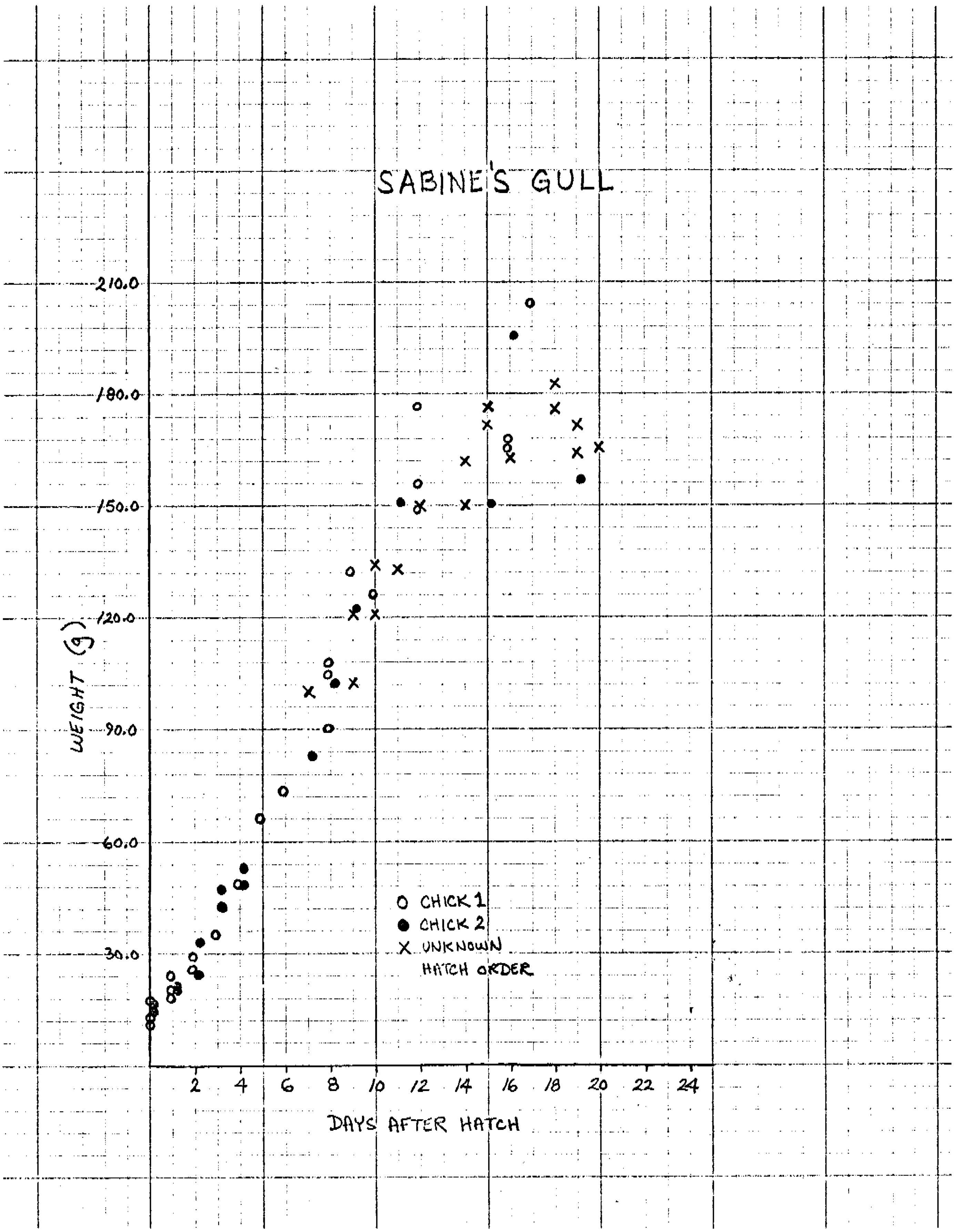

Figure 7. Growth rate (weight) of Sabine's Gull chicks. Cape Espenberg, Alaska. 1976.

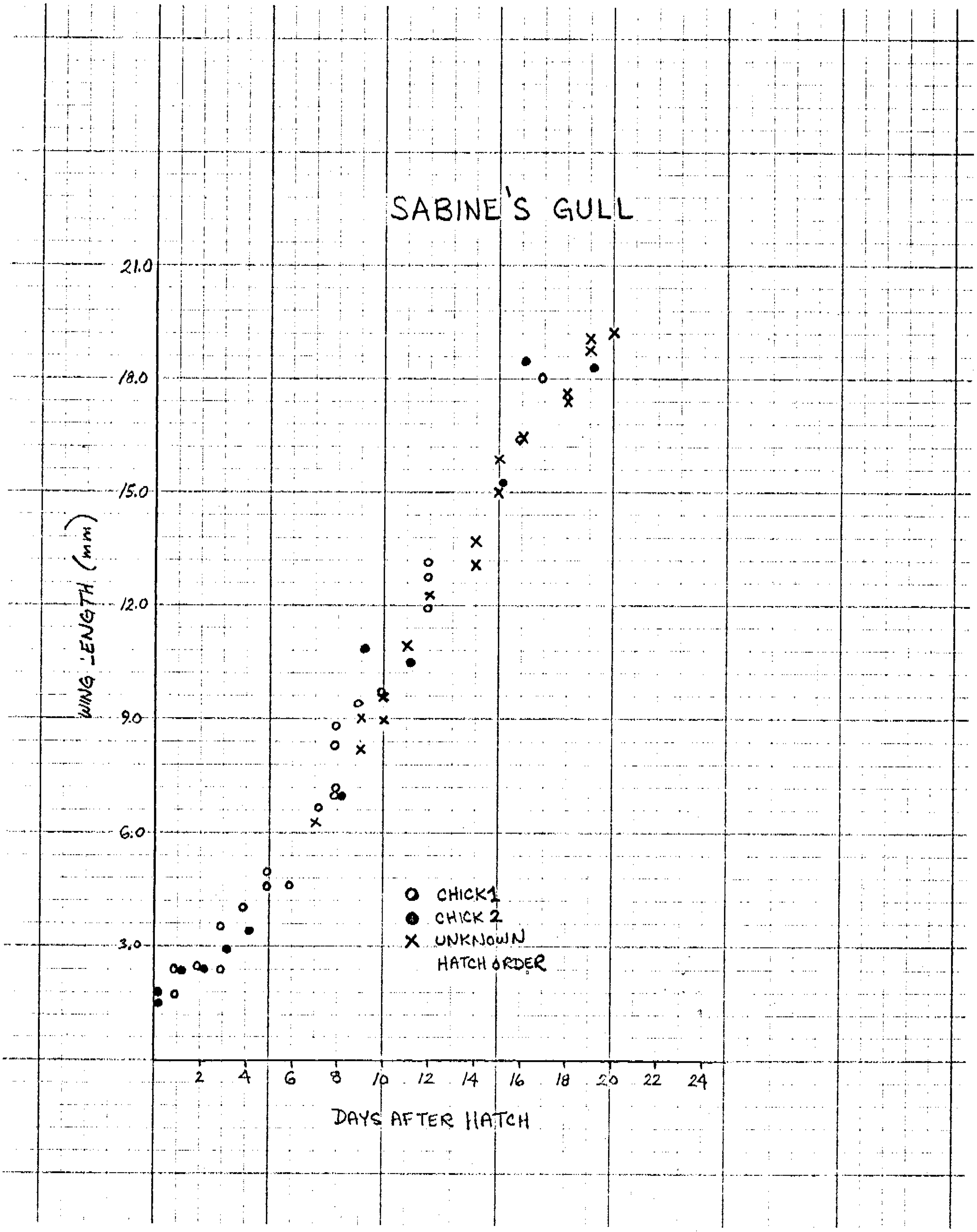

Figure 8. Growth rate (wing length) of Sabine's Gull chicks. Cape Espenberg, Alaska. 1976.

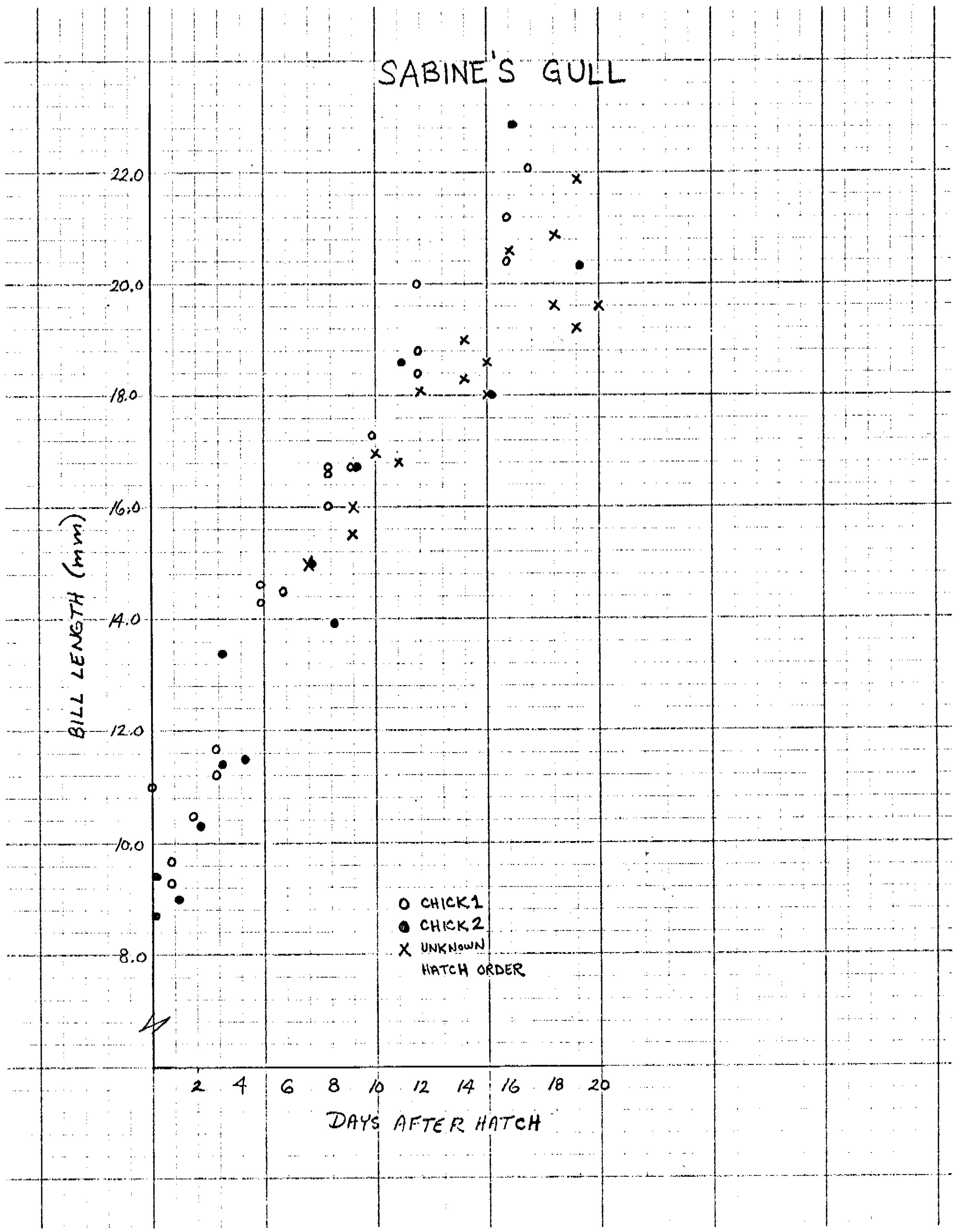

Figure 9. Growth rate (bill) of Sabine's Gull chicks. Cape Espenberg, Alaska. 1976.

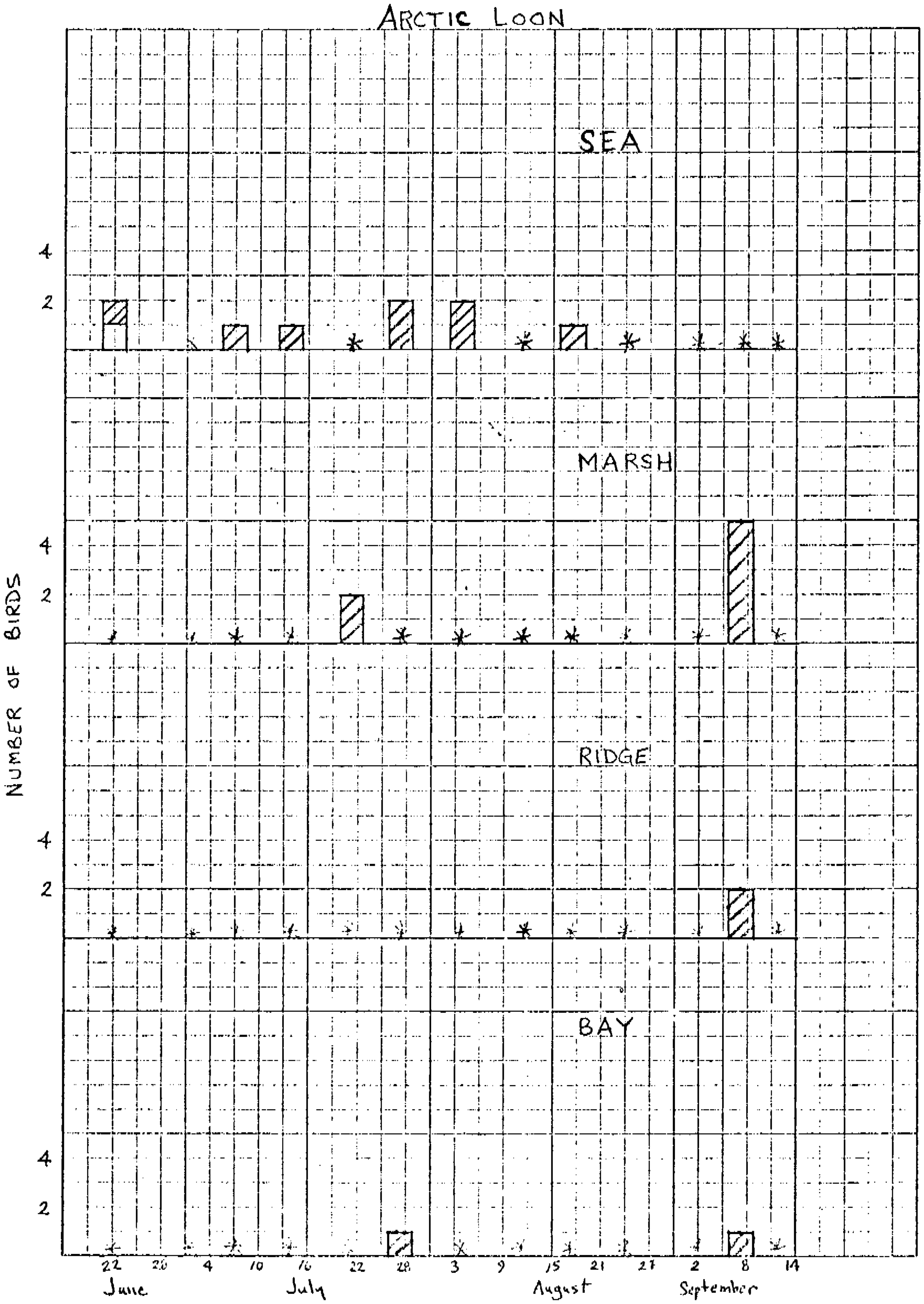

Figure 10. Numbers and distribution of Arctic Loons on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

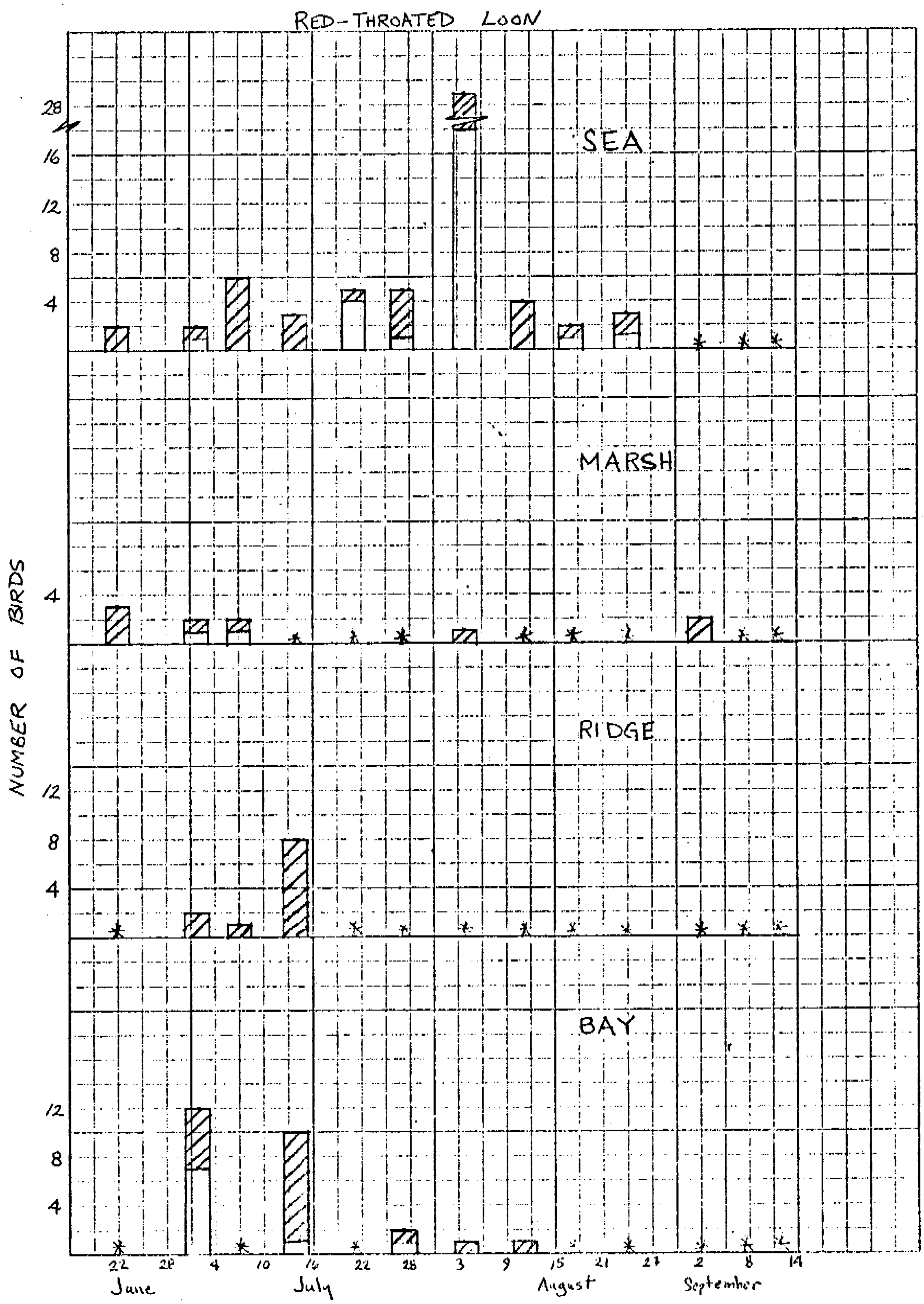

Figure 11. Numbers and distribution of Red-throated Loons on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

Waterfowl - Emperor Geese were infrequently observed on transects until September (Fig. 12). Since they nested only in small numbers at Espenberg, this is not surprising. Fall migrants frequently flew along the bay area, but also rested and fed inland (Fig. 12). These waterfowl were not observed along the Chukchi coast.

Oldsquaw were not observed on transects along either coast after early July (Fig. 13). After late July, they were not seen on any transect. At that time, most of the Oldsquaw remaining on the cape were females with broods. The Espenberg area was not a moulting area for Oldsquaw in 1976.

Common Eiders were found in all transects through late August (Fig. 14). Inland, their numbers peaked on the 2 July transect and thereafter declined until 28 July. This probably corresponds to the peak of nest initiation by these eiders. The small peak of eider numbers on 28 July corresponds to the flocking of females that were either immatures or had failed in their breeding attempts. The disappearance of eiders from the transects in August and early September probably relates to the hatching of nests and the movement of females from the cape to salt water areas nearby. The broods reappeared on both coasts in September, about the time when the first young should be fledging.

Shorebirds - Golden Plovers did not breed on Cape Espenberg. Flying young-of-the-year were regularly seen on transects from mid-August through September (Fig 15). They were noticeably absent from the Chukchi coast transect. Their numerical decline on the 12 September transect is difficult to interpret. This may be either the end of fall migration or just a temporary lag.

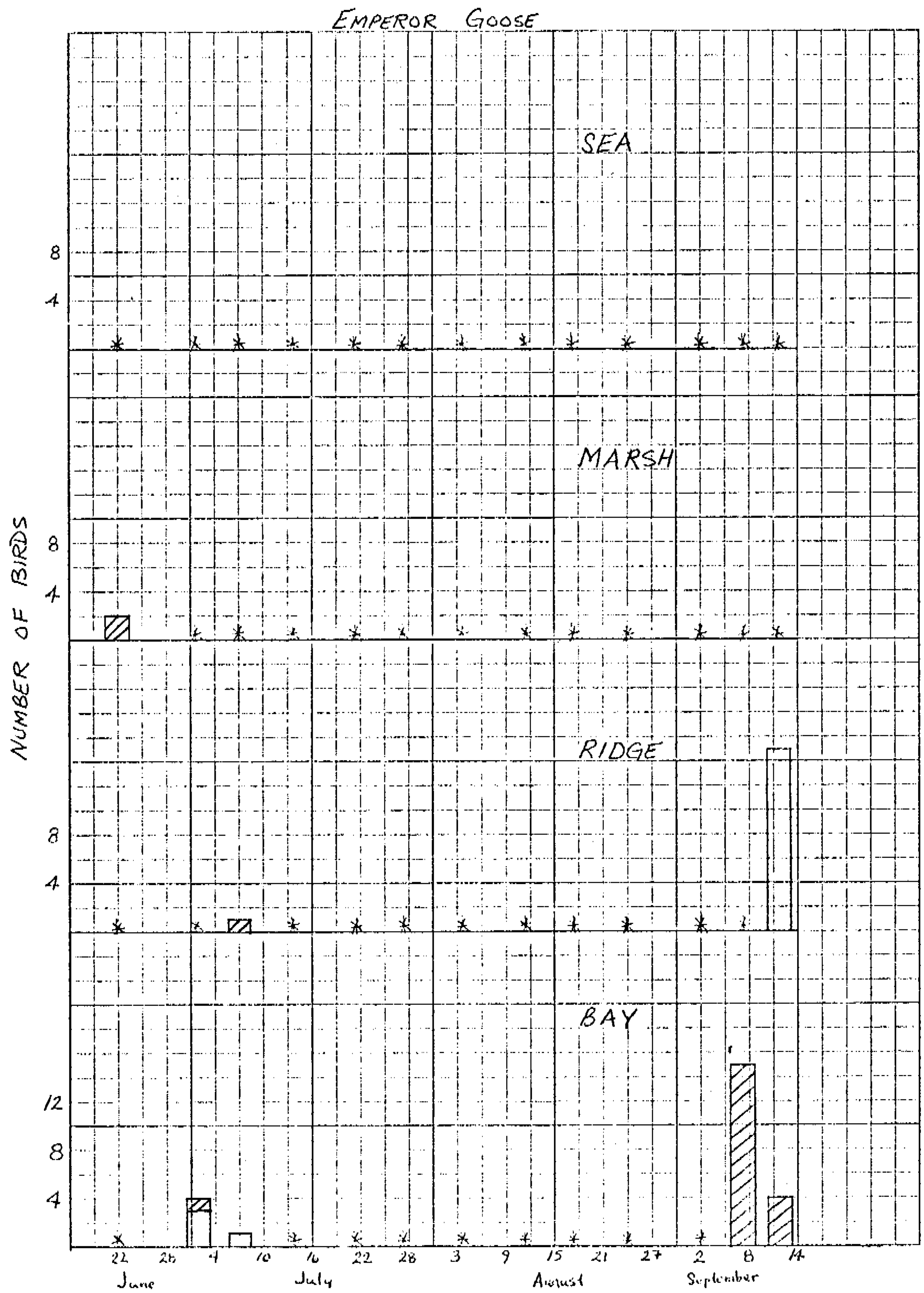

Figure 12. Numbers and distribution of Emperor Geese on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

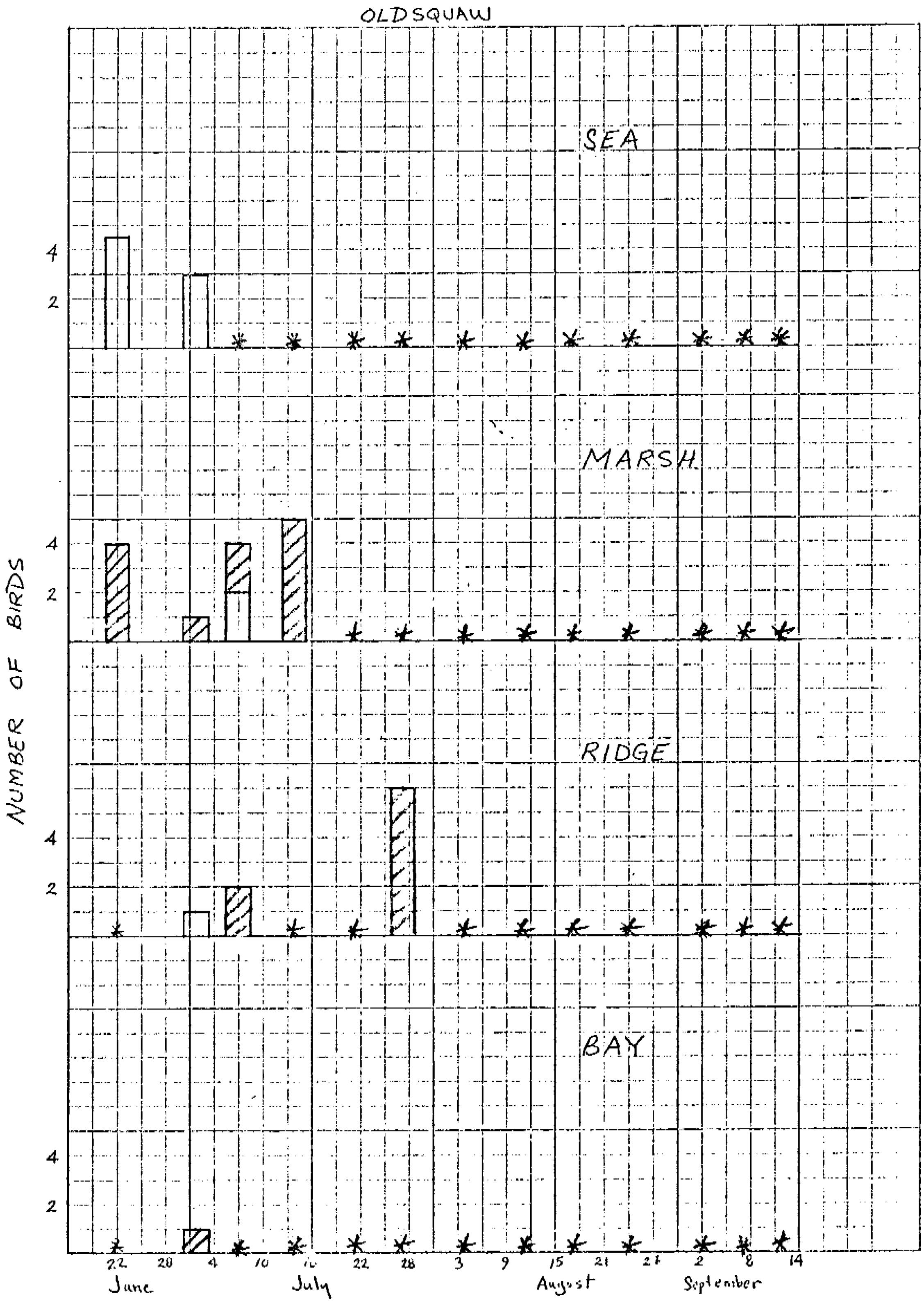

Figure 13. Numbers and distribution of Oldsquaw on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

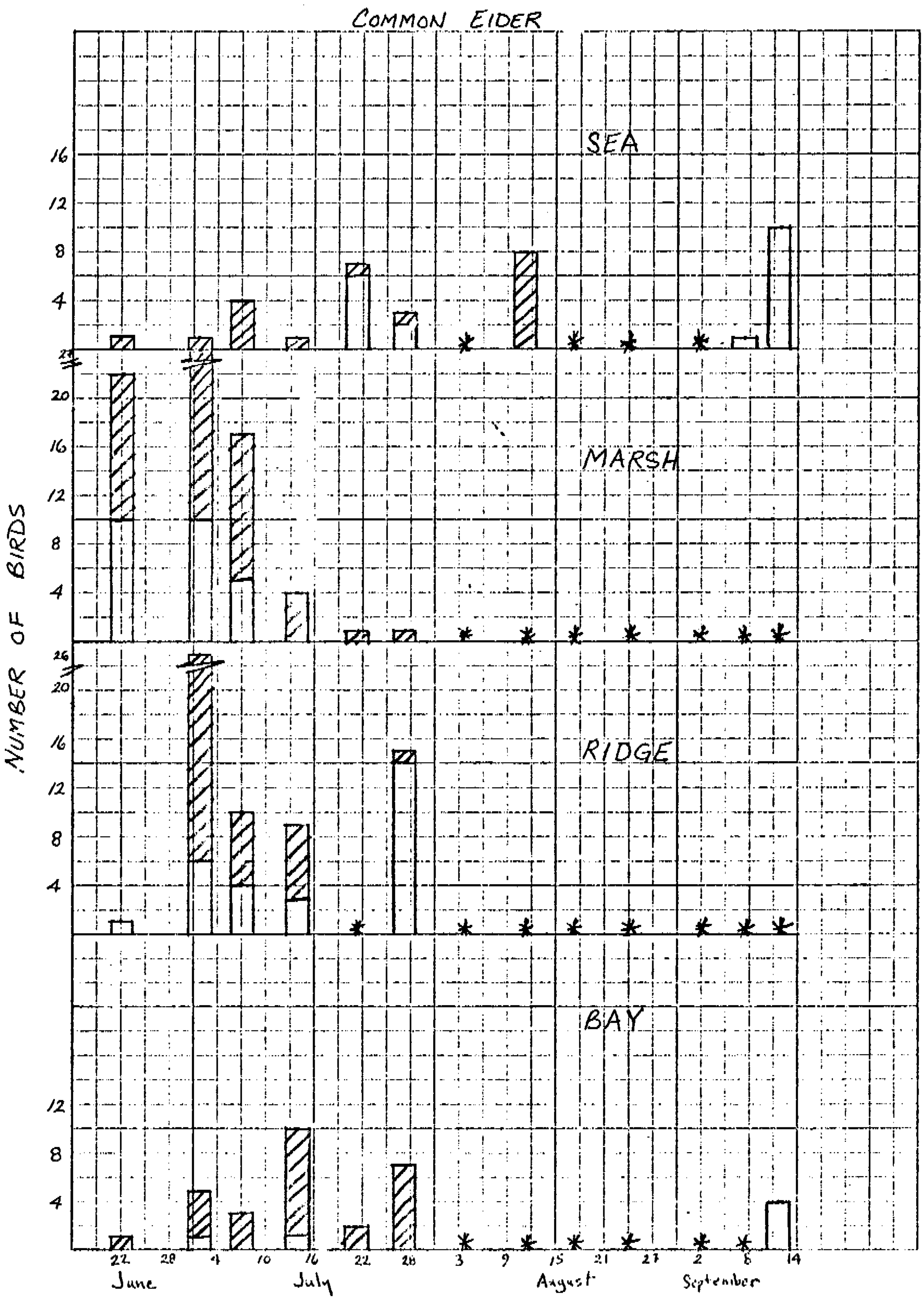

Figure 14. Numbers and distribution of Common Eiders on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

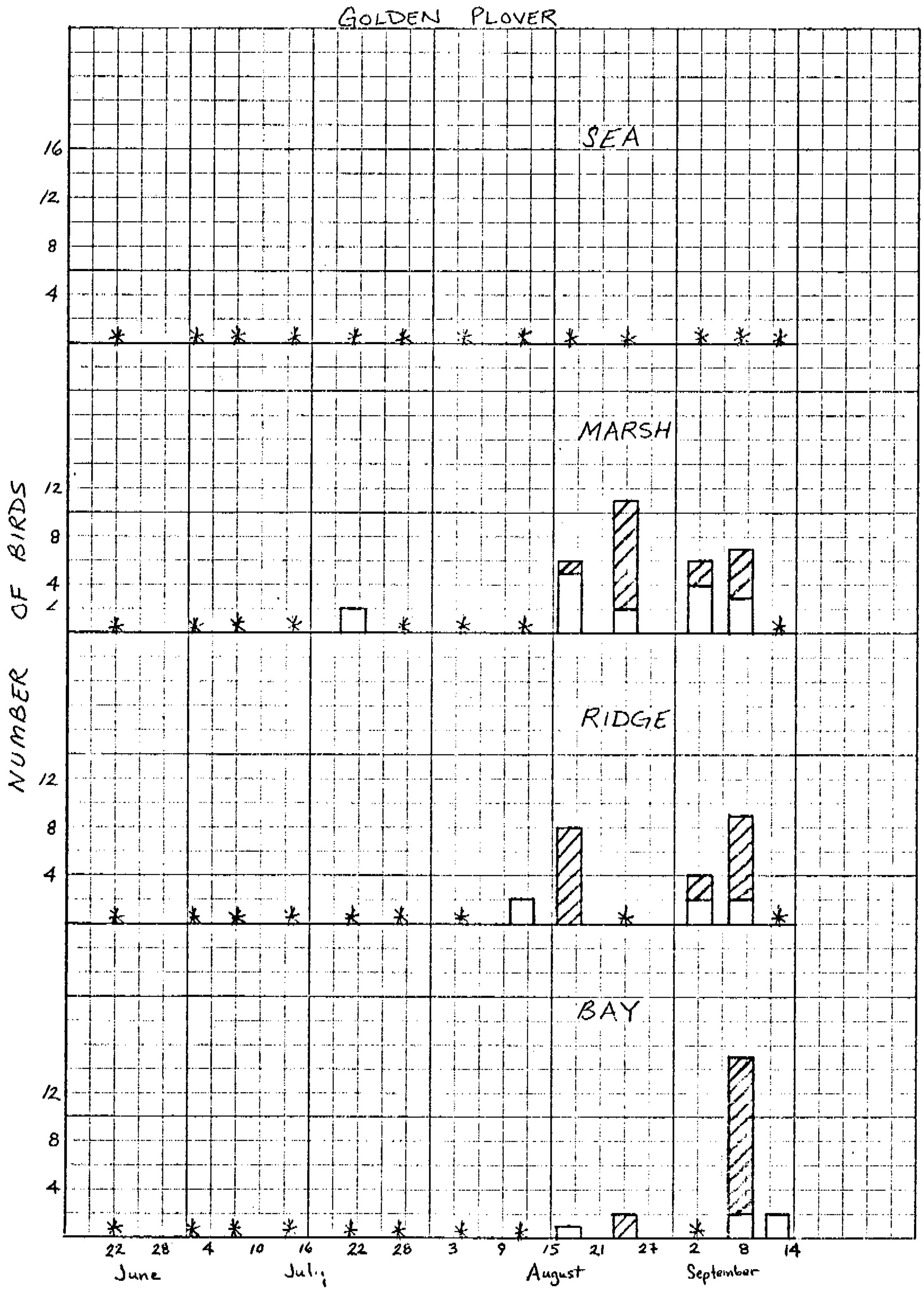

Figure 15. Numbers and distribution of Golden Plovers on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

Pectoral Sandpipers were present, at least in low numbers, throughout the summer (Fig. 16). They were most common during the month of August, particularly in the marsh transect. These birds were migrants. Pectorals were seen in all transects except along the sea coast.

Dunlins nested on Cape Espenberg. They were regularly seen on the two tundra transects throughout the summer (Fig. 17). Along the bay transect, Dunlins were seen only occasionally through early August. After this time, their numbers increased rapidly and remained at a high level through our departure. Dunlins were not seen on the Chukchi coast until late August and thereafter were regularly found in small numbers. Migrants were also found on the two tundra transects in September. These areas seemed to be used most frequently during high tides, which limited feeding habitat in the bay.

Semipalmated Sandpipers vacated the Espenberg area by early August (Fig. 18). Until then they were regularly seen on transects along the sea, marsh and ridge. These birds were only irregularly observed along the bay.

Until early August, Western Sandpipers were regularly seen only on the two tundra transects (Fig. 19). In early August, they were migrating through the area. Although birds were found in all transects at this time, they were mainly found along the two coasts. By late August, very few Westerns remained in the area.

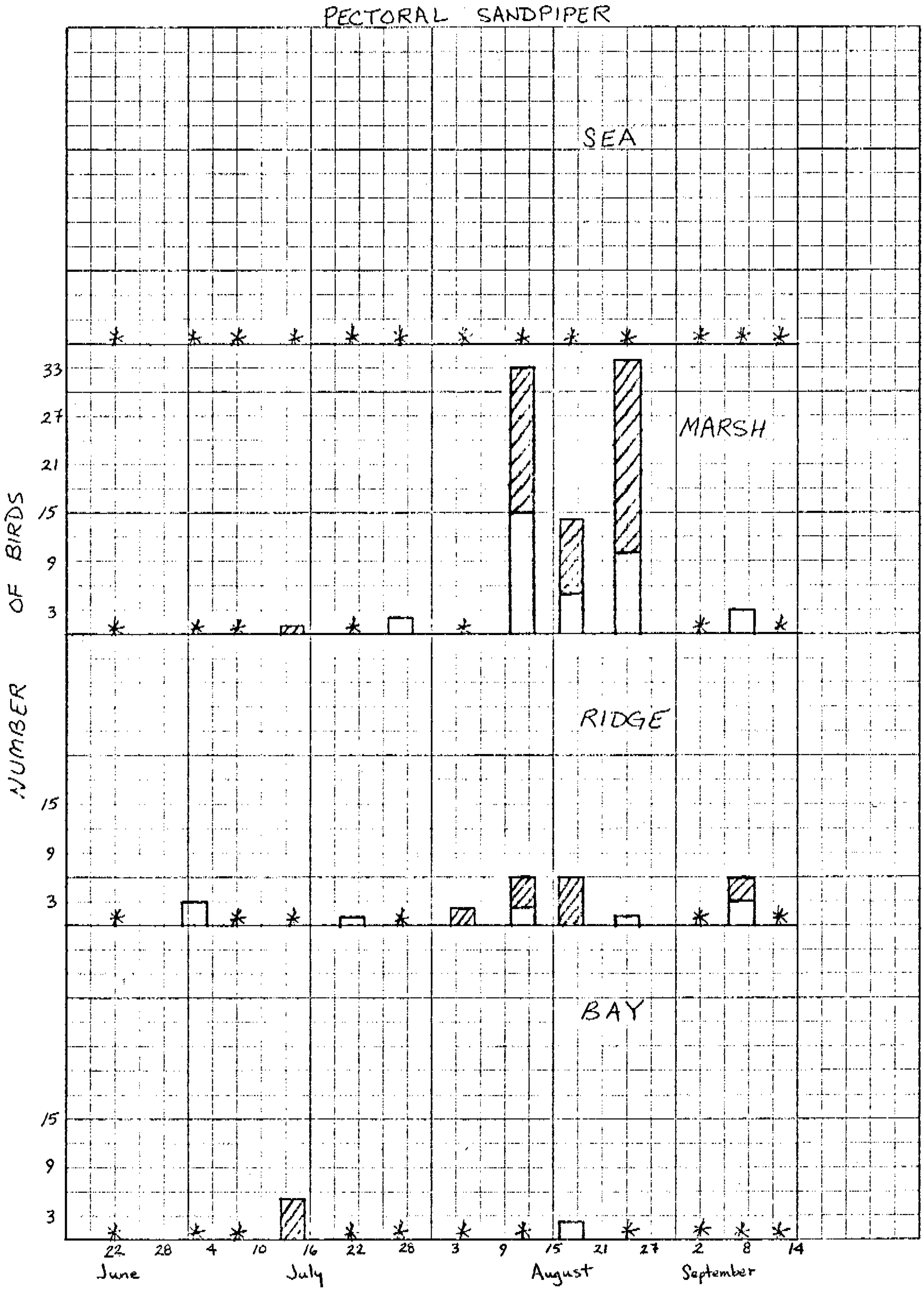

Figure 16. Numbers and distribution of Pectoral Sandpipers on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

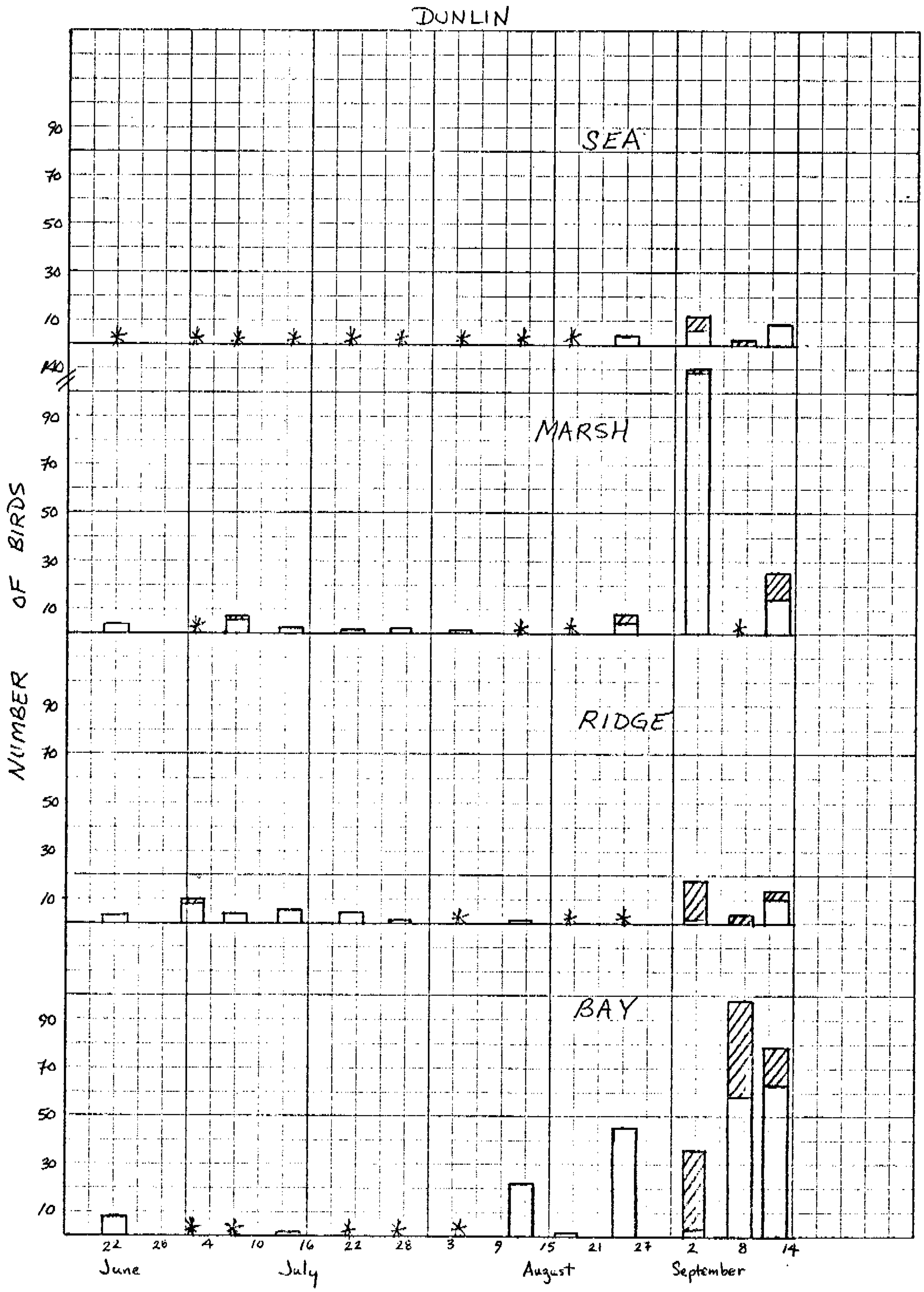

Figure 17. Numbers and distribution of Dunlins on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

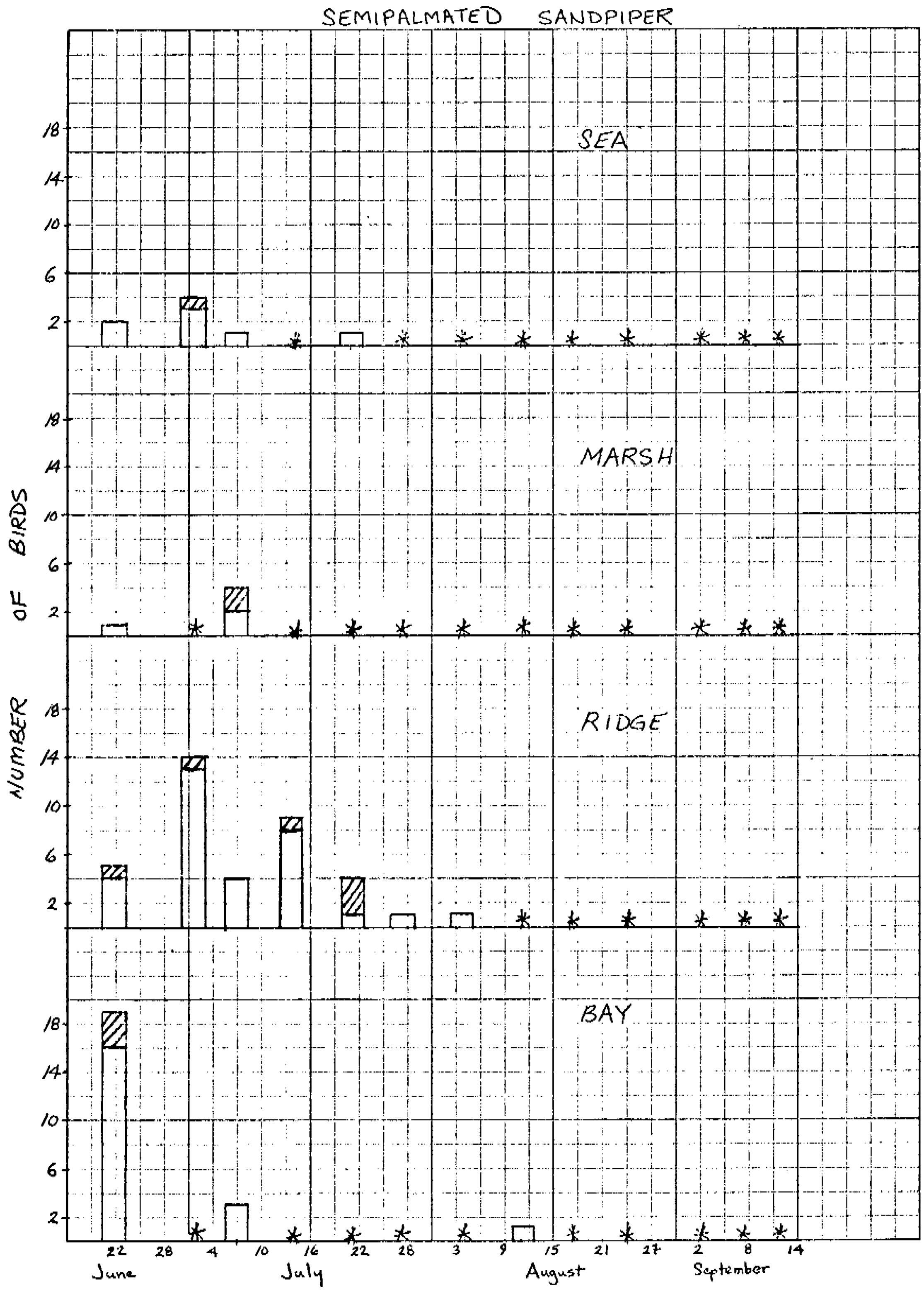

Figure 18. Numbers and distribution of Semipalmated Sandpipers on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

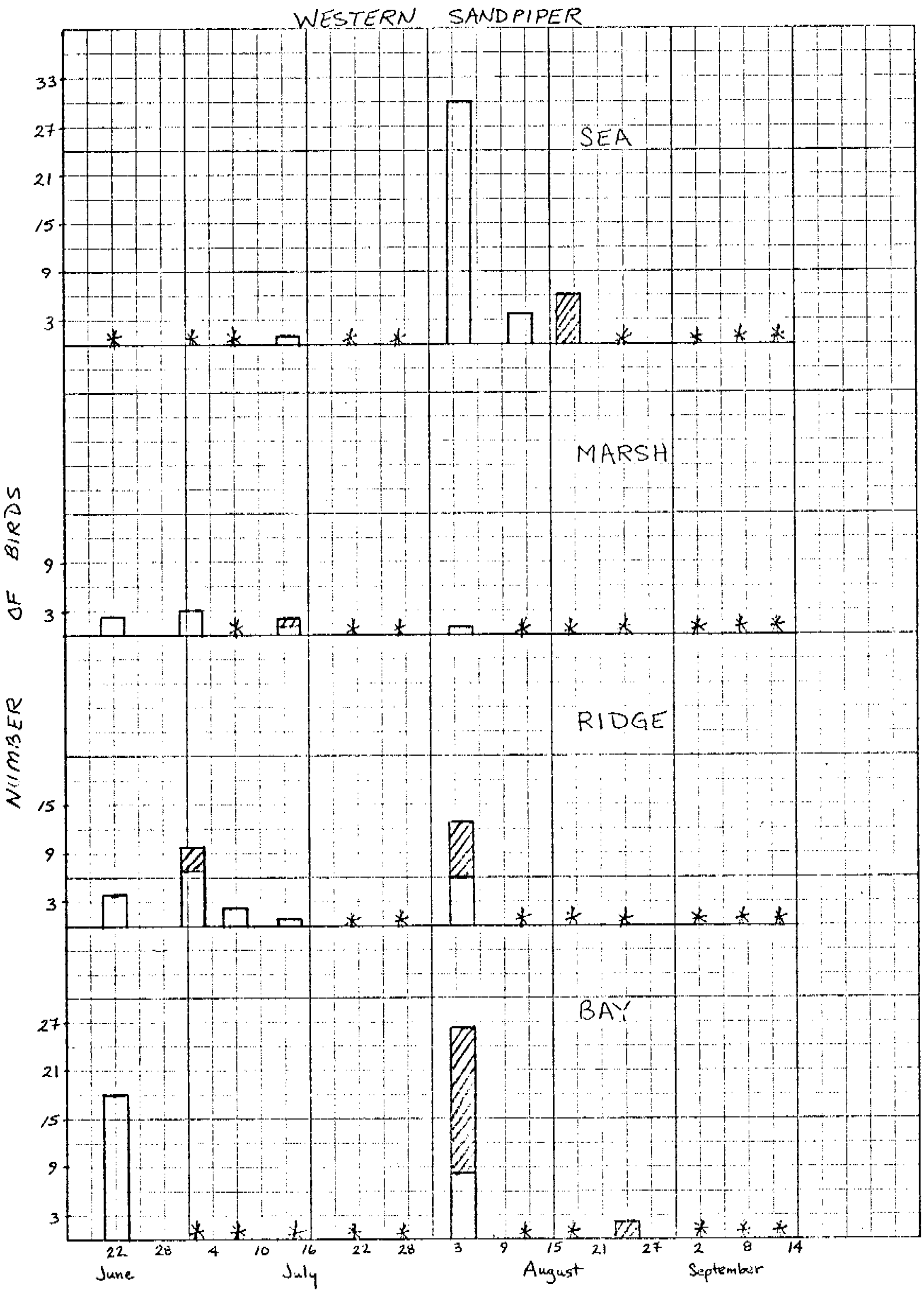

Figure 19. Numbers and distribution of Western Sandpipers on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

Sanderlings did not appear in transects until mid August (Fig. 20). All birds were migrants. They were found almost exclusively along the sea coast (only one was seen on bay transects). Migrant sanderlings were still present at the end of the field season, although their numbers were diminished.

Red Phalarope numbers were greatest on our first transect, 22 June (Fig. 21). Both males and females were feeding in the bay on this date, some of which were apparently paired. The breeding status of these birds is not known. It is unlikely that the males had clutches in the incubation stage, for many appeared paired. After the first part of July, no Red Phalaropes were seen on the coastal transects. After the end of July, none were seen on the tundra transects. This situation contrasts sharply with the Beaufort Sea studies. Connors (1976) found approximately 4000 birds at the Barrow spit in mid August 1975. Further east, near Prudhoe Bay, Schamel (1976) noted the beginning of Red Phalarope movement to nearshore waters in late July and early August, the end of his field season. The absence of late summer migrant phalaropes from Espenberg may be the "typical" situation. Swartz (1967) did not find Red Phalaropes in the Kotzebue Sound area in August 1960. Tne distribution of these birds in the southern Chukchi Sea reported by Swartz (1967) suggests that they may move directly from the Cape Thompson area to the Bering Strait, bypassing Kotzebue Sound.

Northern Phalaropes were found on transects through early August (Fig. 22). In contrast to Red Phalaropes, Northern used both coasts

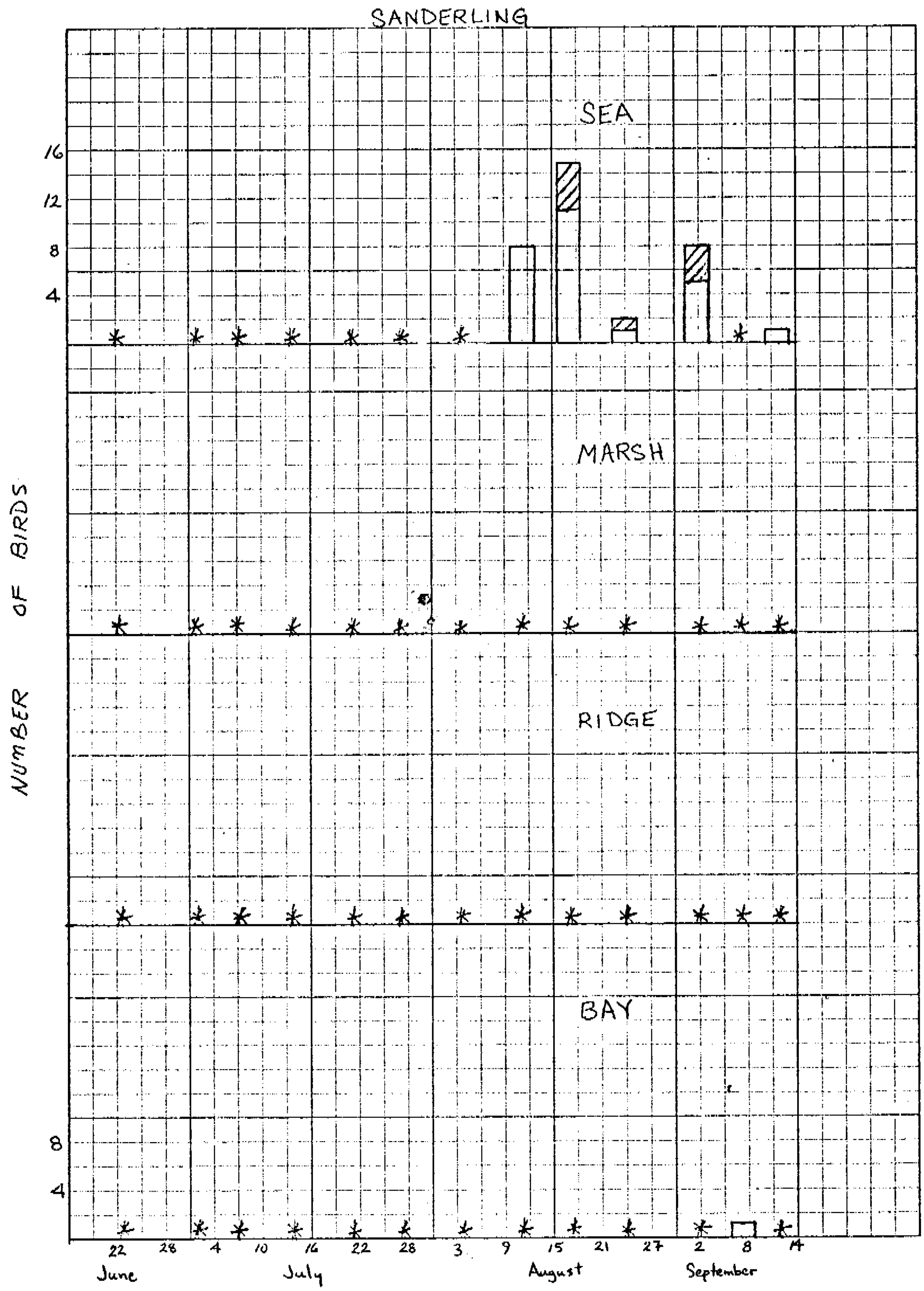

Figure 20. Numbers and distribution of Sanderlings on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded=flying, *= not present).

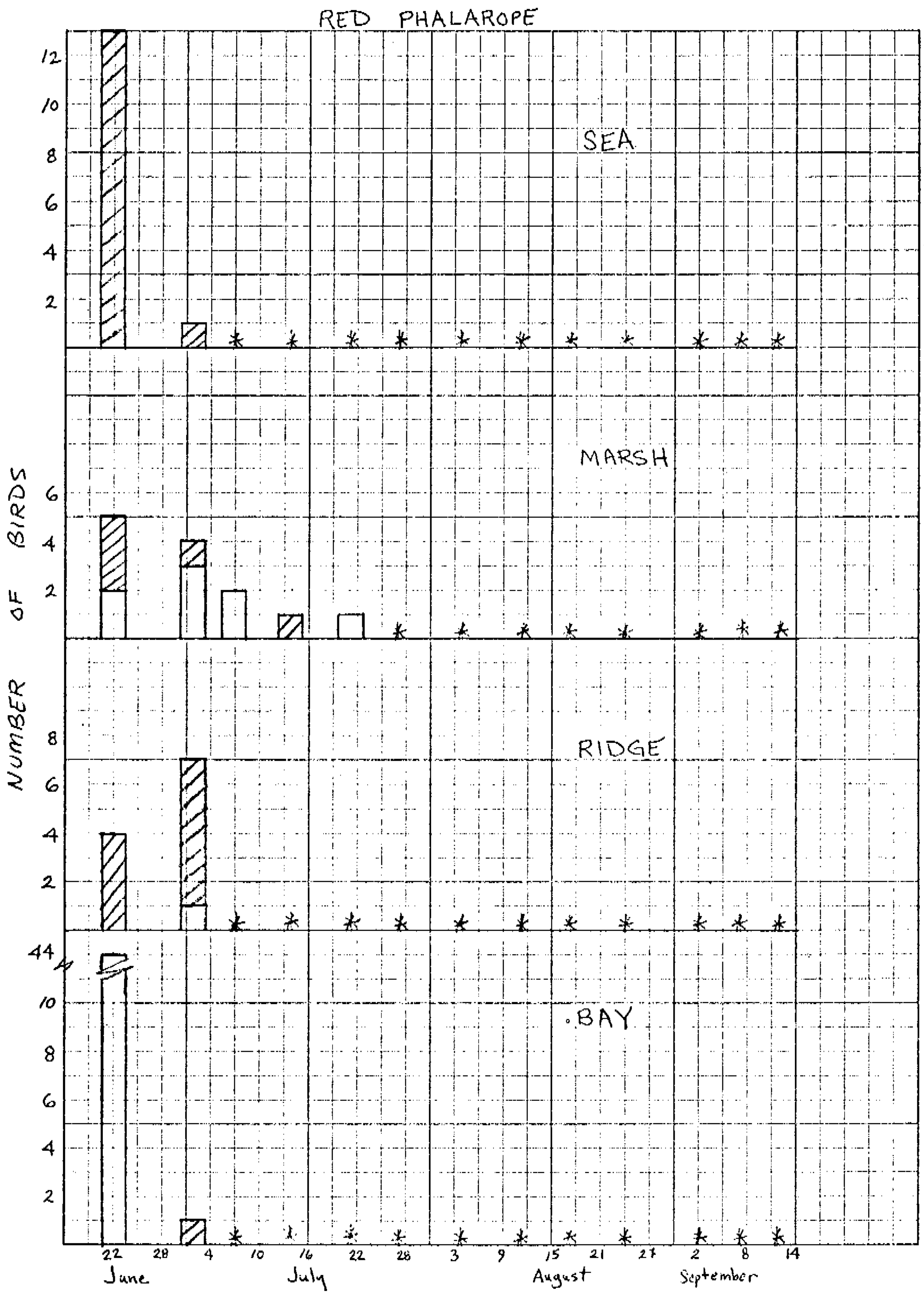

Figure 21. Numbers and distribution of Red Phalaropes on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

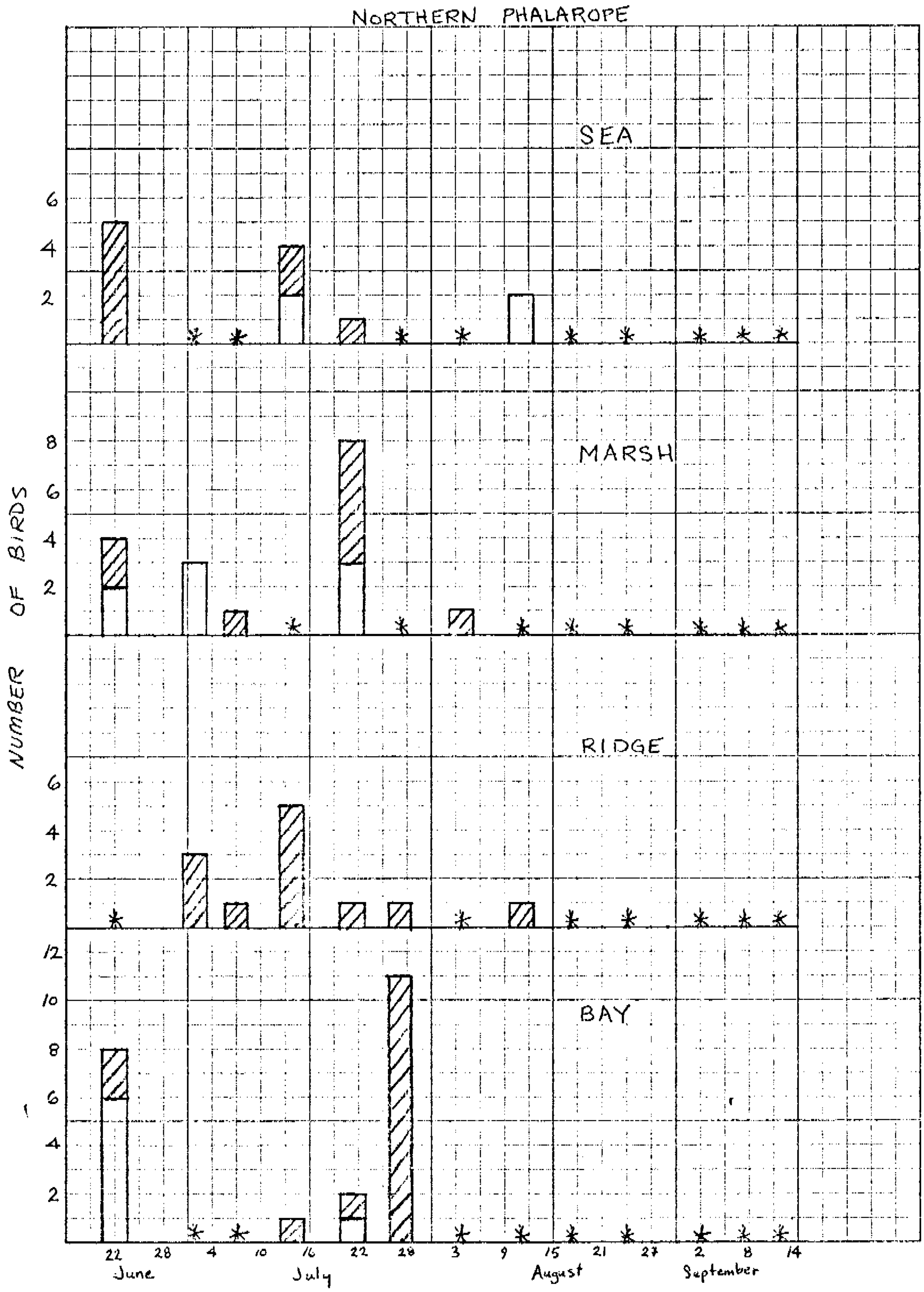

Figure 22. Numbers and distribution of Northern Phalaropes on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

from mid to late July. Similar to Reds, Northerns showed no major numerical build-up along either coast. Swartz (1967) did not find Northern Phalaropes in the Kotzebue Sound area in August 1960.

Gulls and Terns - Glaucous Gulls were found on nearly all transects throughout the summer (Fig. 23). They were most numerous along the Chukchi coast, where they appeared to increase in early September. Many of the young had fledged by this time and both parents and young had vacated tundra nest sites.

Kittiwakes were seen only on sea transects, where they were found throughout the summer (Fig. 24). Nearly all were flying laterally along the coast. Only on one occasion, 14 July, did they feed in transect waters.

In contrast to Kittiwakes, Sabine's Gulls were found only on bay transects (Fig. 25). Only during late June and early July were these birds seen feeding, in small numbers, in this area. No Sabine's Gulls were sighted on transects after 4 August. Few were seen anywhere after this date. Nearly all young Sabine's had fledged by the end of July, after which both adults and young left the cape.

Arctic Terns were regularly seen on transects through late August (Fig. 26). Most of the young had fledged by 10 August. Terns, therefore, remained in the cape area for about 10-14 days post-fledging. Terns fed along the sea and bay in about equal numbers throughout the summer.

Passerines - Lapland Longspurs were found on the tundra transects throughout the summer (Fig. 27). They were sighted on the coasts primarily during migration, in early August through September.

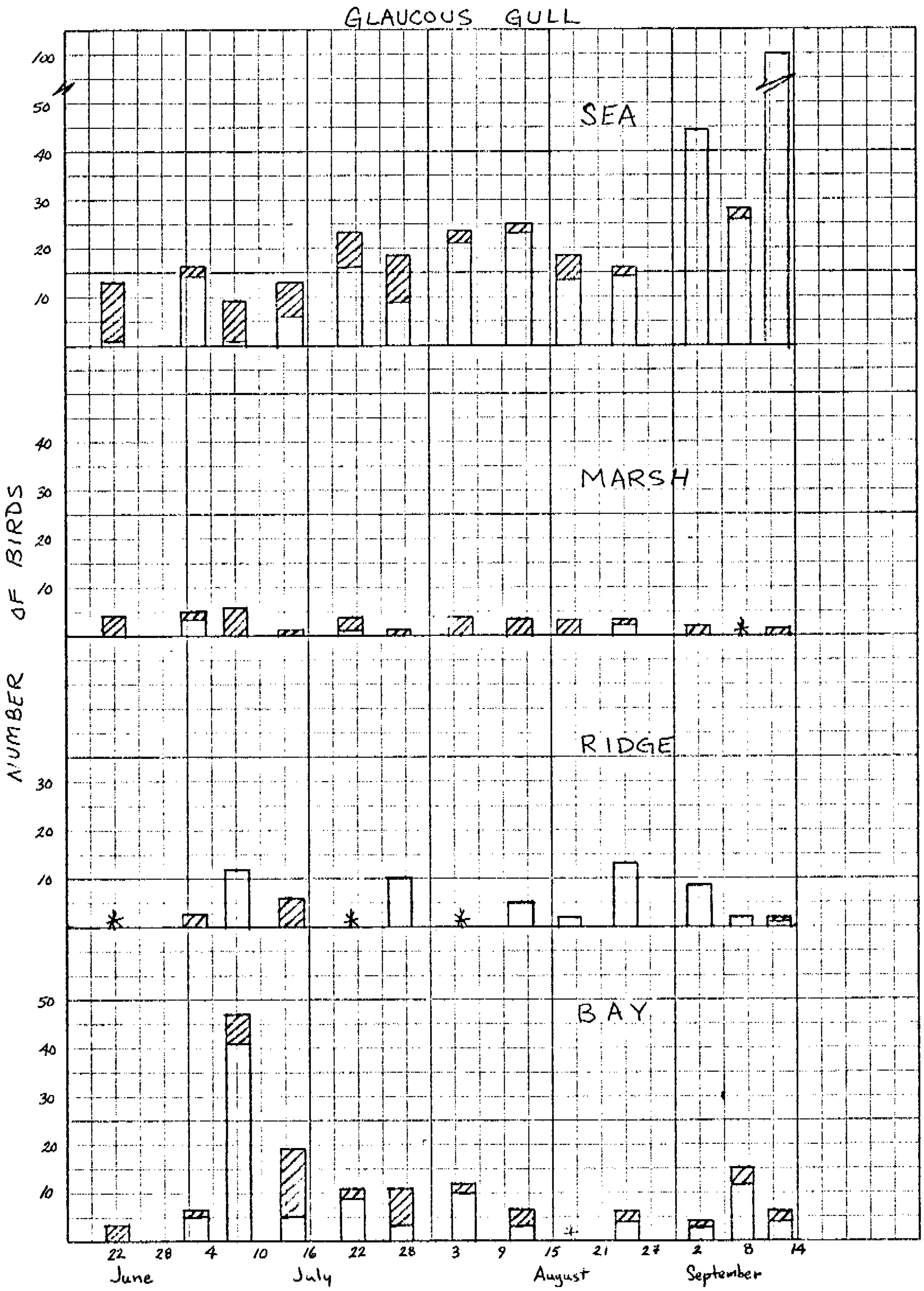

Figure 23. Numbers and distribution of Glaucous Gulls on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

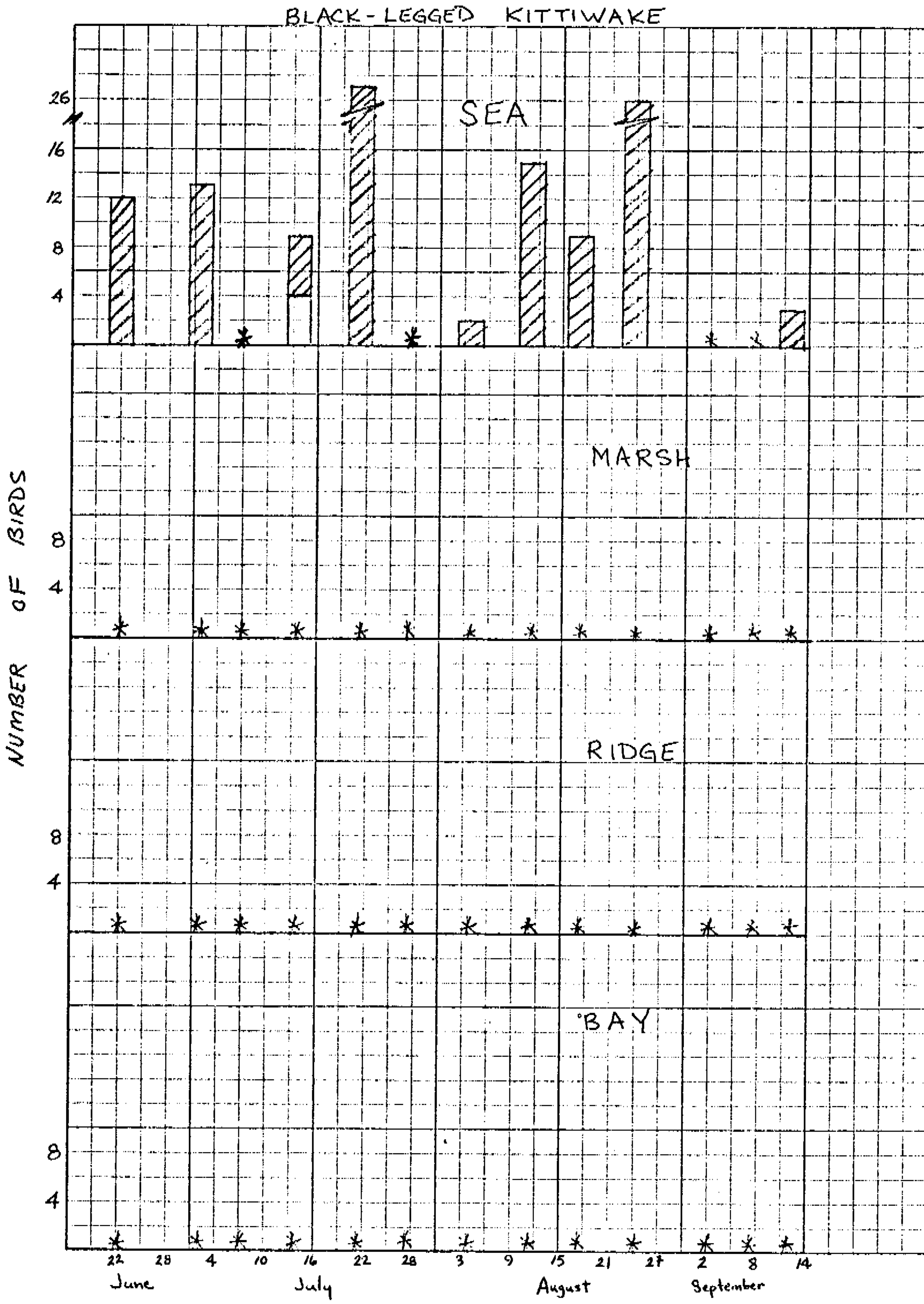

Figure 24. Numbers and distribution of Black-legged Kittiwakes on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

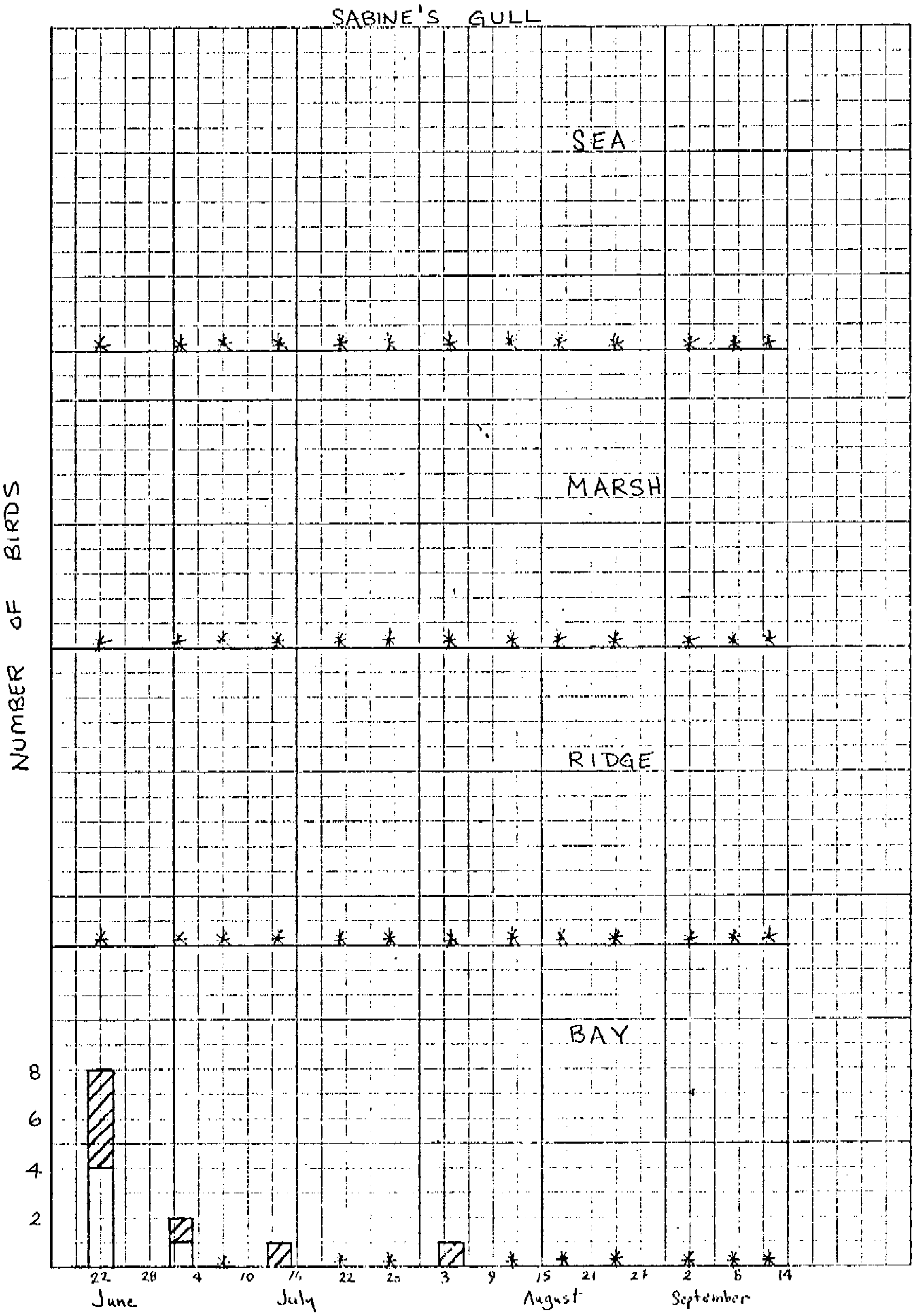

Figure 25. Numbers and distribution of Sabine's Gulls on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

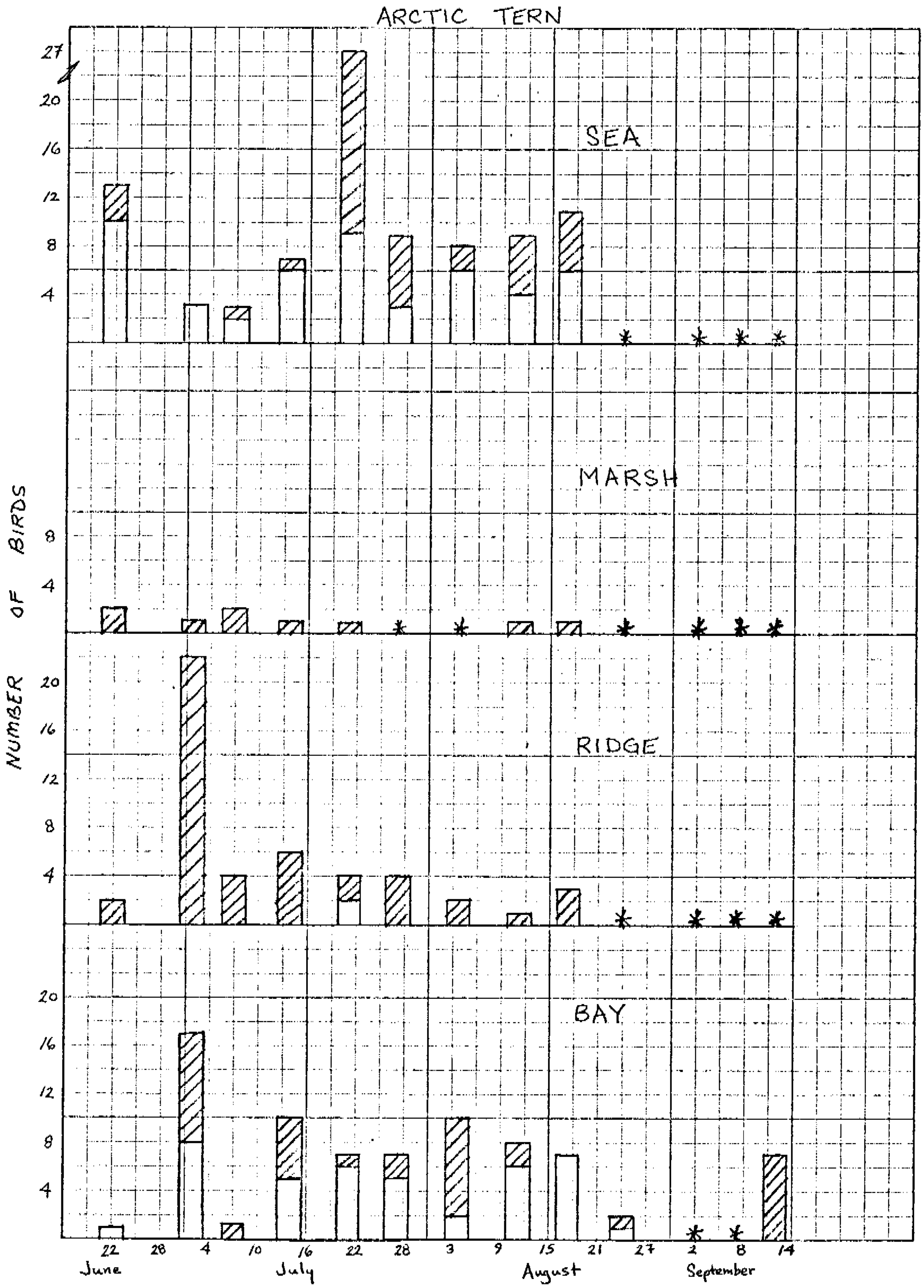

Figure 26. Numbers and distribution of Arctic Terns on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

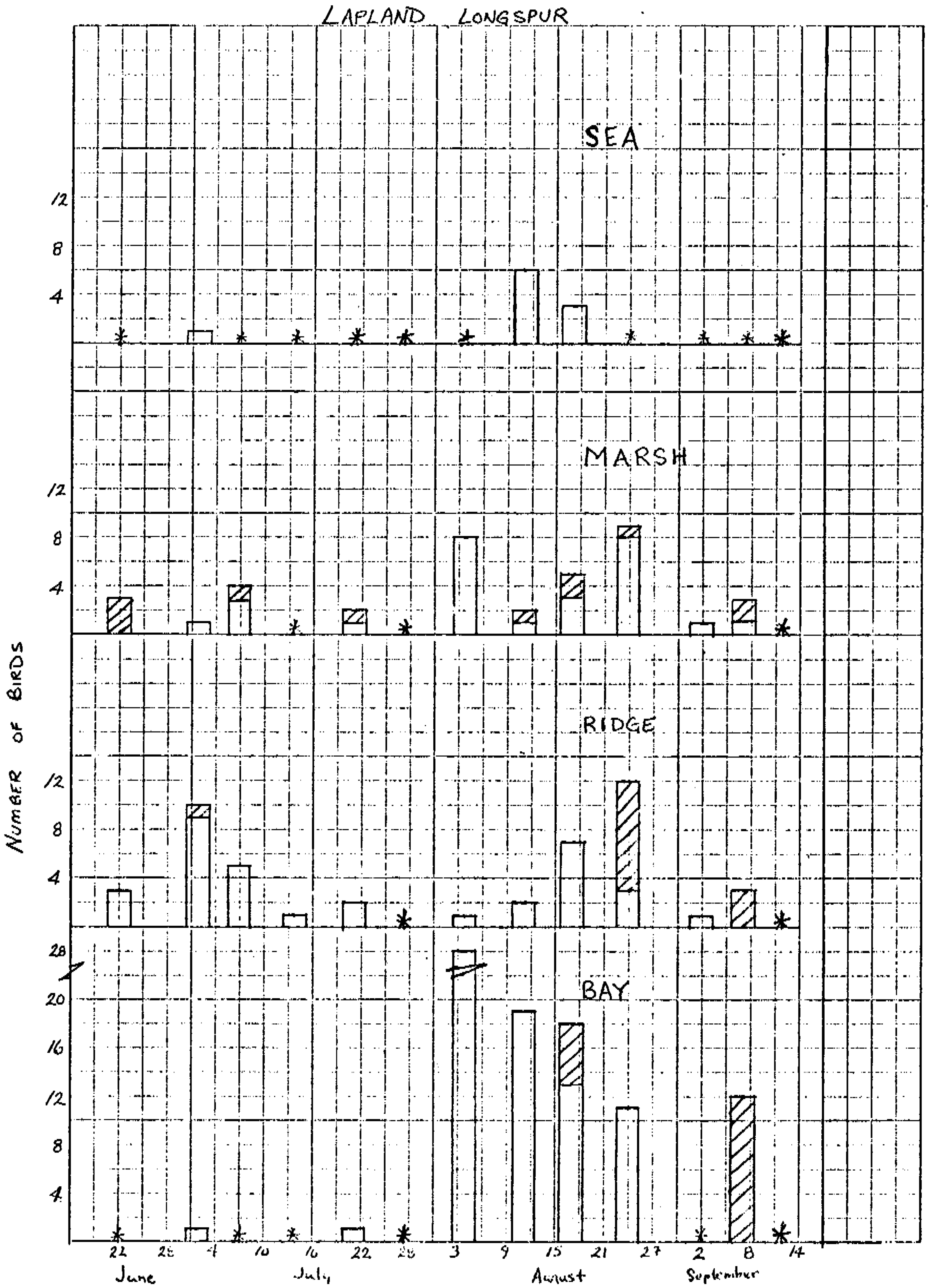

Figure 27. Numbers and distribution of Lapland Longspurs on the census transects. Cape Espenberg, Alaska. 1976. (unshaded= on ground or water, shaded= flying, *= not present).

D. Mudflats Surveys

Beginning in early August, numerous waterbirds were seen on the mudflats near the cape. Thereafter, these areas were monitored opportunistically.

Waterfowl numbers using the South Mudflats (Fig. 2) apparently peaked in early August. Mickelson estimated 1600 Pintails on these mudflats on 3 August (Table 1). Small numbers of eiders were also seen in this area. By 19 August, waterfowl numbers on the South Mudflats had dropped to 15. None were seen here after that date. Few waterfowl were seen on the Island Mudflats (Fig. 2, Table 2).

Glaucous Gulls were present on both mudflats throughout the survey periods. They showed no seasonal numerical trends.

Sabine's Gulls were first noted on the South Mudflats on 24 July, when birds from the breeding colony in the marsh nesting plot (Fig. 2) were observed to fly to this area. Adults and flying young-of-the-year were present on 5 August (Table 1). They were feeding in pools of water on the mudflats and in the shallow sloughs nearby. The sloughs were rich with amphipods at this time. No Sabine's Gulls were seen in the mudflats area on 7 August, or thereafter. Few of these gulls were seen anywhere on the cape after 4 August.

Arctic Terns were seen on the mudflats from 7 August through 22 August (Table 1). Few terns were noted anywhere on the cape after 22 August. Terns fished primarily in the shallow water on the north side of the mudflats.

Table 1. Fall migrant birds on the South Mudflats, Cape Espenberg, Alaska. 1976.

Date	Taxon	No. Birds	Notes
2 August	waterfowl and gulls	1500	Schamel, 10xbinocs, from cape
3	Pintails	1600	Mickelson, 10xbinocs, from cape
3	Sabine's Gulls, shorebirds	"some"	Schamel, aerial overflight
5	Pintails	320	Schamel, 35xscope, from mudflats
	Sabine's Gulls	59	Schamel, 35xscope, from mudflats
	shorebirds	355	Schamel, 35xscope, from mudflats
	Glaucous Gulls	147	Schamel, 35xscope, from mudflats
6	Pintails	300	Schamel, 10xbinocs, from cape
	Glaucous Gulls	150	Schamel, 10xbinocs, from cape
	shorebirds	400	Schamel, 10xbinocs, from cape
7	Pintails	670	Schamel, 35xscope, from cape
	eiders	20	Schamel, 35xscope, from cape
	unk. waterfowl	100	Schamel, 35xscope, from cape
	Glaucous Gulls	70	Schamel, 35xscope, from cape
	Arctic Terns	20	Schamel, 35xscope, from cape
	shorebirds	350	Schamel, 35xscope, from cape
	Sandhill Cranes	2	Schamel, 35xscope, from cape
9	unk. waterfowl	500	Schamel, 10xbinocs, from cape
	Glaucous Gulls	20	Schamel, 10xbinocs, from cape

Table 1. Continued

Date	Taxon	No. Birds	Notes
12	unk. waterfowl	250	Schamel, 10xbincos, from cape
12 August	Glaucous Gulls	110	Schamel, 10xbinocs, from cape
	Arctic Terns	35	Schamel, 10xbinocs, from cape
15	unk. waterfowl	100	Schamel, 10xbinocs, from cape
	Galucous Gulls	26	Schamel, 10xbinocs, from cape
	Arctic Terns	17	Schamel, 10xbinocs, from cape
	shorebirds	300	Schamel, 10xbinocs, from cape
22	Glaucous Gulls	175	Schamel, 10xbinocs, from cape
	Arctic Terns	15	Schamel, 10xbinocs, from cape
	shorebirds[1]	7000	Schamel, 10xbinocs, from cape
30	shorebirds[2]	4000	Schamel, 10xbinocs, from cape
9 September	shorebirds[3]	1500	Tracy, 7xbinocs, from mudflats

[1]Approximately 90% Dunlins, 10% probably Western Sandpipers

[2]Most were probably Dunlins

[3]All Dunlins

Table 2. Fall migrant birds on the Island Mudflats, Cape Espenberg, Alaska. 1976.

Date	Taxon	Birds	Notes
4 August	shorebirds[1]	980	Mickelson, 10xbinocs
7	Dunlins	450	Schamel, 10xbinocs
	Western or Semiplamated Sandpipers	250	Schamel, 10xbinocs
	Northern Phalaropes	10	Schamel, 10xbinocs
9	Pintails	25	Schamel, 10xbinocs
	shorebirds[2]	1200	Schamel, 10xbinocs
	Glaucous Gulls	20	Schamel, 10xbinocs
19	Dunlins	300	Schamel, 10xbinocs
21	Glaucous Gulls	150	Schamel, 10xbinocs
	Dunlins	280	Schamel, 10xbinocs

[1] About equal numbers of Dunlins and Western Sandpipers

[2] At least 80% Dunlins; 20% Western or Semipalmated Sandpipers

Shorebirds were first sighted on the South Mudflats on an overflight on 3 August (Table 1). Less than 400 shorebirds were counted on this mudflat on 5 August. Species present, in decreasing order of abundance, were: Dunlin, Western and or Semipalmated Sandpipers, Red Knot, Northern Phalarope and Black Turnstone. Shorebird numbers in this area probably remained at about this level, or somewhat higher, through 19 August. On 22 August, however, at least 7000 shorebirds, primarily Dunlins, were seen on the South Mudflats. This area was still heavily used by Dunlins in early September (Table 1). The Island Mudflats were also important to migrant shorebirds. This area, however, had peak numbers early in August (Table 2).

E. Shorebird Roost

One small section of marsh, approximately one hectare in area, was used by shorebirds as a roost. This phenomenon was first noted on 9 August, during a high tide, when an estimated 80 Dunlins and 5 Western Sandpipers were resting here. Bird numbers peaked on 19 August, when at least 800 Dunlins were seen at the roost. On 26 August, the last visit to this area, 150 Dunlins were estimated here. On rising tides, the birds arrived at the roost from the bay area. On falling tides, the birds departed the roost and flew towards the bay; some were visually followed to mudflats, where they landed and fed.

F. Invertebrate sampling

Sticky boards - The pooled results of the sticky board insect traps are given in Table 3. Except for a nine-day period in early July, adult

Table 3. Invertebrates collected from 0.25m^2 sticky boards.

Cape Espenberg, Alaska. 1976.

Collection period ending	Taxon							
	Tipulidae (o/o)	Culicidae (o/o)	large midge	small midge	Diptera: Oestridae	other Diptera	all spiders	ichneumonids and braconids
26 June	11/2	46/5	8	570	-	281	2	-
29	9/1	20/5	4	122	-	34	7	1
2 July	5/0	4/0	1	3	-	7	2	1
5	9/1	6/5	0	38	-	83	5	1
8	22/2	11/12	1	13	-	38	5	3
11	19/0	10/13	1	191	-	51	12	23
14	9/0	4/1	3	104	-	22	4	16
17	6/0	2/6	2	429	-	53	8	43
20	-	6/5	6	128	-	60	3	18
25	-	14/1	-	460	-	23	6	14
28	-	1/1	6	299	-	25	-	12
31	-	0/1	7	451	-	41	3	31
3 August	-	-	6	510	-	46	6	15
6	-	0/2	5	345	-	59	3	38
9	-	-	32	251	-	25	3	14
12	-	-	7	199	-	11	4	23
15	-	-	47	200	-	57	3	17
18	-	-	9	235	-	91	-	15
21	-	-	180	251	-	37	2	23
24	-	-	51	258	-	72	2	15
27	2/0	-	33	262	1	35	2	19
30	2/0	-	7	140	-	17	2	25
2 September	2/1	-	8	81	-	23	1	10
5	1/0	-	13	19	-	1	-	-
8	-	-	92	33	-	14	2	9

Table 3. Continued

Collection period ending	Taxon							
	Collembola	Homoptera	Hemiptera	Trichoptera	Coleoptera larvae	Plecoptera	Lepidoptera	TOTAL
26 June	-	-	-	-	-	-	-	925
29	-	-	-	-	-	-	-	203
2 July	-	-	-	-	-	-	-	23
5	-	-	-	-	-	-	-	148
8	-	2	-	-	-	-	-	109
11	-	-	-	1	-	-	-	321
14	32	-	-	1	-	1	-	197
17	11	-	1	-	-	-	1	562
20	6	-	-	5	1	-	-	238
25	9	-	-	7	-	-	-	534
28	9	-	-	6	-	-	-	359
31	2	4	-	13	-	-	-	553
3 August	13	-	-	11	-	-	-	607
6	12	-	-	9	-	-	-	473
9	4	-	-	3	2	-	-	334
12	9	1	-	12	1	-	-	267
15	9	1	-	12	-	-	-	346
18	5	1	1	2	-	-	-	360
21	4	-	1	1	-	-	-	499
24	4	-	1	1	-	-	-	404
27	5	1	1	2	-	-	-	363
30	6	-	-	-	-	-	1	200
2 September	4	-	-	-	1	-	-	126
5	4	-	-	1	-	-	-	39
8	1	-	-	1	-	-	-	152

dipterans were relatively abundant during the brood-rearing period (July). Tipulids were avilable during the early July period and may have been a major food source for the young. The most interesting correlation between insects and their bird predators is demonstrated by the emergence of the Trichoptera (caddisflies). They first appeared on sticky boards on 11 July and were present throughout the remainder of the summer. These insects were frequently captured by adult Arctic Terns and fed to the young. Tern chicks began to hatch at the same time that caddisflies appeared. Although adult terns relied heavily upon fish for their young, caddisflies often supplemented this food base.

Intertidal Invertebrates - Processing of intertidal invertebrate samples is presently incomplete. All samples from the sea, approximately 75% from the bay, and 2 (of 10) from the South Mudflats have been completed. A preliminary list of species found and their general distribution is given in Table 4.

Some very general trends are already apparent. Only three species were found along the sea coast. Of these, only one (*Anisogammarus confervicolus*) was common. Thirteen species have thus far been identified from bay samples. Biomass seems to be greatest in the reduced muds at the base of the Cape, near the slough. Numerous chironomid larvae were found here. These infrequently occurred in bay stations further east, where the sediments are more coarse and less reduced.

Table 4. Preliminary list of invertebrates identified from intertidal samples. Cape Espenberg, Alaska. 1976.

Taxon		Location[1]
Phylum Mollusca	Macoma balthica	B,M
Phylum Annelida	Oligochaeta	B
	Eteone longa	M
	Scolecolepides arctius	B,M
	Pygospio elegans	B,M
	Chone duneri	M
Phylum Arthropoda	Mysis sp.	B
	Saduria entomon	B
	Pontoporeia affinis	B
	Onisimus littoralis	B
	Gammarus setosa	B
	Anisogammarus confervicolus	S,B
	unidentified amphipod	S
	Crangon dalli	B
	Chironomidae, larvae	B,M
	Diptera, pupae	S,B

[1]S = sea; B = bay; M = south mudflats

G. Daily Bird Observations

Daily estimations of species present and their abundance is presented in Table 5. These data are based upon the pooled observations of all investigators and include only those birds sighted from the eastern tip of Cape Espenberg, west to the large slough.

It must be emphasized that these observations are not a reliable indicator of the daily relative abundance of avian species. No census route was followed. The numbers and species seen are a function of variables, such as: 1) number of investigators in the field, 2) distance walked, 3) the working areas, 4) time of day observations were made, 5) degree of concentration demanded by the day's work, and 6) quality of field notes or memory.

Data from 4 to 16 June is incomplete. The daily species observation scheme was not started until 17 June. Consequently, information preceding this date was gathered from sporadic records in field notebooks.

H. Common Eider Breeding Biology

The dates of nest initiation and hatching for colonial nesting Common Eiders are shown in Table 6. Initiation lasted from 12 June to 9 July. The period of hatch extended from 19 July to 8 August.

Average clutch size in the same eider colony on 28 June, 8 July, 15 July, 19 July and 26 July were 6.14, 5.90, 5.63 5.24 and 3.62, respectively (Table 7). Clutch size frequency on the above dates are shown in Table 7.

I. Phenology

Notable events during the 1976 field season are listed in Table 8.

Table 5. Daily bird observations. Cape Espenberg, Alaska. 4 June to 12 September 1976.
(These data are not a reliable indicator of the daily relative abundance of avian species.)

JUNE

	4*	5*	6*	7*	8*	9*	10*	11*	12*	13*	14*	15*	16*	17	18	19	20	21	22	23
Yellow-billed Loon															1+	1	1			
Arctic Loon				1											1+	1	3	2	3	2
Red-throated Loon	10+	10+	6	11+	3	9				1+		1	8	1	1+	8	15		15	15
Whistling Swan	2		2	5	4							2		1+		1	4		7	2
Canada Goose							2							1+	1+					
Black Brant				19	2											30	20		3	
Emperor Goose				10	5	2	5			4	6	4	3	1+	1+	18	18		10	10
Snow Goose							1								1+		15			
Mallard																				
Pintail				9+		7	5			1+	4		17	1+	1+	3	20+		4	
Green-winged Teal				4											1+					1
American Widgeon																				
Greater Scaup		1+	4	10	2		2			1+		1		1+	1+	4	10		2	2
Oldsquaw		4	2	7	20					4+	1	12+	7	1+	6	20+			4	4
Common Eider		10+	2+	19	14+		8	1	1		2	26+	38	1+	1+	25	60+		20+	20+
King Eider					3														2	
Spectacled Eider																	1			
Eider sp.																				
Surf Scoter																				
Red-breasted Merganser				2	1						3		1		1+	4	35+		6	
Goshawk																				
Rough-legged Hawk																				
Marsh Hawk														1+						
Willow Ptarmigan		1		5	1					3		9+	2	1+	1+	3	2		1	2
Sandhill Crane	3+	2+	1+	6		3	2			1+		2	8	1+	1+	3	6		5	2
American Golden Plover											1							1		
Black-bellied Plover				1											1+		1			
Ruddy Turnstone				3								2+			1+	1	5		1	1
Black Turnstone				1								2+		1+	1+		2		2	
Semipalmated Sandpiper		5+	2+	2	6	1	2	2	4	3+	2	10+	2	1+	1+	45+	45+		35	35+
Western Sandpiper				2	6				1	3+			1	1+	1+	40	40		30	
Baird's Sandpiper															1+					
Pectoral Sandpiper				1			1	1		3		1	2	1+	1+	30	30		20	10
Sharp-tailed Sandpiper																				
Dunlin				1		3	1		1	1+		10+	5	1+	1+	6	12		6	
Curlew Sandpiper																			1	
Knot																				
Sanderling																				
Long-billed Dowitcher					2	3	3		1					1+	1+	6	12		6	
Bar-tailed Godwit																				
Hudsonian Godwit																				
Whimbrel															1+		2		1	
Bristle-thighed Curlew																				
Common Snipe																2				

*data incomplete

Table 5. Continued

JUNE

	4*	5*	6*	7*	8*	9*	10*	11*	12*	13*	14*	15*	16*	17	18	19	20	21	22	23
Red Phalarope		1^{+}		21		2			16	7^{+}	1	7^{+}	4	1^{+}	1^{+}	20	30		10	
Northern Phalarope	6^{+}	1^{+}		22	4	3	1		3	9^{+}	3	6^{+}	10	1^{+}	1^{+}	20	20^{+}		5	5
Unidentified Small Shorebirds																				
Unidentified Medium Sized Shorebirds																				
Unidentified Large Shorebirds																				
Pomarine Jaeger					1				1											
Parasitic Jaeger				4							2		5	1^{+}	1^{+}	15	15		6	4
Long-tailed Jaeger			2	1	1				1	4	1			1^{+}	1^{+}	7	5			5
Glaucous Gull				110	82			4	4		10^{+}	70	70^{+}	1^{+}	1^{+}	75	75^{+}		50^{+}	50^{+}
Mew Gull																				
Black-legged Kittiwake															1^{+}	4	5	6	25	5
Sabine's Gull		1				1		1	1		4	5^{+}	2	1^{+}	1^{+}	2	20		2	4
Arctic Tern				2^{+}			2						11	1^{+}	1^{+}	10	20		7	3
Aleutian Tern																				
Common Murre														1^{+}	1^{+}			80		
Thick-billed Murre																				
Murre sp.				200	235				15		6									
Horned Puffin																				
Tufted Puffin																				
Puffin sp.												1		1^{+}			2			
Snowy Owl																				
Short-eared Owl													1		1^{+}					
Common Raven					2				2					1^{+}	1^{+}		1		2	
Wheatear		2																		
Arctic Warbler									1					1^{+}						
Yellow Wagtail														1^{+}	1^{+}	1	1		1	
Redpoll sp.														1^{+}	1^{+}		5		10	
Savannah Sparrow				1					1^{+}											
White-crowned Sparrow																				
Lapland Longspur		5^{+}	2^{+}	2	2^{+}	1			1^{+}	5	1			1^{+}	1^{+}	16	16^{+}		20	20

Table 5. Continued

	JUNE							JULY											
	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12
Yellow-billed Loon					2	3	2	2	1			1		2		1	2	2	2
Arctic Loon		6	3	3	4	4	2	4	4			4			2	1	4	4	6
Red-throated Loon	15	15	15	15	15	15	15	15	15		50+	15	15	15	15	15	15	10	15
Whistling Swan			1		1							3					3		
Canada Goose		1	2	5	2				1										7
Black Brant	15										2	9	2	4			1		
Emperor Goose	8	3	21	15+	13	8		10	12		12	5	8	10	30	8	13		12
Snow Goose																			
Mallard																			
Pintail	15	5	7	1	3	3		8	4		2	2	1	3		1	5	3	
Green-winged Teal			1	2			2							1		2			1
American Widgeon																			
Greater Scaup	2	4	6	12	2	6	2	2	3			2	2	11	2		7	2	2
Oldsquaw	5	2	8	20+	4	4	6	6	10		20	12	12	15	30+	15	30	10	15
Common Eider	20+	60+	100+	100+	20+	20+	20+	20+	20+		50	100	100	50	300	20+	20+	50	50+
King Eider												1		5	1				1
Spectacled Eider		1		1										3	6			12	
Eider sp.																			
Surf Scoter																	5		90
Red-breasted Merganser			10		4	4	2		7		2	10		6	15	1	5	3	2
Goshawk																			
Rough-legged Hawk																			
Marsh Hawk																			
Willow Ptarmigan	3	3	2	3	2	2	3	1	1		2	12	1					1	7
Sandhill Crane	3	6	10+	10+	6	12	4	6	10		10	4	2	12	8		18	33	8
American Golden Plover		1					1												
Black-bellied Plover				1				1	1			1		1				6	
Ruddy Turnstone	2	8	10	12	8	5	2	4	6		1	5	1	5	6	4	3		3
Black Turnstone	5	3	2	2				1	3			3			6		2	5	2
Semipalmated Sandpiper	20+	20+	20+	20+	20+	20+	20+	20+	20+		20+	20+	20+	10	20+		15+	15+	15+
Western Sandpiper	20+	20+	20+	20+	20+	20+	20+	20+	20+		20+	20+	20+		20+		1	15+	15+
Baird's Sandpiper																			
Pectoral Sandpiper	2	3	5	4			1	1	3			3			1				25
Sharp-tailed Sandpiper																			
Dunlin	5	5+	5+	5+	5	5	10	10+	15		3	10+	5	8	10+	5	5	3	15+
Curlew Sandpiper																			
Knot																			
Sanderling																			
Long-billed Dowitcher	10+	10+	10+	10+	4	2	5	1	4		2	8	3	4	10	5	3	4	4
Bar-tailed Godwit							1												
Hudsonian Godwit																			
Godwit sp.																			
Whimbrel	3	4	5	2			5		1		2		3	6	2		26	6	15
Bristle-thighed Curlew							1											1	2
Common Snipe																			

Table 5. Continued

	JUNE							JULY											
	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12
Red Phalarope	2+	20+	20+	20+	45	25	20+	20+	20+		10+	10+	3	11	10+	5	5	5	25+
Northern Phalarope	5	20+	15+	15+	25	20	20+	20+	15		5	15+	3	12	20+	15	20	5	30+
Unidentified Small Shorebirds																			
Unidentified Medium Sized Shorebirds																			
Unidentified Large Shorebirds																			
Pomarine Jaeger	1																		
Parasitic Jaeger	5	15	20+	20+	10	12	12	12	12		5	4	3	12	16	8	9	3	6
Long-tailed Jaeger	8	3	6	8	7	6	2	1	1		10	5	5	2	4	5	2	8	5
Glaucous Gull	20+	20+	20+	20+	20+	20+	20+	20+	20+		20+	20+	20+	20+	20+	20+	20+	20+	20+
Mew Gull																			
Black-legged Kittiwake		2	20	10	35	10+			10		1	5	2		4		7	20	13
Sabine's Gull	4	20+	20+	20+	3	2	4	2	4		2	20+	5	15	20+	20	20	10	30+
Arctic Tern	10	20+	20+	30+	55	30	20	25	25		8	6	15	50	30+	12	40	10	30+
Aleutian Tern																			
Common Murre		3	2			60												10	10
Thick-billed Murre																			
Murre sp.																			
Horned Puffin									10			1	7	1	15	1	1		
Tufted Puffin													40						
Puffin sp.																			
Snowy Owl																			
Short-eared Owl				1	1	1	1									1	1		2
Common Raven	1		2	10												1		7	3
Wheatear																			
Arctic Warbler																			
Yellow Wa tail	1																		
Redpoll sp.		5	15+	5			18		4		2					2			2
Savannah Sparrow		8					7	2	10		3	6	4	3	9	2	6	5+	5+
White-crowned Sparrow																			
Lapland Longspur	15+	15+	15+	15+	15+	15+	15+	15+	15+		15+	15+	15+	15+	25+	20	15	10	20+

Table 5. Continued

JULY

	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Yellow-billed Loon		3		2	1	3	2		2	3	1	1			1			2	
Arctic Loon	3	1	4		5		7	2		4	1	3		6	6		2	6	3
Red-throated Loon	15	50	30	30	23	2	35	10	17	45	10	35	25	16	35	9	100	95	150
Whistling Swan																			
Canada Goose										8									
Black Brant		2																	
Emperor Goose		6								4		2							
Snow Goose																			
Mallard																			
Pintail	2	4	2	2	1	2	3			2	10	10	2	55	81		4	19	30
Green-winged Teal																			
American Widgeon																			
Greater Scaup		4	4	1			2			1		1							2
Oldsquaw	15	70	40	80	30	20+	90	20	30	55	75	40	13	56	45	40	3	35	32
Common Eider	20+	175	195	65	125	15+	155	5	25	70	100	61	6	98	70	10	4	45	30
King Eider		1										2	1	1	1	1			1
Spectacled Eider		4																	
Eider sp.																			
Surf Scoter			4	3															
Red-breasted Merganser	24		3	2	1		11					2	1	1	1			8	
Goshawk																			
Rough-legged Hawk																			
Marsh Hawk																			
Willow Ptarmigan			20	2	3	15	1	3		5		15		14	18	10			5
Sandhill Crane	2	28	18	9	15		24	5	10	47	4	15	10	34	20	8	7	11	13
American Golden Plover														1					
Black-bellied Plover		3	3				1				1								
Ruddy Turnstone	4	5	2	7	3	3	8	3	2	3	2	10	1		7	1	1	2	1
Black Turnstone		2	1	4			3			2	6			2					3
Semipalmated Sandpiper	15+	20+	30+	30+	25	25	25	20	20	35	25	25	3	15	11	15	10	60	85
Western Sandpiper	15+	20+	30+	30+	25	25	25	20	20	35	25	25		20	11	15		20	15
Baird's Sandpiper					3														
Pectoral Sandpiper		7	3	30	14	7	7	1				1		1	10	1		6	9
Sharp-tailed Sandpiper																			
Dunlin	15+	20+	20+	25+	25+	25+	85	20	20	175	60	60		50	25	30		25	20
Curlew Sandpiper																			
Knot																			
Sanderling																			
Long-billed Dowitcher	4	88	7	6	4	10	6	6	3	8	4	7		5	11	14		28	12
Bar-tailed Godwit																			
Hudsonian Godwit																			
Godwit sp.			2						1										
Whimbrel	19	15	21	15	23	8	5	3	5	16	8	2			1	10			15
Common Snipe																			

Table 5. Continued

JULY

	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Red Phalarope	25+	25+	25+	25+	20+	20	15	15	15	15	35	30		8	8	6		5	10
Northern Phalarope	30+	25+	25+	25+	25+	25	25	20	20	45	25	60		40	27	27	2	20	22
Unidentified Small Shorebirds						300											30		
Unidentified Medium Sized Shorebirds																			
Unidentified Large Shorebirds																			
Pomarine Jaeger			1		1														
Parasitic Jaeger	6	11	6	12	15	6	20	6	6	14	9	14	4	9	24	7	3	11	10
Long-tailed Jaeger	4	4	2		2	2	2	2	5			3		1				3	3
Glaucous Gull	20+	20+	140	110	120	16	150	15	40	930	50	75	550+	470	200	25	50	300	560
Mew Gull																			
Black-legged Kittiwake		45	35	10	8		45	8	25		20	19	43	60	7	3	18	60	41
Sabine's Gull	30+	50+	40	40	40	40	40	40	40	50	70	70		40	30	30	3	35	35
Arctic Tern	30+	30+	85	85	45+	45+	75	35	37	45	60	40	78	170	150	35	26	135	160
Aleutian Tern																			
Common Murre		20	120	10	42														
Thick-billed Murre										1									
Murre sp.			1																
Horned Puffin		9	1		5														
Tufted Puffin	20			1									2						
Puffin sp.																			
Snowy Owl															1				
Short-eared Owl					1		2					1	1	1	1			1	2
Common Raven				1	1	1	4		1										
Wheatear																			
Arctic Warbler																			
Yellow Wagtail			1																
Redpoll sp.			1	3								1							
Savannah Sparrow		10	2	3	3	3		1	1	6	1	1		4				1	5
White-crowned Sparrow																			
Lapland Longspur	20+	25	25	25	10+	15	20	15	5	33	11	17	18	11	17	9	1	12	19

Table 5. Continued

AUGUST

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Yellow-billed Loon	2		2	4							2					1		2	2	
Arctic Loon	2	6	4	5	1	1	3	3			12	2	1		1	12	7	17	2	3
Red-throated Loon	45	180	120	150	30	30	108	15	36	4	68	65	25		3	105	18	56	65	10
Whistling Swan																				
Canada Goose				8							5					11			36	1+
Black Brant				19															12	
Emperor Goose																			2	
Snow Goose																				
Mallard								1												
Pintail	330	500	130	410	400	10	48	42	76		85		11		1	15	45	11	17	3
Green-winged Teal											1						2			
American Widgeon	1																			
Greater Scaup			8	8			5	2	1		15									2
Oldsquaw	12	23	27	27		3	1	5	40		25	13				19		8	8	
Common Eider	15	26	100	70	54	35	47	5	14		7				10				2	
King Eider				2																
Spectacled Eider				3			10												6	
Eider sp.																2				
Surf Scoter																				
Red-breasted Merganser	2		1	1				1												
Goshawk																		2	1	
Rough-legged Hawk																				
Marsh Hawk																1	1			
Willow Ptarmigan		16	1	5				9	4										2	
Sandhill Crane	8	24	22	22	6	10	16	10	11	2	20	8	3		2	31	10	14	36	2
American Golden Plover			2	1		1		2	2		4	3			1	3	25	25	33	10
Black-bellied Plover	1										3									
Ruddy Turnstone	1	1	2	1	1	1	2			4	2		1	1						
Black Turnstone							2				4	9				3	1	10	3	
Semipalmated Sandpiper	20	17	20	2	6	2	5	1			11									
Western Sandpiper	9	27	65	140	70	30	50	5	50	11	62	30	4		10	50	16	10	5	
Baird's Sandpiper	1						1				2									
Pectoral Sandpiper		1	2	2		15	10	3	35	1	60	45	20		10	400	160	60	53	20
Sharp-tailed Sandpiper																				
Dunlin	6	20	26	225	5	20	40	40	100		100	20	3			80	100	50	1200	7
Curlew Sandpiper																				
Knot																		2		
Sanderling											8	20	30		7	23	15	10		
Long-billed Dowitcher		6	4	5		2	1		1				1		3	1	13	5	11	1
Bar-tailed Godwit			3	6		3		1		1		12				10	8	10	15	
Hudsonian Godwit																	3			
Godwit sp.																				
Whimbrel	4	2		3	7	1	2	1	1	1	3	3	7			4	25		7	
Bristle-thighed Curlew			2																	
Common Snipe																1				

Table 5. Continued

AUGUST

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Red Phalarope		1	1	3					1			1			1	1			2	
Northern Phalarope	11	28	18	55	2	10	20	2	15		17	8			2	8	10	8	3	1
Unidentified Small Shorebirds			1900																	
Unidentified Medium Sized Shorebirds																				
Unidentified Large Shorebirds																				
Pomarine Jaeger		2	2															1		
Parasitic Jaeger	10	14	7	10	3	8	9	4	5		10	3	6		2	9	6	8	10	
Long-tailed Jaeger		1	3			1		1	1							1		1		
Glaucous Gull	225	70	500+	210	35	25	480	300	140	28	260+	90	50		15	80	70		170	20
Mew Gull			2																	
Black-legged Kittiwake	12	30	6	9		3	75	45	11		23				5	2	30	11	97	
Sabine's Gull	1	20	15	15		7	6		1		1							1	1	
Arctic Tern	40	86	45	130	26	31	215	60	35	10	60	45	14		15	30	40	28	12	5
Aleutian Tern																				
Common Murre			1																	
Murre sp.																				
Horned Puffin																				
Tufted Puffin																				
Puffin sp.																				
Snowy Owl		1	1	1		1	4	1	2		3	1	1			2	2		3	1
Short-eared Owl			2	2				2	2		1	1	1		1	4	1			
Common Raven									3								12			
Wheatear									1											
Arctic Warbler																				
Yellow Wagtail																				
Redpoll sp.		50						6												
Savannah Sparrow		9	4	2				10								1				
White-crowned Sparrow		1									1	1								
Lapland Longspur	13	80	35	95	10	20	50	60	150		85	50	50		5	140	140	55	40	20

Table 5. Continued

AUGUST

	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8
Yellow-billed Loon					1	1		1	1			1						1	1
Arctic Loon	2	3	2	2	2	14		1	9	17	6	6	5		1	2	15	25	15
Red-throated Loon	30	100	41	35	20	40	17	5	23	35	10	10	5		6	1		3	
Whistling Swan				3	1		1	4			1		5		3				
Canada Goose	22	27	18	29	14	42		70	27+	30	16		70				150	240	20
Black Brant							17	18	6	17	25	26			1				
Emperor Goose											30	31	23		10			15	5
Snow Goose																			
Mallard																			
Pintail	3	6	4	24	12	5	3	2	6	10	13	13	13				4	7	
Green-winged Teal									1	1									
American Widgeon																			
Greater Scaup																			
Oldsquaw	5	2		5		3	6	5					2					2	
Common Eider	42	6		35											18			30	20
King Eider																			
Spectacled Eider	3			5														10	
Eider sp.				25															
Surf Scoter																			
Red-breasted Merganser																			
Goshawk	1	3	2	1			1			2		1							
Rough-legged Hawk																	1		
Marsh Hawk	1	1	2	1	1	1	1	2	1	1	2	1			1		1		
Willow Ptarmigan					8	6			13		1						9	12	
Sandhill Crane	7	15	10	19	12	28	2	5	10	6	10	20	20		5	2	7	18	2
American Golden Plover	21	20	40	30	30	30	10	60	50	80	80	50	60			5	15	40	15
Black-bellied Plover																			
Ruddy Turnstone																			
Black Turnstone	2	2	6			3													
Semipalmated Sandpiper																			
Western Sandpiper	10			2															
Baird's Sandpiper																			
Pectoral Sandpiper	23	80	60	117	60	60	50	35	50	30	20	8	5		15	7		22	5
Sharp-tailed Sandpiper				1				4	25	29	45	35	20		10		1	10	
Dunlin	300	1206	12	70	20	161	30		12	35	50	250	350		60	20	20	150	20
Curlew Sandpiper																			
Knot																			
Sanderling	31	35	16	17		21	11	10				5	20		9			4	
Long-billed Dowitcher	9	6	12	3	10	3	1	14	26	45	22	8	1		6	2	2	4	
Bar-tailed Godwit	6			9	2														
Hudsonian Godwit																			
Godwit sp.																			
Whimbrel			12		20	25	1		1										
Bristle-thighed Curlew			1																
Common Snipe																			

Table 5. Continued

	AUGUST 21	22	23	24	25	26	27	28	29	30	31	SEPTEMBER 1	2	3	4	5	6	7	8
Red Phalarope	1			1		1													
Northern Phalarope	20	3	1	1		2		2										1	
Unidentified Small Shorebirds																			
Unidentified Medium Sized Shorebirds									20										
Unidentified Large Shorebirds									25										
Pomarine Jaeger																			
Parasitic Jaeger	10	8	6	12	8	8	4	2	6	4	8	8	8				3		
Long-tailed Jaeger			1			1			1			2							
Glaucous Gull	290	175	30	105	20	70	37	28	30	13	15	20	120		450	5	10	100	10
Mew Gull																			
Black-legged Kittiwake	26	112	6	86		73	20								1				
Sabine's Gull															2				
Arctic Tern	65	22	5	2		7									4				
Aleutian Tern															2				
Common Murre																			
Thick-billed Murre																			
Murre sp.																			
Horned Puffin																			
Tufted Puffin																			
Puffin sp.																			
Snowy Owl	2	2	2	1	2	3	1	1	2	3	3	3	3					1	
Short-eared Owl	1	1		2	1					1	1								
Common Raven			2	2		1	1	1				1							
Wheatear			5		1	6	3	3											
Arctic Warbler																			
Yellow Wagtail																			
Redpoll sp.																			
Savannah Sparrow			1	1											1	1			
White-crowned Sparrow																			
Lapland Longspur	31	50	20	40	20	20	10	5	25	25	15	10	10		3	1		25	

Table 5. Continued

SEPTEMBER

	9	10	11	12
Yellow-billed Loon		1	3	6
Arctic Loon	9	20	15	13
Red-throated Loon		10		
Whistling Swan	10			
Canada Goose	75			
Black Brant			25	
Emperor Goose	20	30	50	80
Snow Goose				
Mallard				
Pintail		1	1	10
Green-winged Teal				2
American Widgeon				
Greater Scaup				2
Oldsquaw		1		1
Common Eider	6			15
King Eider				
Spectacled Eider				
Eider sp.				
Surf Scoter				
Red-breasted Merganser				
Goshawk			1	1
Rough-legged Hawk				
Marsh Hawk		1		
Willow Ptarmigan			1	45
Sandhill Crane		5	2	9
American Golden Plover	10	15	15	20
Black-bellied Plover				
Ruddy Turnstone				
Black Turnstone				
Semipalmated Sandpiper				
Western Sandpiper				
Baird's Sandpiper				
Pectoral Sandpiper	2	20	25	10
Sharp-tailed Sandpiper	2		3	2
Dunlin	10	25	50	150
Curlew Sandpiper				
Knot				
Sanderling		3		1
Long-billed Dowitcher		1	3	7
Bar-tailed Godwit				
Hudsonian Godwit				
Godwit sp.				
Whimbrel				
Bristle-thighed Curlew				
Common Snipe				

Table 5. Continued

SEPTEMBER

	9	10	11	12	13	14
Red Phalarope						
Northern Phalarope						
Unidentified Small Shorebirds						
Unidentified Medium Sized Shorebirds						
Pomarine Jaeger						
Parasitic Jaeger						
Glaucous Gull		125		20	150	
Mew Gull						
Black-legged Kittiwake				3		
Sabine's Gull						
Arctic Tern				7		
Aleutian Tern						
Thick-billed Murre						
Murre sp.						
Horned Puffin						
Tufted Puffin						
Puffin sp.						
Snowy Owl		1	2	2		
Short-eared Owl						
Common Raven						
Wheatear						
Arctic Warbler						
Yellow Wagtail						
Redpoll sp.						
Savannah Sparrow						
White-crowned Sparrow						
Lapland Longspur				15	5	
Common Murre						

Table 6. Date of nest initiation and hatching at a Common Eider colony[1]. Cape Espenberg, Alaska. 1976.

Date	Number of Nests Initiated	Date	Number of Nests Hatched
12 June	1	19 July	10
13	1	20	7
14	4	21	3
15	0	22	0
16	2	23	0
17	2	24	0
18	4	25	0
19	2	26	2
20	3	27	3
21	2	28	1
22	1	29	0
23	0	30	1
24	1	31	0
25	0	1 August	0
26	1	2	0
27	1	3	1
28	0	4	0
29	0	5	0
30	1	6	0
1 July	1	7	1
2	0	8	1

Table 6. Continued

Date	Initiated	Date	Hatched
3 July	0		
4	1		
5	0		
6	0		
7	1		
8	0		
9	1		

[1]Based on an incubation period of 26 days.

Table 7. Size of clutch incubated by Common Eiders at an eider colony. Cape Espenberg, Alaska. 1976.

Clutch Size	Clutch Size Frequency				
	28 June	8 July	15 July	19 July	26 July
0	3	-	35	-	-
1	4	6	7	3	2
2	6	5	4	4	2
3	9	18	17	12	4
4	37	41	23	18	5
5	37	41	31	17	0
6	24	38	31	11	2
7	27	29	17	3	0
8	16	23	16	6	1
9	14	17	10	9	0
10	10	9	7	2	0
11	8	4	1	1	0
12	1	2	1	0	0
13	2	0	0	0	0
14	0	1	0	0	0
15	1	0	0	0	0
Total Nests	199	234	200	86	16
Total Eggs	1204	1382	929	451	58
Average Clutch[1]	6.14	5.90	5.63	5.24	3.62

[1]Excludes clutches of 0 eggs

Table 8. Notes on Phenology. Cape Espenberg, Alaska. 1976.

Date	Observation
13 June	Pedicularis sp. first flowered.
14	Patches of open water among the ice on the north side.
20	Caltha palustris, Geum sp. first flowered.
25	Rubus chamaemorus in flower. First lepidopteran seen.
26	Kotzebue Sound side of peninsula free of ice.
	Stellaria sp. first flowered.
	Elymus arenarius showed first green shoots.
29	All ponds (under 10 ha) ice free.
30	Primula sibirica, Cassiope tetragona, Silene sp. first flowered.
10 July	Mosquitoes very abundant.
11	" " "
13	Ledum decumbens, Silene sp. (moss campion) first flowered.
15	Chrysanthemum arcticum, Potentilla Egedi, and Lathyrus maritimus first flowered.
	North shore (Chukchi Sea side) nearly free of ice.
17	Salix sp. in seed.
	Taraxacum sp., Pedicularis sp. (yellow flower) first in flower.
18	North shore (Chukchi Sea side) totally free of ice within 2 km of shore.
19	Immature Arctic Tern (AHY) fed on north beach by adult arctic terns.
21	First horsetail; in dunes near fox den.
22	Aster sibiricus first flowered.
24	First flying Sabine's Gull chick.
25	Menyanthes trifoliata first in flower.
26	Petasites frigidus, Astragalus alpinus, Castilleja elegans, Iris setosa, Saxifraga hirculus, S. cernua, Angelica lucida, Androsace chamaejasme first in flower.
29	Red-throated Loons congregating in flocks.
1 August	Approximately 300 Pintails southeast of camp.
2	First known flying Arctic Tern chick.
11	First mayflies sighted
16	First known flying Glaucous Gull chick

Dates of first flowering and breakup are among the events included in the table.

J. Beached Bird Survey

The north beach from the tip of Cape Espenberg to the large slough near the base of the peninsula (Fig. 1) (about 13.5 km west of the tip) was searched periodically, on foot, for dead birds. The results are presented in Table 9.

Birds were identified and the location of the carcasses noted. For some individuals, the amount of oil on the remains and degree of decomposition were recorded.

To avoid duplication, after a carcass was censused it was deposited near the dunes bordering the beach, far from the water mark.

IV. Preliminary Interpretation of Results

Growth rates of chicks 1 and 2 are virtually identical for both Arctic Terns and Sabine's Gulls (Figs. 4-9). This contrasts sharply with Lemmetyinen's (1972) data from Spitsbergen, which show second-hatched chicks to grow much more slowly than first-hatched chicks. This similarity of growth rates suggests that food was not severly limiting throughout the season. The deaths of some chicks, primarily with a 4-day period, does suggest a temporary food shortage. Tundra insects were used by terns at least occasionally. This, in itself, may indicate a short supply of prey items from the sea.

Although Cape Espenberg was a good nesting area for many waterbird species and was a good brood rearing area for shorebirds, its use by

Table 9. Summary of beached bird surveys along the north coast of Espenberg Peninsula. 1976[1].

Date	Km of Beach Surveyed	Surveyor	Species Found	Number Found
18 June	7	Mickelson	-	-
10 July	7	Mickelson	Common Raven	1
14	6	Mickelson	Black-legged Kittiwake	2
15	7	Mickelson	Black-legged Kittiwake	1
16	7	Mickelson	-	-
17	3	Ionson	Black-legged Kittiwake	1
19	3	Ionson	Eider sp.	1
			Murre sp.	1
			Horned Puffin[2]	1
22	3	Ionson	Glaucous Gull	1
24	3	Ionson	Black-legged Kittiwake	1
	3	Mickelson	Fulmar	2
			Sooty Shearwater	1
			White-winged Scoter	1
			Black-legged Kittiwake	6
			Common Murre	1
			Murre sp.	3
			Alcid	2
25	4	Mickelson	Oldsquaw	2
			Glaucous Gull	1
			Black-legged Kittiwake	9
			Parasitic Jaeger	1
			Common Murre	5
			Murre sp.	2
26	1	Mickelson	Horned Puffin	1
			Crested Auklet	1
	3	Ionson	Black-legged Kittiwake	2
29	3	Ionson	Arctic Tern	1
30	7	Mickelson	Fulmar	1
			Black-legged Kittwake	1
	7	Ionson	Fulmar	1
			Common Scoter	1
			Black-legged Kittiwake	2
2 August	3	Ionson	Murre sp.	1

[1]North side of peninsula free of ice on 18 July.

[2]Moderate amount of oil on feathers.

Table 9. Continued

Date	Km of Beach Surveyed	Surveyor	Species Found	Number Found
7 August	6	Ionson	Parasitic Jaeger	1
			Long-tailed Jaeger	1
			Black-legged Kittiwake	4
			Common Murre	3
13	6	Ionson	Black-legged Kittiwake	1
			Common Murre	1
18	3	Ionson	Common Eider	1
			Glaucous Gull	1
21	7	Ionson	Oldsquaw	4
			Eider sp.	1
			Dabbler	1
			Glaucous Gull	1
			Black-legged Kittiwake	2
			Horned Puffin	1
			Common Murre	1
			Northern Raven	1
21	6	Tracy	Shearwater sp.	1
			Shorebird	1
			Arctic Tern	1
			Black-legged Kittiwake	1
			Common Murre	2
			Puffin sp.	1
			Unidentified	2
2 Sept.	6	Tracy	Arctic Tern	1
			Kittiwake sp.	1
4	7	Schamel	Kittiwake sp.	5
			Alcid	1
			Unidentified Seabird	5

waterfowl broods was limited. Oldsquaw and Greater Scaup raised broods to fledging on the Cape, as did Arctic and Red-throated loons. Eiders and geese left the Cape with their broods within a few days after hatch. Eider broods were subsequently seen in the bay and its sloughs.

The Cape area also had limited use as a staging area for waterfowl and shorebirds. The only waterfowl species to stage here in numbers was the Pintail. These birds were most abundant on nearby mudflats, particularly in early August (1-2,000 birds). Small flocks of Black Brant, Emperor Geese and Canada Geese flew west past the Cape in late August and September. Emperor and Canada Geese occasionally stopped to feed and rest on the Cape. Flock size was usually between 10-30 birds.

Dunlins were the most numerous of the migrant shorebirds to use the Cape area. These birds were most abundant on mudflats but were not restricted to these areas. They also fed and roosted on the tundra, particularly at high tide. Small numbers of Western Sandpipers (less than 20) persisted on mudflats through late August. Even at the peak of their migration through our area, Westerns were not numerous (largest flock equalled about 300 birds). Nearly all the Semipalmated Sandpipers were gone by early August. Like Westerns, migrants were never very numerous. Pectoral Sandpipers migrated through our area during August and early September, peaking in mid-August, when a minimum of 400 were counted. Migration was from west to east. Migrants rested and fed in the marsh and were only occasionally seen foraging along the coast. Phalaropes, both Red and Northern, were notably absent from coastal waters in August and September.

Beached bird surveys indicate a relatively low level of seabird mortality throughout the summer. Since red foxes scavenged carcasses from the beach, it may be difficult or impossible to document seasonal mortality patterns, unless these involved order of magnitude changes. Analyses of scats from fox dens, collected on a seasonal basis, may clarify this issue. Such information will be forthcoming in the next report.

V. Problems Encountered/Recommended Changes

The discovery of the shorebird roost has led to an interesting and important question: what is the turn-over rate of shorebirds using the mudflats? We do not know how long individual migrants remain in the Espenberg area. The fact that 7000 shorebirds were seen on the South Mudflats on 22 August is impressive. We wonder what percentage of the 4000 shorebirds seen there 8 days later were present on 22 August as well.

The turn-over rate of shorebirds at a migratory feeding station has definite implications with respect to OCS development. For example, if a very local area is affected by petroleum pollution at sub-lethal levels, then a brief stop may not be critical for migrating birds. However, an extended stay in such an area may be dangerous or lethal.

Scavenging activity of foxes along the beach has biased the results of the beached bird surveys. Seasonal scat collections at den sites may help to establish fox dependence on carcasses, seasonally.

VI. Literature Cited

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VII. Acknowledgements

We would like to thank Mr. George Mueller, Director of the Marine Sorting Center, University of Alaska, for assistance with the processing of the intertidal invertebrate samples. Ms. Nora Foster identified the molluscs and Mr. Ken Coyle identified the crustaceans from the samples. Both are associated with the Marine Sorting Center.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 27 R. U. #441

PRINCIPAL INVESTIGATOR: Dr. P. G. Mickelson

A draft Data Management Plan has been submitted for review by the Contract Data Manager. Once agreement on the batching of data has been reached; a schedule for submission of the batches will be forthcoming. Many of the data batches are ready for formating and submission.

TO: NOAA Environmental Research Laboratories, Boulder, Colorado; OCSEA Project Offices, Juneau and Fairbanks, Alaska.

FROM: Principal Investigator, William H. Drury
Organization: College of the Atlantic
Eden Street
Bar Harbor, Maine 04609
Report prepared by: William H. Drury
Benjamin Steele

SUBJECT: Quarterly report on work for 1976.
Contract: 03-6-022-35208 Task # 447
Period: October 1976 - 31 December 1976

TITLE: Studies of Populations, Community Structure and Ecology of Marine Birds at King Island, Bering Strait Region, Alaska.

I. Task Objectives

1. To determine the number and distribution of each species relative to other species, to periods of the breeding season, and to characteristics of available habitat within the colony or study area.
2. To provide estimates of nesting success of principal species.
3. To establish and describe sampling areas which may be utilized in subsequent years or by other persons for monitoring the status of populations.
4. To determine the amount and kinds of foods utilized by the principal species, and to describe daily foraging patterns when possible, to determine the relationship of food selected to that available.
5. To describe the chronology and phenology of events in the biology of breeding birds, including changes in population from the beginning of site occupation in the spring through departure in the fall.
6. To provide comparison of current data with recent historical data.

II. Activities

A. An aerial survey over the ocean was made on September 22. This flight covered approximately 190 miles in transects to and from King Island and Sledge Island. It was made in a double engine (one in front, one behind) Cessna Sky Master flying at about 100 feet and going approximately 100 mph air speed. Observers on both sides of the plane recorded species and numbers during transects of 5 minute duration.
The purpose of this flight was to compare the use of this plane with other methods of doing ocean transects, such as larger planes, helicopters, or ships. This plane is

cheaper and quicker than a ship and affords better visibility than some larger planes from which side vision is limited by the engines and landing gear. It also does not panic birds the way the noise of a helicopter does. We feel that as many birds can be seen from this plane as from a ship, especially if there are two observers on each side. The disadvantages are that there is very little time for species identification, for example between Thick-billed and Common Murres, and it is impossible to collect specimens.

B. Planning was begun for the 1977 field season, including requests for logistics and review of applications for employment. Six months reports have been sent to the King Island Village Corporation and letters have been sent to natives on Little Diomede asking about the possibility of doing bird work there.

III. Accounting

Full accounting for the field season has been submitted to the accounting office in Boulder, Colorado.

Quarterly Report

Contract #03-5-022-56
Research Unit #458
Task Order #28
Reporting Period 10/1 - 12/31/76
Number of Pages 3

AVAIN COMMUNITY ECOLOGY OF THE AKULIK - INGLUTALIK RIVER DELTA, NORTON BAY, ALASKA

Dr. Gerald F. Shields
and
Mr. Leonard J. Peyton
Institute of Arctic Biology
University of Alaska
Fairbanks, Alaska 99701

January 1, 1977

I. Task Objectives

This study will determine the relative importance of the Norton Bay area as breeding habitat for resident birds. Having made this determination, we hope to provide recommendations to lessen potential deleterious effects on this area by future oil development and concomitant human habitation.

II. Field Activities

No field activities have been conducted during this quarter

III. Laboratory Activities

The following data sets have been generated from summer field activities:

Data Batch I - Avifaunal Descriptions
- Breeding Birds

A. Nest Records

1) Numbers of breeding pairs/species/hectar

2) Numbers of nests/ species/ hectar

3) Numbers of eggs laid/ species/ nest

4) Numbers of eggs hatched/ species/ nest

5) Numbers of eggs hatched/ species/ hectar

6) Numbers of young fledged/ species/ hectar

B. Birds Banded

Breeding Birds

1) Numbers of nestlings banded/ species

2) Numbers of breeding adults banded/ species

3) Estimates of breeding - post breeding residence times have been completed for most birds based on both visual observations and capture - recapture of banded birds

C. Nonbreeding General

1) Chronological determinations of abundance of nonresident birds

2) Chronological determinations of nonbreeding birds

The following data sets have been incompletely generated:

Date Batch 4 Botanical communities

1) Species/ location/ ecotype

2) Species density/ hectar

Data Batch 5 Weather

1) Temperature, max-min./ day

2) Wind direction/ day

3) Wind vvelocity/day

4) Precipitation/ in/ day

5) Relative humidity/ day

The following data sets will not be completed until after the 1977 summer field season:

Data Batch 2 Avain Stomach Content Analysis

A) Predator Information

1) Collection location/ specimen

2) Size class/ specimen

3) Dry weight/ specimen

B) Food Information

1) Numbers of food items/ taxon/ specimens

Data Batch 3 Invertebrate Analysis

A) Numbers and dry weight/ taxa/ hectar

1) By sweep net sample

2) By rectangular grid sample

3) By pond dip net sample

IV. Results -- Schedule:

All complete data sets are itemized on IBM computer forms. Submission of data sets awaits negotitation of formats. We anticipate the inclusion of completed data batches I, III, IV and V in our annual report which will be submitted at the end of March 1977.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 28 R. U. #458

PRINCIPAL INVESTIGATORS: Dr. G. F. Shields and Mr. L. J. Peyton

A draft Data Management Plan has been submitted for review by the Contract Data Manager. Once agreement on the batching of data has been reached; a schedule for submission of the batches will be forthcoming. Many of the data batches are ready for formating and submission.

RU #460/461

A COMPARATIVE SEA-CLIFF BIRD INVENTORY OF THE CAPE THOMPSON VICINITY, ALASKA
(Contract 03-6-022-35210)

Quarterly Report
31 December, 1976

RENEWABLE RESOURCES CONSULTING SERVICES, Ltd.

Principal Investigators

David G. Roseneau
Alan M. Springer

I. Activities

No field activities occurred during this quarter. We attended an OCSEAP meeting in Anchorage on 20-22 October. Much of the information we obtained at this meeting will be useful in analysing our results.

Field data have been reduced and are being prepared for formatting and archiving. A meeting in Anchorage with Micheal Crane, EDS Liaison Officer, is planned for February. These data are also being interpreted and our primary efforts during late November and December have been directed towards the preparation of an annual report.

Stomach contents of murres and kittiwakes have been sorted and most identifications of food items are complete. The results of these analyses are presented in Table 1. This list does not include data obtained from late summer, and care should be taken in forming conclusions on the partial information presented here.

Photographs of the colonies have been developed and are being evaluated with regard to their usefulness as a a tool to help monitor the seabird populations at Cape Thompson in future years.

We are currently continuing the compilation and writing of our annual report. We are also currently preparing maps and data for the scheduled Beaufort/Chukchi Sea Synthesis Meeting at Pt. Barrow, 7-11 February 1977. As part of the preparation for this meeting, a preliminary meeting of local OCSEAP investigators was attended by us 17 December 1976 in Fairbanks. D. Roseneau will be assisting D. Schamel about 10 January 1977 in consolidating some of the mapped information.

II. Data analysed

A. Plot counts

B. Analysis of approximately 200 photographs

C. Identification of food items in stomach contents from 38 Thick-billed Murres, 13 Common Murres and 15 Black-legged Kittiwakes.

Table 1.

FOOD HABITS

	Thick-billed Murre		Common Murre		Black-legged Kittiwake	
	n	%	n	%	n	%
Total examined	38		13		15	
Empty	1	3	3	23	2	13
Frequency of invertebrates	31	84	4	40	8	62
Frequency of fish	28	76	7	70	8	62
FISH:						
Boreogadus saida	11	30	4	40	6	46
Myoxocephalus sp.	7	19				
Ammodytes hexapterus	1	3	2	20		
Pungitius pungitius					1	8
species A	3	8	3	30	2	15
species B	2	5	1	10	2	15
INVERTEBRATES:						
Polychaeta						
Nereis sp	7	19				
Mollusca						
Trochidae					1	8
unidentified	7	19			2	15
Crustacea						
Decapoda						
Pandalus goniurus	6	16			1	8
P. montagui	3	8				
P. sp.	1	3			1	8
Enalus gaimardi	5	13			1	8
"shrimp"	6	16	1	10		
unident. crab	5	13				
unident. crustacean	17	46			1	8
Isopoda						
Saduria entomon					1	8
Amphipoda						
Gammaridea	2	5	2	20		
unidentified	2	5	1	10		
Insecta						
Coleoptera (terrestrial)					1	8
Algae	2	8				
Pebbles	14	38	1	10		

QUARTERLY REPORT

RESEARCH UNIT 470
CONTRACT 03-6-022-35192
QUARTERLY ENDING 31 December 1976

THE ECOLOGY OF BREEDING SEABIRDS AT KONGKOK BAY, ST. LAWRENCE ISLAND

GARY F. SEARING

LGL LIMITED
Environmental Research Associates
EDMONTON, ALBERTA

10 December 1976

OBJECTIVES

The primary objectives of the present study are to document

A. the phenology of the breeding season of seabirds at Kongkok Bay with major emphasis on the following

1) arrival of birds in the St. Lawrence Island area,
2) arrival of birds on the cliffs and talus slopes,
3) initiation and peak of laying,
4) initiation and peak of hatching, and
5) initiation and peak of fledging;

B. the numbers of birds in the Kongkok Bay area;

C. the reproductive success of

1) Least and Crested Auklets,
2) Common and Thick-billed Murres, and
3) Black-legged Kittiwakes; and

D. the food habitats and feeding areas of

1) Least and Crested Auklets, and
2) Common and Thick-billed Murres.

Secondary objectives of this study are to document

A. the relation of auklet density to the physical features of their habitat; and

B. the rates and patterns of growth of Least and Crested Auklet chicks.

ACTIVITIES

An annual report is in preparation.

RESULTS AND PRELIMINARY CONCLUSIONS

The timing of the 1976 breeding season was later than average for most of the species that were studied. Table 1 compares the phenology of the 1976 breeding season of species for which comparative information is available with the phenology of these species during earlier years. Large fluctuations in the timing of events during the breeding season is characteristic of birds that breed in arctic areas. The fact that nearly all species of seabirds at Kongkok Bay bred late during 1976 indicates that climatic factors (i.e., prolonged snow-cover on the breeding cliffs) were the probable cause of the retarded season during 1976.

During the last decade, large changes have occurred in the number of seabirds that occupy the cliffs and talus slopes at Kongkok Bay. The numbers of auklets in Kongkok Basin increased 59% from 1966 to 1976. Most of this increase was the result of a 95% increase in the numbers of Least Auklets (to 336,000) whereas Crested Auklets increased by only 18% (to 173,000). The numbers of Common and Thick-billed Murres and Black-legged Kittiwakes that nested at Kongkok Bay during 1976 were substantially lower than the numbers that nested there during 1972. Murres showed a four-fold decrease in numbers from approximately 60,000 in 1972 to about 15,000 in 1976. The number of kittiwakes that were observed during 1976 was only 12.5% of the number that was present at Kongkok Bay during 1972. Rather

TABLE 1. Summary of Phenology of the Breeding Season of Seabirds at Kongkok Bay during 1976 and Relation to "Normal" Breeding Chronology.

Event and Species	CHRONOLOGY Normal	CHRONOLOGY 1976	COMMENTS
Arrival in St. Lawrence Island Area			
Least Auklets	15-21 May	?	Normal?
Crested Auklets	15-20 May	21 May	Slightly late
Murres	late April	earlier than 14 May	Late?
Black-legged Kittiwakes	29 April-11 May	16 May	Late
Parakeet Auklets	15-20 May	17 May	Normal
Tufted Puffins	early May-4 June	17 May	Normal
Horned Puffins	5-28 May	25 May	Slightly late
Arrival on Cliffs			
Least Auklets	20-24 May	29 May	Late
Crested Auklets	18-24 May	29 May	Late
Murres	?	28 May	Late?
Black-legged Kittiwakes	?	27 May	Normal?
Parakeet Auklets	19-24 May	27 May	Late
Initiation of Laying			
Least Auklets	12-28 June	1 July	Normal or Late
Crested Auklets	14-30 June	1 July	Late
Murres	early to late June	28 June	Slightly late?
Black-legged Kittiwakes	late June	29 June	Normal
Initiation of Hatching			
Least Auklets	15-30 July	25 July	Normal
Crested Auklets	19 July-2 August	2 August	Slightly late
Murres	30 July	31 July	Slightly late

TABLE 1. (Cont'd)

Event and Species	CHRONOLOGY		Comments
	Normal	1976	
Initiation of Fledging			
Least Auklets	15-28 August	24 August	Normal
Crested Auklets	26 August-5 September	later than 3 September	Slightly late?
Murres	18 August	21 August	Late

than being caused by an actual population decline, the lower numbers of murres and kittiwakes on the nesting ledges may have been caused by birds that failed to breed due to the late season. The numbers of seven other species of seabirds that nested at Kongkok Bay were also estimated; however, the lack of comparative estimates from previous years did not permit me to determine whether their numbers had increased or decreased.

Table 2 presents the estimates of seabird populations at Kongkok Bay during 1976; these estimates are summarized in relation to estimates from other years and at other colonies on St. Lawrence Island.

The density of Least Auklets was found to be correlated with the angle of slope of the talus, the distance from the edge of the talus, the depth of scree, the sphericity of the talus boulders and the number of Crested Auklets. The density of Crested Auklets was correlated with the degree to which the talus slope faced the bay, the depth of scree and the size (volume and diameter) of the talus boulders. Most (77% to 89%) of the variance in the density of auklets was accounted for by the above mentioned physical features of the nesting habitats.

Basic data were obtained on the breeding success of Least and Crested Auklets, Common and Thick-billed Murres, and Black-legged Kittiwakes and on the growth rates of Least and Crested Auklets in order to provide baseline data for comparison of the breeding effort of seabirds on St. Lawrence Island during 1976 with the breeding effort of other years and of other areas. Least Auklets hatched 48.6% of their eggs whereas Crested

TABLE 2. Summary of Nesting Seabird Populations on St. Lawrence Island, Alaska.

Species	Location	YEAR			
		±1957[1]	±1966[2]	1972[3]	1976[4]
Pelagic Cormorant	Owalit Mountain			300	300
Glaucous Gull	Boxer Bay	50			
	Owalit Mountain				24-30
Herring Gull	Koozata Lagoon	100			
	Ivekan Mountain				2-4
Black-legged Kittiwake	Owalit Mountain			2000[5]	1700-1900
Murres	St. Lawrence Island	100,000			
	Owalit Mountain			60,000	16,000
Pigeon Guillemot	Owalit Mountain				150
Parakeet Auklet	Sevuokok Mountain	Few	2000		
	Kaghkusalik Point	Few			
	Savoonga	Very Few			
	Singikpo Cape	Many			
	Tatik Point-Boxer Bay	Many			
	Owalit Mountain				1200-1800
Crested Auklet	Ivekan Mountain-Kongkok Bay	500,000	185,000		173,000 (Kongkok Basin Only)
	Reindeer Camp		37,000		
	Ataakas-Kookoolik		185,000		
	Savoonga		34,000		
	Kinoegkit		8,000		
	Sevuokok Mountain		72,000		
	Owalit Mountain SW		5,000		
	Owalit Mountain SE				3,000
	Tupurpuk and Sitiilekk		40,000		
	Powooiliak		8,000		

TABLE 2. (Cont'd)

Species	Location	YEAR			
		±1957[1]	±1966[2]	1972[3]	1976[4]
Least Auklet	Sevuokok Mounatin	100,000's	111,000		
	Kongkok Basin	500,000	189,000		336,000
	Tatik Point-Boxer Bay	500,000 (does not include Kongkok Basin)	25,000		
	Reindeer Camp		20,000		
	Ataakas-Kookoolik		128,000		
	Savoonga		51,000		
	Kineeghut		14,000		
	Owalit Mountain SW		8,000		
	Owalit Mountain SE				17,000
	Tupurpuk & Sitiilekk		75,000		
	Powooiliak		14,000		
Horned Puffin	Murphy Bay	1000-2000			
	Sevuokok Mountain		1,500		
	Owalit Mountain				600
	Punuk Islands		None		
Tufted Puffin	Punuk Islands	"large populations"	"honey-combed with burrows"		
	Sevuokok Mountain	None	500		
	Tatik Point-Powooiliak	"locally common"			
	Owalit Mountain				750

[1] Fay and Cade 1959.

[2] Bedard 1969; Sealy and Bedard 1973; Thompson 1967; Sealy 1973

[3] Johnson pers. comm.

[4] Present study.

[5] Kittiwakes counted on less than 1/3 of Owalit Mountain.

Auklets hatched only 30.6% of their eggs. The growth rates of Least and Crested Auklet chicks were not significantly different from each other--Least Auklets gained up to 3.7 gm/day (4.1% of adult weight), Crested Auklets gained up to 8.9 gms/day (3.3% of adult weight). The breeding success of murres (from egg to fledged chick) was 60.6%. Only 4% of the Black-legged Kittiwake nests contained eggs. The nesting failure of kittiwakes during 1976 was apparently widespread throughout the Bering and Chukchi Seas.

QUARTERLY REPORT

Contract: 01-6-022-15670
Research Unit: RU-488
Reporting Period: October 1, 1976 to December 31, 1976
Number of Pages: i + 2

CHARACTERIZATION OF COASTAL HABITAT FOR MIGRATORY BIRDS: NORTHERN BERING SEA

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and

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Co-principal Investigators

and

Matthew Kirchhoff

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January 1, 1977

CHARACTERIZATION OF COASTAL HABITAT FOR MIGRATORY BIRDS:

NORTHERN BERING SEA

INTRODUCTION

This project was initiated during the current reporting period and is an extension of work being conducted as part of Research Unit 3/4 in the Southern Bering and Chukchi Seas under the direction of Paul Arneson and George Divoky, Alaska Department of Fish and Game. The area covered by this study extends from Cape Newenham to the Bering Straits and relates most directly to proposed developments in Norton Sound.

The objective of the study is to characterize coastal habitat and its use by marine birds, and to identify habitats which may be considered unique or of critical importance to individual species.

METHODS

Methods utilized for this study are similar to those described by Arneson in his annual report (April 1976) for RU 3/4. The study will depend substantially on the review and analysis of existing published and unpublished information and on the results of ongoing studies within the region by the Fish and Wildlife Service as well as other OCSEAP Research Units as described in the quarterly report for the period of 1 July to 30 September, 1976.

ACTIVITIES AND ACCOMPLISHMENTS

Primary effort during the present quarter was devoted to the collection, collation, and preliminary mapping of existing data. This work has not proceeded as rapidly as anticipated, but will be completed during the following quarter. Much of the data available from earlier studies requires transformation or reanalysis to meet the more specific needs of the current study.

A NASA ERTS Photo of 29 May 1975 was obtained which spectacularly illustrates flooding associated with the spring breakup of ice on the lower Yukon River. The extensive flooding during spring is a major factor in the ecology of the region, and under differing circumstances, may be of substantial importance in either reducing or extending the potential impact from pollution which may accompany the development of petroleum resources in Norton Sound.

A field report on studies conducted on the Yukon Delta by R. D. Jones and Matthew Kircchoff was completed. Major results and conclusions are summarized in the abstract (Appendix A).

APPENDIX A

Jones, R. D., Jr., and M. Kirchhoff. 1976. Waterfowl habitat on the Yukon Delta. U. S. Fish Wildl. Serv., Off. Biol. Serv., Coastal Ecosystems, Anchorage, Alaska. Field Rept. 76-074. Unpubl. admin. rept. 17 p. + 1 map + 8 p. appendix. Typewritten.

Abstract:--The Yukon Delta is a homogeneous deposit of water-borne silt lying absolutely flat as a classic alluvial fan. It probably remains permanently frozen, without which we think it would present a different configuration. The ecosystem exhibits restricted diversity, though high productivity. Decomposition is markedly retarded.

Vegetative cover consists of dense willow stands on the one hand, and open *Carex* meadows on the other. The ecosystem is strictly dominated by fresh water. We found no evidence of the influence of salt water, but this must be confirmed. We found no dry ground. Recurrent floods, resulting from "ice jams" in the spring thaw and "storm tides" in summer and fall produce a hydric habitat. Microtine rodents and tundra hares are abundant; red foxes and grizzly bears are present but not abundant. Pintail ducks are very abundant in summer and the commonest bird on the Delta. Shovelers and green-winged teal are less abundant, though common. Lesser Canada geese are common and abundant. White-fronted geese are common but not abundant, and emperor geese are present but neither common nor abundant. We observed one pair of black brant with a brood of four goslings. All the above listed waterfowl were reporducing on the Delta. Reproducing shorebirds that are abundant include bar-tailed godwits, long-billed dowitchers, dunlins, semi-palmated sandpipers, northern phalaropes, and common snipe. Sandhill cranes were abundant, and very productive in 1976.

RECEPTORS (BIOTA)

MICROBIOLOGY

RECEPTORS (BIOTA)

MICROBIOLOGY

Quarterly Report

Contract # 03-5-022-85
Research Unit 29
Period 10/1 - 12/31

Assessment of Potential Interactions of Microorganisms and Pollutants Resulting from Petroleum Development on the Outer Continental Shelf in the Beaufort Sea

Submitted by: Ronald M. Atlas
Principal Investigator
Department of Biology
University of Louisville
Louisville, Kentucky 40208

December 31. 1976

I. Task Objectives:

A. To characterize marine microbiological communities in sufficient detail to establish a baseline description of microbiological community characteristics on a seasonal basis;

B. To determine the role of microorganisms in the biodegradation of petroleum hydrocarbons.

II. Field and Laboratory Activities

A. Field Schedule

No field activities were scheduled during this quarter.

B. Laboratory Activities

Testing of 400 microorganisms isolated from summer *Glacier* sampling for numerical tanxonomic analysis was carried out. Data from Winter 1976 sampling was transferred to NIH for analysis and retrieval by NODC.

III. Results

A. Enumeration of Microorganisms - Summer *Glacier* cruise.

Table I shows the sample numbers and approximate collection locations for the summer *Glacier* cruise. We are still awaiting an official report from the Chief Scientist on the sampling locations, depths, salinities and temperatures of the samples collected. Table II shows the enumeration of various groups of microorganisms. Enumeration procedures have been described in previous reports.

B. Hydrocarbon Biodegradation Potential

Table III shows the $^{14}CO_2$ produced from radiolabelled hexadecane and pristane spiked crude oil, in counts per minute, during 5 weeks incubation at 5 C. Procedures for determining hydrocarbon biodegradation potential have been described in previous reports. The higher the counts the greater the biodegradation potential. High biodegradation potentials were found in surface water in the middle of the Colville River sampling area and in sediment in Elson Lagoon, near Prudhoe Bay and east of the Colville River.

C. Description of Data Files Established at NIH
and
Status of Analysis

File 100188 - Contains numeric information on samples collected in the Beaufort Sea during the summer of 1975 and winter of 1976 (also includes numeric information on Gulf of Alaska samples collected during this period). Numeric information includes: geographic locations of sample collections; temperatures; salinities; depths; concentrations of nitrate, ammonium and phosphate ions; enumerations of microorganisms by direct count and indirect counts as heterotrophs at 4 and 20 C, "Vibrio" at 4 and 20 C, and oil utilizers at 4 and 20 C. Samples include ice, water and sediment from near Barrow, Alaska including Elson Lagoon, the Chukchi-Beaufort Sea interface and from transects off Pt. Barrow, Pitt Pt. and from within and a transect off Prudhoe Bay.

Programs should be available shortly to generate three-dimensional graphic representations of the distribution of microorganisms in this region.

File 100191 - Contains desriptive data on 314 heterotrophic microorganisms isolated at random from plates incubated at 20 C from ice, water and sediment samples collected during summer 1975. Descriptive data on each isolated organism includes source of isolation and nutritional, enzymatic, physiological and morphological information. Approximately 400 total characteristic features are recorded for each organism.

Cluster analyses have been run on the complete file of this data. Frequency of features have been determined by location and type of sample and by dominant groups of microorganisms shown by cluster analysis.

File 100192 - Contains descriptive data on 331 heterotrophic microorganisms isolated at random from plates incubated at 4 C from ice, water and sediment samples collected during summer 1975. Descriptive data includes source of isolation and nutritional, enzymatic, physiological and morphological information. Approximately 400 total characteristic features are recorded for each organism.

Cluster analyses have been run on the complete file of this data. Cluster analyses have also been run on merged 100191 and 100192 files by sampling location. Frequency of features has been determined by location and type of sample and by dominant groups of microorganisms shown by cluster analysis.

File 100185 - Contains descriptive data on 390 heterotrophic microorganisms isolated at random from plates incubated at 4 C from ice, water and sediment samples collected during the winter of 1976. Descriptive data on each organisms includes source of isolation, and nutritional, enzymatic, physiological and morphological information. Approximately 300 characteristic features are recorded for each organism.

Cluster analyses have been run on the complete file of this data. Frequency of features has been determined by location and type of sample.

File 100186 - Contains descriptive data on 341 heterotrophic microorganisms isolated at random from plates incubated at 20 C from ice, water and sediment samples collected during the winter of 1976. Descriptive data on each organism includes source of isolation, and nutritional, enzymatic, physiological and morphological information. Approximately 300 characteristic features are recorded for each organism.

Cluster analyses have been run on the complete file of this data. Frequency of features has been determined by location and type of sample.

File 100189 - Contains descriptive information on 200 microorganisms isolated from oil agar plates incubated at 4 and 20 C from the summer of 1975 sampling in both the Beaufort Sea and the Gulf of Alaska. Descriptive data on each organism inlcudes source of isolation, several physiological and morphological features and tests on the ability to utilize representative hydrocarbons found in crude oil. Approximately 100 features are recorded for each organism.

IV. Interpretation of Results

No new interpretation of analyses were made during this period.

V. Problems Encountered

None.

VI. Estimate of Funds

It is estimated that 25% of this year's funds were expended as of December 31, 1976.

Table I

	Sample#	Station	Latitude(N)	Longitude(W)	Depth(m)	Region	Horner Map#
	BW 201	74	70°36'	148°12	1	Prudhoe Bay transect	15
	BW 202	74	70°36'	148°12	1	Prudhoe Bay transect	15
	Bw 203	80	70°32'	147°33'	1	Prudhoe Bay transect	17
	BW 204	81	70°39'	147°37'	1	Prudhoe Bay transect	18
	BW 205	41	70°50'	149°00'	1	Colville River area E.	19A
	BW 206	42	70°57'	149°33'	1	Colville River area	19B
	BW 207	31	71°08'	151°19'	1	Colville River area W.	20
W	BW 208	24	71°43'	151°47'	1	Pitt Pt. transect	21
A	BW 209	24	71°43'	151°47'	15	Pitt Pt. transect	21
T	BW 210	23	71°33'	152°03'	1	Pitt Pt. transect	22
E	BW 211	23	71°33'	152°03'	15	Pitt Pt. transect	22
R	BW 212	22	71°22'	152°20'	1	Pitt Pt. transect	23
	BW 213	22	71°22'	152°20'	15	Pitt Pt. transect	23
	BW 214	21	71°19'	152°32'	1	Pitt Pt. transect	24
	BW 215	20	71°08'	152°57'	1	Pitt Pt. transect	25
	BW 216	16	71°23'	154°21'	1	Pt. Barrow transect	26
	BW 217	15a	71°36'	155°32'	1	Pt. Barrow transect	27
	BW 218	15a	71°36'	155°32'	15	Pt. Barrow transect	27
	BW 219	1	71°21'	156°32'	1	Elson Lagoon	-
	BW 220	2	71°21'	156°26'	1	Elson Lagoon	-
	BB 201	74	70°36'	148°12'	16	Prudhoe Bay transect	15
	BB 203	80	70°32'	147°33'	25	Prudhoe Bay transect	17
	BB 204	81	70°39'	147°37'	25	Prudhoe Bay transect	18
S	BB 205	41	70°50'	149°00'	30	Colville River area E.	19A
E	BB 206	42	70°57'	149°33'	30	Colville River area	19B
D	BB 207	31	71°08'	151°19'	34	Colville River area W.	20
I	BB 208	24	71°43'	151°47'	1700	Pitt Pt. transect	21
M	BB 212	22	71°22'	152°20'	74	Pitt Pt. transect	23
E	BB 214	21	71°19'	152°32'	52	Pitt Pt. transect	24
N	BB 215	20	71°08'	152°57'	40	Pitt Pt. transect	25
T	BB 216	16	71°23'	154°21'	22	Pt. Barrow transect	26
	BB 219	1	71°21'	156°32'	2	Elson Lagoon	-
	BB 220	2	71°21'	156°26'	2	Elson Lagoon	-
	BB 217	15a	71°36'	155°32'	171	Pt. Barrow transect	27

Table II

	Sample#	Direct Count	4 C Heterotrophs Marine Agar	4 C "Vibrio" TCBS	4 C Fungi	4 C Oil Utilizers	20 C Heterotrophs Marine Agar	20 C "Vibrio" TCBS	20 C Fungi	20 C Oil Utilizers
	BW 201	9.3E5	3.7E4	0.34	-	-	1.3E4	19.0	-	-
	BW 202	6.0E5	3.2E4	0.69		7.0E0	4.8E4	2.6	-	3.3E1
	BW 203	4.5E5	2.4E4	0.28	-	1.0E3	1.3E4	0.5	-	4.5E1
	BW 204	2.6E5	1.8E5	0.27	-	1.5E2	2.2E4	4.2	-	7.3E0
	BW 205	3.4E5	2.6E4	0.20	-	2.1E3	1.7E4	44.0	-	1.7E1
	BW 206	4.0E5	7.2E4	0.16	-	5.0E2	8.8E4	0.2	-	-
	BW 207	2.1E6	2.1E4	0.12	-	2.7E1	2.1E4	0.06	-	4.2E0
W	BW 208	3.7E5	3.6E4	0.91	-	1.1E3	1.3E4	0.6	-	2.0E0
A	BW 209	4.5E5	3.7E3	5.9	-	2.0E1	4,4E3	0.6	-	0.7E0
T	BW 210	4.2E5	1.2E5	0.55	-	3.1E0	2.4E4	5.0	-	-
E	BW 211	2.6E5	1.9E3	1.4	-	1.5E0	8.8E7	27.0	-	0.3E0
R	BW 212	6.5E5	1.0E5	8.0	-	6.2E0	2.0E4	5.1	-	1.1E0
	BW 213	5.7E5	9.2E3	5.3	-	3.3E0	6.6E4	0.4	-	1.7E0
	BW 214	5.3E5	7.7E4	2.1	-	5.2E0	4.4E4	0.5	-	4.2E0
	BW 215	3.1E5	2.2E4	3.0	-	3.9E0	1.5E4	0.1	-	2.0E0
	BW 216	3.2E5	8.7E4	2.6	-	2.5E0	3.4E4	4.8	-	0.2E0
	BW 217	2.8E5	1.2E5	3.9	-	0.6E0	1.4E3	0.1	-	0.1E0
	BW 218	6.0E5	8.7E3	7.0	-	1.8E0	4.4E2	0.2	-	0.2E0
	BW 219	2.9E5	1.7E4	14.0	-	3.7E0	4.8E4	4.0	-	1.9E0
	BW 220	3.1E5	1.0E4	20.0	-	-	4.6E4	3.0	-	0.2E0
	BB 201	1.6E9	1.6E6	4.6E4	4.4E5	4.0E4	2.2E6	4.9E3	2.3E5	4.6E3
	BB 203	2.6E9	3.1E6	1.0E5	6.3E5	2.1E4	2.7E6	1.1E4	5.9E4	7.5E3
	BB 204	1.9E9	3.2E6	-	1.6E5	4.7E4	2.6E5	3.3E3	8.9E4	4.6E3
S	BB 205	1.1E9	2.1E6	9.6E4	4.4E5	4.2E4	2.6E5	3.5E3	3.8E4	7.4E3
E	BB 206	1.9E9	1.5E6	8.7E4	4.3E5	4.4E4	3.1E6	3.9E3	7.6E5	-
D	BB 207	1.6E9	6.2E6	1.8E5	2.7E5	5.5E3	2.6E6	9.8E4	2.0E5	-
I	BB 208	1.9E9	3.5E4	3.5E3	1.3E4	1.5E3	1.5E5	1.1E2	8.2E2	2.9E3
M	BB 212	1.5E9	1.2E7	-	-	4.5E3	1.5E6	2.3E4	1.4E4	-
E	BB 214	1.0E9	5.5E6	-	-	2.6E3	2.9E5	2.6E4	5.1E4	1.9E3
N	BB 215	1.1E9	1.2E7	2.1E5	2.1E5	1.6E3	1.5E6	3.6E4	2.7E5	5.1E3
T	BB 216	3.6E9	4.5E7	-	1.6E5	1.7E3	1.9E7	1.2E4	2.5E4	4.1E2
	BB 217	-	-	-	-	-	1.9E5	3.5E2	9.2E2	2.6E2
	BB 219	6.9E9	2.5E6	2.0E4	-	1.5E3	1.1E8	1.5E4	1.1E6	5.4E3
	BB 220	7.6E8	1.7E7	2.1E4	4.0E5	3.0E3	5.3E6	9.0E1	8.3E4	8.1E2

Table III

Hydrocarbon Biodegradation Potential

CPM $^{14}CO_2$ produced from hexadecane/pristane spiked Prudhoe crude oil during 5 weeks incubation at 5 C.

	Sample #	CPM
	BW 201	24
	BW 202	150
	BW 203	22
	BW 204	48
	BW 205	7
	BW 206	430
	BW 207	30
W	BW 208	29
A	BW 209	12
T	BW 210	35
E	BW 211	20
R	BW 212	50
	BW 213	22
	BW 214	27
	BW 215	43
	BW 216	60
	BW 217	62
	BW 218	0
	BW 219	15
	BW 220	15
	BB 201	35
	BB 203	150
	BB 204	420
S	BB 205	270
E	BB 206	28
D	BB 207	15
I	BB 208	41
M	BB 212	5
E	BB 214	58
N	BB 215	63
T	BB 216	70
	BB 217	-
	BB 219	85
	BB 220	165

Quarterly Report

Contract # 03-6-022-35109
Research Unit 30
Period 10/1 - 12/31

Assessment of Potential Interactions of Microorganisms and Pollutants Resulting from Petroleum Development in Cook Inlet

Submitted by: Ronald M. Atlas
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December 31, 1976

I. Task Objectives

A. To characterize marine microbiological communities in sufficient detail to establish a baseline description of microbiological community characteristics on a seasonal basis;

B. To determine the role of microorganisms in the biodegradation of petroleum hydrocarbons.

II. Field and Laboratory Activities

A. Field Schedule

Samples were collected in Cook Inlet during October on a cruise of the *Miller Freeman*. The sampling party was Dr. and Mrs. Tatsuo Kaneko. A total of 21 water and 13 sediment samples were collected. Eight of the samples were collected from intertidal areas.

B. Laboratory Activities

Microorganisms from the samples collected were enumerated according to procedures described in previous reports. Data from Winter 1976 samplings in northeast Gulf of Alaska was transfered to NIH for analysis and retrieval by NODC.

III. Results

A. Enumeration of Microorganisms

Table I shows the sample numbers and collection locations from the October *Miller Freeman* cruise, along with the depths, salinities and temperatures of the samples collected. Table II shows the numbers of various groups of microorganisms enumerated from the samples.

B. Hydrocarbon Biodegradation Potential

Table III shows the $^{14}CO_2$ produced from radiolabelled hexadecane and pristane spiked crude oil, in counts per minute during three weeks of incubation at 5 C. Procedures for determining hydrocarbon biodegradation potentials have been described in previous reports. The higher the counts, the greater the biodegradation potential. The highest biodegradation potential was generally found in samples collected from intertidal areas.

C. Desription of Data Files Established at NIH

and

Status of Analysis

File 100188 - Contains numeric information on samples collected in the northwest Gulf of Alaska during summer 1975 and northeast Gulf of Alaska during winter 1976 (also contains numeric information on samples collected in the Beaufort Sea during this period). Numeric information includes: geographic locations of sample collections; temperatures; salinities; depths; concentrations of nitrate, ammoinium and phosphate ions; enumerations of microorganisms by direct count and indirect counts as heterotrophs at 4 and 20 C, "Vibrio" at 4 and 20, and oil utilizers at 4 and 20 C. Water, sediment and beach samples are included.

Programs should be available shortly to generate three-dimensional grpahic representations of the distribution of microorganisms in this region.

File 100189 - Contains descriptive information on 200 microorganisms isolated from oil agar plates incubated at 4 and 20 C from the summer of 1975 sampling in both the Beaufort Sea and the Gulf of Alaska. Descriptive data on each organism includes source of isolation, several physiological and morphological features and tests on the ability to utilize representative hydrocarbons found in crude oil. Approximately 100 features are recorded for each organism.

File 100190 - Contains descriptive information on 247 heterotrophic microorganisms isolated at random from plates incubated at 4 and 20 C from sediment and water samples collected in northwest Gulf of Alaska during late summer of 1975. Descriptive data on each organism includes source of isolation, and nutritional, enzymatic, physiological and morphological information. Approximately 400 characteristic features are recorded for each organism.

Cluster analyses have been run on the complete file of this data. Frequency of features has been determined by location and type of sample and by dominant groups of microorganisms as shown by the cluster analysis.

File 100212 - Contains descriptive data on 587 heterotrophic microorganisms isolated at random from plates incubated at 4 C from sediment, water and beach samples collected during the winter of 1976 in the northwest Gulf of Alaska. Descriptive data on each organism includes source of isolation, and nutritional, enzymatic, physiological and morphological information. Approximately 300 characteristic features are recorded for each organism.

Cluster analyses have been run on the complete file of this data. Frequency of features has been determined by location and type of sample.

File 100213 - Contains descriptive data on 567 heterotrophic micro-organisms isolated at random from plates incubated at 20 C from sediment, water and beach samples collected during the winter of 1976 in the north-east Gulf of Alaska. Descriptive data on each organism includes source of isolation, and nutritional, enzymatic, physiological and morphological information. Approximately 300 characteristic features are recorded for each organism.

Cluster analyses have been run on the complete file of this data. Frequency of features has been determined by location and type of sample.

IV. Interpretation of Results

No new interpretation of analyses was made during this period.

V. Problems Encountered

None.

VI. Estimate of Funds

It is estimated that 25% of this year's funds were expended as of December 31, 1976.

Table I

	Sample#	Station	Latitude (N)	Longitude (W)	Depth (m)	Temp. (C)	Salinity ($^o/oo$)	
	GW 301	205	59°06'	152°47'	1	9.0	27.5	
	GW 302	216	59°20'	152°12'	1	9.5	27.0	
	GW 303	215	59°20'	152°44'	1	9.5	27.0	
	GW 304	212	59°33'	153°24'	1	8.4	25.0	
	GW 308	M	59°44'	153°21'	0	6.5	22.0	beach
	GW 309	I	59°22'	153°59'	0	12.0	21.0	beach
	GW 310	I	59°22'	153°59'	0	12.0	20.5	beach
	GW 311	204	59°15'	153°40'	1	5.5	28.0	low tide
W	GW 312	225	59°38'	152°33'	1	9.5	26.2	
A	GW 313	229	59°42'	151°09'	1	8.5	24.0	
T	GW 315	J	59°35'	151°11'	0	9.5	24.0	beach
E	GW 317	K	59°36'	151°25'	0	12.0	23.0	beach
R	GW 318	227	59°34'	151°44'	1	9.5	27.0	
	GW 319	226	59°33'	152°09'	1	9.5	27.0	
	GW 320	245	60°00'	152°10'	1	9.0	26.0	
	GW 322	266	60°40'	151°26'	1	8.5	21.0	
	GW 323	265	60°31'	151°50'	1	9.0	19.5	
	GW 325	L	59°50'	153°16'	0	6.0	17.0	beach
	GW 327	214	59°21'	153°15'	1	9.0	26.0	
	GW 329	204	59°15'	153°40'	1	9.5	25.0	high tide
	GW 335	105	58°46'	151°10'	1	9.0	25.5	
	GB 301	205	59°06'	152°47'	148	8.5	-	
	GB 303	215	59°20'	152°44'	73	10.0	27.0	
S	GB 304	212	59°33'	153°24'	28	8.4	26.0	
E	GB 308	M	59°44'	153°21'	0	6.5	-	beach
D	GB 311	204	59°15'	153°40'	31	9.1	23.2	low tide
I	GB 312	225	59°38'	152°33'	75	10.0	26.0	
M	GB 313	229	59°42'	151°09'	28	9.3	26.0	
E	GB 318	227	59°34'	151°44'	88	9.5	28.0	
N	GB 319	226	59°33'	152°09'	45	9.5	28.0	
T	GB 325	L	59°50'	153°16'	0	6.0	-	beach
	GB 327	214	59°21'	153°15'	44	9.0	26.0	
	GB 329	204	59°15'	153°40'	34	9.8	26.5	high tide
	GB 335	105	58°46'	151°10'	120	7.5	28.0	

Table II

	Sample#	Direct Count	4 C: Heterotrophs Marine Agar	4 C: "Vibrio" TCBS	4 C: Fungi	4 C: Oil Utilizers	20 C: Heterotrophs Marine Agar	20 C: "Vibrio" TCBS	20 C: Fungi	20 C: Oil Utilizers
	GW 301	2.7E5	1.2E1	1.4E0	-	7.0E-1	6.1E1	4.5E0	-	1.6E0
	GW 302	4.3E5	3.3E1	3.0E0	-	3.0E-1	6.3E1	1.0E1	-	1.1E0
	GW 303	1.7E5	1.0E1	2.0E0	-	2.1E0	4.0E1	5.0E0	-	2.4E-1
	GW 304	1.5E5	9.0E1	4.0E0	-	5.2E0	2.1E2	1.0E0	-	5.6E0
	GW 308	1.7E5	1.0E4	1.2E2	-	1.6E2	3.1E4	6.7E1	-	7.4E2
	GW 309	1.9E5	4.2E3	1.6E2	-	7.1E1	5.7E3	7.0E1	-	8.3E1
	GW 310	2.1E5	1.1E4	2.4E2	-	1.1E2	1.1E4	1.0E2	-	2.9E2
	GW 311	3.8E5	1.6E2	2.0E1	-	1.7E0	4.2E2	1.5E1	-	5.1E1
W	GW 312	2.5E5	5.0E0	3.0E0	-	3.5E-1	3.3E1	1.0E1	-	1.2E-1
A	GW 313	2.2E5	2.0E2	4.7E0	-	3.1E0	5.0E2	1.4E1	-	2.3E1
T	GW 315	2.3E5	1.0E3	7.0E0	-	2.9E0	4.3E3	5.0E1	-	3.9E1
E	GW 317	4.4E5	1.1E5	1.3E3	-	6.8E2	9.7E4	1.0E3	-	5.2E2
R	GW 318	2.6E5	7.7E1	6.0E0	-	1.9E0	8.3E1	1.0E1	-	-
	GW 319	6.2E4	9.3E1	1.5E1	-	1.1E2	1.1E2	1.4E1	-	4.0E-1
	GW 320	2.2E5	1.1E2	9.0E1	-	5.0E-1	2.1E2	6.0E0	-	-
	GW 322	1.1E6	2.2E2	8.0E1	-	7.0E-2	3.3E3	5.0E1	-	3.2E0
	GW 323	1.5E5	6.1E2	3.7E1	-	2.8E-1	9.3E2	9.0E0	-	2.2E-1
	GW 325	1.1E6	2.9E4	1.7E3	-	6.5E1	5.6E4	1.5E2	-	2.1E1
	GW 327	2.6E5	1.1E2	3.0E0	-	2.8E-1	1.7E2	1.0E1	-	2.5E-1
	GW 329	1.2E7	4.7E2	7.0E0	-	-	5.7E2	1.0E1	-	-
	GW 335	1.9E5	3.0E1	6.0E0	-	-	4.0E1	2.0E1	-	-
	GB 301	5.0E8	8.9E5	7.4E4	4.2E4	1.4E2	4.6E5	2.3E4	1.8E4	2.7E3
	GB 303	5.4E8	8.7E5	7.4E4	2.3E4	2.9E3	1.2E6	3.0E4	1.4E4	3.7E4
S	GB 304	1.1E9	2.6E6	6.3E4	2.1E4	2.6E4	1.1E7	1.7E4	1.7E4	2.2E4
E	GB 308	6.1E8	1.7E7	3.5E4	2.3E4	3.3E3	2.1E7	1.1E4	3.5E6	3.3E4
D	GB 311	2.6E9	2.3E6	1.2E4	3.7E4	5.0E2	2.0E6	2.1E4	2.1E4	1.0E4
I	GB 312	-	2.9E4	2.7E3	6.8E1	6.8E1	4.1E4	1.4E3	1.2E3	4.7E2
M	GB 313	2.9E9	6.0E6	1.5E5	1.1E5	5.4E2	2.2E7	7.3E3	1.4E5	5.2E2
E	GB 318	8.4E8	6.9E6	6.7E4	3.1E4	3.9E2	6.0E6	2.5E4	1.8E4	1.9E4
N	GB 319	3.7E8	1.0E4	8.6E2	6.7E2	6.6E1	4.0E3	2.7E2	2.7E3	6.6E0
T	GB 325	2.7E8	8.4E5	4.9E3	3.2E4	7.0E1	4.5E6	5.3E3	2.4E5	1.9E5
	GB 327	5.9E8	6.5E5	3.4E4	4.2E3	1.8E2	1.0E6	4.2E3	3.3E3	6.0E2
	GB 329	7.1E9	2.1E7	2.5E4	1.2E5	1.6E3	3.2E7	7.4E5	4.6E4	5.6E4
	GB 335	1.2E9	1.5E5	2.6E4	1.3E4	-	1.3E5	7.2E3	4.3E3	-

Table III

Hydrocarbon Biodegradation Potential

CPM $^{14}CO_2$ produced from hexadecane/pristane spiked Prudhoe crude oil during 3 weeks incubation at 5 C.

	Sample #	CPM
	GW 301	0
	GW 302	26
	GW 303	6
	GW 304	28
	GW 308	126
	GW 309	28
	GW 310	102
	GW 311	15
W	GW 312	7
A	GW 313	20
T	GW 315	113
E	GW 317	134
R	GW 318	93
	GW 319	0
	GW 320	14
	GW 322	8
	GW 323	9
	GW 325	185
	GW 327	0
	GW 329	32
	GW 335	7
	GB 301	10
	GB 303	20
S	GB 304	17
E	GB 308	-
D	GB 311	11
I	GB 312	170
M	GB 313	14
E	GB 318	140
N	GB 319	7
T	GB 325	-
	GB 327	150
	GB 329	95
	GB 335	12

Quarterly Report

Task Numbers A-27; B-9
Contract # 03-5-022-68
Research Unit 190
Reported Period 1 October to 30 December, 1976

Number of pages 28

Study of Microbial Activity in the Lower Cook Inlet and Analysis of Hydrocarbon Degradation by Psychrophilic Microorganisms

SUBMITTED BY:

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Date Submitted

December 31, 1976

I. Task Objectives

a. To measure the relative levels of microbial activity in the waters and sediments of the Lower Cook Inlet and to measure the concentration of bacteria found in the same samples using epifluorescent microscopy (Task A-27).

b. To study hydrocarbon degradation by psychrophilic hydrocarbon degrading bacteria (Task B-9).

c. To study the effects of crude oil on growth and metabolism of natural marine microbial populations.

d. To coordinate the above studies with Dr. Atlas and his associates (research unit 29).

II. Field and Laboratory Activities

A. Field trip schedule

During this period, we participated in one field trip in the Lower Cook Inlet; a cruise on board the NOAA ship Miller Freeman from October 17 to October 30, 1976.

B. Scientific party

All of the personnel involved in this project are in the Department of Microbiology, Oregon State University. Dr. Griffiths and Mr. McNamara participated in the field trip mentioned above and conducted related laboratory studies at Oregon State University.

Personnel:

Dr. Robert Griffiths, Co-Investigator
Mr. Thomas McNamara, Technician

C. Methods

The methods were essentially the same as those described in the 6th quarterly report. The beach samples were taken by placing a Niskin "butterfly" water sampler in the surf. Near-shore water samples were taken from a small boat approximately 30 meters from the surf line.

D. Sample locations

The locations and sampling dates for stations taken in the Beaufort Sea during the summer Glacier cruise are given in Figure 1 and Table 1.

The locations and sampling dates for all stations taken in the Lower Cook Inlet during the October, 1976 cruise on the Miller Freeman are given in Figure 2 and Table 2.

E. Data collected

During the Glacier cruise, 18 water and 13 sediment samples were analyzed. These samples were taken from 14 locations.

During the Miller Freeman cruise, 37 water and 12 sediment samples were analyzed. These samples were taken from 27 locations; 9 of these locations were on the shoreline.

III. Results

A. Glacier cruise, Beaufort Sea

During this cruise, 18 water and 13 sediment samples were analyzed for total bacterial concentrations and relative microbial activity as determined by the uptake and respiration of ^{14}C labeled organic substrates. The average concentration of bacteria found in all of the seawater samples tested was 3.7×10^5 cells/ml with a range of from 1.6 to 6.1×10^5 (Table 3). The average number of bacteria per gram dry weight of sample sediment taken during the same cruise was 1.06×10^{10} with a range of 0.24 to 2.63×10^{10} (Table 4b).

1. Water samples

The relative microbial activity in the seawater samples tested was measured using ^{14}C labeled glutamic acid, glucose and algal protein hydrolysate. Only one substrate concentration was used in the glucose and algal protein hydrolysate studies but the usual four substrate concentrations were used for the glutamic acid studies. By using the information from the utilization of glutamic acid by natural populations at these four concentrations, heterotrophic potential data was calculated. Table 5a shows the results of these studies. The values for glucose and glutamic acid uptake are reported in terms of ng substrate utilized by the natural microbial populations per liter of seawater per hr. Since there is no good method for estimating the amount of algal protein utilized by weight, these results are reported in terms of radioactivity incorporated and respired; disintegrations per minute (DPM) per liter of seawater per hr.

As shown in Table 5a, the average maximum potential utilization of glutamic acid (V_{max}) was 21 ng per liter per hr with a range of 0.4 to 85. The average amount of glucose taken up at a concentration of 3.8 μg/liter was 5.1 ng per liter per hr with a range of 1.3 to 12.7. The average uptake of glutamic acid at 2.7 μg/liter was 7.9 ng per liter per hr with a range of 0.5 to 15. The average uptake of algal protein hydrolysate at 93 ng at C/liter (0.05 μCi per sample) was 2.3×10^4 DPM per liter per hr with a range of 0.4×10^4 to 6.2×10^4. In the same seawater samples, the percent of the substrate that was respired relative to that which was taken up by the cells (percent respiration) was calculated for all three substrates tested (Table 6). The average value for glutamic acid was 46% with a range of 20 to 61%. The average value for glucose uptake was 27% with a range of 7 to 41%. The average value for algal protein hydrolysate was 21% with a range of 10 to 32%.

2. Sediment samples

The relative microbial activity was also measured in the sediment samples (Table 5b). The average V_{max} for all samples was 0.69 μg glutamic acid taken up per gram dry weight of sediment per hr. A more representative figure would be the average of all samples except BB212 which is atypically high. If BB212 is excluded from the calculation, the average value is 0.12 μg per g dry weight per hr. The range was 0.02 to 6.4 μg per g dry weight per hr. The average uptake of glucose at a concentration of 2.7 μg/liter was 4.2 ng per g dry weight per hr with a range of 1.3 to 15. The average uptake of glutamic acid at 72.8 μg/liter was 0.14 μg glutamic acid per g dry weight sediment per hr with a range of 0.02 to 0.82. The average amount of algal protein hydrolysate taken up at the same concentration used in the water samples was 2.0×10^4 DPM per g dry weight per hr with a range of 0.3 to 10.3×10^4.

The percent respiration (mineralization) was also calculated for all sediment samples tested (Table 4a). The average percent respiration with glutamic acid was 28 with a range from 14 to 35. The average figure for glucose was 20% with a range of 10 to 27% and the agal protein hydrolysate had an average value of 28% with a range of 5 to 43%.

B. Miller Freeman cruise, Lower Cook Inlet

During this cruise, 37 water and 12 sediment samples were analyzed for the same parameters that were measured during the Glacier cruise. The average concentration of bacteria found in all seawater samples was 4.2×10^5 cells per ml with a range of 0.2 to 16.5×10^5 cells per ml (Table 5). In the sediment samples, the average concentration of bacteria was 4.1 cells $\times 10^9$ per g dry weight with a range of 0.4 to 13.0×10^9 (Table 11b).

The relative microbial activity in seawater and sediment samples was determined using the same methods and substrate concentrations that were used during the Glacier cruise in the Beaufort Sea. The results of the relative microbial activity determinations for all seawater samples tested are presented in Table 8. There was a significant difference between the average values observed in samples taken off shore and those that were taken on or near the beach (within 30 m of the shoreline). For this reason, these values have been computed separately.

The average value for the offshore V_{max} determinations was 28 ng glutamic acid utilized per liter of seawater per hr with a range of 0.2 to 405 ng per liter per hr. If the V_{max} measured in sample GW322, which is considered to be atypical for this group of samples, is not included in the average value, the average V_{max} for offshore samples becomes 9.3 ng per liter per hr. The average value for shore samples was 84 ng per liter per hr with a range of 0.7 to 405. The uptake of glutamic acid in offshore water samples at 2.7 μg/liter was 4.9 ng per liter per hr with a range of 0.17 to 53. If sample GW322 is not included in the average, a more representative value of 2.3 μg per liter per hr is obtained. At the same glutamic acid concentration, the average shore sample showed uptake of 44 ng per liter per hr with a range of 0.4 to 256. The average uptake of glucose in offshore water samples at a concentration of 3.8 ug/liter was 3 ng per liter per hr with a range of 0.06 to 33. If sample GW322 is excluded from the average, the value becomes 1.2 ng per liter per hr. The average uptake of glucose at the same substrate concentration in shore samples was 30 ng per liter per hr. The average uptake of algal protein hydrolysate in terms of the amount of radioactivity taken up was 1.9 x 10^4 DPM per liter of seawater per hr with a range of 0.03 to 16.1. If sample GW322 is excluded from the calculations, the value becomes 1.0 x 10^4 DPM per liter per hr. The average value for the shoreline samples was 19.8 x 10^4 DPM per liter per hr with a range of 0.41 to 92.8 x 10^4 DPM.

The following average values were found in the sediment samples taken in the Lower Cook Inlet using the same experimental parameters used to analyze Beaufort Sea sediments (Table 9): V_{max} with glutamic acid, 0.71 ug per g dry weight per hr (range 0.07 to 6.28); glutamic acid at 72.8 μg/liter, 0.22 ug per g dry weight per hr (range 0.03 to 1.19); glucose at 3.8 μg/liter, 11.5 ng per g dry weight per hr (range 0.7 to 56.3); and algal protein hydrolysate, 5 x 10^4 DPM per g dry weight per hr (range 0.9 to 17).

The percent respiration for the three substrates studied was also measured in all samples (Tables 10 and 11a). The following are the average values found in the water samples: glutamic acid 58% (range 40 to 78); glucose 28% (range 10 to 84) and algal protein hydrolysate 30% (range 19 to 44). The following are the values found in the sediment samples: glutamic acid, 46% (range 38 to 53); glucose, 28% (range 20 to 43); and algal protein hydrolysate, 42% (range 31 to 51).

The average surface water temperature measured during this cruise was 8.3 C (range -1.5 to 12) and the average salinity in the same waters was 23.8 parts per thousand (range 18.0 to 27.5). The average water temperature just above the sediment was 8.8 C (range 8.0 to 10.0) and the average salinity in the same waters was 25.7 parts per thousand (range 19.8 to 29.0). These data are shown in Table 12.

C. Winter Gulf of Alaska and Beaufort Sea studies

All of the data except the nutrient data has already been reported in the 5th and 6th quarterly reports. We have just recently received the results of the nutrient analyses for these samples from Dr. Alexander. Dr. Atlas will present these data in detail in his 7th quarterly report, thus we will not repeat them in this report. The following, however, are the average values obtained from the seawater samples analyzed from these two cruises: Gulf of Alaska; PO_4, 1.88 μg-at/liter (range 0.56 to 2.13), NH_3, 0.08 μg-at/liter (range 0 to 0.4); NO_3, 16 μg-at/liter (range 9.4 to 18.1); and SiO_3, 30 μg-at/liter (range 25 to 33). The following are the average nutrient values observed in the seawater samples analyzed from the Beaufort Sea: PO_4, 1.14 μg-at/liter (range 0.52 to 1.83); NH_3, 2.2 μg-at/liter (range 0 to 32.4); NO_3, 5.1 μg-at/liter (range 2.0 to 8.5); and SiO_3, 21 μg-at/liter (range 11 to 33). During the winter Beaufort Sea field trip, ice samples were taken at each station. The average values for the nutrient analysis of these samples are as follows: PO_4, 0.06 μg-at/liter (range 0 to 0.33); NH_3, 0.9 μg-at/liter (range 0 to 12.3); NO_3, 1.8 μg-at/liter (range 0.7 to 3.0) and SiO_3, 3.6 μg-at/liter (range 1 to 8).

VI. Preliminary Interpretation of Results

A. Relative microbial activity

1. Correlations with geographical location

In general, the water samples taken in the vicinity of Prudhoe Bay during the summer Beaufort Sea study showed the highest V_{max} values of the samples analyzed during that cruise. This was also the case when the relative activity was measured using algal protein hydrolysate, glucose or glutamic acid at one substrate concentration.

During the Lower Cook Inlet study, definite trends were noted between relative microbial activity and the sample site location within the inlet. The offshore stations can be grouped into three distinct clusters according to the relative microbial activity in seawater samples as determined by V_{max} values. The group of stations showing the lowest activity contained stations number 106, 216, 215, 105, 206, 225, 207, and 206. These stations are all located near the mouth of the inlet. Another group of offshore stations showed intermediate activity and are all located in or near the major bays. This group includes stations 227, 214, 226, 212, and 204. The highest microbial activity seen in the offshore stations was measured in the northernmost stations studied. These were stations 245, 246, 265, and 266. One station that did not fit this general pattern was station number 229 which was located in Kachemak Bay. Judging from the extremely high levels of activity that were observed at the shore station at Homer (samples GW316 and GW317), it seems reasonable to assume that the relatively high level of activity observed at this station was caused by pollutants dumped into the bay near Homer. The supposition is further supported by the fact that the activity seen in the water sample taken just off the beach at station J (sample number GW314) showed lower activity than that found in the bay at station 229. Station J is location in Halibut Cove which is currently in a relatively natural state.

One station that was of particular interest was station number 266 located near East Foreland. The seawater sample taken at this station showed a level of microbial activity that was roughly one order of magnitude greater than any other offshore station studied. This level of activity is particularly impressive when one compares the values found at this station with the value measured in the seawater sample taken at the control station 246. Station 246 was located on the same side of Lower Cook Inlet as 266 and approximately the same distance off shore but in an area that was less perturbed than 266. The microbial activity at station 266 was roughly 20 times greater than that observed at station 246 as determined by the V_{max} values. It is our understanding that there was a significant spill of JP-5 fuel in this region approximately six weeks before we sampled in this area. At this time we do not know if this high level of activity was related to this spill or not. Only further observations in this region will clarify this point.

When one compares the relative microbial activity in the offshore and beach water samples, there is a marked difference. The same trend is seen here that we observed in the Gulf of Alaska winter field trip (Table 13). The average V_{max} value for offshore water samples was 28 μg per liter per hr and for beach water samples it was 84 μg per liter per hr. If one excludes the value observed in sample number GW322 (station 266) which we consider to be atypical, the average V_{max} value for the offshore station would be only 9.3 ug per liter per hr. If this higher microbial activity along the beach reflects a generalized phenomenon, then it would appear that when petroleum products do reach the shoreline, the rate of microbial degradation would be greater there than in open waters. The same type of statement can be made for oil spills that might occur in locations within the Lower Cook Inlet where high levels of activity were observed. If the same assumption is made, oil spills which occur in the northern segment of the Lower Cook Inlet should be degraded at higher rates than those which occur near the mouth of the inlet (all other factors being equal).

At each shore station, we took two water samples; one approximately 30 m from shore and one on the beach. In all cases, the V_{max} value for the sample taken on the beach was higher than that found a short distance offshore (Table 14a). The difference seen between these two values did not appear to be related to either geographical location or to tidal state.

2. Correlations with sample depth (above and below the halocline)

During the Beaufort Sea cruise on the Glacier, a comparison was made between the microbial activity seen in the surface waters and that seen below the halocline (15 m). The salinity at the surface was very low and reflected the effects of ice melt input. It was felt that such a fresh water input might significantly alter the relative microbial activity in these waters when compared to the water just below the halocline. In the four stations where this comparison was made, the surface waters showed as high or higher activity than that observed in the saltier waters at 15 meters (Table 14b). These observations tend to support our previous ice melt data.

3. Comparison of the relative microbial activities observed in all studies made to date

Table 13 summarizes the data collected during all field studies made to date. The relative microbial activity observed during our three Beaufort Sea sampling periods reflect differences seasonally which were to be expected; namely that microbial activities in both seawater and sediments are higher in the summer than in the winter. Even though the average seawater temperature was significantly lower in the Beaufort Sea water samples, the level of potential microbial activity was very similar to that found in the Lower Cook Inlet. Similarly, the level of activity in the sediments was about the same during both summer sampling seasons in the Beaufort Sea as they were in the Lower Cook Inlet. It will be interesting to see if these trends continue in our future field studies.

4. Comparison of relative microbial activity using heterotrophic potential studies and uptake of labeled substrate at one concentration.

During the Beaufort Sea cruise on the Glacier and the Lower Cook Inlet cruise, we attempted to evaluate the relative merits of using the Wright-Hobbie method of determining relative microbial activity which uses four concentrations of the same substrate (labeled glutamic acid in this case) and uptake of glutamic acid, glucose and algal protein hydrolysate at one substrate concentration. We also wanted to compare the relative utility of using more than one substrate in our routine measurements of relative microbial activity in natural microbial populations. The rational behind these studies was twofold; first, to determine which substrates should be used to give the most representative determination of relative microbial activity and secondly, to determine if measurements using one substrate concentration could be substituted for studies using multiple concentrations.

The correlation coefficients between the relative levels of microbial activity using these different substrates and methods have been calculated and are presented in Tables 15a and 15b. These comparisons show that there is no significant advantage of using algal protein hydrolysate instead of glutamic acid for these determinations because the correlation coefficient between these two are very high in all cases (a correlation of 0.90 being the lowest observed). As a whole, the measurements made using glucose correlated the worst when compared with the other substrates and methods used. Since glucose is a much different substrate than either glutamic acid or the algal protein hydrolysate, it is undoubtedly measuring somewhat different functions and possibly different types of microbial populations. Since the uptake of glucose may reflect the relative abundance of a specific group of organisms that might be missed by the glutamic acid studies, we will continue to make measurements using labeled glucose.

At present, the only way that one can measure the potential maximum uptake of a substrate by a mixed natural microbial population is to measure the uptake and respiration of that substrate at several concentrations. This, of course, is very time consuming and tedious work. If similar types of data could be generated using only one substrate concentration, both the field work and the analysis of the data could be greatly simplified. We felt that if, in some samples, only one substrate was used, the errors generated by this approach could be offset by the greater number of samples that could be analyzed with the same work load. We compared the levels of microbial activity observed using one concentration as opposed to that obtained from V_{max} determinations made by using four concentrations of the same substrate. Tables 15a and 15b show the resulting correlation coefficients when these factors are compared. The relatively low correlation that was observed in Beaufort Sea water samples between these methods indicates that under certain conditions, relative microbial activity should be determined by the multiconcentration method. The high correlations between these factors in all sediments studied and in the water samples taken in the Lower Cook Inlet indicated that the one concentration determination may be useful under other conditions.

B. Total bacterial concentrations in water and sediments samples

Total bacterial numbers were measured using direct observations through an epifluorescent microscope. A summary of the direct count data is shown in Table 13. When one compares the counts found in the seawater samples collected during these two cruises with previous measurements, one is struck by the consistancy of the values obtained. Even though there were large differences in the average V_{max} values obtained in the various studies, the average concentration of bacteria was relatively constant. In general, the bacterial concentrations in both water samples and in sediments were lower during the winter sampling trips than in the summer and fall trips.

C. Percent respiration (mineralization)

As was the case in past studies, we measured the percent respiration in all sediment and water samples. During these two cruises, we measured the percent respiration using not only glutamic acid but also algal protein hydrolysate and glucose. As can be seen in Table 13, the average percent respiration was again lower in the sediments than it was in the water samples when glutamic acid was used as the substrate. When all of the studies are compared, it is interesting to note that the average percent respiration varied with location and season in the seawater samples but was relatively constant in the sediments. The average percent respiration with glucose was approximately the same in the seawater samples taken from both the Beaufort Sea and the Gulf of Alaska. The average we observed in these samples is close to that which has been observed by others in similar studies. In the same samples, the algal protein hydrolysate gave an average percent respiration in the Beaufort Sea samples that was close to that reported by other investigators. The average percent respiration seen in the Lower Cook Inlet water samples was somewhat higher than expected.

V. Problems encountered, recommended changes, and acknowledgements

A. Problems encountered

We did not encounter any serious problems during our field work this quarter; however, we have had difficulty completing the laboratory work that we had hoped to accomplish during this period. The current funding level for this contract is not sufficient to hire the personnel required to collect, analyze and report our field data and to maintain and man our laboratory at Oregon State. With only two full time people, we are not able to initiate and continue laboratory studies that require a sustained effort because we are continually being interupted by the field studies. We are not going to be able to complete the critical crude oil degradation studies with the manpower currently available.

B. Recommended changes

We strongly recommend that monies be made available for continued microbiological studies in the Beaufort Sea. Of all of the continental shelf areas in Alaska where petroleum development is planned, this is the one that has the greatest potential for long term deleterious effects from crude oil perturbation.

The data from the summer Beaufort Sea and Lower Cook Inlet studies indicate that uptake studies utilizing algal protein hydrolysate are no longer required and that in some cases, the uptake of glutamic acid at one substrate concentration could be used instead of the multiconcentration method which is currently being used in all samples.

C. Acknowledgments

Our cruise on board the Miller Freeman in the Lower Cook Inlet was one of the most productive we have experienced. The cooperation that we received from Captain Atwell and the crew of the Miller Freeman can only be described as "fantastic". It was a real pleasure to work with a crew which was capable of doing anything we requested and doing it well. This is a ship that the rest of the NOAA fleet would do well to imitate.

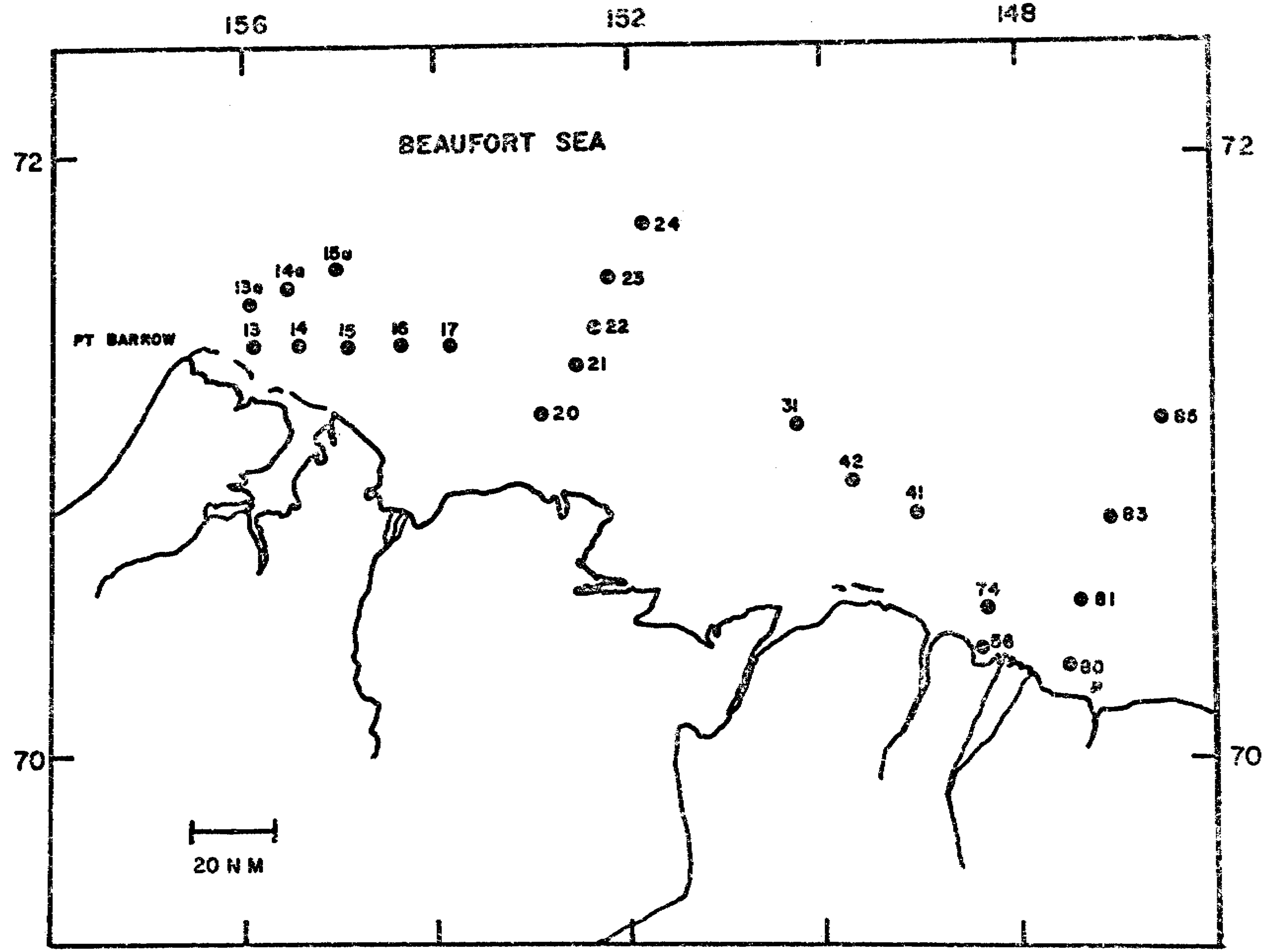

Figure 1. Location of stations sampled during the August, 1976 cruise in the Beaufort Sea.

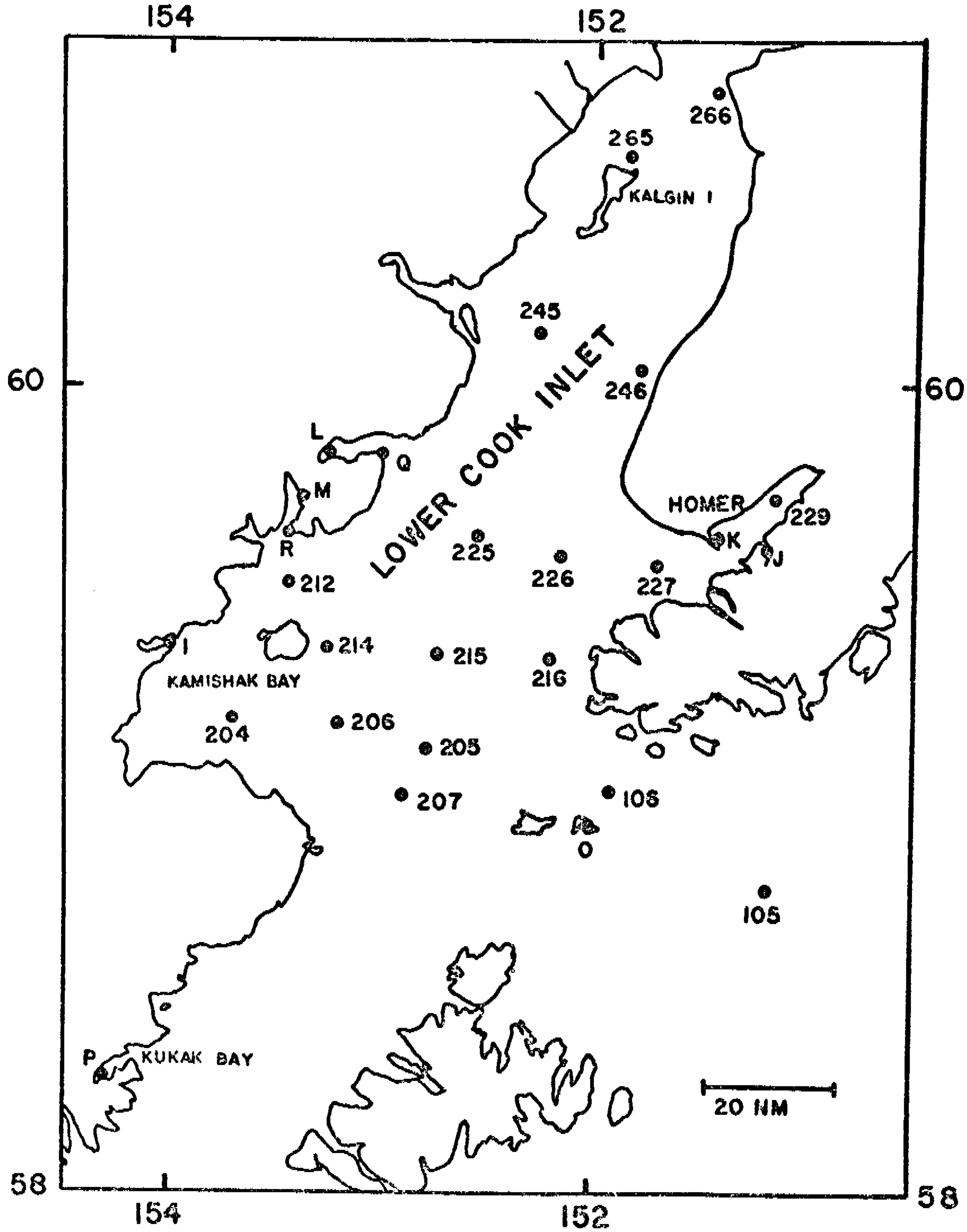

Figure 2. Location of stations sampled during the October, 1976 cruise in the Lower Cook Inlet.

Table 1. Station location and the date and time of sampling for all water samples taken during the August Beaufort Sea cruise on board the Glacier. (*) those water samples that were taken at a depth of 15 meters, all other water samples were taken within one meter of the surface.

Sample #	Station	Date	Time of Sampling	Latitude(N)	Longitude(W)
BW 201	74	8/23	1530	70°36'	148°12'
BW 202	74	8/24	1920	70°36'	148°12'
BW 203	80	8/25	1930	70°32'	147°33'
BW 204	81	8/26	0830	70°39'	147°37'
BW 205	41	8/27	1030	70°50'	149°00'
BW 206	42	8/27	2245	70°57'	149°33'
BW 207	31	8/28	1415	71°08'	151°19'
BW 208	24	8/29	1300	71°43'	151°47'
*BW 209	24	8/29	1300	71°43'	151°47'
BW 210	23	8/30	2200	71°33'	152°03'
*BW 211	23	8/30	2200	71°33'	152°03'
BW 212	22	8/30	1600	71°22'	152°20'
*BW 213	22	8/30	1600	71°22'	152°20'
BW 214	21	8/31	0545	71°19'	152°32'
BW 215	20	9/1	0835	71°08'	152°57'
BW 216	16	9/2	0315	71°23'	154°21'
BW 217	15a	9/2	1410	71°36'	155°32'
BW 218	15a	9/2	1410	71°36'	155°32'

Table 2. Summary of station location, water depth at station and the time and date at which the station was occupied during the October cruise in the Lower Cook Inlet. (*) stations taken on shore.

Station number	Date	Time of sampling	Station position Latitude(N)	Station position Longitude(W)	Depth of water column in meters
205	10/18	1545	59°07.8'	152°45.4'	146
216	10/19	0400	59°18.8'	152°13.8'	86
215	10/19	1330	59°19.6'	152°44.3'	73
212	10/20	0245	59°33.4'	153°25.4'	28
*R	10/20	1130	59°38.8'	153°25.0'	-
*M	10/20	1245	59°44.2'	153°21.5'	-
*I	10/21	1110	59°22.5'	153°59.3'	-
204	10/21	1600	59°15.8'	153°40.8'	30
225	10/22	0300	59°32.5'	152°35.9'	53
229	10/22	1000	59°41.9'	151°10.3'	58
*J	10/22	1000	59°34.7'	151°11.1'	-
*K	10/22	1130	59°36.4'	151°24.0'	-
227	10/22	1500	59°33.2'	151°44.8'	73
226	10/23	0300	59°32.9'	152°08.5'	47
245	10/23	0950	59°60.3'	152°12.3'	48
246	10/23	1245	60°02.3'	151°45.9'	26
266	10/24	0245	60°41.2'	151°25.0'	46
265	10/24	0328	60°33.7'	151°50.2'	24
*L	10/24	1420	59°50.3'	153°15.0'	-
*Q	10/24	1524	59°50.4'	152°59.5'	-
214	10/24	2350	59°20.9'	153°15.7'	38
206	10/25	0130	59°10.2'	153°08.5'	84
204	10/25	0300	59°16.1'	153°40.9'	35
215	10/25	1000	59°20.8'	152°43.7'	68
*P	20/26	1530	58°15.95'	154°16.45'	-
207	10/27	2200	58°59.7'	152°52.8'	168
106	10/28	0230	59°02.7'	151°58.7'	200
105	10/28	0620	58°50.2'	151°21.3'	122
*O	10/28	1030	58°55.3'	125°00.1'	-

Table 3. Total numbers of bacteria present reported as the number of cells per ml seawater. These samples were all taken during the August Beaufort Sea cruise. The determinations were made on fixed samples using epifluorescent microscopy.

Sample number	Cells/ml seawater $\times 10^5$
BW201	3.4
BW202	3.3
BW203	4.4
BW204	3.7
BW205	5.0
BW206	6.1
BW207	4.7
BW208	3.2
BW209	2.3
BW210	4.6
BW211	4.5
BW212	3.0
BW213	1.9
BW214	1.6
BW215	1.6
BW216	3.5
BW217	3.7
BW218	5.4
Average value	3.7×10^5

Table 4a. Percent respiration measured in water samples collected during the August 1976 cruise in the Beaufort Sea. The percent respiration was measured using ^{14}C labeled glutamic acid, glucose and algal protein hydrolysate. (too low) those samples in which the level of microbial activity was too low to obtain an accurate measurement.

Sample number	Glutamic acid	Algal protein hydrolysate	Glucose
BB201	-	34	27
BB203	27	35	11
BB204	14	5	10
BB205	26	9	27
BB206	26	20	21
BB207	34	43	15
BB208	too low	32	21
BB212	32	31	20
BB214	29	31	25
BB215	35	31	25
BB216	31	27	18
Average values	28	28	20

Table 4b. Total numbers of bacteria present reported as the number of cells per gram dry weight of sediment. These determinations were made on fixed samples using epifluorescent microscopy.

Sample number	Cells/g dry weight $\times 10^9$
BB201	2.4
BB203	4.8
BB204	26.7
BB205	12.8
BB206	13.5
BB207	11.1
BB208	26.3
BB212	6.7
BB214	7.5
BB215	9.8
BB216	9.9
Average value	10.6×10^9

Table 5a. Relative microbial activity observed in seawater taken during the August 1976 cruise in the Beaufort Sea. The relative microbial activity is expressed in terms of the actual rate of substrate utilization or potential maximum utilization (V_{max}).

Sample number	Station number	V_{max} ng/liter/hr	Algal protein DPM/liter/hr x 10^4	Glucose ng/liter/hr	Glutamic acid ng/liter/hr
BW201	74	85	4.5	9.7	15
BW202	74	41	6.2	12.7	24
BW203	80	34	2.4	6.0	16
BW204	81	-	4.4	9.0	22
BW205	41	13	1.5	3.8	6.9
BW206	42	31	4.2	7.8	13
BW207	31	14	2.4	4.9	7.3
BW208	24	6	1.4	3.7	1.6
BW209	24	6	2.3	3.4	2.8
BW210	23	27	2.8	3.9	12
BW211	23	5	1.3	2.7	4.5
BW212	22	6	1.3	4.5	4.7
BW213	22	0.4	1.1	2.9	0.5
BW214	21	4	0.4	1.3	1.1
BW215	20	-	0.6	2.1	1.2
BW216	16	56	1.6	6.5	4.7
BW217	15a	7	2.4	4.4	4.0
BW218	15a	2	1.0	2.7	1.5
Average values		21	2.3	5.1	7.9

Table 5b. Relative microbial activity observed in sediment samples taken during the August 1976 cruise in the Beaufort Sea. The relative microbial activity is expressed in terms of the actual rate of substrate utilization or potential maximum utilization (V_{max}).

Sample number	Station number	V_{max} μg/g dry weight/hr	Algal protein DPM/g dry weight/hr x 10^4	Glucose ng/g dry weight/hr	Glutamic acid μg/g dry weight/hr
BB201	74	0.10	0.9	1.6	0.10
BB203	80	0.28	2.9	15	0.18
BB204	81	0.18	2.3	5.8	0.16
BB205	41	0.06	0.4	1.8	0.03
BB206	42	0.02	0.3	1.3	0.02
BB207	31	0.06	0.8	3.9	0.07
BB208	24	0.02	0.5	1.7	0.02
BB212	22	6.40	10.3	4.9	0.82
BB214	21	0.09	0.5	2.5	0.04
BB215	20	0.13	1.7	4.9	0.10
BB216	16	0.21	1.5	3.0	0.11
Average values		0.69	2.0	4.2	0.15
Average values without BB212		0.12	1.2	4.1	0.08

Table 6. Percent respiration measured in water samples collected during the August, 1976 cruise in the Beaufort Sea. The percent respiration was measured using ^{14}C labeled glutamic acid, glucose, and algal protein hydrolysate.

Sample number	Glutamic acid	Algal protein hydrolysate	Glucose
BW201	42	23	7
BW202	42	13	23
BW203	53	10	11
BW204	29	15	31
BW205	45	14	24
BW206	20	22	18
BW207	40	17	32
BW208	31	17	24
BW209	59	16	24
BW210	55	24	25
BW211	61	31	42
BW212	54	25	35
BW213	43	30	41
BW214	56	32	34
BW215	-	28	29
BW216	48	22	25
BW217	54	20	25
BW218	53	17	41
Average values	46	21	27

Table 7. Total numbers of bacteria present reported as the number of cells per ml seawater. These samples were all taken during the October Lower Cook Inlet cruise. The determinations were made on fixed samples using epifluorescent microscopy.

Sample number	Cells/ml seawater $\times 10^5$
GW301	2.6
GW302	1.7
GW303	0.8
GW304	2.7
GW305	13.7
GW306	11.0
GW307	1.7
GW308	15.5
GW309	12.5
GW310	12.3
GW311	2.4
GW312	0.8
GW313	3.4
GW314	2.9
GW315	2.7
GW316	3.3
GW317	2.7
GW318	1.4
GW319	0.4
GW320	0.8
GW321	1.3
GW322	11.6
GW323	1.4
GW324	9.7
GW325	16.5
GW326	0.9
GW327	1.3
GW328	1.0
GW329	0.6
GW330	0.5
GW331	6.9
GW332	4.0
GW333	0.5
GW334	0.5
GW335	1.3
GW336	0.2
GW337	1.2
Average value	4.2×10^5

Table 8. Relative microbial activity observed in seawater samples taken during the October Lower Cook Inlet cruise. The relative microbial activity is expressed in terms of the actual rates of substrate utilization or potential maximum utilization. (*) samples taken at shore stations. (@) samples with activity that was too high for accurate measurement of V_{max}. (¢) samples with activity that was too low for accurate measurement of V_{max}.

Sample number	Station number	V_{max} ng/ liter/hr	Algal protein DPM/liter/hr x 10^4	Glucose ng/ liter/hr	Glutamic acid ng/liter/hr
GW301	205	0.6	0.16	0.31	0.32
GW302	216	0.2	0.09	0.66	0.17
GW303	215	0.2	0.14	0.09	0.20
GW304	212	5.0	1.2	0.97	3.5
GW305	R*	21	5.4	13	14
GW306	R*	9.1	1.8	2.8	4.9
GW307	M*	24	1.1	4.0	5.8
GW308	M*	@	20.7	34	26
GW309	I*	83	9.0	14	21
GW310	I*	104	13.1	27	39
GW311	204	5.7	1.4	1.4	3.5
GW312	225	0.6	0.16	0.03	0.34
GW313	229	12.7	1.8	0.84	3.1
GW314	J*	6.0	0.63	0.53	0.93
GW315	J*	55	2.7	3.8	8.3
GW316	K*	@	92.8	77	239
GW317	K*	@	91.7	94	256
GW318	227	1.2	0.36	0.28	0.69
GW319	226	3.6	0.45	0.66	1.3
GW320	245	8.7	0.99	1.3	3.0
GW321	246	22	4.3	2.0	11
GW322	266	405	16.1	33	53
GW323	265	53	3.9	8.1	14
GW324	L*	404	19.6	65	50
GW325	L*	386	16.9	75	51
GW326	Q*	23	-	-	11
GW327	214	3.1	0.55	0.97	1.3
GW328	206	0.9	-	-	0.2
GW329	204	5.2	0.47	0.68	1.1
GW330	215	0.5	-	-	0.22
GW331	P*	9.7	-	-	3.5
GW332	P*	11	-	-	2.1
GW333	207	0.8	-	-	0.25
GW334	106	¢	0.03	0.06	0.17
GW335	105	0.4	0.36	0.28	0.27
GW336	O*	0.7	0.41	0.19	0.44
GW337	O*	38	1.9	2.2	7.3
Average offshore values		27.9	1.9	3.0	4.9
Average offshore values without sample GW266		9.3	1.0	1.2	2.3
Average beach values		84	20	30	44

Table 9. Relative microbial activity observed in sediment samples taken in the Lower Cook Inlet during the October, 1976 cruise. The relative microbial activity is expressed in terms of the actual rate of substrate utilization or potential maximum utilization. (*) sediment sample taken at a shore station that was essentially a soil sample.

Sample number	Station number	V_{max} μg/g dry weight/hr	Algal protein DPM/g dry weight/hr x 10^4	Glucose ng/g dry weight/hr	Glutamic acid μg/g dry weight/hr
GB301	205	0.11	1.4	2.3	0.07
GB304	212	0.13	3.6	1.9	0.13
*GB308	M	6.28	17.0	56.3	1.19
GB311	204	0.33	5.5	9.7	0.07
GB313	229	0.25	3.1	5.3	0.17
GB318	227	0.22	7.1	12.0	0.12
GB325	L	0.02	--	--	0.03
GB327	214	0.08	1.4	3.5	0.07
GB328	206	0.07	--	--	0.04
GB329	204	0.48	--	--	0.31
GB333	207	0.42	--	--	0.36
GB335	105	0.12	0.9	0.7	0.07
Average values		0.71	5.0	11.5	0.22
Average values without station GB308		0.20	3.3	5.1	0.13

Table 10. Percent respiration measured in water samples collected during the October Lower Cook Inlet cruise. The percent respiration was measured using ^{14}C labeled glutamic acid, glucose and algal protein hydrolysate. (too low) those samples where the activity was too low to accurately estimate the percent respiration.

Sample number	Glutamic acid	Algal protein hydrolysate	Glucose
GW301	66	41	72
GW302	44	29	84
GW303	68	44	68
GW304	59	41	30
GW305	62	31	28
GW306	57	28	26
GW307	56	28	27
GW308	55	27	27
GW309	52	25	24
GW310	57	29	25
GW311	56	31	22
GW312	74	19	20
GW313	63	21	29
GW314	54	31	24
GW315	64	34	25
GW316	68	28	29
GW317	68	31	31
GW318	53	25	19
GW319	59	26	16
GW320	54	34	15
GW321	50	29	20
GW322	40	30	10
GW323	40	27	12
GW324	50	28	21
GW325	51	33	24
GW326	42	-	-
GW327	53	22	-
GW328	59	-	-
GW329	53	32	16
GW330	73	-	-
GW331	55	-	-
GW332	59	-	-
GW333	65	-	-
GW334	too low	24	13
GW335	68	too low	too low
GW336	78	31	31
GW337	68	34	26
Average values	58	30	28

Table 11a. Percent respiration measured in sediment samples collected during the October, 1976 cruise in the Lower Cook Inlet. The percent respiration was measured using ^{14}C labeled glutamic acid, glucose and algal protein hydrolysate.

Sample number	Glutamic acid	Algal protein hydrolysate	Glucose
GB301	41	39	43
GB304	53	51	42
GB308	50	40	23
GB311	49	38	25
GB313	53	48	21
GB318	44	40	20
GB325	44	-	-
GB327	40	31	28
GB328	43	-	-
GB329	49	-	-
GB333	46	-	-
GB335	38	46	25
Average values	46	42	28

Table 11b. Total numbers of bacteria present reported as the number of cells per gram dry weight of sediment. These determinations were made on fixed samples using epifluorescent microscopy.

Sample number	Cells/gram dry weight sediment x 10^9
GB304	5.3
GB308	5.6
GB311	1.4
GB313	10.0
GB318	0.4
GB325	0.4
GB327	3.0
GB328	1.2
GB329	13.0
GB333	1.5
GB335	3.3
Average value	4.1×10^9

Table 12. Temperature and salinity data for water samples taken at the surface and a few meters off the bottom during the October, 1976 cruise in the Lower Cook Inlet. All depths are in meters and all salinities are in parts per thousand. (*) samples taken at shore stations.

	Surface		Bottom	
Sample number	Temperature	Salinity	Temperature	Salinity
GW301	9.0	27.5	8.5	--
GW302	9.5	27.0	--	--
GW303	9.5	27.0	10.0	27.0
GW304	8.4	25.0	8.4	26.0
GW305*	8.0	23.3	--	--
GW306*	8.0	23.3	--	--
GW307*	5.5	22.5	--	--
GW308*	6.5	22.0	--	--
GW309*	12.0	21.0	--	--
GW310*	12.0	20.5	--	--
GW311	5.5	28.0	9.1	23.2
GW312	9.5	26.2	10.0	26.0
GW313	8.5	24.0	9.3	26.0
GW314*	10.0	25.0	--	--
GW315*	9.5	24.0	--	--
GW316*	12.0	24.0	--	--
GW317*	12.0	23.0	--	--
GW318	9.5	27.0	9.5	28.0
GW319	9.5	27.0	9.5	28.0
GW320	9.0	26.0	9.0	26.0
GW321	9.0	20.5	9.0	26.5
GW322	8.5	21.0	8.0	22.0
GW323	9.0	19.5	8.5	19.8
GW324*	6.5	16.3	--	--
GW325*	6.0	17.0	--	--
GW326*	8.0	23.0	--	--
GW327	9.0	26.0	9.0	26.0
GW328	9.0	27.5	9.0	27.0
GW329	9.5	25.0	9.8	26.5
GW330	9.5	28.0	--	--
GW331*	2.0	18.0	--	--
GW332*	-1.5	18.0	--	--
GW333	8.0	23.7	7.0	22.5
GW334	7.5	24.0	8.0	29.0
GW335	9.0	25.5	7.5	28.0
GW336*	8.0	27.5	--	--
GW337*	5.0	27.5	--	--
Average values	8.3	23.8	8.8	25.7

Table 13. Data summary of the average values measured during all field studies. (*) Average values calculated with one sample excluded; a value which we consider more typical. (NA) these data have not been received by us as of 12/76.

Factor	Units	Beaufort Sea Summer 1975		Beaufort Sea Winter 1976		Beaufort Sea Summer 1976		Lower Cook Inlet Fall 1976		Gulf of Alaska Winter 1976	
		Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range
V_{max} (Offshore water)	ng x $liter^{-1}$ x hr^{-1}	40	4 to 118	3.1	0.2 to 14	21	0.4 to 85	28 (9.3)*	0.2 to 405	1.4	0.3 to 3.4
V_{max} (Beach water)	ng x $liter^{-1}$ x hr^{-1}	-	- -	-	- -	-	- -	84	0.7 to 404	63.0	9.7 to 113
Percent Respiration (water)	%	59	44 to 76	85	52 to 100	46	20 to 59	58	40 to 78	72	53 to 93
Percent Respiration (sediments)	%	43	32 to 71	45	35 to 87	28	14 to 35	46	38 to 53	44	30 to 72
V_{max} x 10^{-1} (sediments)	µg x gr dry $weight^{-1}$ x hr^{-1}	5.2	0.2 to 17	0.5	0.04 to 1.8	6.9	0.2 to 64	7.1 (2.0)*	0.2 to 63	45	2 to 103
Sample Temperature	°C	1.2	-0.8 to 3.2	-1.9	-2.0 to -1.5		NA	8.3	-1.5 to 12	3.8	2.0 to 5.0
Sample Salinity (water)	o/oo	20.5	9.0 to 26.5	24	17 to 29		NA	23.8	20.5 to 27.5	31.9	30.7 to 35.5
Number of bacteria x 10^5 (seawater)	cells x ml^{-1}	4.5	0.1 to 11.9	1.5	0.8 to 2.7	3.7	1.6 to 6.1	4.2	0.2 to 16.5	1.9	1.2 to 2.7
Number of bacteria x 10^8 (sediments)	cells x dry $weight^{-1}$	6.3	0.1 to 41.4	10	0.5 to 19	106	24 to 267	41	4 to 130	15	0.1 to 31

Table 14a. A comparison of the V_{max} values measured in samples taken in the surf and those taken approximately 30 meter offshore during work in the Lower Cook Inlet. The V_{max} values are expressed in terms of ng glutamic acid taken utilized per liter of seawater per hr. (E) ebbing tide. (F) flooding tide. (too high) the microbial activity was too high to obtain an accurate measurement of V_{max}. *estimated value.

Station number	Tidal state	V_{max} of sample from beach	V_{max} of sample from offshore
P	E	11	10
R	F	21	09
O	E	38	0.7
J	F	55	06
I	F	104	83
M	F	*203	24
K	F	too high	too high

Table 14b. Comparison of the V_{max} values observed in seawater samples taken above and below the halocline during the Beaufort Sea cruise. The V_{max} values are in ng per liter per hr.

Station number	V_{max} in surface water samples	V_{max} in water samples taken below the halocline
24	6	6
23	27	5
22	6	0.4
15a	7	2

Table 15a. The correlation coefficients between the levels of potential and actual substrate utilization by natural microbial populations studied in the Beaufort Sea.

1. Seawater samples

Factors that were compared	vs.	Correlation coefficient
glutamic acid	Vmax	0.769
glucose	Vmax	0.770
algal protein	glutamic acid	0.902
algal protein	glucose	0.935
glutamic acid	glucose	0.884
algal protein	Vmax	0.648

2. Sediment samples

glutamic acid	Vmax	0.980
glucose	Vmax	0.092
algal protein	glutamic acid	0.962
algal protein	glucose	0.310
glutamic acid	glucose	0.239
algal protein	Vmax	0.967

Table 15b. The correlation coefficients between the levels of potential and actual substrate utilization by natural microbial populations studied in the Lower Cook Inlet.

1. Seawater samples

glutamic acid	Vmax	0.945
glucose	Vmax	0.757
algal protein	glutamic acid	0.995
algal protein	glucose	0.855
glutamic acid	glucose	0.853
algal protein	Vmax	0.934

2. Sediment samples

glutamic acid	Vmax	0.966
glucose	Vmax	0.983
algal protein	glutamic acid	0.923
algal protein	glucose	0.972
glutamic acid	glucose	0.976
algal protein	Vmax	0.917

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DETERMINE THE FREQUENCY AND PATHOLOGY OF MARINE ANIMAL DISEASES IN THE BERING SEA, GULF OF ALALSKA, AND BEAUFORT SEA

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(1)

Quarterly Report

I. Task Objectives

Task A-28. Determine by field and literature studies the incidence and pathology of disease presently existing in fish, shellfish, birds, and mammals for use in evaluating future impacts of petroleum-related activity.

II. Field and Laboratory Activities

A. Ship Schedule

Vessel: NOAA Ship MILLER FREEMAN

Cruise: RP-4-MF-76B

Dates: Leg I: September 1 - 24, 1976

Leg II: September 26 to October 13, 1976

B. Scientific Party

1. Field Activities

Leg I and Leg II:

William D. Gronlund

NMFS, NOAA, NWAFC

Role: Party Chief, Assisted in the examination of fish and invertebrates for pathological conditions, processing of biological data, autopsying of animals, and preparation of cruise reports.

Katherine King

NMFS, NOAA, NWAFC

Role: Invertebrate pathologist, concerned primarily with the examination and autopsy of invertebrates for abnormalities, participated in the processing of fish, and the preparation of cruise reports.

2. Laboratory Activities

Bruce B. McCain, PhD

NMFS, NOAA, NWAFC

Role: Principal Investigator, coordinates field and laboratory activities, participates in microbiological analyses, and writes progress reports and manuscripts.

Harold O. Hodgins, PhD

NMFS, NOAA, NWAFC

Role: Principal Investigator, supervises NMFS investigations and reviews all reports and manuscripts.

Mark S. Myers

NMFS, NOAA, NWAFC

Role: performs microbiological tests and participates in data analysis and computer analyses.

S. R. Wellings, MD, PhD

Department of Pathology, School of Medicine, University of California (Davis).

Role: Coordinates histopathological analyses of tissue specimens.

Glen McArn, PhD

Affiliation is the same as Dr. Wellings.

Role: Performs histopathological analyses of tissue specimens.

C. Methods

1. Field Procedures

a. Examination of hauls

Fish and invertebrates were sorted according to species and subsamples were selected by members of OCSEAP R.U.'s 175, 281, and 332. These animals were examined for externally visible pathological conditions and, when feasible, for readily recognizable internal disorders. The following information was recorded for each haul in the Haul Data Sheet: haul number, date, number of animals examined of each species, sex (this data was available for fish from the length-frequency records of R.U. 175), the type of pathological condition observed, and the number of animals with each type of condition for each species and often each sex.

b. Examination of individual fish and invertebrates

Animals with apparently abnormal conditions were processed while still alive or freshly dead. Each animal was assigned a specimen number and the following information was recorded on the Individual Data Sheet: species, sex, dimensions (length for fish), weight, method of age determination (otolith or scale, applicable to fish only), condition, and location and size of the condition(s). In some instances, particularly with respect to the lesion location code, the format of the data sheet was not sufficient for invertebrate descriptions. Consequently some descriptions of individual invertebrates were kept in a separate notebook to be adjusted to a new format which is presently being formulated and will be approved by OCSEAP. Photographs were taken of representative and unusual conditions. Fish samples were preserved in 10% formalin with phosphate-buffered saline and invertebrates were kept in a 10% formalin and seawater solution. Specimens were also preserved in a special fixative for electron microscopy.

Bacteria or fungi were detected inside lesions and internal organs by sterilizing the surface of the tissue to be sampled, opening the tissue with a sterile scalpel, removing an inoculum with a sterile loop and streaking the inoculum in a petri dish of Ordal's Seawater Cytophaga Agar (OSCA). Representative colonies were purified by restreaking and stored in tubes containing OSCA.

Samples of invertebrates lacking external lesions were also collected to spot-check for internal disorders by routine histology.

Haemolymph samples from Argis lar and Sclerocrangon boreas were taken by sterilizing the cephalothorax/abdomen junction with a drop of alcohol and extracting fluid near the pericardial sinus with a syringe. Smears were made by placing a drop of haemolymph on a clean slide, spreading, and air drying it, and fixing it in absolute methanol for 5 minutes. Microbial cultures were made by placing a drop of haemolymph on OSCA and streaking it as any other inoculum.

2. Laboratory Procedures

a. Norton Sound and Chukchi Sea

Laboratory activities were mainly concerned with processing the specimens and data obtained during Legs I and II of Cruise MF-76-B. Tissue specimens from animals with the main pathological conditions to be examined histologically were matched with the photographic colored slides showing the gross appearance of the lesions. Histological procedures were initiated. Specimens from normal-appearing invertebrates are being trimmed and blocked. Selected pieces of tissue are carefully described, placed in small vials containing fixative, and are being sent to the Department of Pathology, School of Medicine, University of California (Davis) for histological processing under the supervision of Dr. S. R. Wellings.

Scales and otoliths from abnormal fish are currently being examined for age determination.

The Haul Data and Individual Data Sheets were updated and summarized as much as possible. However, since fish parameters do not apply to invertebrates, a new lesion location code and computer format have been developed for use with invertebrates. After approval by PMEL personnel, the data will be transcribed to new data sheets and then transferred to computer cards for further analysis. Information on the Haul Data Sheets was also used to construct distribution maps of the major abnormalities.

b. Bering Sea (NOAA Ship MILLER FREEMAN, Cruise M-76-1)

Laboratory activities, including histopathology and microbiology, were continued on specimens obtained from the Bering Sea during the spring and summer of 1976. Histopathology consisted of both light and electron microscopy. Microbiological procedures included taxonomic bacterial tests and *in vitro* virus transmission tests.

D. Sample Localities

The sampling stations at which animals were examined are the same as those used by R.U. 175 during Legs I and II, Cruise MF-76-B, of the NOAA Ship MILLER FREEMAN.

E. Data Collected

1. Number and type of samples

Of the 25,557 individual invertebrates and 26,901 fish examined, potentially pathological conditions were seen on 1,228 invertebrates and 329 fish. The biological parameters and lesion characteristics for each affected animal were recorded.

2. Number and types of analyses

Specimens were collected from about 360 invertebrates and 25 fish for histopathological examination. About 150 specimens were randomly selected from normal-appearing invertebrates. Eleven fungal and four bacterial isolates were obtained and purified. Review of 21 slide smears may reveal presence/absence of microbes in crangonid haemolymph.

III. Results

A. Field Activities (Norton and Chukchi Areas)

1. Fish

Three of the 28 species of fish examined had a significant pathological condition (Table 1, 2). This condition is called "black spot disease" and is recognizable by the presence of black patches, from 1 to 2 mm in diameter, on the skin. The species involved and the overall frequency of this condition were: Pacific herring (Clupea harengus pallasi), 4.5%; the toothed smelt (Osmerus mordax dentex), 3.9%; and the saffron cod (Eleginus gracilis), 0.8%. Fish were considered infected when they had around 20 or more black spots; some heavily infested fish had several hundred such spots (Figure 1).

Microscopic examination of individual black spots revealed the presence of an encysted trematode, probably a metacercaria (Figure 2). The cysts were usually surrounded by melanin-containing cells, such as melanocytes. The trematode is very similar to Cryptocotyle lingua.

The geographic distribution of toothed smelt (Figure 3) and saffron cod (Figure 4) with "black spot" disease was very similar, with the highest prevalence in Norton Sound. Pacific herring (Figure 5) with this disease were numerous in both Norton Sound and the Chukchi Sea; however, the condition was much more common in the latter area.

2. Invertebrates

Of the 31 species of epibenthic invertebrates examined, six species had seven potentially pathological conditions which were observed at more than five sampling stations and with an overall frequency equal to or greater than 1.0% (Table 2, 3). Parasitism (in five species) and discoloration (in two species) were the major conditions of this cruise. The affected species, associated conditions, and population frequency of each condition were as follows: Sclerocrangon boreas (crangonid shrimp), leech eggs on the hosts' pleopods, 40.5%; Leptasterias sp. (sea star), parasitic gastropods (snail), 10.8%; Leptasterias polaris (sea star), parasitic gastropods, 4.7%; Pagurus capillatus (hermit crab), rhizocephalan (barnacle) parasite, 5.7%; Argis lar (crangonid shrimp), bopyridean (isopod) parasite, 1.2%; Hyas coarctatus alutaceus (spider crab), darkened exoskeleton suspected to be melanization, 7.1%; Argis lar, pale and enlarged eggs, 2.7%. Additional information concerning the prevalence of these abnormalities is given in Table 2.

a. "Parasitic conditions

The leech eggs on S. boreas were found in greatest proportion southeast of St. Lawrence Island (Figure 6); the condition was more prevalent, however, in central and eastern Norton Sound where it occurred in 11 of 16 stations. Incidence of this condition within a haul ranged from 9.6% to 100.0%. The leech eggs were circular, about 1 mm in diameter, and peppered the pleopods; but if the surface area was crowded, they were found on the ventral abdomen and/or on egg clutches (Figure 7). Occurrence was almost exclusively on gravid females whose fanning pleopods would aerate the leech young along with the developing shrimp eggs. Histological examination will reveal the damage, if any, caused the parent shrimp or its offspring by the leech eggs.

The sea stars Leptasterias polaris and Leptasterias sp. carried parasitic gastropods internally in 26 of 41 stations for the former and 16 of 29 stations for the latter, with a range of 0.1% to 75.0% and 1.2% to 37.8% in a haul, respectively. The greatest frequency in Leptasterias polaris occurred near the entrance to Kotzebue Sound (Figure 8); for Leptasterias sp. the highest proportion was found in central Norton Sound (Figure 9). The adult gastropod, a bright orange, bean-shaped lump, varied in size from approximately 1 mm to 27 mm in length, the larger ones distending the ossicles/epidermis of the sea stars (Figure 10, 11). As many as 25 were found in one host, in the central disc as well as in the rays. Identification as a gastropod was affirmed by the presence of shelled veliger larvae within the parent's body mass (Figure 12). The adult gastropod was walled off from the sea star coelom by a thin, clear membrane; further analysis will show whether this is peritoneum or host response to the snail.

Rhizocephalan (barnacle) parasites were noted on the abdomens of hermit crabs, primarily Pagurus capillatus, in 27 of 43 stations involved. The highest proportion in one haul occurred in the northeastern part of the study area; frequency extended from 2.0% to 50.0% (Figure 13).

Argis lar carried bopyridean parasites under the carapace in 23 of 132 stations. The greatest proportion in a haul occurred in southern Norton Sound (Figure 14), and frequency ranged from 0.5% to 88.9%. This parasite was most common in stations less than 25 meters in depth (19 of 63) in Norton Sound and Kotzebue Sound.

b. Discoloration conditions

Darkened and/or eroded exoskeleton was noticed in 12 of 26 stations yielding Hyas coarctatus alutaceus with highest frequency in the southeast Chukchi Sea. Of these crabs, 5.3% to 50.0% were affected in a haul (Figure 15). Since fouling was usually heavy on these animals, it is assumed that this condition, probably melanization, was a result of prolonged periods between molting or its termination altogether.

Argis lar also carried discolored (necrotic) eggs in 17 of the 132 stations investigated, ranging in frequency from 1.2% to 90.0% (Figure 16). These enlarged, pale eggs were seen only in the Chukchi Sea/Kotzebue areas, with highest incidence in Kotzebue Sound (Figure 17). Histological examination in the laboratory may reveal the cause of these mortalities.

c. Miscellaneous conditions

Other conditions were observed which, because of their low frequency or questionable pathological significance, will be mentioned only briefly.

Darkened and/or eroded exoskeleton was also seen in Argis lar in 21 of 132 stations. Although the overall occurrence of 0.6% is not impressive, the 50.0% frequency near the entrance to Norton Sound shows high incidence in patches (Figure 18). A blackened tail condition was associated with gravid females in and near Norton Sound.

Argis lar also had a white "splotch" at the anterior cephalothorax near the rostrum, occurring most heavily (22.2%) at the southern entrance to Kotzebue Sound. This discoloration was no longer evident on the formalin-fixed specimens.

This same species carried a round nodule under the carapace over the gill (0.1%), forming a bump similar to that caused by bopyridean parasites. In 0.2% of Argis lar, the branchiostegal parasites were seen in 0.2% of Crangon dalli and among the pleopods of 3.1% of Eualus sp. (shrimp).

Rhizocephalan parasites were seen on 0.1% of Pagurus trigonocheirus (hermit crab). About 0.1% of the Paralithodes camtschatica (king crab) had darkened/eroded exoskeleton, but this occurred in only 3 of 36 stations. Darkening was also noted in Chionoecetes opilio (tanner crab), Telmessus cheiragonus (crab), Pandalus goniurus (shrimp), Pandalus hypsinotus (shrimp), Crangon dalli (shrimp), and Pagurus trigonocheirus (hermit crab).

It should be noted that the number of stations refers only to those where a particular species was examined, not to all stations where an animal was found.

d. Normal-appearing animals to be examined for microscopic lesions

Some molluscs (snail Neptunea heros, mussel Musculus discors) and coelenterates (anemone Stomphia) were sampled for this purpose but were not consistently studied throughout the cruise. Hepatopancreas samples from Argis lar and Sclerocrangon boreas (crangonid shrimps) and Chionoecetes opilio (tanner crab) have also been preserved for histological review. Bacterial/fungal cultures as well as smears were made from haemolymph of Argis lar and Sclerocrangon boreas.

B. Laboratory Activities

1. Histopathology of fish specimens from the Bering Sea

As part of a continuing effort to better understand the pathological conditions found on fish in the Bering Sea, histopathological examinations of disease specimens at the light and electron microscope levels are being performed. Two new types of neoplasia were found in two different pollock, an infiltrating epidermoid carcinoma associated with a typical pseudobranchial tumor, and a lymphosarcoma consisting of a tumor attached to gills and anterior kidney composed of lymphocyte-like cells which invaded the kidney, liver, and spleen (Figure 19, 20).

Several typical and atypical lymphocystis-like growths which were found on the eyed-side of yellowfin sole (Limanda aspera) were examined. No growths found on the eyed-side body were diagnosed as lymphocystis; one such growth was identified as an osteoma. All lymphocystis growths found on the eyed-side were located on either the dorsal, anal, or caudal fins.

Another significant histopathological finding was an angioepithelial nodule (AEN) on a two to three-year-old female rock sole (Lepidopsetta bilineata). Previous work by us has shown that flatfish from Puget Sound, Washington may develop AEN's between 8 and 10 months after hatching, and these tumors transform into epidermal papillomas between the age of 12 to 16 months. The finding of a two to three-year-old rock sole in the Bering Sea with an AEN suggests that the pathogenesis of the disease may be much slower than in more temperate climates.

2. Microbiological analyses of microorganisms from the Bering Sea

The taxonomic characterization of the bacteria isolated from cod skin ulcers has reduced the number of fish yielding identical isolates to five. The number of isolates being investigated has been reduced to nine. As has been previously reported, these isolates appear to be a species of *Pseudomonas*.

Attempts were made to infect fish cell cultures with extracts of lymphocystis growths from a yellowfin sole. The growths had been maintained in liquid nitrogen (-196°C) and were thawed and homogenized. The extracts were clarified by low-speed centrifugation, and membrane-filtered and unfiltered aliquots were placed in cultures derived from embryonic chinook salmon tissue. The cultures were incubated at 15° and 10°C. After two months, no cellular changes have been detected.

IV. Preliminary Interpretation of the Results

A. Field Activities

The most striking aspect of our investigations of the baseline health status of marine animals in Norton Sound and the Chukchi Sea has been the low frequency of pathological conditions in these areas. Tumors and tumor-like lesions observed in fish of the eastern Bering Sea have been totally absent in this study. Parasitic conditions seem to be the most prevalent and severe conditions encountered. Parasitism may be an indicator of general health in that an animal that has been weakened by other factors may be more susceptible to parasitic infestation. Conversely, parasitism may lower an animal's resistance to environmental insult.

Some of the conditions described may not be proven pathological with further laboratory investigation. For example, the significance of melanization in crustaceans is difficult to assess since it may be the result of mechanical as well as microbial injury. Consequently, most of the conditions will require histopathological analysis to determine if, in fact, they appear to be deterimental to the host, and/or if they are caused by factors other than simple mechanical injury.

The reasons for the lack of recognizable pathological conditions on fish in the Norton/Chukchi area are not clear. Conditions found in the nearby Bering Sea included pseudobranchial tumors of cod (Gadus macrocephalus) and pollock, skin tumors of rock sole (Lepidopsetta bilineata, and the virus-caused lymphocystis of yellowfin sole. The total absence of cod and rock sole and the small numbers of pollock in the study area is one important explanation for the differences between the two areas. However, since yellowfin sole were present in sufficient numbers to detect lymphocystis, it appears likely that in this case the virus or vector responsible for virus transmission is not present in the Norton/Chukchi area.

Other disease-causing factors may be in the Norton/Chukchi area at reduced levels compared to the Bering Sea. For example, pseudobranchial tumors are presently known to be in three species of gadids, Pacific cod, pollock, and Atlantic cod (Gadus morhua). It is possible that all gadids are susceptible to this disease; nevertheless, over 10,000 saffron cod and 2,952 Arctic cod (Boreogadus saida) were examined in the Norton/Chukchi area and no tumors were found. Either the hypothesis concerning the universal susceptibility of gadids to these tumors is not valid, or the saffron and Arctic cod we examined were not exposed to the tumor-inducing factor.

The low density of fish in the Norton/Chukchi area may be another contributing factor for the absence of fish diseases in this region.

Fish capable of transmitting an infectious agent which may enter this area may not come in close enough contact with other fish for transmission to occur.

It is difficult to assess at this time the pathological effects of the "black spot" disease on the Pacific herring, toothed smelt, and Saffron cod. Cryptocotyle lingua, a trematode that has metacercariae very similar in appearance to the trematode we found in the above species, has been reported to cause "black spot" condition in cod (G. callarias), plaice (Pleuronectes platessa), and herring (Clupea harengus) in the Atlantic Ocean. Cercariae of C. lingua have been experimentally shown to blind and kill immature herring. Nevertheless, the species examined in the Norton/Chukchi area with the "black spot" condition did not appear to be adversely affected.

B. Laboratory Activities

So far, three invasive forms of neoplasia have been found in pollock from the Bering Sea; pseudobranchial tumors, a lymphosarcoma, and an epidermoid carcinoma. All three types are obviously very detrimental to the affected animals, and may play a significant role in the population dynamics of this species.

Our original observation that yellowfin sole develops lymphocystis only on the blind side has been reconfirmed with only minor exceptions; the eyed-side of the dorsal, anal, and caudal fins may have growths. Therefore all lymphocystis lesions may be initiated by contact of the blind side with an abrasive substrate contaminated with virus or in the presence of water-borne virus. Also, failure of attempted in vitro infectivity tests suggests that this virus may be species specific.

V. Problems Encountered

No significant problems were encountered.

VI. Estimate of Funds Expended (October 1 - December 31, 1976)

Salaries	$8,485.00
Travel	1,495.00
Shipping	14.00
Phone	82.00
Services	97.00
Supplies	61.00
University of California (Subcontract)	5,731.00
Total	$15,965.00

Table 1

Major fish species exhibiting no significant pathology

Species	No. examined	No. of stations where examined
Pleuronectes quadrituberculatus (Alaska plaice)	1,423	104
Limanda aspera (Yellowfin sole)	3,279	88
Platichthys stellatus (Starry flounder)	739	82
Boreogadus saida (Arctic cod)	2,952	135
Agonus acipenserinus (Sturgeon poacher)	53	12
Theragra chalcogramma (Walleye pollock)	270	26
Mallotus vellosus (Capelin)	215	10
Limanda probiscidea (Longhead dab)	322	19
Hippoglossoides robustus (Bering flounder)	144	42
Liparid sp. (5 species) (Snail fish)	267	13
Myoxocephalus sp. (3 species) (Sculpin)	480	28
Liopsetta glacialis (Arctic flounder)	63	15
Other (7 species)	69	19

Table 2

The average disease frequency, the numbers of hauls out of 214 total hauls in which a diseased species was captured, and the average frequency of the hauls in which diseased animals were present for each of the major pathological conditions

Species and condition	No. examined	No. affected	Average disease frequency (%)	No. of hauls with species	No. of hauls with affected animals
Clupea harengus pallasi (Pacific herring) "black spot"	2,027	92	4.5	115	17
Osmerus mordax dentax (Toothed smelt) "black spot"	3,772	146	3.9	26	24
Eleginus gracilis (Saffron cod) "black spot"	10,826	91	0.8	128	15
Sclerocrangon boreas (Shrimp) Leech eggs	672	272	40.5	29	18
Leptasterias sp. (Sea star) Parasitic gastropod	747	81	10.8	28	16
Hyas coarctatus alutaceus (Spider crab) Dark/eroded exoskeleton	645	46	7.1	26	12
Pagurus capillatus (Hermit crab) Rhizocephalan parasite	1,529	87	5.7	43	27
Leptasterias polaris (Sea star) Parasitic gastropod	5,231	244	4.7	51	26
Argis lar (Shrimp) Pale, enlarged eggs	6,704	183	2.7	132	17
Bopyridean parasite	6,704	83	1.2	132	23

Table 3

Major invertebrate species exhibiting no significant pathology

Species	No. examined	No. of stations where examined
Chionoecetes opilio (Tanner crab)	5,036	66
Pagurus trigonocheirus (Hermit crab)	1,692	39
Pandalus goniurus (Shrimp)	636	21
Strongylocentrotus drobachiensis (Sea urchin)	617	25
Crangon dalli (Shrimp)	598	27
Labidochirus splendescens (Hermit crab)	447	18
Paralithodes camtschatica (King crab)	400	36
Telmessus cheiragonus (Crab)	269	22
Other (16 species)	330	48

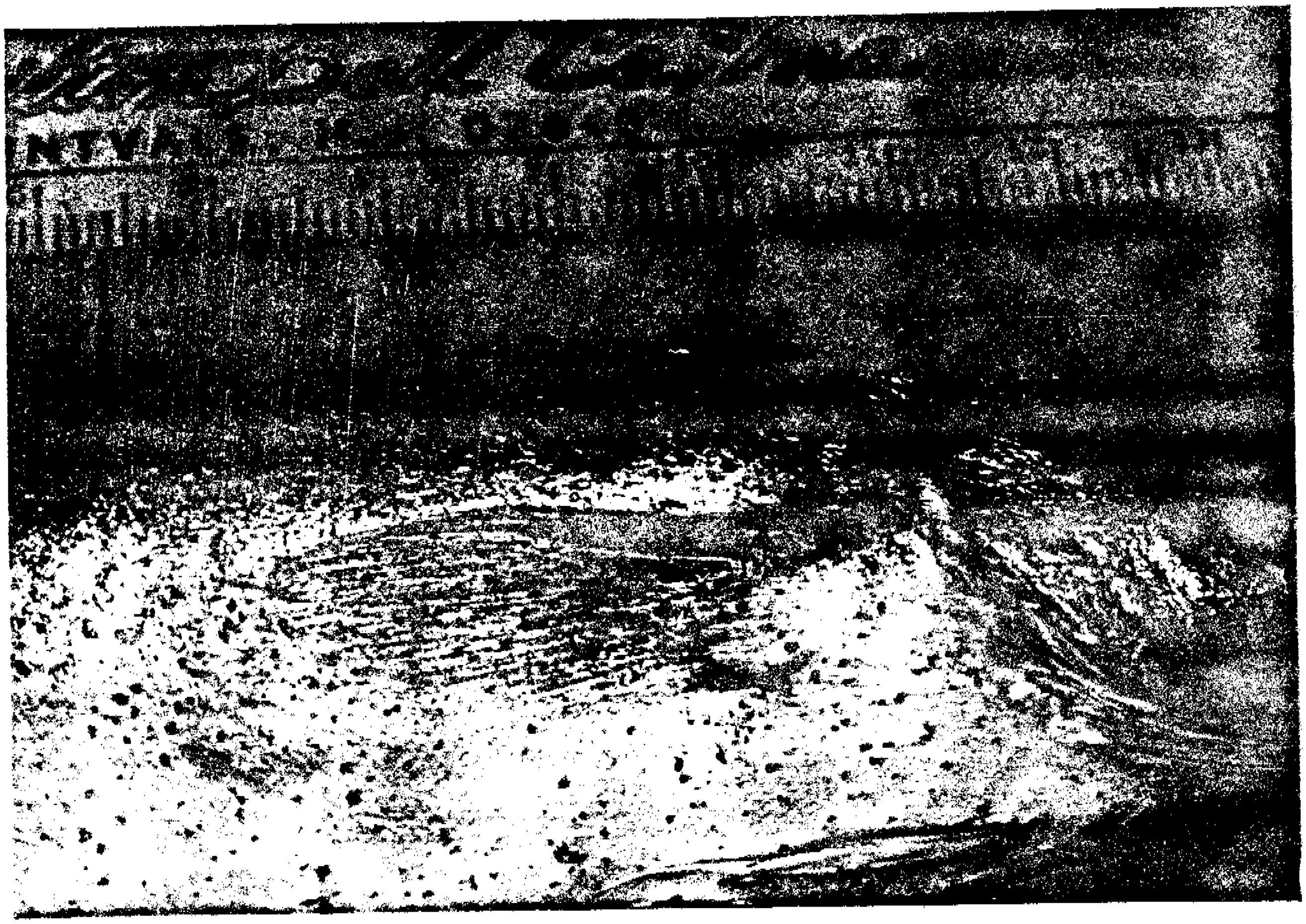


Figure 1. Saffron cod with numerous "black spots" on its skin.

Figure 2. A photomicrograph of a "black spot" in the pectoral fin of a saffron cod. Encysted area contains a larval helminth. (Magnification: 450X).

Fig. 3. Frequencies of "black spot" in Smelt at haul stations where this species was caught

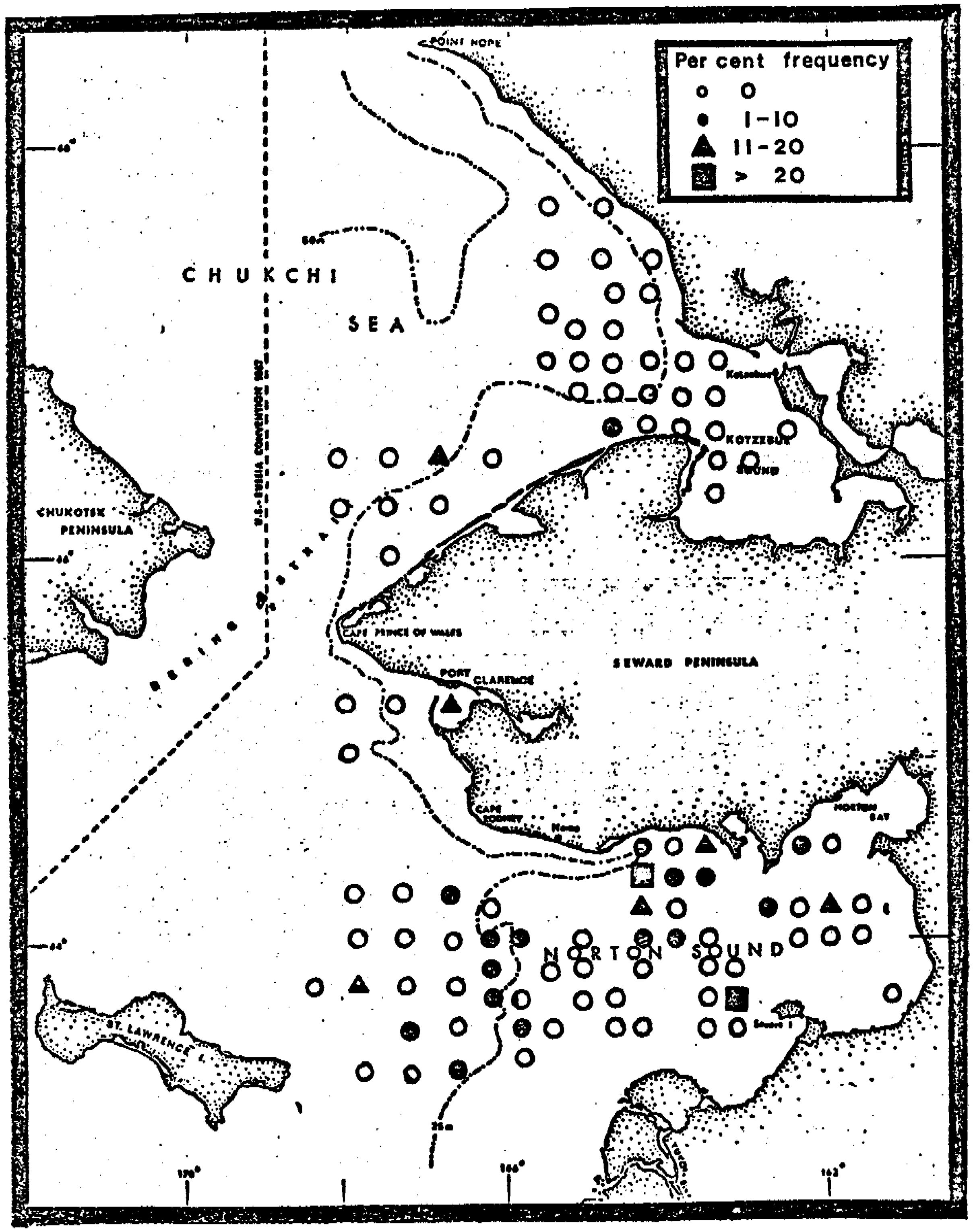


Fig. 4. Frequencies of "black spot" in Saffron Cod at haul stations where this species was caught

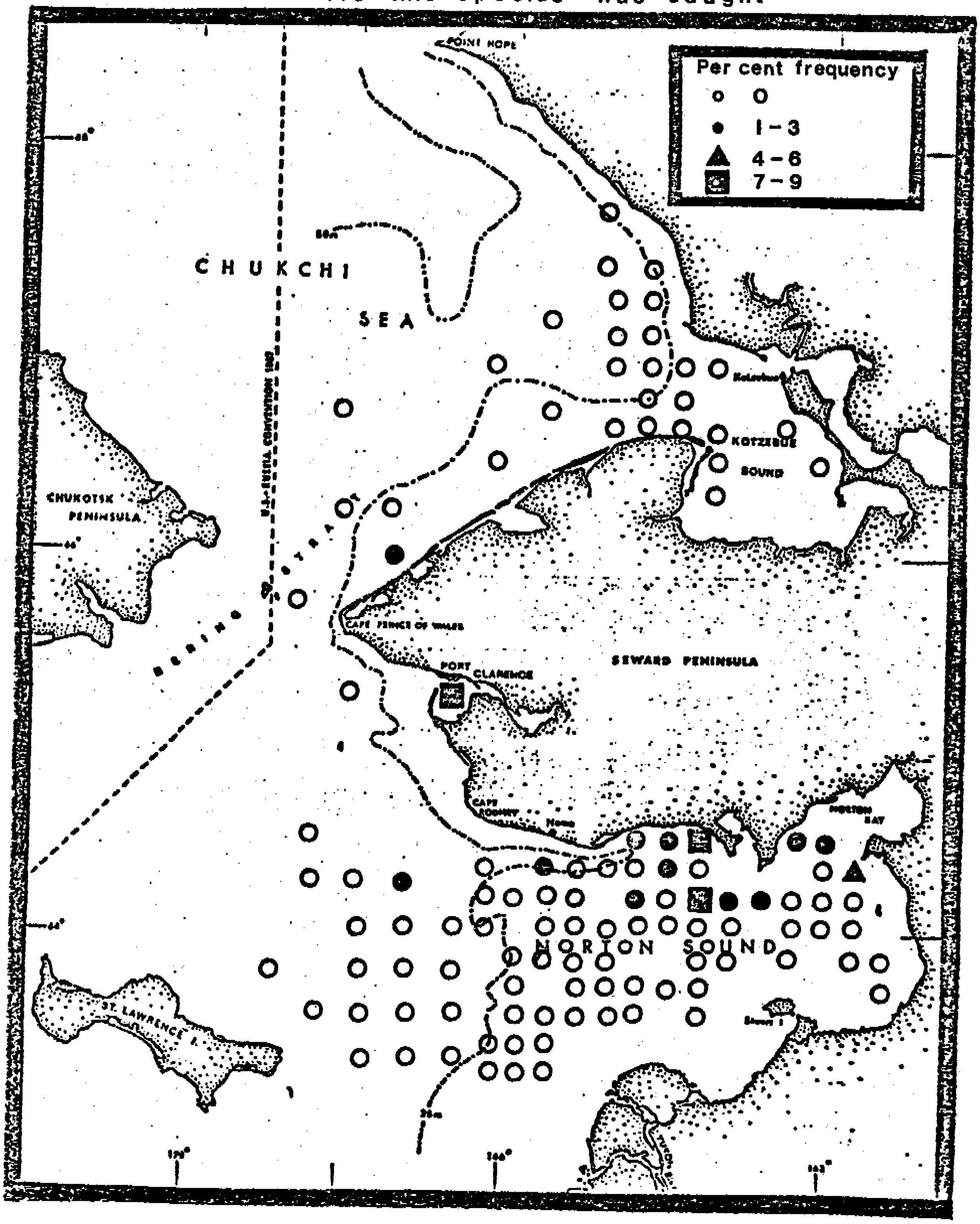


Fig. 5. Frequencies of "black spot" in Herring at haul stations where this species was caught

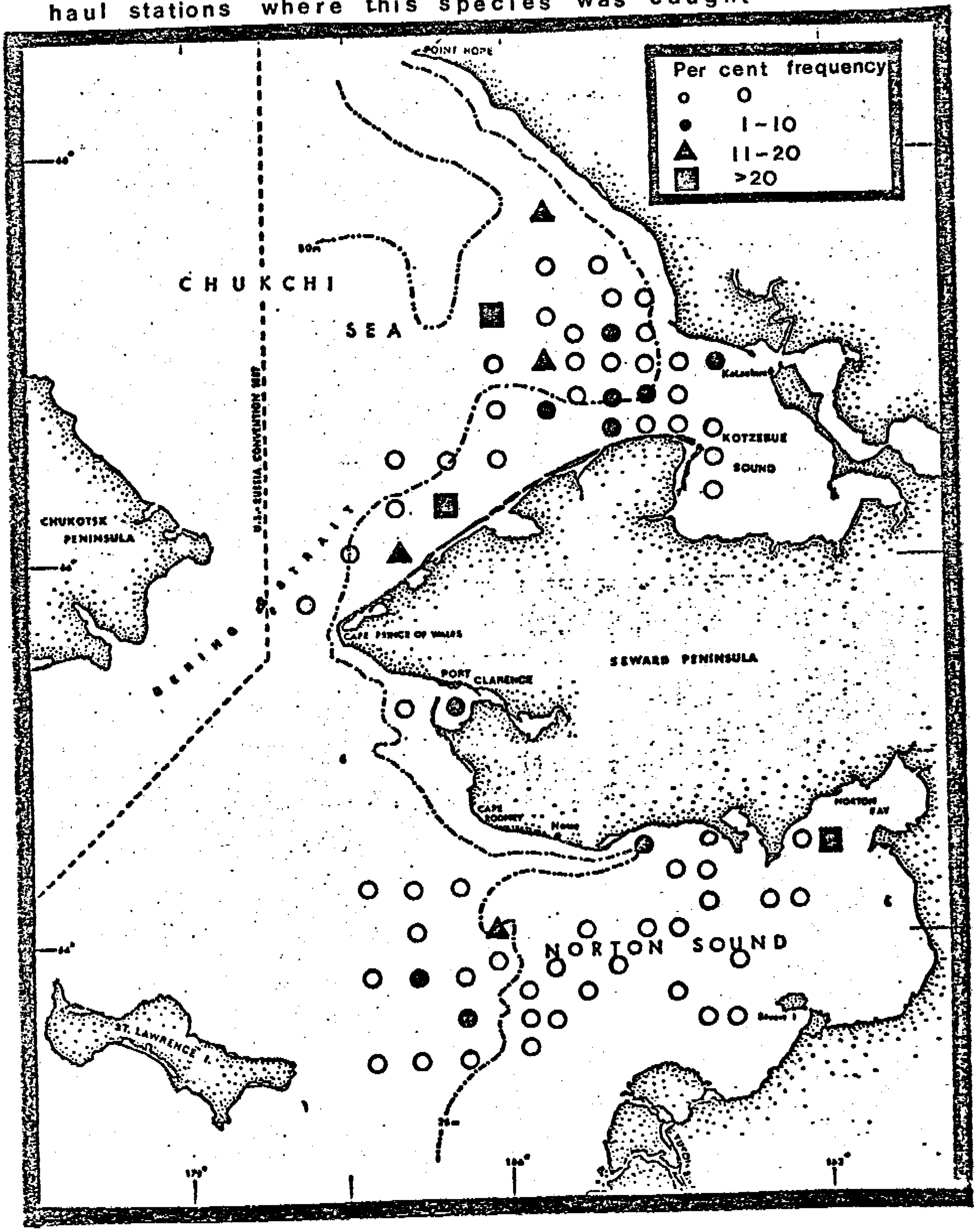


Fig.6. Frequencies of leech eggs on <u>Sclerocrangon boreas</u> at haul stations where this species was caught

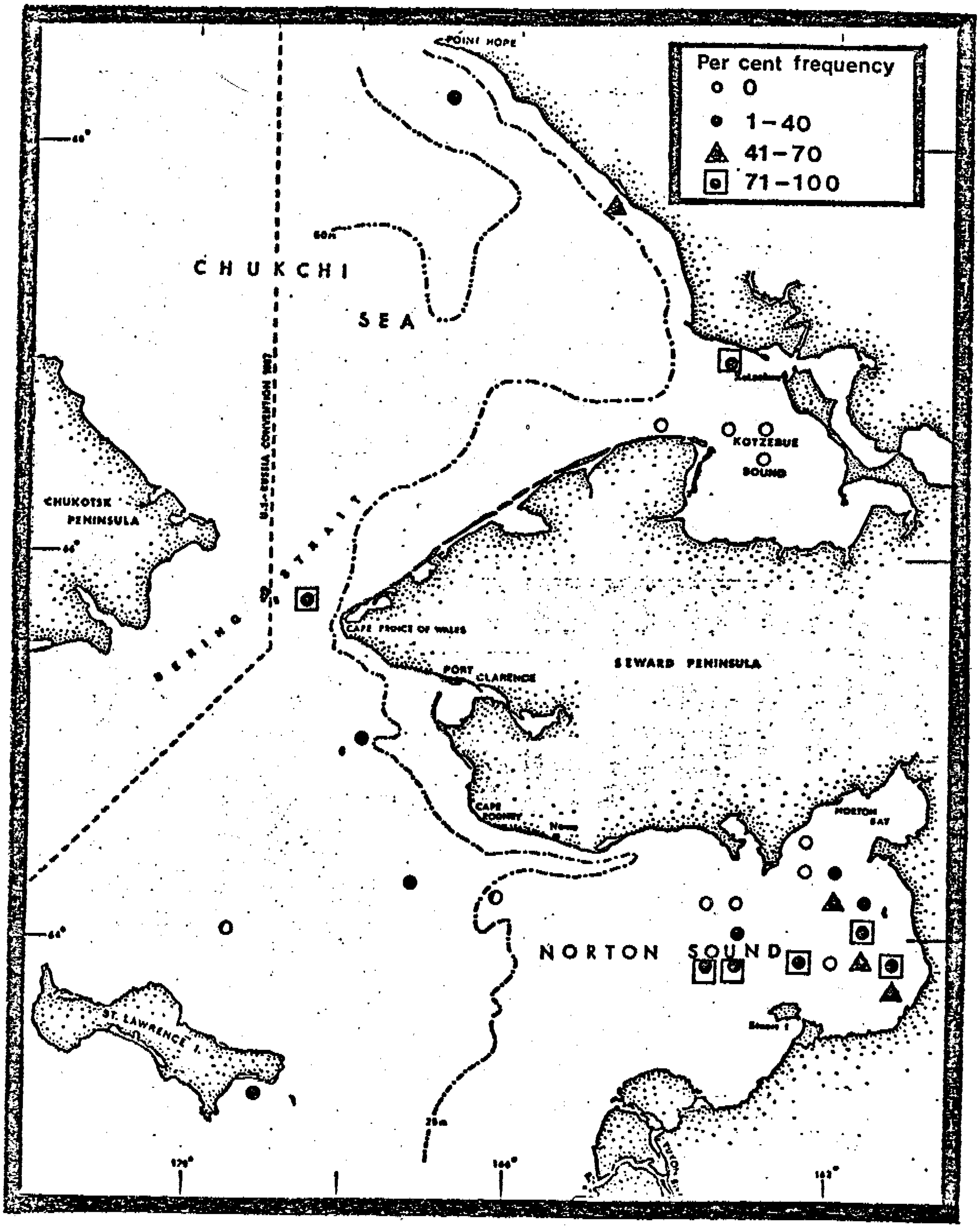


Figure 7. Leech eggs (arrow) on pleopods of gravid *Sclerocrangon boreas*.

Fig. 8. Frequencies of parasitic gastropods in Leptasterias polaris at haul stations where this species was caught

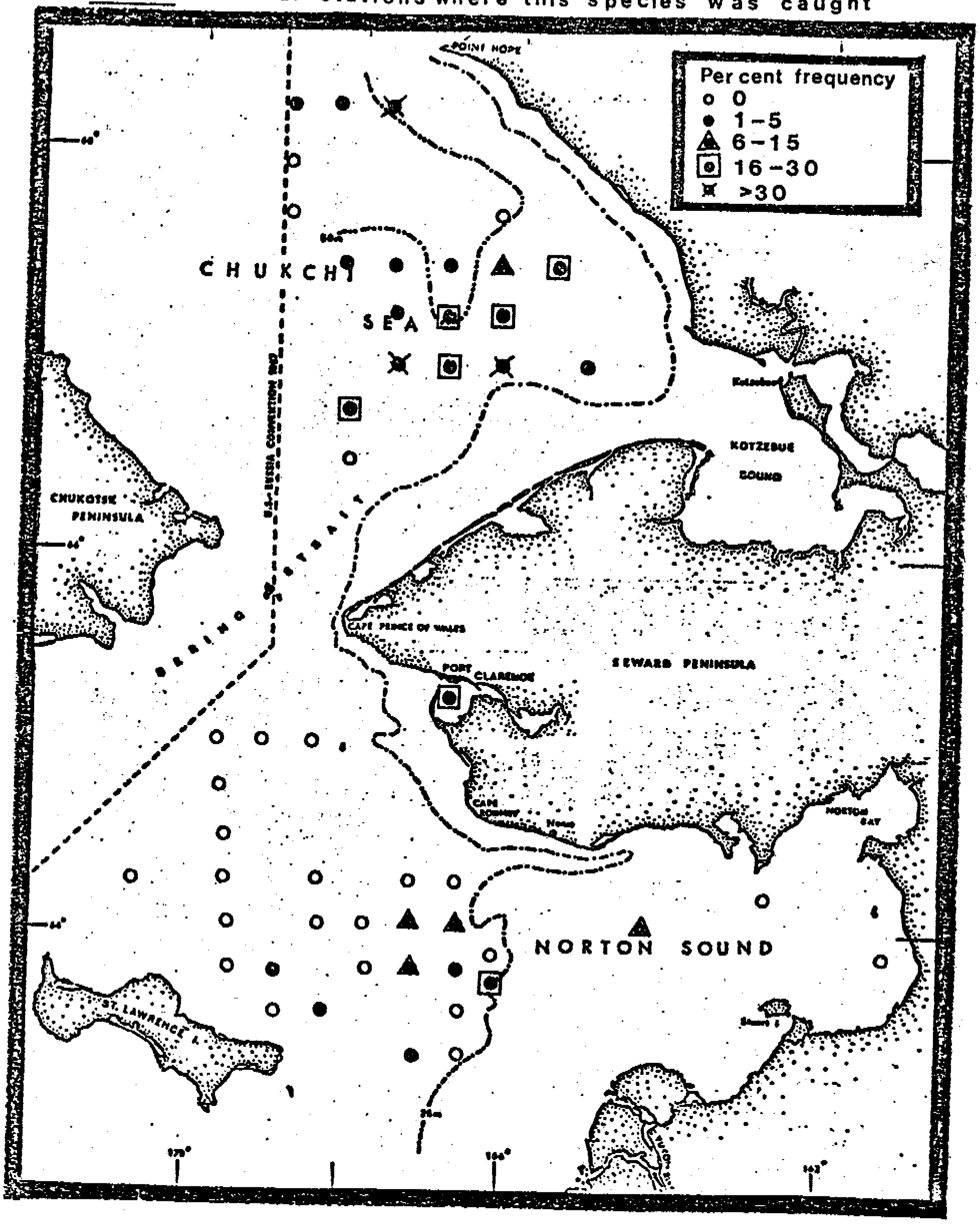
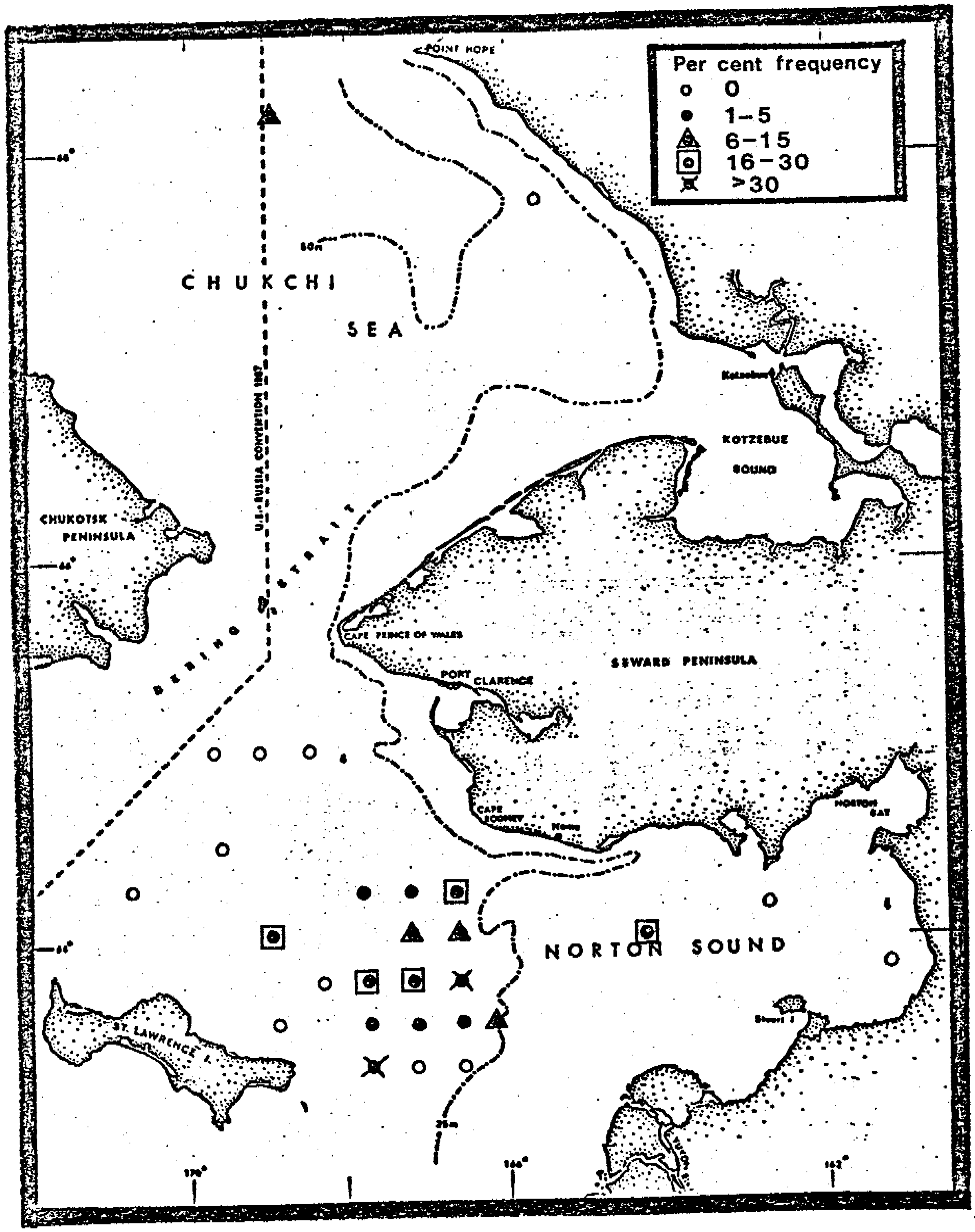


Fig. 9. Frequencies of parasitic gastropods in <u>Leptasterias</u> sp. at haul stations where this species was caught



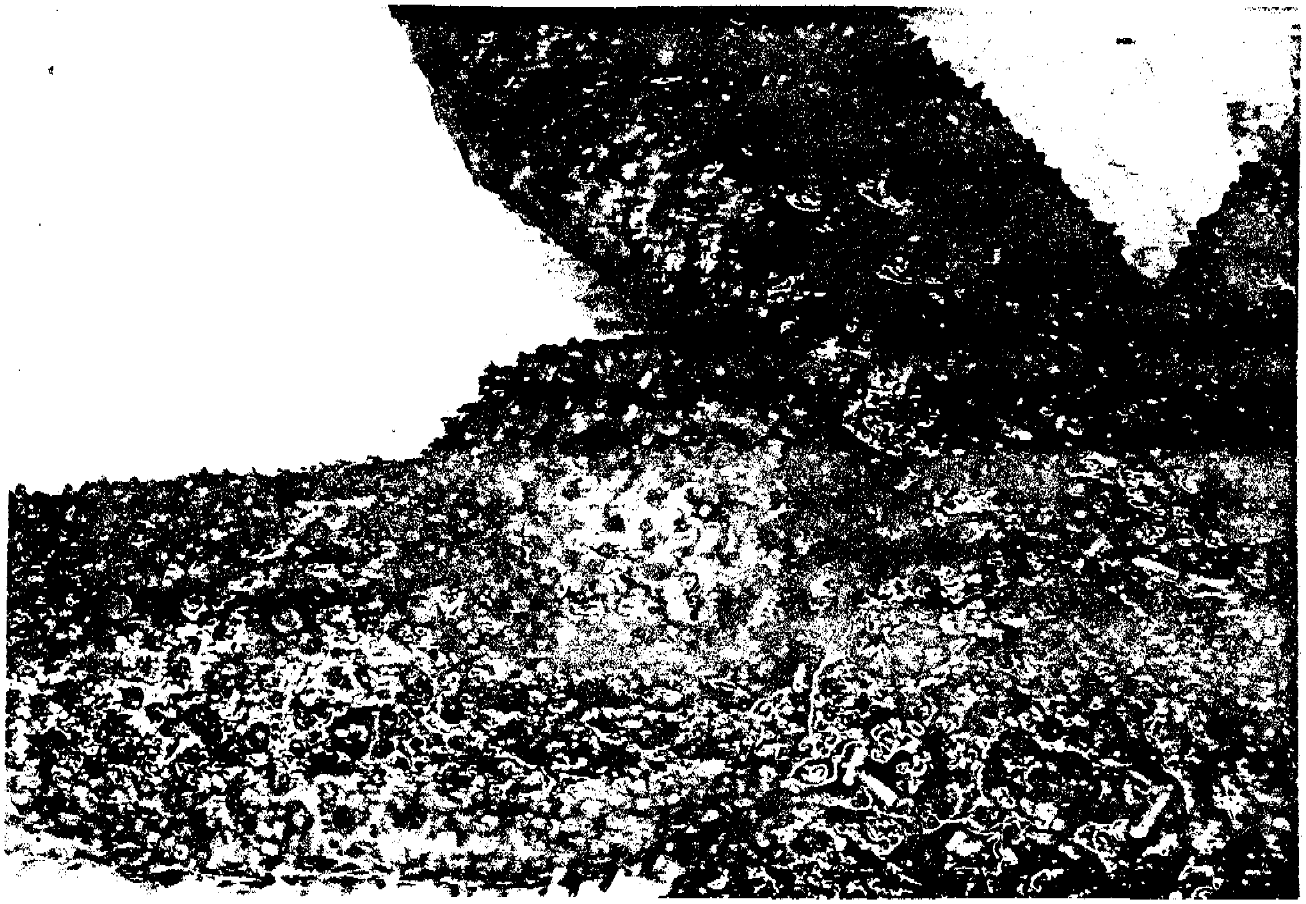


Figure 10. Parasitic gastropod distending the surface of *Leptasterias polaris*.

Figure 11. Adult parasitic gastropod (S) in Leptasterias polaris; another parasite, Dendrogaster (D), apparently not associated with the gastropod.

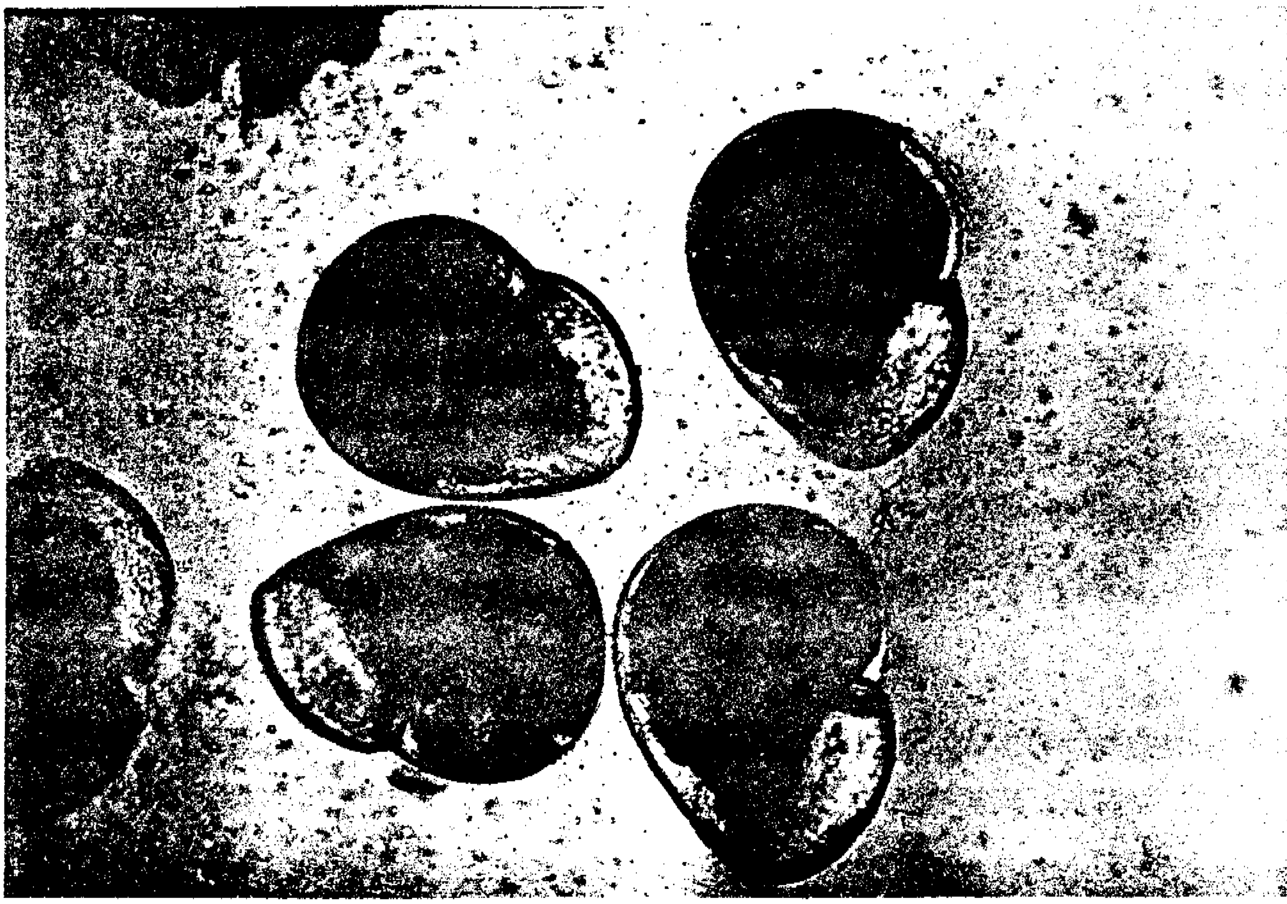


Figure 12. Veliger larvae found in body mass of adult parasitic gastropod in *Leptasterias polaris* (150X).

Fig.13. Frequencies of rhizocephalan parasites in *Pagurus capillatus* at haul stations where this species was caught

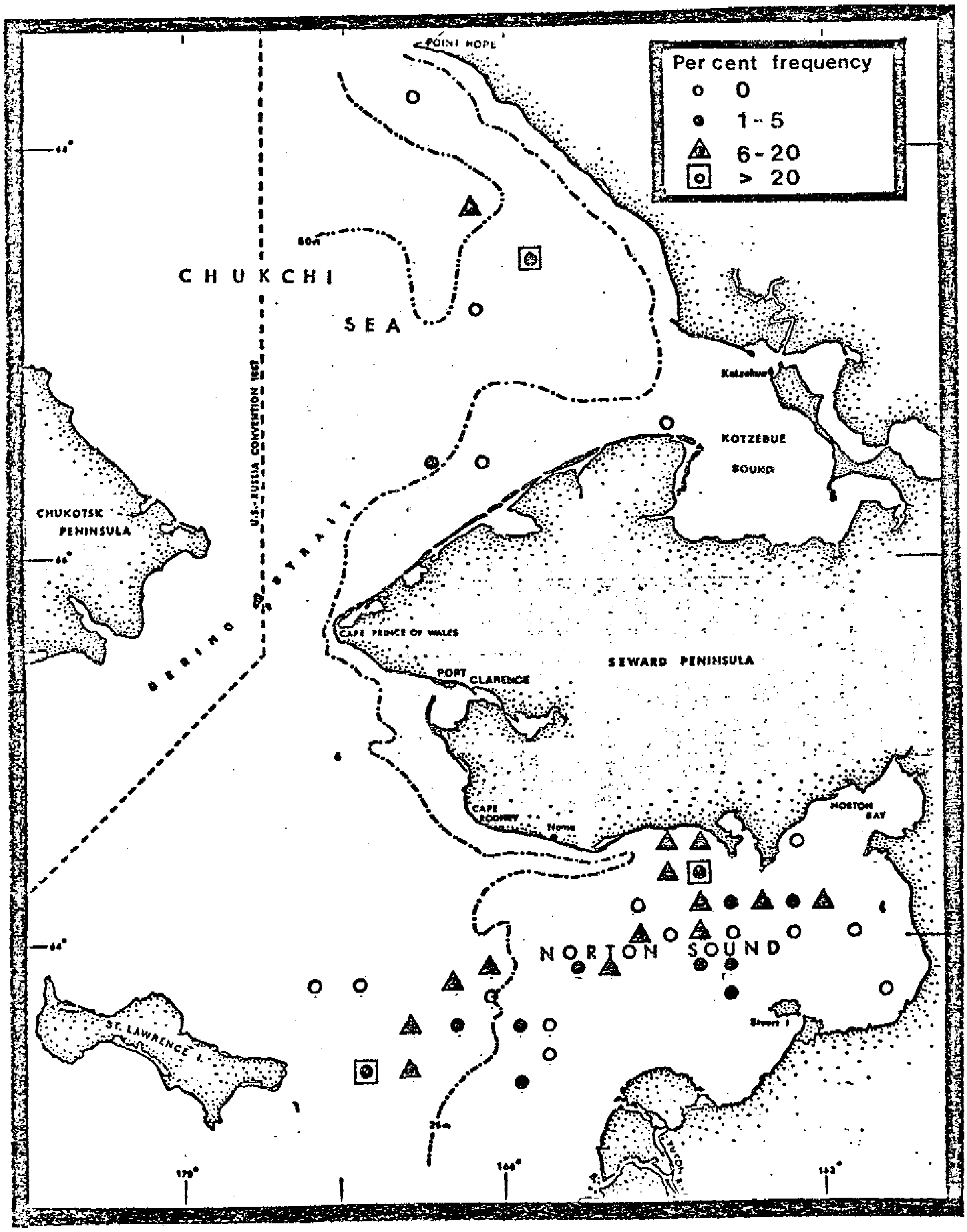


Fig. 14. Frequencies of bopyridean parasites in Argis lar at haul stations where this species was caught

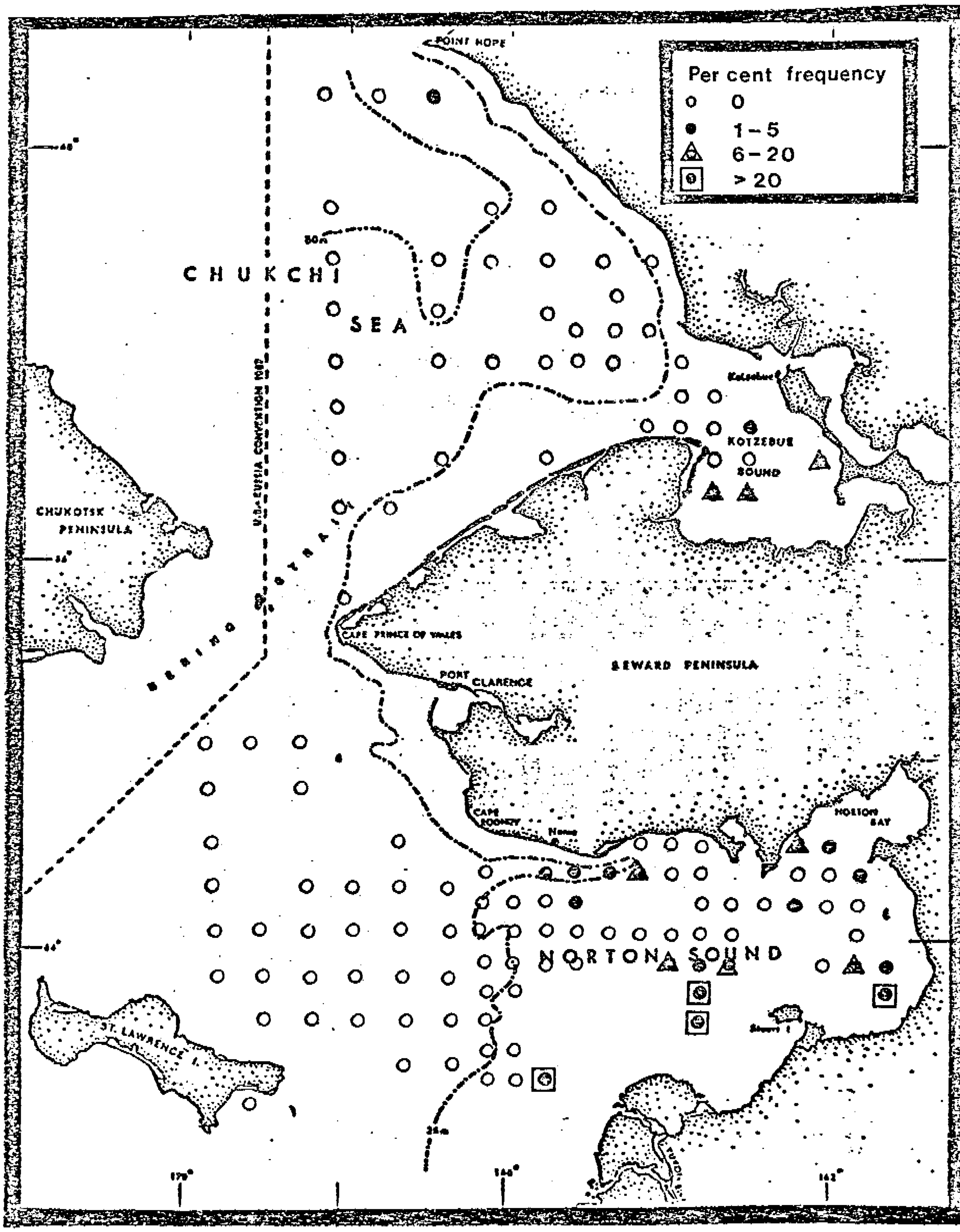


Fig.15. Frequencies of "melanization" on <u>Hyas</u> <u>coarctatus</u> <u>alutaceus</u> at haul stations where this species was caught

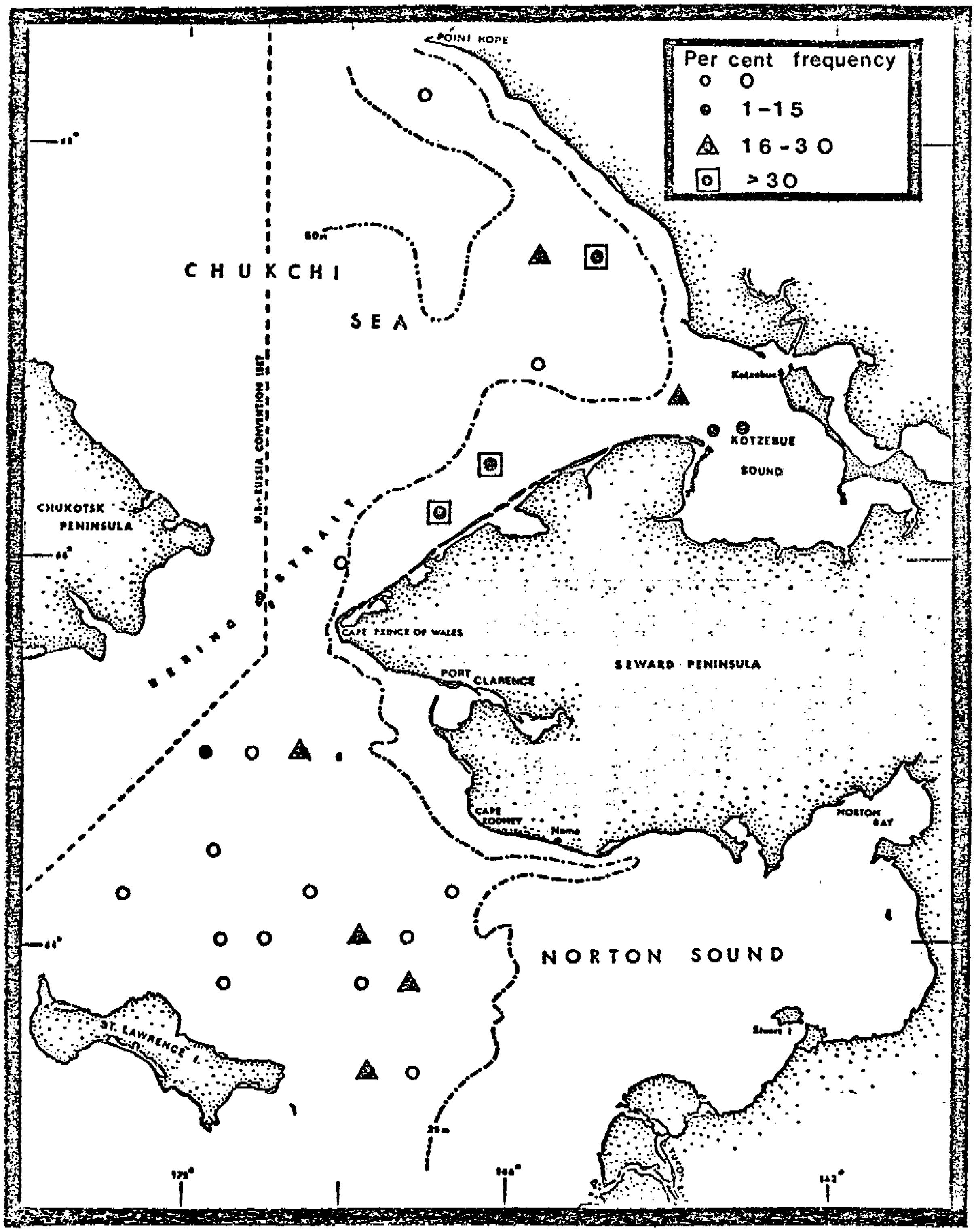
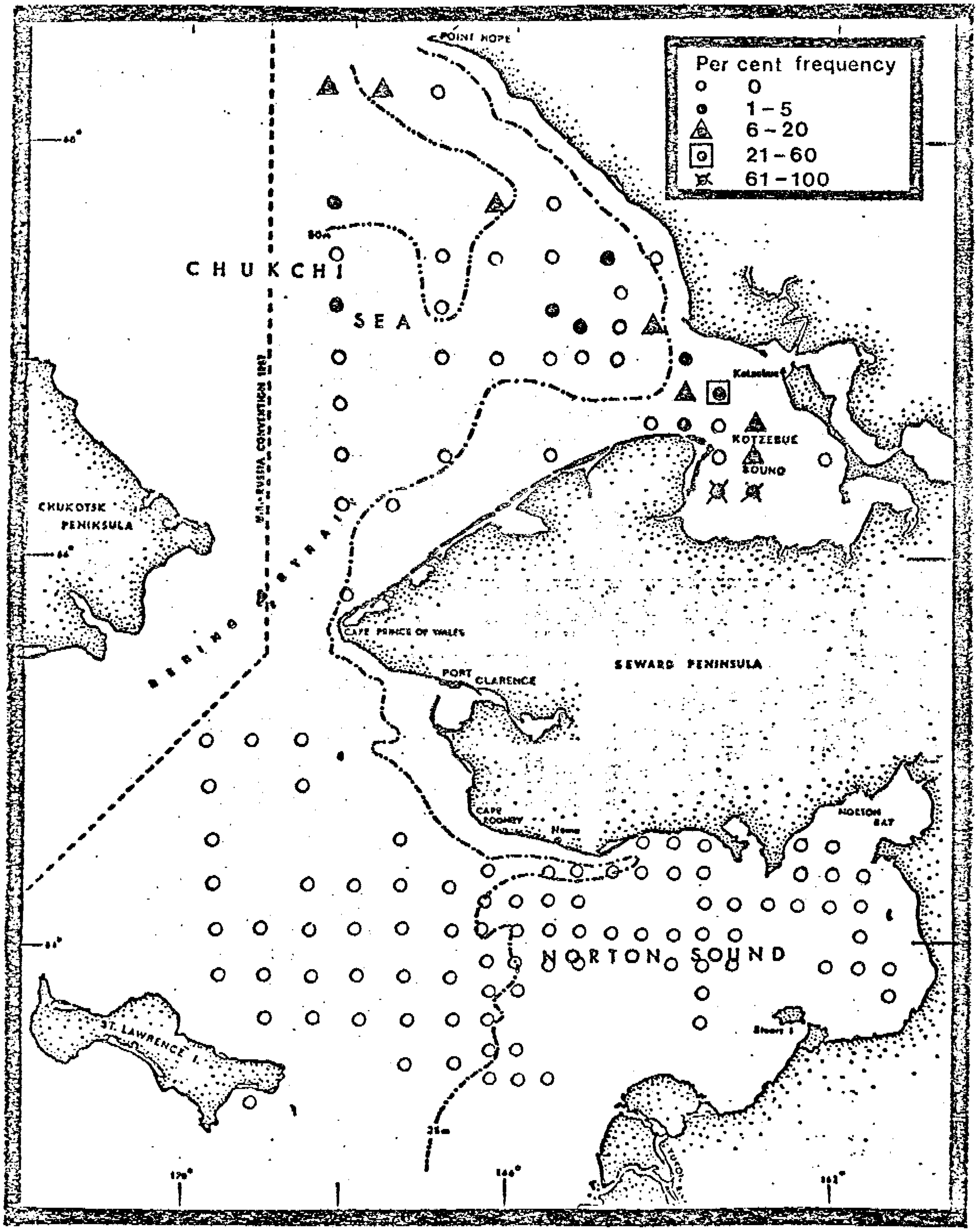


Fig.16. Frequencies of pale eggs in Argis lar at haul stations where this species was caught



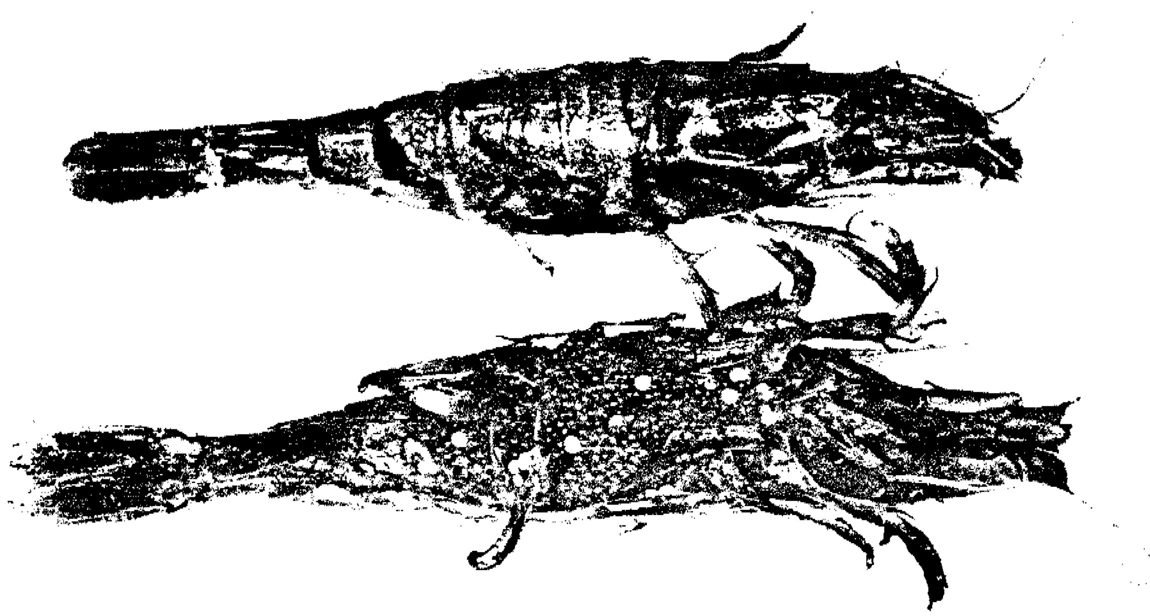


Figure 17. Pale eggs (necrotic) on Argis lar.

Fig.18. Frequencies of "melanization" in Argis lar at haul stations where this species was caught

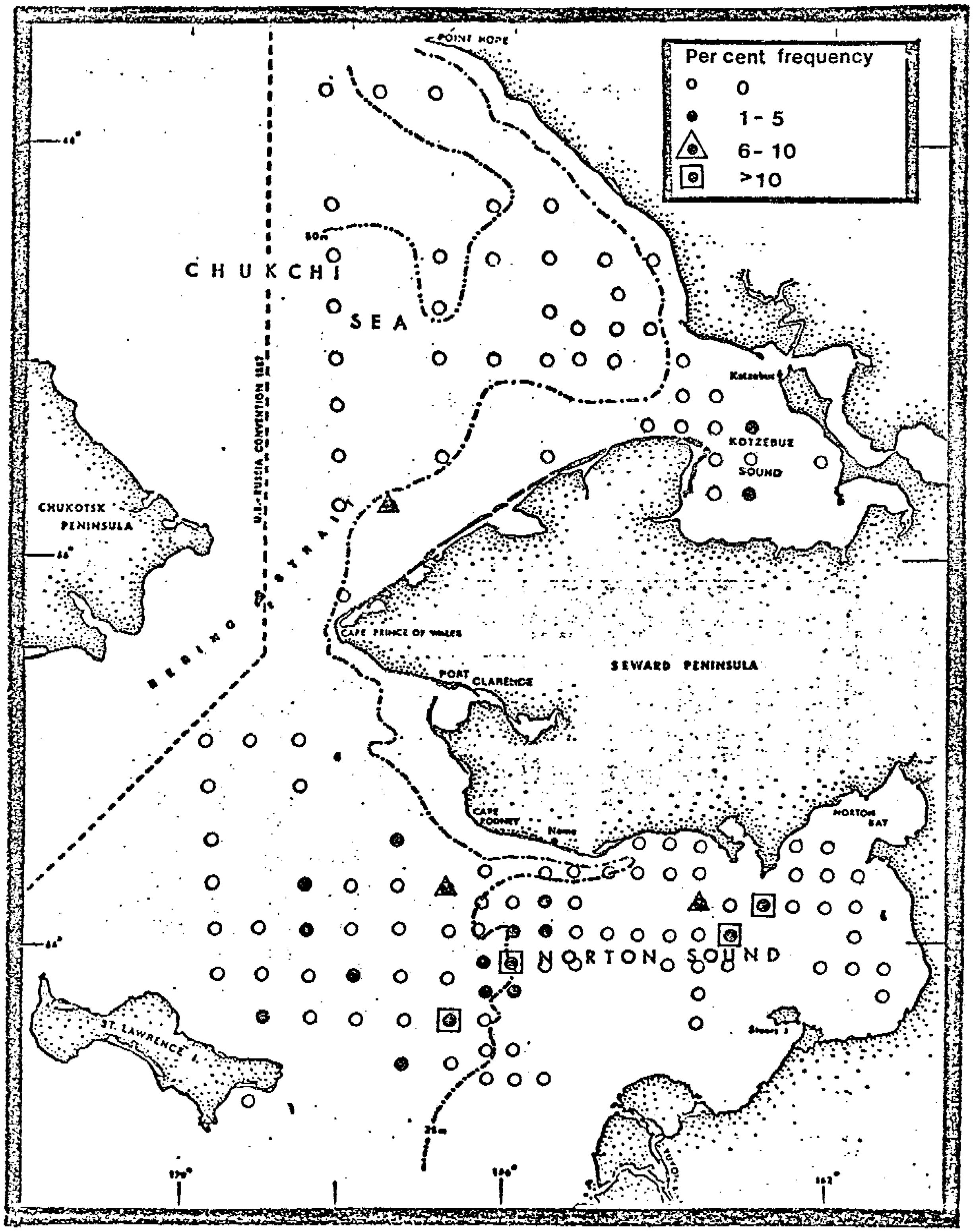


Figure 19. A photomicrograph of a pseudobranchial tumor (T) from a pollock which has given rise to, or been invaded by, an infiltrating epidermal carcinoma (E). (Hematoxylin and eosin stain, 110X).

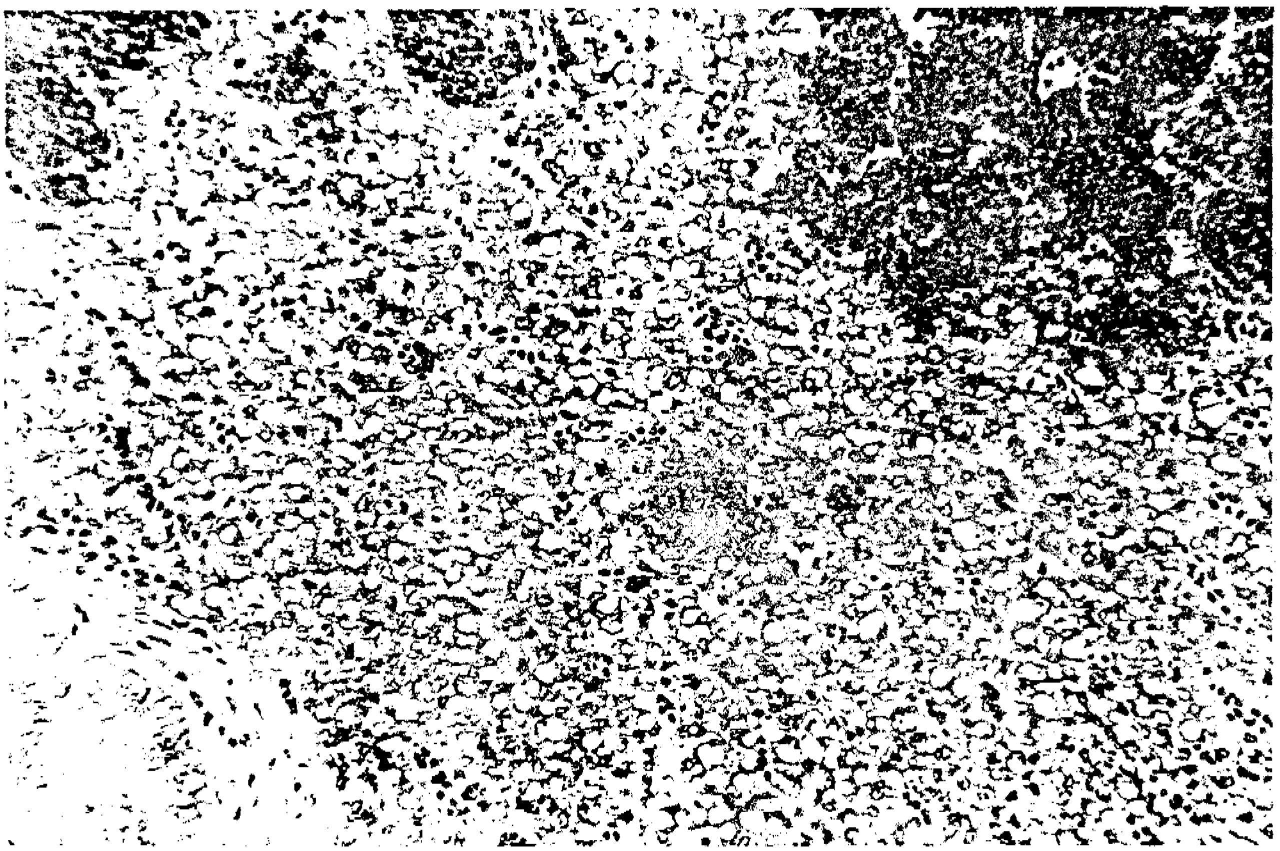


Figure 20. A photomicrograph of a liver from a pollock which has been invaded by a lymphosarcoma (L). The primary tumor was located next to the gills in the opercular region and had also spread to the kidney and spleen. (Hematoxylin and eosin stain, 270 X).

Quarterly Report

Contract #03-5-022-56
Research Unit #427
Task Order #1
Reporting Period 10/1 - 12/31/76
Number of Pages 2

PHYTOPLANKTON STUDIES IN THE BERING SEA

Dr. Vera Alexander
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

January 1, 1977

I. Task Objectives

To study the dynamics of the phytoplankton populations at the edge of the retreating ice pack in the Bering Sea in order to assess the significance of the ice edge in the productivity of the Bering Sea. Also, in order to estimate the relative importance of ice-related production, to also study the productivity rates during the ice-free season in the Southeast Bering Sea. The distribution and seasonality of algae growing in the sea-ice-water interface is also being assessed. The role of these various productivity regimes in the food web is being assessed. The role of these various productivity regimes in the food web is being approached using Coulter Counter grazing experimental techniques.

II. Field Activities

None. This period was provided only with a maintenance budget, and even this money has not materialized. No field work could be undertaken. The three-month period has been spent as follows:

1. Moving the laboratory to new quarters and setting up the autoanalyzer

2. Work has begun, and almost completed on the nutrient samples from the Surveyor cruise Su 001.

3. Phytoplankton counts for SU 001 are almost completed and compiled.

4. All primary productivity, chlorphyll, pH and alkalinity data from Surveyor SU 001 have been calculated and compiled.

5. A start has been made on modeling the ice-edge regime. Dr. Katherine Green visited the University of Alaska at Fairbanks for two days and the proposed model has been outlined and a preliminary matrix has been established. She spent time in discussion with all persons potentially involved (Dr. R. T. Cooney, Dr. R. J. Barsdate, Dr. C. Geist and Dr. V. Alexander). She also discussed the relationship between this proposed model and the PROBES model with Dr. C. P. McRoy.

III. Results

The major success of last year's field work has been the delineation of the timing of the spring ice-edge bloom, and from this we have concluded that to complete the picture, we now need some more data from late April through mid-May. The major facet still lacking in our data is the importance and distribution of the underice bloom, and we hope to design a sampling program to approach this this spring. With this information in hand, we can begin an assessment of the relative importance of the various production regimes, and then go on to concentrate more extensively on the food chain implications.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 1 R.U. NUMBER: 159/164

PRINCIPAL INVESTIGATOR: Dr. Vera Alexander

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	4
Discoverer Leg I #808	5/15/75	5/30/75	submitted	submitted	None	None
Discoverer Leg II #808	6/2/75	6/19/75	submitted	submitted	None	None
Discoverer Leg I #810	8/9/75	8/28/75	submitted	submitted	None	None
Miller Freeman #815	11/10/75	11/26/75	submitted	submitted	None	None
Surveyor Su/001/2	3/76	4/76	(a)	(a)	None	None

Note: [1] Data Management Plan and data Formats have been approved and are considered contractual.

(a) These samples will be processed, pending funding for October - December 1977, as requested by proposal submitted 9/13/76. Data submission will be made 120 days after end of processing as per contract.

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