Environmental Assessment of the Alaskan Continental Shelf

Environmental Assessment of the Alaskan Continental Shelf

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

ENVIRONMENTAL RESEARCH LABORATORIES
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VOLUME I

CONTENTS

MARINE MAMMALS

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Fourth Quarter Report

Contract No. R7120804(suppl.)
Research Unit 14
Period 1 April - 30 June 1976
Number of pages 13

Distribution of the Pacific Walrus

Principal Investigators

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28 June 1976

Fourth Quarterly Report, April - June, 1976

I. Task Objectives.

The Pacific Walrus (Odobenus rosmarus) occurs in the Bering Sea in the winter and spring and is thought to concentrate in two areas; southwest of St. Lawrence Is. and N/WBristol Bay. Through the use of aerial surveys we will further delineate late winter and spring distribution (March to May) and will monitor spring migration of walrus through mid June. Additionally, information will be collected regarding group (pod) size and herd composition. Particular attention will be paid to proposed oil-gas lease site areas (Bristol Bay Basin, Norton Basin and Hope Basin).

II. Field or Laboratory Activities.

A. Ship or Field Trip Schedule:

	Dates	Location	Aircraft	Charter
1.	6-19 April	King Salmon	N780 Goose	OAS
2.	13-23 April	Nome	P2V	OAS
3.	8-15 June	Nome/King Salmon	N780 Goose	OAS

B. Scientific Party:

1. 6-23 April, 1976 — Dr. Howard W. Braham, Principal Investigator
Mr. Bruce Krogman, Field Coordinator
Mr. Robert Everitt and Mr. Keith Parker
Marine Mammal Division
Northwest Fisheries Center
Seattle, Washington

2. 8-15 June, 1976 - all of the above except Keith Parker.

C. Methods:

Sightings of marine mammals were made from aircraft flying at altitudes between 200 and 1500 feet. Visual estimates and photographic records were made to verify species identification and numbers of animals seen. Walrus surveys over ice were flown at 500' to 1500'; 500 to 700 feet for normal photographs and counts and 1500 feet for overview photos and for locating pods when not flying randomly selected transects.

At least three observers were used during each survey; one acted as the recorder and two as observers. Most surveys used a stratified random series of transects or systematic transects depending upon the area or type of animal to be surveyed (e.g. open leads for bowhead whales, etc). Note: RU 14 surveys were flown with those for RU 67 and RU 69. By using these methods of sampling an unbiased estimate of the number of animals observed can be made; representing a statistically reliable procedure for ascertaining species abundance.

Each transect flown, whether random or systematic, is in actuality a duplicate strip census. That is, both sides of the aircraft (Super Goose) are used to observe out to one-half mile from 90° vertical to the side of the aircraft. Animals directly below the airplane were not scored (i.e. could not be observed). This method in essence allows one to obtain duplicate samples of adjacent habitat. Approximately 1/7 th. of a mile at 500 feet and 1/5 th. of a mile at 700 feet are not surveyed using the Super Goose. All animals are sampled within a one mile wide transect using the P2V.

D. Aerial survey locations and tracklines flown:

1. 6-15 April, Bristol Bay (Figure 1).
2. 13-15 April, Northern Bering Sea (Figure 1 and 2).
3. 17-19 April, Bristol Bay (Figure 3).
4. 19-23 April, Northern Bering Sea (Figure 2).
5. 8-14 June, Northern Bering/Southern Chukchi Sea (Figure 4-5).
6. 14 June, Northern Bristol Bay (Figure 6).

E. Data collected or analyzed:

	Data Recordings[+]	Trackline Miles[++]
1. 6-12 April, 17-19 April	1,330	4,350
2. 13-15 April, 19-23 April	1,279	3,300
3. 8-14 June	2,407	3,690
Totals	5,016	11,340

[+]A data recording is a single logged entry at a specific time and location and represents one or more animals sighted; or, environmental data. All values are approximate at this time.

[++]In nautical miles.

III. Results.

The numbers of walruses observed this spring have been summarized in Table 1. These values are only tentative as most have been taken from field log sheets. Final verification of most walrus pods observed will come from tabulation of the photographs taken throughout the spring (final photo interpretation is in process). Data from March is included in Table 1 as it was not presented during the 3rd quarter reporting period.

IV. Preliminary interpretation of results.

March surveys conducted adjacent to St. Lawrence Is. identified a large concentration of walrus just north of the Island. Relatively few animals were observed to the southeast, east or southeast at that time. These results immediately suggest that the spatial distribution of this species is more dynamic than had been thought for this area; or, it represents a shift in their hauling-out behavior this year. We will explore this interesting situation and report on our thoughts in detail for the final report.

Walrus were found throughout the entire Bristol Bay study area during early to mid April, except that no animals were observed in the shallow northern portion of the Bay. Again, these results suggest walrus seem to utilize the whole

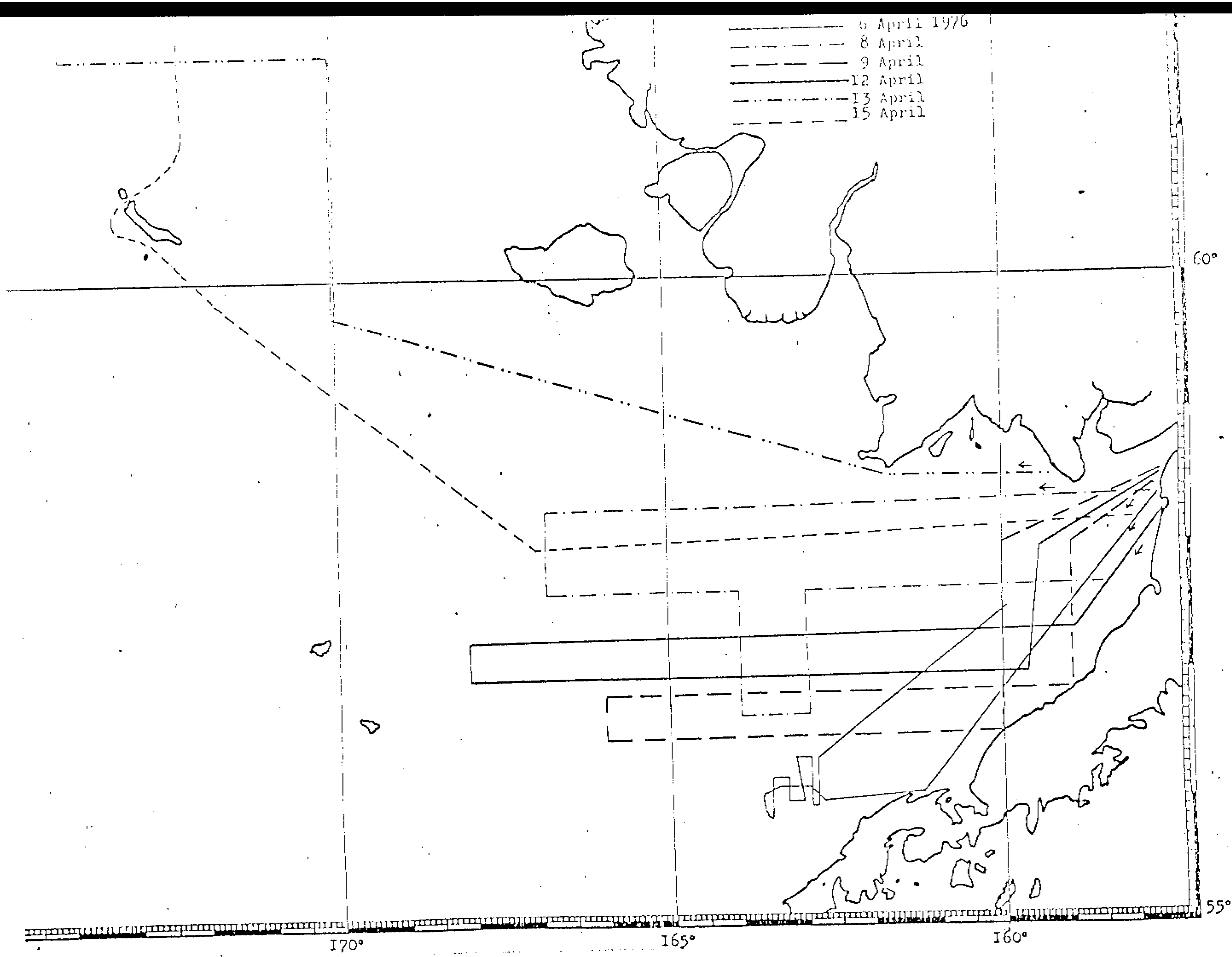

Figure 1. Marine mammal aerial survey tracklines in Bristol Bay during April, 1976 (RU 67-A4 and RU 14-A1).

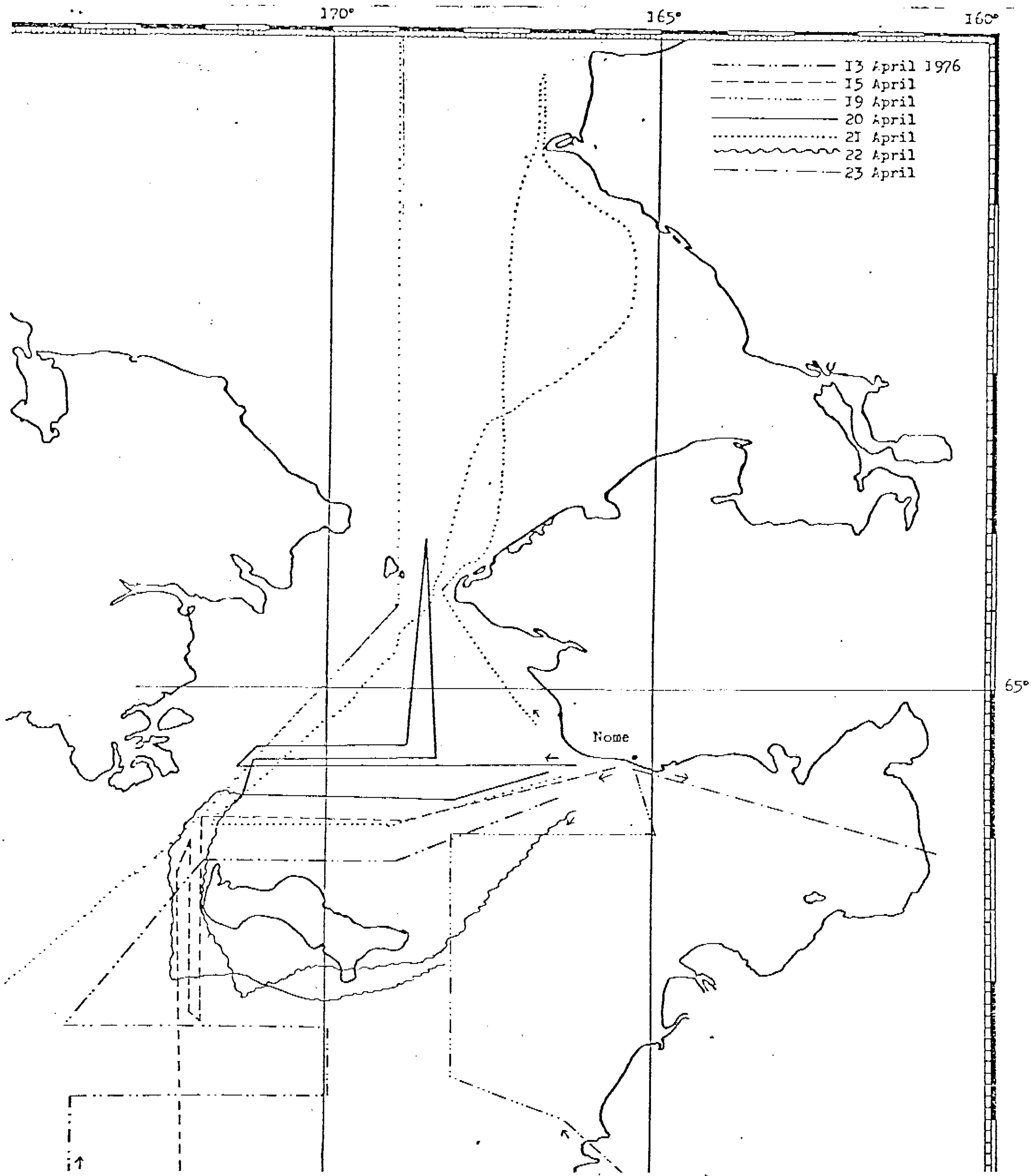

Figure 2. Marine mammal aerial survey tracklines in the northern Bering and southern Chukchi Seas during April, 1976 (RU 67-A4, RU 69-A2 and RU 14-A1).

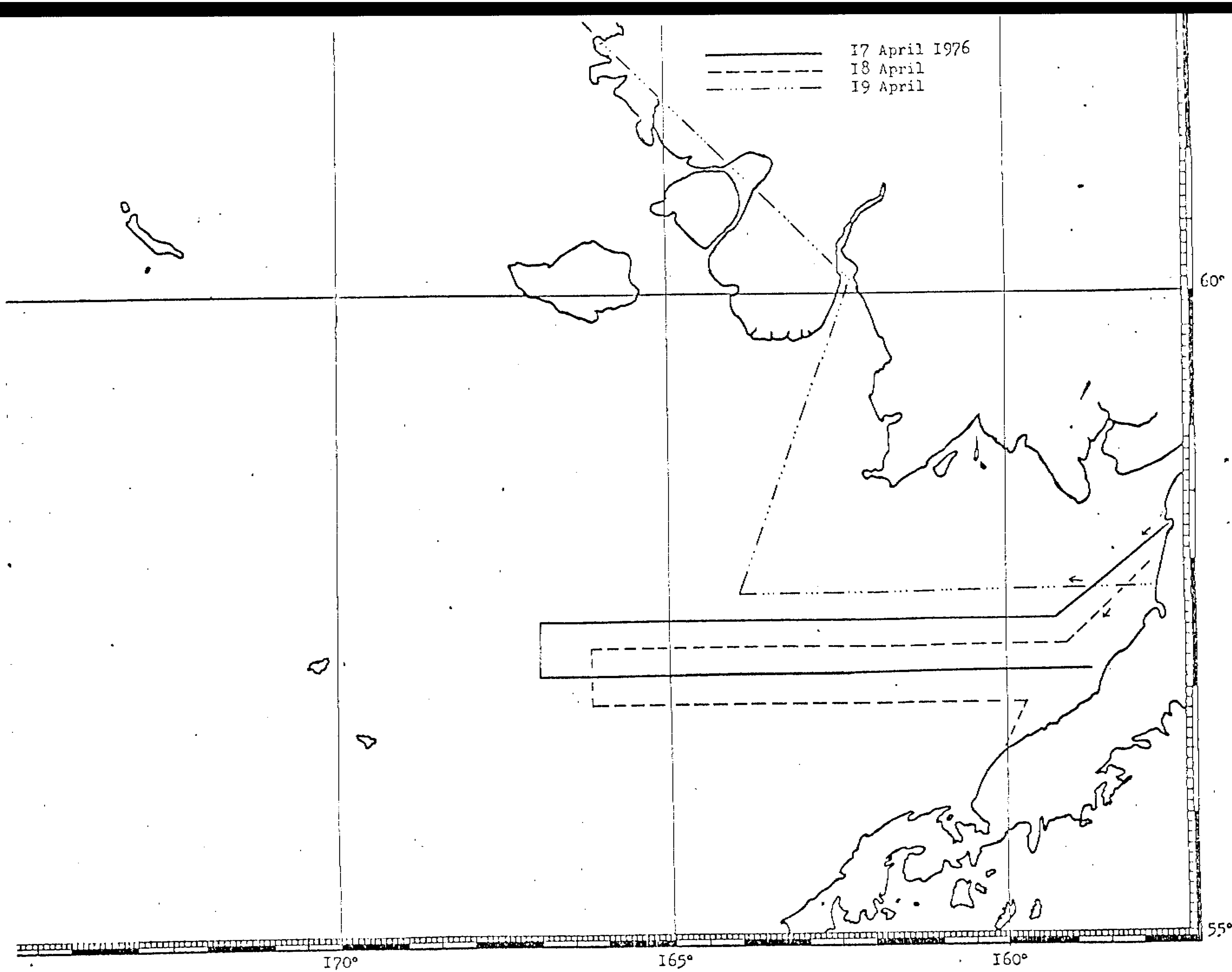

Figure 3. Marine mammal aerial survey tracklines in Bristol Bay during April, 1976 (RU 67-A4 and RU 14-A1).

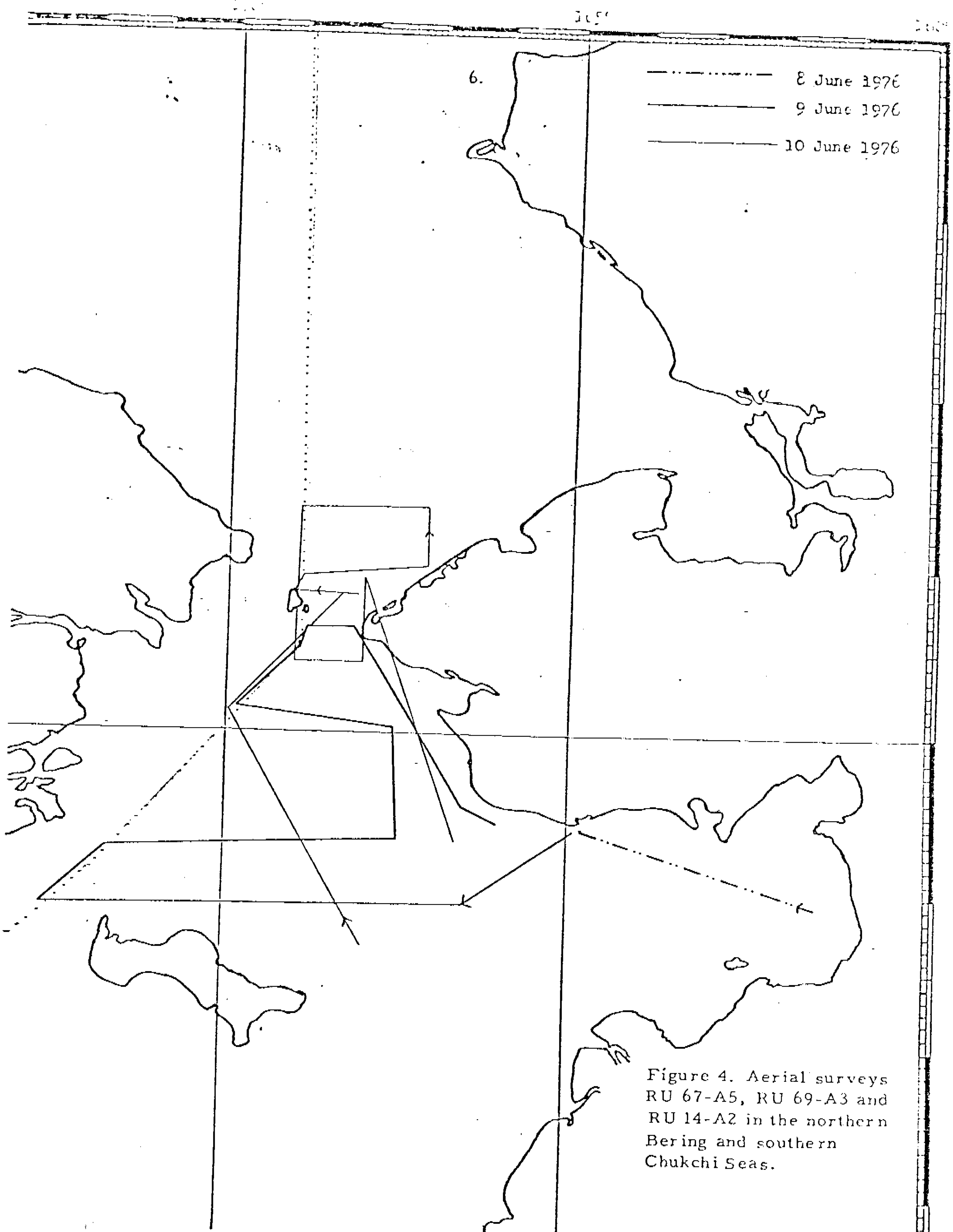

Figure 4. Aerial surveys RU 67-A5, RU 69-A3 and RU 14-A2 in the northern Bering and southern Chukchi Seas.

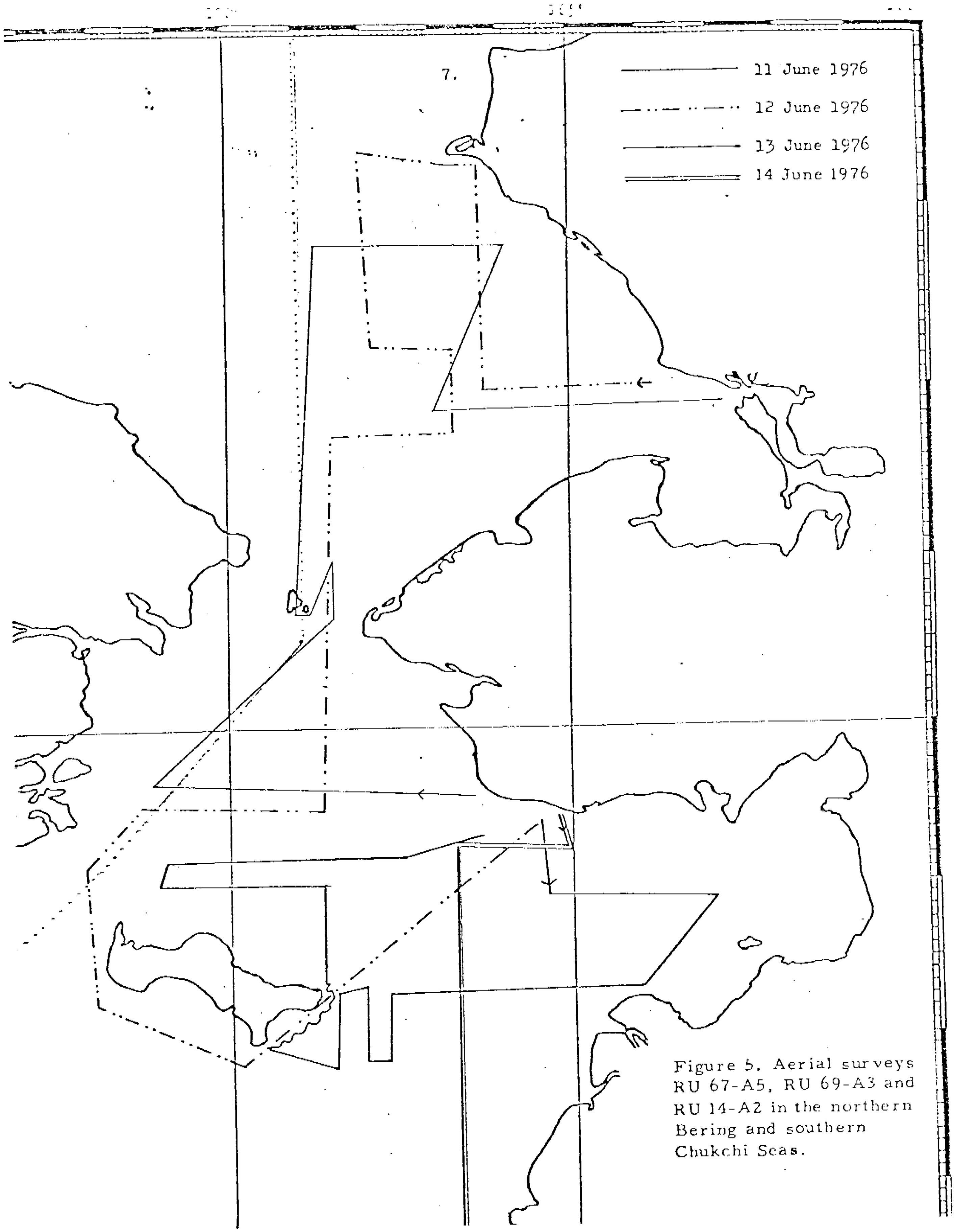

Figure 5. Aerial surveys RU 67-A5, RU 69-A3 and RU 14-A2 in the northern Bering and southern Chukchi Seas.

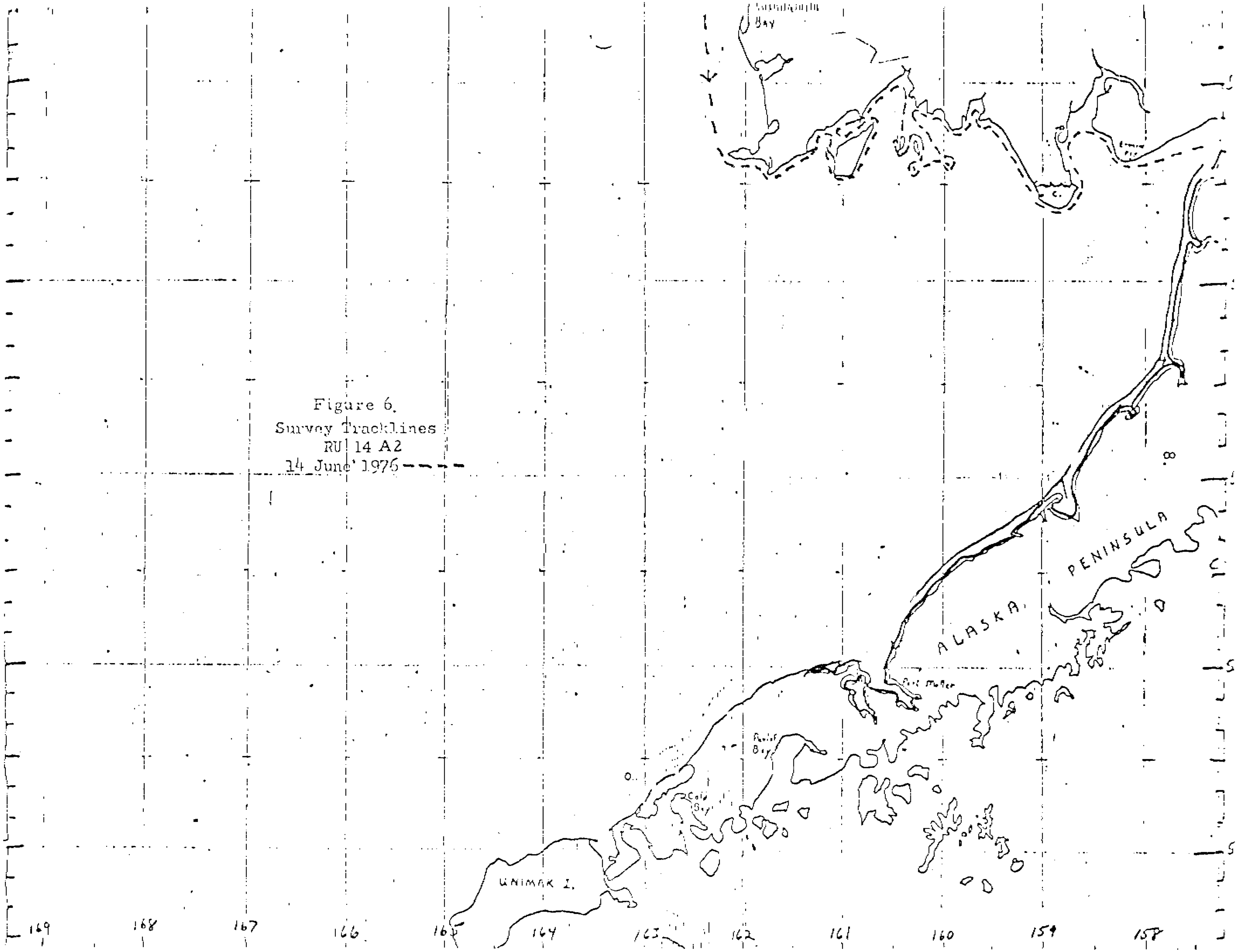

Figure 6.
Survey Tracklines
RU 14 A2
14 June 1976

Table 1. Estimated numbers of Walruses (Odobenus rosmarus) observed daily in or adjacent to three major oil lease sites during aerial surveys from 15 March to 20 June, 1976.

Date	Bristol Bay Basin	Norton and Hope Basins	West of Beaufort Basin
March 14		727	
March 18		44	
March 19		955(+3)$^+$	
March 21		4,235	
April 6	517		
April 8	435		
April 9	1,729(+11)$^+$		
April 12	366(+9)$^+$		
April 13	4	924(+6)$^+$	
April 15	361	694(+3)$^+$	
April 17	159		
April 18	87		
April 19	343	75	
April 20		878	
April 21		519	
April 22		68	
April 23		2	

Table 1. (cont'd)

Date	Bristol Bay Basin	Norton and Hope Basin	West of Beaufort Basin
June 8		14	
June 9		2,150	
June 10		3,362	
June 11		10,125	
June 12		3,457	
June 13		16,203	
June 14	8,000	31,555	
June 18	0	0	619
June 19	0		2,600
June 20	0		

+ (+n) means that an additional number of pods were seen, but as yet, have not been tabulated from aerial photographs.

of Bristol Bay during spring, rather than concentrate into a more descrete area in the northwest region of the Bay. Implicite with all interpretations is the fact that walruses are closely associated with pack ice, and that for this year, the ice extended over more of Bristol Bay than in past years.

Late April surveys in and near Norton and Hope Basins indicated that walrus had not as yet begun their northerly migration through the Bering Strait. By early June however, when these areas were again surveyed, walrus had already moved north as large concentrations were observed in Norton Basin as well as in Hope Basin. By late June, walrus were beginning to arrive west of Wainwright in northeastern Chukchi Sea.

Calves were first seen in June with regularity. More anaysis of field data is required before further discussion of age structure is feasible.

Within any survey area, large daily variation in numbers of walrus seen was the rule rather than the exception. This variation is attributable to the numbers of animals hauling out on ice rather than any daily movement into or out of a survey area. Environmental information (e.g. wind, temperature, ice configuration, etc.) has been recorded in an effort to identify which factors, if any, may account for this variation. If this can be done, better estimates of walrus abundance will be possible. It is quite possible, however, that this variation cannot be explained by any information gatherable by aerial survey. It may be, for instance, that walrus haul-out behavior is related to some type of feeding schedule or rhythm, which is influenced by prey species availability, social interaction, or what ever.

A thorough analysis of the data are now being conducted to delineate any associations.

V. Problems Encountered/Recommended Changes.

We feel that our walrus surveys have been as comprehensive and as productive as is possible considering the nature of walrus distribution (extremely clumped). To date we have had no difficulties to report, but do strongly recommend that at least one additional years data be collected to reenforce our findings. We will elaborate on the desirability of continued research in the final report.

VI. Estimate of Funds Expended.

A. March (not included in the 3rd quarterly report)

Flight Time	$3,674.50
Salaries/Overtime	1,366.00
Travel/Perdiem	918.00
	$ 5,958.50

B. April

Flight time	$12,360.50
Salaries/Overtime	515.50
Travel/Per diem	1,016.00
	$ 13,892.00

C. June

Flight time	$3,008.50
Salaries/Overtime	1,275.00
Travel/Per diem	918.00
	$ 5,201.50
Total - March-April-June	$ 25,052.00

VII. Revised data submission schedule.

All field data collected in FY '76 including aerial surveys of the Bristol Bay Basin, Norton Basin and Hope Basin will be submitted to the Juneau OCSEAP Project Office on magnetic tape on or before 30 November 1976.

VIII. Revised milestone chart (see page 13).

Milestone Chart

Project: Distribution of the Pacific [illegible]rus.

Date: 28 June 1976

PI(s): Mr. Clifford H. Fiscus and Dr. Howard W. Braham

	Major Milestones/Activities	1976 Jan			Apr			Jly			Oct		
1	Bristol Bay Basin Survey												
2	No. Bering/So. Chukchi Sea aerial survey												
3	Summarization of spring field data												
4	Computer logging of field data												
5	EDS formatting - magnetic tapes to the Juneau Project Off.												
6	Data analysis and synthesis												
7	Final report writing												
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QUARTERLY REPORT

Contract #03-6-022-35135
Research Unit #34
Reporting Period 1 April-
30 June 1976
Number of Pages 5

ANALYSIS OF MARINE MAMMAL REMOTE SENSING DATA

G. Carleton Ray and Douglas Wartzok
The Johns Hopkins University
615 North Wolfe Street
Baltimore, Maryland 21205

24 June 1976

I. Task Objectives

We will analyze remote sensing data obtained from aerial surveys of walrus populations in the Bering, Chukchi and Beaufort Seas with particular emphasis on:

1. walrus presence in an area and the ice characteristics
2. the degree to which walrus movements are influenced by ice dynamics
3. the behavioral, ecological and meteorological conditions influencing walrus hauling-out behavior.

The walrus, Odobenus rosmarus, is the major, but not only species of our interest. We also emphasize the bowhead, Balaena mysticetus, and the belukha, Delphinaptarus leucas, and are attempting to map their seasonal distribution and abundance.

II. Field or Laboratory Activities

A. Ship or Field trip schedule

1. Dates: 9-28 April 1976

   Aircraft: NASA CV-990 Not chartered or supported by NOAA.

B. Scientific Party:

G. Carleton Ray
The Johns Hopkins University
Principal Investigator
Marine Mammal Observer

Paul D. Sebesta
NASA
Marine Mammal Observer
UV Camera Operator
IR Scanner Assistant

George H. Taylor
The Johns Hopkins University
Marine Mammal Observer
UV Camera Operator

Rodney V. Salm
The Johns Hopkins University
Marine Mammal Observer

Other members of the scientific party not directly involved in BESMEX but from whom we obtain data were listed in Appendix I of the annual report.

C. Methods: <u>Visual Photography</u>:

9" camera with 6" lens
73 degree field of view
Color film SO 397

5" camera with 12" lens
21 degree field of view
Color film SO 397

<u>Ultraviolet Photography</u>:

70mm camera with 105 mm quartz lens
37 degree field of view
B/W film Tri X
Kodak 18A UV band-pass filter

<u>Infrared Scanner</u>:

RS-310 Scanner
1 and 5 milliradian spatial resolution; 1 and 0.1 degree C thermal resolution

<u>Other</u>:

L Band Radar and Microwave radiometer (19.35 GHz) data was also acquired by other experimenters and is available for analysis as needed.

D. Sample localities: See Table I.

E. Data Collected:

1. Number and type of data:
   - 9" color film: 881 frames
   - 5" color film: 4760 frames
   - UV film: 150 frames
   - IR data: 4 rolls, 1" magnetic tape, 9600 feet in length

2. Number and types of analyses: None on April data since processed films arrived 17 June and IR not yet available.

3. Miles of trackline: 1049 nmi. (See Table I)

III. Results

Since the imagery from the April mission is still not all available and that which is has been in hand for only a few days, we have not been able to critically analyze the results. Preliminary viewing of the color imagery indicates that efforts to tune the camera lenses to survey altitudes of 3000 to 5000 feet resulted in the best resolution to date.

The April mission provided the best test of the capabilities of the ultraviolet camera system since for the first time it was mounted in a nadir viewing position and was able to be triggered when the operator was certain animals were within the field of view. A preliminary survey of the films obtained reconfirmed our earlier conclusion that uv is not an effective device for walruses.

One of the flights of the April mission was conducted in the evening to obtain additional information on the circadian hauling out patterns of the walrus. The utility of the infrared scanner was demonstrated by obtaining images of walrus groups when light levels were too low for visual photography and also through thin layers of clouds. When analyzed this data will be used to refine the hauling-out behavior model presented in our annual report.

The cataloging of films from past flights continues. Each frame is surveyed and the following information recorded: Date, roll number, format, time, latitude, longitude, altitude, quality of imagery (excellent, good, fair, poor), background (1-3 tenths ice, 4-7 tenths ice, 8-10 tenths ice, water, land, clouds), animals (number visible, orientation, group structure).

The distribution of belukha whales (*Delphinapterus leucas*) at different times of the year and their orientation relative to ice leads is being mapped. A similar investigation of our imagery of bowhead whales (*Balaena mysticetus*) has recently been started.

IV. Preliminary interpretation

Until we have had more time to analyze the results from the April mission and integrate those findings with similar information on species distribution and abundance obtained on earlier flights, it would be premature to speculate on how the data should be interpreted.

V. Problems encountered/recommended changes:
The problems remain the same as those outlined in the annual report as do our suggestions for changes.

VI. Estimation of funds expended:

Category	Allotted	Spent to 31 Mar.	Spent this Quarter	Total Spent
Salary	2,609.00	880.00	1,027.00*	1,907.00
Personal Benefits	391.00	132.00	154.00	286.00
Supplies	87.00	-	-	-
Duplicating	100.00	-	-	-
Services	1,200.00	4.16	47.70	51.86
Postoffice	30.00	5.59	21.58	27.17
Service Agreements	1,500.00	-	-	-
Travel	1,300.00	-	-	-
Equipment	1,100.00	1,319.00	-	1,319.00
Telephone	200.00	-	-	-
Computer Charges	700.00	-	-	-
Costs (Indirect @31%)	2,783.00	725.63	387.59	1,113.22
TOTAL	12,000.00	3,066.38	1,637.87	4,704.25

* We have added a summer employee to our staff. Ms. Nancy Murray is a graduate student at the University of New Hampshire and has had experience in analysis of remote sensing data as well as field experience observing marine mammals. She is concentrating on seasonal distribution and abundance maps for bowhead whales as obtained from BESMEX data.

TABLE I

Date	Flight #	Area	Coordinates	No. of Runs	Data Miles
13 Apr. 76	6	Bering Sea (St. Lawrence Island; Bristol Bay).	64-30N 171-00W 64-30N 169-00W 64-00N 171-55W 64-00N 169-00W Bristol Bay	7	210 (St. Lawrence Island)
18 Apr. 76	9	Bering Sea (St. Lawrence Island).	64-30N 170-50W 64-00N 169-00W 64-00N 171-43W 64-00N 170-00W	9	383
19 Apr. 76	10	Bering Sea (St. Lawrence Island).	64-16N 171-13W 64-16N 170.00W 64-11N 171-25W 64-00N 171-00W 63-59N 170-00W	15	456

Fourth Quarterly Report

Contract No. R7120804
Research Unit 67
Period: 1 April 1976
30 June 1976
Number of Pages 23

Baseline Characterization of Marine Mammals in the Bering Sea

Principal Investigators

Mr. Clifford H. Fiscus
Dr. Howard W. Braham

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Marine Mammal Division
7500 Sand Point Way N.E., Bldg. 32
Seattle, Washington 98115

28 June 1976

RU67 Fourth Quarterly Report; April-June, 1976

I. Task Objectives

The objectives of Research Unit 67 are to obtain information on the general life history, ecology, and seasonal distribution and abundance of marine mammals in the Bering Sea. During the fourth quarter (April through June) our specific objectives were to quantify pinniped and cetacean distribution and abundance as they relate to spring ice conditions during the breeding season. These objectives were, or are in the process of being, accomplished through a comprehensive literature review, and by means of collecting population data using aerial and shipboard survey methods.

II. Field or Laboratory Activities

A. Ship or field trip schedule

	Dates	Location	Aircraft	Charter
1.	6-23 April	King Salmon	N780 Goose	OAS
	" "	Nome	P2V	OAS
2.	8-15 June	Nome	N780 Goose	OAS
3.	18-20 "	King Salmon	Widgeon	Peninsula Airways

B. Scientific Party

1. 5-23 April, 8-15 June
   Dr. Howard Braham, P.I.
   Bruce Krogman, Asst.
   Robert Everitt, Asst.
   Marine Mammal Division
   Northwest Fisheries Center
   NMFS, NOAA, Seattle, Wash.

2. 18-20 June
   Clifford Fiscus, P.I., MMD, NWFC, NMFS, Seattle
   Dr. Howard Braham, P.I.
   Robert Everitt, Asst.

C. Methods

Sightings of marine mammals were made from aircraft flying at altitudes between 200 and 1500 feet. Visual estimates and photographic records were made to verify species identification and numbers of animals seen. Geographic areas were surveyed according to the type of habitat available (i.e., ice, open water, etc.) and animals to be surveyed. Ice was flown-over at elevations of 200 to 500 feet to record data on seals. Island rookeries and hauling grounds (sea lions, etc.) were flown-over at 400 to 600 feet and open water at 500 to 1000 feet. One thousand to 1500 feet altitudes were used for overview photographic work (e.g., harbor seals at Port Moller), and when counting large pods of walruses (e.g., Norton Basin).

Three observers were used during each survey; one acted as the recorder and two as observers. Most surveys used a stratified random series of transects (Bering and Chukchi Seas, 8-14 June) as well as systematic transects (especially the Alaska Peninsula survey, 14-20 June). By using these methods an unbiased estimate of the number of animals observed can be made; representing a statistically reliable procedure for ascertaining species abundance.

Each transect flown, whether random or systematic, is in actuality a duplicate strip census. That is, both sides of the aircraft (Goose and Widgeon) are used to observe out to one-half mile from 90° vertical to the side of the aircraft. Animals directly below the airplane are not scored (i.e., cannot be observed). This method in essence allows one to obtain duplicate samples of adjacent habitat. Approximately 1/7th of a mile at 500 feet and 1/5th of a mile at 700 feet are not surveyed using the Super Goose and Widgeon aircraft. All animals are sampled within a one mile wide transect using the P2V aircraft.

Below is a summary of the general methodology, techniques and logistics during the 4th quarter surveys:

Location	Survey method	Aircraft type	Altitude	Principal species
Bristol Bay	Random	Goose	2-700'	Ice seals
Bering/Chukchi Seas	Random and systematic	Goose and P2V	2-700'	Ice seals and gray whales
Alaska Peninsula	Systematic	Widgeon	2-500'	Harbor seals sea lions

D. Aerial survey locations and tracklines flown (Figures 1- 9)

1. 6-15 April, Bristol Bay (Figure 1).
2. 13-15 April, Northern Bering Sea (Figures 1 and 2).
3. 17-19 April, Bristol Bay (Figure 3).
4. 19-23 April, Northern Bering Sea (Figure 2).
5. 8-14 June, Northern Bering - Southern Chukchi Seas (Figures 4-5).
6. 14-15 June Northern Bristol Bay - Northeast Alaska Peninsula (Figure 6).
7. 18-20 June, Alaska Peninsula - Eastern Aleutian Islands (Figures 7-9).

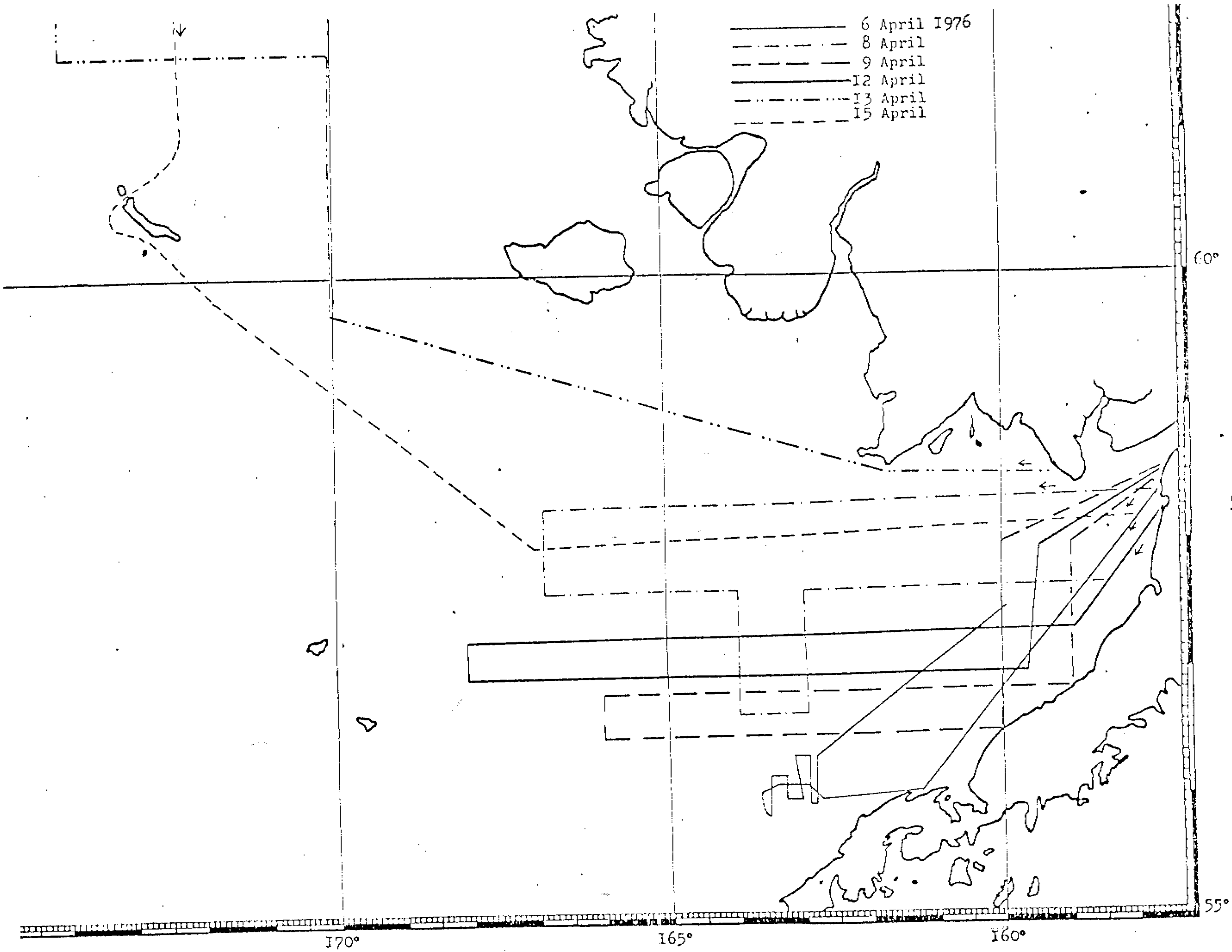

Figure 1. Marine mammal aerial survey tracklines in Bristol Bay during April, 1976 (RU 67-A4 and RU 14-A1).

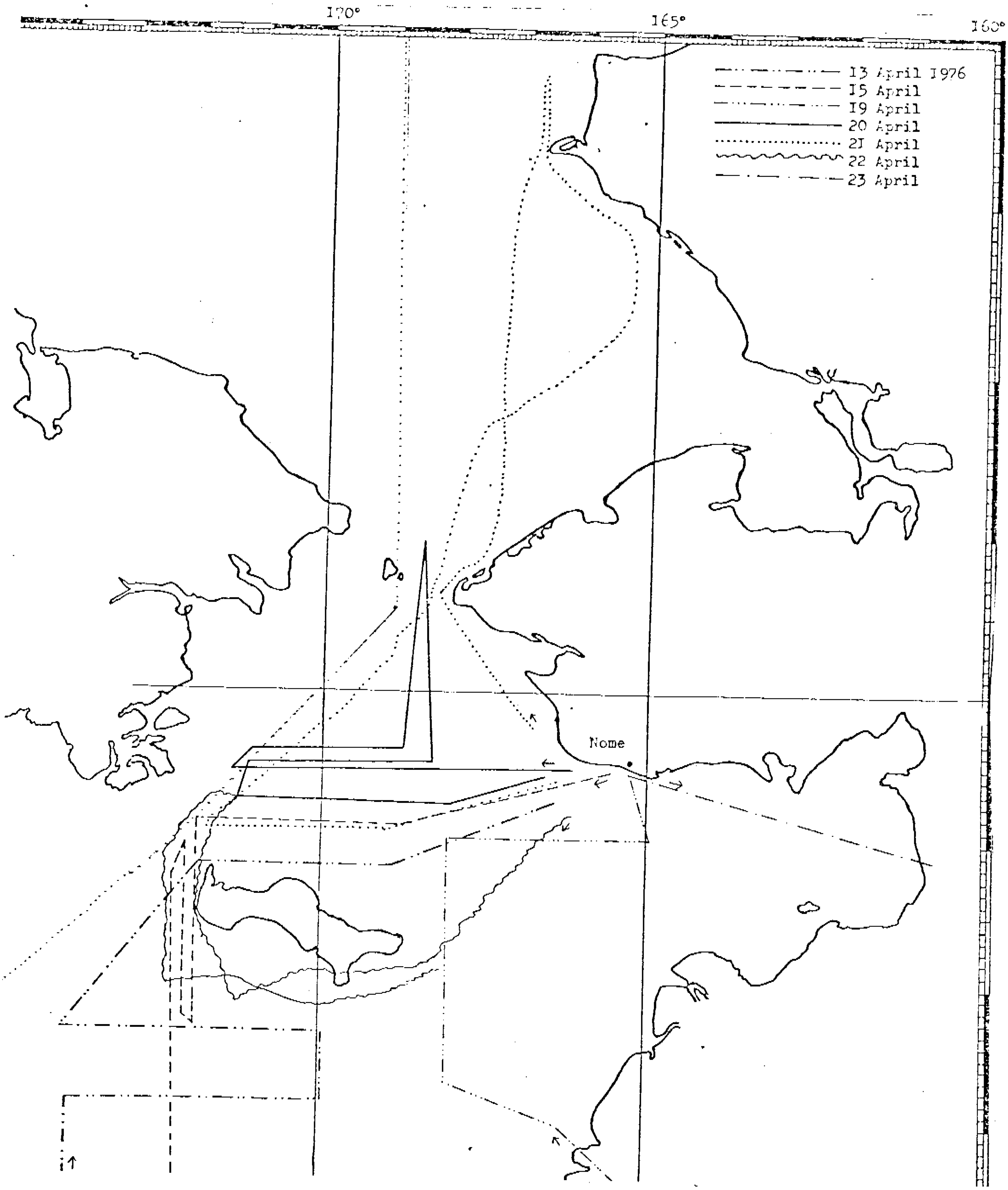

Figure 2. Marine mammal aerial survey tracklines in the northern Bering and southern Chukchi Seas during April, 1976 (RU 67-A4, RU 69-A2 and RU 14-A1).

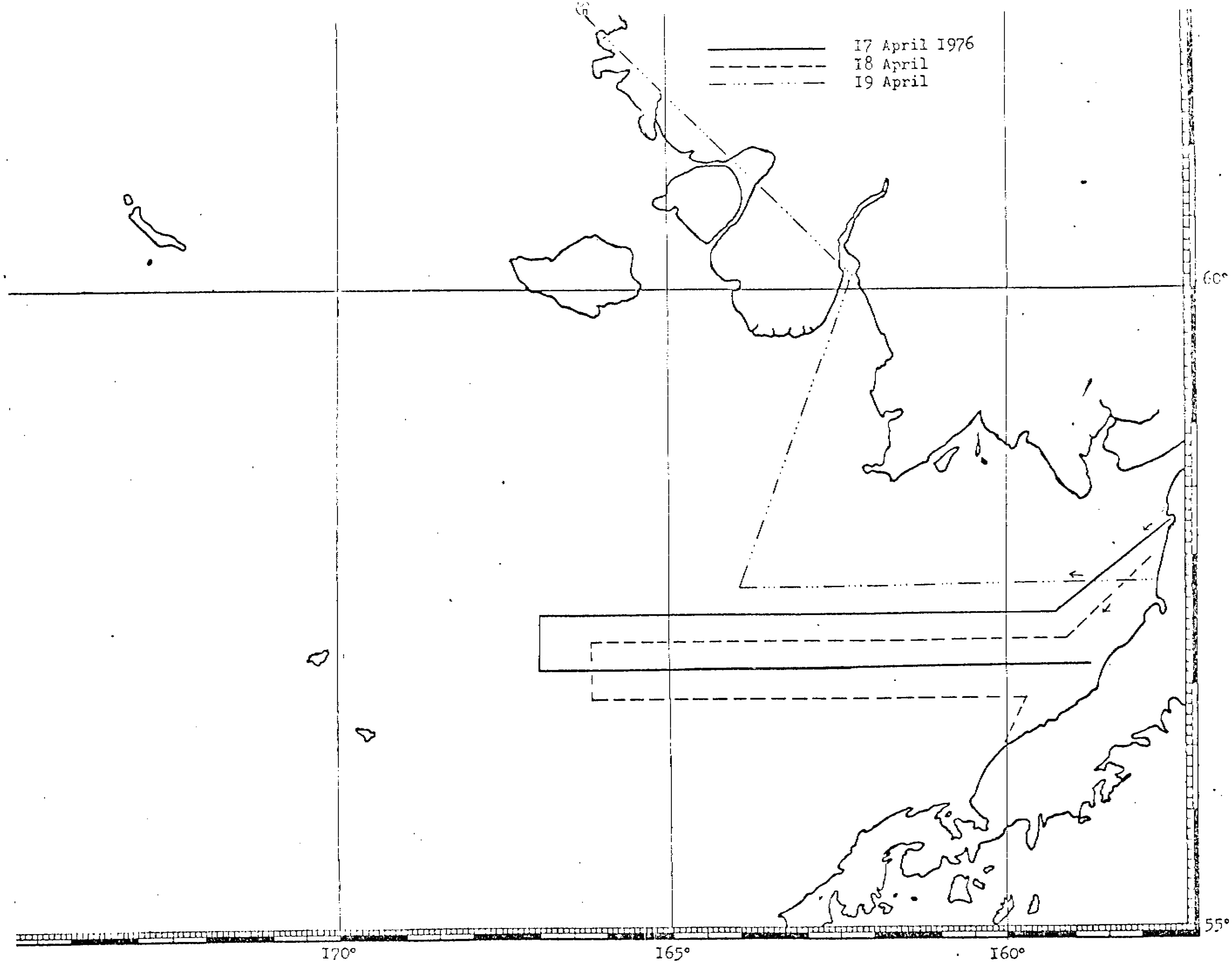

Figure 3. Marine mammal aerial survey tracklines in Bristol Bay during April, 1976 (RU 67-A4 and RU 14-A1).

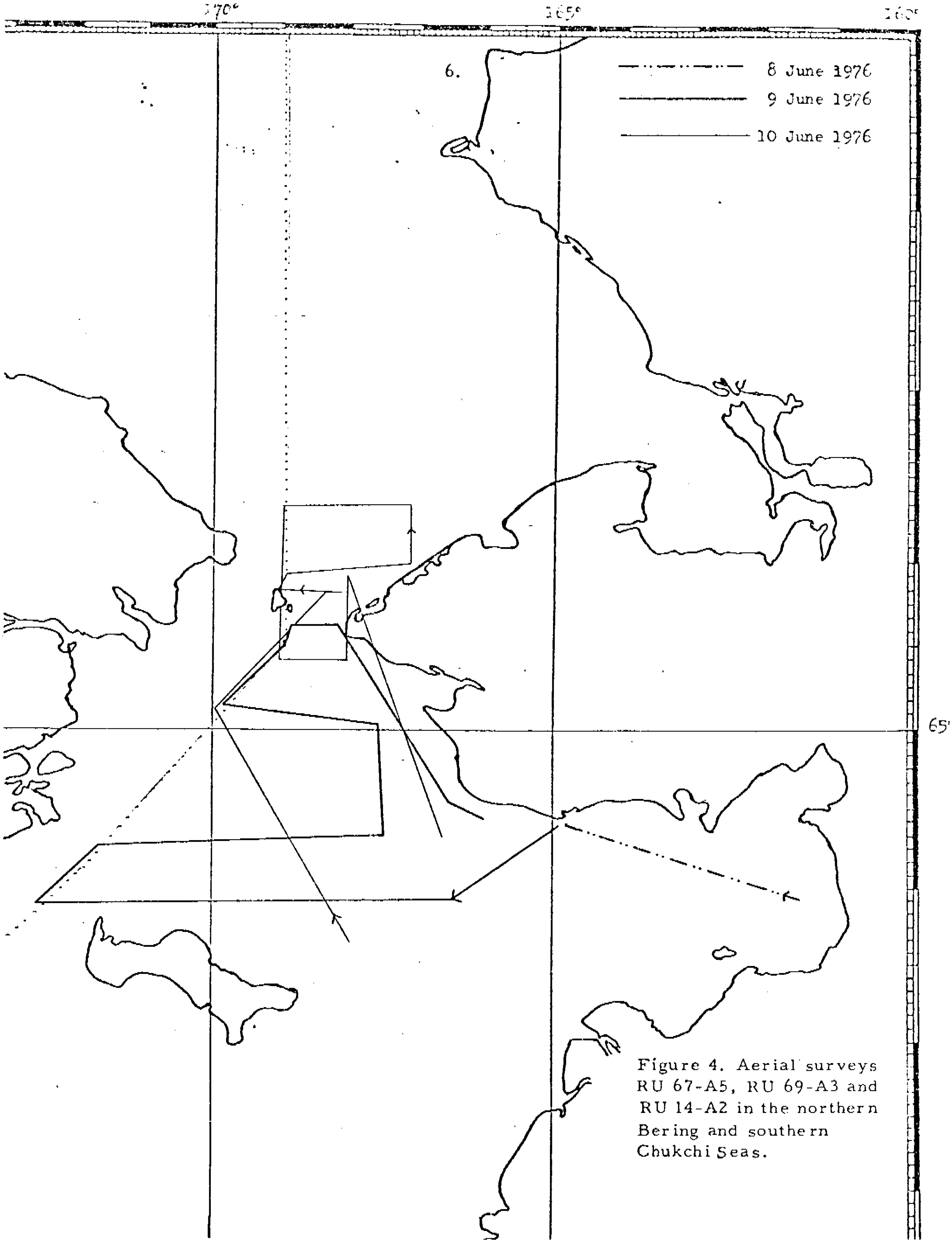

Figure 4. Aerial surveys RU 67-A5, RU 69-A3 and RU 14-A2 in the northern Bering and southern Chukchi Seas.

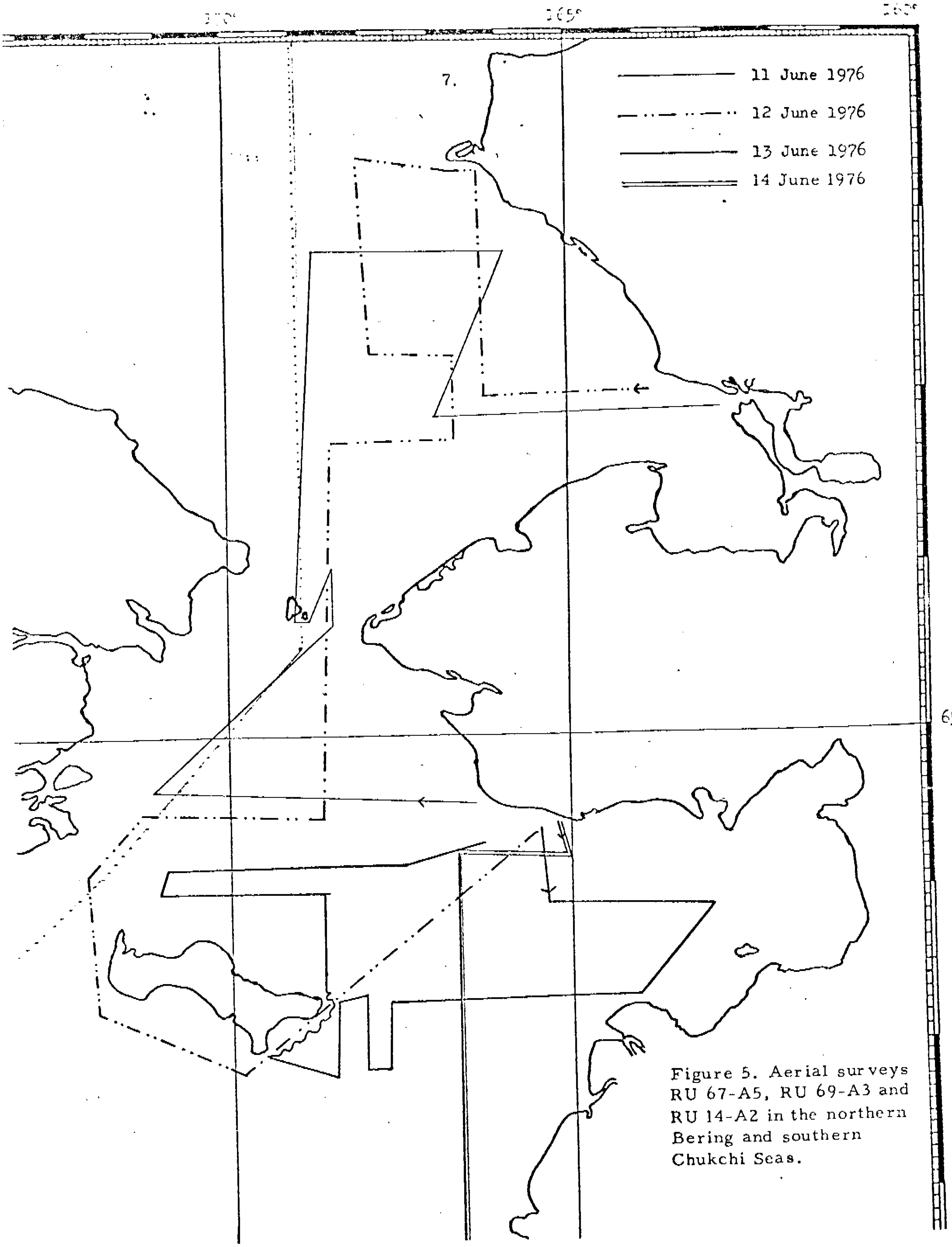

Figure 5. Aerial surveys RU 67-A5, RU 69-A3 and RU 14-A2 in the northern Bering and southern Chukchi Seas.

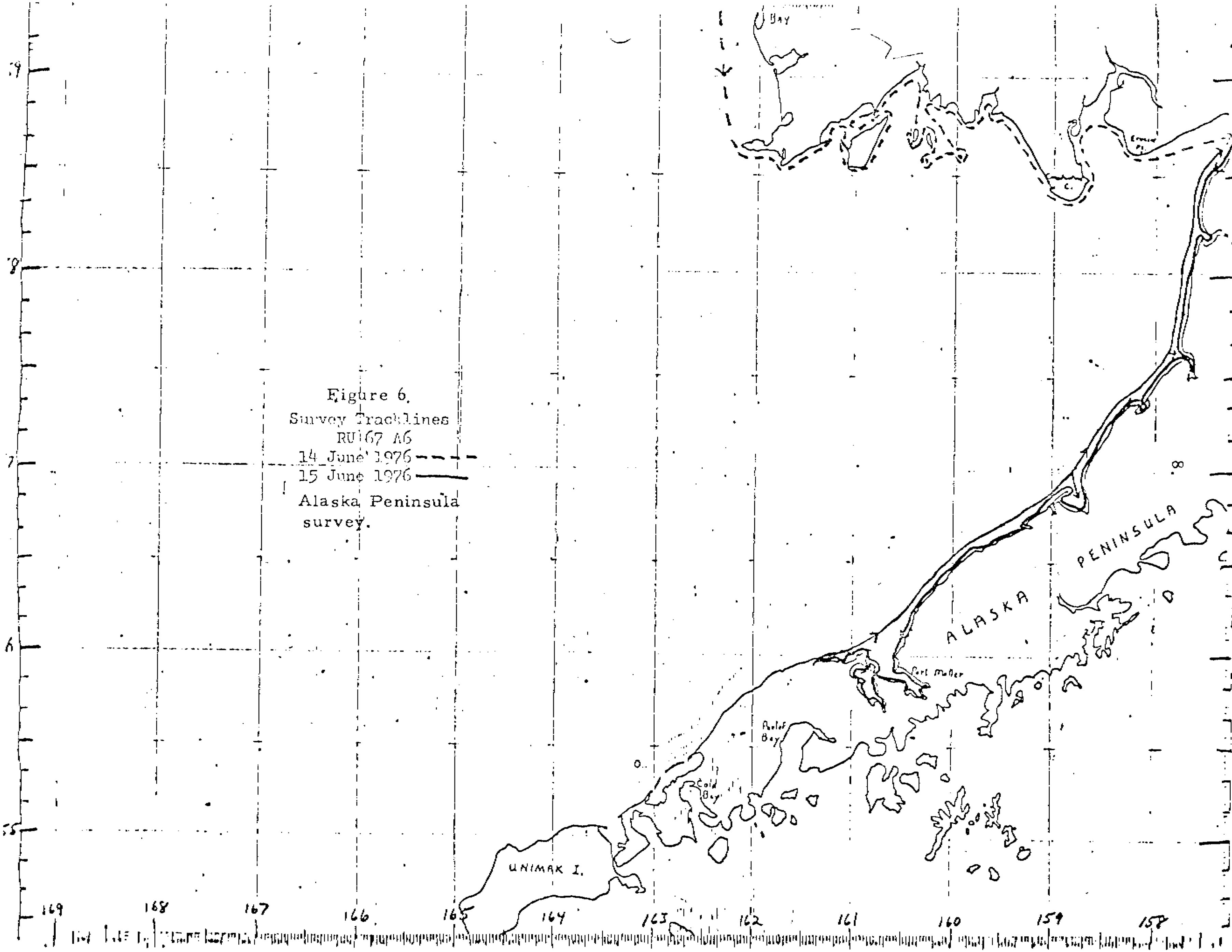

Figure 6.
Survey Tracklines
RU167 A6
14 June 1976 - - - -
15 June 1976 ———
Alaska Peninsula
survey.

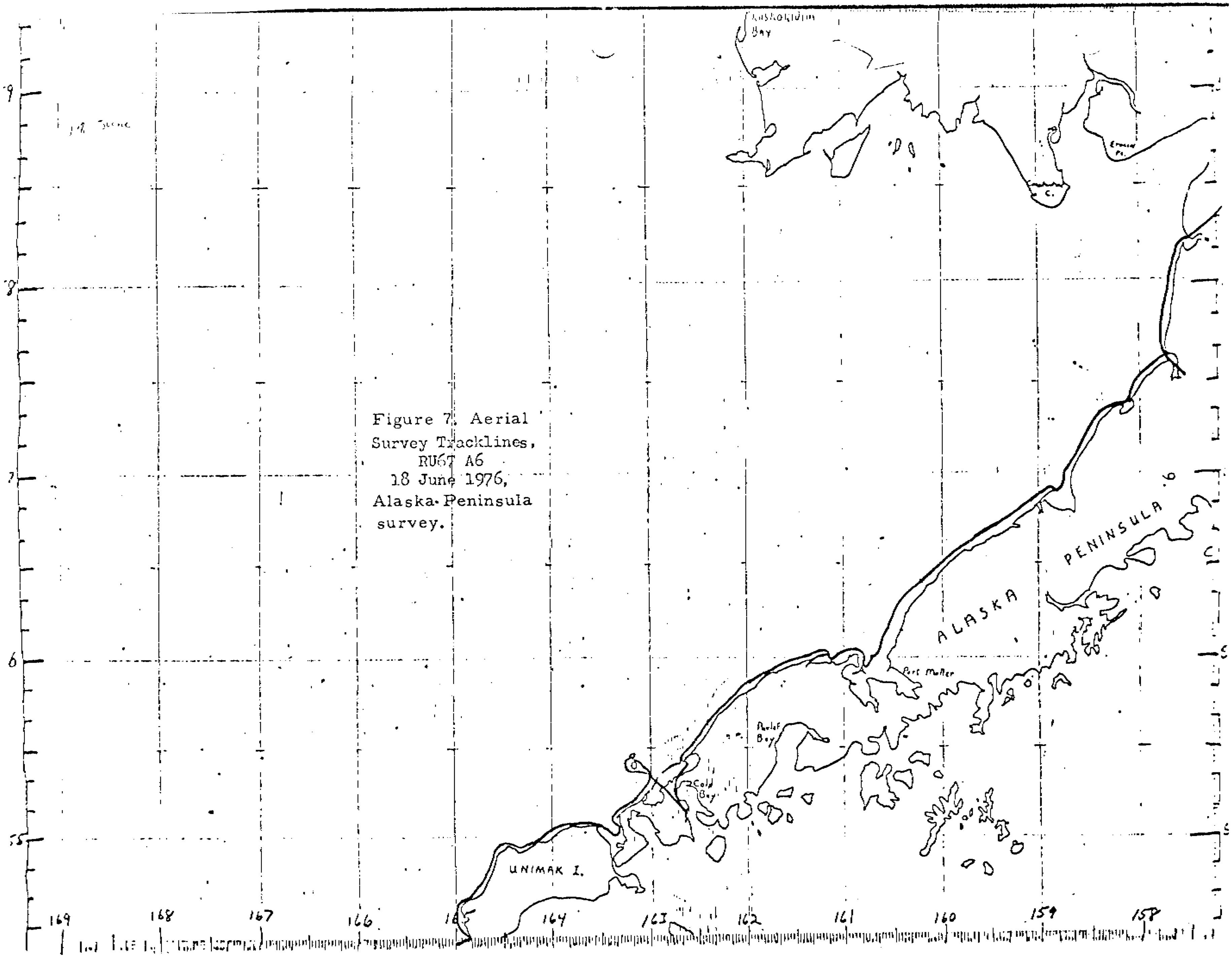

Figure 7. Aerial Survey Tracklines, RU67 A6 18 June 1976, Alaska Peninsula survey.

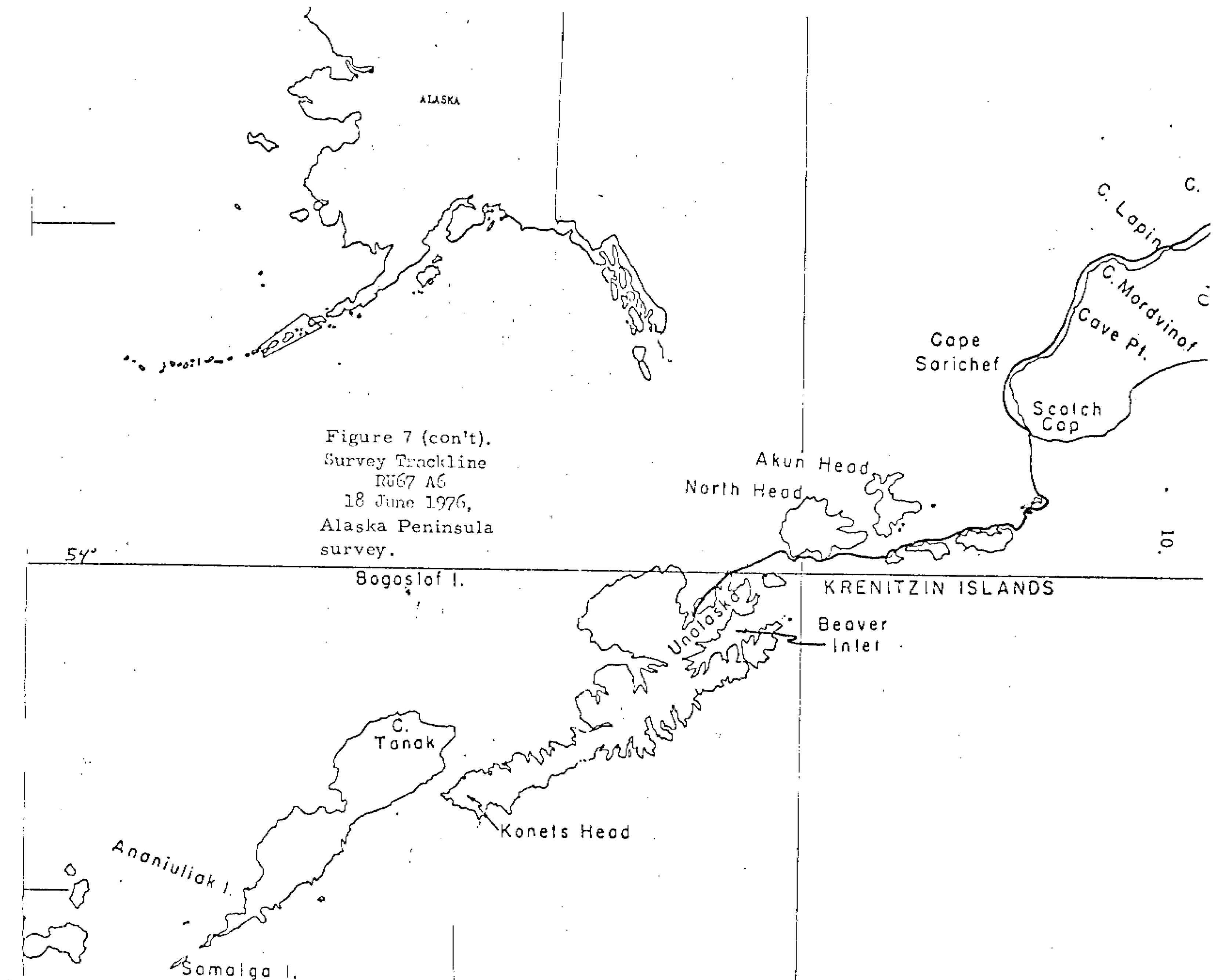

Figure 7 (con't).
Survey Trackline
RU67 A6
18 June 1976,
Alaska Peninsula
survey.

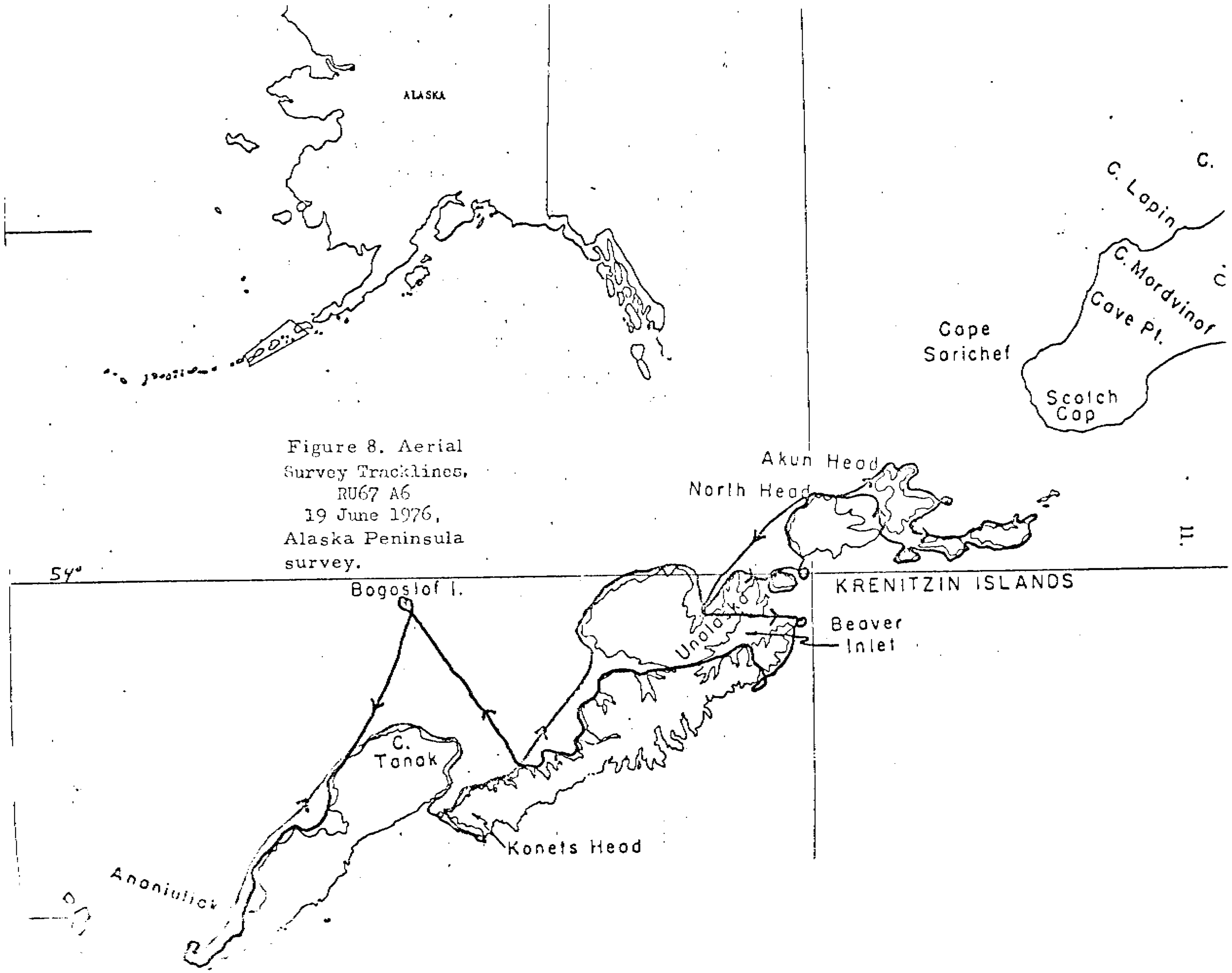

Figure 8. Aerial Survey Tracklines, RU67 A6 19 June 1976, Alaska Peninsula survey.

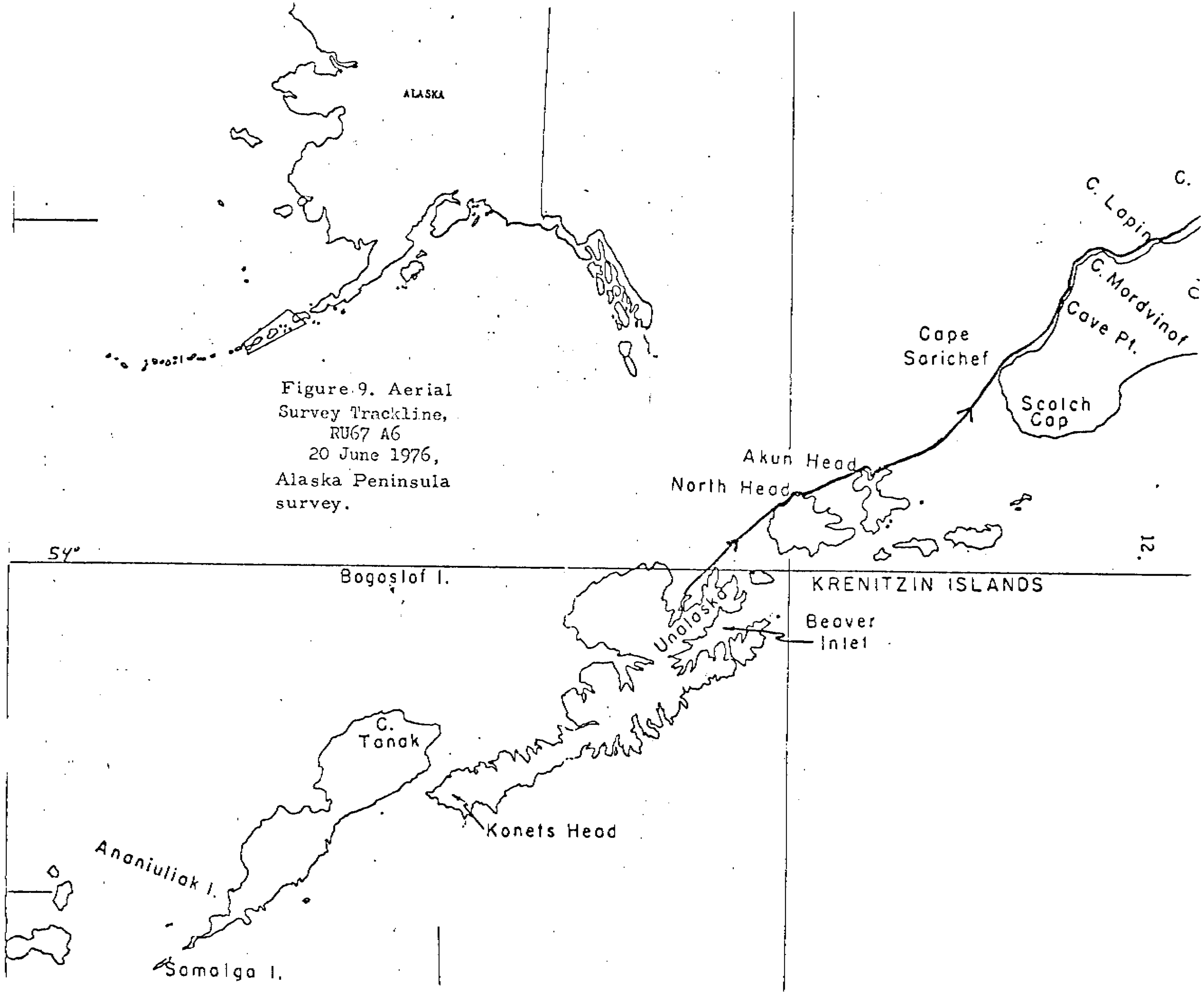

Figure 9. Aerial Survey Trackline, RU67 A6 20 June 1976, Alaska Peninsula survey.

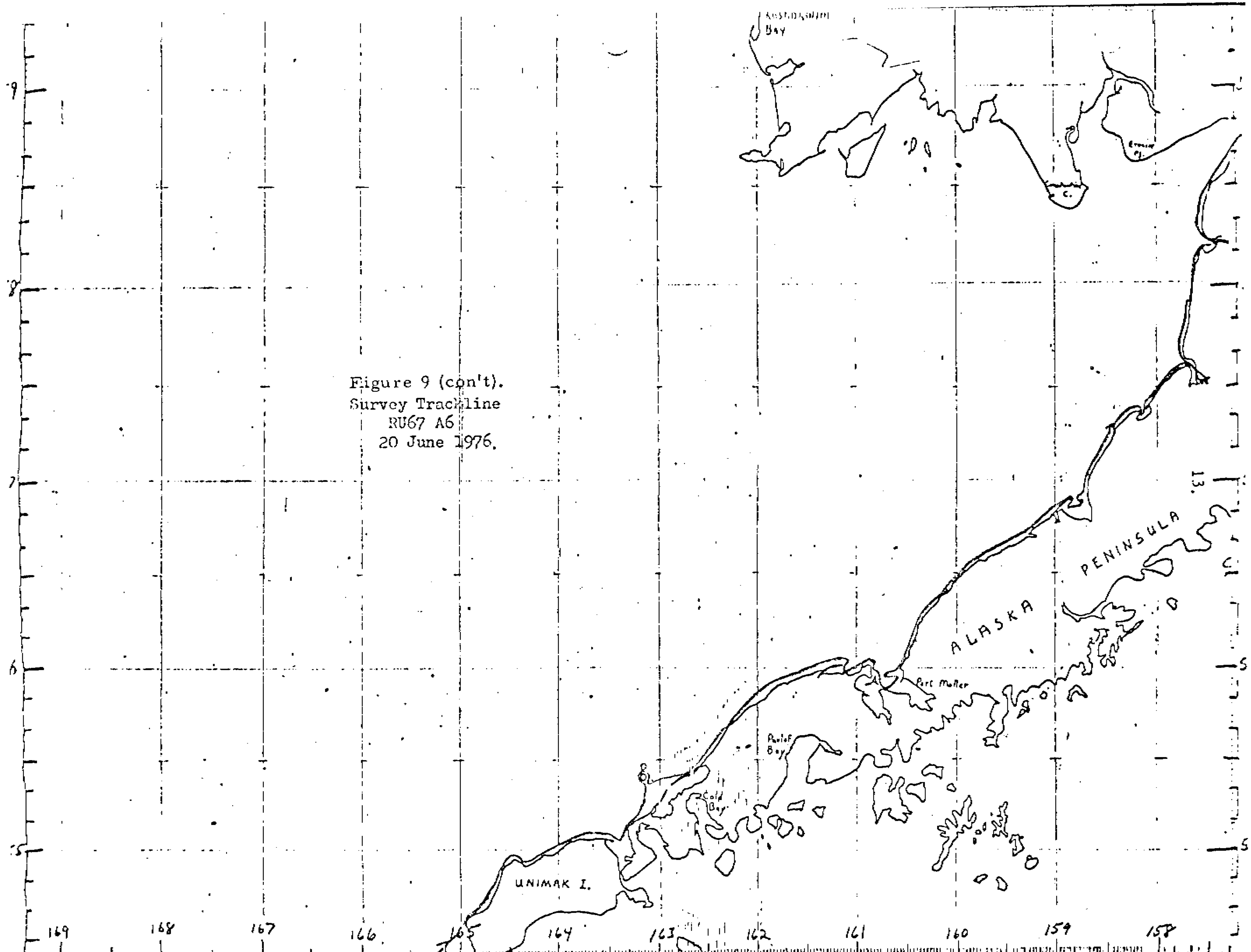

Figure 9 (con't).
Survey Trackline
RU67 A6
20 June 1976.

E. Data collected or analyzed

	Data Recordings*	Trackline Miles**
1. 6-12 April, 17-19 April	1,330	4,350
2. 13-15 April, 19-23 April	1,279	3,300
3. 8-14 June	2,407	3,690
4. 15-20 June	587	1,840
Approximate Totals	5,603	13,180

* A "data recording" is a single logged entry at a specific time and location, and represents one or more animals sighted; or, environmental data. All values are approximate at this time.
** In nautical miles.

III. Results

A. Bristol Bay survey, 6-19 April, 1976

The numbers of marine mammals observed in association with the seasonal ice pack in the southeastern Bering Sea and Bristol Bay during April are summarized in Table 1. The most numerous pinniped observed was the walrus (see RU 14 quarterly report for details). The approximate number of "pagophilic" seals per square nautical mile of ice surveyed was: ringed seals (*Phoca hispida*) - 0.013; harbor (*Phoca vitulina richardi*) or spotted seals (*Phoca vitulina largha*) - 0.22; bearded seals (*Erignathus barbatus*) - 0.07. No variance estimates are available at this time, hense these values should not be quoted.

Too few belukha (*Delphinapterus leucas*) and gray whales (*Eschrictius robustus*) sightings were made to make any meaningful estimate of abundance.

B. Northern Bering Sea survey, 13-23 April, 1976

The number of marine mammals observed in the northern Bering Sea and southern Chukchi Sea during April are summarized in Table 2. Data collected during the March survey are also included. The approximate number of bearded seals per square nautical mile was 0.05, and that for ringed seals, 0.02 animals per nmi^2. Bowhead and belukha whale data are discussed in the fourth quarterly report under RU 69.

Table 1. Numbers of marine mammals observed daily during aerial surveys of Bristol Bay from 6 - 19 April, 1976.

Date	Pinnipeds				Cetaceans	
	Walruses	Ringed Seals	Harbor - Largha Seals	Bearded Seals	Belukha	Gray Whale
6 April	517	0	457	29	0	0
8 April	435	1	51	64	0	0
9 April	1,729(+11)+	9	159	51	17	0
12 April	366(+9)	7	42	46	0	0
13 April*	4	6	25	72	0	0
15 April*	361	4	95	12	0	0
17 April	159	23	66	16	0	0
18 April	87	2	50	12	0	5
19 April*	343	6	14	8	0	0
Totals	5,619	58	959	310	17	5

* - abbreviated surveys, remainder of time spent in no. Bering Sea

\+ - number of additional pods present but not counted from photographs as yet.

Table 2. Numbers of marine mammals observed daily during aerial surveys from 15 March to 23 April, 1976, from St. Matthew Island to the Bering Strait including Norton Basin.

Date	Pinnipeds			Cetaceans	
	Walrus	Ringed Seal	Bearded Seal	Bowheads	Belukhas
15 March	727	0	0	0	8
18 March	44	0	2	0	18
19 March	955(+3)+	0	1	0	2
21 March	4, 235	0	41	0	0
13 April*	924(+6)+	61	39	0	0
15 April*	694(+3)+	4	0	0	0
19 April*	75	0	0	1	4
20 April	878	1	50	1	4
21 April	519	0	28	2	118
22 April	68	1	7	0	25
23 April	2	8	9	0	1
Totals	9, 486(+)	75	177	4	180

* part of this survey was done in S/E Bering Sea.

+ additional number of pods not counted from photographs as yet.

C. Northern Bering - Southern Chukchi Sea survey, 8-14 June, 1976

The number of marine mammals observed during the June survey in the Norton and Hope Basins are summarized in Table 3. Data on walruses and bowhead whales are discussed in RU 14 and RU 69 quarterly reports, respectively. The approximate number of animals seen per square nautical mile of trackline was: ringed seals - 0.06; bearded seals - 0.20; and gray whales - 0.21. More ringed seals were seen in June (235) than in April (75), and the same was true for bearded seals (April 177; June 737). The unidentified whales observed (13) are believed to be gray whales as our sightings of unidentified cetaceans occurred at times when we were observing gray whales.

D. Alaska Peninsula survey, 14-20 June 1976

The number of marine mammals observed along the shore of northern Bristol Bay, the north coast of the Alaska Peninsula and throughout the eastern Aleutian Islands is summarized in Table 4. The total number of harbor seals seen (22,741) reflects the total of all days flown (5), and includes replicate areas surveyed along the Peninsula (15, 18 and 20 June). Naturally, many (if not most) were counted on replicate days. As with all the data for this quarterly report, total numbers seen and estimates of abundance are preliminary, and do not necessarily reflect the actual number of animals in each area surveyed. A more accurate estimate of the number of harbor seals and sea lions, for example, will be provided in the final report.

It is believed that the number of gray whales observed from 14-18 June (150) represents an independent non-duplicate count for all whales between Egegik and Port Moller. We estimate that the total number of independent gray whale observations between 14 and 20 June was 177. Details of this adjustment will be discussed later. Too few data on other marine mammals (harbor porpoises, etc.) exists from this survey for any meaningful evaluation.

IV. Preliminary Interpretation of Results

A. Bristol Bay survey, 6-19 April, 1976

During the spring in the Bering Sea the type and amount of ice present plays a major role in the spatial distribution of most species of seals. Therefore, an estimate of the number of animals per square mile only has meaning in relation to habitat availability. A detailed analysis of the amount and type of ice used by each species is underway in our laboratory. For the final report we anticipate evaluating these important variables to make a more accurate interpretation of distribution and abundance data with regards to ice.

Table 3. Numbers of marine mammals observed daily during aerial surveys from 8 to 14 June, 1976, in the northern Bering and southern Chukchi Seas.

Date	Pinnipeds					Cetaceans					
	Ringed Seals	Bearded Seals	Walruses	Harbor Seals	Unid.	Gray Whales	Bowhead Whales	Belukha Whales	Unid. Whales	Unid. Porpoises	Pohr Bears
8 June	9	7	14	0	2	0	0	0	0	0	0
9 June	13	57	2,150	0	12	73	0	0	5	1	0
10 June	42	129	3,362	0	4	20	0	0	3	0	0
11 June	67	234	10,125	0	13	145	0	0	0	0	0
12 June	153	249	3,457	0	10	291	2	0	3	0	6
13 June	25	49	16,203	0	13	217	0	18	2	0	0
14 June	0	12	31,555	26	10	0	0	0	0	0	0
Totals	235	737	66,866	26	64	746	2	18	13	1	6

Table 4. Number of marine mammals observed during aerial surveys of the eastern Bering Sea, along the coast, from Cape Newenham to the Krenitzin Islands, 14 - 20 June, 1976.*

Date	Pinnipeds			Cetaceans							Carnivores
	Sea Lions	Harbor Seals	Unid.	Gray Whales	Minke Whales	Killer Whales	Belukha Whales	Dall Porpoises	Harbor Porpoises	Unid.	Sea Otters
June 14	267	107	4	37	0	2	1	0	0	0	0
June 15	0	10,627	0	59	0	0	0	0	0	11	0
June 18	7,979	2,497	0	54	7	2	1	0	19	1	467
June 19	9,987	820	0	0	3	13	0	3	0	0	125
June 20	3,325	8,690	0	76	0	0	0	8	8	0	5
Totals	21,558	22,741	4	225	10	17	2	11	27	12	597

* 14 June - Cape Newenham to Egegik; 15 June - Egegik to Port Moller, return; 18 June - Egegik to Dutch Harbor; 19 June - Krenitzin Islands; 20 June - Dutch Harbor to Egegik.

The variation in the numbers of animals observed between survey days is in part a function of sample location and environmental conditions. For example, on 6 April we observed 457 spotted or harbor seals hauled out onto the ice approximately 20 nmi behind the ice front (i.e., ice edge) in an area less than 5 nmi^2. The animals were thus contageously distributed (i.e., clumped). On 8 April, we surveyed approximately 200 nmi^2 just north of the ice front and found very few animals. An estimate of the numbers of animals is therefore confounded by the stratified nature of habitat usage. These conditions were also observed for walruses and ringed seals, but less so for bearded seals.

Our observation of five gray whales in mid-April represents the earliest known sightings for this species in the spring in the Bering Sea.

B. Northern Bering Sea survey, 13-23 April, 1976

Spotted seals are conspicuously absent in the northern Bering Sea during the early spring (March through May) as they breed near the ice front. The number of ringed seals is also normally low during April as this species remains secluded in ice rifts (dens) during the breeding season and does not come out to moult until about June. Those ringed seals seen during this survey (most on the same day and location, 13 April) were probably immatures or peripheral non-breeding individuals. Only bearded seals and walruses were seen in April with any regularity, their numbers varying greatly depending upon the spatial arrangement of ice.

C. Northern Bering - Southern Chukchi Seas survey, 8-14 June, 1976

Whether more ringed seals and bearded seals seen in June than April is a reflection of seasonality, areas surveyed, miles flown, or some other factor or combination of factors cannot be determined at this time. The most logical explanation has to do with post-mating behavior, that is, these animals spend more time on the ice during warmer days to bask and moult.

During our June survey we have located two apparent major feeding grounds for the gray whale. Also, from sighting records throughout the Bering Sea, it looks like a substantial portion of the gray whale migration path can be further delineated. We will elaborate on these new findings in the final report.

D. Alaska Peninsula survey, 14-20 June, 1976

On 15 June we flew from Naknek to Port Moller and back. The number of gray whales observed flying to Port Moller (1444 to 1645 hours) was 56, while the number seen flying back to Naknek (1814 to 2015 hours) was 59. It would appear that both our precision in observing gray whales and the accuracy at noting the number of animals present was good, if not remarkable! Most animals were seen within one-quarter of a mile from shore enhancing our survey technique.

On 18 June we observed 48 gray whales between Naknek and Port Moller and on 20 June we observed 54. These data might lead one to conclude that there may be a relatively uniform temporal displacement of gray whales between Naknek and Port Moller (220 nmi), and thus throughout their range. This conclusion is, of course, premature, however, it is being explored as are other hypotheses. Also of interest was that many cows were seen with calves, often followed closely by a single adult (presumably a male). Since few calves were seen in the northern Bering Sea during June it would appear that gray whales may be distributed along the migration route according to age-sex and/or reproductive status. A few gray whales were seen near Unimak Pass in June. It would appear that migrating animals are still moving into the Bering Sea, but probably at significantly fewer numbers than during the previous month. A quantitative appraisal of gray whale sighting data will be included in the final report.

The number of harbor seals along the Alaska Peninsula vary greatly from day to day and between tide cycles. Reliable variance estimates will, therefore, be extremely difficult to obtain. Estimates of sea lion (Eumatopius jubatus) abundance from data collected this year may be low because fewer animals were hauled out this year than in the past. We make this conjecture, tentatively, because few pups were seen on traditional rookeries. Our surveys may have been conducted a few weeks too soon. Cooler weather and greater ice exposure during the spring may have contributed to a late arrival of animals. Other factors such as fewer total numbers of sea lions this year than in past years, or lower sea lion production may account for fewer adults and pups observed this spring. These possibilities will be explored as soon as we can analyze our data and photographs, and compare our findings with other OCS teams working on sea lions along the southern edge of the Alaska Peninsula (RU 243).

V. Problems Encountered/Recommended Changes

We have had three set backs that are presently being resolved or "worked around." First, our annotated bibliography research assistant may have a serious illness, thus delaying finalization of the bibliography. We will attempt to complete the bibliography in as comprehensive a manner as possible should this employee not return. Second, we lost a highly qualified field coordinator/biostatistician in early June to a permanent position in another state. This adjustment is being compensated for by a reallocation of the workload. Last, we have been experiencing some difficulty in coordinating access to a computer capable of magnetic taping and local terminal analysis. We anticipate this problem should be resolved if a terminal can be installed at the MMD.

VI. Estimate of Funds Expended

April survey:

Flight time	$15,405.25
Salaries/overhead	2,275.00
Travel/per diem	1,848.00
Equipment, misc.	2,000.00
	$21,528.25

June survey:

Flight time	$ 9,477.25
Salaries/overhead	680.00
Travel/per diem	1,380.00
Equipment, misc.	200.00
	$11,737.25
Total	$33,265.50

VII. Revised Data Submission Schedule

Data to be sent to the Juneau Project Office on magnetic tapes will be finalized for shipment on or before the following dates:

	Survey dates	Survey Area	Dates to Juneau
1976	14-21 March	Norton Basin	30 July, 1976
	6-19 April	Bristol Bay	30 August, 1976
	13-23 April	Norton/Hope Basins	30 September, 1976
	8-14 June	Norton/Hope Basins	30 September, 1976
	15-20 June	Alaska Peninsula	30 November, 1976
1975	17-20 June	Alaska Peninsula	30 November, 1976
	9-13 August	Alaska Peninsula	30 November, 1976
	9-14 October	Norton Basin	30 November, 1976

RU 67

VIII Revised Milestone Chart

Milestone Chart

Project: Baseline Characterization of Marine Mammals: Bering Sea

Date: 28 June 1976

PI(s): Mr. Clifford H. Fiscus and Dr. Howard W. Braham

1976

	Major Milestones / Activities
1	Bristol Bay Aerial survey
2	Northern Bering - Southern Chukchi Sea surveys
3	Alaska Peninsula surveys
4	Summarization of spring field data
5	Computer logging of field data
6	EDS formatting - magnetic tapes to Juneau Project Office
7	(all field research for FY '75-'76)
8	Data analysis and synthesis (all FY '75-'76 data)
9	Final Report-writing (final and 5th quarterly)
10	Possible ship cruises (fall '76); data included in FY'77.
11	Possible aerial surveys (fall '76); data included in FY'77.
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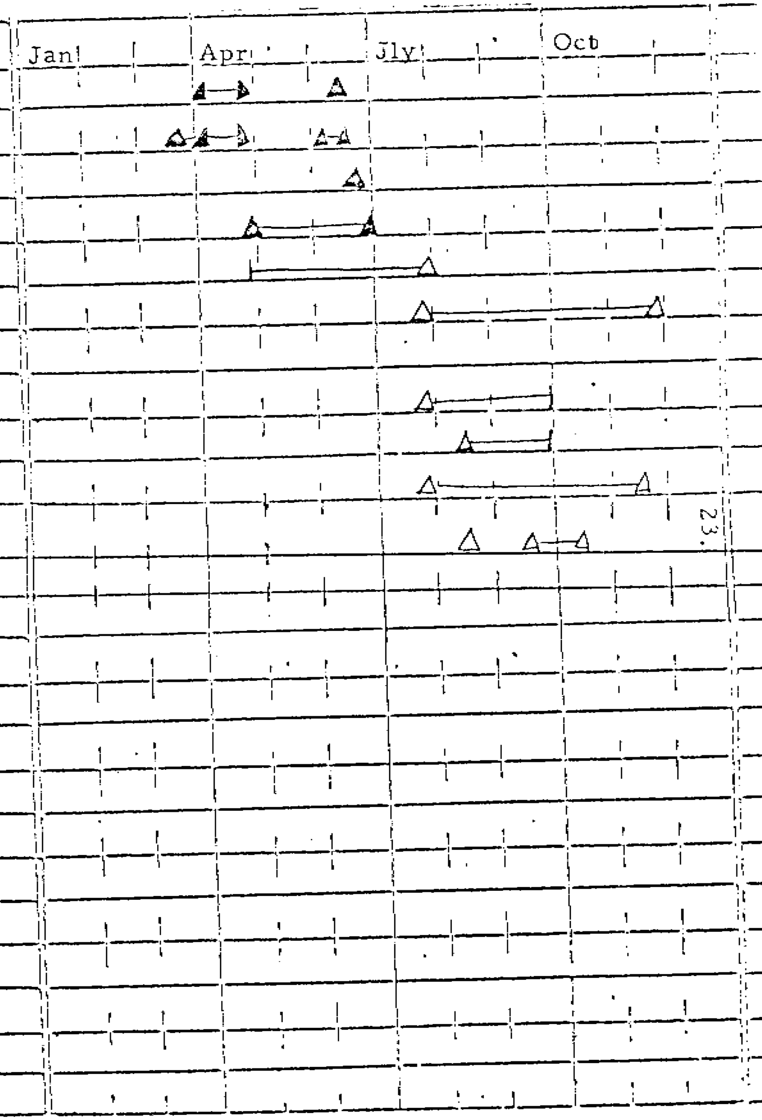

23.

Fourth Quarterly Report

Contract No. R71208606
Research Unit 68
Period: 1 April 1976
30 June 1976
Number of Pages 5

Abundance and Seasonal Distribution of Marine Mammals in the Gulf of Alaska

Principal Investigators:

Mr. Clifford H. Fiscus
Dr. Howard W. Braham
Lt. Roger W. Mercer

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest Fisheries Center
Marine Mammal Division
7500 Sand Point Way N.E., Bldg. 32
Seattle, Washington 98115

June 16, 1976

Fourth
Quarterly Report

I. Task Objectives

The baseline objectives of this project are to provide a better understanding of the relative seasonal distribution and abundance of marine mammals. These objectives will be accomplished by integrating (1) sighting records taken aboard NOAA ships and chartered vessels working in and crossing the Gulf of Alaska; (2) data from aircraft surveys collected by supporting OCSEAP projects (e.g. Alaska Department of Fish and Game): and (3) historical whaling and sealing records.

The northern and coastal regions of the Gulf of Alaska are expected to be important areas where oil-gas research and tanker traffic will occur. These areas also represent localized habitats for breeding marine mammals (e.g. northern sea lion, Eumetopias jubatus) and for seasonal migration (e.g. California gray whale, Eschrichtius robustus). The Gulf of Alaska, therefore, represents an important area of study for understanding the interaction between marine mammal resources and oil-gas resource development.

II. Field or laboratory activities

A. Ship schedules

NOAA Ship DISCOVERER 4/1/76 - 6/5/76 NEGOA
4/6/-4/30 MMD Observer Marsha Caunt aboard

NOAA Ship SURVEYOR 4/1/76 - 6/22/76 Bering Sea & GOA

3/8-4/2 MMD Observer Bob Everitt aboard
4/6-4/22 MMD Observer Pat McGuire aboard
4/26-6/1 No MMD Observer aboard*
6/5-6/22 MMD Observer Carl Peterson aboard

NOAA Ship FAIRWEATHER 5/12/76 - 6/30/76 Cook Inlet
No MMD Observer scheduled aboard*

NOAA Ship RAINIER 6/21/76 - 6/30/76 Icy Bay
No MMD Observer scheduled aboard*

NOAA Ship MILLER FREEMAN 4/1/76 - 6/22/76 Bering Sea
3/15-6/3 No MMD Observers aboard*
6/6-6/23 MMD Observer Ken Raedeke aboard

NOAA Ship MAC ARTHUR No MMD Observers aboard*	5/5/76 - 6/30/76	Prince William Sound
NOAA Ship DAVIDSON No MMD Observers aboard*	5/12/76 - 6/30/76	NEGOA

* Sightings were compiled by the ship's Marine Mammal Officer (II B) during periods for which no Marine Mammal Division (MMD) observers were aboard.

B. Scientific Party (all MMD personnel)

Mr. Clifford Fiscus - Task Leader of Pinnipeds Group and Principal Investigator for Research Units 67, 68, 69 and 70, affiliated with the Northwest Fisheries Center.

Dr. Howard Braham - Principal Investigator of OCSEAP Research Units 67, 68, 69 and 70 with the Northwest Fisheries Center.

Lt. Roger Mercer - Principal Investigator of OCSEAP Research Unit 68 and manager of Platforms of Opportunity Program with the Northwest Fisheries Center.

Mr. Bruce Krogman - FY'76 field co-coordinator for all OCSEAP projects, providing assistance with data analysis.

Ms. Nancy Severinghaus - OCSEAP Literature Research Assistant compiling an annotated bibliography for Gulf of Alaska marine mammal information.

Mr. Kenneth J. Raedeke - Working as an observer aboard selected NOAA vessels and assisting with data processing.

Mr. Robert Everitt - Working as an observer aboard selected NOAA vessels and assisting with data processing.

Mr. Patrick McGuire - Working as an observer aboard selected NOAA vessels and assisting with data processing.

Mr. Carl Peterson - Working as an observer aboard selected NOAA vessels and assisting with data processing.

Mr. Ronald Sonntag - Working primarily with data processing.

NOAA personnel working aboard NOAA vessels at compiling marine mammal sightings include the following:

Ltjg. Roddy J. Swope	NOAA Ship OCEANOGRAPHER
Ens. Susan J. Ludwig	NOAA Ship DISCOVERER
Ltjg. Todd Baxter	NOAA Ship SURVEYOR
Ens. Patrick J. Rutten	NOAA Ship MILLER FREEMAN
Ens. Mark Sullivan	NOAA Ship FAIRWEATHER
Ens. John C. Osborn	NOAA Ship RAINIER
Ens. Gerald E. Wheaton	NOAA Ship DAVIDSON
Ens. Lars A.G. Pardo	NOAA Ship MAC ARTHUR
Mr. Tom Dunatov, 1st Mate	NOAA Vessel JOHN COBB
Mr. Riley Wilson, Deck Hand	NOAA Vessel OREGON

C. Methods

1. A comprehensive bibliography is being prepared of all known literature on marine mammals in the Gulf of Alaska.

2. Marine mammal observers aboard NOAA ships (the Platform of Opportunity Program) will have little input into trackline selection. Hence, there is no systematic sampling method behind data collection efforts using NOAA vessel personnel. A pilot study using systematic sampling procedures is being tested by Marine Mammal Division employees.

3. Sightings are coded and carded for species, number seen, location, behavior, direction of travel, and related information. Computer printout of the data and charts indicating location of sightings by month are being compiled.

4. Distributional data are examined through computer programs by month, where sufficient sightings are available, or by season (3 month periods). Sightings per unit effort are compared and displayed in a manner similar to that used in studies on pelagic fur seal distribution. Since most pelagic and coastal research in the study area is conducted from spring through the late fall (March-November), data on winter distribution and abundance will be minimal.

D. Sample Localities/Ship Tracklines

The vessels listed in section II-A-1 of this report have recorded marine mammal sightings incidental to ship's operations in and proceeding to and from their respective project areas. Trackline plots, Marine Operations Abstracts and Marine Operations Station Abstracts are being prepared by the Juneau Outer Continental Shelf Energy Assessment Program Project Office and should soon be available.

E. Data collected:

1. The following is an abstract of all 1976 data that has been received and filed to date by Marine Mammal Division, NWFC.

Vessel	From day/mo		To day/mo/yr	# Sightings
DISCOVERER	6/4	-	30/4/76	157
MILLER FREEMAN	24/4	-	13/5/76	33
MILLER FREEMAN	16/5	-	4/6/76	39
SURVEYOR	9/3	-	29/4/76	331

2. No analysis of data has been made at this time.

3. Miles of trackline will be available upon completion of plotting programs presently being developed by Marine Mammal Division, NWFC.

III. RESULTS

Data has been gathered and is being prepared for submission to NODC. No analysis of data has been done to date. (See VII.)

IV. Preliminary Interpretation of Results:

None.

V. Problems Encountered/Recommended Changes:

Some problems have been experienced in obtaining programs and equipment necessary for expedient data processing but we feel the schedule outlined in Section VII can be met.

The primary source of our data has been the NOAA Officers assigned to compiling marine mammal sightings aboard NOAA vessels. The recent institution by OCS of the Marine Operations Abstract and Marine Operations and Station Abstract has caused sufficient confusion among contributing vessels that marine mammal logs have not been kept in some instances in the belief that the MOA and MOSA provided us with reliable information. The MOA and MOSA are an excellent record of the vessel's position by time, but do not provide sufficient space for describing marine mammal sightings. Hopefully, the inadequacies involving MOA, MOSA and Marine Mammal Logs can be resolved soon.

VI. Estimate of Funds expended:

Original	55.0 K	
Overhead	10.2 K	
Sub-Balance	44.8 K	Balance
Spent to Date	27.1 K	17.7 K
Obligated - July, Aug., Sept.	2.6 K	15.1 K

VII. Revised Schedule:

Computer listings for 1975 data have been prepared for final editing purposes, smooth listings should be completed by 15 July 1976. Plots of 1975 data by cruise should be available by 30 July 1976. The 1976 data are being logged presently with plots and listings of those data scheduled for completion by 30 August 1976 for all data received prior to 15 July 1976. A tape of 1975 Discoverer data will be submitted to the National Oceanographic Data Center through the Juneau Project Office by 15 July 1976. More data will be forwarded to NODC soon after this initial batch has been checked by NODC.

Analysis of data will be undertaken after plotting and listing programs have been completed which should be before 15 July 1976.

A revised milestone chart was prepared during a meeting with OCSEAP Juneau Project Office Coordinator Mr. Donald Day on 7-8 June 1976. He will attach a copy of the revised chart to this report upon receiving same.

Fourth Quarterly Report

Contract No. R7120807
Research Unit 69
Period 1 April - 30 June, 1976
Number of pages 12

Distribution and Abundance of Bowhead and Belukha Whales in the Bering Sea

Principal Investigators

Mr. Clifford H. Fiscus
Dr. Howard W. Braham

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest Fisheries Center
Marine Mammal Division
7500 Sand Point Way N.E., Bldg. 32
Seattle, Washington 98115

28 June 1976

Fourth Quarterly Report, April-June, 1976

I. Task Objectives:

The objectives of RU 69 are to determine the distribution and abundance of bowhead (Balaena mysticetus) and belukha (Delphinapterus leucas) whales in the Bering Sea during the spring migration north to the Arctic Ocean. Aerial survey techniques are used to locate wintering areas, identify time and location of movements of these whales as spring leads develope, and to determine if bowheads may be breeding and/or calving within oil-gas lease sites. Surveys in March were designed to provide data on animal movement during the wintering period and as an opportunity to develope practical aerial survey sampling techniques. April surveys were flown to provide information on timing of migration and areas of staging prior to migration; while surveys flown in June expected to determine length of the migration period and possible offshore routes into the southern Chukchi Sea. This information will be invaluable in timing vessel movements and development activity so as not to jepordize important migratory routes of bowheads. Because of potential interrelationships between marine mammals in the Bering Sea, population density and distribution data were also made on other species, such as walruses (Odobenus rosmarus) and bearded seals (Erignathus barbatus).

II. Field and Laboratory Activities:

A. Ship or Field Trip Schedule:

	Dates	Location	Aircraft	Charter
1.	6-19 April	King Salmon	N780 Goose	OAS
2.	13-23 April	Nome	P2V	OAS
3.	8-15 June	Nome	N780 Goose	OAS

B. Scientific Party:

1. 6-23 April - Dr. Howard Braham, Principal Investigator
Mr. Bruce Krogman, Field Coordinator
Mr. Robert Everitt
Mr. Keith Parker

Marine Mammal Division
Northwest Fisheries Center
National Marine Fisheries Service
Seattle, Washington

2. 8-15 June - Same as above except Mr. Keith Parker.

II. Con't.

C. Methods:

Sightings of marine mammals were made from aircraft flying at altitudes between 200 and 1500 feet. Visual estimates and photographic records were made to verify species identification and numbers of animals seen. Leads were flown-over at elevations of 500 to 1000 feet to record data on bowheads and belukha whales. Other data were collected in conjunction with RU 67 and RU 14 as outlined in the "Objectives" section.

At least three observers were used during each survey; one acted as the recorder and two as observers. Most surveys used a stratified random series of transects (Bering and Chukchi Seas, 8-14 June) as well as systematic transects (when flying just a lead system). By using these methods an unbiased estimate of the number of animals observed can be made; representing a statistically reliable procedure for ascertaining species abundance.

Each transect flown, whether random or systematic, is in actuality a duplicate strip census. That is, both sides of the aircraft (for the Super Goose) are used to observe out to one-half mile from 90° vertical to the side of the aircraft. Animals directly below the airplane were not scored (i.e. cannot be seen). This method in essence allows one to obtain duplicate samples of adjacent habitat. Approximately 1/7 th. of a mile at 500 feet and 1/5 th. of a mile at 700 feet are not surveyed using the Super Goose. All animals are sampled within a one mile wide transect using the P2V aircraft.

D. Aerial Survey Locations and Tracklines:

1. 6-15 April, Bristol Bay (Figure 1).
2. 13-15 April, Northern Bering Sea (Figure 1 and 2).
3. 17-19 April, Bristol Bay (figure 3).
4. 19-23 April, Northern Bering/Southern Chukchi Seas (Figure 2).
5. 8-14 June, Northern Bering/Southern Chukchi Seas (Figures 4-5).

E. Data Collected or Analysed:

	Data Recordings+	Trackline Miles++
1. 6-12 April, 17-19 April	1,330	4,350
2. 13-15 April	1,279	3,300
3. 8-14 June	2,177	3,410
Approx. Totals	4,786	11,060

+A data recording is a single logged entry at a specific time and location and represents one or more animals sighted; or, environmental data. All values are approximate at this time.

++In nautical miles.

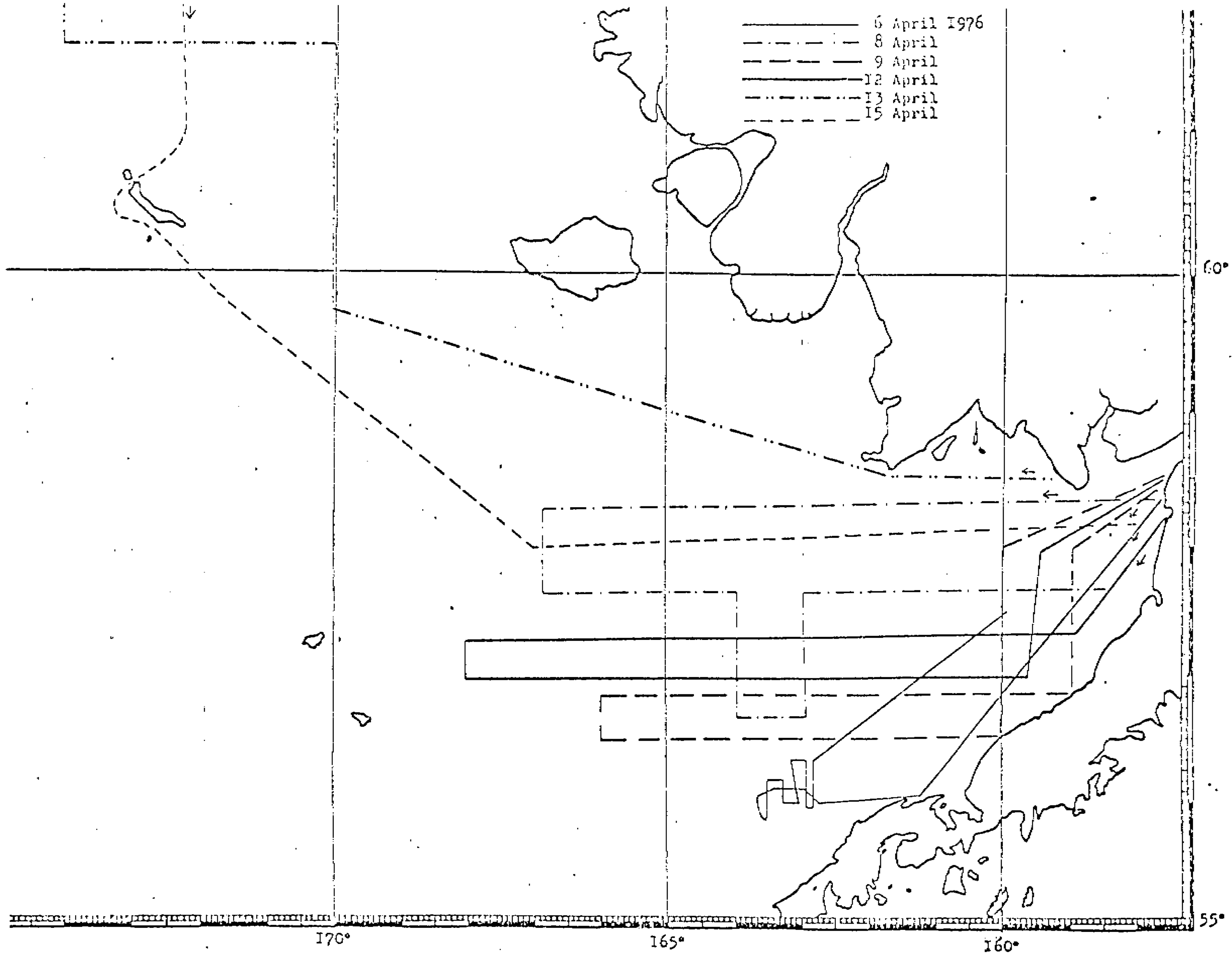

Figure 1. Marine mammal aerial survey tracklines in Bristol Bay during April, 1976 (RU 67-A4 and RU 14-A1).

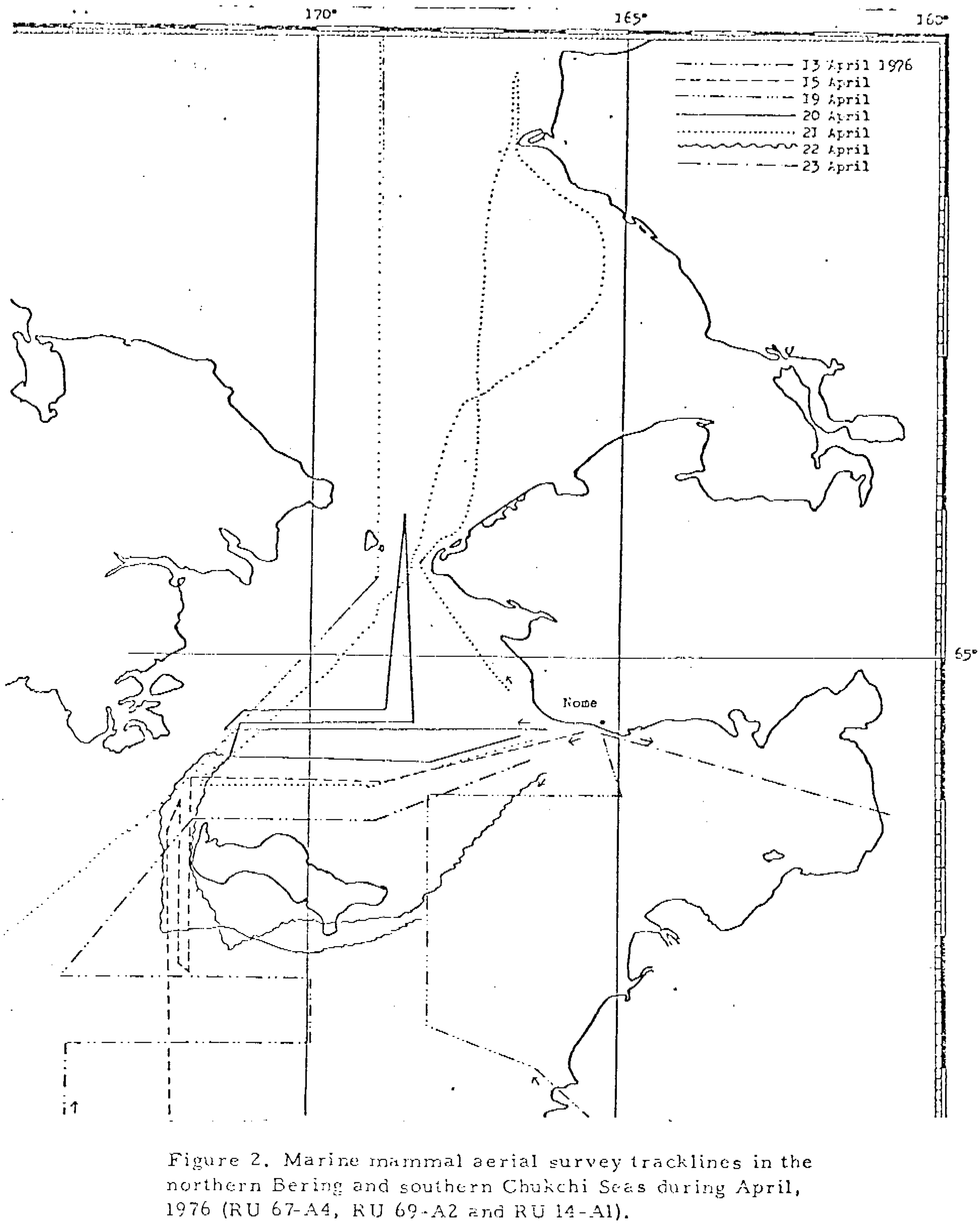

Figure 2. Marine mammal aerial survey tracklines in the northern Bering and southern Chukchi Seas during April, 1976 (RU 67-A4, RU 69-A2 and RU 14-A1).

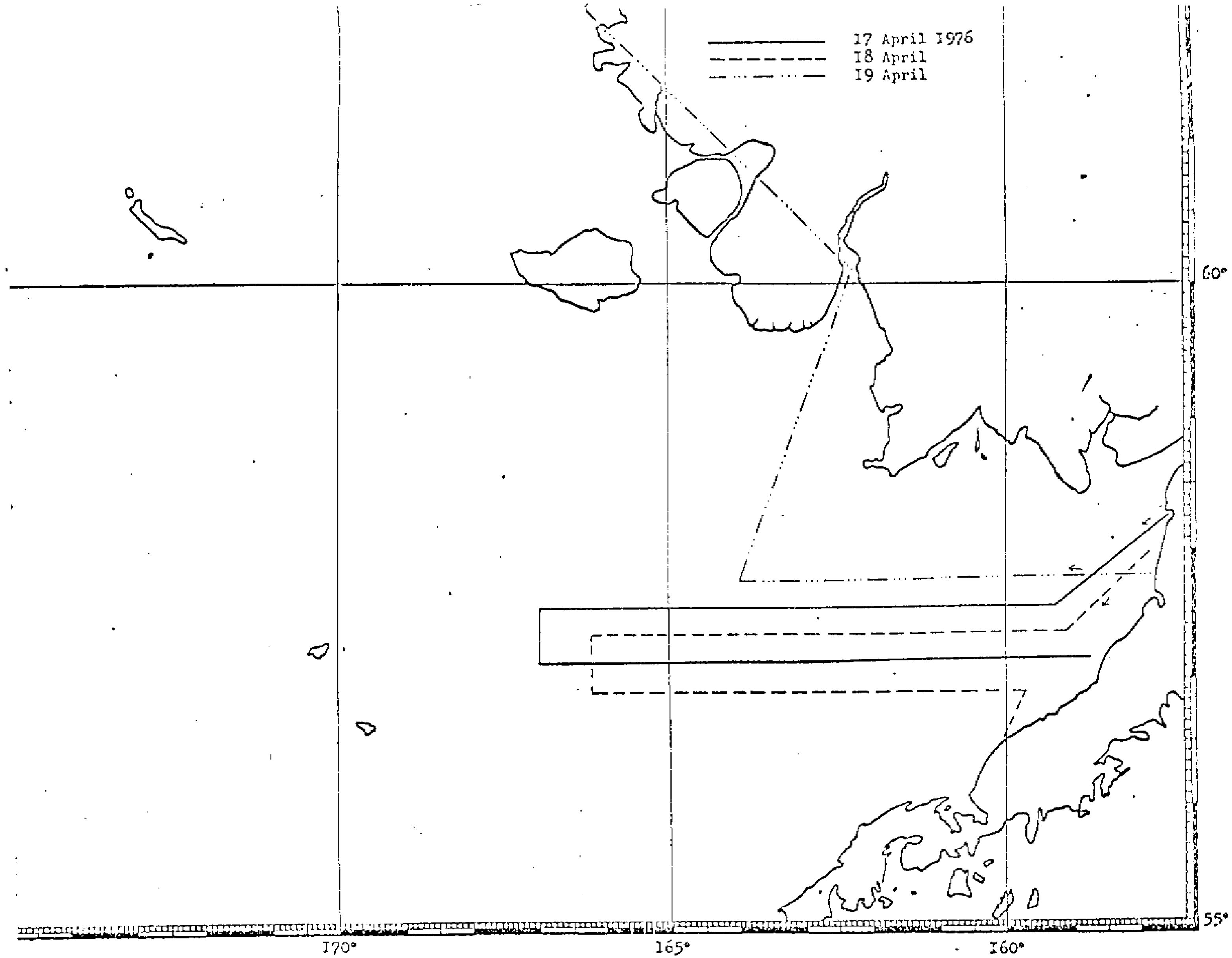

Figure 3. Marine mammal aerial survey tracklines in Bristol Bay during April, 1976 (RU 67-A4 and RU 14-A1).

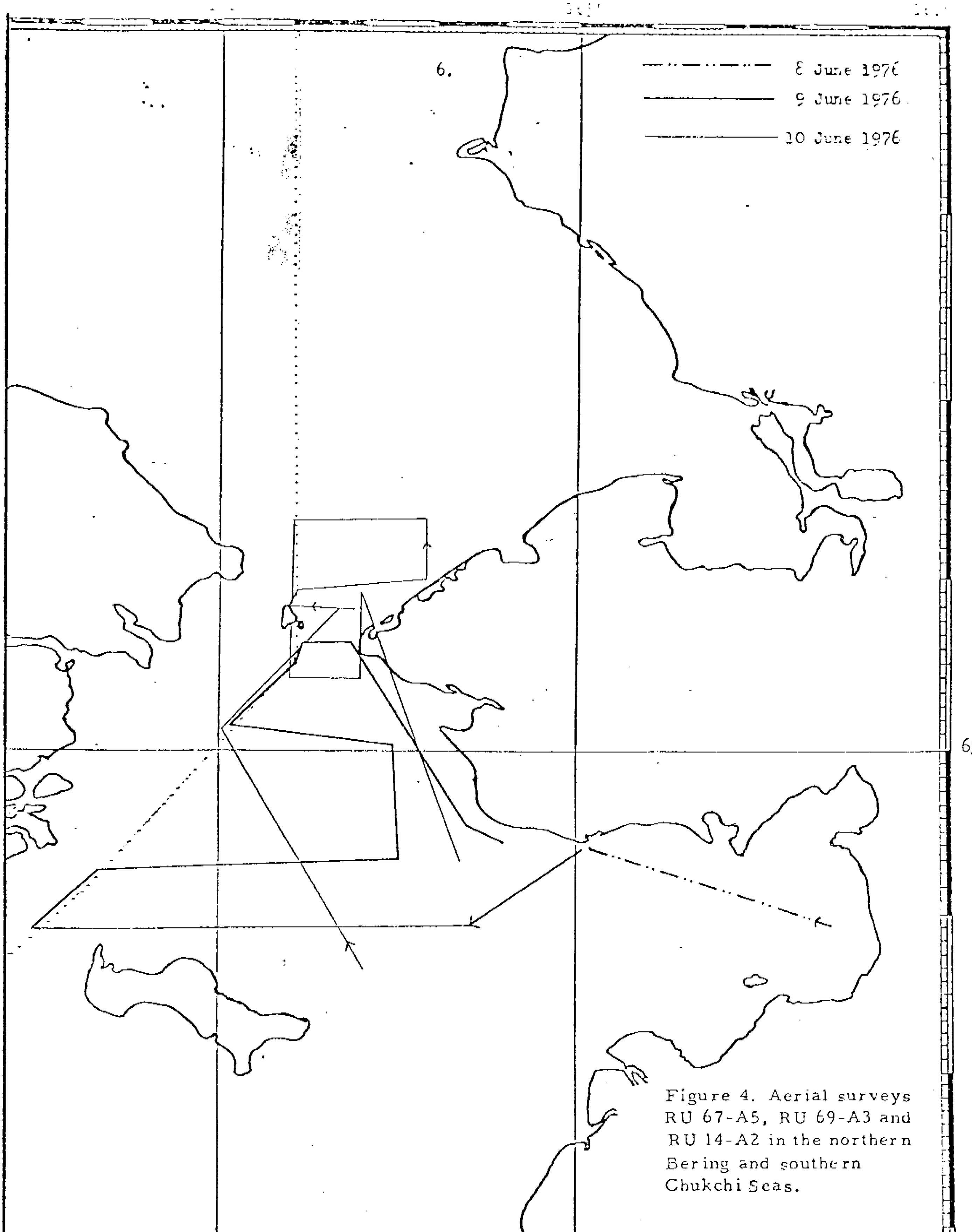

Figure 4. Aerial surveys RU 67-A5, RU 69-A3 and RU 14-A2 in the northern Bering and southern Chukchi Seas.

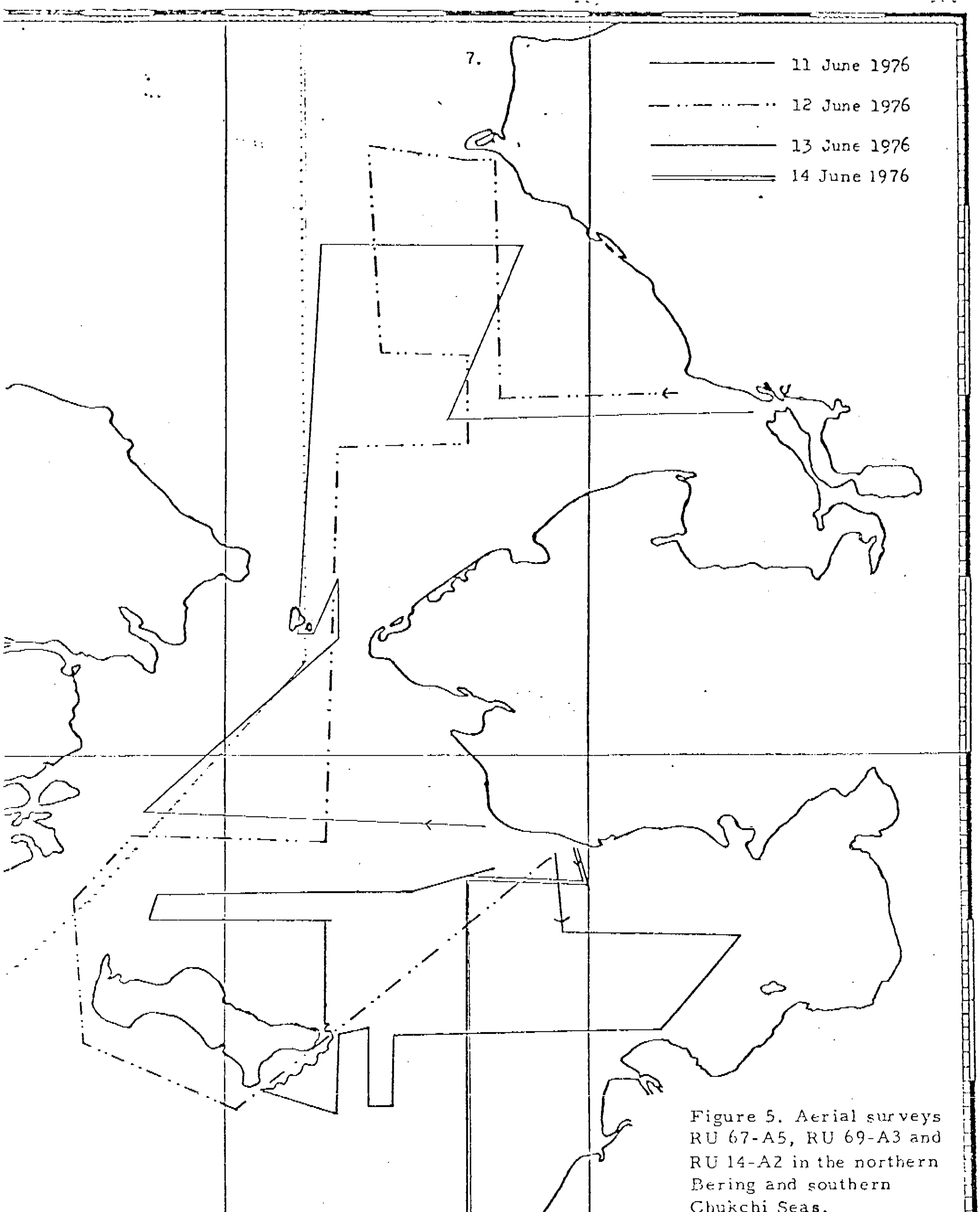

Figure 5. Aerial surveys RU 67-A5, RU 69-A3 and RU 14-A2 in the northern Bering and southern Chukchi Seas.

III. Results.

A. Bristol Bay, 6-23 April, 1976.

One bowhead whale sighting was made throughout April in southeast Bering Sea on 23 April, 1210 hours at Latitude 56°45' Longitude 162°38' by Robert Everitt while on an aerial survey cruise with Mr. John Burns (RU 231), Alaska Department of Fish and Game, in the P2V aircraft. Three bowhead sightings were made from aboard the NOAA ship surveyor on the 19-21 April by Patrick McGuire, a Marine Mammal Division - OCS employee. Although the sightings were independent, they may represent the same animal. The 20 April Sighting was at Lat. 57°06' Long. 172°13'.

Thirty-three belukha whales were seen in a small lead at 1615 hours on the 9th. of April at 58°02' Latitude and 159°45' Longitude. At least seven and perhaps as many as eleven were immatures. No other belukha whales were seen throughout Bristol Bay in April by our aerial survey team.

B. Northern Bering/Southern Chukchi Sea, 13-23 April, 8-14 June, 1976.

The number of bowhead and belukha whales (and other marine mammals) observed during April are summarized in Table 1, and those observed in June summarized in Table 2. Data collected in March are also included in Table 1.

IV. Preliminary Interpretation of Results.

Too few bowhead whales were observed in the Bering Sea from April to June to make any statements about definitive distribution or abundance. This is unfortunate because we have made great strides in assessing distribution and abundance of bowheads along the shores of the Chukchi and Beaufort Seas (RU70) during the spring. Bowheads have been seen in the southern Bering Sea but these sightings may represent the "unusual" occurrance for this species. It simply points up the fact that we have very little information on this species suggesting that continued research is needed. Our sightings of bowheads in the northern Bering Sea occurred near St. Lawrence Is. and north of the Bering Strait. One bowhead was seen directly east of St. Lawrence, one northwest of St. Lawrence and two approximately half way between St. Lawrnce Is. and the Bering Strait. These sightings occurred in April (Table 1). At this point we have not been able to delineate wintering grounds nor early spring movements for bowheads. Additional flights into the western Bering Sea are needed from late February to mid May to assist in the analysis of spring migration or distribution. Whale counting stations at strategic places (Gamble, St. Lawrence Is.; Whales; Point Hope and Barrow) should allow us to collect more reliably quantifiable data on distribution and abundance.

A quantitative analysis of the distribution and abundance of belukha whales will be provided in the final report.

V. Problems Encountered/Recommended Changes.

A. Changes - Increase our emphasis on ice based counting stations at locations where bowhead whales are harvested by Eskimos. Continue aerial surveys for bowhead and belukhas at specific times and locations (e.g.

Table 1. Numbers of marine mammals observed daily during aerial surveys from 15 March to 23 April, 1976, from St. Mathew Island to the Bering Strait including Norton Basin.

	Pinnipeds			Cetaceans	
Date	Walrus	Ringed Seal	Bearded Seal	Bowheads	Belukhas
15 March	727	0	0	0	8
18 March	44	0	2	0	18
19 March	955(+3)	0	1	0	2
21 March	4, 235	0	41	0	0
13 April*	924(+6)	61	39	0	0
15 April*	694(+3)	4	0	0	0
19 April*	75	0	0	1	4
20 April	878	1	50	1	4
21 April	519	0	28	2	118
22 April	68	1	7	0	25
23 April	2	8	9	0	1
Totals	9, 486(+)	75	177	4	180

* part of this survey was done in S/E Bering Sea.

+ additional number of pods not counted from photographs as yet.

Table 2. Numbers of marine mammals observed daily during aerial surveys from 8 to 14 June, 1976, in the northern Bering and southern Chukchi Seas.

Date	Pinnipeds					Cetaceans					Pohr Bears
	Ringed Seals	Bearded Seals	Walruses	Harbor Seals	Unid.	Gray Whales	Bowhead Whales	Belukha Whales	Unid. Whales	Unid. Porpoises	
8 June	9	7	14	0	2	0	0	0	0	0	0
9 June	13	57	2,150	0	12	73	0	0	5	1	0
10 June	42	129	3,362	0	4	20	0	0	3	0	0
11 June	67	234	10,125	0	13	145	0	0	0	0	0
12 June	153	249	3,457	0	10	291	2	0	3	0	6
13 June	25	49	16,203	0	13	217	0	18	2	0	0
14 June	0	12	31,555	26	10	0	0	0	0	0	0
Totals	235	737	66,866	26	64	746	2	18	13	1	6

southwestern Bering Sea in March and early April, and May in the northern Bering and southern Chukchi Seas).

B. Problems - We have had three setbacks that are presently being resolved or "worked around". First, our annotated bibliography research assistant may have a very serious illness thus delaying finalization of the bibliography. We will attempt to complete the bibliography in as comprehensive a manner as possible should this employee not return. Second, we lost the services of a very highly qualified field coordinator/biostatistician in early June to a permanent position in another state. This adjustment is being compensated for by a reallocation of the workload.

VI. Estimate of Funds Expended.

A. March (omitted from 3rd. quarterly report)

Flight time	$4,721.75
Salaries/Overtime	417.00
Travel/Per diem	918.00
	$6,056.75

B. April

Flight Time	$5,918.00
Salaries/Overtime	518.00
Travel/Per diem	1,224.00
	$7,660.00

C. June

Flight Time	$3,008.50
Salaries/Overtime	978.00
Travel/Per diem	762.00
	$4,748.50

March-April-June Totals $18,465.25

VII. Revised Data Submission Schedule.

All field data collected in FY'76 including aerial surveys for bowhead and belukha whales in the Bering and Chukchi Seas will be submitted to the Juneau OCSEAP Project Office on magnetic tapes on or before 30 November 1976.

Milestone Chart

Project: Abundance and Distribution of Bowhead and Belukha Whales in the Bering Sea.

Date: 28 June 1976

12.

[illegible]: Mr. Clifford Fiscus and Dr. Howard Braham

Major Milestones / Activities

1 Aerial surveys in the northern Bering and Southern
2 Chukchi Seas, and Bristol Bay.
3 Summarization of Spring Field Data
4 Computer logging of Field Data
5 EDS Formatting - Magnetic Tapes to Juneau Project Office
6 Data Analysis and Synthesis
7 Final Report Writing
8
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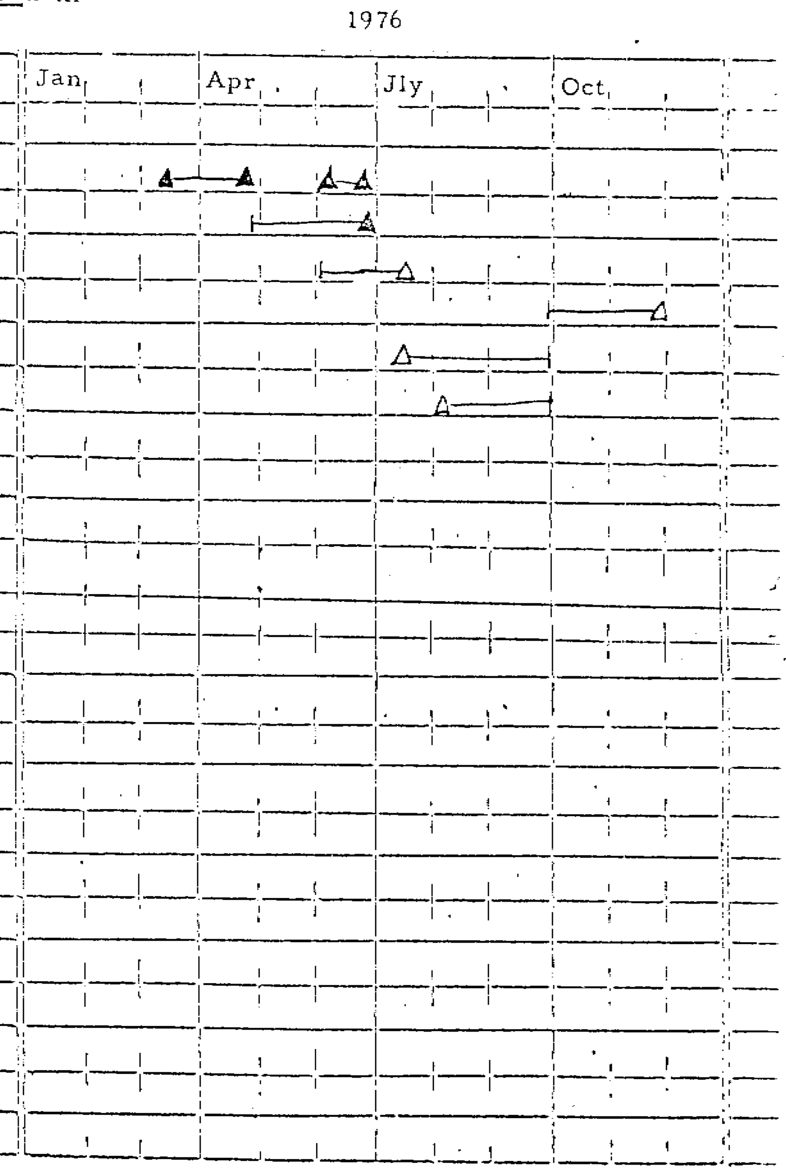

Fourth Quarterly Report

Contract No. R7120808
Research Unit 70
Period: 1 April 1976
30 June 1976
Number of Pages 16

Distribution and Abundance of Bowhead and Belukha Whales in the Beaufort and Chukchi Seas

Principal Investigators:

Mr. Clifford H. Fiscus
Dr. Howard W. Braham
Mr. Willman M. Marquette

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest Fisheries Center
Marine Mammal Division
2725 Montlake Boulevard East
Seattle, Washington 98112

28 June 1976

RU 70 Fourth Quarterly Report, April-June, 1976

I. Task Objectives

RU 70 objectives are to delineate the abundance and seasonal distribution of bowhead whales (*Balaena mysticetus*) and belukha whales (*Delphinapterus leucas* in the Beaufort and Chukchi Seas. More specifically, for the fourth quarter of FY 1976, ice based counting station surveys and aerial surveys were conducted to: (1) make stock estimates in the Beaufort Sea during the spring; and (2) to delineate temporal and spacial migratory patterns of both species.

II. Field or Laboratory Activities

A. Ship or Field Trip Schedule

The ice based counting station located near Barrow, Alaska, was set up on 25 April when the shore lead opened. A 24 hour watch was maintained as weather and ice conditions permitted. The ice station was disbanded on 2 June because shore fast ice had progressed to a melt stage where ice activities became dangerous.

Spring aerial surveys were initiated on 30 April shortly after the ice station was set up. Survey flights of the Chukchi and Beaufort Seas originated at the Naval Arctic Research Laboratory (NARL) and were made aboard a Twin Engine Otter (N127RL) aircraft. Two flights were made aboard a single engine Cessna 180 aricraft on May 33 and a single engine OTTER on May 28. Aerial surveys were made on all favorable days (i.e. visibility, and lead conditions) through 20 June. A summary of flights by day and animals observed in provided in Table 2 of Section III.

B. Scientific Party

1. Ice based counting station:

Member	Affiliation	Role
Mr. Geoffery Carrol	NMFS/MMD	Field Supervisor
Ms. Joan McPhee	NMFS/MMD	Observer
Mr. Edwin Iten	NMFS/MMD	Observer
Mr. John Smithisler	NMFS/MMD	Observer

2. Aerial Survey

Member	Affiliation	Role
Dr. Howard Braham	NMFS/MMD	P.I./Observer
Mr. Bruce Krogman	NMFS/MMD	Field Sup./Observer
Mr. Robert Everitt	NMFS/MMD	Field Sup./Observer
Lt. Roger Mercer	NMFS/MMD	Observer

C. Methods

1. Ice Based Counting Station (Field Sampling).

A 24 hour watch was maintained (weather and ice permitting) for bowhead and belukha whales. Changes in ice condition necessitated a change in ice station location so that two locations were used, not simultaneously, at 70°24'N 156°23.0'W (North of Point Barrow) and 71°20'N 156°52.0'W (a point 5 miles from land directly west from Barrow).

An Eskimo whaling captain, Mr. James Matumeak, was hired to forewarn and protect the ice crew of dangerous ice conditions.

Conditions permitting, four hour shifts were maintained throughout the day with one to four men manning each shift. Whales were counted as (1) those seen by the ice crew and (2) those seen by Eskimos but not by the ice crew. This methodology allows for repeatability of the counting effort if in the future, Eskimos are not utilized. Furthermore, it allows the use of data collected by Eskimos which increases accuracy of abundance estimates. Observations by Eskimos were accepted as true if: (1) a nearby crew down the lead reported a whale was passing but the ice crew did not see it surface; (2) a crew up or down the lead was seen pursuing a whale; (3) if a whale was shot (but missed) which the ice crew had not counted; and (4) if members of the whaling crew became intently excited over the observation of a whale(s) made by some members of the crew but not seen by the counting crew. As the season progressed, and the counting crew became more experienced, the porportion (whales seen by ice crew/whales seen by Eskimos) increased.

See results for discussion of methodology with regard to data analysis.

2. Aerial Survey (Field Sampling).

Aerial surveys for bowhead and belukha whales was conducted from 200 to 2000 feet depending on weather, visibility, and lead conditions. Altitudes of 700 - 1000 feet were optimum. Near and offshore leads (north to 72°11'N) were surveyed.

Three observers (including the pilot) were commonly used during each survey. Visual estimates were made and photographs were taken to verify species identification and numbers of animals seen.

See results for discussion of methodology with regard to data analysis.

D. Sample localities/ship or aircraft tracklines.

Figures 1a through 1g illustrate sample locality and tracklines flown for each survey conducted from 30 April to 31 May. Flights are indexed to the figures listed in 11.E.

Recent June surveys are currently being processed and tracklines are as yet unavailable.

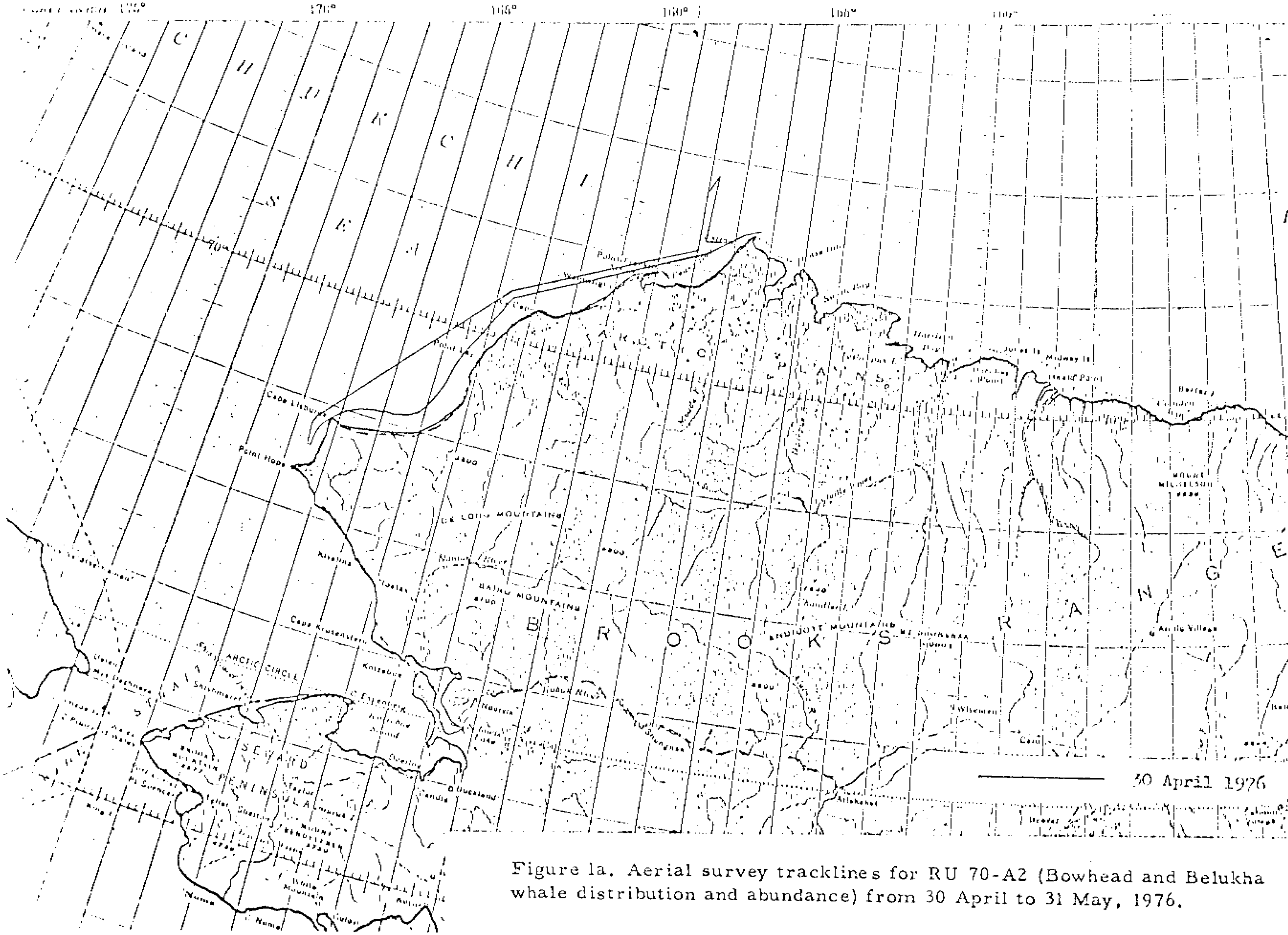

Figure 1a. Aerial survey tracklines for RU 70-A2 (Bowhead and Belukha whale distribution and abundance) from 30 April to 31 May, 1976.

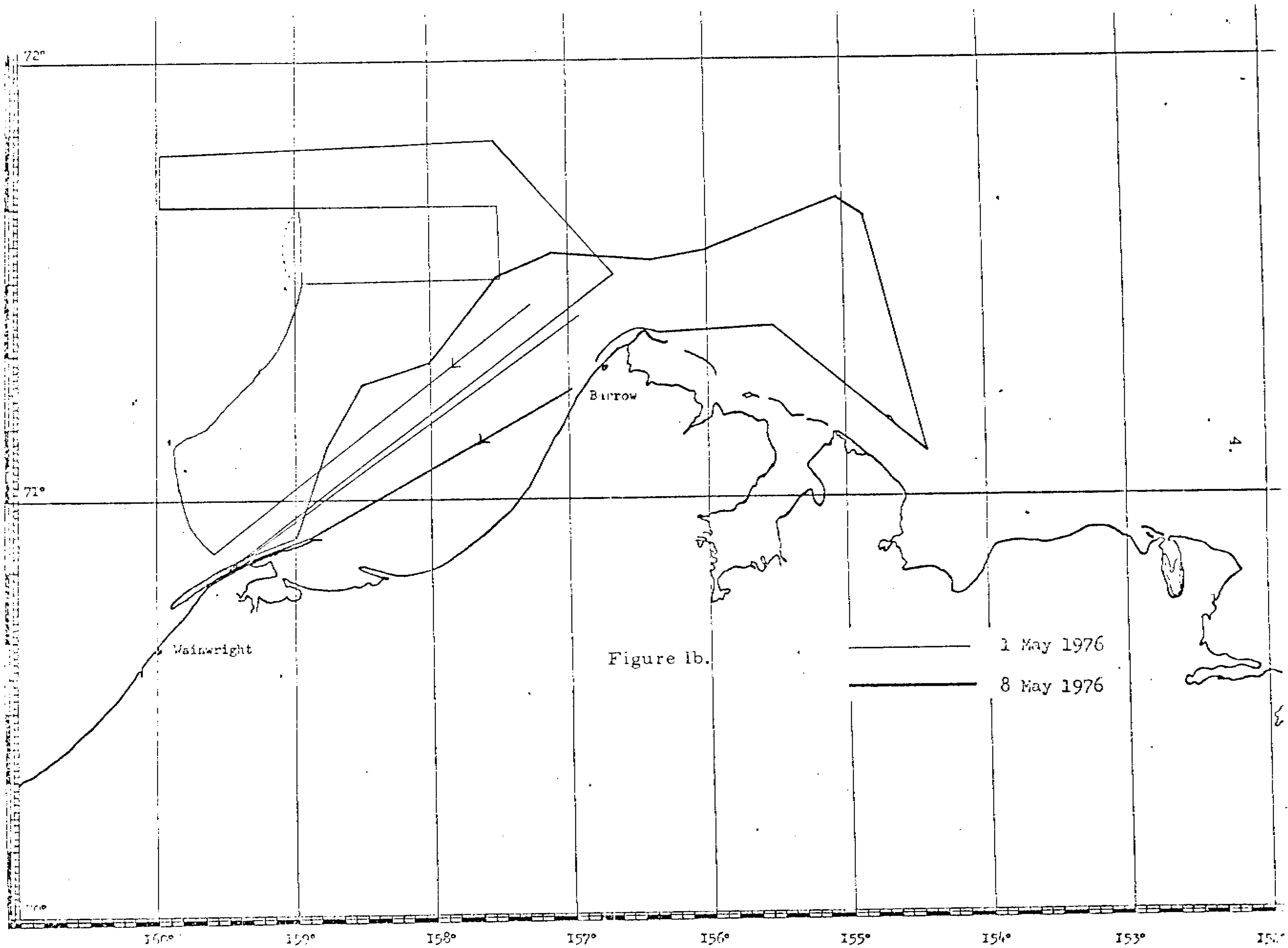
72°
71°
Barrow
Wainwright
1 May 1976
8 May 1976
158°
157°
156°
155°
154°
153°
4.

Figure 1b.

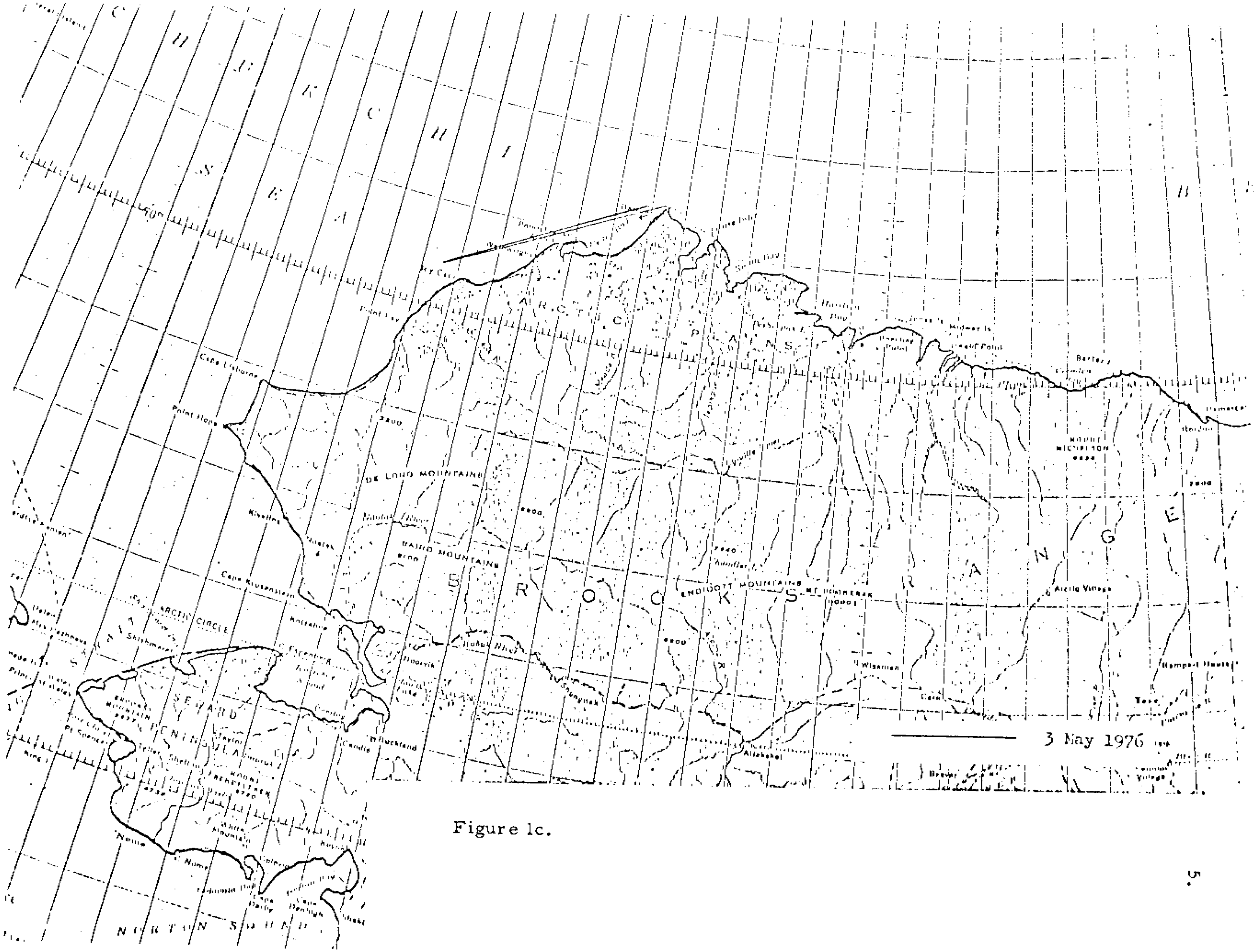
CHUKCHI SEA
ARCTIC PLAINS
Cape Lisburne
Point Hope
DE LONG MOUNTAINS
Kivalina
BAIRD MOUNTAINS
Cape Krusenstern
Kotzebue
ARCTIC CIRCLE
BROOKS RANGE
ENDICOTT MOUNTAINS
Arctic Village
Wiseman
Shungnak
Allakaket
Buckland
Candle
SEWARD PENINSULA
Nome
NORTON SOUND
3 May 1976

Figure 1c.

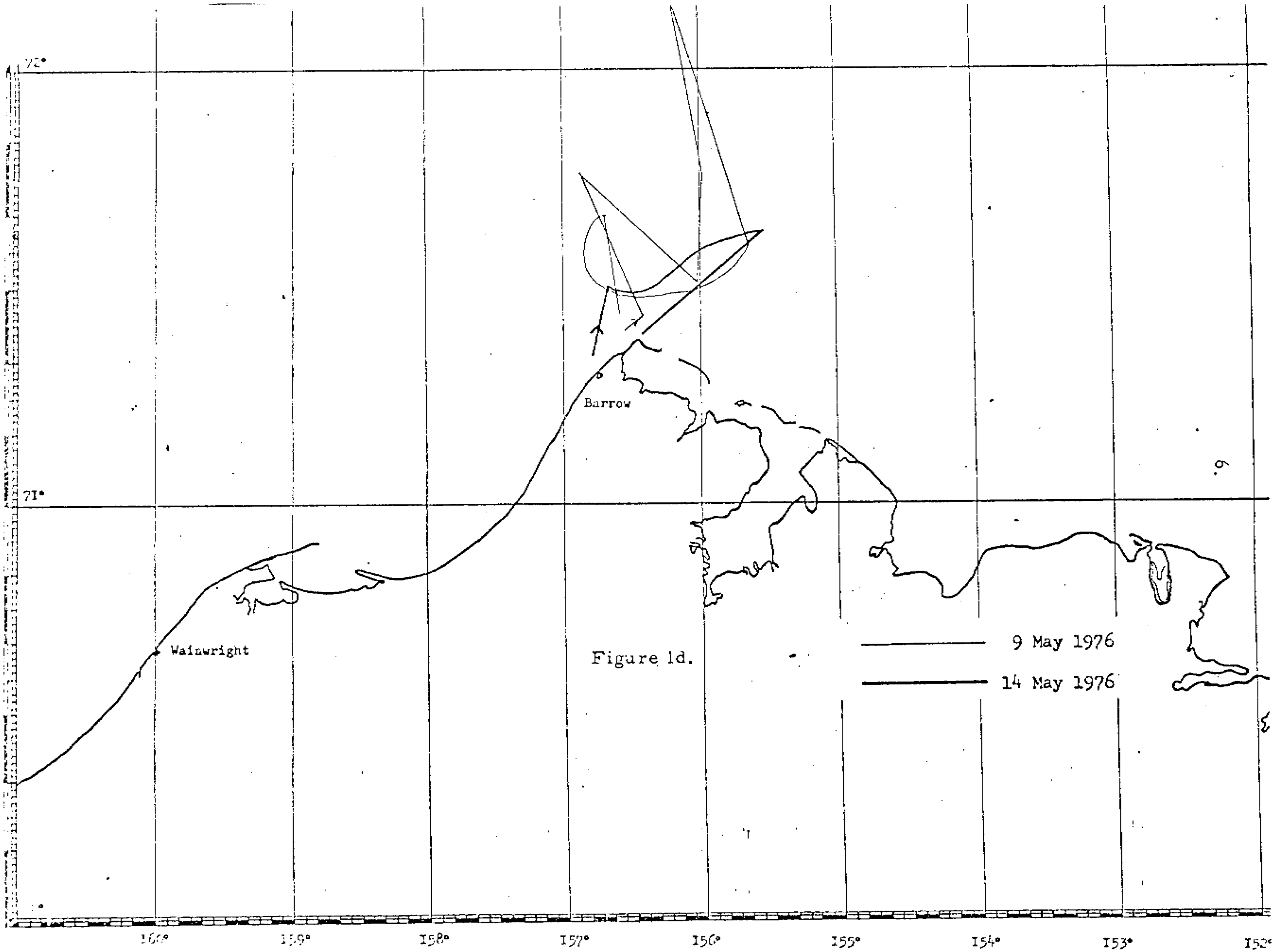
72°
71°
Barrow
Wainwright
9 May 1976
14 May 1976
160°
159°
158°
157°
156°
155°
154°
153°
152°

Figure 1d.

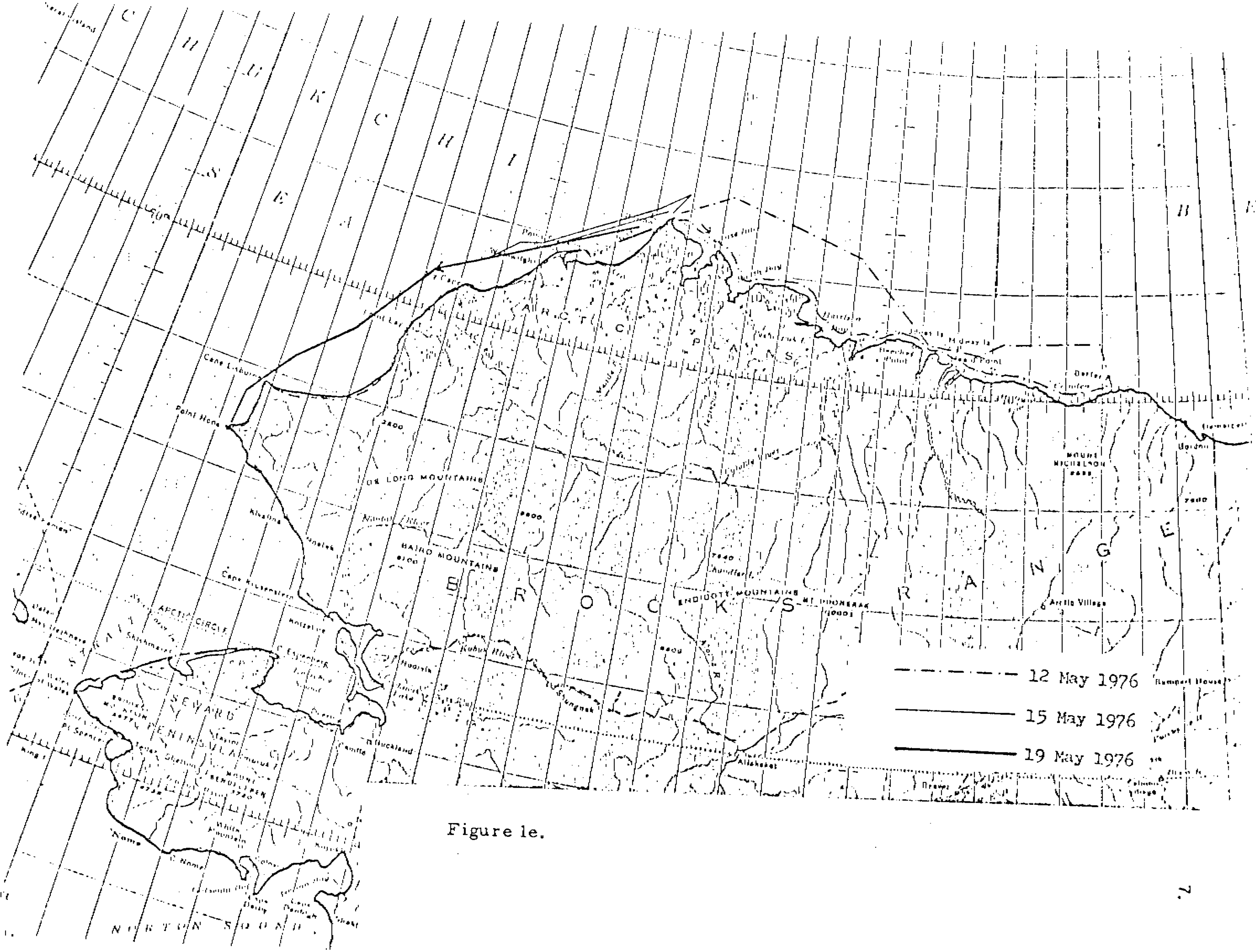
12 May 1976
15 May 1976
19 May 1976
Point Hope
Cape Lisburne
DE LONG MOUNTAINS
BAIRD MOUNTAINS
ENDICOTT MOUNTAINS
B R O O K S R A N G E
ARCTIC CIRCLE
SEWARD PENINSULA
Kotzebue
Nome
Allakaket
Arctic Village
Rampart House
N O R T O N S O U N D

Figure 1e.

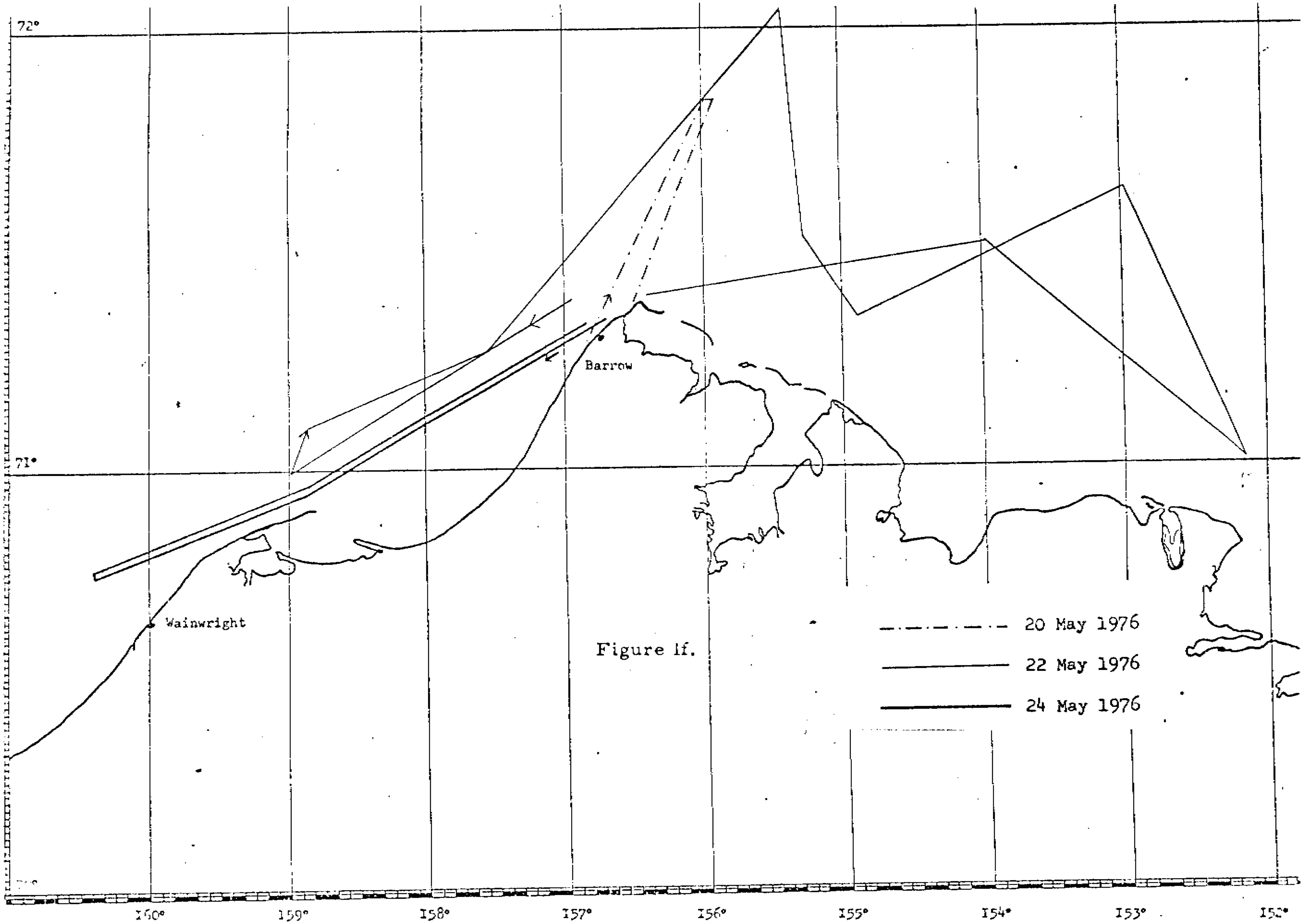
72°
71°
Barrow
Wainwright
20 May 1976
22 May 1976
24 May 1976
160°
159°
158°
157°
156°
155°
154°
153°
152°

Figure 1f.

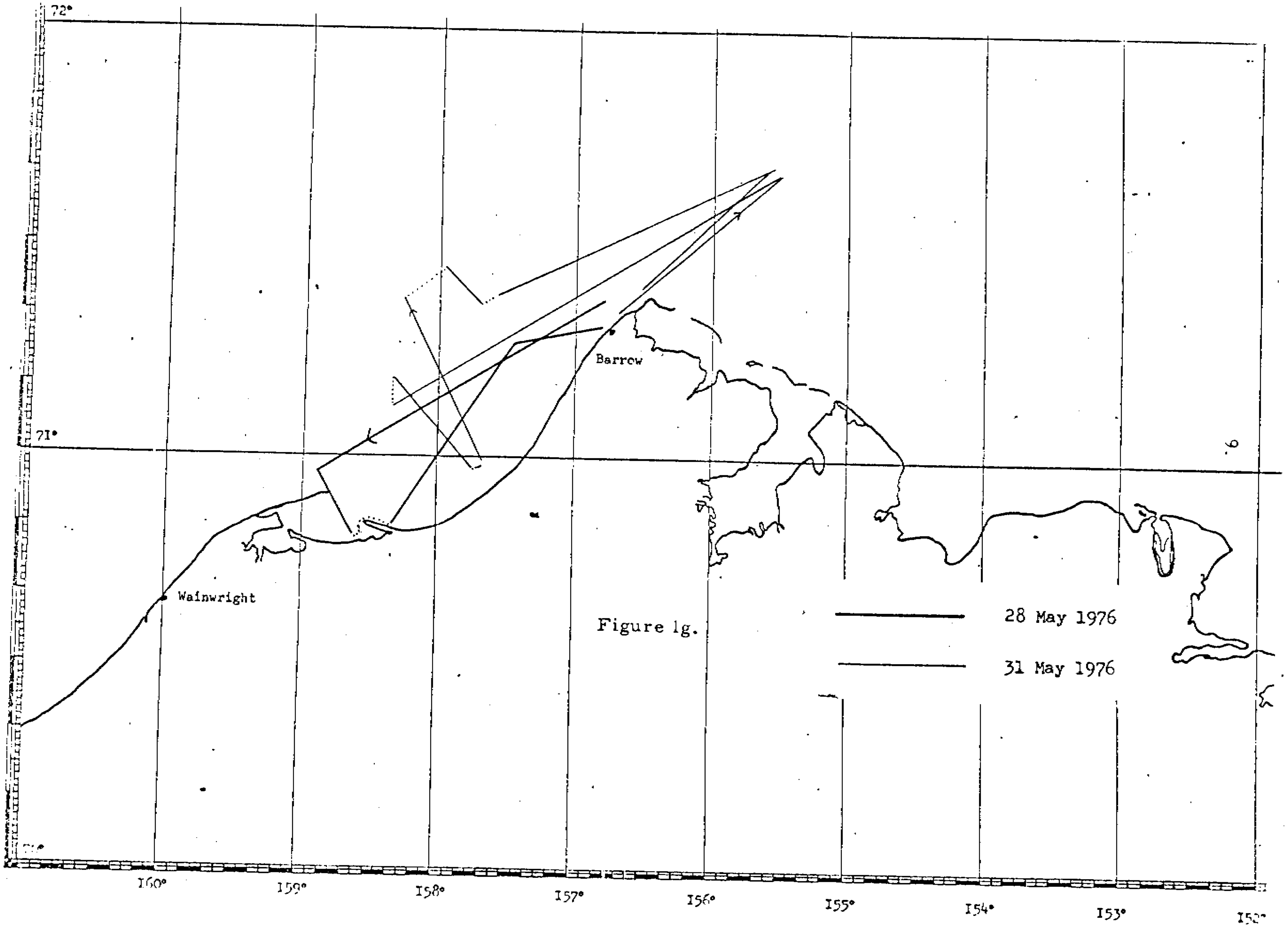
72°
71°
Barrow
Wainwright
28 May 1976
31 May 1976
160°
159°
158°
157°
156°
155°
154°
153°

Figure 1g.

E. Data collected or analyzed

Summary of aerial survey flights.

Date	Location of survey	Number of data recordings	Miles of trackline	Figure
30 April	W. of Barrow to Pt. Hope	190	595	1a
1 May	W. of Barrow to Wainwright and offshore	133	419	1b
3 May	W. of Barrow to Icy Cape	76	250	1c
8 May	W. of Barrow to Wainwright and E. to Cape Simpson	171	260	1b
9 May	E. of Barrow and offshore	80	161	1d
12 May	E. of Barrow to Barter Is.	66	600	1e
14 May	E. and N. of Barrow		60	1d
15 May	W. of Barrow to Wainwright	114	225	1e
19 May	W. of Barrow to Pt. Hope	67	270	1e
20 May	N.E. of Barrow (offshore)	31	70	1f
22 May	W. of Barrow to Wainwright offshore, E. to Lonely	116	352	1f
24 May	W. of Barrow to Wainwright	61	150	1f
28 May	W. of Barrow to Pearl Bay	83	110	1g
31 May	W. of Barrow to Wainwright	133	250	1g
		1,321	3,772	

III. Results

A. Ice based counting stations.

Table 1 provides a summary of animals counted per day by both the ice counting crew and Eskimos as well as totals by day for the whole counting period, 25 April - 2 June 1976. The counting ice crew counted 244 bowheads, and the Eskimos counted 91, which totals 335 animals.

The ice counting crew counted 309 belukha whales: 2 on 16 May, 100 on 18 May and 207 on 22 May. This count must be considered as less than the minimum number of belukhas which passed the ice station during observation effort because belukha whales were not as easily seen as the bowhead.

Further analysis of methodology is required before any conclusive statement regarding precision of bowhead counts can be made. Preliminary evidence suggests that whale counts will vary from year to year depending on ice and other invironmental conditions, etc. Repeated surveys, i.e. next season(s), are required for this question of precision to be properly addressed.

B. Aerial survey

The results of our aerial surveys are summarized in Table 2. Primary emphasis was placed on sighting bowheads and belukhas with other marine mammal sightings made in an incidental fashion. Occassionally, exceptions were made in the case of ringed seals when special transects were flown for ring seal cruises. Commonly the situation would arise where patches of fog would reduce visibility at higher altitudes and thus force low level flights over ice; acceptable only for ringed seal survey. Or, the lead would be disjointed and the ice would be surveyed between leads.

Results of aerial surveys show that many more belukha whales were counted from the air than from the ice based counting station (air = 1020 versus ice = 309). Conversely, fewer bowhead whales were counted from the air than from the ice based station (air = 108 versus ice 335). These data must be analyzed further before general statements can be made regarding the suitability of air versus ground census techniques on these cetaceans. Ice conditions, fog, wind, observer fatigue and lead width all must be considered simultaneously before a valid evaluation can be made.

Aerial surveys indicate that bowhead whales primarily migrate through near shore leads as opposed to offshore leads. Our current state of data analysis indicates that no bowhead whales were observed in offshore leads north to 72°11', approximately 50 miles north of Pt. Barrow. Belukha whales however, were observed to utilize these offshore leads, but the percentage breakdown has not yet been determined.

Table 1. Numbers of bowheads counted per day by the ice based counting station and by Eskimos assisting the ice station.

Date	Numbers			Date	Numbers (cont.)		
	Ice crew	Eskimos	Total		Ice crew	Eskimos	Total
25 April	3	2	5	14 May	5	0	5
29 April	11	6	17	15 May	11	3	14
30 April	7	10	17	16 May	18	11	29
1 May	17	3	20	17 May	26	9	35
2 May	3	6	9	18 May	52	9	61
3 May	0	1	1	19 May	1	0	1
5 May	12	6	18	21 May	4	0	4
6 May	13	15	28	22 May	20	0	20
7 May	8	1	9	23 May	0	0	0
8 May	4	1	5	24 May	9	0	9
9 May	2	0	2	25 May	1	0	1
10 May	0	1	1	26 May	6	0	6
11 May	0	0	0	31 May	1	0	1
12 May	0	0	0	1 June	0	0	0
13 May	10	7	17	2 June	0	0	0
				Total	244	91	335

Table 2. Numbers of Bowhead and Belukha whales and other marine mammals observed during aerial surveys of the north/eastern Chukchi and western Beaufort Seas from 30 April to 20 June, 1976.

Dates	Cetaceans			Pinnipeds				Polar Bears
	Bowheads	Belukhas	Gray Whales	Bearded Seals	Ringed Seals	Walruses	Unid.	
30 April	4	248	0	60	6	0	6	0
1 May	6	48	0	11	0	0	0	0
3 May	3	67	0	0	6	0	0	0
8 May	34	85	0	46	0	0	0	0
9 May	5	27	0	20	8	0	0	4
12 May	2	0	0	1	15	0	0	0
15 May	18	134	0	4	2	0	0	2
19 May	3	8	0	2	13	0	0	2
20 May	0	20	0	2	0	0	0	34
22 May	4	129	0	5	10	0	2	35
24 May	3	1	0	1	1	0	2	7
28 May	1	0	0	7	78	0	0	1
31 May	4	1	0	5	81	0	0	10
1 June	3	144	0	1	63	0	0	0
4 June	15	35	0	5	69	0	0	0
5 June	2	0	0	0	245	0	0	0
18 June	0	12	0	0	9	619	0	0
19 June	1	61	2	4	77	2600	1	1
20 June	0	0	0	0	66	0	0	0
Totals	108	1020	2	174	749	3219	11	96

IV. Preliminary interpretation of results.

Laboratory analysis of both aerial and ice based counting data, so that abundance estimates can be derived, is now underway. Distribution of observations by time is being determined so that the appropriate statistical estimator can be used for making abundance estimates.

Results from both surveys indicate that air and ground (ice) census techniques are extremely compatible and in fact should be employed simultaneously. Counts of bowheads are higher from the ground, but counts of belukha are higher from the air. There counts however, have not as yet been adjusted fot total sample space, but even after this has been done, we feel that the same trend will continue. Aerial surveys have been invlauable to the ground survey as migratory patterns of whales (for the 1976 season) were delineated, thus allowing better intrepretation of the ice based counts.

Preliminary results verify that bowhead whales enter the Beaufort Sea (and Hope Basin) offshore oil lease sites during late April through May and a few are still entering in June. The time period that bowheads actually spend in the oil lease site areas before leaving has not been determined. Late spring survey flights, however, indicate that most bowheads have probably moved through both lease site areas by late June.

Belukha whales appear to enter the lease sites during the same period as bowheads, but further analysis of collected data is required to verify this.

Results from aerial surveys, so far, suggest that bowhead whales will be most vulnerable to oil development if oil spills occur in the nearshore leads during April through June. Oil spills, wherever they occur, during May through June will probably disturb belukha whales. Disturbance, if it occurs, will be either direct as whales come into contact with oil slicks or indirect as would be the case if some major changes in ice water dynamics resulted, or if prey species were affected. The feeding habits of bowhead whales during the spring are not known however.

V. Problems encountered/recommended changes.

Some problems still remain with obtaining aircraft time when desired, however this matter is small as compared to the problems we encountered during the fall of 1975. The costs associated with fueling the aircraft on the weekends (especially sunday) are absolutely ridiculous! making our task difficult to complete. In general, though, we were very pleased with the cooperation we received this spring, particulary with the pilots.

VI. Estimate of funds expended.

A. April

Salaries/overtime	$ 1,225.00
Travel/per diem	1,092.00
Equipment/misc.	2,090.00
	$4,407.00

B. May

Flight time	$14,043.55
Salaries/overtime	8,809.23
Travel/per diem	9,454.00
Equipment/misc.	593.00
	$32,899.78

C. June

Flight time	$2,980.00
Salaries/overtime	1,210.40
Travel/per diem	2,160.00
Equipment/misc.	60.00
	$6,410.40

April-May-June totals	$43,717.18

VII. Revised data submission schedule.

All FY '75-'76 field data which includes aerial survey data from fall 1975 and spring 1976 and the ice based counting station data will be sent to the Juneau OCSEAP Project Office on magnetic tape on or before 30 November 1976.

VII. Revised milestone chart. (please see next page)

Abundance and Distribution of Bowhead and Belukha Whales in the Beaufort and Chukchi Seas.

Date 28 June 1976

Mr. Clifford H. Fiscus, Dr. Howard Braham and Mr. Willman M. Marquette.

1976

Major Milestones / Activities	Jan.	Apr.	Jly.	Oct.
Ice based counting station recording period				
Aerial surveys - Beaufort and Chukchi Seas				
Summarization of 1976 spring field data				
Computer logging of field data (FY'76-'75)				
EDS formatting - magnetic tapes to Juneau Project Office				
Data analysis and synthesis				
Final report writing and 5th quarter report				
Possible fall aerial survey				

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 8
Quarter Ending -
30 June 1976

MORBIDITY AND MORTALITY OF MARINE MAMMALS

Dr. Francis H. Fay
Associate Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

A. To collect and necropsy sick and moribund seals and walruses, in connection with joint U. S. - Soviet marine mammal studies, Bering Sea, via the Soviet commercial sealing vessel *Zagoriany*.

B. Same, in connection with other OCS projects, via NOAA vessel *Surveyor*.

C. To survey and necropsy stranded dead and moribund marine mammals on the northern coast of the Alaska Peninsula.

II. Field and Laboratory Activities

A. Field Trip Schedule

Zagoriany cruise, eastern Bering Sea, 12 March - 5 May (Principal Investigator and graduate assistant Howard Ferren).

Surveyor cruises, eastern Bering Sea, 14 March - 1 May (biological technician Larry Shults).

Alaska Peninsula survey, 25 May - 4 June (Associate Investigator, Robert Dieterich, and biological technicial Larry Shults).

B. Laboratory Activities

Bacterial, viral, and mycological isolates obtained during field trips were submitted to the Alaska Department of Health diagnostic laboratories, Fairbanks, and the Naval Biomedical Research Laboratory, Oakland, for culture and identification, and serum samples were sent to the latter for viral antibody determinations. Tissue samples were prepared for histopathological study; teeth were sectioned and osteological samples compared for age estimation; photographs were processed and compared for confirmation/identification of specimens.

C. Methods

Selective collection of sick and moribund animals was not feasible on the *Zagoriany* cruise; instead, project personnel were obliged to make use, on an opportunistic basis, of specimens taken non-selectively by the Soviet sealers. Neither was there any opportunity for thorough necropsy of any of the specimens; only partial examination of the exterior and of certain parts of the viscera was feasible, as the animals were rapidly processed for their skins, oil, and meat. On this account, only the most grossly apparent pathological conditions were noted. Blood samples for serological analysis were taken via 10 ml syringe and 15 gu needle from the intervertebral venous sinus of seals and from the axillary vein of walruses, as soon as possible after the animals were brought aboard. These samples were held at room temperature for 12 to 24 hours, before the serum was drawn off by pipette and stored in sterile tubes at 4 to 6°C. Blubber samples (10-20 gm each) for hydrocarbon analysis were wrapped and sealed in non-lubricated aluminum foil and stored in Amies transport medium at 4-6°C. Tissue samples for histopathological study were fixed in 10 percent buffered formalin and stored at room temperature.

Specimens available on the *Surveyor* cruise were taken selectively for purposes of this and other OCS projects (#230, 232). Each was examined thoroughly for gross pathological conditions and parasites. Blood samples were collected from the free flow at the site of the wound, immediately after the animals were shot, but otherwise were treated as described above. Tissue and helminthic samples were fixed in 10 percent formalin; bacterial, viral, and mycological isolates were stored in Ritter's viral transport medium at 4-6°C. Blubber samples were frozen.

The northern coast of the Alaska Peninsula, from Naknek to Bechevin Bay, was surveyed via supercub aircraft in three transects (as in 1975). Each transect was surveyed aerially in its entirety first, recording species and location of all carcasses. Subsequently, landings were made at all of the accessible carcasses and necropsies performed when feasible, in accordance with the procedures outlined in the project manual (see draft in Annual Report, 30 March 76).

III. Results

A. *Zagoriany* Cruise

In the course of the cruise (Fig. 1), the Soviet sealers took 158 walruses (*Odobenus rosmarus*), 59 larga seals (*Phoca largha*), 23 ribbon seals (*Phoca fasciata*), and 2 bearded seals (*Erignathus barbatus*). Each was examined cursorily for evidence of external debilitating injuries and cutaneous infections and for gross pathological conditions of the viscera. Serum samples were obtained from 55 of the walruses, 19 largas, and 14 ribbon seals; blubber samples were taken from 30 walruses, 9 largas, 6 ribbon seals, and 2 bearded seals. The majority of the walruses were males, most of which showed an assortment of shallow, superficial wounds, mainly about the neck and shoulders; in addition, the older adults had a few larger, deeper wounds, occasionally penetrating to the underlying musculature. Most of the latter were judged to have been several weeks old, since some healing had taken place around them; only one was clearly abcessed and suppurative. Such severe wounding is characteristic of adult males during and after February-March mating season. The wounds apparently are inflicted by the tusks of other males. Cutaneous lesions, resembling mycotic infections, were identified in both sexes in 10 out of 26 individuals. For the most part, these were situated only on the flippers (Fig. 2); in two cases they were more extensive, covering most of the ventral surface of the body. Most of the adult males and a few of the sub-adults were extremely lean, with blubber thicknesses as low as 3 cm. The majority of sub-adults and younger animals, and all of the females were much fatter, with blubber thicknesses up to 6-7 cm. One of the adult females had a cystic ovary, filled with caseous material; another had a large (18 x 21 cm) sterile cyst, filled with necrotic material (probably blood), on the ventro-medial surface of the spleen (Fig. 3).

Thirty-four of the 59 larga seals taken were pups, ranging in age from a few days to four weeks. Two of these were grossly undernourished "starvelings" that had apparently been abandoned prematurely by their mother; the rest were in excellent condition, as were all of the older individuals of this species. One of the latter had several healed lesions, probably from helminth-induced ulcers, on the stomach; several others had extensive fibrosis of the liver margins, possibly relics from some earlier tissue reaction to a pathogen. Four of the 23 ribbon seals also were pups and in excellent condition, as were all but two of the older animals. One of the latter had a slightly mangled and greatly swollen left rear flipper, which was abcessed and gangrenous. Two probable pathogenic Streptococci were isolated from the lesion. One other adult had a healing, crescentic scar, about 25 cm logn and 3 cm deep, on the right flank. Such scars and flipper lesions have been attributed previously by Shustov (1969. *In* Marine Mammals, Moscow:ANSSSR, p. 86) to bites by the polar shark, *Somniosus microcephalus*.

B. *Surveyor* Cruise

During the *Surveyor* cruises (Legs I & II), 6 Steller sea lions (*Eumetopias jubatus*), 2 harbor seals (*Phoca vitulina richardsi*), 15 larga seals, 5 ribbon seals, and 1 bearded seal were examined. Serum samples were obtained from five of the Steller sea lions, two harbor seals, ten largas, four ribbon seals, and one bearded seal; blubber samples were taken from four sea lions, two harbor seals, 12 largas, five ribbon seals and one bearded seal; all of the specimens were examined for parasites.

Two of the largas were found to have greatly enlarged spleens (about 1.5 times normal size and three times normal weight), the etiology of which remains to be determined. Fibrous thickening of the capsule at the margins of the liver was noted in two largas and one ribbon seal. In an adult ribbon seal, there was extensive hair loss, not attributable to a normal molt, and some associated cutaneous lesions. One probable pathogenic *Streptococcus* and one fungal agent (as yet unidentified) were isolated from those lesions.

C. Alaska Peninsula Survey

A total of 51 marine mammal carcasses was recorded along the 754 km (406 mi) of transects on the northern coast of the Alaska Peninsula. Twenty-four of these were old remains (mainly bones) from previous years; 27 were more recently stranded. The later comprized one sea otter (*Enhydra lutris*), eight walruses, 14 hair seals (including at least four largas and one bearded seal), three gray whales (*Eschrichtius robustus*), and one minke whale (*Balaenoptera acutorostrata*). The majority of these had been excessively scavenged by gulls, eagles, bears, foxes, and man, and most of the rest were autolized to the extent that useful autopsy was precluded. Preliminary findings suggest that the sea otter (an 84 cm pup) had starved, perhaps from premature separation from its mother, and at least four of the seals had died from bullet wounds.

IV. Preliminary Interpretation of Results

No further interpretation feasible at this time.

V. Problems Encountered/Recommended Changes

The survey and necropsy of stranded carcasses on St. Lawrence Island, which was to have begun on 25 June, has been cancelled (at least temporarily) due to a ban placed on all scientific investigations on the island by the Gambell and Savoonga Native Corporations. According to information received by letter and telephone from the Secretary and the President of the Gambell Corporation, no research will be allowed there until the patent to the island is received by those organizations, and then only by special permit. Permission was requested by the Principal Investigator (letter 1 June 1976) to carry out the survey as scheduled, but this was denied. The possibility of a later survey is being investigated.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 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			
1976 Field Season	ongoing		*			

Note: 1 Data Management Plan has been approved by M. Pelto; we await approval by the Contract Officer.

* 1976 environmental data will be submitted after receipt and and formal approval of Data Management Plan. Format has been received and approved by all parties.

QUARTERLY REPORT

Contract # 03-5-022-69
Research Unit #229
1 April 1976 - 30 June 1976
Number of Pages - 5

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
Alaska Department of Fish and Game
333 Raspberry Road
Anchorage, Alaska 99502

July 7, 1976

I. Task Objectives

A. Determination of food habits and trophic relationships in different areas of the Gulf by season.

B. Investigate population productivity with emphasis on determining age of sexual maturity and age specific reproductive rates.

C. To examine growth rates, development and body condition.

D. Collection of incidental data regarding seasonal distribution, population composition, use of critical habitat and sex and age composition.

II. Field Activities

A. Ship schedule

1. M. V. Resolution, Alaska Department of Fish and Game vessel charter

    a. April 11 through April 22

2. R. V. Surveyor, NOAA vessel

    a. May 24 through June 3

B. Scientific Parties

1. April 11 through April 22

    a. Kenneth Pitcher, Alaska Department of Fish and Game Principal Investigator

    b. Donald Calkins, Alaska Department of Fish and Game Co-Principal Investigator

    c. Roger Aulabaugh, Alaska Department of Fish and Game collecting crew

    d. Roger Smith, Alaska Department of Fish and Game collecting crew

    e. Ben Ballenger, Alaska Department of Fish and Game collecting crew

2. May 24 through June 3

    a. Kenneth Pitcher, Alaska Department of Fish and Game Principal Investigator

    b. Donald Calkins, Alaska Department of Fish and Game Principal Investigator

c. Roger Aulabaugh, Alaska Department of Fish and Game, Observer and collecting crew

d. Walt Cunningham, Alaska Department of Fish and Game, Observer and collecting crew

e. Kathy Frost, Alaska Department of Fish and Game, Observer and collecting crew

C. 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 (Johnson and Lucier 1975). 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 or 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 determination of 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 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.

D. Sample Localities

During this quarter, harbor seals were collected from the following locations: Harris Bay, Aialik Bay, Shuyak Island, Afognak Island, Raspberry Straits, Middleton Island,Kayak Island, Icy Bay, and Yakutat Bay.

E. Data Collected or Analyzed

1. A total of 53 harbor seals were collected.

2. Laboratory analyses were not completed on the specimen materials.

3. On the "Surveyor" cruise observations of harbor seal concentrations were recorded in conjunction with helicopter surveys for sea lions RU #243 and collecting activities of RU #229.

III. Results

1. As laboratory procedures have not been completed results for food habits and reproduction are not available.

2. Body measurements and weights for growth and conduction have been submitted to meet the data archival requirement. Analysis of these data are not completed.

3. Harbor seal concentrations were documented at the following locations: Raspberry straits, Middleton Island, Icy Bay, Yakutat Bay and at the mouths of the Kikluth, Seal, Tsiu, Kaliakh, Yahtse, Situk, Dangerous, Akwe and Alsek Rivers.

IV. Preliminary Interpretation of Results

None

V. Problems Encountered/Recommended Changes

None

VI. Estimate of Funds Expended

75% - $45,000

Quarterly Report

Contract # 02-5-022-53
Research Unit #230
Reporting Period: April-June 1976
Number of Pages:

The natural history and ecology of the bearded seal (*Erignathus barbatus*) and the ringed seal (*Phoca* (*Pusa*) *hispida*)

Principal Investigators:

John J. Burns - bearded seal
Marine Mammals Biologist
Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701

Thomas J. Eley - ringed seal
Marine Mammals Biologist
Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701

30 June 1976

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 Activities

A. Schedule

Date	Location	Purpose
March-April 1976	Cape Lisburne	Collection of specimen and survey of habitat
March-April 1976	*Surveyor* cruise	Collection of specimen and survey of habitat
May 1976	Point Hope	Collection of specimens
June 1976	Barrow	Seal and ice survey and collection of specimen
June 1976	Kotzebue	Seal survey of Kotzebue Sound

B. Scientific Party

Name	Affiliation	Role
John J. Burns	ADF&G	Principal Investigator
Thomas J. Eley	ADF&G	Principal Investigator
David James	ADF&G	Technician
Glenn Seaman	ADF&G	Technician
Edward Muktoyuk	ADF&G	Technician
Bonnie Friedman	ADF&G	Technician

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 permits.

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, Arctic 25:279-290).

Analytical methods are discussed in detail in our Annual Report for FY-1976.

D. Sample Localities

1. Kotzebue Sound - Aircraft tracklines are shown in Fig. 1.

2. Cape Krusenstern to Barter Island - Aircraft tracklines are listed in Appendix 1.

III-IV. Results and Preliminary Interpretation

A. Specimens

During April to June, 1976, 76 ringed seals and 8 bearded seals were obtained from villages or collected by the Principal Investigators (Table 1). Measurements, jaws, claws, stomachs and reproductive tracts were obtained from all specimens. We also obtained blubber, tissue, organ and blood samples from most specimens. All of these specimens, and those of previous years, are being processed as rapidly as possible.

Table 1. Specimens obtained between April and June 1976.

Location	Male	Female	Unknown	Total
Barrow				
Ringed Seal	5	2	-	7
Cape Lisburne				
Ringed Seal	8		11	19
Bearded Seal	-	1	-	1
Point Hope				
Ringed Seal	37	7	3	47
Nome				
Ringed Seal	1	2	-	3
Bearded Seal	3	2	1	6
Surveyor				
Bearded Seal	1	-	-	1

B. Food Habits

See Quarterly Report of "Trophic relationships among ice inhabiting phocid seals" (RU #232).

C. Seal Surveys

Ringed seals spend much of the year in the water or in subnivean lairs in the shorefast and moving pack ice. From late April until breakup in late June, ringed seals haul out on the ice on sunny days, and during this haul out period they undergo their annual molt. The hauling out period appears to take place largely on the shorefast ice and appears to reach a peak in mid-June just before breakup. This hauling out period appears to be the best time for aerial counts. However, the relationship between the number of molting seals hauled out in an area and the number of seals breeding in that same area is unknown.

Other marine mammals (primarily polar bear (Ursus maritimus), bearded seal, and belukha (Delphinapterus leucas)), although encountered in far less numbers than ringed seals, also are counted on these ringed seal surveys.

1. Kotzebue Sound and Hotham Inlet

In June, 23 transects totaling 689 square miles and 3 transects totaling 29 square miles were flown, respectively, over Kotzebue Sound and Hotham Inlet (Fig. 1). In Kotzebue

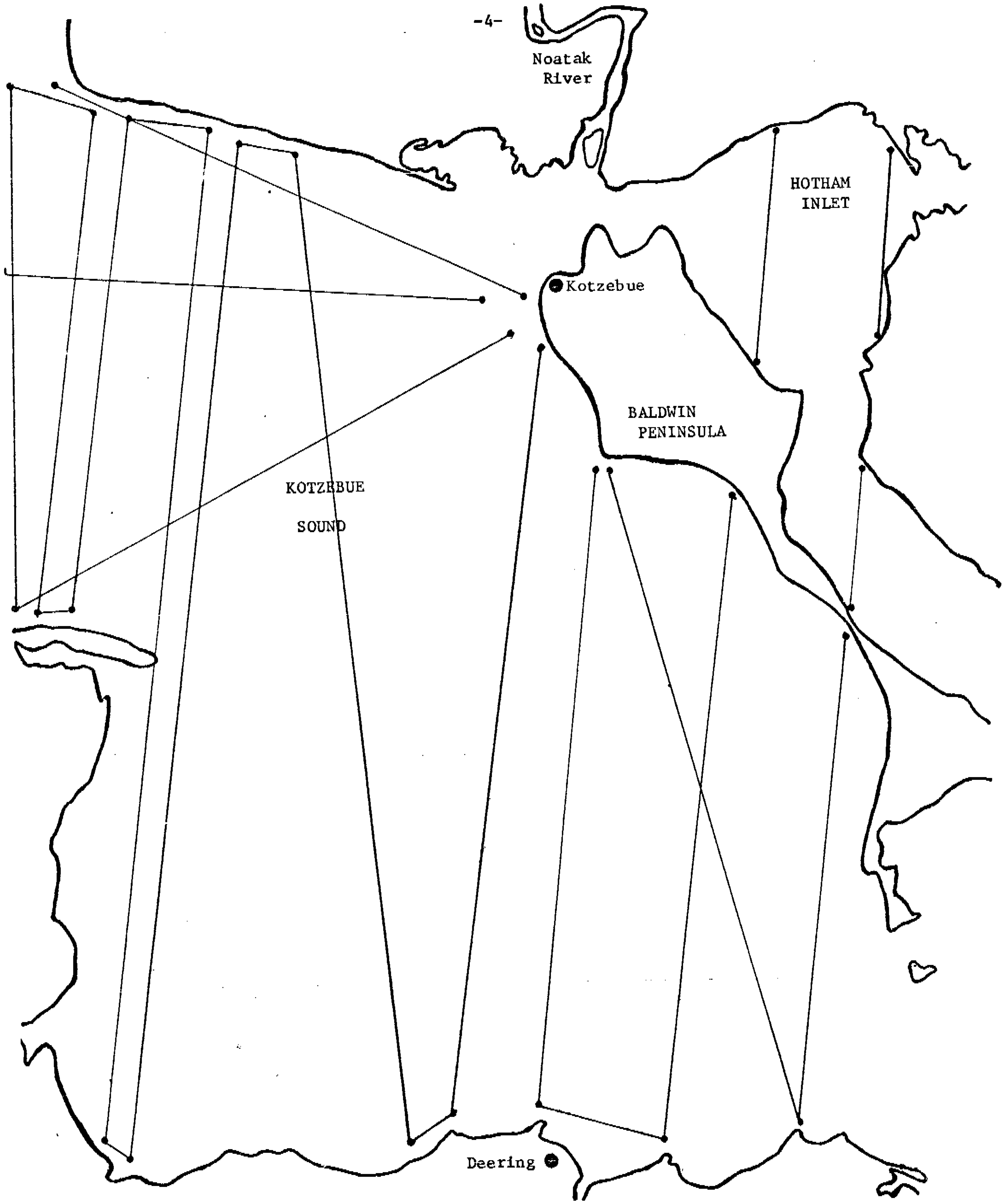

Figure 1. Seal survey tracks, Kotzebue Sound and Hotham Inlet, June, 1976.

Sound 504 ringed seals were observed, yielding an ecological density of 0.73 ringed seals per square mile of available habitat. In addition, one bearded seal and two spotted seals (Phoca vitulina largha) were observed in Kotzebue Sound. No seals were seen in Hotham Inlet.

The ecological density of ringed seals varied from 0.92 seals per square mile at the mouth of the Sound to 0.26 seals per square mile in the eastern portion of the Sound. The higher density of seals at the mouth was due to more stable ice conditions in this area. In the eastern portion of the Sound and in Hotham Inlet the ice had begun to break up due to warm weather and the influx of warm water from the Noatak, Kugruk, Kiwalik, Buckland, Selawik and Kobuk Rivers.

The ice cover in Kotzebue Sound was estimated to be 2,715 square miles and from the transects an ecological density of 0.73 seals per square mile was determined. Therefore, the estimated molting population of ringed seals is about 2000 animals.

2. Cape Krusenstern to Barter Island

Two to five transects were flown in major geographic sections of coastline between Cape Krusenstern and Barter Island (Table 2). Data from these surveys are still being analysed and compared to survey data from previous years, however, several trends are apparent.

The highest densities of ringed seals are found in the Chukchi Sea and in areas of stable shorefast ice such as between Cape Lisburne and Point Lay and between Barrow and Wainwright. The higher densities in the Chukchi Sea are reflective of the better ice conditions and higher overall productivity of the Chukchi as compared to the Beaufort Sea.

3. Pack Ice Transects

The density of molting ringed seals in the moving pack ice is known to be less than the shorefast. This year transects were flown over the pack ice of Chukchi and Beaufort Seas to provide comparative data for our shorefast ice surveys. The data from these pack ice transects are still under analyses but the tentative findings are summarized at the bottom of Table 2.

It is obvious that densities of molting ringed seals are considerably less in the moving pack ice than in the shorefast ice. As was found in the shorefast ice, densities of ringed seals in the Chukchi Sea are 2 to 2.5 times higher than in the Beaufort Sea.

Table 2. Ringed seal surveys flown between Cape Krusenstern and Barter Island, Alaska, during June 1976.

Geographic Area	Miles Surveyed (naut. mi.^{2})	Ringed seals observed	Ringed seal density (per (naut. mi.^{2})	Species and numbers of other marine mammals observed
Cape Krusenstern to Point Hope	209	544	2.6	*Erignathus barbatus*, 19
Point Hope to Cape Lisburne	72	78	1.1	*Odobenus rosmarus*, 25 *Ursus maritimus*, 1
Cape Lisburne to Pt. Lay	82	461	5.6	*Erignathus barbatus*, 8
Pt. Lay to Wainwright	352	761	2.2	*Erignathus barbatus*, 6 *Ursus maritimus*, 2
Wainwright to Barrow	356	1560	4.4	*Erignathus barbatus*, 3
Barrow to Lonely	136	226	1.7	*Erignathus barbatus*, 3
Lonely to Oliktok	140	175	1.2	*Erignathus barbatus*, 3 *Ursus maritimus*, 3
Oliktok to Flaxman Island	158	255	1.6	*Erignathus barbatus*, 5
Flaxman Island to Barter Island	110	47	0.4	*Erignathus barbatus*, 4 *Ursus maritimus*, 1
Chukchi Sea (moving pack ice)	218	44	0.2	*Erignathus barbatus*, 22 *Ursus maritimus*, 6 *Balaena mysticetus*, 1 Whale sp., 2
Beaufort Sea (moving pack ice)	111	12	0.1	*Odobenus rosmarus*, 2 *Balaena mysticetus*, 1

D. Data Management

Throughout the quarter we have moved rapidly forward with data management. Measurement and food habits data from ringed seals collected at Wainwright during 1975 have been submitted to NODC. Measurements of specimens collected during this quarter (Table 1) have been formated and await keypunching. The data from the seal surveys conducted this quarter are being formated at this time.

V. Recommendations

Various tissue samples (hide and blubber, striated muscle, liver, heart, etc.) have been obtained from many seal specimens and these tissue samples have been wrapped in aluminum foil and frozen. These tissue samples could now be analyzed for important environmental pollutants such as chlorinated hydrocarbons, petrochemicals and heavy metals. However, there are no personnel within ADF&G qualified to conduct analyses for pollutants.

The tissue samples have been collected over several years and thereby provide baseline data that are impossible to duplicate. We recommend that the OCSEAP arrange to have these tissue samples analyzed for environmental pollutants. A delay may result in a loss of the specimens due to age or to the omnipresent electrical power failures during the Alaskan winter.

VI. Estimate of Funds Expended

100	Salaries and wages	$58,705.33
200	Travel	6,252.43
300	Contractual	5,664.51
400	Commodities	3,731.62
500	Equipment	163.58
		$74,517.47

Appendix I. Flight tracks, Cape Krusenstern to Barter Island.

Geographic Area	Date	Start Coordinates		Stop Coordinates	
Cape Krusenstern	10 June 1976	68°20'N	166°55'W	67°07'N	163°49'W
to					
Point Hope	12 June 1976	67°07'N	163°53'W	68°20'N	166°57'W
Point Hope	10 June 1976	68°54'N	166°07'W	68°20'N	166°55'W
to					
Cape Lisburne	12 June 1976	68°20'N	166°57'W	68°48'N	166°18'W
Cape Lisburne	12 June 1976	68°48'N	166°18'W	69°45'N	163°14'W
to					
Point Lay					
Point Lay	10 June 1976	70°40'N	160°06'W	70°01'N	162°44'W
to	12 June 1976	69°45'N	163°14'W	70°41'N	160°15'W
Wainwright	16 June 1976	70°38'N	160°17'W	69°47'N	163°15'W
	16 June 1976	69°41'N	163°05'W	70°38'N	160°01'W
Wainwright	10 June 1976	71°18'N	156°48'W	70°40'N	160°06'W
to	12 June 1976	70°41'N	160°15'W	71°18'N	156°48'W
Barrow	16 June 1976	71°22'N	156°42'W	70°38'N	160°17'W
	16 June 1976	70°38'N	160°01'W	71°22'N	156°48'W
Barrow	15 June 1976	71°23'N	156°42'W	70°59'N	153°16'W
to					
Lonely	15 June 1976	71°04'N	153°16'W	71°21'N	156°35'W
Lonely	15 June 1976	70°59'N	153°16'W	70°37'N	149°53'W
to					
Oliktok	15 June 1976	70°42'N	149°53'W	71°04'N	153°16'W
Oliktok	15 June 1976	70°37'N	149°53'W	70°24'N	146°03'W
to					
Flaxman Island	15 June 1976	70°29'N	146°03'W	70°37'N	149°53'W
Flaxman Island	15 June 1976	70°24'N	146°03'W	70°08'N	143°35'W
to					
Barter Island	15 June 1976	70°08'N	143°35'W	70°24'N	146°03'W

Quarterly Report

Contract #03-5-022-53
Research Unit #231
Reporting Period - 1 March 1976-
30 June 1976
Number of pages: 11

An Aerial Census of Spotted Seals, *Phoca vitulina largha*

Principal Investigators:

John J. Burns
Alaska Department of Fish and Game
Fairbanks, Alaska 99701

Samuel J. Harbo, Jr.
University of Alaska
Fairbanks, Alaska 99701

30 June 1976

I. Task Objectives

This project is primarily addressed to OCSEAP task A-2; determination of the seasonal density and distribution of spotted seals, Phoca vitulina largha, in the ice front of eastern Bering Sea. During late winter and early spring, this seal occurs in considerable numbers, within the proposed Bristol Bay, St. George Basin and Navarin Basin lease areas.

Task A-1 is also an integral part of this project. This task is the summarization and evaluation of existing literature and unpublished data on distribution and abundance of spotted seals.

II. Field and Laboratory Activities

All of the field activities required for the completion of this project were conducted during March and April. During these months spotted seals are concentrated in the ice front where they haul out to molt and/or bear young. Field activities consisted of two separate, semi-coordinated (because of problems with communications) activities. These were work aboard the OSS SURVEYOR and extensive aerial surveys utilizing the P2V aircraft operated by the Office of Aircraft Services.

A. Ship Schedule

The OSS SURVEYOR operated in the ice front of eastern Bering Sea from 18 to 27 March and again from 16 to 27 April. The SURVEYOR is a NOAA vessel.

Aircraft Schedule

The P2V aircraft was utilized for surveys in the ice front during the period 7 April to 23 April 1976. Survey flights originated from either King Salmon or Cold Bay, depending upon which sectors of the ice front were being surveyed. This aircraft is operated by the USDI Office of Aircraft Services and was chartered utilizing OCS funds allocated to project RU #239.

B. Scientific Party

The following personnel were on board the OSS SURVEYOR during the period 18 to 27 March, and contributed to this project:

Lloyd Lowry, Alaska Department of Fish and Game (ADF&G); mainly involved in other projects, particularly RU #232. Lowry participated in some of the surveys made with the ship's helicopter and was involved in the collection of seals.

Edward S. Muktoyuk, ADF&G. Muktoyuk's activites were the same as Mr. Lowry's.

John J. Burns, ADF&G. Burns was involved in setting up and conducting the initial helicopter surveys and the collection of seals from selected groups.

Personnel aboard the OSS SURVEYOR during the period 16 April to 26 April and contributing to this project included:

Kathryn J. Frost, ADF&G. Principal observer on all of the helicopter surveys conducted during this period of time.

John D. Hall, U. S. Fish and Wildlife Service. Principal observer on all helicopter surveys conducted during this time.

Lloyd F. Lowry, ADF&G. Observer and recorder on some of the helicopter flights, as well as the collection of seals from selected locations.

Patrick McGuire, NMFS. Recorder on some of the helicopter surveys.

It should be noted that Donald Winter and William Harrigan, both NOAA helicopter pilots and Gary Mitchell, mechanic (also NOAA) were instrumental in the successful completion of helicopter operations from the SURVEYOR.

Scientific personnel aboard the P2V aircraft included:

John J. Burns, ADF&G, principal observer and recorder.

Samuel J. Harbo, Jr., University of Alaska, biometrician and observer on the first few flights.

David James, ADF&G, survey observer on all flights.

Robert Everett, NMFS, observer on the last series of flights.

George Y. Harry, NMFS, observer on the flights of 21 and 23 April.

Personnel from the Office of Aircraft Services responsible for piloting and navigation included Louis Caulkett, chief pilot, Thomas Belleau, pilot and Wendell Bean, engineer.

C. Methods

The major mission of the OSS SURVEYOR during March was support of oceanographic and biological studies, with aerial surveys of marine mammals as a secondary priority. As opportunity arose, it was our intent to obtain information about where animals were concentrated, the species and age composition in different geographic regions and activity patterns during the mid to late March period. The ship's helicopter was used for limited surveys. Sampling schemes to be utilized during the intensive survey period (April 8 to 23) were developed and tested. The excellent visibility, slow flying speed and Global Navigation System (GNS) of the Bell 206 helicopter made it an ideal vehicle for verification of survey results obtained during the extensive survey flights of the P2V. On 26 March a large concentration of spotted seals was located in Bristol Bay and a survey was conducted.

Flights were made along predetermined tracks, using the GNS. Flight altitude was 300 feet at an air speed of 80 miles per hour. Width of the track within which seals were recorded was one-half mile on either side of the helicopter. Except for width of the survey tracks, these methods were used in April.

During April, an effort was made to conduct as many helicopter surveys as conditions allowed. A total of six surveys were completed. Depending on conditions, track width varied from one-fourth to one-half mile on either side of the helicopter.

As stated previously, the P2V flights began on 7 April. The last flight was made on 23 April. Flights of 8, 9 and 11 April were flown using a zig-zag pattern in an area extending from the eastern boundary of Bristol Bay to 172°52'W longitude and from the ice edge to approximately 70 miles north of the edge. Subsequent flights (17, 19, 20 and 21 April) followed prechosen tracks according to a random stratified scheme in previously recognized areas of high, medium and low seal densities. The survey conducted on 21 April reached the western most point; 178°58'E. Tracks were chosen to cover intensively the ice covered portions of the proposed Bristol Bay and St. George Basin leases.

Altitude of survey flights in the P2V was 300 feet, speed averaged 140 knots and width of the survey track was one-half mile on either side of the aircraft. The mile wide track was divided into four segments; 0 to 1/4 mile and 1/4 mile to 1/2 mile, on either side of the aircraft. Records of sightings were kept accordingly. Animals sighted outside of the survey track were also recorded, but will not be included in the statistical analyses.

After completion of surveys conducted with the P2V, all data were put on data forms in accordance with approved formats. This task has not been completed for data obtained from the helicopter.

D. Sample Localities

For each flight, survey tracks were divided into legs, bounded on each end by a designated waypoint. The date, local time and positions of all waypoints are indicated in Table 1.

Table 1. Date, waypoint number, time when waypoint was reached and position of waypoints bounding all survey legs flown. Aircraft type is also indicated.

Time	Waypoint No.	Position	
A. Helicopter Survey, 27 March 1976			
1411	0	55°49'N	164°26'W
1427	1	56°00'N	164°07'W
1444	2	56°10'N	164°07'W
1448	3	56°10'N	164°15'W
1457	4	56°00'N	164°14'W
1500	5	56°00'N	164°21'W
1510	6	56°10'N	164°22'W
1514	7	56°10'N	164°30'W
1522	8	56°00'N	164°28'W
1528	9	56°00'N	164°35'W
1538	10	55°49'N	164°26'W
B. Helicopter Survey, 20 April 1976			
1635	1	57°19'N	173°19'W
1641	2	57°24'N	173°19'W
1646	3	57°24'N	173°28'W
1652	4	57°29'N	173°28'W
1657	5	57°29'N	173°19'W
1703	6	57°34'N	173°19'W
1708	7	57°34'N	173°28'W
1714	8	57°39'N	173°28'W
1720	9	57°39'N	173°19'W
C. Helicopter Survey, 23 April 1976			
1620	1	56°05'N	163°01'W
1625	2	56°10'N	163°00'W
1630	3	56°10'N	163°09'W
1636	4	56°15'N	163°09'W
1645	5	56°15'N	162°52'W
1652	6	56°20'N	162°52'W
1701	7	56°20'N	163°09'W
1706	8	56°25'N	163°09'W
1716	9	56°25'N	162°52'W
D. Helicopter Survey, 24 April 1976			
1335	0	56°00'N	163°22'W
1348	1	56°12'N	163°22'W
1350	2	56°12'N	163°24'W
1360	3	56°00'N	163°24'W
1401	4	56°00'N	163°26'W

Time	Waypoint No.		Position	
1415	5		56°12'N	163°26'W
1416	6		56°12'N	163°28'W
1426	7		56°00'N	163°28'W
1427	8		56°00'N	163°29'W

E. Helicopter Survey, 24 April 1976

1642	0		56°24'N	162°27'W
1654	1		56°36'N	162°27'W
1655	2		56°36'N	162°29'W
1708	3		56°24'N	162°29'W
1710	4		56°24'N	162°31'W

F. Helicopter Survey, 25 April 1976

1330	0		55°53'N	162°57'W
1333	1		55°48'N	162°57'W
1334	2		55°48'N	162°55'W
1344	3		55°58'N	162°55'W
1346	4		55°58'N	162°53'W
1354	5		55°48'N	162°53'W
1356	6		55°48'N	162°51'W
1414	7		55°58'N	162°51'W
1416	8		55°58'N	162°49'W
1425	9		55°48'N	162°49'W

G. Helicopter Survey, 25 April 1976

1642	0		55°40'N	163°00'W
1649	1		55°55'N	163°00'W
1650	2		55°55'N	163°02'W
1658	3		55°45'N	163°02'W
1660	4		55°45'N	163°04'W
1711	5		55°55'N	163°04'W
1712	6		55°55'N	163°06'W
1720	7		55°45'N	163°06'W
1721	8		55°45'N	163°08'W
1739	8		55°45'N	163°08'W
1752	9		55°55'N	163°08'W

H. P2V Survey, 8 April 1976

0905	1	ice edge	58°43'N	157°27'W
0921	2	beach, no survey	58°32'N	158°46'W
0924	3	beach, no survey	58°26'N	158°58'W
0943	4		57°55'N	160°07'W
1018	5	ice edge	56°34'N	160°08'W
1031	6		56°57'N	160°47'W
1058	7	ice edge	56°12'N	162°15'W
1113	8		56°34'N	162°59'W
1126	9	ice edge 1 mile south	56°13'N	163°37'W
1143	10		56°38'N	164°22'W

Time	Waypoint No.			
1150	11		56°52'N	164°22'W
1218	12	ice edge	56°07'N	165°43'W
1225	13		56°14'N	165°56'W
1239	14		56°44'N	165°55'W
1258	15	ice edge	56°15'N	166°48'W
1315	16		56°40'N	167°30'W
1334	17	ice edge	56°06'N	168°17'W
1342	18		56°06'N	167°44'W
1404	19		56°40'N	166°30'W
1421	20	ice edge	56°07'N	165°31'W
1458	21		56°52'N	163°07'W
1519	22	ice edge, over open water	56°17'N	162°06'W
1521	23	ice edge, over open water	56°17'N	161°55'W
1543	24		56°51'N	160°43'W
1552	25		56°35'N	160°16'W
1603	26	ice edge	56°18'N	160°40'W
1606	27	ice edge	56°13'N	160°48'W
1610	28	no survey,poor visibility	56°19'N	161°00'W
1615	29	ice edge, no survey, poor visibility	56°17'N	161°14'W
1621	30	ice edge, over open water	56°13'N	161°40'W
1631	31	ice edge, over open water	56°13'N	162°10'W
1637	32		56°28'N	162°09'W
1700	33	ice edge 1 mile SE	56°29'N	160°26'W
1703	34		56°36'N	160°20'W
1707	35	ice edge 1 mile SE	56°39'N	160°02'W
1758	36	beach	58°31'N	159°08'W

I. P2V Survey, 9 April 1976

1031	1	inside of ice edge	58°18'N	157°56'W
1035	2		58°14'N	158°14'W
1042	3		57°58'N	158°57'W
1047	4	ice edge	57°46'N	158°00'W
1050	5	ice edge 6 miles SE	57°39'N	158°11'W
1058	6	ice edge 4 miles E	57°26'N	158°42'W
1102	7		57°15'N	158°41'W
1109	8	ice edge 7 miles E	57°09'N	159°13'W
1121	9	ice edge 2 miles SE	56°48'N	159°44'W
1137	10		56°18'N	160°31'W
1140	11	ice edge	56°10'N	160°35'W
1141	12		56°12'N	160°37'W
1152	13		56°11'N	161°26'W
1204	14		56°34'N	162°06'W
1207	15		56°31'N	162°14'W
1217	16		56°09'N	162°20'W
1220	17	ice edge, over open water	56°03'N	162°20'W
1222	18	ice edge, over open water	56°04'N	162°25'W
1236	19		56°30'N	163°11'W
1251	20	ice edge	56°08'N	163°55'W

Time	Waypoint No.		Position	
1300	21		56°23'N	164°23'W
1310	22		56°46'N	164°22'W
1337	23	ice edge	56°03'N	165°38'W
1358	24		56°36'N	166°47'W
1408	25		56°21'N	167°21'W
1419	26		56°45'N	167°25'W
1433	27		57°09'N	168°03'W
1503	28	ice edge	56°21'N	169°36'W
1523	29		56°49'N	170°42'W
1534	30		57°11'N	170°46'W
1558	31	ice edge	56°31'N	171°59'W
1603	32		56°39'N	172°12'W
1630	33		57°43'N	172°14'W
1654	34		57°00'N	171°18'W
1714	35		56°50'N	169°58'W
1753	36		56°34'N	167°27'W
1800	37		56°30'N	166°57'W
1840	38		56°30'N	164°19'W
1904	39		56°28'N	162°40'W
1912	40	ice edge	56°09'N	162°46'W

J. P2V Survey, 11 April 1976

0924	1	ice edge	56°19'N	163°49'W
0925	2		56°20'N	163°52'W
1007	3	ice edge 3 miles S	56°20'N	166°42'W
1101	4		56°47'N	170°00'W
1136	5		57°00'N	172°13'W
1140	6	ice edge	56°53'N	172°26'W
1150	7		57°11'N	172°52'W
1218	8		58°09'N	172°46'W
1259	9		57°19'N	169°57'W
1317	10		57°03'N	168°31'W
1357	11		56°45'N	165°35'W
1431	12		56°46'N	163°00'W
1447	13	ice edge, no survey, stop at Cold Bay	56°12'N	163°00'W
1627	14	ice edge	56°12'N	162°32'W
1630	15		56°19'N	162°31'W
1708	16		57°00'N	160°00'W
1747	17	ice edge	58°12'N	157°54'W

K. P2V Survey, 17 April 1976

1307	1	ice edge	58°15'N	157°48'W
1339	2		57°16'N	160°18'W
1356	3		56°42'N	161°37'W
1407	4		56°14'N	161°41'W
1421	5		56°45'N	161°52'W
1435	6		56°15'N	161°51'W

Time	Waypoint No.		Position	
1452	7		56°45'N	162°02'W
1505	8	long, slow turn	56°14'N	162°03'W
1507	9		56°15'N	162°10'W
1522	10		56°45'N	162°09'W
1537	11		56°14'N	162°37'W
1554	12		56°45'N	162°37'W
1608	13		56°16'N	163°23'W
1611	14		56°08'N	163°22'W

L. P2V Survey, 19 April 1976

1002	1	ice edge	55°52'N	162°50'W
1012	2		56°18'N	162°56'W
1026	3		56°52'N	162°55'W
1043	4		56°18'N	163°10'W
1059	5		56°53'N	163°10'W
1129	6		56°53'N	165°06'W
1204	7		56°53'N	167°29'W
1225	8		56°54'N	169°00'W
1237	9		56°30'N	168°59'W
1250	10		56°27'N	168°02'W
1310	11		56°24'N	166°38'W
1320	12		56°19'N	165°52'W
1323	13		56°18'N	165°38'W
1335	14		56°18'N	164°49'W
1349	15		56°50'N	164°50'W
1403	16		56°25'N	164°24'W
1405	17		56°24'N	164°16'W
1422	18		57°00'N	164°16'W
1438	19		56°25'N	164°00'W
1456	20		57°01'N	163°59'W
1512	21		56°25'N	163°47'W
1531	22		57°00'N	163°45'W
1550	23		56°19'N	163°12'W
1607	24		57°00'N	163°10'W
1626	25		56°19'N	162°56'W
1629	26		56°22'N	162°54'W
1647	27		57°01'N	162°52'W
1710	28		56°09'N	162°50'W
1716	29		55°55'N	162°52'W

M. P2V Survey, 20 April 1976

1127	1	ice edge	55°53'N	162°35'W
1136	2		56°09'N	162°30'W
1142	3		56°11'N	162°56'W
1152	4		56°11'N	163°40'W
1201	5		56°10'N	164°17'W
1203	6	ice edge 8 miles W	56°14'N	164°19'W
1231	7		56°15'N	166°24'W
1235	8		56°20'N	166°34'W
1245	9		56°23'N	167°13'W

Time	Waypoint No.		Position	
1255	10	ice edge	56°23'N	168°02'W
1301	11	ice edge 14 miles W	56°35'N	168°04'W
1319	12		56°35'N	169°27'W
1330	13		56°37'N	169°50'W
1339	14	ice edge 10 miles E	56°36'N	170°55'W
1346	15		56°50'N	171°01'W
1402	16		56°50'N	172°14'W
1419	17		57°29'N	172°14'W
1448	18		57°31'N	174°30'W
1509	19		58°20'N	174°31'W
1605	20		58°20'N	178°39'W
1611	21		58°31'N	178°40'W
1712	22		58°20'N	174°29'W
1740	23		57°48'N	172°43'W
1824	24		57°03'N	170°23'W
1942	25		56°20'N	165°00'W
2014	26		56°20'N	162°49'W
2025	27	ice edge	55°52'N	162°47'W

N. P2V Survey, 21 April 1976

1102	1	ice edge	56°06'N	163°01'W
1105	2		56°10'N	163°03'W
1138	3		57°02'N	165°05'W
1153	4		57°17'N	166°03'W
1237	5		58°01'N	169°03'W
1310	6		58°01'N	172°02'W
1336	7		58°30'N	174°00'W
1434	8	ice edge	58°41'N	178°48'W
1441	9		58°59'N	178°51'W
1506	10		59°00'N	178°58'E
1515	11		59°20'N	178°58'E
1550	12		59°20'N	177°59'W
1609	13		58°55'N	176°24'W
1614	14		58°42'N	176°22'W
1635	15		58°24'N	174°26'W
1655	16		58°06'N	172°58'W
1806	17		57°11'N	167°09'W
1815	18		57°07'N	166°30'W
1819	19		57°05'N	166°09'W
1821	20		57°00'N	166°00'W
1845	21		56°49'N	164°00'W
1859	22		56°22'N	163°38'W
1903	23	ice edge	58°18'N	163°24'W

O. P2V Survey, 23 April 1976

1115	1	ice edge	55°50'N	162°55'W
1123	2		56°12'N	163°01'W
1141	3		56°00'N	164°09'W
1148	4		56°07'N	163°58'W
1246	5		58°01'N	161°00'W
1315	6	ice edge	58°27'N	158°18'W

E. Data Collected or Analyzed

The seven surveys utilizing the Bell 206 helicopter amounted to a total of approximately 354 nautical miles of survey lines. For purposes of design and analysis, this distance was divided into 46 survey legs.

Surveys from the P2V produced a total of approximately 8,400 miles of trackline, which were divided into 184 survey legs.

Data derived from the helicopter surveys has been compiled in a general way. All of the data is presently ready for keypunching. Data from the P2V surveys is voluminous and analyses have not yet been undertaken. These data are now in appropriate formats and in the hands of the keypuncher. Analyses will be made as soon as the data cards are punched and verified. Because of the number of marine mammal species observed and the number of individuals of each species, results will be analysed as six separate surveys covering identical tracks. Treatment will be of spotted seals, bearded seals, ringed seals, ribbon seals, walruses and sea lions. The greatest number of observations were of spotted seals and walruses.

It should be noted that NMFS personnel, under the direction of Dr. Howard Braham, conducted surveys at the same time as ours, but in areas further north. We were in contact during the course of our respective surveys, planned our efforts to be collaborative and, from the standpoint of data management, compatible. It is our intent to combine the data of the April surveys.

III. Results

Preliminary results are available from the helicopter surveys and are presented in Table 2.

Table 2. Numbers and densities of spotted seals as determined by helicopter surveys during March-April 1976.

Date	Miles of Trackline	Width of Track (NM)	Number of Spotted Seals	Average Density/NM
27 March	83	1	558	6.7
20 April	40	1	0	0
23 April	55	1/2	87	3.2
24 April	52	1/2	150	5.7
24 April	26	1/2	3	0.2
25 April	49	1/2	75	3.1
25 April	49	1/2	166	6.8

Complete analyses of all data will be undertaken and reported by 30 September.

IV. Preliminary Interpretation of Results

Aerial surveys provide a great deal of varied information and are thus undertaken for a variety of objectives. They are useful for finding out such things as: where animals occur; how they are distributed; the extent to which they associate with other species; habitat preferences; density; and, in some instances, size of the population.

[illegible] extensive surveys [illegible] April were extremely [illegible]. [illegible] examples, it was found that the distribution of breeding adult spotted seals was continuous from Bristol Bay as far west as we flew, although some regions supported very low densities. This indicates the probability of one single stock of spotted seals in central and eastern Bering Sea. A large concentration of spotted seals, mainly subadults, was found in western Bristol Bay, within the proposed lease area. Density of spotted seals was in excess of six per square nautical mile.

Walruses were numerous throughout Bristol Bay, particularly in the southern and central parts. Sea lions were restricted to the first few miles of the ice front and were most numerous south of the Pribilof Islands. Ribbon seals occurred over the entire survey area but were most numerous to the west of the Pribilof Islands.

We were able to keep a continuous record of ice conditions for near ground level verification of available satellite imagery. Sea ice was very extensive during April, in line with the conditions which have existed each spring since 1971. The southern limit of sea ice during recent years appears to have been farther south than at any time during the decade of the 1960's.

V. Problems Encountered

Three very different kinds of problems have been encountered. The first was related to the very extensive ice cover during April 1976. In view of the increased area over which marine mammals were distributed, we were not able to achieve the intensity of coverage which was desired. Second was that weather conditions were, for the most part, marginal. This certainly influenced the behavior of seals and walruses and resulted on some days in low numbers of animals out on the ice where they could be seen. The third problem is one we are currently facing, a delay in keypunching services due to summer vacations. Unless alternate arrangements can be made, this will affect completion date of the project.

VI. Estimate of Funds Expended to Date

Science*	–	$ 7,700
Logistics	–	$35,000
Total	–	$42,700

*Does not include salaries

Quarterly Report

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Trophic Relationships Among Ice Inhabiting Phocid Seals

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30 June 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 the fifth quarter were extensive. Collection efforts were made in the St. George Basin and Bristol Bay from the NOAA ship OSS SURVEYOR. Seal stomach samples and invertebrate and fish reference material was obtained. Stomach samples were obtained from coastal hunting villages of Pt. Hope, Barrow, Gambell, Savoonga and Nome. Additional stomachs were collected at Cape Lisburne in conjunction with RU#230, natural history of ringed and bearded seals. A collection effort was made at Oliktok, but no specimens were obtained due to bad weather and poor flying conditions. See Fig. 1 for sample localities.

Fifth quarter laboratory activities consisted of intermittent processing of stomach samples and of extensive work on the identification of accumulated fish material. Reference collections of otoliths, skeletal parts and cottid preopercular bones were established. An OASIS literature search and other library work were conducted with special emphasis on fishes and invertebrates of the Alaskan arctic and subarctic.

Data management continued to require considerable amounts of time from all project participants. OCS formats for reporting stomach contents data were finalized and back data were put into this form by our data manager. The first batch of data was keypunched, transferred to magnetic tape and submitted to NODC.

Table 1 provides a more complete listing of field and laboratory activities for the fifth quarter. Dates and personnel involved are included.

Methods

Field collection procedures at coastal hunting villages and methods for laboratory analysis of specimen material are described in the annual report for RU #232. In addition we collected seals from the OSS SURVEYOR, conducted otter trawls for fishes and invertebrates, and developed methods for identification of fish material. Those methods are described below.

The SURVEYOR cruise was utilized to collect seals for food habits, parasitology and natural history information (RU#s 230, 232 and 194) and to do aerial surveys in conjunction with RU #231. Collection of seals was done in the ice front with the aid of a Bell 206 helicopter. Hunting without the helicopter would have been largely impossible as the seals were well into the ice, much farther than either the SURVEYOR or a small Boston whaler could penetrate. Animals were collected on the ice, returned to the ship and processed as described in our annual report. Stomach contents were removed for later laboratory analysis. In addition, contents of the small intestine were examined for otoliths. In cases where the stomach was empty this often provided some information on recent diet.

Bottom sampling for fishes and invertebrates was conducted with a 16 foot otter trawl. Trawls were of 20 minute duration, at a ship speed of 3-4 knots. Contents of each trawl were identified, enumerated and representative specimens of organisms retained. Fish were measured, weighed and the otoliths removed and measured to determine otolith size

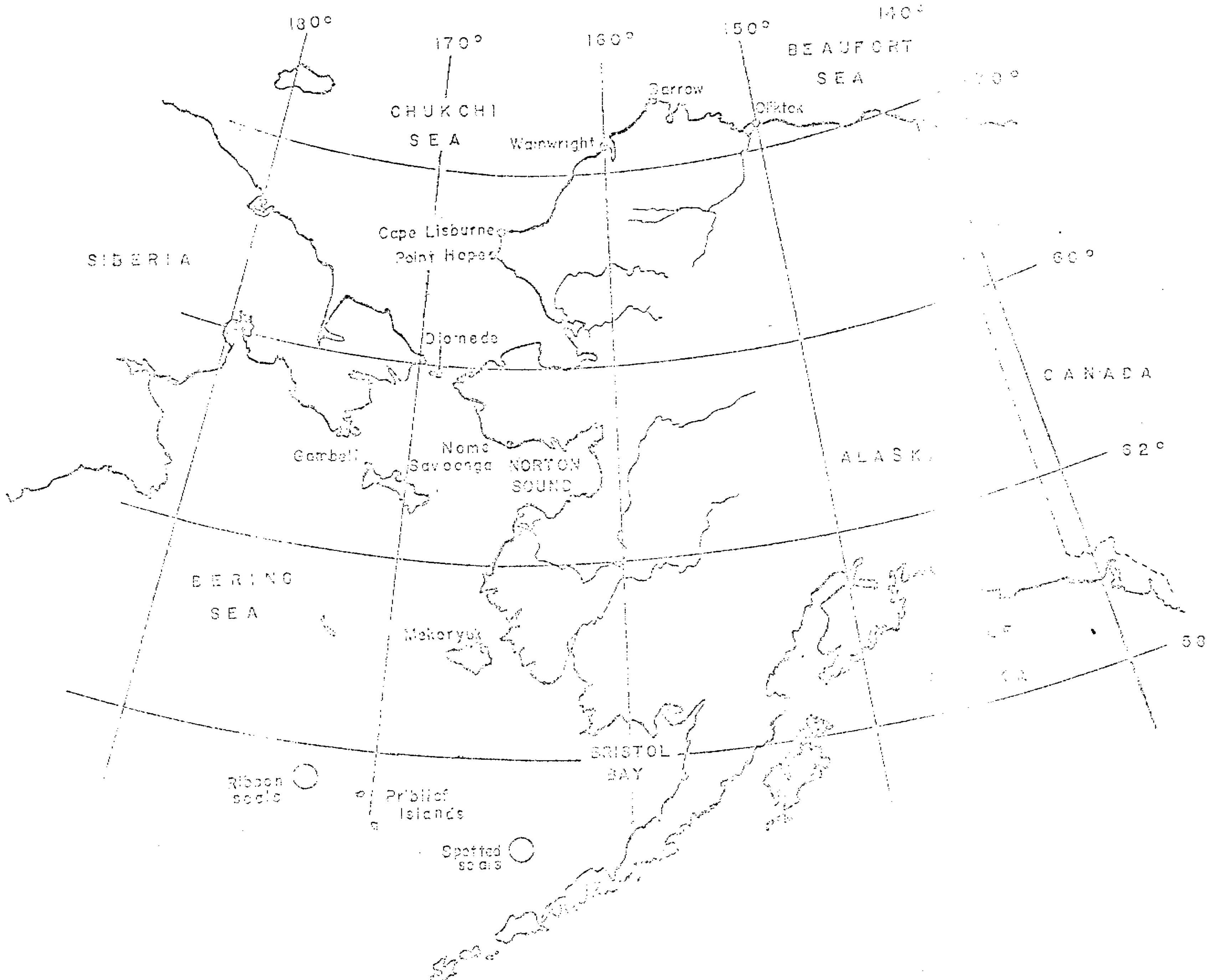


Figure 1. Locations at which specimen material was collected during the fifth [illegible] ter.

Table 1. Field and laboratory activities from 1 April - 15 June 1976.

Activity	Dates	Personnel
Bering Sea ice front cruise on NOAA OSS SURVEYOR - collection of seal specimen material and otter trawls for invertebrate and fish reference material and assessment of food availability	12 April-1 May	L. Lowry, K. Frost J. Burns, E. Muktoyuk
Specimen collection at Cape Lisburne in conjunction with RU#230	10 March-20 April	T. Eley
Specimen collection at Pt. Hope in conjunction with bowhead whale studies	19 April-1 June	G. Seaman
Specimen collection attempt at Oliktok	10-19 May	J. Burns, L. Lowry, E. Muktoyuk
Gulf of Alaska OSS SURVEYOR cruise - otter trawls for collection of fish reference material	23 May-4 June	K. Frost
Specimen collection at Barrow	6-25 May	R. Everett, NMFS
Specimen collection at St. Lawrence Island and Little Diomede Island	1 May-30 June	ADF&G personnel
Specimen collection at Barrow	10-20 June	J. Burns
Specimen collection at Nome, Norton Sound	11-21 June	L. Lowry, K. Frost
Laboratory processing of specimen material - seal stomachs, invertebrate identification, fish material identification, reference collections	Intermittent	K. Frost, L. Lowry
Compilation of literature from OASIS search, other literature work	Intermittent	K. Frost, L. Lowry
Data management - development of data forms, transcription and keypunching of data	Continuous	L. Vaughan, K. Frost, L. Lowry
Submission of first data tape to NODC	8 June	L. Vaughan
Compilation of data and preparation of OCS quarterly report	7-18 June	L. Lowry, K. Frost

to fish size relationships. Some fish were preserved as reference specimens, some frozen to provide skeletal parts for comparative identification purposes, and some were saved for other OCSEAP investigators (James Morrow and Ron Smith). Otter trawls were also conducted a month later in the northern Gulf of Alaska in cooperation with Ken Pitcher, RU #229, to provide additional reference material and to fill in gaps in our collection.

Primary emphasis in the laboratory during the fifth quarter, in addition to processing recently acquired stomachs, was on developing the capabilities necessary to identify fish material found in seal stomachs. Work was done with whole fish, skeletal parts (primarily vertebrae of gadids and the preopercular bones of cottids) and otoliths.

The fish material found in seal stomachs was in varying stages of digestion. Some fish were almost intact and could be identified with available fish keys for Alaskan waters and compared to our reference collection. Others were highly digested and had to be identified from bits and pieces. Gadid vertebral columns were characteristic as were the preopercular bones of cottids. Preopercular bones also provided a good indication of the size of fish.

An otolith reference collection was compiled during the fifth quarter. Otoliths were taken from fish recovered by otter trawls, as well as from existing ADF&G fish collections. These otoliths were mounted on slides and used for comparison with otoliths found in stomachs. In addition we worked with a preliminary copy of J. Morrow's otolith key, testing its applicability to the sorts of material we encountered. As most of the otoliths we dealt with were partilly degraded by either formalin or stomach digestive juices we degraded examples of identified otoliths with pepsin for comparative purposes. Most otoliths encountered could be identified at least to family, many to genus and species. They were then counted and the number of fish estimated. Displacement volume was determined for total fish material, but not for each separate species due to the impossibility of sorting out non-characteristic parts. Data for food items composed of fish are reported as percent of the total number of fishes identified which belonged to a given taxonomic group.

Data Collected or Analyzed

Table 2 summarizes the results of our collection efforts from 1 March to 15 June 1976. A total of 75 stomachs was collected. Forty-two of these were from the Chukchi Sea, 9 from the north Bering Sea, 5 from Norton Sound, 14 from Bristol Bay and 5 from the St. George Basin. Ringed seals, mostly from the Chukchi Sea, made up the largest sample of 50 stomachs. Seven bearded seals from several localities, 13 spotted seals from Bristol Bay and 5 ribbon seals from the St. George Basin were collected by us. These 5 ribbon seals were the first to be obtained during this project.

Table 2. Seal stomachs collected during the period 1 March 1976 to 15 June 1976. Not all stomachs contained food.

Location	*Phoca (Pusa) hispida*	*Erignathus barbatus*	*Phoca vitulina largha*	*Phoca (Histriophoca) fasciata*
Barrow	3			
Cape Lisburne	4			
Pt. Hope	35			
Nome/Norton Sound	2	3		
Gambell	2	3		
Savoonga	4			
Bristol Bay (NOAA SURVEYOR)		1	13	
St. George Basin (NOAA SURVEYOR)				5
Totals	50	7	13	5

A total of 49 otter trawls were conducted on OSS SURVEYOR cruises in March through May. Representatives of 45 invertebrate species and 37 fish species were identified and saved for reference specimens. Otoliths were obtained from 37 species of common Bering Sea fishes, and preopercular bones from 13 kinds of cottids. (See Appendix I for a list of fish material obtained for our collection.)

Despite the intermittent nature of lab work during the fifth quarter analysis of all stomach samples collected during the first four quarters of this project was completed. Identification of accumulated fish material from the 95 stomachs previously reported was also completed. Five ribbon seal stomachs were analyzed. Twenty-six spotted seal stomachs from Mekoryuk, Savoonga and the SURVEYOR cruises were processed. In addition, pre-1975 samples from Norton Sound including 22 ringed, bearded and spotted seals were analyzed.

III. Results

Ringed and Bearded Seals

With the aid of reference specimen material collected from the SURVEYOR and in collections at ADF&G, we have analyzed the fish remains from stomachs from which only invertebrate material was previously analyzed (Table 3). As discussed in the previous section, a variety of methods were used for determining the identity of fish remains depending on type, condition, etc. Several potential sources of error or bias

Table 3. Fishes identified from ringed and bearded seal stomachs given as percent of [illegible] total number of fishes identified which belonged to a given taxonomic group.

Fish Species	*Phoca (Pusa) hispida* Mekoryuk N=6	*Phoca (Pusa) hispida* Diomede N=12	*Phoca (Pusa) hispida* Wainwright N=19	*Phoca (Pusa) hispida* Barrow N=9	*[illegible]nathus barbatus* Mekoryuk N=12	*[illegible]nathus barbatus* Gambell N=[illegible]	*[illegible]nathus barbatus* Savoonga N=7	*[illegible]nathus barbatus* Diomede N=6	*[illegible]nathus barbatus* Wainwright N=[illegible]2
Unidentified Gadidae	2.4		21.4						3.7
Theragra chalcogramma					6.9				
Eleginus gracilus	65.3		7.1	25.0	4.8				
Boreogadus saida		42.9		25.0			25.0	2.8	
Total Family Gadidae	67.7	42.9	28.6	50.0	11.7		25.0	2.8	3.7
Unidentified Cottidae	31.5		14.3		82.5			18.3	14.5
Myoxocephalus sp.		28.6	14.3			83.3	37.5	36.6	11.1
Myoxocephalus quadriconis			14.3					15.5	48.1
Megalocottus platycephalus								5.6	3.7
Gymnocanthus sp.		28.6			1.1	16.7	25.0	11.3	14.8
Icelus canaliculatus					0.5			5.6	
Microcottus sellaris					1.1				
Dasycottus setiger									3.7
Total Family Cottidae	31.5	57.1	42.8		85.1	100.0	62.5	93.0	96.3
Mallotus villosus			14.3	50.0					
Ammodytes hexapterus			7.1		1.6			4.2	
Unidentified Pleuronectidae			7.1						
Unidentified Cryptacanthodidae					1.6				
Unidentified Stichaeidae	0.8						12.5		
Total number of fishes identified	124	7	14	4	188	6	8	71	[illegible]
Mean volume of fishes (ml)	39.2	7.6	5.9	0.4	26.5	41.[illegible]	29.8	184.0	5[illegible].4
% of the total food volume made up by fishes	58.5	13.8	25.2	2.0	19.2	20.[illegible]	15.2	30.8	[illegible].4

merit mention at this point. As both otoliths and preopercular bones are certainly retained in stomachs for an unknown period after ingestion, it is difficult to quantitatively evaluate their importance. Otoliths degrade in stomach acid and preservatives and become progressively more difficult to identify (e.g. Pleuronectids and Lycodes spp.). Some species (e.g. Mallotus villosus and Ammodytes hexapterus) have minute otoliths which disintegrate rapidly and are undoubtedly sometimes overlooked in the sorting process. Finally, some groups of species, for example Myoxocephalus spp. and Megalocottus platycephalus in which preopercular bones and otoliths are both similar and variable, have proven quite difficult to identify with confidence.

In ringed seals from Mekoryuk, fishes made up [illegible] percent of the total contents. Eleginus gracilus (saffron cod) comprised most of the volume, and a number of unidentifiable cottid otoliths were also found. At Diomede, only 7 fishes, 13.8 percent of the total contents, were identified. These were 3 Boreogadus saida (polar cod), 2 Myoxocephalus sp. and 2 Gymnocanthus sp. (both genera are cottids). At Wainwright, 25 percent of the total contents was fishes, mostly gadids (cods) and cottids. In addition, 2 Mallotus villosus (capelin), 1 Ammodytes hexapterus (sandlance) and 1 unidentified Pleuronectid (flatfish) were found. At Barrow, where only 20 percent of the volume was fishes, the remains of 1 Eleginus, 1 Boreogadus and 2 Mallotus were found.

In bearded seals, cottids were consistently the most common type of fish found, accounting for 62.5-100 percent of the identified fishes at the various localities. Several species belonging mostly to the genera Myoxocephalus and Gymnocanthus were identified. Theragra chalcogramma (pollock) and Eleginus were found in stomachs from Mekoryuk and Boreogadus was found in stomachs from Savoonga and Diomede.

Ribbon Seals

Very little intact food remains were found in the stomachs of ribbon seals collected from the SURVEYOR. However, numerous otoliths and some fragments of invertebrates were found in the stomachs and small intestines. These are treated together in Table 4 and expressed as a mean number of individuals represented. The range and percent of the total fishes accounted for by each individual species are also given.

Theragra was by far the most common food item, with numerous otoliths being found in every animal. Lycodes sp. (eelpouts) were also represented in each specimen with some otoliths identifiable as L. palearis while others could not be assigned a species. Mallotus villosus otoliths representing five individuals were found in small intestines of two specimens. Otoliths of Lumpenus sp. and an unidentifiable agonid were each found once. The most common invertebrate found was the small bivalve mollusc Nuculana sp. Since these were also found in the alimentary canal of Lycodes palearis taken in the immediate vicinity, it is highly likely that that was their source. That may also be the case with the gastropod operculum. One cephalopod beak, one carapace of Pandalus borealis and one chela from a crangonid shrimp were also found.

Table 4. Food items identified from stomachs and small intestines of five ribbon seals taken April 19 - April 20, 1976.

Food Species	Mean number of individuals	Range	% of total fishes
Fishes			
Theragra chalcogramma	111	13-402	92.7
Mallotus villosus	1	0-4	0.8
Lycodes palearis	1	0-4	[illegible]
Lycodes sp.	6.4	[illegible]	5.3
Lumpenus sp.	0.2	0-1	0.2
Family Agonidae	0.2	0-1	0.2
Invertebrates			
Nuculana sp.	9.8	0-32	
Gastropod operculum	0.2	0-1	
Cephalopod beak	0.2	0-1	
Pandalus borealis	0.2	0-1	
Family Crangonidae	0.2	0-1	

Spotted Seals

Three separate collections of spotted seal stomachs obtained in 1975-76 were analyzed during the past quarter (Table 5). Thirteen stomachs were collected from the SURVEYOR, 10 between 25 and 27 March and 3 on 24 April 1976. Seven of the 10 stomachs collected in March contained exclusively capelin with an average of 40 individuals and 506.3 ml. Examination of the small intestines of these animals revealed many capelin otoliths as well as otoliths from at least 13 pollock and 2 Myoxocephalus sp. Three of the animals taken in March, and all 3 collected in April had completely empty stomachs and no otoliths in the small intestine.

The 8 stomachs examined from Mekoryuk contained 13.5 percent invertebrates and 86.5 percent fishes. The invertebrates were all shrimp; five species were represented but only Crangon dalli was present in appreciable amounts. Five greenlings (Hexagrammos sp.) from a single stomach made up most of the volume of fish. One stichaeid, one Myoxocephalus sp. and one herring (Clupea harengus) were identified.

At Savoonga, 99.8 percent of the volume of stomach contents was invertebrates. Parathemisto libellula, Thysanoessa sp. and Neomysis rayii were found in small amounts in one stomach each. Most of the invertebrate material was shrimp, with Pandalus goniurus by far the most common species. The only fish encountered was the remains of one Myoxocephalus sp.

Table 5. Food items identified from 20 spotted seal stomachs taken at three locations. Data are expressed as percent of total volume for invertebrates and total fish material and percent of total individuals identified for species of fish. Percent frequency of occurrence[1] is also given.

	Bristol Bay-SURVEYOR March 25-27, 1976 N=7		Mekoryuk N=8		Savoonga N=5	
Food Species	% Vol/#	% Freq.	%Vol/#	%Freq.	%Vol/#	%Freq.
Amphipods Total					4.8	20
Parathemisto libellula					4.8	20
Euphausiids Total					4.8	20
Thysanoessa sp.					4.8	20
Mysids Total					*	20
Neomysis rayi					*	20
Shrimp Total			13.5	87.5	90.4	60
Lebbeus polaris			0.6	50.0	1.0	60
Eualus fabricii					2.1	40
Crangon dalli			10.5	25.0		
C. septemspinosa			0.7	25.0		
Sclerocrangon boreas			1.6	25.0		
Pandalus goniurus			0.1	12.5	87.3	60
Invertebrates Total			13.5	87.5	99.8	100
Fishes Total	100	100	86.5	25.0	0.2	20
Mallotus villosus	100	100				
Clupea harengus			12.5	12.5		
Myoxocephalus sp.			12.5	12.5	100.0	20
Hexagrammos sp.			62.5	12.5		
Family Stichaeidae			12.5	12.5		
Total No. fishes identified	281		8		1	
Mean volume of contents	506.3		97.7		104.7	

* Indicates food species which constitute less than 1% of the total volume

[1] Frequency of occurrence = $\frac{\text{number of times taxon found}}{\text{number of stomachs examined}} \times 100$

Norton Sound

We have in the past quarter organized, analyzed and compiled data from previous years samples from Norton Sound (Table 6). The bulk of this material was collected at Nome in the years 1970 through 1975. A total of 25 stomachs with food are represented.

As was found at other localities, bearded seals fed primarily on invertebrates. Shrimp accounted for 40 percent of the total volume and were found in every stomach examined. At least eight species were represented with Pandalus hypsinotus, Argis crassa, Argis lar and Crangon septemspinosa most abundantly found. Molluscs, almost entirely Serripes sp., made up 30 percent of the total volume. Crabs (Haplogaster grebnitzkii, Paralithodes sp., Pagurus spp., Hyas coarctatus, Chionoecetes sp. and Telmessus sp.) were found in small amounts. The relatively large quantity of other invertebrates (16.4%) is primarily the result of 190 ml of anemones found in a single stomach. Fish accounted for only 4.9 percent of the total volume, with otoliths and preopercular bones usually the only remains found. By far the majority of the fishes were cottids, mostly Myoxocephalus sp., with gadids (saffron cod and polar cod) next in importance.

Ringed seals in Norton Sound ate about one fourth invertebrates and three fourths fishes. The invertebrates were almost entirely shrimp, mostly Pandalus hypsinotus. Polar cod and saffron cod were by far the most common fishes eaten with small amounts of rainbow smelt (Osmerus dentex) and capelin found.

Spotted seals ate almost entirely fishes. Saffron cod was the most common food item followed by smelt, herring and capelin. The mean volume found was almost a liter. This was largely the result of several stomachs containing large volumes of herring.

IV. Preliminary interpretation of results

At this point in the project interpretation of results can only be made at a very general level. Considerably more material must be collected and analyzed before relative importance of various prey items at specific localities can be evaluated with certainty. Seasonal variation may be significant but again more samples must be looked at. Age and sex-related dietary differences cannot yet be evaluated.

In ringed seals, the importance of fishes in the diet varied from 58.5 percent of the total volume at Mekoryuk to 20 percent at Barrow. Gadids and cottids always made up the bulk of the fishes. As reported in our annual report, euphausiids, amphipods, mysids and shrimp were the most common invertebrate food items. It appears that at certain locations feeding is entirely on plankton (euphausiids and mysids) while in other areas nektobenthos (shrimps and amphipods) and demersal fish (gadids and cottids) form the bulk of the diet. These seals appear capable of utilizing a wide variety of food items.

Table 6. Food items identified from bearded, ringed and spotted seal stomachs from Norton Sound. Data are expressed in the same manner as in Table 5.

Food Species	Bearded Seals N=7 % Vol/#	Bearded Seals N=7 % Freq.	Ringed Seals N=8 % Vol/#	Ringed Seals N=8 % Freq.	Spotted Seals N=10 % Vol/#	Spotted Seals N=10 % Freq.
Shrimp Total	39.8	100	26.4	25.0	*	10
Argis crassa	9.7	57.1				
Argis lar	9.6	42.9				
Crangon septemspinosa	5.3	42.9				
Pandalus hypsinotus	10.9	28.6	25.3	25.0		
Pandalus goniurus	0.4	28.6	1.1	12.5		
Other shrimp	3.9	85.7	*	12.5		
Molluscs Total	28.8	28.6				
Serripes sp.	27.5	28.6				
Other molluscs	1.3	14.3				
Anomuran crabs	6.9	57.1	*	12.5	*	10
Brachyuran crabs	1.9	42.9				
Other Invertebrates	16.4	71.5	0.2	25.0	*	10
Invertebrates Total	93.8	100	26.6	50	*	10
Fishes Total	4.9	85.7	73.4	87.5	100	100
Eleginus gracilus	14.1	42.9	30.4	25.0	61.7	40
Boreogadus saida	1.1	14.3	67.0	62.5		
Osmerus dentex	0.5	14.3	1.3	12.5	20.7	30
Mallotus villosus			0.4	12.5	2.0	10
Clupea harengus					14.3	50
Myoxocephalus sp.	63.8	42.9			0.5	10
Other cottids	18.9	42.9	0.8	12.5		
Other fishes	1.6	28.6			1.2	10
Total number fishes identified	185		227		405	
Mean volume contents (ml)	215.6		101.3		968.9	

In bearded seals, fishes accounted for 10.4 to 30.8 percent of the food volume. Cottids were by far the most common fish with Myoxocephalus and Gymnocanthus the most common genera. Invertebrates most commonly found were clams, crabs and shrimp. It seems that bearded seals are closely tied to a benthic food web, feeding almost exclusively on species living on or just above or below the substrate.

The five ribbon seals examined had very little material in the stomachs, however examination of stomachs and intestines showed that pollock and eelpout (Lycodes spp.) were the most common items recently eaten. Four 20 minute otter trawls were taken within a few miles of the area where the seals were collected. Pollock was 10 times more abundant than any other species found in the trawls. Lycodes palearis and L. diapterus ranked seventh and eighth in abundance in the trawls, with three species of flatfish, Lumpenus spp. and Icelus spp. being found more commonly than Lycodes. It appears that either Lycodes was under-represented in the trawl samples, or they are a favored food of ribbon seals. The lack of flatfish remains in ribbon seal stomachs, in fact in stomachs of all species examined, is interesting and at present unexplained.

Spotted seal stomachs examined and analyzed from four locations over a number of years show several different feeding patterns. Specimens collected at Nome between September and December during several years and in the central Bering Sea at the ice edge in March and early April contained almost entirely fish. Species composition of the diet in the two areas was different - capelin made up 100 percent of the diet in the March ice edge samples, whereas Eleginus, Osmerus and Clupea were the primary food items in the fall-winter Nome samples. In both areas, however, spotted seals appeared to feed almost exclusively on midwater aggregating or schooling fishes. At Savoonga, on the other hand, where specimens were collected in May and June, the seals fed entirely on invertebrates, almost exclusively the shrimp Pandalus goniurus. Mekoryuk specimens, also collected in May and June, fed on both fish and invertebrates. This sample, with only eight stomachs and widely varying contents, emphasizes the need for more samples taken throughout the year.

Collections from the first three areas indicate that spotted seals feed primarily on densely aggregated schooling species. Fish comprise most of the fall, winter and early spring samples whereas invertebrates, more specifically shrimp, make up all of the late spring-early summer sample at Savoonga. This is probably a function of seasonal distribution and abundance of prey species. Additional spring-summer samples would be most interesting.

It is impossible at this time to evaluate selectivity on the part of the seals for either fish or invertebrates without further information on prey availability at different times of the year. However, it is interesting to note that whereas the spotted seals collected in March in the Bering Sea were eating entirely capelin, otter trawls conducted in the same area recovered none. Instead, the trawls brought up primarily invertebrates, shrimps and king crabs, and a few flatfish and agonids. This points out the difficulty in obtaining unbiased estimates of prey availability, as capelin were obviously present in the area, and in distinguishing selective feeding on an uncommon prey item from non-representative resource sampling.

It appears from our information collected to data that cottids, especially Myoxocephalus spp., are an important food item for ice inhabiting phocids. Bearded seals in all areas consume substantial numbers of cottids. They are quite commonly found in ringed seals at some locations and they show up occasionally in spotted seal stomachs. As cottids are of no commercial importance, very little ecological work has been done on this group. One rather alarming result obtained by the Canadian Beaufort Sea Project (Percy and Mullin, Beaufort Sea Project Technical Report No. 11) showed that the fry of Myoxocephalus quadricornis were extremely sensitive to oil, with all test animals killed by 24 hour exposure to heavy dispersions. Obviously more work on the sensitivity to oil of this group, and in fact of all key prey items pointed out in this and our annual report, should be commenced without delay.

Norton Sound

The food items found in bearded seals from Norton Sound differed little from those found in other areas. The most common shrimp found, Pandalus hypsinotus, had not been found in bearded seal stomachs from other areas, and the second most common species, Argis crassa, had been found only in small amounts. The clam Serripes was an important food item as had been the case with the Wainwright sample. The crab Hyas coarctatus which had accounted for up to 42 percent of the food volume in samples from other areas was found only in small amounts. Fish remains indicated that cottids were consumed most frequently, with gadids next in importance, which was similar to the pattern found in other areas. The mean volume of contents (215.6ml) was within the range found at other locations (137.9-596.6ml).

Ringed seals in Norton Sound fed entirely on arctic cod, saffron cod and shrimp. The same species of shrimp, P. hypsinotus, that was found most commonly in bearded seals made up 25 percent of the volume of contents in ringed seals. The mean volume of contents (101.3ml) was higher than that found in other areas (19.2-67.0ml).

Spotted seals ate entirely fishes, with saffron cod, rainbow smelt and herring most commonly found. The primary fish eaten by ringed seals, polar cod, was not found at all in spotted seals. The complete lack of shrimp in the diet is curious since they were a fairly substantial food source at Mekoryuk and Savoonga. This is perhaps related to seasonal availability of prey. The mean volume of contents (968.9ml) was far greater than that found in other areas (97.7-506.3ml).

Bearded seals and spotted seals feeding in Norton Sound exhibit little or no trophic interaction. Stomach contents of bearded seals reflect a completely benthic or epibenthic diet whereas spotted seals collected to date fed exclusively on schooling or aggregating fish. There does seem to be trophic interaction between ringed and bearded seals, with both species feeding in substantial quantities on Pandalid shrimps. The potential for interaction between ringed seals and spotted seals exists, as both feed on schooling fishes, however the two species are temporally separated.

V. Problems Encountered/Recommended Changes

Field work during the fifth quarter generally proceeded well and without complications. Spring and summer are traditionally the times when coastal hunting activity is at its peak and collecting conditions are best. The two major problems encountered were loss of critical working time in the Bering Sea ice front during March and April due to ship breakdowns and the unsuccessful collecting trip to Oliktok due to bad weather and poor flying conditions.

Future needs for marine mammal trophics work include suitable ships available for extensive ice front and in ice work in Norton Sound and the Chukchi Sea. Helicopter capabilities are essential as are workable small boats such as Boston whalers. In addition more complete and accurate information on fish distribution, especially in Norton Sound, the north Bering Sea and the Chukchi Sea, is needed, as is a key to the skeletal parts of fishes.

More rapid compilation and distribution by the Project Office of the annual and quarterly progress reports of other OCS investigators would greatly expedite communication among projects and would delineate areas where OCS investigators might be of help to each other.

VI. Estimate of Funds Expended

As of May 31, we have expended approximately the following amounts.

Salaries and benefits	-	$31,500
Travel and per diem	-	4,300
Contractual services	-	2,200
Commodities and supplies	-	3,400
Equipment	-	850
Total Expenditures		$42,250

Appendix I. Fish specimens, otoliths and skeletal material collected during the fifth quarter and from existing ADF&G collections.

Species Name	Common Name	Whole fish	Otoliths	Skeletal parts
Gadidae				
Boreogadus saida	Polar cod	x	x	x
Eleginus gracilis	Saffron cod	x	x	x
Gadus macrocephalus	Pacific cod	x	x	x
Microgadus proximus	Pacific tomcod		x	
Theragra chalcogramma	Pollock	x	x	
Osmeridae				
Mallotus villosus	Capelin	x	x	x
Osmerus dentex	Rainbow smelt		x	x
Spirinchus thaleichthys	Longfin smelt	x	x	
Thaleichthys pacificus	Eulachon	x	x	
Clupeidae				
Clupea harengus pallasi	Pacific herring		x	x
Agonidae				
Asterotheca alascana	Gray starsnout	x	x	
Podothecus acipencerinus	Sturgeon poacher	x	x	x
Sarritor frenatus	Sawback poacher	x	x	
1-fin unidentified poacher		x	x	
Zoarcidae				
Lycodes brevipes	Shortfin eelpout	x	x	
Lycodes diapterus	Black eelpout	x	x	x
Lycodes palearis	Wattled eelpout	x	x	x
Stichaeidae				
Lumpenella longirostris	Longsnout prickleback		x	
Lumpenus fabricii	Slender eelblenny	x	x	
Lumpenus maculatus	Daubed shanny	x	x	
Cryptacanthodidae				
Lyconectes aleutensis	Dwarf wrymouth	x	x	
Hexagrammidae				
Hexagrammos stelleri	Whitespotted greenling	x		
Pleurogrammus monopterygius	Atka mackeral		x	
Bathymasteridae				
Bathymaster signatus	Searcher	x	x	

Appendix I. (continued)

Pleuronectidae				
Atherestes stomias	Arrowtooth flounder		x	
Glyptocephalus zachirus	Rex sole		x	
Hippoglossoides elassodon	Flathead sole	x	x	x
Hippoglossus stenolepsis	Pacific habibut		x	
Lepidopsetta bilineata	Rock sole		x	
Limanda aspera	Yellowfin sole	x	x	x
Liopsetta glacialis	Arctic flounder	x	x	
Microstomias pacificus	Dover sole		x	
Platichthys stellatus	Starry flounder		x	
Pleuronectes quadrituberculatus	Alaska plaice	x	x	
Reinhardtius hippoglossoides	Greenland halibut	x	x	
Cottidae				
Artediellus scaber		x		x
Dasycottus setiger	Spinyhead sculpin	x	x	x
Enophrys diceraus	Antlered sculpin	x		x
Gymnocanthus galeatus	Armorhead sculpin	x	x	x
Hemilepidotus jordani	Irish lord	x	x	x
Icelus canaliculatus		x	x	x
Icelus spatula	Spatulate sculpin	x	x	x
Malacocottus kincaidi	Blackfin sculpin	x		x
Megalocottus platycephalus	Flathead sculpin	x	x	x
Microcottus sellarus		x		x
Myoxocephalus jaok	Plain sculpin	x	x	x
Myoxocephalus polyancanthocephalus	Great sculpin	x	x	x
Myoxocephalus quadricornis	Fourhorn sculpin			x
Myoxocephalus scorpius	Shorthorn sculpin	x	x	x
Triglops metopias		x	x	
Triglops sp.		x	x	
Ammodytidae				
Ammodytes hexapterus	Pacific sandlance	x	x	

QUARTERLY REPORT

Contract # 03-5-022-69
Research Unit #240
Reporting Period 1 April - 30 June 197
Number of Pages - 5

Assessment of the Distribution and Abundance of Sea Otters along the Kenai Peninsula, Kamishak Bay and the Kodiak Archipelago

Karl B. Schneider

Alaska Department of Fish and Game

July 1, 1976

I. Task Objectives

To determine the distribution and relative abundance of sea otters around the Kenai Peninsula, the Kodiak Archipelago and in Kamishak Bay.

II. Field or Laboratory Activities

A. Field Trip Schedule

12 March - 14 March 1976 - Aerial survey of portions of Kenai Peninsula and Kodiak Archipelago made in conjunction with RU #243. Chartered Grumman Super Widgeon. (While this survey was conducted during the last quarter, results were not available at the time the annual report was prepared).

1 April 1976 - Aerial survey of Kamishak Bay and the area between Kachemak Bay and Anchor Point conducted in conjunction with CZM activities. OAS Turbo - Goose.

20 May 1976 - Aerial survey of portions of Barren Islands made in conjunction with RU #243. Super Widgeon.

8 June - 10 June 1976 - Aerial survey of portions of the Kenai Peninsula and Kodiak Archipelago made in conjunction with RU #243. Super Widgeon.

Sightings and partial counts of sea otters were collected from other biologists throughout the period.

B. Scientific Party

Karl Schneider - Alaska Department Fish and Game - Principal Investigator and observer 12 - 14 March, 1 April, 20 May, 8 - 10 June.

Donald Calkins - Alaska Department Fish and Game - Principal Investigator RU #243 and observer 12 - 14 March, 1 April, 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.

C. Methods

Sea otters were recorded on aerial surveys of sea lions. The trackline on these surveys normally covers only small portions of sea otter habitat. The observer placement in the aircraft is such that few sea otters on the left side of the aircraft are seen. Therefore, the number of sea otters counted is 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 1 April survey differed considerably. 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. 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 estimate number. The effective track width for individual animals was probably no more than 0.25 miles however.

D. Aircraft Tracklines

Tracklines for portions of the surveys that contributed useful information are shown in figures 1 - 13.

III. Results

Tracklines and counts of sea otters for portions of the surveys which provided information significant to this project are presented in figures 1 - 13. Three short survey reports of sightings made during seabird counts are also included.

For the most part these data represent fragments of information that are of limited value unless viewed with more complete counts presented in the annual report and with historical information.

The counts should be considered conservative as they were made from fixed-wing aircraft and in some cases made during surveys designed for other purposes. A more complete discussion of survey conditions will be presented in the final report.

IV. Preliminary interpretation of results

There are several general conclusions that can be drawn from the data presented.

Kenai Peninsula

The existence of very low densities of sea otters along the east side of Resurrection Bay and the Chiswell Islands seems to have been confirmed. (Figure 1 and 9). As higher densities occur nearby, it can be concluded that these areas contain relatively low quality sea otter habitat.

Sightings of sea otters along the south side of Kachemak Bay show a slightly higher number of sea otters than observed on the October 1976 helicopter survey and probably more accurately

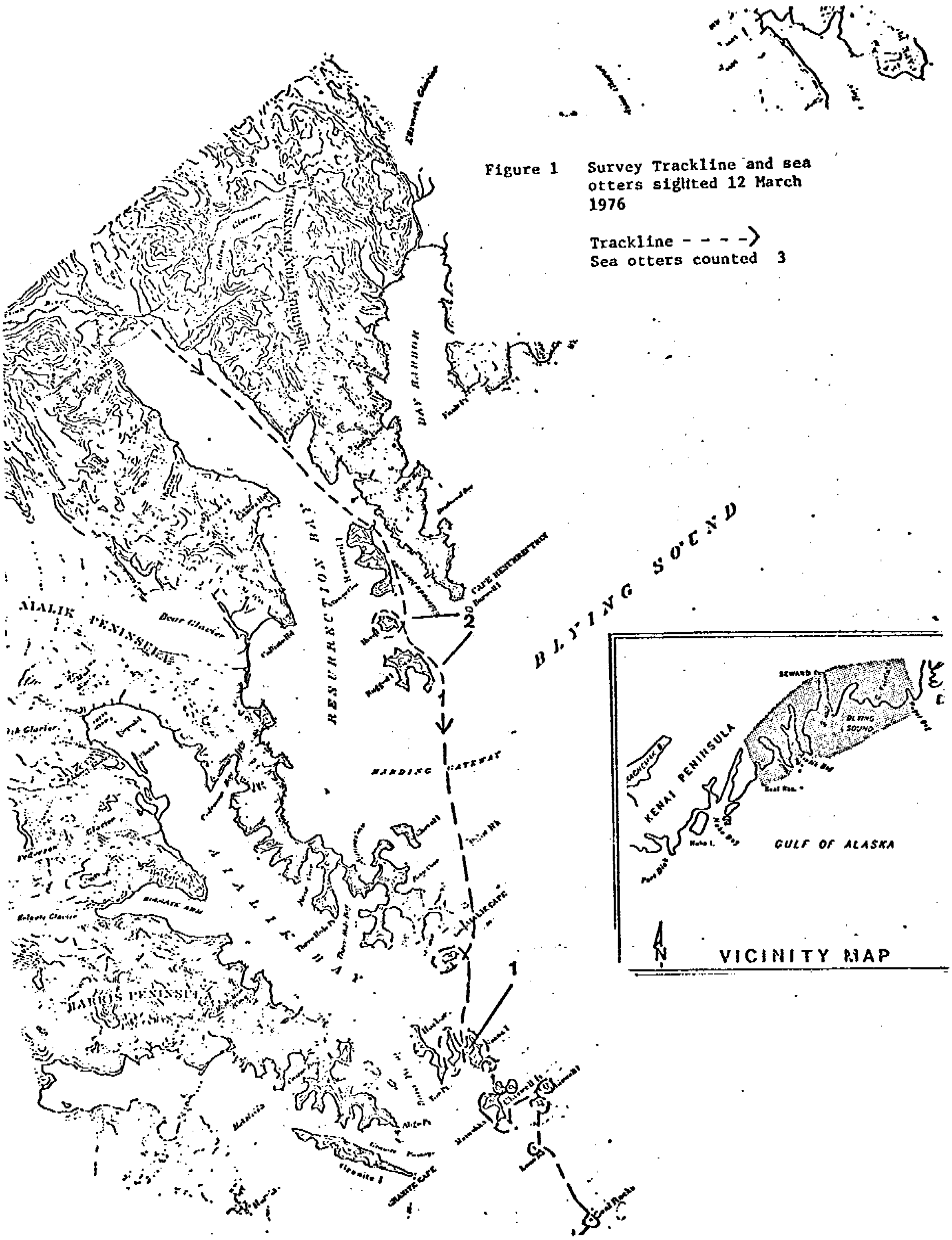


Figure 1 Survey Trackline and sea otters sighted 12 March 1976

Trackline - - - ->
Sea otters counted 3

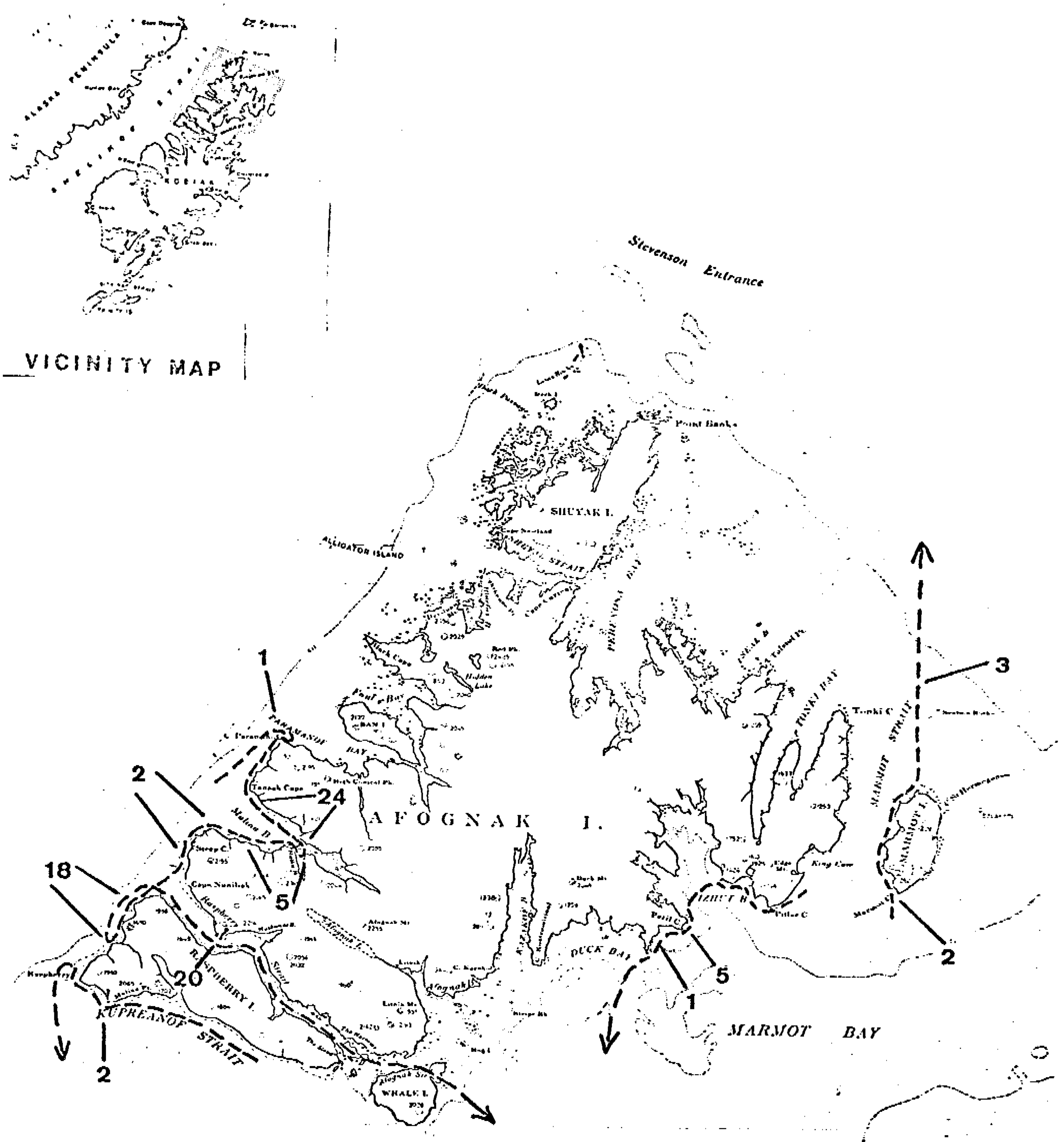


Figure 2 Survey Trackline and sea otters sighted 13-14 March 1976

Trackline - - - ->
Sea otters counted - 83

Figure 3 Survey Trackline and Sea otters counted 13-14 March 1976

Trackline - - - ->
Sea otters counted - 1

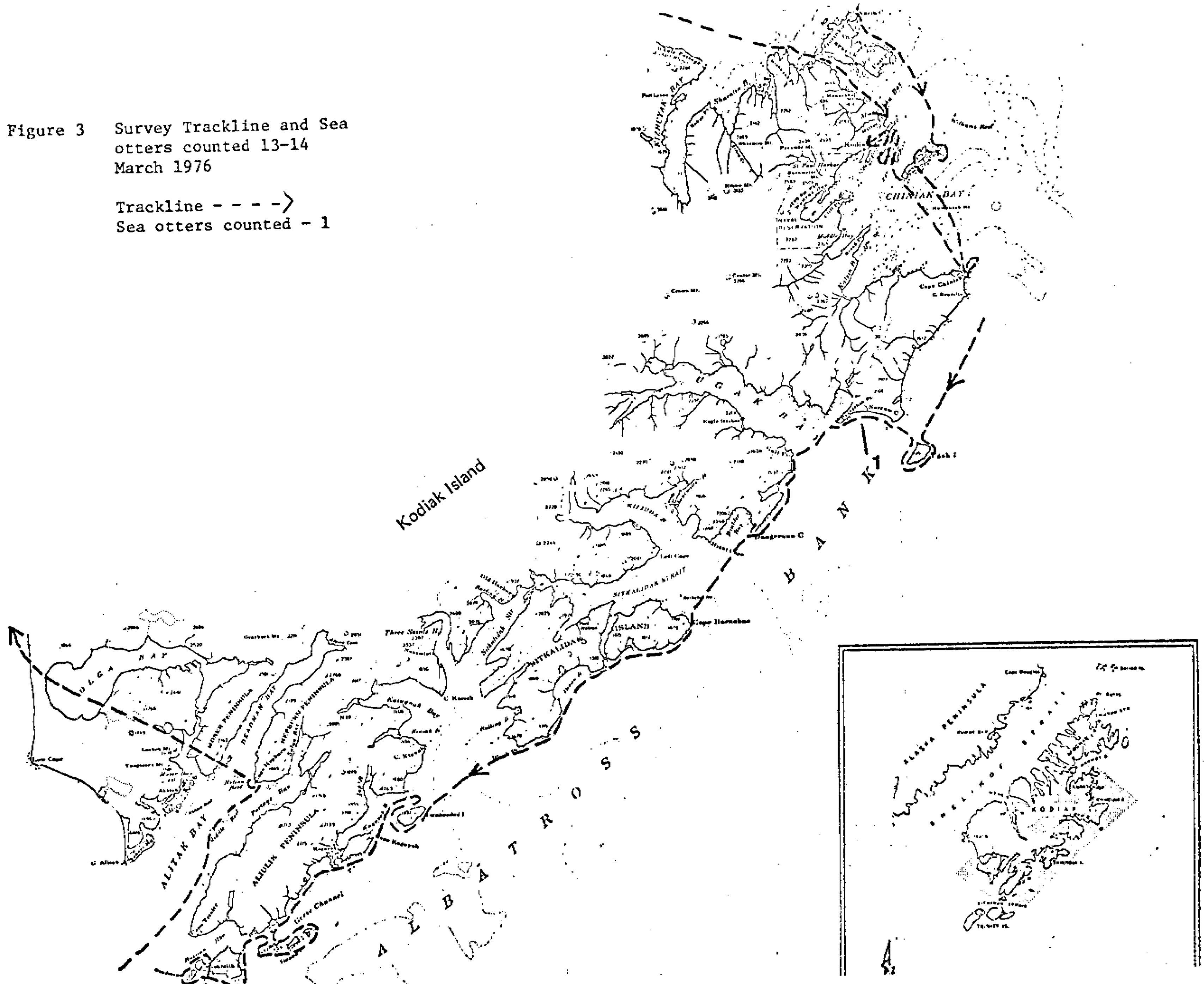
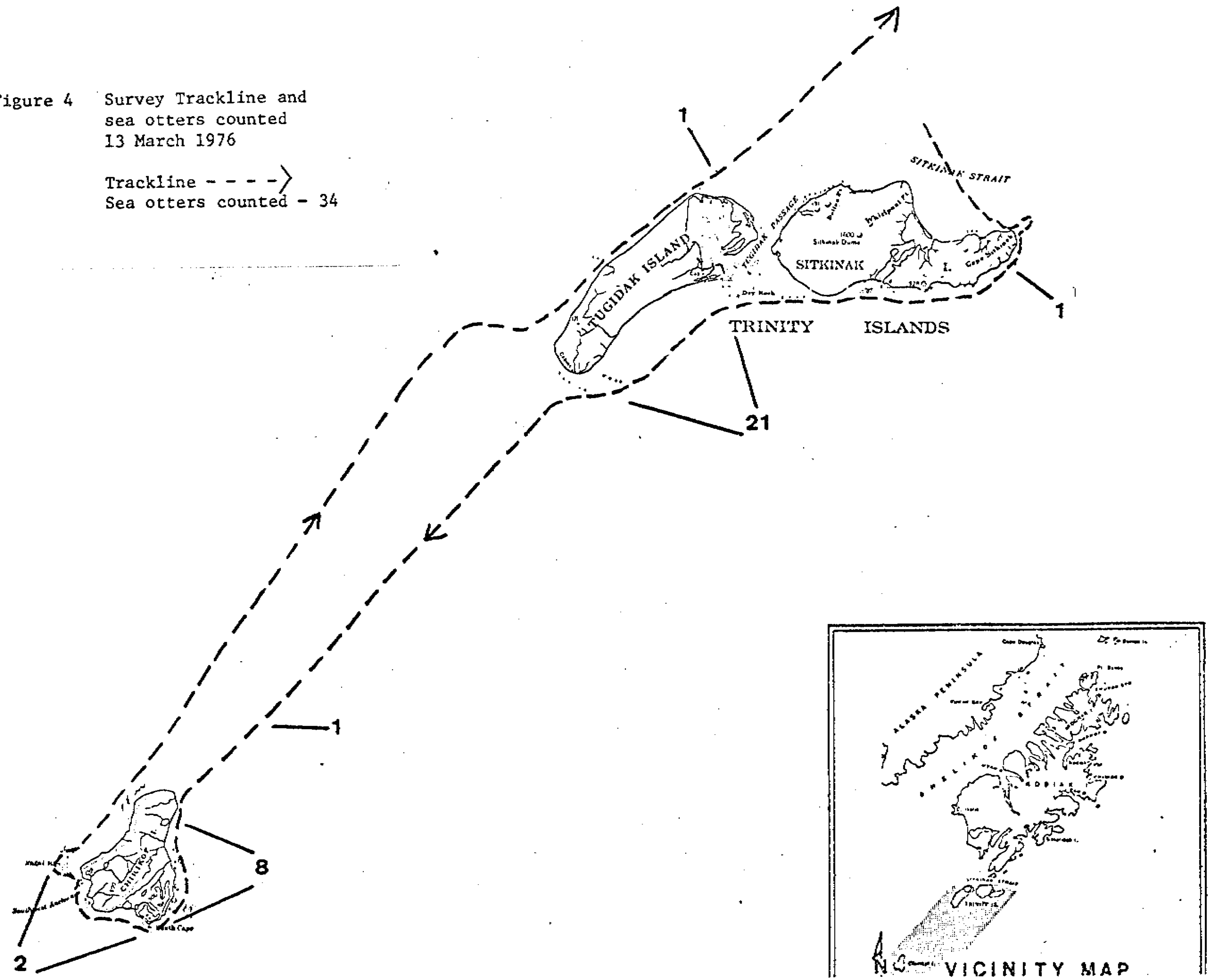


Figure 4 Survey Trackline and sea otters counted 13 March 1976

Trackline - - - ->

Sea otters counted - 34



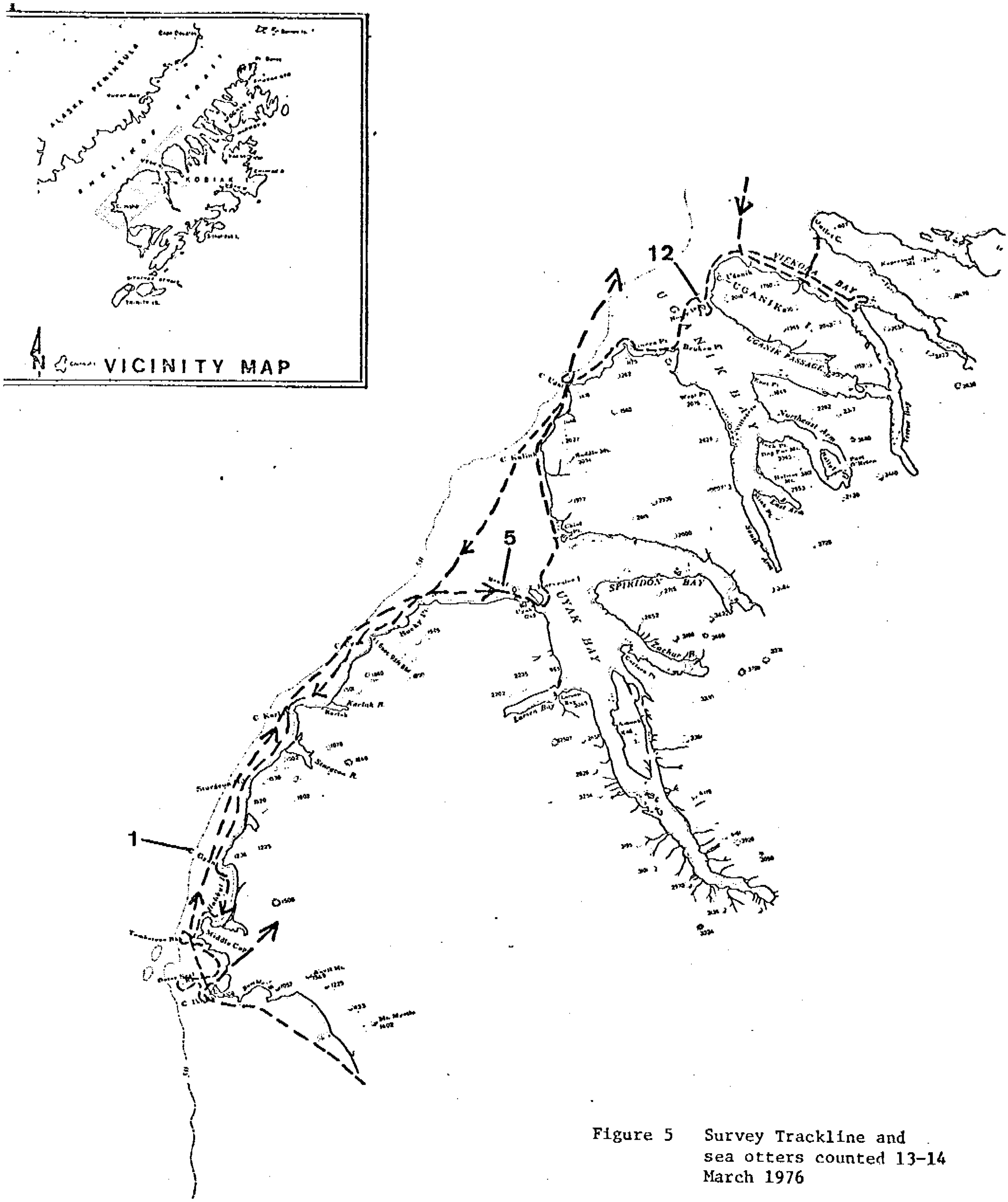


Figure 5 Survey Trackline and sea otters counted 13-14 March 1976

Trackline - - - - 〉
Sea otters counted - 19

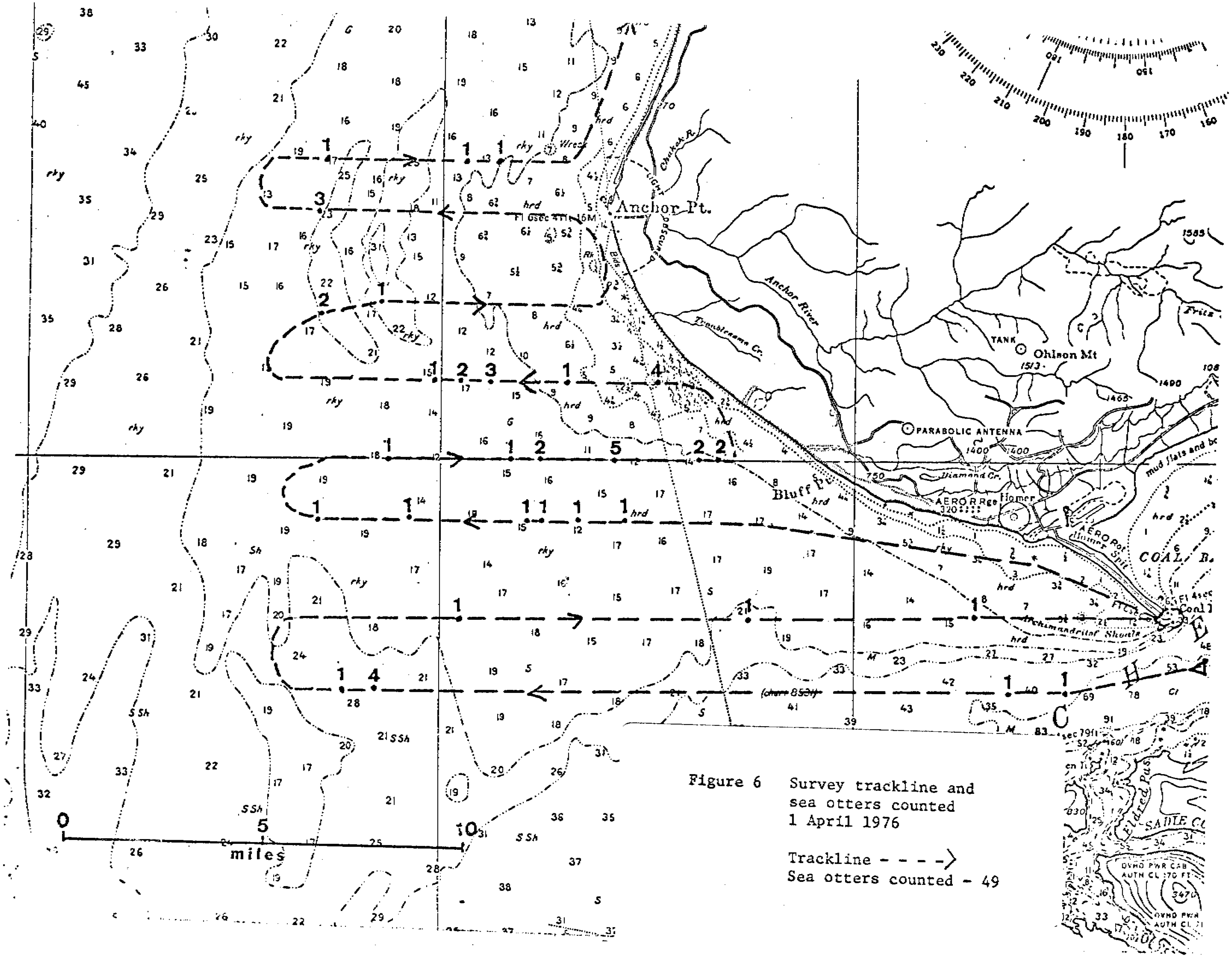


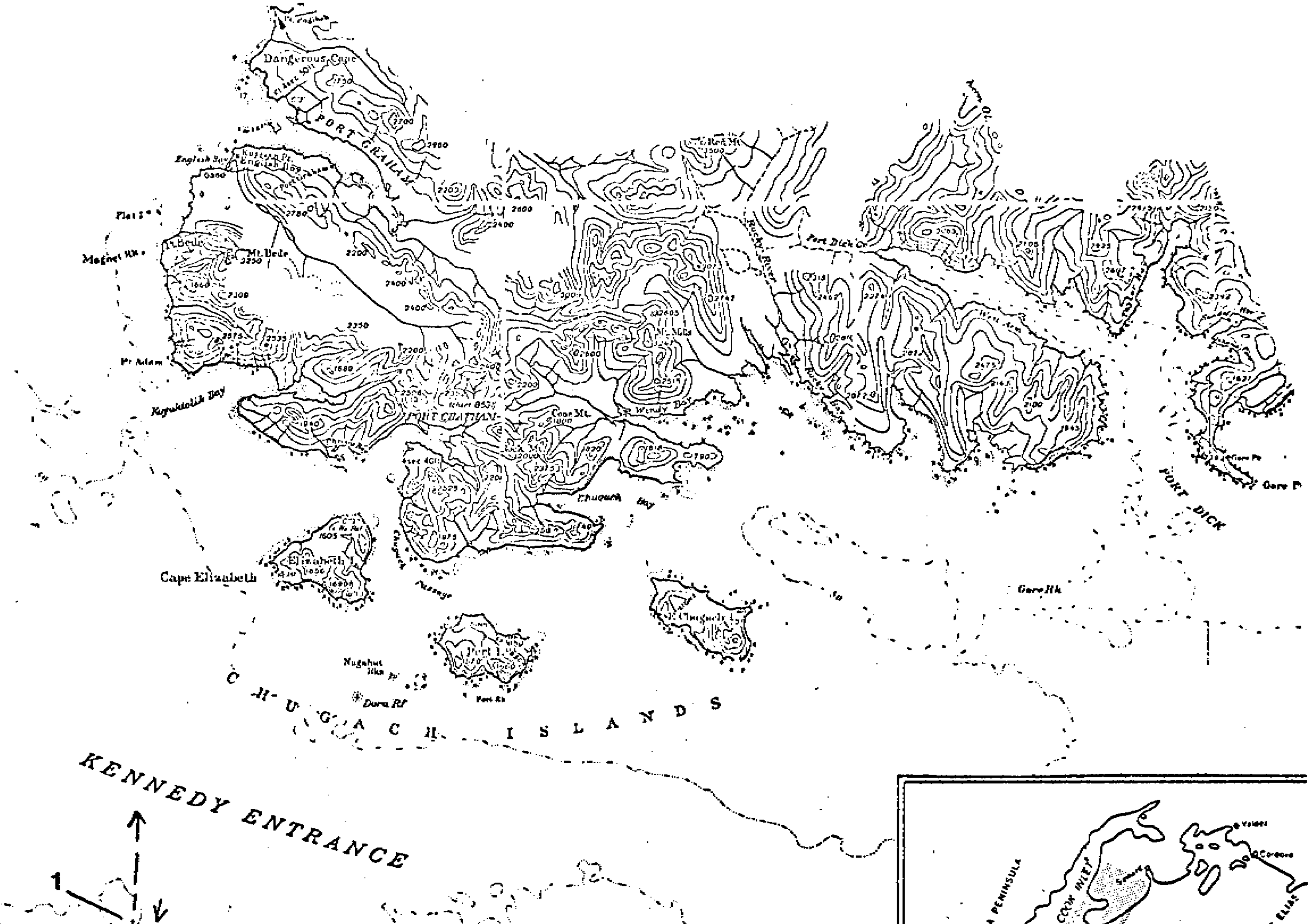
Figure 6 Survey trackline and sea otters counted 1 April 1976

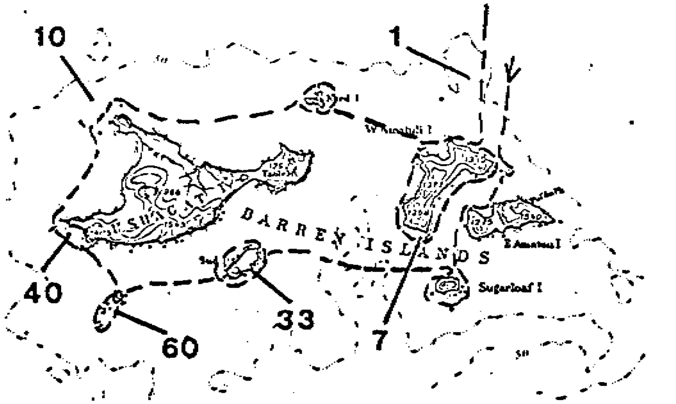
Trackline - - - ->
Sea otters counted - 49

Figure 7 Survey Trackline and sea otters counted 1 April 1976

Trackline - - - ->
Edge of drift ice
Sea otters counted - 73

73





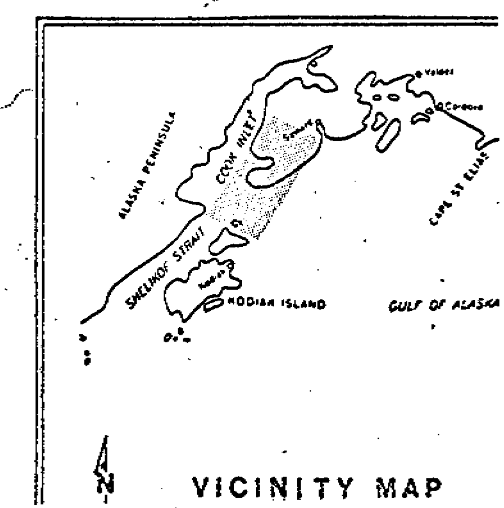


Figure 8 Survey Trackline and sea otters counted 20 May 1976

Trackline - - - - >

Sea otters counted - 151

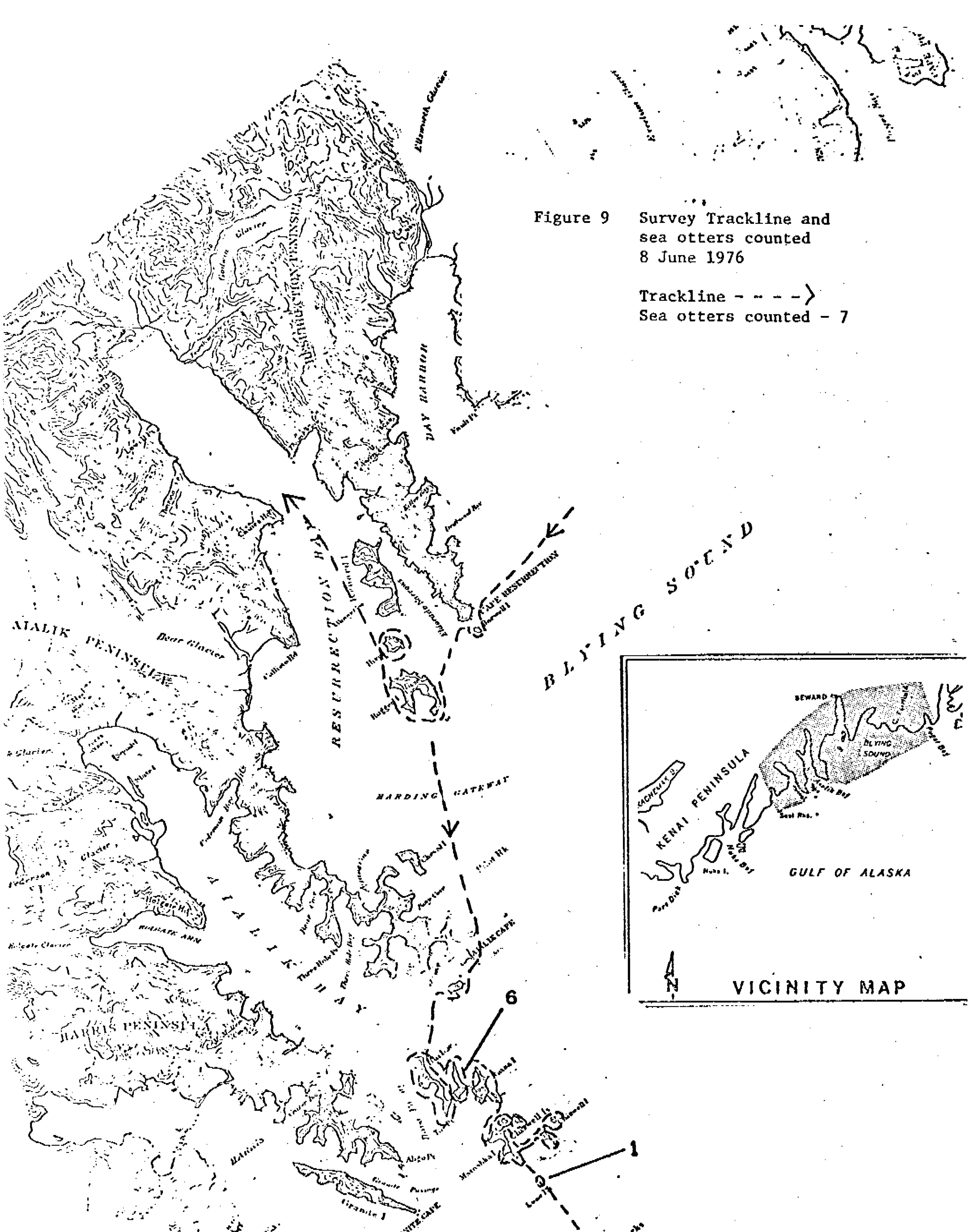


Figure 9 Survey Trackline and sea otters counted 8 June 1976

Trackline - - - ->
Sea otters counted - 7

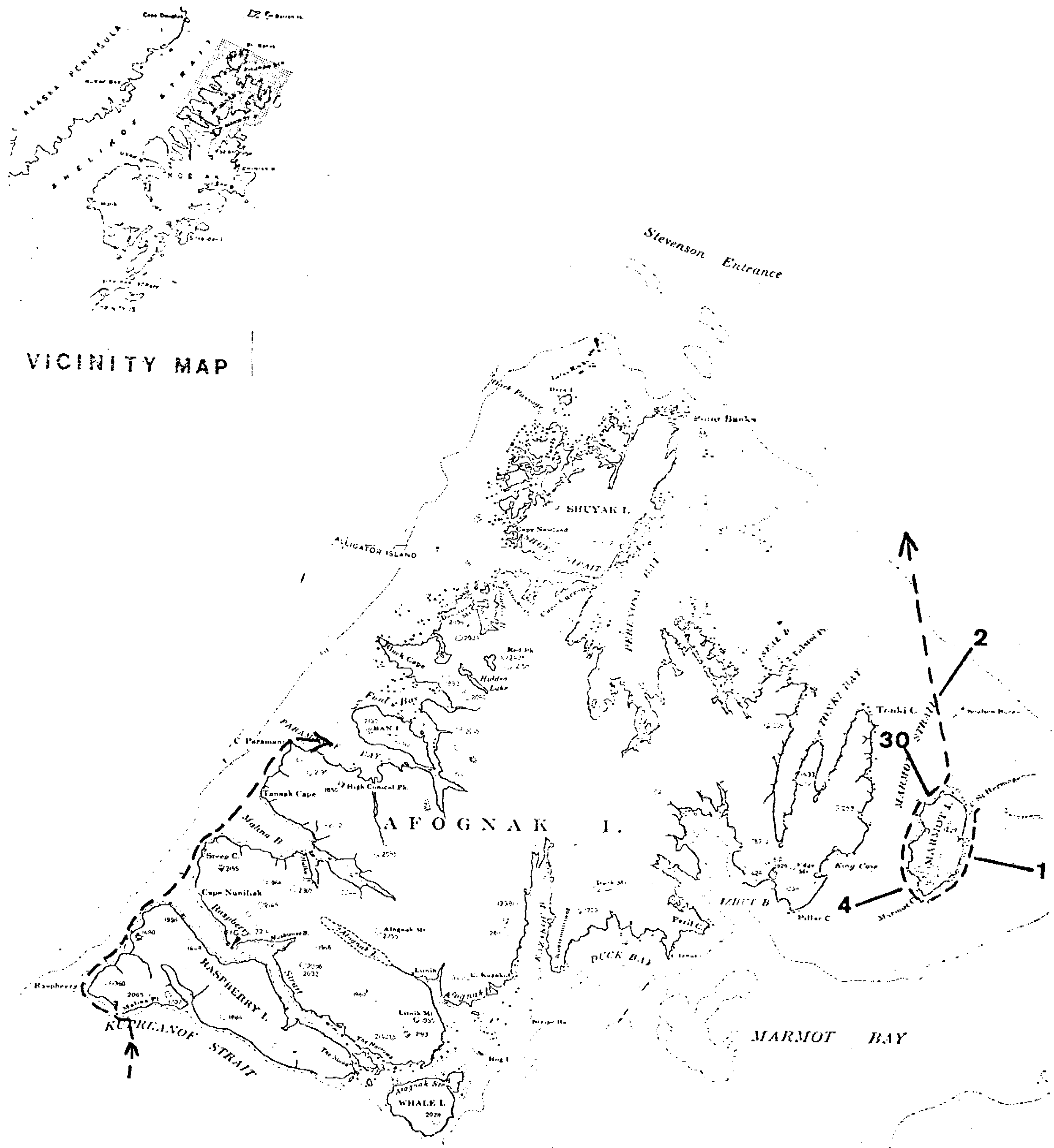
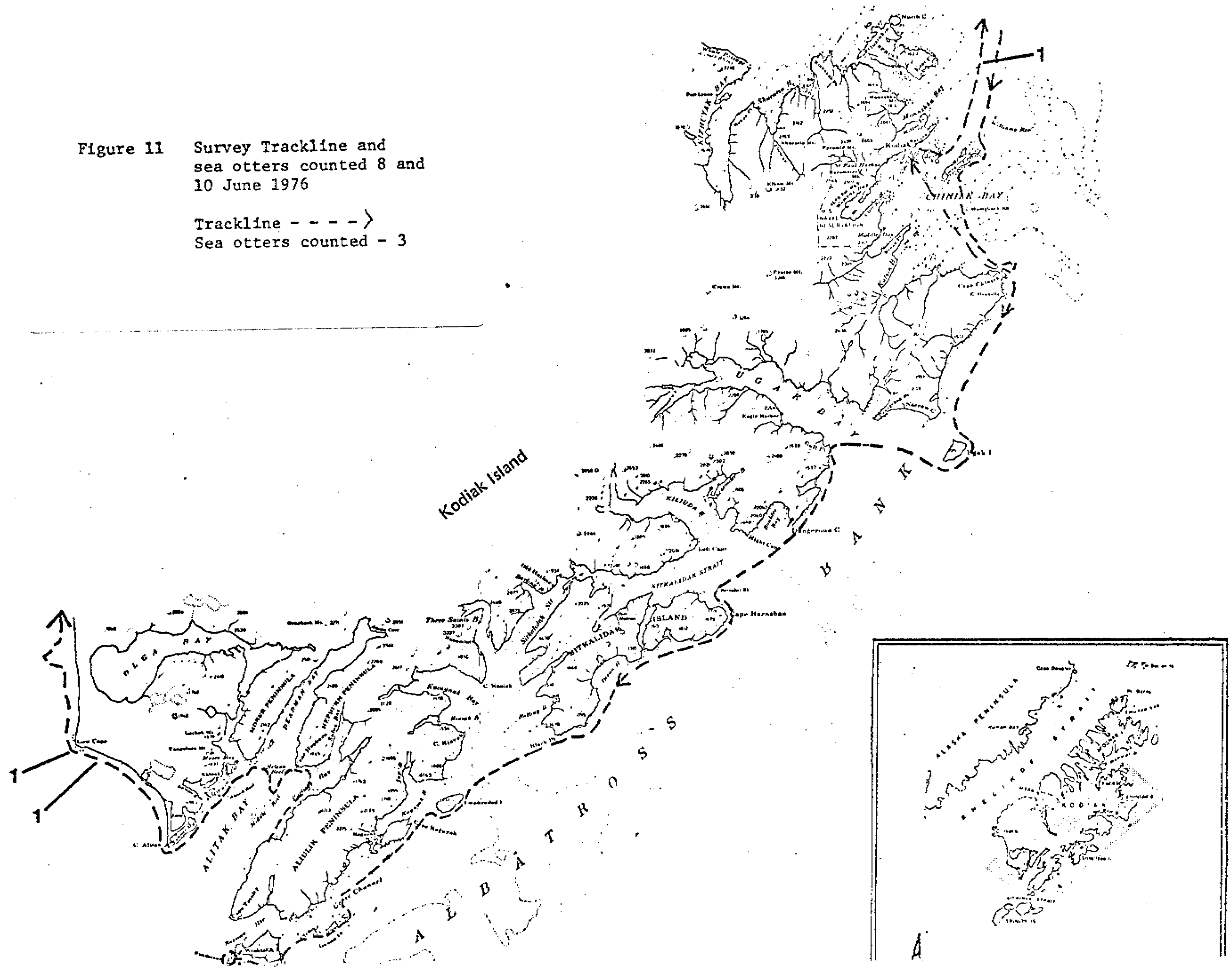


Figure 10 Survey Trackline and sea otters counted 8 and 10 June 1976

Trackline - - - - 〉
Sea otters counted - 37

Figure 11 Survey Trackline and sea otters counted 8 and 10 June 1976

Trackline - - - - 〉
Sea otters counted - 3



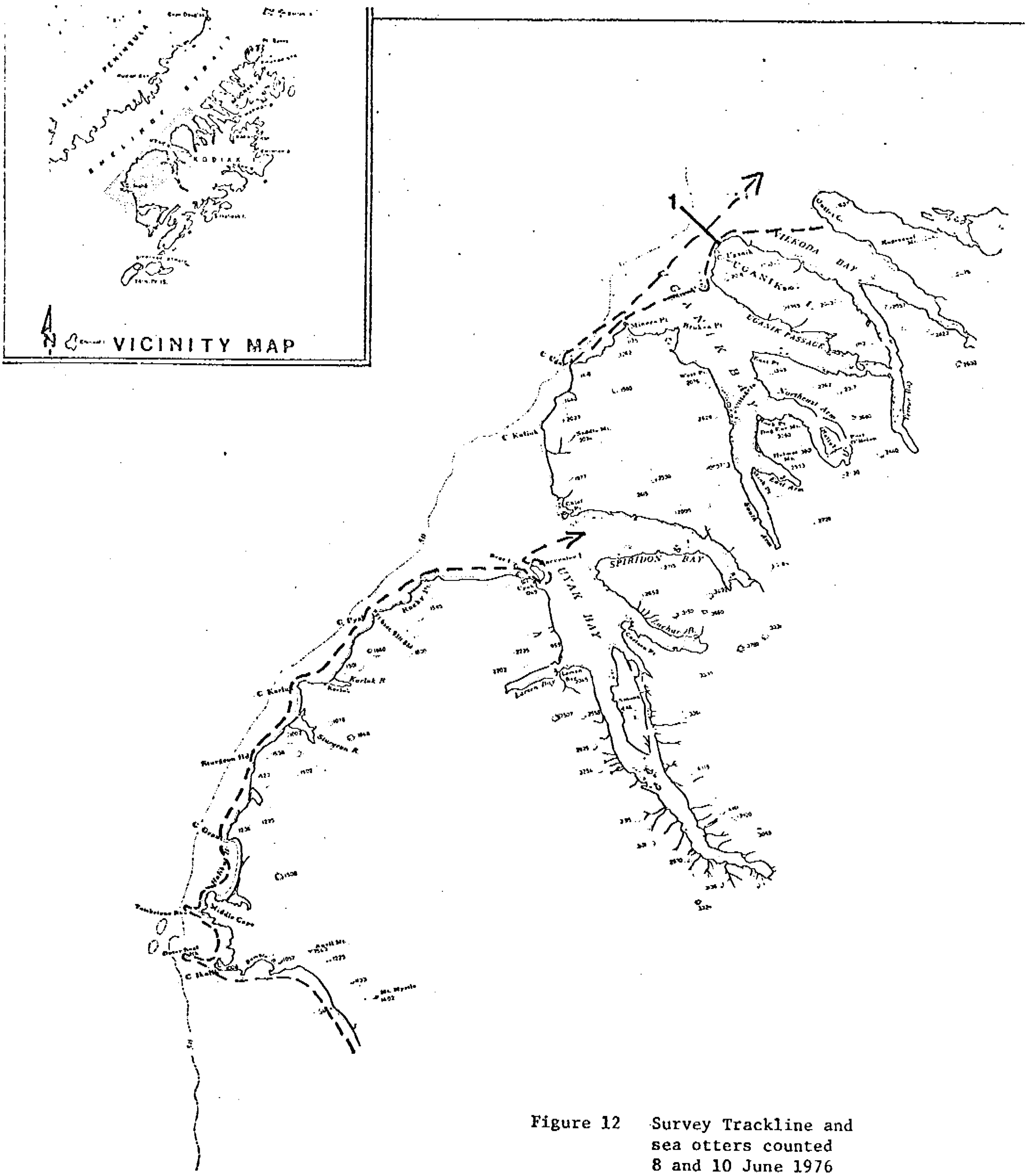
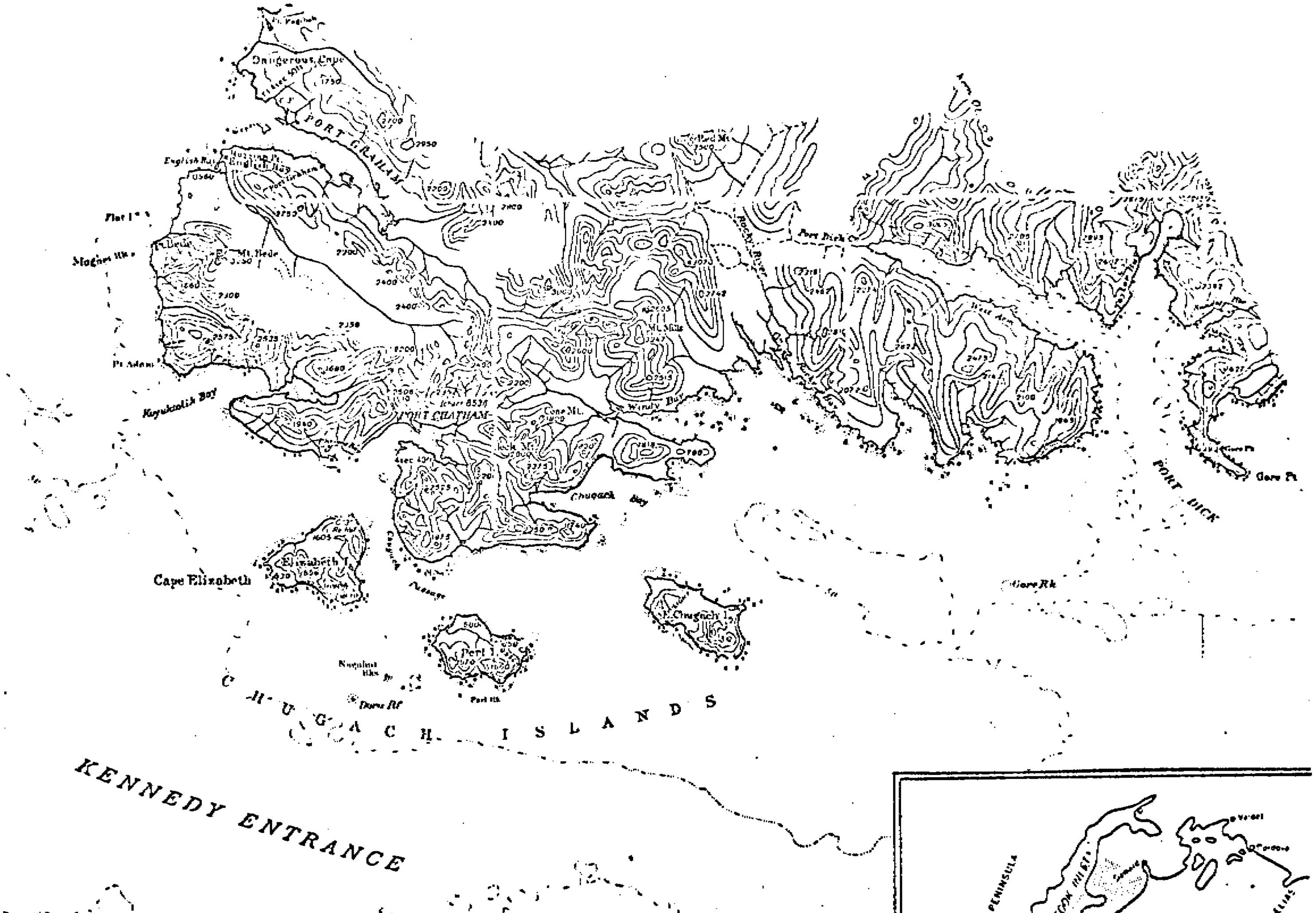


Figure 12 Survey Trackline and sea otters counted 8 and 10 June 1976

Trackline - - - - 〉
Sea otters counted - 1



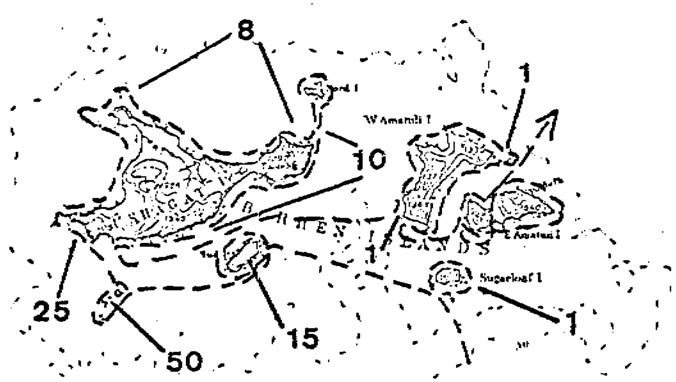
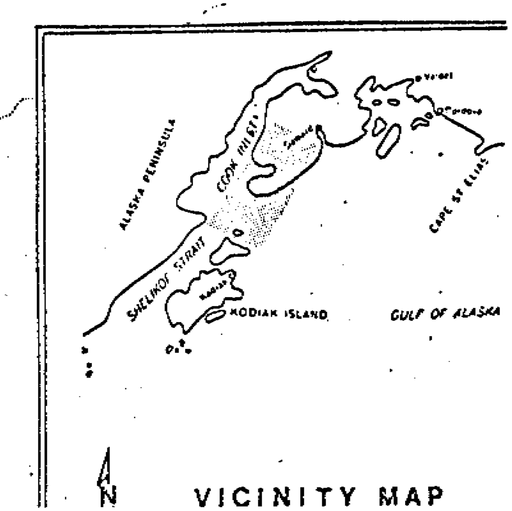


Figure 13 Survey Trackline and sea otters counted 10 June 1976

Trackline - - - - 〉
Sea otters counted - 111



Sea otter observations
St. Augustine Island

March 5, 1976

A shoreline survey of St. Augustine Island was conducted by the Fish and Game utilizing a Grumman "Goose" with Warren Ballard, Game Biologist II and David Erickson, Technician III as observers.

The area surveyed was from the storm zone out to 200 meters from the plane on the seaward side.

A total of 50 sea otter were sighted on a sandy beach along the northwest side of the island. About half of the otter took to the water as we approached in the plane, swimming in very close contact with one another.

Sea otter observations
Kachemak Bay

March 1976

Date	Location	No.
3/4	Mouth of small boat harbor at Homer	1
3/8	Along southern boundary of crab sanctuary	6
3/12	Mouth of small boat harbor at Homer	1
3/17	Eastern side of Yukon Island	2
3/23	Bluff Point	4

Sea otter observations along
the Crab Sanctuary boundary (Lat 59^{o} 35' 54")
in Outer Kachemak Bay

March 30, 1976

A transect was run from the end of the Homer Spit along the Crab Sanctuary boundary out to the boundary of Kachemak Bay in order to census seabirds and marine mammals.

Observations were recorded along the entire transect (26.7 nautical miles) out to a distance of 200 meters on each side of the boat.

The vessel used was the M/V Enforcer and observations were made from atop the wheel house which is approximately 15 ft. off the water. The sea was rather rough making observation more than 200 meter very difficult.

A total of 30 sea otter were seen with the first being sighted about ½ mile from the end of the spit and the last group near the end of the transect. Most of the otters were in groups of 4 to 6 spread somewhat evenly throughout the area. None were observed feeding.

Sea otter observations during the
winter sea bird survey of
lower Cook Inlet

Feb. 9, 10, and 18, 1976

This survey was conducted by the Department of Fish and Game utilizing a de Havilland "Beaver" with Paul Arneson, Game Biologist III, Warren Ballard, Game Biologist II and David Erickson, Technician III, as observers.

The survey was flown from Cape Douglas to the West Foreland on the western side and from Gore Pt. to the East Foreland on the eastern side. The elevation was 100 ft. with an average speed of 80 knots.

The extent of the survey included the area from the storm zone of the beach out 200 meter past the plane.

Date	Area	No. of sea otter	
		Adults	Young
2/9	Taylor Bay	3	
"	Western shore of Port Dick	9	1
2/10	Large cove east of Rocky Bay	1	
"	Western shore of Rocky Bay	3	
"	Head of Rocky Bay	1	
"	Windy Bay	6	
"	Chugach Bay	10	
"	Between Chugach Bay and East Chugach Island	4	
"	East Chugach Island	14	
"	Elizabeth Island	10	1
"	Perl Island	5*	
"	Between Port Chatham and Chugach Bay	6	1
"	Koyuktolik Bay	17	
"	Pt. Bede to Russian Pt.	14	
"	Port Graham	23	
"	Dangerous Cape to Seldovia Bay	6	
"	Gray Cliff to Barabara Pt.	14	
"	Hesketh Island	1	
"	Yukon Island	3	
"	Aurora Lagoon to Bear Cove	1	
	Total	222	3

* incomplete survey due to malfunction of recorder

represents the distribution of sea otters in the area. This distribution is typical of the front of an expanding population.

The systematic survey of the area between Kachemak Bay and Anchor Point (figure 6) and recent sightings demonstrate that the offshore population of sea otters is larger and more widely distributed than previously believed. A reliable population estimate is not possible from the data, however, it would appear that over 400 sea otters occupy the area 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 apparantly 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 trackline. Sea otters are capable of feeding in 40 fathoms and in rare cases over 50 fathoms of water although most normally remain in 30 fathoms or less. Depending on the availability of food large areas of lower Cook Inlet contain potential sea otter habitat. Many of these areas coincide with proposed lease areas.

Barren Islands

Neither survey of the Barren Islands was considered satisfactory. Conditions were unacceptable on 20 May although several pods were seen. The water was unusually calm on 10 June, however, the animals were scattered and shadows from high cliffs impaired visibility.

Several counts of over 300 sea otters have been made since the 1950's. The distribution and approximate abundance appear to have changed little since that time. The population is probably at carrying capacity. All surveys have indicated a concentration of sea otters south of Ushagat Island.

This population may have contributed significantly to the repopulation of the Kenai Peninsula in the 1960's and perhaps the Afognak area in the 1950's. It may still contribute animals to these areas, however, its role in the process of repopulation of former sea otter habitat appears less significant today.

Kodiak

The March and June surveys more clearly defined the present limits of the northern Kodiak sea otter population. As indicated in the annual report high densities of sea otters occur as far south as Marmot Island on the east side of the archipelago with small numbers scattered throughout Marmot Bay to the vicinity of the town of Kodiak. The population appears to have expanded its range somewhat further south than originally believed on the west side of the archipelago. Substantial numbers occur between Cape Paramanof and Uganik Island indicating that the group previously located in the Noisy Islands represents the "front" of the population rather than an isolated subpopulation.

No significant population appear to inhabit the remainder of Kodiak Island although scattered animals do occur in several areas.

Coverage of the southern Kodiak, Trinity Islands and Chirikof Island area was inadequate but the 13 March survey did contribute significantly to our limited knowledge of this population. The survey indicated a concentration south of Tugidak Island and other sightings suggest significant numbers north of Tugidak.

Small numbers have been seen between Tugidak and Chirikof Islands. The area of potential sea otter habitat in this area is vast and it appears sea otters use much of the area. The population is probably considerably larger than indicated and is growing. This area is an extremely important one to marine mammals and should be systematically surveyed prior to leasing of tracts in the immediate vicinity.

Kamishak Bay

The April 1 survey was the first attempt to systematically cover all of Kamishak Bay on a sea otter survey. From this and past partial surveys it appears that sea otters move throughout the area within the 20 fathom curve; however, there is normally a concentration around the north and west sides of Augustine Island. On this particular survey many sea otters were associated with patches of drift ice and a total of 17 were actually hauled out on ice.

Potential habitat extends accross Cook Inlet in some areas. There is a possibility of interchange of sea otters between Kamishak Bay and the area west of Homer. A strong possibility exists that some of the sea otters near Homer immigrated from Kamishak Bay although some almost certainly came from the Port Graham area which appears to have suffered a reduction in sea otter numbers in recent years.

This population is known to extend around Cape Douglas with a concentration of over 200 in the vicinity of Shakun Rocks. A recent survey of the area west of Cape Nukshak indicated that this population has not expanded its range west of there although it is expected to do so in the future.

V. Problems encountered/recommended changes

Generally the information gathered to date provides an adequate basis for OCS related decisions affecting sea otters within the study areas. The one exception is the area south of Kodiak Island which could not be completely surveyed with available funds.

Several areas outside of the study area should be examined in more detail. Specific concerns are the apparant expansion of sea otter range from the area south of Hinchinbrock Island toward the Copper River Delta, the recent sightings of sea otters in the vicinity of Icy Bay, and the tenuous status of several small populations in the Fox and Krenitzin Islands adjacent to the Aleutian Shelf Lease Area.

Problems encountered on this project include limited funding which has been largely overcome by coordination with RU #243 and by assistance from other funding sources. Data management was severely hampered by the failure of the Contract data manager to provide final formats until very recently. Poor design of the formats has complicated the process of data submission. Much time that could have been devoted to field work or data analysis has been wasted in the data management process. All available data will be submitted in the assigned formats in the near future, however, the annual and final reports are expected to provide more useful compilations of data.

VI. Estimate of funds expanded

$11,075.00

QUARTERLY REPORT

Contract # 03-5-022-69
Research Unit #241
Reporting Period 1 April - 30 June 1976
Number of pages - 1

Distribution and Abundance of Sea Otters in Southwestern Bristol Bay

Karl Schneider

Alaska Department of Fish and Game

July 1, 1976

I. Task Objectives

To estimate the size of the population of sea otters which inhabits the waters north of Unimak Island and the Alaska Peninsula and to determine its current distribution.

II. Field or Laboratory Activities

No field activities were conducted under this research unit during this quarter. A single transect was flown through the area on 14 June 1976 during the return trip from a survey conducted under RU #243.

The primary field work under this unit is scheduled to begin 27 July 1976.

All efforts to the present have been devoted to selection of tracklines, platform, observer configuration and data recording formats.

III. Results

Observations made on 14 June and reports from other biologists indicate that the main population remains concentrated in the southwestern portion of its range. Therefore, the survey which is scheduled to commence 27 July will be concentrated between Cape Leontovitch and Cape Sarichef. The area between Port Heiden and Cape Leontovitch will be surveyed less intensively.

The survey will be made from the OAS Turbo Goose. Strip transects will be flown at an altitude of 200 feet along north - south tracklines every 5 minutes of longitude between Cape Sarichef and Cape Leontovitch. Tracklines will be broken into 5 minutes of latitude segments and will extend to the vicinity of the 40 fathom curve. Two pairs of observers will be used. One pair will count all sea otters in a limited strip (Probably 0.1 nm) to either side of the aircraft. Transect width will be determined with the aid of an inclinometer specifically designed for the survey. The second pair of observers will count all sea otters within sight of the aircraft to provide a basis for stratifying the area and to determine if unusual concentrations are missed in the narrow transects. Bechevin Bay, Izembek Lagoon, Moffet Lagoon and the shoreline of Amak Island will be surveyed separately.

IV. Preliminary Interpretation of Results

None

V. Problems encountered/recommended changes

None

VI. Estimates of Funds Expended

$0

QUARTERLY REPORT

Contract # 03-5-022-69
Research Unit #243
Reporting Period April 1, 1976 - June 30
Number of Pages - 11

Population assessment, ecology and trophic relationships of Steller sea lions in the Gulf of Alaska

Principal Investigators:

Donald Calkins, Marine Mammals Biologist
Kenneth Pitcher, Marine Mammals Biologist
Alaska Department of Fish & Game
333 Raspberry Road
Anchorage, Alaska 99502

July 8, 1976

I. Task Objectives

The task objectives which were particularly emphasized during this quarter were the determination of population numbers and distribution, seasonal and annual movements, population productivity and food habits. Population numbers and distribution was investigated through two complete aerial surveys of the Gulf of Alaska and by observations made during combined harbor seal (RU #229) and sea lion collecting trips. Seasonal and annual movements were studied through the use of aerial photo surveys, collecting trips and branding operations. Material was collected for the study of population productivity and food habits through the use of vessels in selected areas of the Gulf.

Due to an extremely heavy field schedule for all investigators involved, much of the information and material collected during the quarter remains unanalyzed. A large proportion of the next quarters activities involves analysis of this information and material.

II. Field Activities

A. Aircraft and Ship Schedule

1. Grumman widgeon aircraft, private charter.

   a. March 1 through March 19

2. M. V. Resolution, ADF&G vessel charter.

   a. April 11 through April 22

3. Grumman widgeon aircraft, private charter.

   a. May 20

4. R. V. Surveyor, NOAA Vessel.

   a. May 24 through June 3

5. Grumman widgeon aircraft, private charter.

   a. June 7 through June 16, 1976

6. Bell Jet Ranger helicopter - private charter.

   June 21 through June 30

B. Scientific Parties

1. March 1 through March 19

   a. Donald Calkins, Alaska Department of Fish and Game Principal Investigator

   b. Karl Schneider, Alaska Department of Fish and Game Observer

c. Roger Aulabaugh, Alaska Department of Fish and Game
Observer and recorder

d. Charles Irvine, Alaska Department of Fish and Game
Observer and Recorder

2. April 11 through April 22

a. Kenneth Pitcher, Alaska Department of Fish and Game
Principal Investigator

b. Donald Calkins, Alaska Department of Fish and Game
Principal Investigator

c. Roger Aulabaugh, Alaska Department of Fish and Game
Collecting crew

d. Roger Smith, Alaska Department of Fish and Game
Collecting crew

e. Ben Ballenger, Alaska Department of Fish and Game
Collecting crew

3. May 20, 1976

a. Donald Calkins, Alaska Department of Fish and Game
Principal Investigator

b. Karl Schneider, Alaska Department of Fish and Game
Observer and Recorder

c. Dave Ericksen, Alaska Department of Fish and Game
Marine Bird Observer

4. May 24 through June 3, 1976

a. Kenneth Pitcher, Alaska Department of Fish and Game
Principal Investigator

b. Donald Calkins, Alaska Department of Fish and Game
Principal Investigator

c. Roger Aulabaugh, Alaska Department of Fish and Game
Observer and Collecting Crew

d. Walt Cunningham, Alaska Department of Fish and Game
Observer and Collecting Crew

e. Kathy Frost, Alaska Department of Fish and Game
Observer and Collecting Crew

5. June 7 through June 16

   a. Donald Calkins, Alaska Department of Fish and Game
      Principal Investigator

   b. Karl Schneider, Alaska Department of Fish and Game
      Observer and Recorder

   c. Roger Aulabaugh, Alaska Department of Fish and Game
      Observer and Recorder

   d. Dave K-------, Alaska Department of Fish and Game
      Marine Bird Observer

6. June 21 through June 30

   a. Donald Calkins, Alaska Department of Fish and Game
      Principal Investigator

   b. Roger Aulabaugh, Alaska Department of Fish and Game
      Branding Crew

   c. Roger Smith, Alaska Department of Fish and Game
      Branding Crew

   d. Walt Cunningham, Alaska Department of Fish and Game
      Branding Crew

   e. Ben Ballenger, Alaska Department of Fish and Game
      Branding Crew

   f. Dave Hardy, Alaska Department of Fish and Game
      Branding Crew

   g. M. J. Cunningham, Alaska Department of Fish and Game
      Branding Crew

   h. Francis Palmer, Alaska Department of Fish and Game
      Branding Crew

   i. Al Franzmann, Alaska Department of Fish and Game
      Branding Crew

   j. Julius Reynolds, Alaska Department of Fish and Game
      Branding Crew

   k. Donald Cornelius, Alaska Department of Fish and Game
      Branding Crew

C. <u>Methods</u>

1. Photo surveys

   a. The method of photographic surveying involves flying by rookeries and hauling areas at an altitude of 100 to 200 m and photographing all hauled out sea lions with a hand held 35 mm motor driver camera. Sea lions are counted from mosaics constructed from the developed slides.

2. Collecting sea lions sample

   a. Sea lions are collected through the use of skiffs working off larger vessels. Collection of individuals is biased towards animals in the water to facilitate food habits studies.

3. Sea lion Branding

   a. Sea lion pups were branded with a hot iron cattle type brand on the right front shoulder. The brands consisted of gothic style letters which were heated by propane torch.

D. Sample Localities

1. Photo surveys

   a. All known sea lion rookeries were photographed as visual counts made from Cape Spencer to Unimak Pass.

2. Collecting Trips

   a. Sea lions were collected from the eastern Kenai Peninsula, the northern portion of the Kodiak Archipelago, Cape St. Elias and Middleton Island.

3. Sea Lion Branding

   a. Sea lion pups were branded at the following 6 rookeries in the Gulf of Alaska:

      1. Marmot Island - Off Afognak Island
      2. Sugarloaf Island - In the Barren Islands
      3. Outer Island - Kenai Peninsula
      4. Fish Island - In the Wooded Islands off Montague Island
      5. Seal Rocks - In Hinchinbrook Entrance
      6. Pinnacle Rock - At Cape St. Elias

E. Data Collected or analyzed

1. Table 1. shows the sea lion surveys completed to date with visual estimates of animals present. No photo counts are available for either survey.

2. Sea lion collecting has resulted in our obtaining a total of 38 sea lions during the quarter.

3. Table 2. gives totals of sea lions branded

III. Results

1. Results of the photo surveys are presented in Table 1.
2. Results of collecting of 38 sea lions: No results presently available
3. Table 2 shows the results of the branding operation
4. Recovery of branded animals

As of this writing we have a total of 4 separate sightings of sea lion pups which were branded in 1975 on Sugarloaf and Marmot Islands. The first re-sighting of 1975 branded pups occured in the Chiswell Islands on the eastern Kenai Peninsula. On April 13, 1976, 27 branded animals were observed in the area of the Chiswells. It was not possible to determine if these animals were accompanied by their maternal cows. In several instances, the branded animals were with groups of either an agregate of sub-adult sea lions and adult cows or large groups of animals which appeared to be the same age class. In no case were branded animals seen with groups of adult bulls, in fact, very few large adult bulls were present in the area of the Chiswell Islands during our visit in April. All branded animals observed which had readable brands were branded with an X. This indicates they were born and branded on Sugarloaf Island in the Barren Islands. Some of the brands were not readable.

The second sighting of a branded animal took place on Pinnacle Rock at Cape St. Elias on May 27, 1976. One animal was collected with the X brand on the left front shoulder and three others were sighted. Again this indicates sea lions born and branded at Sugarloaf Island in the Barren Islands in 1975.

The third sighting of a branded sea lion was made at Pinnacle Rock on June 26, 1976. This animal was clearly an O brand which indicates it was branded on Marmot Island in 1975.

The fourth and last sighting of a branded sea lion was at Seal Rocks in Hinchinbrook Entrance. This brand was only briefly observed and was not readable.

IV. Preliminary Interpretation of Results

Since very little laboratory analysis of specimen material was accomplished no preliminary interpretation of results are available on the collected sea lions.

The photo survey analysis is not complete for the June or March surveys so no interpretations are possible on the survey material either. All of this information will be reported on in detail with full analysis in the final report at the end of the contract period.

Re-sightings of branded sea lions had yielded some very valuable information. It is apparant that Sugarloaf Island in the Barren Islands and Marmot Island are extremely critical habitats for sea lions. These two small Islands have a breeding population whose range extends over much of the Northern Gulf of Alaska. It is quite likely that many of the sea lions that utilize the non-breeding areas found in the Gulf, particularly those wintering areas of the northern Kodiak, Kenai Peninsula and Prince William Sound areas, are born on either Sugarloaf or Marmot Island.

The longest movement of a single sea lion so far recorded in this study is that of the yearling which was branded on Marmot Island and sighted at Cape St. Elias. This represents a straight line distance of approximately 237 miles. The coastline between the two locations has 40 different rookeries and hauling areas which this sea lion could have visited.

V. Problems encountered/recommended changes

A. None of any great significance

VI. Estimate of funds expended

A. Funds expended or committed to March 31 - $114,000
B. Funds expended on photo surveys - $11,000
C. Funds expended on collecting trips - $10,000
D. Funds expended on branding - $14,000
E. Funds expended on miscellaneous - $3,000
(Supplies, travel, perdiem etc.)

Estimate of total funds expended or committed - $152,000

TABLE 1. - Visual estimates of sea lions on rookeries and hauling areas in the Gulf of Alaska

ROOKERY OR HULLING AREA	MARCH 1976 VISUAL ESTIMATE	JUNE 1976 VISUAL ESTIMATE	REMARKS
Venisa Point	0	0	
Harbor Point	2	60	
Cape Fairweather	150	0	
Sitkagi Bluffs	200	0	
Pinnacle R. K. (Plus)	450	1,475	
Middleton Island	130	2,500	
Fish Island	795	750	
Seal Rocks (PWS)	2,500	1,250	
Porpoise Rocks	0	0	
Fox Point	0	0	Probably not a true hauling area
Knowles Head	0	0	Probably not a true hauling area
Glacier Island	150	0	Winter hauling area
Perry Island	225	0	Winter hauling area
Point Eleanor	250	0	Winter hauling area
The Needle (PWS)	1,000	400	
Latouche Island	0	0	
Danger Island	0	0	
Point Elrington	3,500	400	
Cape Puget	0	60	
Cape Junken	0	0	
Barwell Island	0	0	
Rugged Island	-	-	
Hive Island	0	0	
Chat Island	0	0	
Chiswell Island	4,000	900	
Seal Rocks (Kenai)	150	No Estimate	

TABLE 1 - Continued

ROOKERY OR HULLING AREA	MARCH 1976 VISUAL ESTIMATE	JUNE 1976 VISUAL ESTIMATE	REMARKS
Outer Island	2,075	2,475	
Nuka Point	0	0	
Gore Point	375	500	
E Chugach Island	100	0	
Perl Island	8	40	
Nagahut Rocks	75	175	
Cape Elizabeth	60	100	
Flat Island	0	0	
W Amatuli Island	0	-	
Sugarloaf Island	350	3,200	
Sud Island	0	2	
Rocks SW of Sud Island	975	650	
SW Point Ushagat Isl.	0	650	
NW Point Ushagat Isl.	0	75	
Latax Rocks	80	700	
Sea Otter Island	45	400	
Tonki Cape	0	1	
Sea Lion Rocks (Kodiak	225	325	
Marmot Island	3,500	5,800	
Long Island	22	0	
Cape Chiniak	400	375	
Ugak Island	0	0	
Gull Point	100	130	
Cape Barnabas	200	300	
Twoheaded Island	1,500	1,000	
Sundstrom Island	0	0	

TABLE 1 - Continued

ROOKERY OR HULLING AREA	MARCH 1976 VISUAL ESTIMATE	JUNE 1976 VISUAL ESTIMATE	REMARKS
Cape Sitkinak	300	250	
Chirikof Island	2,000	1,800	
Nagai Rocks	950	350	
Bert Point	0	0	
Cape Hepburn	0	0	
Outer Seal Rocks	0	0	
Cape Ikolik	1,100	3	
Tombstone Rocks	0	190	
Kiddle Cape	0	40	
Sturgeon Head	25	0	
Cape Ugat	75	0	
Noisy Islands	0	0	
Malina Point	0	0	
Raspberry Str.	0	0	
N. Steep Cape	250	0	
Cape Paramanof	0	0	
Cape Nukshuk	0	0	
Cape Ugyak	0	0	
Cape Gull	20	200	Rocky Island of Cape Gull
Takli Island	100	2,000	Little Island of Cape Iktugitak
Puale Bay	1,000	2,585	
Ugaiushak Island	0	125	Rock SE of Island
Cape Kujlik	0	0	
Foggy Cape	0	0	
Sutwik Island	40	4	
Kak Island	0	0	

TABLE 1 - Continued

ROOKERY OR HULLING AREA	MARCH 1976 VISUAL ESTIMATE	JUNE 1976 VISUAL ESTIMATE	REMARKS
Atkulik Island	0	0	
Chowiet Island	2,500	Not Surveyed	
Seal Cape	0	0	
Mitrofania Island	0	0	
Spitz Island	0	17	
Kupreanof Point	0	0	
The Whaleback	0	0	
The Haystacks	0	0	
Castle Rock	No Estimate	250	
Atkins Island	No Estimate	3,500	
Simeonof Island	0	0	
Chernabura Island	-	1,150	
Twins	0	0	
Nagai Island	No Estimate	375	
Sea Lion Rocks	260	160	
Unga Island	0	0	
Wosnesenski Island	0	0	
Jude Island	0	175	
Pinnacle Rock Sandman Reef	125	1,180	
Cherni Island	0	0	
Clubbing Rock	0	600	
South Rock	0	632	
Bird Island	Not Surveyed	90	
Rock Island	Not Surveyed	30	
Cape Lutke	Not Surveyed	0	

TABLE 2 - Results of Branding Sea lion pups in the Gulf of Alaska, June 1976

ROOKERY	NUMBER BRANDED	ESTIMATE OF PUPS PRESENT
Outer I	249	750
Fish I	29	35
Seal Rocks	316	500
Pinnacle Rock	23	25
Sugarloaf Island	1,443	4,500
Marmot Island	3,669	5,000

FIFTH QUARTERLY REPORT

TITLE: The Relationships of Marine Mammal Distributions, Densities and Activities to Sea Ice Conditions in the Bering, Chukchi and Beaufort Seas

PERIOD: 1 April 1976 - 30 June 1976

PRINCIPAL INVESTIGATORS: John J. Burns, Alaska Department of Fish and Game; Francis H. Fay, Institute of Marine Science, University of Alaska; Lewis H. Shapiro, Geophysical Institute, University of Alaska

I. TASK OBJECTIVES: To determine the relationships of marine mammal distributions, densities and activities to sea ice conditions in the Bering, Chukchi and Beaufort seas.

II. FIELD AND LABORATORY SCHEDULE: Field work in all areas - compilation of existing data - evaluation of satellite imagery.

III. RESULTS: A. During this quarter, the principal investigators participated in the following field programs:

1. Bering Sea ice front cruise of NOAA OSS SURVEYOR
2. Bering Sea cruise of the Russian vessel ZAGORIANY
3. Bering Sea ice front-aircraft survey
4. Kotzebue Sound to Barter Island - aircraft survey of landfast ice and pack ice in some areas.

Ground truth regarding both ice conditions and mammal occurrences required for this project were obtained during these activities. For details refer to reports of RU #194, 232 and 230. Data for this project was also acquired during the surveys conducted at Cape Lisburne by T. J. Eley under RU #230.

B. Compilation of unpublished field data from old notes by Burns and Fay is nearing completion. Compilation from unpublished notes by other members of the Alaska Department of Fish and Game is in progress.

C. Calculation of the late spring geostrophic wind field in the Bering Sea has been completed and the results are being analyzed in connection with the "ice remnant" problem referred to in the annual report of this project.

D. A survey of the occurrence and persistence of major features of the ice-cover of the entire study area, based upon study of NOAA satellite imagery, is in progress. This is projected for completion during the present quarter.

E. The digital tapes of one LANDSAT image which includes several ice environments have been acquired. These will be used for further studies of methods of extracting relevant information from the imagery. Most of the required programming has been done and the actual investigation is in its preliminary stage.

IV. PRELIMINARY INTERPRETATION: None

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES: None

VI. ESTIMATED FUNDS EXPENDED: Approximately $30,000 this quarter.

MARINE BIRDS

MARINE BIRDS

MARINE BIRDS

QUARTERLY REPORT

Contract #03-5-022-69

Research Unit #3/4

Reporting Period April 1, 1976-
June 30, 1976

Pages

Identification, Documentation and Delineation of Coastal Migratory Bird habitat in Alaska.

Paul D. Arneson

Alaska Department of Fish and Game

June 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, Beaufort Sea and Chukchi Sea, and on barrier islands in the Beaufort Sea.

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, Beaufort Sea and Chukchi Sea; and on barrier islands in the Beaufort Sea. Identify critical species particularly in regard to possible effects of oil and gas development.

3. Describe dynamics and trophic relationships of selected species at coastal study sites on the Beaufort Sea.

III. Field Activities

The report of activities in the Beaufort and Chukchi Seas will be completed by George Divoky, Alaska Department of Fish and Game, Fairbanks.

A. Schedule

1. Not reported in the April 1, 1976 Quarterly Report was the completion of the survey in the Kodiak Archipelago. On March 22-24 a State of Alaska chartered Grumman Goose was utilized to complete the survey of Kodiak Afognak, and Shuyak Islands.

2. On April 1, 1976 the Office of Aircraft Services "Super" Goose, the "Aleutian Goose" was used in pelagic surveys in the Kamishak Bay and outer Kachemak Bay regions of Lower Cook Inlet.

3. From April 30 to May 8 a Chitina Air Service Cessna 185 and Gulf Air Service Cessna 180 were used for bird surveys from Cordova to Cape Fairweather.

4. Surveys from the Kvichak River to Cape Newenham in Bristol Bay were completed May 17-20 using a Cessna 185 of Charlie Allen's Flying Service.

5. Partial habitat mapping and bird observations were made on the south side of the Alaska Peninsula from June 14-16 using a Peninsula Airways Grumman Widgeon.

B. Scientific Party

1. Three secondary observers were used for the three day survey of Afognak-Shuyak Islands. William Donaldson, Alaska Department of Fish and Game, Kodiak, Alaska; Richard MacIntosh, National Marine Fisheries Service, Kodiak; Vernon Berns, U. S. Fish and Wildlife Service, Kodiak National Wildlife Refuge, Kodiak.

2. For the lower Cook Inlet survey, David Erikson, Alaska Department of Fish and Game, Homer was the secondary observer.

3. On April 30, M. E. (Pete) Isleib, on contract to U. S. Fish and Wildlife Service, was the second observer for surveys of the Copper River Delta. From May 1 to the present David Kurhajec, Alaska Department of Fish and Game technician has been the second observer for all surveys (3-5 above). In all but the June 14-16 survey Paul Arneson, Alaska Department of Fish and Game, Anchorage has been one of the two observers used per flight.

C. Methods

As described in the April 1, 1976 Annual Report with Quarterly summary, a stratified random sampling scheme was used for bird surveys in the Kodiak Archipelago. The entire Archipelago was stratified into eight habitat types and count units within each type were marked off using identifiable geographic features to mark the starting and ending points of each unit. These count units were then numbered and totaled. The habitat types and total numbers of units were:

Strata Code	Stratum	Number of Sample Units
A	Outside Waters - Forested	20
B	Inside Waters - Forested	44
C	Heads of Bays - Forested	4
D	Outside Waters - Rock/tundra/alder	46
E	Inside Waters - Tundra/alder	86
F	Mudflats Heads Bays - Tundra/alder	20
G	Estuaries/lagoons	30
H	Low Tundra/mud-sand Beach	17

With the help of Dr. Samuel J. Harbo, Jr., University of Alaska biometrician, relative bird densities for each strata were decided upon and the minimum number of units to be sampled was finalized:

Stratum	Density Rating	Strata	Number Sampled
A	1	A	4
D	1	B	12
H	2	C	4 (all units)
B	8	D	6
E	8	E	24
F	8	F	6
G	8	G	8
All "C" units to be censused.		Total	68

It was felt that weather, time and money would not allow a complete census of the islands so this stratified-random sampling design was used. Units to be sampled were selected using a table of random numbers. Open water portions needed to be surveyed so an amphibious aircraft was used and an attempt was made to count all birds within the count unit.

Techniques used in other areas varied with the type of habitat being surveyed. Amphibious aircraft were used in rocky coastal areas and single-engine aircraft on wheels along sandy coastline. Aircraft speed varied from 80 to 120 knots but an altitude of 100 ft. (30m) was maintained as much as possible.

Observers were used on both sides of the aircraft. While surveying long, straight beaches the aircraft flew slightly seaward of the waterline and the shoreside observer enumerated all birds visible to the beach ridge. The oceanside observer recorded all birds within 1/8 mile (200m) of the aircraft and noted concentrations outside of this zone. In extensive estuaries where total counts were not possible, transects were flown at equidistant intervals and birds were recorded by both observers within 1/8 mile of the aircraft. Upland vegetation inundated by storm tides was also surveyed.

All observations were recorded on cassette-type tape recorders. Information recorded was: bird identification to lowest taxa 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 is started and ended.

Because of the speed at which observations must be made from aircraft, only a limited number of environmental parameters were recorded. Choppy water and diving birds made species identification and number estimation difficult. Photographs were taken where it was practical-largely for enumeration of large flocks.

A second survey was conducted at higher altitudes (300-400 ft) to map habitat types and to denote the storm tide line wherever possible. Mapping was done on USGS 1:63,360 maps on areas where this scale map was available. This process is only conducted once per area but cannot be done until late May or June in most areas.

D. Localities See attached maps (Figures 1-5).

E. Data collected

In the Kodiak Archipelago 28 randomly selected plus three other count units were completed during this report period. About 30 species were seen in six habitat types. In this survey a definite trackline was not followed.

During the pelagic surveys in Lower Cook Inlet 450 mautical miles were covered in Kamishak Bay and 118 nautical miles in outer Kachemak bay. Fifteen species were recorded in these open water transects.

Over 800 miles of shoreline were flown from Cape Fairweather to Cordova in Northeast Gulf of Alaska surveying birds and mapping shoreline. Approximately 45 species were observed in at least eight habitat types. In addition 150 miles of transects were flown in the Copper River Delta region.

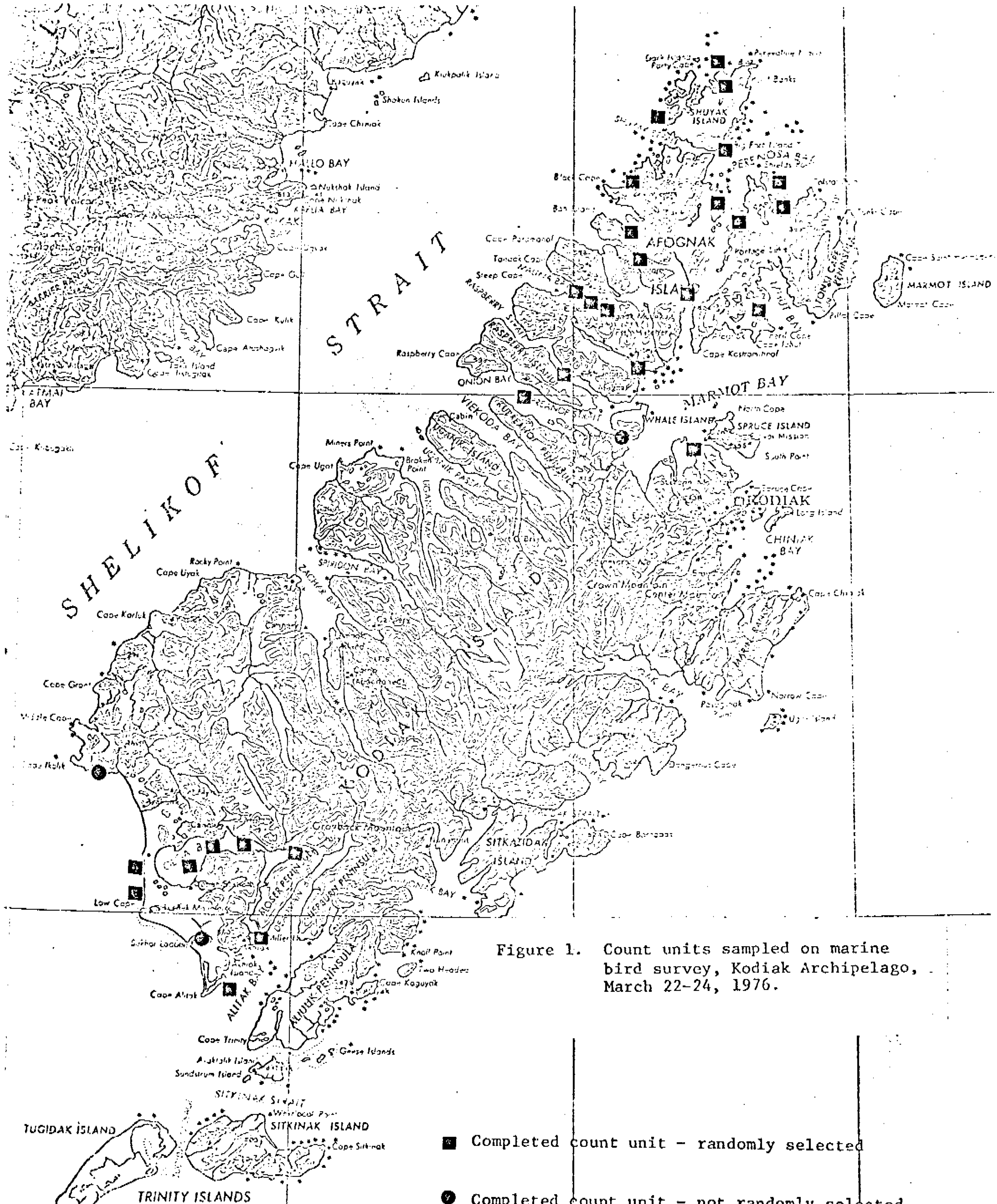


Figure 1. Count units sampled on marine bird survey, Kodiak Archipelago, March 22-24, 1976.

■ Completed count unit - randomly selected

● Completed count unit - not randomly selected

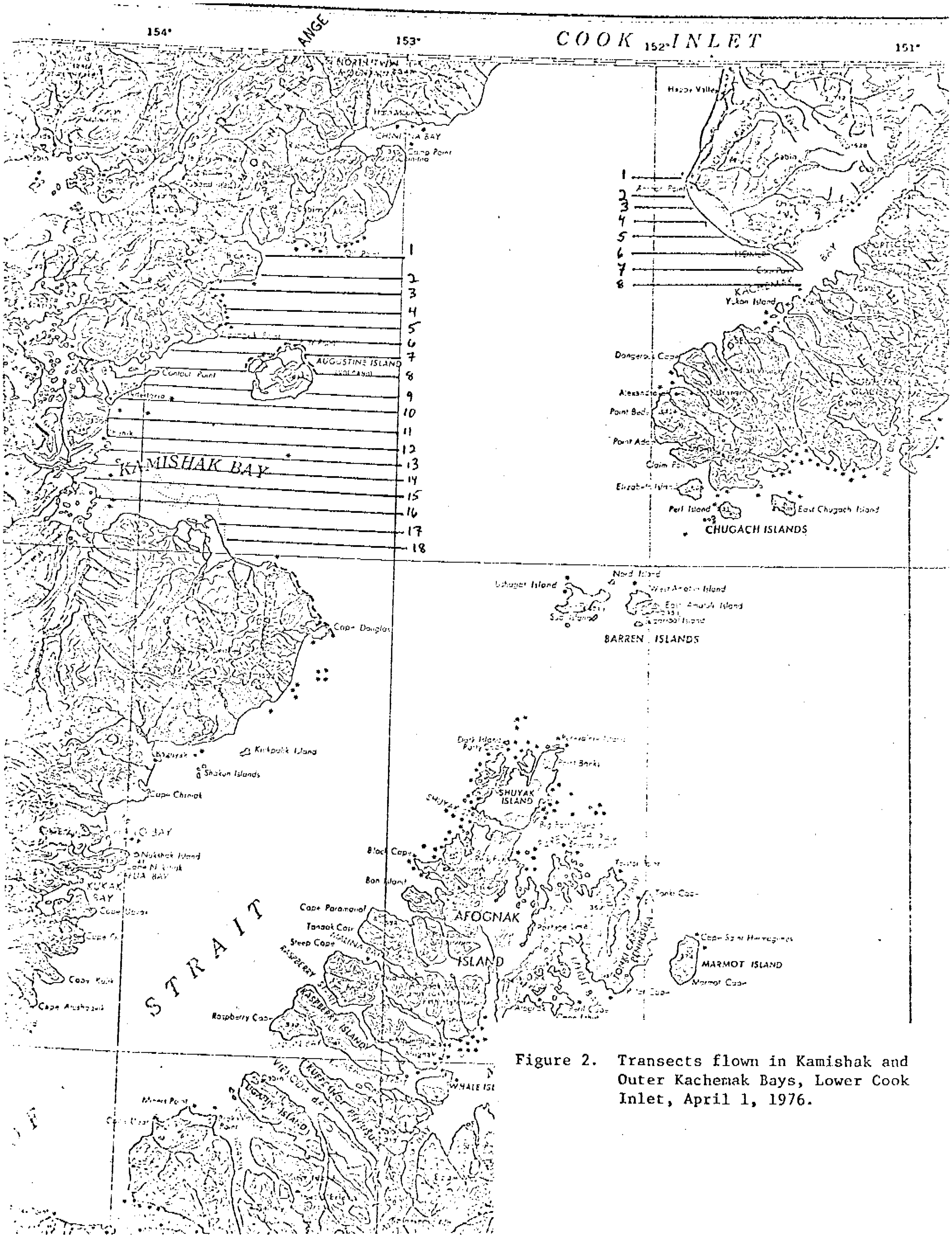


Figure 2. Transects flown in Kamishak and Outer Kachemak Bays, Lower Cook Inlet, April 1, 1976.

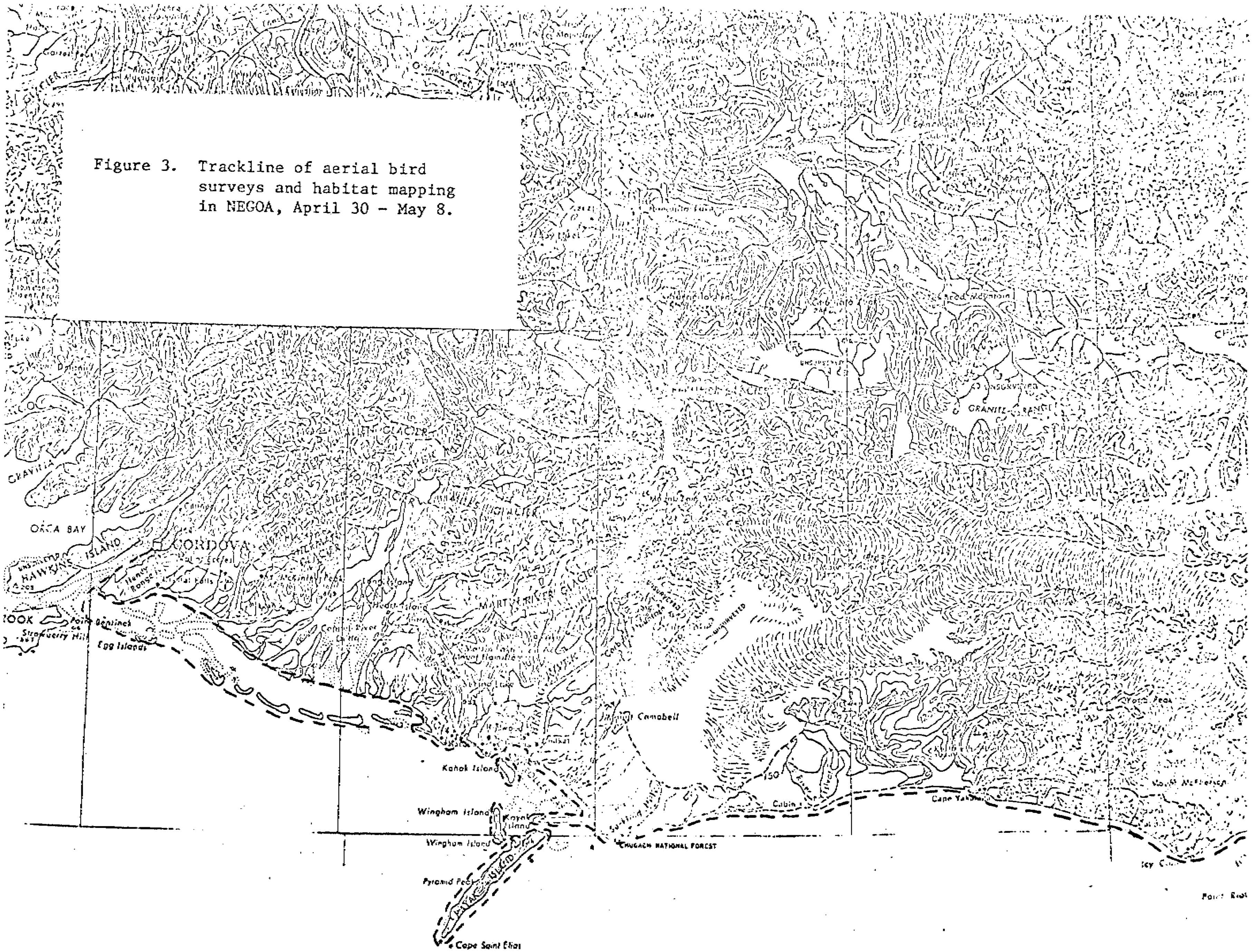


Figure 3. Trackline of aerial bird surveys and habitat mapping in NEGOA, April 30 - May 8.

Figure 3. (continued)

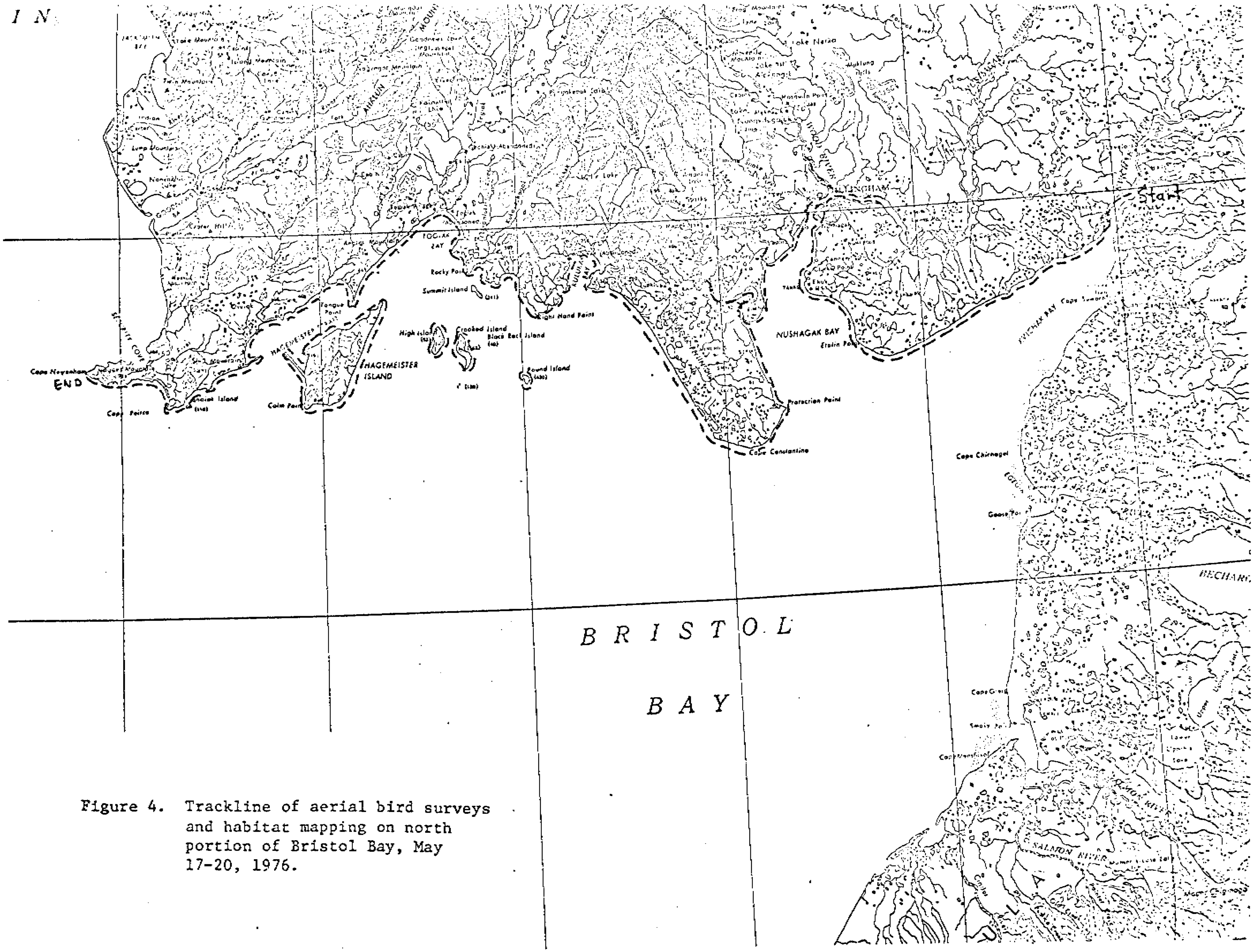


Figure 4. Trackline of aerial bird surveys and habitat mapping on north portion of Bristol Bay, May 17-20, 1976.

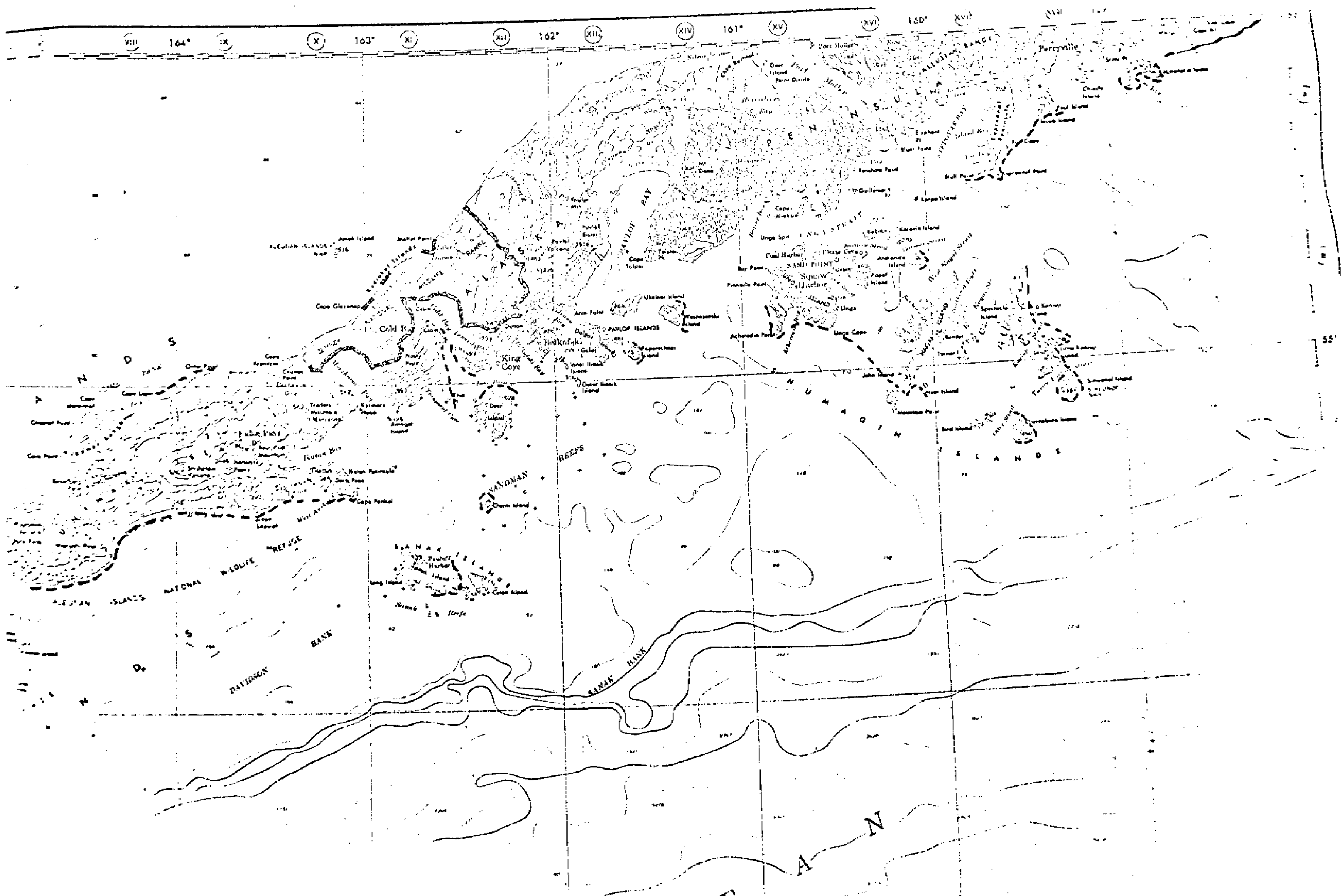


Figure 5. Trackline of aerial habitat mapping on south side of Alaska Peninsula, June 14-16, 1976.

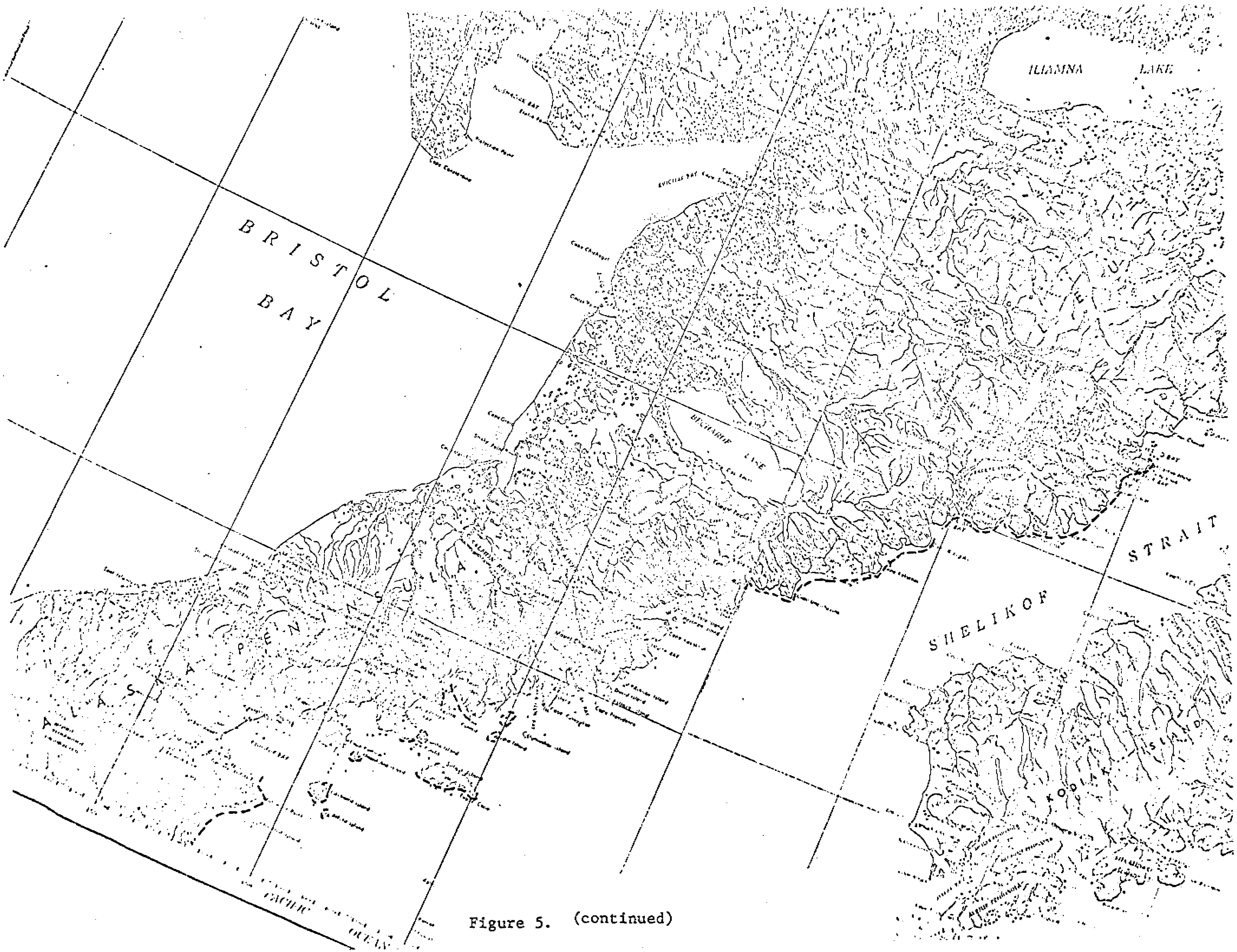


Figure 5. (continued)

On the north side of Bristol Bay 500 miles of shoreline (including Hagemeister Island) were surveyed and mapped. The other Walrus Islands (40 miles of shoreline) were mapped only. Again 45 species were observed in about eight habitat types.

Approximately 540 miles of shoreline along the south side of the Alaska Peninsula were mapped and miscellaneous bird observations made by Dave Kurhajec while accompanying a marine mammal survey crew.

III. The final format for data processing is the final stages of acceptance by NOOC/EDS. Therefore, no survey data has yet been transcribed. It is hoped that all surveys will be transcribed and analyzed by the next quarterly report.

On shoreline surveys of the Kodiak Archipelago, the 28 randonly selected count units surveyed in early March meant 76 total units were surveyed. Densities of birds appeared to be substantially less in the forested bays of Afognak-Shuyak Islands in comparison with non-forested areas on Kodiak Island but absolute numbers are not yet known.

Preliminary analysis of the pelagic surveys in Lower Cook Inlet indicated marked differences in species composition and densities between Kamishak and outer Kachemak Bays (Table 1.) Most of the eiders within Kamishak Bay transects were Common Eiders (*Somateria mollissima*) and several thousand more were observed outside the transects in the vicinity of Augustine Island. The majority of alcids observed were murres (*Uria* sp.)

Table 1. Differences in bird densities and species composition between Kamishak and outer Kachemak Bay. April 1, 1976.

	Kamishak	Outer Kachemak
% Eiders	54	13
% Scoters	2	67
% Total Seaducks (includes unid.)	87	81
Alcids	Tr.	18
Cormorants and Loons	1	1
Gulls	12	1
Birds/Km^2	21.4	60.9

During surveys from April 30-May 8 in NEGOA, staging areas for shorebirds were noted since the peak of spring migration was occurring for many shorebird species. The majority of migrant waterfowl had already passed and the arctic tern migration was just commencing. Many loons and notable numbers of dark phase parasitec jaegers (Sterorarius parasitius) were also observed as well as resident gulls. Inclement weather precluded surveying on several days but did not appear to deter bird migration.

Fewer shorebirds (than expected) were observed in north Bristol Bay during surveys on May 17-20 but large numbers of waterfowl were staging in lagoons, fluvial floodplains, and nearshore coastal waters. Most noteworthy were large numbers of greater scaup (Aythy marila) in nearshore saltwater along with scoters and meagansers. Most inland ponds were still frozen and the ducks were likely waiting for spring breakup before leaving coastal waters. Many loons and grebes were also present on nearshore waters along with alcids and larids in the vicinity of their breeding colonies.

Habitat types mapped in Bristol Bay are summarized in Table 2. A notable change in habitat types appears to occur in the Togiak area and further analysis will reveal if bird densities and species composition are reflected by this change.

The primary purpose of the June 14-16 flights was to survey marine mammals. Therefore, few bird observations were made and only partial habitat mapping was accomplished. An estimated 47,600 alcids, shearwaters and kittiwakes were observed one mile offshore just north of Izembek Lagoon.

Table 2. Quantity of various habitat types for the beach of the north side of Bristol Bay, Kuichak River to Cape Newenham and Walrus Islands.

	Shoreline in Miles											Area in Square Miles				
	Mud	Mud & Sand	Sand	Gravel	Rock	Sand & Rock	Gravel & Rock	Rock & Sand	Sand & Gravel	Gravel & Sand	Rock & Gravel	Mud Flats	Sand Flats	Mud & Sand Flats	Mixed Forbes (Inter-tidal)	Elymus
Cape Horn to Etolin Point	24.7	3.5	34.1									10.25	27.38	19.78	19.69	
Etolin Point to Dillingham	81.3	0	16.7									23.80	0	4.62	59.38	
Dillingham to Cape Constantine	95.0	3.3	30.1									45.10	.05	0	55.27	
Cp. Constantine to Tvativak Bay	0	0	40.8	0	2.6	0	3.8					3.54	.27	0	21.57	
Tvativak Bay to Right Hand Point	0	0	12.2	0	2.1	9.0	3.6	0.9			1.4	0.94	.24	0	9.45	
Right Hand Point to Togiak	5.1	0	7.6	0.9	10.9	0.7	5.1		9.4			0.24	0	0	5.78	
Togiak to Tongue Point	0	0	13.8		1.6	0.3			4.3						0.61	0.71
Tongue Point to Asigyukpak Spit	0	0	24.1		2.1		1.9		9.6						2.73	1.21
Asigyukpak Spit to Cape Newenham	0	0	17.2	1.1	18.7				0.3	0.6	5.3				2.64	
Hagemeister Is.	0	0	48.4	3.0	6.5	1.4	0.6	2.7	0.2		1.5			3.92	0.69	3.31
Summit Is.			1.4		1.5		3.5									
High Is.			1.3		1.6	1.3	2.8				3.1					0.07
Crooked Is.			3.6	0.8	4.3	0.4	1.2				1.5				0.09	
Round Is.				1.2	1.7		1.7									
Total	206.1	6.8	251.3	7.0	53.6	13.1	24.2	3.6	23.8	0.6	12.8	83.87	27.94	28.32	177.90	5.30

IV. Interpretation of results.

No interpretation will be attempted until the data is transcribed when the data processing format is finalized by EDS.

V. Problems - nothing noteworthy.

VI. Estimate of funds expended.

Salaries	$ 9,750
Per diem/travel	2,000
Logistics (air charter, etc.)	9,000
Commodities	750
Equipment	114
Total	$21,614

RU# 38

NO REPORT SUBMITTED

The principal investigator is in the field.

QUARTERLY REPORT

Contract #

Research Unit #77

Reporting Period

4-1-76 to 6-30-76

Number of Pages 8

Ecosystem Dynamics

Birds and Marine Mammals

Co-Principal Investigator F. Favorite

Co-Principal Investigator W. B. McAlister

Northwest Fisheries Center
2725 Montlake Boulevard East
Seattle, Washington 98112

June 1976

QUARTERLY REPORT

I. Task Objectives:

To develop an ecosystem model of the Eastern Bering Sea, which will aid in multispecies and multidisciplinary decision making processes and specially depict the effects of man's activity (fishing, gas and oil developments, etc.) on the dynamic changes and balances in this marine ecosystem. The first year task required the development of a conceptual model with emphasis on a submodel of two dominant species in four different ecological groups.

II. N/A

III. Results:

Based on concept development and design of an advanced numerical dynamic marine ecosystem model during previous quarters, an eight-component marine ecosystem model was programmed for Eastern Bering Sea during this quarter. This computer program contains two mammal species (fur seal and bearded seal), two bird species (shearwater and murres), two fish species (pollock and herring) and two zooplankton subgroups (copepods and euphausids). By necessity this submodel became a considerable program (over 2000 cards deck). A 16 x 16 point array was used (Fig. 1) with a grid size of 92.25 km. The model requires 33 K words of computer core and about 180 K words of disk storage with random access. With monthly time-steps it runs in about 45 minutes on

CDC 3100 computer for a full year computation. Many of the initial input fields (e.g. the distribution of mammals, birds, etc.) were obtained from the results of the earlier work of this project, as were various coefficients and constants (i.e. obtained from previous literature search). A relatively large number of debugging, tuning, and preliminary productions runs were made with this model.

IV. Preliminary interpretation of results:

An advanced numerical dynamic ecosystem model has been programmed for the Eastern Bering Sea. A number of different computer runs of this model were made, using slightly different inputs (e.g. varying the initial standing crops of various ecological groups, food composition, food coefficients, etc.). The results from these runs support a number of hypotheses regarding ecosystem behavior, a few of which are listed below:

1. The availability of food for medium and high food chain components (e.g. pollock, seals) of the ecosystem is determining the possible maximum standing stocks of these components.

2. The interspecies interactions in respect to competition for food can cause major shifts in ecosystem composition without the intervention of the man (e.g. interaction and interchange of small pollock, herring, capelin and shrimp as major food items for pollock and some seal species).

3. The effects of man's actions (except certain interventions during breeding) are relatively minor on the marine bird ecosystem in comparison to effects of natural factors.

4. Marine mammals in the Bering Sea have greater effect on the fish components (e.g. pollock) of marine ecosystem than man's activity (fishing).

5. Some fish species have a natural periodicity of abundance, brought about through relatively complex interaction of food composition change with age and cannibalism; the magnitude of these changes in abundance can be large and the length of the periods may be many years.

6. The natural decline of a given population abundance can be relatively rapid (e.g. within one year), whereas the recovery (increase) is slow.

7. The lower end of the marine food chain (e.g. plankton) is seldom a direct limiting factor of productivity for a specific component of the upper levels of the marine food chain but it has a major large-scale impact in determining the general productivity level of the total marine ecosystem.

8. Many of the data available in the literature on food composition, food requirements, growth, etc. must be considered as "spot samples" only and cannot be generalized in space and time. A number of additional research requirements and priorities are being identified from the present numerical model.

This preliminary numerical marine ecosystem model has become more useful for solving practical (applied) as well as scientific problems than had been previously expected. During the course of preliminary tuning of the model, it was found that many of the plausible magnitudes of the standing stocks can be determined with an iterative procedure (method) within this model. Furthermore, many of the effects of man's interventions can be evaluated quantitatively with the present model. Examples of the model outputs are shown on appended figures (Figs. 2 and 3), as well as a work plan and milestone chart for next quarter (Fig. 4). A single copy of the computer output of a typical run has been furnished to the Juneau OCSEAP office.

V. Problems encountered/recommended changes:

No special problems were encountered, except those pertaining to various input data, their quality, quantity and general reliability. The numerical program was consequently designed to alleviate some of the direct data deficiencies. For example, iterative solutions were used to obtain standing stocks and food consumption and composition was computed by considering its availability at any time and location.

The model became more complex and more useful in various ways than envisioned at the start of this project and no difficulties are foreseen to fulfill and exceed the originally planned task.

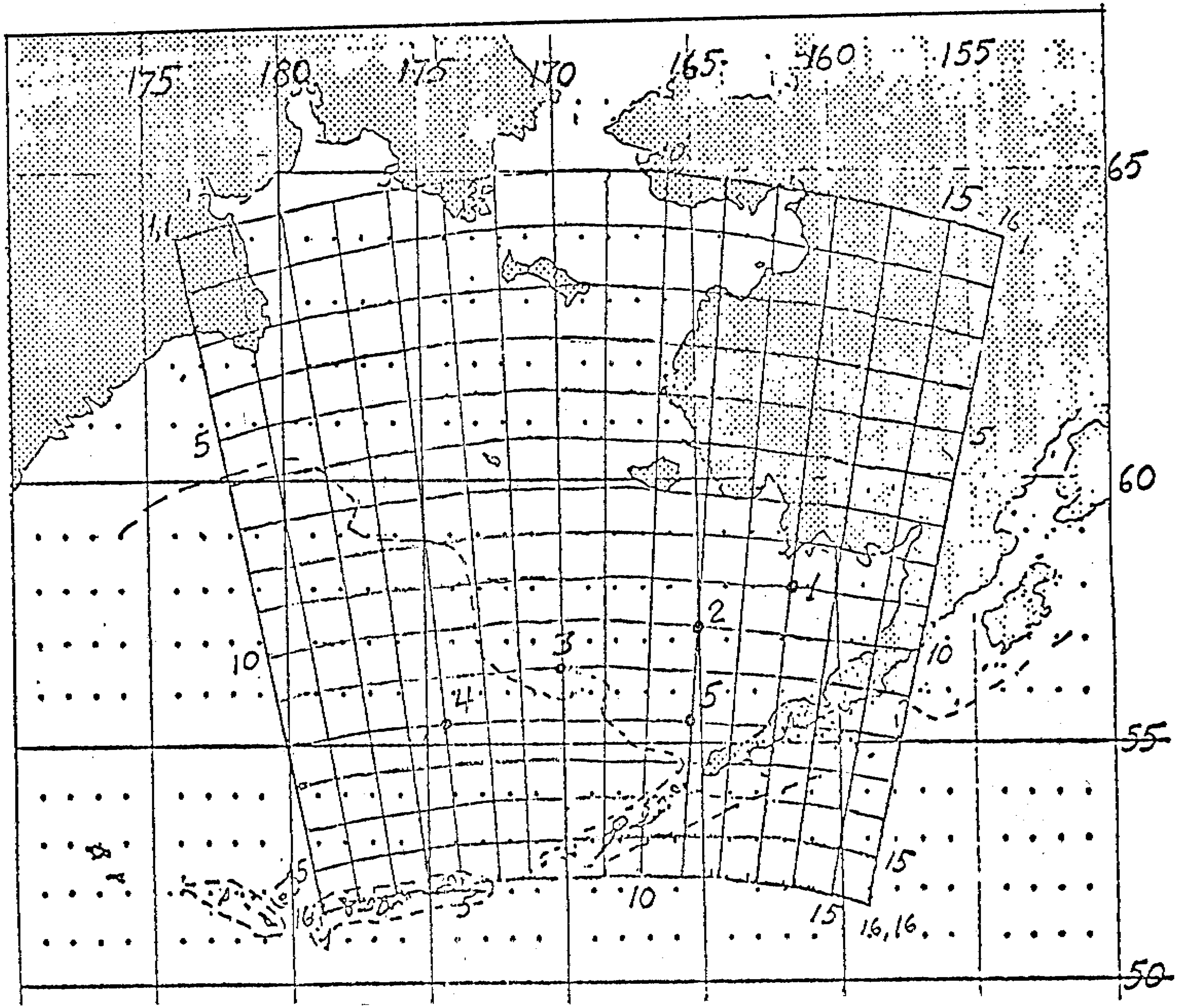


Figure 1. Computational grid for eastern Bering Sea.

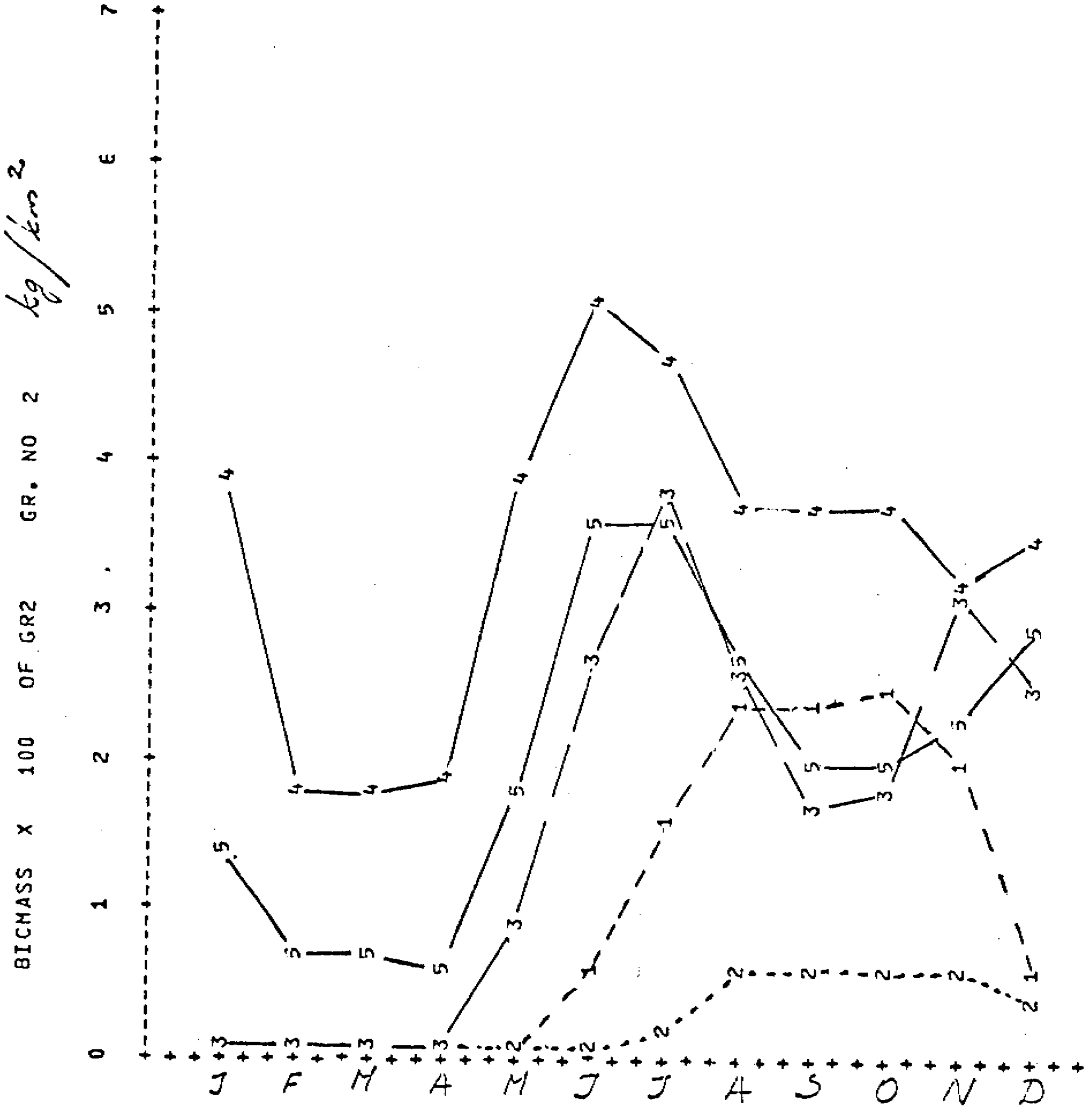


Figure 2. Example of change of juvenile pollock (1 to 30 cm) standing stock at 5 different locations (locations see Fig. 1).

FINAL POLLOCK BIOM.,INCL.CANNIBALISM,KG/SQKM,M= 5 (May)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	1.	2.	2.	3.	2.	0.	1.	0.	0.	0.	0.	0.	0.	0.
4	0.	2.	12.	20.	28.	31.	25.	15.	6.	0.	0.	0.	0.	0.	0.	0.
5	0.	26.	88.	134.	177.	172.	123.	64.	18.	0.	0.	0.	0.	0.	0.	0.
6	0.	159.	414.	594.	740.	623.	393.	180.	52.	0.	0.	0.	0.	0.	0.	0.
7	0.	544.	1280.	1823.	2215.	1712.	983.	412.	121.	0.	1.	0.	0.	0.	0.	0.
8	0.	1179.	2779.	4075.	4697.	3771.	2156.	931.	376.	145.	26.	1.	0.	0.	0.	0.
9	0.	1763.	4453.	6923.	5921.	7358.	4697.	2527.	1229.	542.	177.	24.	1.	0.	0.	0.
10	0.	2717.	6633.	10315.	13250.	12085.	8080.	5761.	3092.	1593.	568.	113.	6.	0.	0.	0.
11	0.	3608.	8612.	13308.	16960.	16846.	13790.	9167.	5773.	3010.	1243.	301.	20.	1.	0.	0.
12	0.	3698.	9244.	14506.	18601.	20081.	18564.	15195.	9950.	4949.	2347.	533.	0.	0.	0.	0.
13	0.	2595.	8104.	13133.	17171.	19378.	19089.	16388.	11723.	5640.	2191.	0.	0.	0.	0.	0.
14	0.	1773.	5306.	9096.	12182.	14179.	14336.	12286.	7668.	0.	136.	0.	0.	0.	0.	0.
15	0.	634.	2137.	3887.	5386.	6374.	6476.	5407.	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

TOTAL POLLOCK LOSS DUE TO CANNIBALISM, IN 1000 TONS, M= 5 185.2 (May)

FINAL POLLOCK BIOMASS IN 1000 TONS, M= 5 5161.1 (May)

Figure 3. Example of a model output. Distribution of pollock.

Figure 4.--Work plan and milestones - Research Unit #77, period 1 April to 30 September 1976

Activity	April	May	June	July	August	September	Remarks
1. Programming of 8-component ecosystem model for Eastern Bering Sea							
a. Programming	---------	-X					
b. Digitization of input fields		---X					
c. Debugging		----	----X				
2. Test runs with the model with modified input parameters			------	------	------X		Use of the model continues
3. Documentation of the model				------	-----X		
4. Preparation on interim report on the results (essential findings and further research suggestions).					-------	------ R	R=reproduction

5th Quarterly Report

Contract # 03-5-022-72
Research Unit 83
Reporting Period 1 April - 30 June 1976
8 pages

Reproductive Ecology of Pribilof Island Seabirds

George L. Hunt, Jr.
Department of Ecology
and Evolutionary Biology
University of California
Irvine, California 92717

1 July 1976

I. Task Objectives

The task objectives for the 5th quarter were:

a) To arrange logistics and mail equipment and supplies to St. Paul Island.
b) To observe the recolonization of the island by seabirds at the start of the breeding season.
c) To conduct radial transects by ship in the vicinity of the islands to determine the distribution of birds at sea.
d) Conduct aerial surveys of Walrus and Otter Islands by helicopter and to determine and photograph the numbers and kinds of seabirds using these islands.
e) To commence the second field season of studies on St. Paul and set up work on St. George.

II. Field or Laboratory Activities

A. Ship and field trip schedule

19 May 1976 - Doug Causey arrive St. Paul Island.
2-4 June 1976- Doug Causey on R/V Moana Wave (NOAA vessel).
10 June 1976 - Doug Causey on NOAA OSS Surveyor Helicopter SU-1.
12 June 1976 - Doug Causey on NOAA OSS Surveyor Helicopter SU-1.
15 June 1976 - Doug Schwartz and Zoe Eppley arrive St. Paul Island.
19 June 1976 - George Hunt and Molly Hunt arrive St. Paul Island.
25 June 1976 - Molly Hunt to St. George Island until 3 or 7 July.

B. Scientific Party

George L. Hunt, Jr., Assistant Professor, University of California, Irvine, Principal Investigator

Molly Warner Hunt, Assistant Specialist, University of California Irvine, Project Leader

S.D.L. Causey, Research Assistant, University of California, Irvine, Field observer

Zoe Eppley, Laboratory Assistant, University of California, Irvine, Field observer

Doug Schwartz, Laboratory Assistant, University of California, Irvine, Field observer

C. Methods

1) Recolonization of the St. Paul seabird cliffs was accomplished by making usual counts of birds occupying cliff nesting sites at approximately 5 day intervals beginning 22 May. The cliffs were counted from 96 separate sites on 7 major cliffs so that variability within and between areas can be measured.

2) Radial transects by ship were conducted over the tracks outlined in Figure 1, except that the transects planned for leg two were dropped as insufficient ship time was available.

Sightings of birds were recorded on a temporary form (Figure 2), but in future work will be recorded on the standard Bird Sighting Log (Figure 3) which we also use in California for our BLM sponsored baseline studies.

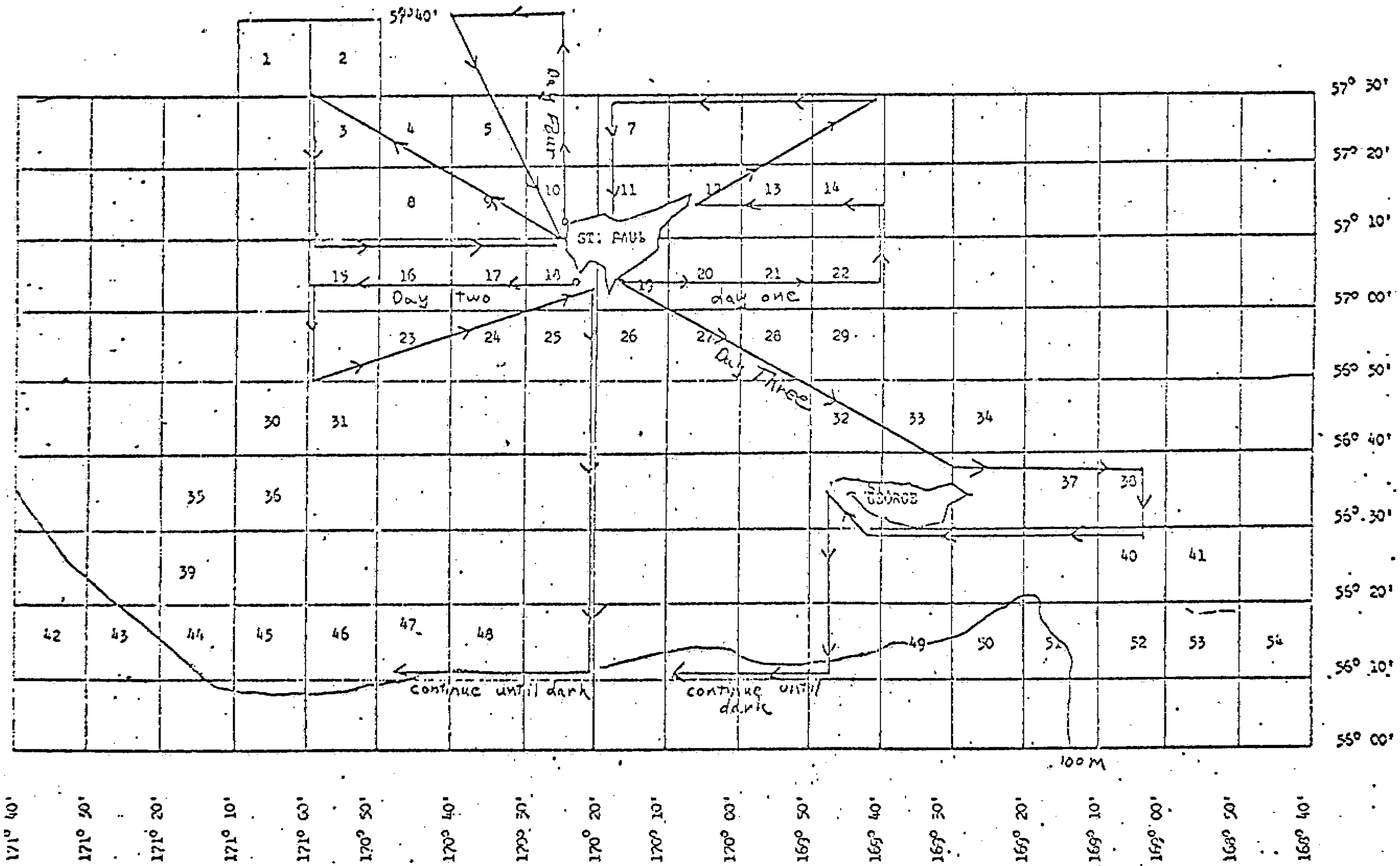


Figure 1

Tentative Cruise Tracks 1976

Radial Transects Pribilof Island Seabirds

Figure 2

REGION ______	DB ___ WB ___ RH ___ DP ___	DB ___ WB ___ RH ___ DP ___
St LAT ______ LONG ______	WDDIR ______ SPEED ______ G ___	WDDIR ______ SPEED ______ C ___
END LAT ______ LONG ______	SKY ______ VSBY ______	SKY ______ VSBY ______
TIME START ______ END ______	PRESS ______ TREND ______	PRESS ______ TREND ______
Observer ______	SFC SEA ______ COLOR ______	SFC SEA ______ COLOR ______
TRANSECT ______	WV HT ______ FROM ______ SWELL ______	WV HT ______ FROM ______ SWELL ______
SHIP ______	COURSE ______ SPEED ______	COURSE ______ SPEED ______
Ht Above Water ______	VSBY INDEX	VSBY INDEX
	TIME WX	TIME WX

TIME	SPECIES	ZONE 0-100	ZONE 100-200	ZONE 200-300	REMARKS

Figure 3

Hunt-4

Page___ of___

BIRDS SIGHTING LOG

DATE________ OBSERVER________ SEGMENT NUMBER________

TIME START______ TIME STOP______ FATIGUE______ HEIGHT______ft

SHIP______ CRUISE______ WIND DIR/SPEED______kn

COURSE/SPEED______°mag/kn AIR TEMP______°C VISIBILITY______kn

SURFACE TEMP.______°C FOREL #______ CLOUD COVER (10th's)______

SEA STATE______(BEAUFORT) BARO PRESS______mb TREND______

SWELL______ft GLARE______ COMMENTS______

TIME	SPECIES: NUMBER/RANGE												REMARKS

3) Aerial surveys of Walrus and Otter Islands as well as of St. Paul were made by low altitude helicopter flights. Photographs were taken on Tri X film with a Nikon camera fitted with an 80-200mm zoom lens. In addition, on Otter Island, 6 hours were spent on foot in a detailed survey of the island.

4) Disturbance by aircraft: as the helicopter approached bird nesting cliffs, record was kept of the distance at which birds took flight. We attempted to calculate this distance knowing the speed of the aircraft and the time elapsed between when the birds took flight and when the helicopter crossed the top of the cliff. This proved impossible because of variability in the speed of the helicopter and estimates of the distance at which birds took flight were based on the judgements of 2 biologists and the pilot.

5) Studies of reproductive ecology of Pribilof Island seabirds is being conducted by the same methods outlined in our 6th month and annual reports. They will not be repeated here.

D. Sample Localities

1) Radial transects to survey for marine birds at sea are presented in Figure 1. Transects for leg two were ommitted due to lack of ship time, and ½ of leg four was dropped because of deteriorating weather.

2) Aerial surveys by helicopter were made of the coastlines of St. Paul, Walrus and Otter Islands.

3) Studies of reproductive ecology are being conducted on St. Paul, and, with the help of Dr. Hickey's group, on St. George, Pribilof Islands.

E. Data collected

1) Recolonization of the island: at the 96 separate sites, 4 to 5 counts have been made beginning 22 May. We presently are analyzing these data.

2) Radial transect surveys of birds at sea: 36 transect segements were counted during 28 hours of observation. Coding of this material for computer analysis is completed and has been sent to Juneau.

3) Aerial surveys of St. Paul, Otter and Walrus Islands: eighty exposures of bird cliffs made; they are now being printed prior to counting. Six hours of land survey were accomplished on Otter Island.

4) Disturbance by aircraft: nine passes at the cliffs were made with the helicopter from the Surveyor; 4 were directed at the cliff face, 5 were parallel at varying distances.

5) Studies of reproductive ecology:

a) Reproductive Success: studies of laying dates, numbers of eggs laid, hatching and fledging success have been commenced as listed below. The number of sites and nests will be expanded as time allows. No report on the numbers of nests being followed on St. George are available yet.

St. Paul Island

Species	Number of sites	Number of nests	Number of birds
Red-faced Cormorant	4	52	
Black-legged Kittiwake	4	88	
Red-legged Kittiwake	5	41	
Common Murre	6		181
Thick-billed Murre	9		200

St. George Island

Species	Number of sites	Number of nests	Number of birds
Red-faced Cormorant	2		
Black-legged Kittiwake	2		
Red-legged Kittiwake	2		
Common Murre	2		
Thick-billed Murre	2		

b) Phenology: in addition to following the above listed nests for timing of reproductive events, we also have been mist-netting Least Auklets in an attempt to
1) distinguish breeding birds from non-breeding birds;
2) obtain data on the timing of breeding through examination of gonad size and brood patch condition; 3) obtain food samples.
To date, 21 Least Auklets have been collected, sexed and had their gonads measured. In addition 137 Least Auklets have been mist-netted, weighted, had brood patch condition checked and released.

6) Food Studies: of the Least Auklets collected, 17 contained traces of food in their stomachs and samples were taken for analysis in the laboratory. Much of this material is sufficiently digested that identification of food items taken will be difficult or impossible. In addition, one auklet regurgitated a sample of Calanus in excellent condition. Within the week we expect to collect food samples from auklets at sea and from other species near shore.

III & IV. Results and Interpretation

It is too early in the data gathering process to present results or interpret our findings in detail. However, eyeballing the data has revealed several patterns of possible interest.

1) Recolonization of St. Paul Islands: Red-faced Cormorants were the first species to recolonize St. Paul and commence nesting in mid May. Murres of both species and then Black-legged Kittiwakes were the second group of birds to reoccupy the cliffs. Least and Parakeet Auklets were in the next wave of birds returning, almost three weeks behind the cormorants. Crested Auklets were seen on the water shortly after the Least and Parakeet Auklets commenced breeding activities, but not until about 20 June were Crested Auklets seen on the cliffs of St. Paul.

Red-legged Kittiwakes returned to St. Paul cliffs at the start of the second week of June, about 10 days after the Black-legged Kittiwakes had arrived in numbers. In radio communication with Dr. Hickey's research team on St. George Island, revealed that Red-legged Kittiwakes were present on St. George in numbers two to three times greater than Black-legged Kittiwakes there. This was during the period that Black-legged Kittiwakes were first arriving at St. Paul.

Thus, although the two islands are only forty miles apart, the ecology of the two species of kittiwakes is very different on St. Paul and St. George. The differences in timing of colony reoccupation success that food availability may differ in the vicinity of the two islands early in the spring, either because of differences in productivity or in ice cover.

2) Radial transect surveys at sea: although we will not be in a position to discuss the results of these surveys until analysis is completed, we were impressed by the uneven distribution of seabirds. First, we found concentrations of birds near each island and relatively low numbers of birds midway between the islands. Second, we found very large concentrations of birds on the shoals six miles due east of St. George Island. These shoals are clearly of major importance in the foraging ecology of the immense numbers of birds nesting on St. George Island. An oil spill in the vicinity of these shoals would be a major catastrophe for at least St. George Island seabird populations.

3) Aerial surveys of St. Paul, Otter and Walrus Islands. The opportunity to conduct these surveys come too early in the nesting season to obtain maximum counts of breeding birds. In another year late June or early July would be optimum. Two patterns of significance were obvious even at the early season when we made our survey. First, virtually no Murres were seen on Walrus Island confirming our observations of last year that this once large Murre colony is presently deserted. Much of the top of the island was covered by Stellar's Sea Lions. Second, Otter Island supports large, dense nesting colonies of Murres and Kittiwakes, which at first look, appear to equal or exceed the colonies on St. Paul Island. From the helicopter we also observed that shoals to the south of Otter Island were an important foraging area for large numbers of marine birds and mammals. This island clearly deserves more attention in future baseline studies.

4) Disturbance by aircraft: the data for this study has yet to receive even preliminary analysis. The distances at which we found birds taking flight are likely to be near the maximum for the type of aircraft involved, as prior to incubation birds are easily scared from the cliffs.

5) Studies of Reproductive Ecology. This work has just commenced and there is little data available for discussion. It is our impression that nesting activity is later this year than it was last year.

V. Problems Encountered

The only major problem confronting us is the lack of reliable transportation on St. Paul. At present we have one motorcycle which is reliable, one that occasionally works despite the committment of 50-75% of D. Causey's time to maintenance, and one like that serves as a source of spare parts. Even if Harley-Davidson does manage to obtain and send us the spare parts ordered from Italy (where the bikes were made) we foresee little improvement in the situation. We are seeking alternative sources of transport on St. Paul, although there is no hope of a long term vehicle loan from the National Marine Fisheries Service.

VI. Estimate of Funds Expended

	Estimated Accumulated expense to 30 June 1976	Total Funds Allocated
		$60,332.
Salaries	$17,005.	
Employee benefits	291.	
Supplies and expenses	6,507.	
Equipment	5,714.	
Travel and per diem	11,337.	
Other	609.	
	Funds remaining	$18,869.

It is my belief that the funds remaining will be sufficient to cover the anticipated costs that will be incurred in the fulfillment of our contract obligations.

THE JOHNS HOPKINS UNIVERSITY
SCHOOL OF HYGIENE AND PUBLIC HEALTH
615 NORTH WOLFE STREET
BALTIMORE, MARYLAND 21205, U. S. A.

DEPARTMENT OF PATHOBIOLOGY

July 4, 1976

P.O. Box 280
Cordova, AK 99574

RECEIVED

NEGOA

Dr. Jay Quast
Project Scientist
NOAA/OCSEAP - Juneau Project Office
P.O. Box 1808
Juneau, Alaska 99802

Dear Dr. Quast:

You are certainly invited to visit our project here on the Copper Delta any time. We have a cabin at the mouth of the Eyak River, about five miles from Egg Island, gratis Mr. Ralph Pirtle, Area Management Biologist, ADF&G, and also a cabin-frame for our wall tent on Egg Island. July is our big month since the islands are covered with chicks to band.

We have just spent three days with Lt. Don Winters and Gary Mitchell of NOAA Ship SURVEYOR on board the Bell 206 B helocopter completing location survey, overview and population counts of nesting Glaucous-winged Gulls on the barrier islands off the Copper Delta. I would like to express my complete satisfaction with the performance of these men and my gratitude for the aircraft time. Our research has made a real jump forward, and I am dazzeled by the observation powers one has from the helo as a platform. This instrument is a credit to the NOAA research program and should be used to full extent without undue wear on pilot or machine. After witnessing the capacity of the helo for biological survey work, it is difficult to "come back to earth." Don Winters operated machine with precision and proper concern for safety, and Aircraft Mechanic Gary Mitchell turned out to be an excellent field man as well in assisting with our research on the barrier islands.

We surveyed the entire stretch of barrier islands from Hinchenbrook to Oaklee Spit, gaining much information in a compressed period of time. Such a survey by Zodiac or similar boat would have been impossible, since it would have been too expensive in time, physical energy, and in safety. We spent ground time on Strawberry Reef and Copper Sands, and made collections of adult birds, eggs for petrochemical assay, and banded 100 chicks at each locality. We are processing the birds here; the eggs have been sent to USF&WS Patuxent Research Laboratory; and the gull chicks are hopefully growing feathers to fly away.

We our continuing our main research program on Egg Island as last year with methods as previously described. A portion of the east end of Egg Island has eroded away last winter, and the Light Tower has fallen onto the beach and been replaced by the Coast Guard. Our survey area has been slightly foreshortened due to beach erosion. Distance to nearest neighbor in the gull colonies has been compressed, with more pairs nesting in the area by some 20%. Clutch size is clearly not as high as the 2.9/nest I assumed last year, but resembles something like 2.4. Hatching success is good to date. We are tracking 186 nests in our 150 x 150 m^2 study area, and have been on site since May 20th, with visits into Cordova.

We have been studying an additional 75 nests contingent to our main survey area in an egg oiling experiment with NS Crude provided by Auke Bay Lab and mineral oil commercially available. Hatching success in both cases is markedly reduced. I don't want to go any further right now because the study is still in progress, but the results are interesting to say the least to date. We have received the commentary to our oiling proposal draft from both Mr. Rice of NMFS and a staff chemist at Patuxent F&WS. Both contain valuable suggestions.

We have been receiving weather data for the Cordova area as requested through Jim Audet of NODC for this and the past two years. We will incorporate relevant abstracts to this weather data as they relate to our gull study, viz. snow cover vs. nest construction, etc.

Also our collecting and banding permits from USF&WS Office of Biological Services, Anchorage, were awaiting us in Cordova upon our arrival, so we are experiencing no difficulties here.

Weather has been moderate this season so far, with only one southeast storm in June. We hope this will last, since we have had much good field time to date, and blessfully good weather for the 'copter survey.

Thank you again for your hospitality upon our May stopover in Juneau.

Our best contact in Cordova is c/o U.S. Forest Service, at the P.O. Building; drop us a line and we'll meet you with our Zodiac 'NOAA's Ark".

Sincerely yours,

Sam

Samuel M. Patten, Jr.
M. Sc.
Associate Investigator
Pathobiology

Gulls collected to date:	Eggs collected:	Chicks banded:
Egg Island: 2	Egg Island: 30	Egg Island: 3
Strawberry Reef: 25	Strawberry Reef: 30	Strawberry Reef: 97
Copper Sands: 16	Copper Sands: 10	Copper Sands: 100
total: 43 gulls	total: 70 eggs	total: 200 chicks
		2 adults banded & color-marked yellow on rt. side.

Blood samples: 20 adults

nest survey: 186 nests
oiling experiment: 75 nests

----

cc. Bob Meyer
Lou Butler
Dr. Lensink F&WS

Quarterly Report

Contract No. 03-5-022-68

Research Unit No. 108

Reporting Period: 1 April 1976-
30 June 1976

Number of Pages: 8

COMMUNITY STRUCTURE, DISTRIBUTION, AND INTERRELATIONSHIPS OF MARINE BIRDS IN THE GULF OF ALASKA

John A. Wiens

Research Assistants: Wayne Hoffman
Dennis Heinemann

Department of Zoology
Oregon State University
Corvallis, Oregon, 97331

25 June 1976

I. TASK OBJECTIVES

A. Patterns of seasonal abundance and distribution are being studied because of their direct relevance to oil development and transport activities, and also to use in our analysis of marine bird energetic impact.

B. The dynamics of feeding flocks of seabirds are being investigated to determine the degrees and directions of dependency and/or interference between seabird species. This involves a description of the roles of different species in flock formation and development and an analysis of their contribution to the efficiency and performance of the system as a whole.

C. The energetics analysis is designed to estimate the impacts of marine birds on oceanic ecosystems in the Gulf of Alaska, and to predict the effects on those systems of major changes in bird populations, such as may occur from oil development and transport accidents.

II. FIELD ACTIVITIES.

A&B. Ship schedule and Scientific Party.

Discoverer	13 April - 9 May	Wayne Hoffman
Discoverer	10 May - 20 May	Dennis Heinemann
Surveyor	10 May - 21 May	Wayne Hoffman
Miller Freeman	7 June - 23 June	Wayne Hoffman

C. Methods.

1. Distribution of Seabirds. Observations are made at all periods of the day, but proximate decisions on observations are largely dependent upon weather, visibility, and ship's activity. Observations are made as follows: the observer places himself on the flying bridge or elsewhere high on the

forward part of the ship. Observation is normally limited to one quadrant, from the bow to the beam. The side of the ship to be used is chosen on the basis of visibility and weather. Observations are made for periods of 15 minutes or more while the ship is travelling at a constant course and speed. We collect data on the behavior, position, distance, and identification of each bird seen. These data will allow us to calculate area-specific densities of seabirds to a greater level of accuracy than has previously been accomplished.

2. Multispecies Feeding Aggregations. During the fifth quarter, flock observations were made from the OCS Project ships as flocks were encountered. Data were collected on species roles in flock formation and development, on arrival and departure times and patterns, on flock dimensions and characteristics, and on time-specific species composition and behavior. Flocks were also similarly observed from the Surveyor's skiff. In the coming quarter, these data will be supplemented with observations by spotting scope from suitable sites on land at several locations in the gulf of Alaska.

3. Energetics. Data collected in the field on distribution and abundance of birds and on their food habits will be used, along with energetics, productivity, meteorological and breeding biology data from the literature, as inputs to the BIRD model (Wiens and Innis, 1974) to calculate the population energetics of the marine birds in Gulf of Alaska ecosystems. We will then be able to conduct computer simulations, modifying model inputs to predict the energetic consequences of various possible patterns of oil-related disturbances.

D. Ship Tracklines.

Transects were taken throughout the ships' legs listed in section IIA of this report.

Table One

Transect Data, Fifth Quarter

Month	Transects	Minutes	Birds	Species	Birds/minute
April	62	1110	4879	36	4.41
May	41	1125	12241	30	10.88
June	38	1125	182657	42	162.36
June, minus large conc. of Shearwaters	38	1125	6657	42	5.92
Totals	141	3360	199777	58	59.46
totals, minus large conc. of shearwaters	141	3360	23777	58	7.08

III. RESULTS AND PRELIMINARY INTERPRETATION

A. Seasonal Movements.

The transect observations conducted this spring allowed fairly precise timing of the arrival dates of several migrant and summer resident species. Areas of concentration of two uncommon species were also discovered.

Yellow-billed Loon. Gavia adamsi. Yellow-billed loons were observed in numbers in the Trinity Islands area in November 1975 and we suggested that this may be a mayor undiscovered wintering area for this rare bird. This observation was confirmed in May 1975, when these birds were again seen several miles east of Sitkinak Island. The size of the wintering population cannot yet be estimated.

Black-footed Albatross. Diomedea nigripes. This species is considered rare or absent from the Gulf of Alaska in winter. Our observations indicated that they first appeared in any numbers in late April, in the Eastern Gulf. Observations in June showed them to be much less common than in late summer, and those that were present were concentrated around the 100 fathom line. In late summer they are scattered over the Gulf from the 100 fathom line out to the deepest areas.

Sooty and Short-tailed Shearwaters. Puffinus griseus and P. tenuirostris. The main flux of these abundant migrants from the southern hemisphere occurred in mid to late April. Short-tailed shearwaters appeared in great numbers in the eastern Gulf of Alaska at that time. The literature (e.g. King 1965, Spec. Sci. Rep. Fish. no. 586) indicates that this species enters the Northwest Pacific at this time, and gradually move east, arriving in the Gulf in late summer. Our observations contradict this report.

Mottled Petrel (Scaled Petrel) Pterodroma inexpectata. this is a rare migrant which breeds in New Zealand. The total world population is apparently quite small. There are several old records from Alaska, but until about 1970 it was considered to be only a straggler to the North Pacific. Since then they have been regularly seen in small numbers far offshore in the Gulf of Alaska and south of the Aleutians. We discovered a concentration of these birds on 19-21 June around 54° N, 150° W, about 180 miles south-southeast of Kodiak. It now seems likely that the whole species population may migrate to the offshore areas of the North Pacific and Gulf of Alaska.

Fork-tailed Petrel. Oceanodroma furcata. Fork-tailed Petrels were absent from the Eastern Gulf of Alaska in April but appeared in large numbers in the first week of May, and have been common since.

Migrating Waterfowl. Throughout the last three weeks of April, migrating waterfowl were common over the Gulf of Alaska. Canada Geese and Pintails were most frequently seen, but smaller numbers of Whistling Swans, Mallards, American Wigeons, Greater Scaup, Goldeneyes, and Scotors were also seen.

Red Phalarope. Phalaropus fulicarius. Phalaropes were first seen in the Gulf of Alaska in late April. They have been abundant in many areas since May 1.

Jaegers. Stercorarius sp. The Jaegers depend upon terns and kittiwakes for much of their food. The first Jaeger seen occurred upon April 20, which was also the day the first Arctic Terns arrived. Jaegers were regular from May 1 until the end of the quarter.

Gulls. Seasonal patterns of movement of most gull species were not obvious. Around the first of May, large numbers of Boneapartes Gulls were moving through the Glacier Bay area.

Arctic Terns. Sterna paradisaea. Arctic Terns first appeared April 20. Numbers increased gradually until about April 30, when they were moderately common. Then by May 4 they were abundant. By June 6 most had moved off the ocean to coastal or inland areas.

Horned Puffins. Fratercula corniculata. Horned Puffins were absent from the Gulf of Alaska until early May, and the main influx of this common summer breeder occurred in late May.

Rhinoceros Auklets. Cerorhinca monocerata. Rhinoceros Auklets were seen in breeding plumage near Sundstrom Island in the Trinity Islands in mid-May. This suggests a possible extension of their breeding range.

The other seabirds observed were already present at the beginning of our field deason and generally conformed to previously published reports of distribution.

B. Energetics. The energetics calculations will begin when we have completed collecting the data needed as inputs. These data relate chiefly to distributional patterns and abundances, oceanographic conditions (primarily surface temperatures) and trophic functions. The model structure necessary to conduct these calculations is now operative at Oregon State University, and is presently undergoing revision to add greater specificity in marine bird population energetic analyses.

C. Feeding Flocks. The great majority of feeding shearwaters (Puffinus griseus and P. tenuirostris) seen during this quarter were in large flocks, at times numbering in the hundreds of thousands of individuals. Other seabirds were infrequent in and around these flocks. At least some of the flocks were feeding on Euphausids or other pelagic crustaceans.

Flocks of seabirds feeding on fish schools were observed frequently in August and September 1975 but were much less frequent and much more spotty in occurrence during this quarter. The surface schooling behavior of the prey fishes may be largely restricted to the summer months.

D. Census Techniques. Our marine bird census technique has been refined to what we feel is a definitive state. We now are in the process of preparing a manuscript for submission to the appropriate Ecological Journal describing our technique. Progress is also being made in the pre-programming stages of preparation for our simulation test of census technique reliability.

V. PROBLEMS ENCOUNTERED / RECOMMENDED SOLUTIONS

A. Surveyor's Launches. The usefulness of the Surveyor for feeding flock studies was reduced this quarter by the ship's decision to suspend use of the Survey Launches. During 1975 we found that we could do our best flock observing from these launches. They are much more useful than the motor whaleboats because 1) they can operate in a greater range of weather conditions without endangering personnel or equipment, 2) they offer a better viewing platform, 3) they have covered cabins which allow both sientific and ship's personnel to keep warmer and thus work longer.

Apparently use of the launches was suspended because they weren't running well and the ship's crew had difficulties in launching them.

We request that the launches be overhauled during this summer inport, and that the deck crew be trained in the proper and efficient use of the crane for launching them.

VI. ESTIMATE OF FUNDS EXPENDED (through 30 June 1976)

A. Salaries and Wages		
Principal Inversigator	$ 1118	
Graduate Research Assistants and Hourly Wages	4630	
B. Payroll Assessments	934	
C. Services and Supplies	5426	
D. Travel	4443	
E. Permanent Equipment		
Camera equipment	3455	
Camping and collecting equipment	443	
Other equipment	1 018	
F. Total Direct Costs		$ 21467
G. Indirect Costs	2256	
TOTAL		$ 23,723

Amendment to Data Management Plan

We have received some of the smoothplots of the surveyor's trackline of August-September and November 1975, but have been informed that some are presently unaccounted for.

Data transmission has been delayed because we are involved in the summer's fieldwork. We expect to transmit a major block of data by 1 August 1976.

At the present time if appears that we can maintain the schedule in all other respects.

Project ______________________________ Date ______________

P.I.(s) ______________________________

		FY 1976															FY 1977								
		1			2			3			4			5			1			2			3		
	Major Milestones / Activities	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May	June
1	Surveyor Cruise – Transect and flock data																								
2	Surveyor data preparation and transmission							*																	
3	Disco Cruise – Transect and flock data																								
4	Pribilofs – Transect intercalibration cruise w/Hunt, USFWS																								
5	Onshore flock observation																								
6	Information exchange with PMC																								
7	Semiannual report preparation																								
8	1976 season data preparation and transmission																								
9	Total data analysis																								
10	Energetics simulation																								
11	Preparation of publications																								
12	a. start																								
13	b. internal review																								
14	c. preparation of final drafts																								
15	d. submit for publication, and to NOAA																								
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									

* Delay is result of waiting for format.

Activity: ├──────┤ Start End

Milestone: Planned △

Completed (shaded △)

QUARTERLY REPORT

Research Unit #172
Reporting Period: 1 April - 30 June 1976
Number of Pages: 2

Shorebird Dependence on Arctic Littoral Habitats

Research Coordinator: Peter G. Connors
Bodega Marine Laboratory
University of California
Bodega Bay, Ca.

Principal Investigator: R. W. Risebrough

Date of Report: June 24, 1976

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. (1) Field season begun at NARL, Barrow, May 29, 1976.
   (2) Reconnaissance of potential study sites in Kotzebue Sound: Kotzebue, Cape Krusenstern, Cape Espenberg, Wales. By chartered aircraft from Baker Aviation, Kotzebue, June 1 - June 4.

B. Scientific Party
   Peter G. Connors: Research Coordinator
   Frank A. Pitelka: Consultant
   J. P. Myers: Research Assistant
   Russell Greenberg: Research Assistant
   Carolyn Connors: Research Assistant

C. Methods
   Establish transects in a variety of littoral and near-littoral habitats. Begin periodic censuses, as described in first annual report, March 31, 1976.

D. Not applicable

E. Data Collected
   (1) Approximately 70 transect censuses completed.

III. Results

It is not possible to analyze these data during the field season.

IV. Preliminary Interpretation

In general, patterns of shorebird habitat use appear similar to results presented in the annual report, March 31, 1976. Phenology of events seems considerably different, however, with the present season judged to be unusually early. This may alter the use of littoral habitats by shorebirds later in this season.

V. Problems: None

VI. Funds Expended

During the field season, without access to accounting records, we are unable to make this estimate. We are confident, however, that our field progress is keeping pace with expenditures.

QUARTERLY REPORT

RU # 215

Contract 03-5-022-56
Task Order Number 11
Quarter Ending -
30 June 1976

AVIFAUNAL UTILIZATION OF THE OFFSHORE ISLAND AREA NEAR PRUDHOE BAY, ALASKA

George Mueller, Director
Marine Sorting Center
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

The main objectives of the present study are to document:

A. Seasonal numerical changes by species and sex.

B. Daily and seasonal trends in spatial distribution, by species and sex.

C. Diurnal activity rhythms, by species and sex.

II. Field and Laboratory Activities

None.

III. Results

The final report is in preparation.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 11 R.U. NUMBER: 215

PRINCIPAL INVESTIGATOR: Mr. George Mueller

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

RU# 237/238

NO REPORT SUBMITTED

The principal investigator is in the field.

RU# 239

NO REPORT SUBMITTED

The principal investigator is in the field.

Quarterly Report

Contract #
Research Unit #330/196 ~~and 3/4~~
Reporting Period: March-June 1976
Number of Pages

The distribution, abundance and feeding ecology of birds associated with Bering Sea and Beaufort Sea pack ice

and

The identification, documentation and delineation of coastal migratory bird habitat in Alaska

George Divoky
Alaska Department of Fish and Game

July 15, 1976

I. Task Objectives

The proposed research addresses in part the following tasks identified in the Draft Study Plan "Environmental Assessment of the Gulf of Alaska, Southeastern Bering Sea and Beaufort Seas":

A-4 - Summarize and evaluate existing literature and unpublished data on the distribution, abundance, behavior and food dependencies of marine birds.

A-5 - Determine the seasonal density distribution, critical habitats, migratory routes, and breeding locales for principal marine species in the study areas. Identify critical species particularly in regard to possible effects of oil and gas development.

A-6 - Determine the dynamics and trophic relationships of selected species at offshore and coastal study sites.

A-31 - Determine the relationship of living resources to the ice environment (including the edge of the drifting ice, land fast ice and inner pack ice) on a seasonal basis in the Bering, Chukchi and Beaufort Seas.

II. Field Activities

A. Ship and Field Trip Schedule

Dates	Location	Activity
15 March - 1 April	NOAA ship SURVEYOR Kodiak to Bering Sea and return	Pelagic observations and specimen collecting. Divoky, Woodby
12 April - 31 April	NOAA ship SURVEYOR Kodiak to Bering Sea and return	Pelagic observations and specimen collecting Woodby
6 May - 3 June	Barrow	Migration observations along offshore lead. Woodby
15 May	Barrow to Icy Cape	Aerial survey of birds over lead. Woodby
19 May	Barrow to Pt. Hope	Aerial survey of birds over lead. Woodby
1 June - 15 June	Wales to Pt. Hope	Migration watch. MacDonald
4 June	Barrow to Lonely	Aerial survey of birds over lead. Harvey, Darling, Woodby
5 June	Barrow to Wainwright	Aerial survey of birds over lead. Darling, Harvey

7 June - 14 June	Oliktok and vicinity	Foot survey of birds along coast. Darling, Harvey
8 June - 18 June	Wales	Migration watch. Gibson
10 June	Barrow to north of Pt. Lay	Aerial survey of birds over lead and coast. Woodby, Wilson
11 June	Barrow to Icy Cape	Aerial survey of birds over lead. Boekelheide
12 June	Barrow to north of Cape Halkett	Aerial survey of birds over lead. Wilson, Harvey
15 June	Cooper Island	Barrier island study. Boekelheide
16 June - 21 June	Peard Bay and vicinity	Foot survey of birds along coast. Darling, Wilson
21 June	Barrow to Icy Cape	Aerial survey of birds along coast. Hirsch, Harvey
22 June - 1 July	Prudhoe Bay	Barrier island study. Oakley, Woodby, Hirsch
22 June - 1 July	Barter Island	Barrier island survey. Divoky, Good
23 June - 27 June	Cape Lisburne to Cape Sabine	Foot survey of birds along coast
27 June - 1 July	Barrow	Aerial surveys of birds along lead and coast. Harvey

B. Scientific Party

Principal Investigator: George J. Divoky
Alaska Department of Fish and Game

Field Assistants: Robert Boekelheide, Kate Darling, Dan Gibson, Ed Good, Tom Harvey, Katie Hirsch, Steve MacDonald, Ken Wilson, Doug Woodby
Alaska Department of Fish and Game

D. Sample Localities

Noon Positions for SURVEYOR Cruise

15 March	55°20'	156°13'
16 March	54°23'	155°19'
17 March	54°43'	167°45'
18 March	56°36'	168°24'
19 March	56°22'	168°31'

20 March	56°04'	168°34'
21 March	56°02'	166°36'
22 March	56°11'	166°32'
23 March	55°54'	166°27'
24 March	55°55'	164°31'
25 March	56°05'	164°13'
26 March	55°59'	164°46'
27 March	55°48'	165°09'
28 March	55°48'	165°23'
29 March	55°54'	165°41'
30 March	55°14'	168°39'
31 March	54°53'	165°25'
1 April	54°46'	158°14'
13 April	55°29'	155°38'
14 April	54°19'	164°47'
15 April	54°55'	169°25'
16 April	56°25'	170°21'
17 April	57°03'	172°14'
18 April	57°16'	172°48'
19 April	57°07'	173°52'
20 April	57°16'	173°17'
21 April	57°08'	173°37'
22 April	56°13'	171°17'
23 April	56°05'	163°49'
24 April	56°04'	162°45'
Location of Cooper Island	71°14'N	155°41'W

E. Data Collected

SURVEYOR Cruise - March

Number of 15 minute transect observations = 160
Number of station observations = 21
Specimens collected

Common Murre	=	17
Ivory Gull	=	6
Glaucous-winged Gull	=	6
Thick-billed Murre	=	3
Black Guillemot	=	2
Thayer's Gull	=	1
Crested Auklet	=	1

Nautical miles of trackline = 2200

SURVEYOR Cruise - April

Number of 15 minute transect observations = 103
Number of station observations = 4
Specimens collected

Common Murre	=	14
Thick-billed Murre	=	10
Black-legged Kittiwake	=	5
Ivory Gull	=	4
Fulmar	=	3
Glaucous Gull	=	3
Black Guillemot	=	2

Nautical miles of trackline = 2200

Migration observations at Barrow

Number of hours of observations of migratory birds = 131

Specimens collected

King Eider = 2

Cooper Island

No data totals available yet

Barrow Aerial Surveys

Number of hours	=	26
Nautical miles of trackline	=	2631

Coastal Habitat Foot Survey

Number of hours	=	94
Nautical miles of trackline	=	70

III. Results

Data collected is still on field forms and summary sheets. Due to the intensive and extensive field season that is still underway, no processing of the data has yet been accomplished.

IV. Preliminary Interpretation of Results

SURVEYOR Cruises - Large concentrations of birds were observed in the leads and polynias several miles north of the ice edge and at the edge itself. The most abundant birds were Common and Thick-billed Murres, which were often observed in feeding flocks of several birds. Low bird densities were observed over all deep water areas.

Migration at Barrow - Many seabirds were observed passing eastward along the offshore lead: King Eiders were the most abundant migrants, and flew in greatest numbers on afternoons with southwesterly winds. One-half of the total King Eider population of western North America passed Barrow within a 12 hour period on May 26 with favorable winds and warm temperatures.

Aerial Surveys - Numbers of migrants on the offshore lead decreased throughout June with an increase in density. Sea ice progressed rapidly through early stages of melting without major openings occurring until late June.

V. No major problems were encountered. Cooperation of NARL personnel has greatly aided the efficiency of field operations.

VI. Estimate of funds expended.

As of 30 June, we have expended approximately the following amounts:

Salaries	22,435.91
Travel and per diem	3,366.46
Contractual services	1,134.86
Commodities and supplies	2,422.65
Equipment	4,542.37
Total expenditures	$33,902.25

QUARTERLY REPORT

Contract: 01-5-022-2538
Research Unit: RU-337
Reporting Period: April 1, 1976 to June 30, 1976
Number of Pages: i + 7

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 C. Bates
Co-investigators

U.S. Fish and Wildlife Service
Office of Biological Services - Coastal Ecosystems
800 A Street - Suite 110
Anchorage, Alaska 99501

July 1, 1976

INTRODUCTION

This report describes activities by U.S. Fish and Wildlife Service personnel related to shipboard surveys of marine birds in Alaskan waters during the two quarters from 1 January to 30 June 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."

The objective of this research unit is to describe the seasonal density distribution of marine birds in those portions of the Gulf of Alaska, the Bering Sea, and the Beaufort Sea that have been identified by the U.S. Department of the Interior for leasing and development of their oil and gas potentials. This research unit considers only the offshore environment and does not include species generally confined to the nearshore and littoral habitats. It does not directly consider the distribution of pelagic species when they occupy shoreline habitats such as during the breeding season.

STUDY AREA

Shipboard surveys of birds during the first half of 1976 were conducted mainly in the Gulf of Alaska and the southeastern and southcentral Bering Sea. Observations were also made during five transits between Seattle and Alaska. Table 1 lists the localities in which surveys were conducted (see our Annual Report RU #337, Part I., p. 512, 1 April 1976, for the delineation of our survey regions).

METHODS

Methods used in the shipboard surveys of marine birds are described in our Annual Report RU #337, Part I, of 1 April 1976.

RESULTS AND DISCUSSION

U.S. Fish and Wildlife Service personnel conducted shipboard surveys of marine birds from aboard a variety of ships during the first half of 1976 (Table 1). Personnel were aboard the R/V _Moana Wave_ and the R/V _Discoverer_ all of the time and the R/V _Miller Freeman_ during much of the time that these vessels operated in Alaskan waters. Personnel spent less time aboard the R/V _Surveyor_ in our effort to avoid duplicating the almost identical efforts by George J. Divoky (RU 330/196). Because we deferred to his project and occasionally to those of Juan Guzman (RU #239) and Dennis Heineman and Wayne Hoffman (RU #108), we did not participate on all cruises of NOAA-operated vessels. Because we deferred to these other projects, our acquisition of data at and near the ice edge, in the ice, in the Bering Sea during winter and in the central and northeastern Bering Sea from spring through summer is minimal. Surveys were also conducted from aboard the Lindblad cruise ship M/V Explorer and from the F/V Nordic Prince which was chartered by the U.S. Fish and Wildlife Service as part of our Research Units #341 and 342.

During the first and second quarters of 1976, 11 and 19 cruise/field operations, respectively, were conducted aboard vessels by our personnel. Table 1 identifies by our field operation number, personnel, location, and period of effort for these operations.

During quarter 1 April to 30 June 1976, shipboard surveys data acquired during our Cruise/Field Operations 75004, 75018, and 75028 (see our Annual Report RU #337, Part I, Table 1, p. 11-16) were transcribed into the new data format which NOAA made available to us early in 1976. Data from our Cruise/Field Operation 75028 have been keypunched and verified, stored on magnetic tape, and delivered to the OCSEAP Juneau Project Office in the form of tape and a copy of the cruise/field operation report.

Transcription and processing of data acquired during 1975 will continue during the forthcoming quarters so that both the U.S. Fish and Wildlife Service and the Bureau of Land Management can make timely use of those data in recommending tract selection or deletion and in the development of environmental impact statements.

A majority of the data acquired during 1976 is in the new format and awaiting keypunching and verification before submittal. Some of the earliest cruise/field operations were conducted before the NOAA format was made available to the investigators and before that format could be modified by us to meet some rather practical problems associated with data collection in the field.

Table 1. Log of U. S. Fish and Wildlife Service, Office of Biological Services - Coastal Ecosystem's field operations for the study of marine birds, 1 January to 30 June 1976.

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
8 Jan	76001	Aerial - P2V	UCI, LCI, NWGOA	Craig Harrison, Scott Hatch, Ed Bailey
15-20 Feb	76002	MOANA WAVE	Seattle-Seward	Gerald Sanger, Matt Kirchhoff, Mark Phillips, Dave Hardy
18-20 Feb	76003	Reconnaissance	Middleton I.	John Hall, Kent Wohl (BLM)
20 Feb - 5 Mar	76004	MOANA WAVE	PWS, NEGOA, NWGOA	Matt Kirchhoff
24-27 Feb	76005	DISCOVERER	Seattle-Kodiak	Dave Hardy, Dave Frazer
28 Feb - 8 Mar	76006	Aerial - P2V	BB, SGB, UMB, APS KB, SS, NWGOA, LCI	Craig Harrison, Scott Hatch, Art Sowls
1-13 Mar	76007	DISCOVERER	KB, NEGOA	Dave Frazer
8-12 Mar	76008	SURVEYOR	Seattle-Kodiak	Colleen Handel
8-26 Mar	76009	MOANA WAVE	KB, APS, BB, SGB	Mark Phillips
15-21 Mar	76010	MILLER FREEMAN	Seattle-Kodiak	Gerald Sanger, Susan Bates, Colleen Handel, Mark Rauzon, Ted Schad
16-29 Mar	76011	DISCOVERER	KB, NWGOA, NEGOA, PWS	Matt Kirchhoff
23 Mar - 21 Apr	76012	MILLER FREEMAN	NWGOA, APS, BB, SGB, SCB	Mark Rauzon
29 Mar - 15 Apr	76013	MOANA WAVE	NWGOA, LCI, UCI	Dave Frazer

(Table continued)

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
29-30 Mar	76014	Aerial - P2V	PWS, NEGOA, NWGOA LCI	Craig Harrison, Scott Hatch, Colleen Handel
4 Apr	76015	Aerial - P2V	UCI, LCI, KB, SS, NWGOA	Craig Harrison, Scott Hatch, Mark Phillips
6-13 Apr	76016	DISCOVERER	UCI, LCI, KB, NWGOA, NEGOA, PWS	Craig Harrison
10-26 Apr	76017	SURVEYOR	SGB, BB, KB, APS, NAV	John Hall
13- Apr	76018	DISCOVERER	Leg	Ted Schad
19 Apr - 1 May	76019	MOANA WAVE	NEGOA, NWGOA, KB	Tony DeGange
20 Apr - 27 May	76020	Field Camp	Unimak Pass	Mark Phillips
20 Apr - 13 May	76021	MILLER FREEMAN	NAV, SGB, SCB, OA	Doug Forsell
22 Apr to date	76022	Field Camp	Hinchinbrook I.	David Nysewander, Pete Knudtson
26 Apr to date	76023	Field Camp	Cape Peirce	Margaret Peterson, Marilyn Sigman
29 Apr to date	76024	Field Camp	Semidi Is.	Scott Hatch, Martha Hatch
29 Apr to date	76025 to 49	NORDIC PRINCE	Prince William Snd to Cape Peirce	Art Sowls, Allen Moe, Jerry Ruehle, Don Dumm, Jim Bartonek, Gerald Sanger, Pat Gould, Colleen Handel, John Hall, Sue Bates Pat Baird, et al.
3-5 May	76050	DISCOVERER	NEGOA, KB,	Patrick Gould, Mark Rauzon

(table continued)

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
6-8 May	76051	DISCOVERER	LCI, NWGOA	Patrick Gould, Mark Rauzon
12-20 May	76052	DISCOVERER	KB, NEGOA, PWS NWGOA	Patrick Gould
9 May to date	76053	Field Camp	Forrester I.	Dave Frazer, Earl Possardt, Tony DeGange
11 May to date	76054	Field Camp	Barren Is.	David Manuwal, Dee Boersma, Naomi Manuwal, Mike Amarel, Mary Nerini
16 May to date	76056	Field Camp	Nelson Lagoon	Bob Gill, Paul Jorgenson
17 May - 4 Jun	76057	MILLER FREEMAN	OA, UMB, BB, SGB NAV, APS, SS, NWGOA	Doug Forsell
7 May -	76058	MOANA WAVE	leg	Tony DeGange
20 May to date	76059	Field Camp	Semidi Is.	Galen Burrell, Lora Leschner
20 May to date	76060	Field Camp	Ugaiushak I.	Duff Whele
20 May to date	76061	Field Camp	Ugaiushak I.	Eric Hoberg
20 May to date	76062	Field Camp	Big Koniuji I.	Bob Day
20 May to date	76063	Field Camp	Big Koniuji I.	Ted Schad, Allen Moe
24 May - 3 Jun	76064	SURVEYOR	KB, NEGOA, NWGOA	Patrick Gould, Craig Larson
26 May - 5 Jun	76066	MOANA WAVE	KB, APS, UMB, SGB, BB	Keith Metzner
5-22 Jun	76067	MOANA WAVE	UMB, BB, ECB, SGB, APS, KB	Keith Metzner
25 May - 17 Jun	76068	LINBLAD EXPLORER	SE, SW, SC Alaska	Mark Rauzon

(Table continued).

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
1 Jun to date	76069	Field Camp	Kodiak I.	Matt Dick, Jay Nelson
7-17 Jun	76070	MILLER FREEMAN	Leg IV	Patricia Baird
18-23 Jun	76071	MILLER FREEMAN	Leg, Transit	Patricia Baird
8-12 Jun	76072	Aerial	NB, HB	Craig Harrison
6 Jun to date	76073	Field Camp	Middleton I.	Marshall Howe, Dave Frazer
22 Jun to date	76074	MOANA WAVE	Leg VIII	Doug Forsell
15 Jun to date	76075	Field Camp	Yukon Delta	Bob Jones, Matt Kirchhoff
30 Jun to date	76076	Field Camp	Unimak Pass	Mark Rauzon
9 July	76077	DISCOVERER	Seattle - Kodiak	Keith Metzner
9 July	76078	DISCOVERER	NWGOA	Keith Metzner
14-16 June	76079	NORDIC PRINCE	NEGOA, PWS	John Hall, Art Sowls, Colleen Handel, Beverly Eggen, Kent Wohl
27 April to date	76080	Field Camp	Copper R. Delta	Stan Senner
7 May to date	76081	Field Camp	Wooded Islands	Peter Mickelson, Bud Lenhausen

1/

APS-Alaskan Peninsula South
BB-Bristol Bay
BCS-British Columbia Shelf
BFT-Beaufort Basin
ECB-Eastern Central Bering Sea
HB-Hope Basin
KB-Kodiak Basin
LCI-Lower Cook Inlet
NaB-Navarin Basin
NB-Norton Basin
NCS-Northern California Shelf
NEGOA-Northeast Gulf of Alaska
NWGOA-Northwest Gulf of Alaska
OA-Oceanic Aleutians
OAPS-Oceanic Alaskan Pen. South
OBC-Oceanic British Columbia
OGOA-Oceanic Gulf of Alaska
ONC-Oceanic Northern California
OO-Oceanic Oregon
OS-Oregon Shelf
OSC-Oceanic Southern California
OSK-Oceanic South Kodiak
OW-Oceanic Washington
PWS-Prince William Sound
SCB-South Central Bering Sea
SCS-Southern California Shelf
SEAS-Southeast Alaska Shelf
SGB-St. George Basin
SS-Shelikof Strait
TNP-Transitional North Pacific
UCI-Upper Cook Inlet
UMB-Umnak Basin
WS-Washington Shelf

QUARTERLY REPORT

Contract: 01-5-022-2538
Research Unit: RU-337
Reporting Period: April 1, 1976 to
June 30, 1976
Number of pages: v + 82 p.

SEASONAL DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS: PART II. AERIAL SURVEYS

Calvin J. Lensink,

James C. Bartonek

and

Craig S. Harrison

Co-principal Investigators

U.S. Fish and Wildlife Service
Office of Biological Services - Coastal Ecosystems
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July 1, 1976

LIST OF TABLES

LIST OF MAPS

Abstract. Aerial surveys were conducted in the Gulf of Alaska, the Pacific Ocean south of the Alaska Peninsula and the Bering Sea between 8 January and 12 June 1976 by U.S. Fish and Wildlife Service personnel. Data were drawn from 5 mission reports, one of which was in cooperation with the National Marine Fisheries Service and which was from too great an altitude to make detailed observations. In total, 676 quadrats or units of information were collected.

Summaries of bird population data are presented by species, 1-month intervals and oceanographic region in 22 tables. Monthly summaries of total bird densities in the Alaskan outer continental shelf regions are presented in 4 maps.

Distributional data from aerial transects are deemed inadequate to measure the potential impacts of OCS leasing on avifauna in most regions during 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.

STUDY AREA

Aerial observations of sea birds have been made during this reporting period within 12 of 32 oceanographic regions identified on Map 1. These oceanographic regions were subjectively delineated by us so as to, in part, encompass sedimentary basins identified by the U.S. Department of the Interior for leasing (Map 2) and, in part, in consideration of political boundaries or oceanographic characteristics. Map 3 shows the aerial transects which were flown in 1975 or will be flown in 1976. Specific locations are reported in the Results section, but in general the boundaries for this reporting period have been the 142°W meridian to the east in the Gulf of Alaska, the 52°30'N latitude to the south in Umnak Basin, the 172°W meridian to the west in the Bering Sea and the 61°N latitude to the north in Prince William Sound.

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 periods 8 January to 22 June, 1976. Data from field reports 76-1, 76-6, 76-14 and 76-15 comprise the basis for this report.

Table 2 summarizes the distribution of effort for censusing marine birds by the aerial transect method. Furthermore, data are summarized for each of 12 oceanographic regions by month (Tables 3-24). Occurrence, percent occurrence, number of birds and birds/km^2 are given for each species in each basin by month. Total bird concentrations are mapped by month (Maps 4-7).

DISCUSSION

Maps 4-7 illustrate the 676 quadrats surveyed during the period January-April, 1976. This effort has resulted in filling many of the major gaps in our knowledge of seabird distribution in Alaska. The January survey (Map 4) emphasized the extreme importance of the nearshore areas of Shuyak, Afognak, Kodiak and the Trinity Islands for wintering scoters, eiders, oldsquaw, cormorants, murres and small alcids. Furthermore, it indicated that murres winter on the continental shelf and that tufted puffins and kittiwakes winter in truly pelagic areas beyond the 1,000-f line. Also, it was established that a small remnant population of non-breeding shearwaters overwinters in Alaskan waters.

The surveys in late February in the Bering Sea (Map 5) demonstrated the importance of the ice edge to wintering murres, least auklets and fulmars. Rafts of up to several thousand murres were seen in polynya in 4-6 okta ice at the interface between pack ice and open water and these birds would be extremely vulnerable to oil spills in this habitat. It was further established that polynya in pack ice can provide suitable habitat for murres and least auklets as far as fifty miles into the ice from the ice edge, but that in general the pack ice has few, if any, birds. The north shore of Unimak Island is important eider and small alcid wintering grounds, especially for king eiders, parakeet auklets and crested auklets. Fulmar and fork-tailed petrels were recorded frequently in the pelagic areas beyond the 1,000-f line in the Bering Sea.

The March surveys (Maps 6ab) revealed that the open water south of the Alaska Peninsula are crucial wintering areas for large populations of eiders, scoters, murres, small alcids, cormorants and glaucous-winged gulls. In particular, the area south of Unimak Island, Cold Bay, Sanak Island, the Sandman Reefs and the Shumagin Islands had substantial numbers of birds. Umnak and the Shumagin Islands had sizeable numbers of emperor geese in intertidal areas and it is expected that they are present in similar habitat throughout this area. Unimak Pass, a very crucial area at other times of the year, did not support many wintering birds. Shelikof Strait had large numbers of eiders and murres and may represent a staging area for these species. Katmai Bay, Raspberry Strait and especially Kachemak Bay had substantial numbers of murres and waterfowl. The late March surveys in the Northeast and Northwest Gulf of Alaska indicate that large numbers of birds are not at this time in continental shelf waters but that kittiwakes and murres are relatively abundant. Fulmars, tufted puffins and fork-tailed petrels appear to be present along the continental slope.

Although our survey of early April had to be aborted due to a failure of the GNS-500 system, we did establish the fact that murres were present in the vicinity of the Barren Islands.

CONCLUSIONS

The 676 quadrats surveyed during this quarter have supplied much-needed information on the abundance and distribution of marine birds during their winter ranges. It is especially difficult to collect data during this time of year due to logistical problems associated with weather patterns and available light. Most importantly, we can now state that Kachemak Bay, Shuyak Island, Kodiak Island, the Trinity Islands, Shelikof Strait, the Shumagin Islands and the Bering Sea ice edge are extremely important wintering areas for marine birds. This must be taken into consideration for OCS planning due to the fact that seabirds are probably subjected to maximum physiological stress during this season and are therefore especially vulnerable to environmental disruption. Furthermore, they tend to aggragate in large flocks in specific areas which would make an oil spill in such an area particularly disasterous for the population concerned. It is suggested that oil development be steered away from these areas to the extent practicable.

NEEDS FOR FURTHER STUDY

The aerial data to date has provided a solid first step toward understanding marine bird use of Alaskan waters, but it is necessarily a first step. We need data on the Chukchi Sea for all seasons when open water is present. Transects will be developed and flown in this area in 1976. Large parts of the Eastern Central Bering Sea and the Navarin Basin have very inadequate data. Areas which have been surveyed in 1975 and 1976 need to be resurveyed at similar time periods in succeeding years in order to evaluate year to year as well as seasonal changes in population size and species composition.

These needed surveys will be made in 1976 to the extent practicable considering funding, aircraft availability and suitable weather.

As time permits, unreported and unanalyzed aerial survey data on seabirds collected by U.S. Fish and Wildlife Service personnel since 1969 will be incorporated in with these currently acquired data.

SUMMARY OF 5TH QUARTER OPERATIONS

Aerial surveys in the fifth quarter are summarized in Table 1. The survey of 4 April is included in this report and the survey in cooperation with the National Marine Fisheries Service of 8-12 June in the Hope and Norton Basins will be analyzed to the extent practicable considering the limitations of bird surveying at the higher altitudes used in marine mammal surveys.

Table 1. Log of U. S. Fish and Wildlife Service, Office of Biological Services - Coastal Ecosystem's field operations for the study of marine birds, 1 January to 30 June 1976.

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
8 Jan	76001	Aerial - P2V	UCI, LCI, NWGOA	Craig Harrison, Scott Hatch, Ed Bailey
15-20 Feb	76002	MOANA WAVE	Seattle-Seward	Gerald Sanger, Matt Kirchhoff, Mark Phillips, Dave Hardy
18-20 Feb	76003	Reconnaissance	Middleton I.	John Hall, Kent Wohl (BLM)
20 Feb - 5 Mar	76004	MOANA WAVE	PWS, NEGOA, NWGOA	Matt Kirchhoff
24-27 Feb	76005	DISCOVERER	Seattle-Kodiak	Dave Hardy, Dave Frazer
28 Feb - 8 Mar	76006	Aerial - P2V	BB, SGB, UMB, APS KB, SS, NWGOA, LCI	Craig Harrison, Scott Hatch, Art Sowls
1-13 Mar	76007	DISCOVERER	KB, NEGOA	Dave Frazer
8-12 Mar	76008	SURVEYOR	Seattle-Kodiak	Colleen Handel
8-26 Mar	76009	MOANA WAVE	KB, APS, BB, SGB	Mark Phillips
15-21 Mar	76010	MILLER FREEMAN	Seattle-Kodiak	Gerald Sanger, Susan Bates, Colleen Handel, Mark Rauzon, Ted Schad
16-29 Mar	76011	DISCOVERER	KB, NWGOA, NEGOA, PWS	Matt Kirchhoff
23 Mar - 21 Apr	76012	MILLER FREEMAN	NWGOA, APS, BB, SGB, SCB	Mark Rauzon
29 Mar - 15 Apr	76013	MOANA WAVE	NWGOA, LCI, UCI	Dave Frazer

(Table continued)

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location [1]	Personnel
29-30 Mar	76014	Aerial - P2V	PWS, NEGOA, NWGOA LCI	Craig Harrison, Scott Hatch, Colleen Handel
4 Apr	76015	Aerial - P2V	UCI, LCI, KB, SS, NWGOA	Craig Harrison, Scott Hatch, Mark Phillips
6-13 Apr	76016	DISCOVERER	UCI, LCI, KB, NWGOA, NEGOA, PWS	Craig Harrison
10-26 Apr	76017	SURVEYOR	SGB, BB, KB, APS, NAV	John Hall
13- Apr	76018	DISCOVERER	Leg	Ted Schad
19 Apr - 1 May	76019	MOANA WAVE	NEGOA, NWGOA, KB	Tony DeGange
20 Apr - 27 May	76020	Field Camp	Unimak Pass	Mark Phillips
20 Apr - 13 May	76021	MILLER FREEMAN	NAV, SGB, SCB, OA	Doug Forsell
22 Apr to date	76022	Field Camp	Hinchinbrook I.	David Nysewander, Pete Knudtson
26 Apr to date	76023	Field Camp	Cape Peirce	Margaret Peterson, Marilyn Sigman
29 Apr to date	76024	Field Camp	Semidi Is.	Scott Hatch, Martha Hatch
29 Apr to date	76025 to 49	NORDIC PRINCE	Prince William Snd to Cape Peirce	Art Sowls, Allen Moe, Jerry Ruehle, Don Dumm, Jim Bartonek, Gerald Sanger, Pat Gould, Colleen Handel, John Hall, Sue Bates Pat Baird, et al.
3-5 May	76050	DISCOVERER	NEGOA, KB,	Patrick Gould, Mark Rauzon

(table continued)

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
6-8 May	76051	DISCOVERER	LCI, NWGOA	Patrick Gould, Mark Rauzon
12-20 May	76052	DISCOVERER	KB, NEGOA, PWS NWGOA	Patrick Gould
9 May to date	76053	Field Camp	Forrester I.	Dave Frazer, Earl Possardt, Tony DeGange
11 May to date	76054	Field Camp	Barren Is.	David Manuwal, Dee Boersma, Naomi Manuwal, Mike Amarel, Mary Nerini
16 May to date	76056	Field Camp	Nelson Lagoon	Bob Gill, Paul Jorgenson
27 May - 4 Jun	76057	MILLER FREEMAN	OA, UMB, BB, SGB NAV, APS, SS, NWGOA	Doug Forsell
7 May -	76058	MOANA WAVE	leg	Tony DeGange
20 May to date	76059	Field Camp	Semidi Is.	Galen Burrell, Lora Leschner
20 May to date	76060	Field Camp	Ugaiushak I.	Duff Whele
20 May to date	76061	Field Camp	Ugaiushak I.	Eric Hoberg
20 May to date	76062	Field Camp	Big Koniuji I.	Bob Day
20 May to date	76063	Field Camp	Big Koniuji I.	Tod Schad, Allen Moe
24 May - 3 Jun	76064	SURVEYOR	KB, NEGOA, NWGOA	Patrick Gould, Craig Larson
26 May - 5 Jun	76066	MOANA WAVE	KB, APS, UMB, SGB, BB	Keith Metzner
5-22 Jun	76067	MOANA WAVE	UMB, BB, ECB, SGB, APS, KB	Keith Metzner
25 May - 17 Jun	76068	LINBLAD EXPLORER	SE, SW, SC Alaska	Mark Rauzon

(Table continued).

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
1 Jun to date	76069	Field Camp	Kodiak I.	Matt Dick, Jay Nelson
7-17 Jun	76070	MILLER FREEMAN	Leg IV	Patricia Baird
18-23 Jun	76071	MILLER FREEMAN	Leg, Transit	Patricia Baird
8-12 Jun	76072	Aerial	NB, HB	Craig Harrison
6 Jun to date	76073	Field Camp	Middleton I.	Marshall Howe, Dave Frazer
22 Jun to date	76074	MOANA WAVE	Leg VIII	Doug Forsell
15 Jun to date	76075	Field Camp	Yukon Delta	Bob Jones, Matt Kirchhoff
30 Jun to date	76076	Field Camp	Unimak Pass	Mark Rauzon

1/
APS-Alaskan Peninsula South
BB-Bristol Bay
BCS-British Columbia Shelf
BFT-Beaufort Basin
ECB-Eastern Central Bering Sea
HB-Hope Basin
KB-Kodiak Basin
LCI-Lower Cook Inlet
NaB-Navarin Basin
NB-Norton Basin
NCS-Northern California Shelf
NEGOA-Northeast Gulf of Alaska
NWGOA-Northwest Gulf of Alaska
OA-Oceanic Aleutians
OAPS-Oceanic Alaskan Pen. South
OBC-Oceanic British Columbia
OGOA-Oceanic Gulf of Alaska
ONC-Oceanic Northern California
OO-Oceanic Oregon
OS-Oregon Shelf
OSC-Oceanic Southern California
OSK-Oceanic South Kodiak
OW-Oceanic Washington
PWS-Prince William Sound
SCB-South Central Bering Sea
SCS-Southern California Shelf
SEAS-Southeast Alaska Shelf
SGB-St. George Basin
SS-Shelikof Strait
TNP-Transitional North Pacific
UCI-Upper Cook Inlet
UMB-Umnak Basin
WS-Washington Shelf

Table 2. Distribution of effort for censusing marine birds by the aerial transect method, January-April, 1976.

Region	Region Abbreviation	January	February	March	April	Total
Alaska Peninsula South	APS	0	0	68	0	68
Bristol Bay	BB	0	67	0	0	67
Beaufort Basin	BFT	0	0	0	0	0
Eastern Central Bering Sea	ECB	0	0	0	0	0
Hope Basin	HB	0	0	0	0	0
Kodiak Basin	KB	70	0	24	3	97
Lower Cook Inlet	LCI	6	0	13	15	34
Navarin Basin	NAV	0	6	0	0	6
Norton Basin	NB	0	0	0	0	0
Northeast Gulf of Alaska	NEGOA	0	0	102	0	102
Northwest Gulf of Alaska	NWGOA	17	0	66	7	90
Prince William Sound	PWS	0	0	4	0	4
St. George Basin	SGB	0	98	18	0	116
Shelikof Strait	SS	2	0	17	2	21
Upper Cook Inlet	UCI	0	0	2	4	6
Umnak Basin	UMB	0	0	65	0	65
Total		95	171	379	31	676

Table 3. Bird observations on aerial transects, Alaska Peninsula South, March, 1976.

Species Name	Occurence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	11	16	15	0.2
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel	5	7	6	0.1
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	11	16	53	0.6
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose	3	4	76	0.8
White-fronted Goose				

Species Name	Occurence	% Occurence	No. Birds	Birds/km^2
Snow Goose				
Unid. Goose				
Mallard	1	1	9	0.1
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead	1	1	2	tr.
Oldsquaw	4	6	48	0.5
Harlequin Duck				
Steller's Eider	3	4	125	1.4
Common Eider	2	3	265	2.9
King Eider	5	7	92	1.0
Spectacled Eider				
Unid. Eider	3	4	27	0.3
White-winged Scoter	2	3	11	0.1
Surf Scoter				
Black Scoter	3	4	38	0.4
Unid. Scoter				
Unid. Duck	2	3	8	0.1
Red-breasted Merganser				
Bald Eagle	1	1	2	tr.
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Rock Sandpiper	1	1	50	0.6
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	18	27	178	2.0
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	7	10	29	0.3
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre	1	1	2	tr.
Unid. Murre	23	34	571	6.3
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet	8	12	96	1.1
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet	4	6	122	1.4
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid	1	1	107	1.2
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
Common Raven	1	1	3	tr.					
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	5	7	18	0.2					
Totals/Average			1953	21.7					

Cruise numbers data are compiled from: 76-6

Table 4. Bird observations on aerial transects, Bristol Bay, February, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	3	4	9	0.1
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	5	7	30	0.3
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw	7	10	32	0.3
Harlequin Duck				
Steller's Eider				
Common Eider	2	3	16	0.2
King Eider	4	6	567	5.5
Spectacled Eider				
Unid. Eider	2	3	33	0.3
White-winged Scoter	2	3	3	tr.
Surf Scoter	1	1	1	tr.
Black Scoter				
Unid. Scoter				
Unid. Duck	1	1	60	0.6
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occur-ence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	12	18	24	0.2
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	2	3	5	tr.
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occur-ence	% Occurence	No. Birds	Birds/Km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull	1	1	1	tr.
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	9	13	1456	14.2
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid	2	3	3	tr.
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet	8	12	36	0.4
Crested Auklet	3	4	159	1.5
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid	2	3	39	0.4
Horned Puffin	1	1	1	tr.
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	3	4	10	0.1					
Totals/Average			2485	24.2					

Cruise numbers data are compiled from: 76-6

Table 5. Bird observations on aerial transects, Kodiak Basin, January, 1976.

Species Name	Occurrence	% Occurrence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon	1	1	1	tr.
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	21	30	71	0.8
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater	1	1	1	tr.
Unid. Shearwater	4	6	25	0.4
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	7	10	31	0.3
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				

Species Name	Occurrence	% Occurrence	No. Birds	Birds/km^2
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw	2	3	9	0.1
Harlequin Duck				
Steller's Eider	1	1	2	tr.
Common Eider	1	1	50	0.5
King Eider	1	1	1	tr.
Spectacled Eider				
Unid. Eider	2	3	11	0.1
White-winged Scoter				
Surf Scoter	2	3	9	0.1
Black Scoter	7	10	101	1.1
Unid. Scoter	5	14	231	2.5
Unid. Duck				
Red-breasted Merganser				
Bald Eagle	1	1	1	tr.
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	26	37	252	2.8
Slaty-backed Gull				
Western Gull				
Herring Gull	1	1	1	tr.
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	16	23	73	0.8
Red-legged Kittiwake				
Ross' Gull				
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull	1	1	1	tr.
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	22	31	280	3.1
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid	5	14	6	0.1
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet	1	1	3	tr.
Unid. Small Alcid	1	1	2	tr.
Horned Puffin				
Tufted Puffin	12	17	27	0.3
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	1	1	1	tr.					
Totals/Average			545	5.9					

Cruise numbers data are compiled from: 76-1

Table 6. Bird observations on aerial transects, Kodiak Basin, March, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	5	21	6	0.2
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant				
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider				
Common Eider	2	8	303	10.3
King Eider	3	12	80	2.7
Spectacled Eider				
Unid. Eider	3	12	79	2.7
White-winged Scoter				
Surf Scoter				
Black Scoter				
Unid. Scoter				
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	5	21	9	0.3
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake				
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	14	58	381	13.0
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid	1	4	15	0.5
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet	13		67	2.3
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet	1	4	1	tr.
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid	3	12	6	0.2
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	4	17	15	0.5					
Totals/Average			962	32.8					

Cruise numbers data are compiled from: 76-6

Table 7. Bird observations on aerial transects, Kodiak Basin, April, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Loon					Snow Goose				
Yellow-billed Loon					Unid. Goose				
Arctic Loon					Mallard				
Red-throated Loon					Gadwall				
Unid. Loon					Pintail				
Red-Necked Grebe					Green-winged Teal				
Horned Grebe					American Widgeon				
Western Grebe					Shoveler				
Black-footed Albatross					Redhead				
Laysan Albatross					Canvasback				
Unid. Albatross					Greater Scaup				
Fulmar					Lesser Scaup				
Pink-footed Shearwater					Unid. Scaup				
New Zealand Shearwater					Common Goldeneye				
Sooty Shearwater					Barrow's Goldeneye				
Short-tailed Shearwater					Bufflehead				
Unid. Shearwater					Oldsquaw				
Scaled Petrel					Harlequin Duck				
Fork-tailed Storm Petrel					Steller's Eider				
Leach's Storm Petrel					Common Eider				
Ashy Storm Petrel					King Eider				
Unid. Storm Petrel					Spectacled Eider				
Brown Pelican					Unid. Eider				
Double-crested Cormorant					White-winged Scoter				
Brandt's Cormorant					Surf Scoter				
Pelagic Cormorant					Black Scoter				
Red-faced Cormorant					Unid. Scoter				
Unid. Cormorant					Unid. Duck				
Whistling Swan					Red-breasted Merganser				
Canada Goose					Bald Eagle				
Black Brant					Gyrfalcon				
Emperor Goose					Peregrine Falcon				
White-fronted Goose					Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
American Golden Plover					Sabine's Gull				
Unid. Turnstone					Unid. Immature Gull				
Ruddy Turnstone					Unid. Gull				
Black Turnstone					Common Tern				
Whimbrel					Arctic Tern				
Sharp-tailed Sandpiper					Aleutian Tern				
Unid. Sandpiper					Unid. Tern				
Red Phalarope					Common Murre				
Northern Phalarope					Thick-billed Murre				
Unid. Phalarope					Unid. Murre				
Pomarine Jaeger					Unid. Guillemot				
Parasitic Jaeger					Black Guillemot				
Long-tailed jaeger					Pigeon Guillemot				
Unid. Jaeger					Unid. Large Alcid				
Skua					Marbled Murrelet				
Glaucous Gull					Kittlitz's Murrelet				
Glaucous-winged Gull	1	33	4	0.9	Xantus' Murrelet				
Slaty-backed Gull					Ancient Murrelet				
Western Gull					Unid. Murrelet				
Herring Gull					Cassin's Auklet				
Herring/Glaucous-wg. Hyb.					Parakeet Auklet				
Thayer's Gull					Crested Auklet				
California Gull					Least Auklet				
Ring-billed Gull					Rhinoceros Auklet				
Mew Gull					Unid. Small Alcid				
Black-headed Gull					Horned Puffin				
Bonaparte's Gull					Tufted Puffin				
Heermann's Gull					Unid. Puffin				
Ivory Gull					Short-eared Owl				
Unid. Kittiwake					Snowy Owl				
Black-legged Kittiwake					Tree Swallow				
Red-legged Kittiwake					Black Swallow				
Ross' Gull					Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			4	0.9					

Cruise numbers data are compiled from: 76-15

Table 8. Bird observations on aerial transects, Lower Cook Inlet, January, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar				
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater	1	17	1	tr.
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant				
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider				
Common Eider				
King Eider				
Spectacled Eider				
Unid. Eider				
White-winged Scoter				
Surf Scoter				
Black Scoter				
Unid. Scoter				
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	3	50	6	0.5
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	1	17	2	0.2
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull	1	17	1	tr.
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	3	50	15	1.4
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			25	2.3					

Cruise numbers data are compiled from: 76-1

Table 9. Bird observations on aerial transects, Lower Cook Inlet, March, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar				
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	6	46	129	6.9
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw	4	31	28	1.5
Harlequin Duck				
Steller's Eider				
Common Eider				
King Eider	1	8	50	2.7
Spectacled Eider				
Unid. Eider	3	23	37	2.0
White-winged Scoter	6	46	205	11.0
Surf Scoter	2	15	20	1.1
Black Scoter	5	38	272	14.6
Unid. Scoter	4	31	64	3.4
Unid. Duck	1	8	8	0.4
Red-breasted Merganser				
Bald Eagle	1	8	2	0.1
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	8	62	25	1.3
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull	2	15	2	0.1
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake				
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull	1	8	2	0.1
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	9	69	192	10.3
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid	3	23	32	1.7
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven Water Pipit Bohemian Waxwing									
Orange-crowned Warbler Townsend's Warbler Wilson's Warbler									
Pine Siskin Savannah Sparrow White-crowned Sparrow									
Lapland Longspur Unid. Passerine Unid. Bird	 3	 23	 17	 0.9					
Totals/Average			1085	58.3					

Cruise numbers data are compiled from: 76-6 and 76-14

Table 10. Bird observations on aerial transects, Lower Cook Inlet, April, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar				
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant				
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider				
Common Eider				
King Eider				
Spectacled Eider				
Unid. Eider				
White-winged Scoter				
Surf Scoter				
Black Scoter	1	7	2	0.1
Unid. Scoter				
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occur-ence	% Occurence	No. Birds	Birds/km²
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	4	27	11	0.5
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	1	7	60	3.0
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occur-ence	% Occurence	No. Birds	Birds/km²
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	4	27	56	2.8
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			129	6.4					

Cruise numbers data are compiled from: 76-15

Table 11. Bird observations on aerial transects, Navarin Basin, February, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²
Common Loon					Snow Goose				
Yellow-billed Loon					Unid. Goose				
Arctic Loon					Mallard				
Red-throated Loon					Gadwall				
Unid. Loon					Pintail				
Red-Necked Grebe					Green-winged Teal				
Horned Grebe					American Widgeon				
Western Grebe					Shoveler				
Black-footed Albatross					Redhead				
Laysan Albatross					Canvasback				
Unid. Albatross					Greater Scaup				
Fulmar					Lesser Scaup				
Pink-footed Shearwater					Unid. Scaup				
New Zealand Shearwater					Common Goldeneye				
Sooty Shearwater					Barrow's Goldeneye				
Short-tailed Shearwater					Bufflehead				
Unid. Shearwater					Oldsquaw				
Scaled Petrel					Harlequin Duck				
Fork-tailed Storm Petrel					Steller's Eider				
Leach's Storm Petrel					Common Eider				
Ashy Storm Petrel					King Eider				
Unid. Storm Petrel					Spectacled Eider				
Brown Pelican					Unid. Eider				
Double-crested Cormorant					White-winged Scoter				
Brandt's Cormorant					Surf Scoter				
Pelagic Cormorant					Black Scoter				
Red-faced Cormorant					Unid. Scoter				
Unid. Cormorant					Unid. Duck				
Whistling Swan					Red-breasted Merganser				
Canada Goose					Bald Eagle				
Black Brant					Gyrfalcon				
Emperor Goose					Peregrine Falcon				
White-fronted Goose					Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
American Golden Plover					Sabine's Gull				
Unid. Turnstone					Unid. Immature Gull				
Ruddy Turnstone					Unid. Gull				
Black Turnstone					Common Tern				
Whimbrel					Arctic Tern				
Sharp-tailed Sandpiper					Aleutian Tern				
Unid. Sandpiper					Unid. Tern				
Red Phalarope					Common Murre				
Northern Phalarope					Thick-billed Murre				
Unid. Phalarope					Unid. Murre	1	17	22	2.0
Pomarine Jaeger					Unid. Guillemot				
Parasitic Jaeger					Black Guillemot				
Long-tailed jaeger					Pigeon Guillemot				
Unid. Jaeger					Unid. Large Alcid				
Skua					Marbled Murrelet				
Glaucous Gull					Kittlitz's Murrelet				
Glaucous-winged Gull	1	17	1	0.1	Xantus' Murrelet				
Slaty-backed Gull					Ancient Murrelet				
Western Gull					Unid. Murrelet				
Herring Gull					Cassin's Auklet				
Herring/Glaucous-wg. Hyb.					Parakeet Auklet	1	17	4	0.4
Thayer's Gull					Crested Auklet				
California Gull					Least Auklet	1	17	203	18.3
Ring-billed Gull					Rhinoceros Auklet				
Mew Gull					Unid. Small Alcid				
Black-headed Gull					Horned Puffin				
Bonaparte's Gull					Tufted Puffin				
Heermann's Gull					Unid. Puffin				
Ivory Gull	1	17	1	0.1	Short-eared Owl				
Unid. Kittiwake					Snowy Owl				
Black-legged Kittiwake	1	17	1	0.1	Tree Swallow				
Red-legged Kittiwake					Black Swallow				
Ross' Gull					Unid. Swallow				

Table Continued.

Species Name	Occurence	% Occurence	No. Birds	Birds/km²	Species Name	Occurence	% Occurence	No. Birds	Birds/km²
Common Raven Water Pipit Bohemian Waxwing									
Orange-crowned Warbler Townsend's Warbler Wilson's Warbler									
Pine Siskin Savannah Sparrow White-crowned Sparrow									
Lapland Longspur Unid. Passerine Unid. Bird	1	17	5	0.5					
Totals/Average			237	21.4					

Cruise numbers data are compiled from: [illegible]

Table 12. Bird observations on aerial transects, Northeast Gulf of Alaska, March, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	31	30	91	0.8
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	1	1	1	tr.
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw	3	3	9	0.1
Harlequin Duck				
Steller's Eider				
Common Eider				
King Eider				
Spectacled Eider				
Unid. Eider				
White-winged Scoter	2	2	3	tr.
Surf Scoter				
Black Scoter	3	3	27	0.2
Unid. Scoter	1	1	8	0.1
Unid. Duck				
Red-breasted Merganser	1	1	5	tr.
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper	1	1	25	0.2
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	23	21	54	0.5
Slaty-backed Gull				
Western Gull				
Herring Gull	5	5	5	tr.
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	53	52	158	1.4
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull	1	1	1	tr.
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	24	24	89	0.8
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet	1	1	7	0.1
Unid. Small Alcid	5	5	9	0.1
Horned Puffin				
Tufted Puffin	15	15	103	0.9
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	2	2	3	tr.					
Totals/Average			598	5.3					

Cruise numbers data are compiled from: 76-14

Table 13. Bird observations on aerial transects, Northwest Gulf of Alaska, January, 1976.

Species Name	Occurrence	% Occurrence	No. Birds	Birds/Km²
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	4	23	17	0.6
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	4	24	297	10.3
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider	1	6	40	1.4
Common Eider				
King Eider				
Spectacled Eider				
Unid. Eider	2	12	145	5.0
White-winged Scoter	2	12	3	0.1
Surf Scoter				
Black Scoter	1	6	52	1.8
Unid. Scoter				
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
American Golden Plover					Sabine's Gull				
Unid. Turnstone					Unid. Immature Gull				
Ruddy Turnstone					Unid. Gull				
Black Turnstone					Common Tern				
Whimbrel					Arctic Tern				
Sharp-tailed Sandpiper					Aleutian Tern				
Unid. Sandpiper					Unid. Tern				
Red Phalarope					Common Murre				
Northern Phalarope					Thick-billed Murre				
Unid. Phalarope					Unid. Murre	7	41	78	2.7
Pomarine Jaeger					Unid. Guillemot				
Parasitic Jaeger					Black Guillemot				
Long-tailed jaeger					Pigeon Guillemot				
Unid. Jaeger					Unid. Large Alcid	1	6	1	tr.
Skua					Marbled Murrelet				
Glaucous Gull					Kittlitz's Murrelet				
Glaucous-winged Gull	10	59	54	1.9	Xantus' Murrelet				
Slaty-backed Gull					Ancient Murrelet				
Western Gull					Unid. Murrelet				
Herring Gull					Cassin's Auklet				
Herring/Glaucous-wg. Hyb.					Parakeet Auklet				
Thayer's Gull					Crested Auklet				
California Gull					Least Auklet				
Ring-billed Gull					Rhinoceros Auklet				
Mew Gull					Unid. Small Alcid	8	47	174	6.0
Black-headed Gull					Horned Puffin				
Bonaparte's Gull					Tufted Puffin				
Heermann's Gull					Unid. Puffin				
Ivory Gull					Short-eared Owl				
Unid. Kittiwake					Snowy Owl				
Black-legged Kittiwake	5	29	12	0.4	Tree Swallow				
Red-legged Kittiwake					Black Swallow				
Ross' Gull					Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			873	30.3					

Cruise numbers data are compiled from: 76-1

Table 14. Bird observations on aerial transects, Northwest Gulf of Alaska, March, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	10	15	130	1.6
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel	4	6	33	0.4
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	6	9	33	0.4
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider				
Common Eider	1	2	7	0.1
King Eider				
Spectacled Eider				
Unid. Eider	2	3	101	1.3
White-winged Scoter	1	2	3	tr.
Surf Scoter				
Black Scoter	2	3	24	0.3
Unid. Scoter	2	3	14	0.2
Unid. Duck	1	2	3	tr.
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	27	41	200	2.5
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull	4	6	5	0.1
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	24	36	190	2.4
Red-legged Kittiwake				
Ross' Gull				
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull	3	5	3	tr.
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	38	58	311	3.9
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet	1	2	25	0.3
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin				
Tufted Puffin	2	3	7	0.1
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurrence	No. Birds	Birds/km²	Species Name	Occurrence	% Occurrence	No. Birds	Birds/km²
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	1	2	17	0.2					
Totals/Average			1106	13.9					

Cruise numbers data are compiled from: 76-6 and 76-14

Table 15. Bird observations on aerial transects, Northwest Gulf of Alaska, April, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²
Common Loon					Snow Goose				
Yellow-billed Loon					Unid. Goose				
Arctic Loon					Mallard				
Red-throated Loon					Gadwall				
Unid. Loon					Pintail				
Red-Necked Grebe					Green-winged Teal				
Horned Grebe					American Widgeon				
Western Grebe					Shoveler				
Black-footed Albatross					Redhead				
Laysan Albatross					Canvasback				
Unid. Albatross					Greater Scaup				
Fulmar					Lesser Scaup				
Pink-footed Shearwater					Unid. Scaup				
New Zealand Shearwater					Common Goldeneye				
Sooty Shearwater					Barrow's Goldeneye				
Short-tailed Shearwater					Bufflehead				
Unid. Shearwater					Oldsquaw				
Scaled Petrel					Harlequin Duck				
Fork-tailed Storm Petrel					Steller's Eider				
Leach's Storm Petrel					Common Eider				
Ashy Storm Petrel					King Eider				
Unid. Storm Petrel					Spectacled Eider				
Brown Pelican					Unid. Eider				
Double-crested Cormorant					White-winged Scoter	1	14	3	0.3
Brandt's Cormorant					Surf Scoter				
Pelagic Cormorant					Black Scoter				
Red-faced Cormorant					Unid. Scoter				
Unid. Cormorant	3	43	9	0.9	Unid. Duck				
Whistling Swan					Red-breasted Merganser				
Canada Goose					Bald Eagle				
Black Brant					Gyrfalcon				
Emperor Goose					Peregrine Falcon				
White-fronted Goose					Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	5	71	31	3.1
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	1	1	14	0.1
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	7	100	58	5.8
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	1	14	1	0.1					
Totals/Average			116	11.6					

Cruise numbers data are compiled from: 76-15

Table 16. Bird observations on aerial transects, Prince William Sound, March, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar				
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	1	25	1	0.2
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider				
Common Eider				
King Eider				
Spectacled Eider				
Unid. Eider				
White-winged Scoter				
Surf Scoter				
Black Scoter				
Unid. Scoter				
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull				
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	1	25	1	0.2
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre				
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			2	0.3					

Cruise numbers data are compiled from: 76-14

Table 17. Bird observations on aerial transects, St. George Basin, February, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	26	27	205	1.8
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel	14	14	49	0.4
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant				
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider				
Common Eider				
King Eider	1	1	150	1.3
Spectacled Eider				
Unid. Eider	1	1	8	0.1
White-winged Scoter				
Surf Scoter				
Black Scoter				
Unid. Scoter				
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	13	13	28	0.2
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	6	6	9	0.1
Red-legged Kittiwake	2	2	11	0.1
Ross' Gull				

Species Name	Occurence	% Occurence	No. Birds	Birds/km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull	4	4	6	0.1
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	25	25	3882	33.8
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid	1	1	3	tr.
Marbled Murrelet				
Kittlitz's Murrelet	2	2	3	tr.
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet	4	4	6	0.1
Crested Auklet	1	1	1	tr.
Least Auklet	7	7	44	0.4
Rhinoceros Auklet				
Unid. Small Alcid	5	5	5	tr.
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	2	2	2	tr.					
Totals/Average			4412	38.5					

Table 18. Bird observations on aerial transects, St. George Basin, March, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	5	28	14	0.7
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	3	17	12	0.6
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider				
Common Eider				
King Eider				
Spectacled Eider				
Unid. Eider				
White-winged Scoter				
Surf Scoter				
Black Scoter				
Unid. Scoter	1	6	2	0.1
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occur-ence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	10	56	26	1.3
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	1	6	2	0.1
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occur-ence	% Occurence	No. Birds	Birds/Km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre	2	11	18	0.9
Unid. Murre	8	44	106	5.4
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet	1	6	3	0.2
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin	1	6	1	0.1
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	1	6	1	0.1					
Totals/Average			185	9.4					

Cruise numbers data are compiled from: 76-6

Table 19. Bird observations on aerial transects, Shelikof Strait, January, 1976.

Species Name	Occurence	% Occurence	No. Birds	Birds/Km²
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar				
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant				
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				

Species Name	Occurence	% Occurence	No. Birds	Birds/km²
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider	1	50	700	190.
Common Eider				
King Eider				
Spectacled Eider				
Unid. Eider				
White-winged Scoter				
Surf Scoter				
Black Scoter				
Unid. Scoter				
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	1	50	4	1.1
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake				
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre				
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid	1	50	1	0.3
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurence	% Occurance	No. Birds	Birds/km²
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			705	191					

Cruise numbers data are compiled from: 76-1

Table 20. Bird observations on aerial transects, Shelikof Strait, March, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	6	35	14	0.6
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel				
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	1	6	25	1.2
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose				
White-fronted Goose				
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider	1	6	1	tr.
Common Eider	4	23	156	7.2
King Eider				
Spectacled Eider				
Unid. Eider	1	6	5	0.2
White-winged Scoter	2	12	142	6.5
Surf Scoter				
Black Scoter	2	12	25	1.2
Unid. Scoter	2	12	175	8.1
Unid. Duck				
Red-breasted Merganser				
Bald Eagle				
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occur-ence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occur-ence	% Occurence	No. Birds	Birds/km^2
American Golden Plover					Sabine's Gull				
Unid. Turnstone					Unid. Immature Gull				
Ruddy Turnstone					Unid. Gull				
Black Turnstone					Common Tern				
Whimbrel					Arctic Tern				
Sharp-tailed Sandpiper					Aleutian Tern				
Unid. Sandpiper					Unid. Tern				
Red Phalarope					Common Murre				
Northern Phalarope					Thick-billed Murre				
Unid. Phalarope					Unid. Murre	11	65	289	13.3
Pomarine Jaeger					Unid. Guillemot				
Parasitic Jaeger					Black Guillemot				
Long-tailed jaeger					Pigeon Guillemot				
Unid. Jaeger					Unid. Large Alcid				
Skua					Marbled Murrelet				
Glaucous Gull					Kittlitz's Murrelet				
Glaucous-winged Gull	8	47	41	1.9	Xantus' Murrelet				
Slaty-backed Gull					Ancient Murrelet				
Western Gull					Unid. Murrelet				
Herring Gull					Cassin's Auklet				
Herring/Glaucous-wg. Hyb.					Parakeet Auklet				
Thayer's Gull					Crested Auklet				
California Gull					Least Auklet				
Ring-billed Gull					Rhinoceros Auklet				
Mew Gull					Unid. Small Alcid				
Black-headed Gull					Horned Puffin				
Bonaparte's Gull					Tufted Puffin				
Heermann's Gull					Unid. Puffin				
Ivory Gull					Short-eared Owl				
Unid. Kittiwake					Snowy Owl				
Black-legged Kittiwake	6	35	21	1.0	Tree Swallow				
Red-legged Kittiwake					Black Swallow				
Ross' Gull					Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	1	6	5	0.2					
Totals/Average			899	41.4					

Cruise numbers data are compiled from: 76-6

Table 21. Bird observations on aerial transects, Shelikof Strait, April, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Loon					Snow Goose				
Yellow-billed Loon					Unid. Goose				
Arctic Loon					Mallard				
Red-throated Loon					Gadwall				
Unid. Loon					Pintail				
Red-Necked Grebe					Green-winged Teal				
Horned Grebe					American Widgeon				
Western Grebe					Shoveler				
Black-footed Albatross					Redhead				
Laysan Albatross					Canvasback				
Unid. Albatross					Greater Scaup				
Fulmar					Lesser Scaup				
Pink-footed Shearwater					Unid. Scaup				
New Zealand Shearwater					Common Goldeneye				
Sooty Shearwater					Barrow's Goldeneye				
Short-tailed Shearwater					Bufflehead				
Unid. Shearwater					Oldsquaw				
Scaled Petrel					Harlequin Duck				
Fork-tailed Storm Petrel					Steller's Eider				
Leach's Storm Petrel					Common Eider				
Ashy Storm Petrel					King Eider				
Unid. Storm Petrel					Spectacled Eider				
Brown Pelican					Unid. Eider				
Double-crested Cormorant					White-winged Scoter				
Brandt's Cormorant					Surf Scoter				
Pelagic Cormorant					Black Scoter				
Red-faced Cormorant					Unid. Scoter				
Unid. Cormorant	1	50	2	0.5	Unid. Duck				
Whistling Swan					Red-breasted Merganser				
Canada Goose					Bald Eagle				
Black Brant					Gyrfalcon				
Emperor Goose					Peregrine Falcon				
White-fronted Goose					Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	1	50	3	0.8
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake				
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre	2	100	13	3.5
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			18	4.9					

Cruise numbers data are compiled from: 76-15

Table 22. Bird observations on aerial transects, Upper Cook Inlet, March, 1976.

Species Name	Occurrence	% Occurrence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²
Common Loon					Snow Goose				
Yellow-billed Loon					Unid. Goose				
Arctic Loon					Mallard				
Red-throated Loon					Gadwall				
Unid. Loon					Pintail				
Red-Necked Grebe					Green-winged Teal				
Horned Grebe					American Widgeon				
Western Grebe					Shoveler				
Black-footed Albatross					Redhead				
Laysan Albatross					Canvasback				
Unid. Albatross					Greater Scaup				
Fulmar					Lesser Scaup				
Pink-footed Shearwater					Unid. Scaup				
New Zealand Shearwater					Common Goldeneye				
Sooty Shearwater					Barrow's Goldeneye				
Short-tailed Shearwater					Bufflehead				
Unid. Shearwater					Oldsquaw				
Scaled Petrel					Harlequin Duck				
Fork-tailed Storm Petrel					Steller's Eider				
Leach's Storm Petrel					Common Eider				
Ashy Storm Petrel					King Eider				
Unid. Storm Petrel					Spectacled Eider				
Brown Pelican					Unid. Eider				
Double-crested Cormorant					White-winged Scoter				
Brandt's Cormorant					Surf Scoter				
Pelagic Cormorant					Black Scoter				
Red-faced Cormorant					Unid. Scoter				
Unid. Cormorant					Unid. Duck				
Whistling Swan					Red-breasted Merganser				
Canada Goose					Bald Eagle				
Black Brant					Gyrfalcon				
Emperor Goose					Peregrine Falcon				
White-fronted Goose					Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper	1	50	25	7.1
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull				
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake				
Red-legged Kittiwake				
Ross' Gull				

Species Name	Occurrence	% Occurance	No. Birds	Birds/km²
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre				
Unid. Murre				
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet				
Crested Auklet				
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid				
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurrence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			25	7.1					

Cruise numbers data are compiled from: 76-14

Table 23. Bird observations on aerial transects, Upper Cook Inlet, April, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km²	Species Name	Occurrence	% Occurence	No. Birds	Birds/km²
Common Loon					Snow Goose				
Yellow-billed Loon					Unid. Goose				
Arctic Loon					Mallard				
Red-throated Loon					Gadwall				
Unid. Loon					Pintail				
Red-Necked Grebe					Green-winged Teal				
Horned Grebe					American Widgeon				
Western Grebe					Shoveler				
Black-footed Albatross					Redhead				
Laysan Albatross					Canvasback				
Unid. Albatross					Greater Scaup				
Fulmar					Lesser Scaup				
Pink-footed Shearwater					Unid. Scaup				
New Zealand Shearwater					Common Goldeneye				
Sooty Shearwater					Barrow's Goldeneye				
Short-tailed Shearwater					Bufflehead				
Unid. Shearwater					Oldsquaw				
Scaled Petrel					Harlequin Duck				
Fork-tailed Storm Petrel					Steller's Eider				
Leach's Storm Petrel					Common Eider				
Ashy Storm Petrel					King Eider				
Unid. Storm Petrel					Spectacled Eider				
Brown Pelican					Unid. Eider				
Double-crested Cormorant					White-winged Scoter				
Brandt's Cormorant					Surf Scoter				
Pelagic Cormorant					Black Scoter				
Red-faced Cormorant					Unid. Scoter				
Unid. Cormorant					Unid. Duck				
Whistling Swan					Red-breasted Merganser				
Canada Goose					Bald Eagle				
Black Brant					Gyrfalcon				
Emperor Goose					Peregrine Falcon				
White-fronted Goose					Black Oystercatcher				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
American Golden Plover					Sabine's Gull				
Unid. Turnstone					Unid. Immature Gull				
Ruddy Turnstone					Unid. Gull				
Black Turnstone					Common Tern				
Whimbrel					Arctic Tern				
Sharp-tailed Sandpiper					Aleutian Tern				
Unid. Sandpiper					Unid. Tern				
Red Phalarope					Common Murre				
Northern Phalarope					Thick-billed Murre				
Unid. Phalarope					Unid. Murre				
Pomarine Jaeger					Unid. Guillemot				
Parasitic Jaeger					Black Guillemot				
Long-tailed jaeger					Pigeon Guillemot				
Unid. Jaeger					Unid. Large Alcid				
Skua					Marbled Murrelet				
Glaucous Gull					Kittlitz's Murrelet				
Glaucous-winged Gull					Xantus' Murrelet				
Slaty-backed Gull					Ancient Murrelet				
Western Gull					Unid. Murrelet				
Herring Gull					Cassin's Auklet				
Herring/Glaucous-wg. Hyb.					Parakeet Auklet				
Thayer's Gull					Crested Auklet				
California Gull					Least Auklet				
Ring-billed Gull					Rhinoceros Auklet				
Mew Gull					Unid. Small Alcid				
Black-headed Gull					Horned Puffin				
Bonaparte's Gull					Tufted Puffin				
Heermann's Gull					Unid. Puffin				
Ivory Gull					Short-eared Owl				
Unid. Kittiwake					Snowy Owl				
Black-legged Kittiwake					Tree Swallow				
Red-legged Kittiwake					Black Swallow				
Ross' Gull					Unid. Swallow				

Table Continued.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occurrence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird									
Totals/Average			0	0					

Cruise numbers data are compiled from: 76-15

Table 24. Bird observations on aerial transects, Umnak Basin, March, 1976.

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Common Loon				
Yellow-billed Loon				
Arctic Loon				
Red-throated Loon				
Unid. Loon				
Red-Necked Grebe				
Horned Grebe				
Western Grebe				
Black-footed Albatross				
Laysan Albatross				
Unid. Albatross				
Fulmar	31	48	68	0.9
Pink-footed Shearwater				
New Zealand Shearwater				
Sooty Shearwater				
Short-tailed Shearwater				
Unid. Shearwater				
Scaled Petrel				
Fork-tailed Storm Petrel	3	5	5	0.1
Leach's Storm Petrel				
Ashy Storm Petrel				
Unid. Storm Petrel				
Brown Pelican				
Double-crested Cormorant				
Brandt's Cormorant				
Pelagic Cormorant				
Red-faced Cormorant				
Unid. Cormorant	8	12	22	0.3
Whistling Swan				
Canada Goose				
Black Brant				
Emperor Goose	3	5	316	4.0
White-fronted Goose				

Species Name	Occurrence	% Occurence	No. Birds	Birds/Km^2
Snow Goose				
Unid. Goose				
Mallard				
Gadwall				
Pintail				
Green-winged Teal				
American Widgeon				
Shoveler				
Redhead				
Canvasback				
Greater Scaup				
Lesser Scaup				
Unid. Scaup				
Common Goldeneye				
Barrow's Goldeneye				
Bufflehead				
Oldsquaw				
Harlequin Duck				
Steller's Eider	4	6	27	0.3
Common Eider	1	2	2	tr.
King Eider	2	3	5	0.1
Spectacled Eider				
Unid. Eider	7	11	29	0.4
White-winged Scoter	1	2	9	0.1
Surf Scoter				
Black Scoter				
Unid. Scoter	2	3	4	0.1
Unid. Duck				
Red-breasted Merganser				
Bald Eagle	3	5	7	0.1
Gyrfalcon				
Peregrine Falcon				
Black Oystercatcher				

Table Continued.

Species Name	Occur-ence	% Occurence	No. Birds	Birds/Km^2
American Golden Plover				
Unid. Turnstone				
Ruddy Turnstone				
Black Turnstone				
Whimbrel				
Sharp-tailed Sandpiper				
Unid. Sandpiper				
Red Phalarope				
Northern Phalarope				
Unid. Phalarope				
Pomarine Jaeger				
Parasitic Jaeger				
Long-tailed jaeger				
Unid. Jaeger				
Skua				
Glaucous Gull				
Glaucous-winged Gull	14	22	598	7.6
Slaty-backed Gull				
Western Gull				
Herring Gull				
Herring/Glaucous-wg. Hyb.				
Thayer's Gull				
California Gull				
Ring-billed Gull				
Mew Gull				
Black-headed Gull				
Bonaparte's Gull				
Heermann's Gull				
Ivory Gull				
Unid. Kittiwake				
Black-legged Kittiwake	14	22	17	0.2
Red-legged Kittiwake	1	2	1	tr.
Ross' Gull				

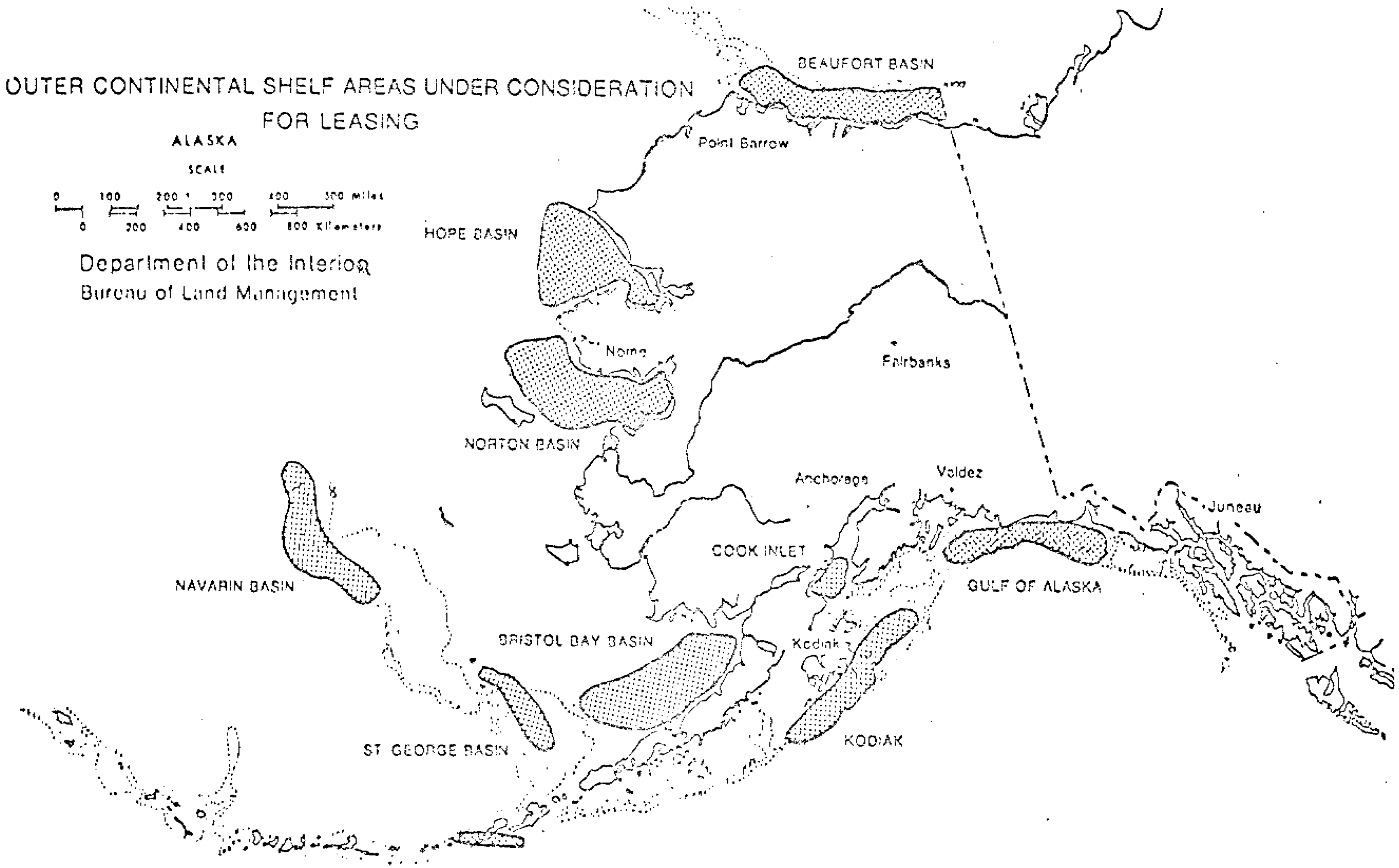
Species Name	Occur-ence	% Occurence	No. Birds	Birds/Km^2
Sabine's Gull				
Unid. Immature Gull				
Unid. Gull				
Common Tern				
Arctic Tern				
Aleutian Tern				
Unid. Tern				
Common Murre				
Thick-billed Murre	8	12	18	0.2
Unid. Murre	15	23	83	1.1
Unid. Guillemot				
Black Guillemot				
Pigeon Guillemot				
Unid. Large Alcid				
Marbled Murrelet				
Kittlitz's Murrelet				
Xantus' Murrelet				
Ancient Murrelet				
Unid. Murrelet				
Cassin's Auklet				
Parakeet Auklet	2	3	3	tr.
Crested Auklet	1	2	15	0.2
Least Auklet				
Rhinoceros Auklet				
Unid. Small Alcid	1	2	2	tr.
Horned Puffin				
Tufted Puffin				
Unid. Puffin				
Short-eared Owl				
Snowy Owl				
Tree Swallow				
Black Swallow				
Unid. Swallow				

Table Continued.

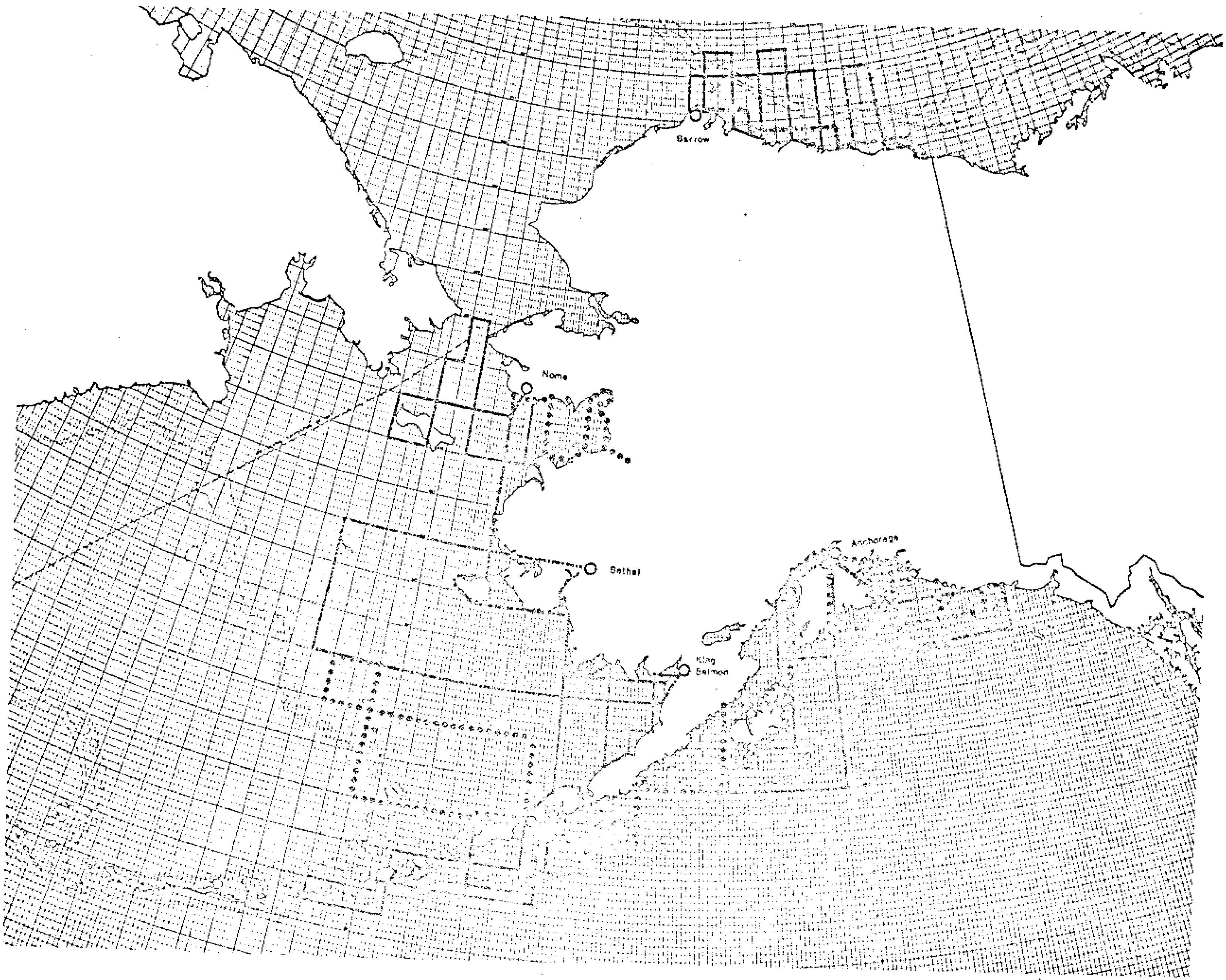
Species Name	Occur-ence	% Occurence	No. Birds	Birds/Km^2	Species Name	Occur-ence	% Occurence	No. Birds	Birds/km^2
Common Raven									
Water Pipit									
Bohemian Waxwing									
Orange-crowned Warbler									
Townsend's Warbler									
Wilson's Warbler									
Pine Siskin									
Savannah Sparrow									
White-crowned Sparrow									
Lapland Longspur									
Unid. Passerine									
Unid. Bird	2	3	2	tr.					
Totals/Average			1233	15.8					

Cruise numbers data are compiled from: 76-6

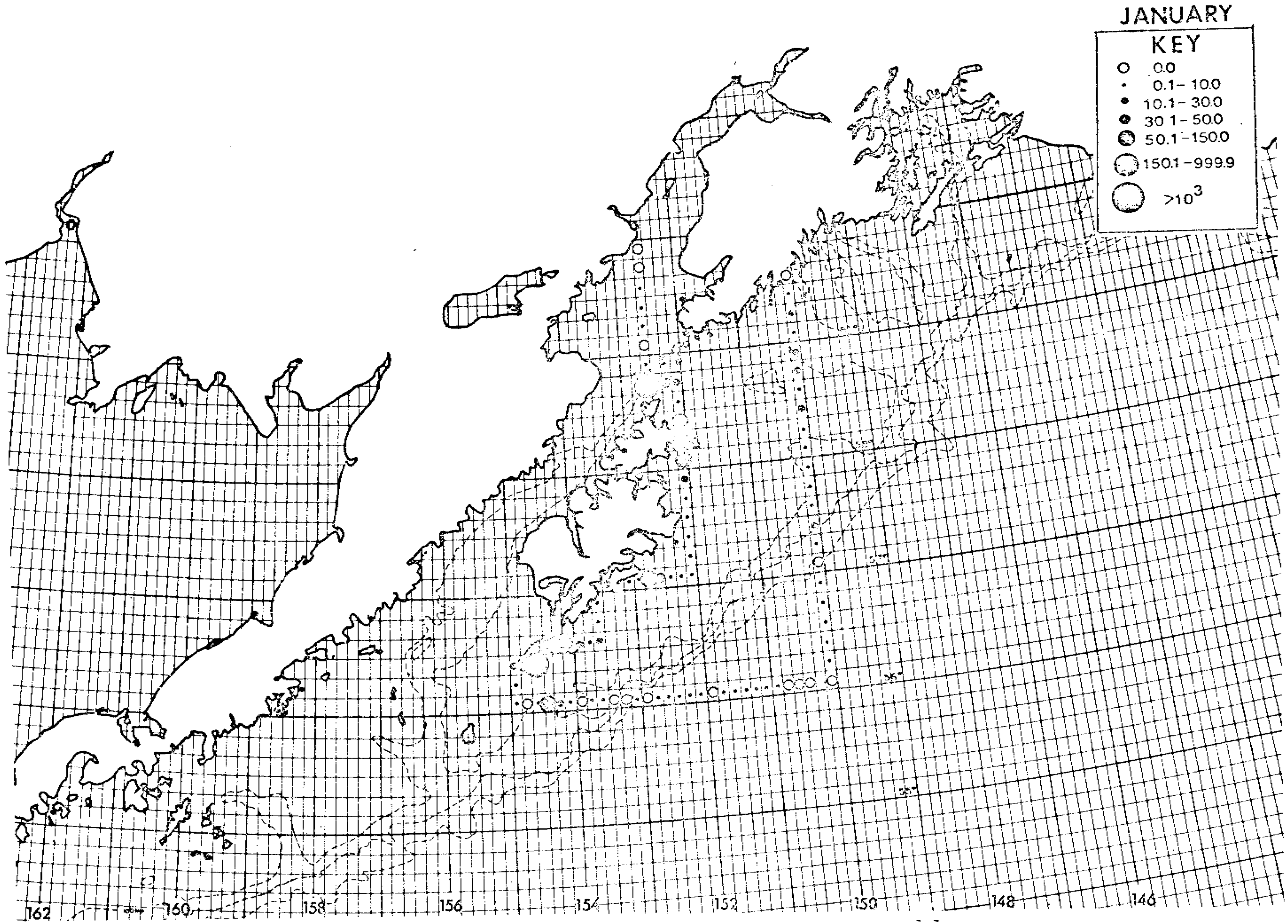
Map 1. Oceanographic regions for which aerial survey data on marine birds are summarized.



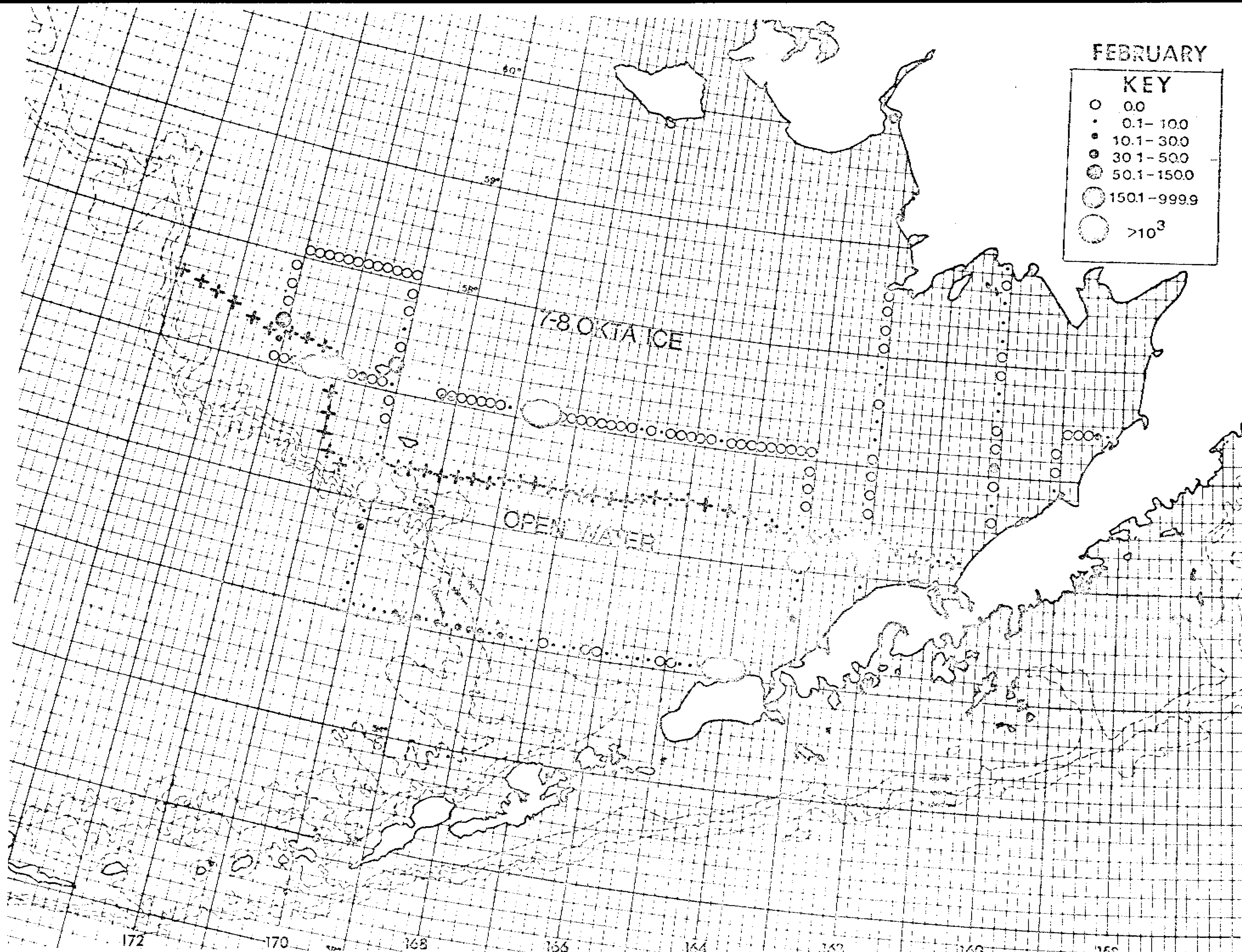
Map 2. Outer continental shelf areas under consideration for leasing (from U.S.D.I. News Release, BLM, November 14, 1974, "BLM announces new tentative OCS lease sale schedule through 1978").



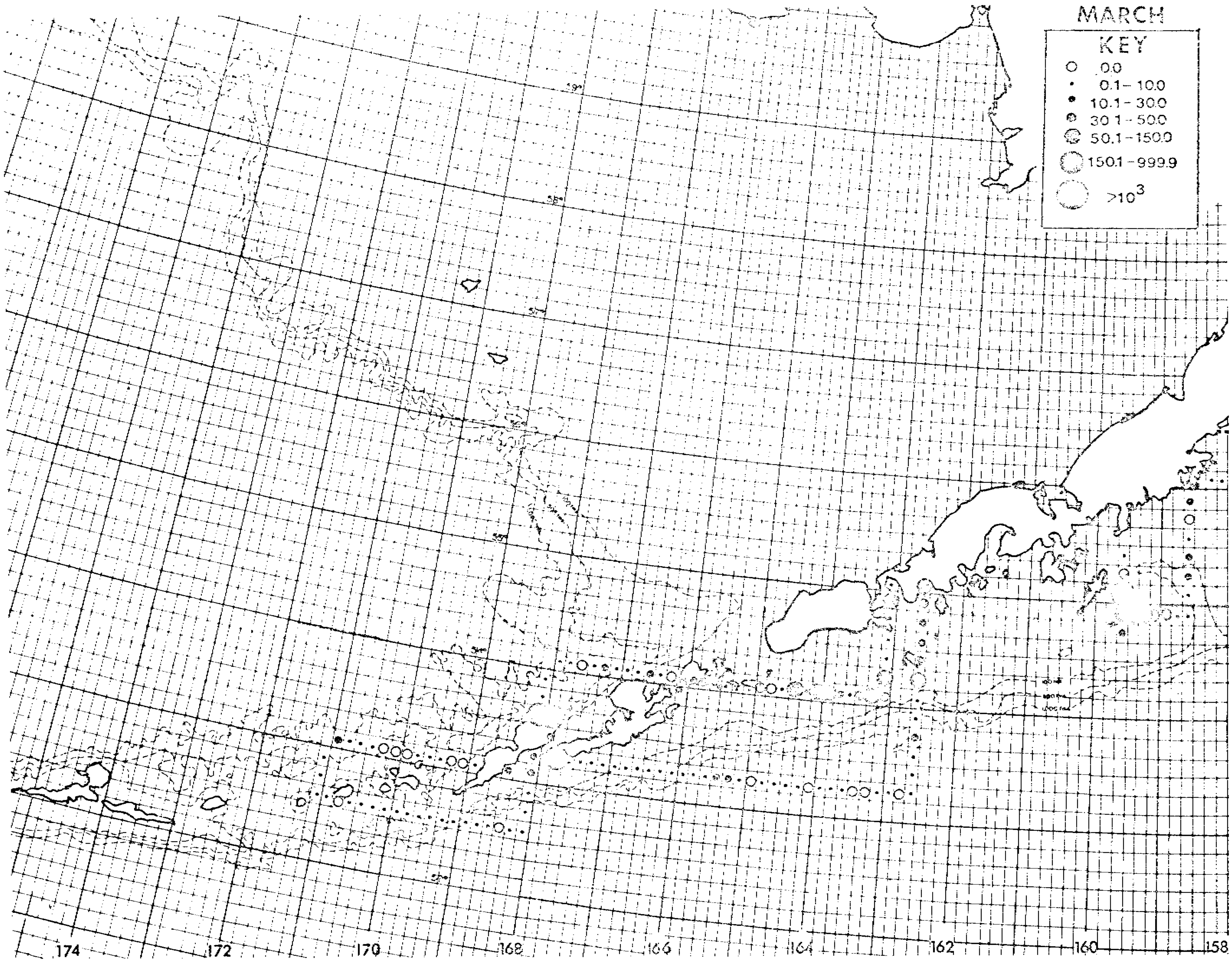
Map 3. Coverage of aerial surveys of marine birds during 1975 and the first half of 1976, with transect lines being differentiated by symbols for each day of survey.



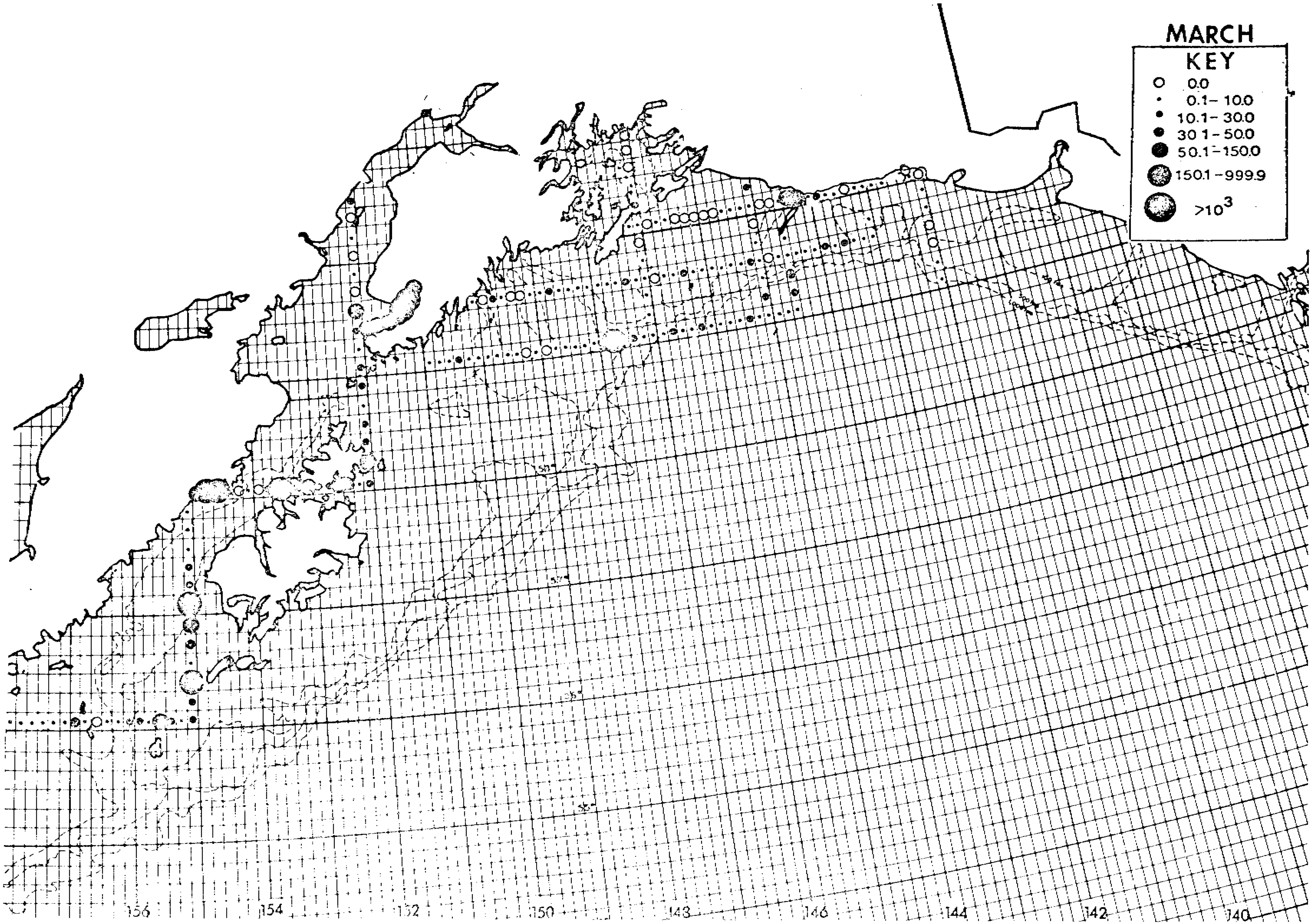
Map 4. Aerial transects showing density of birds per Km^2 for all areas surveyed in January, 1976.



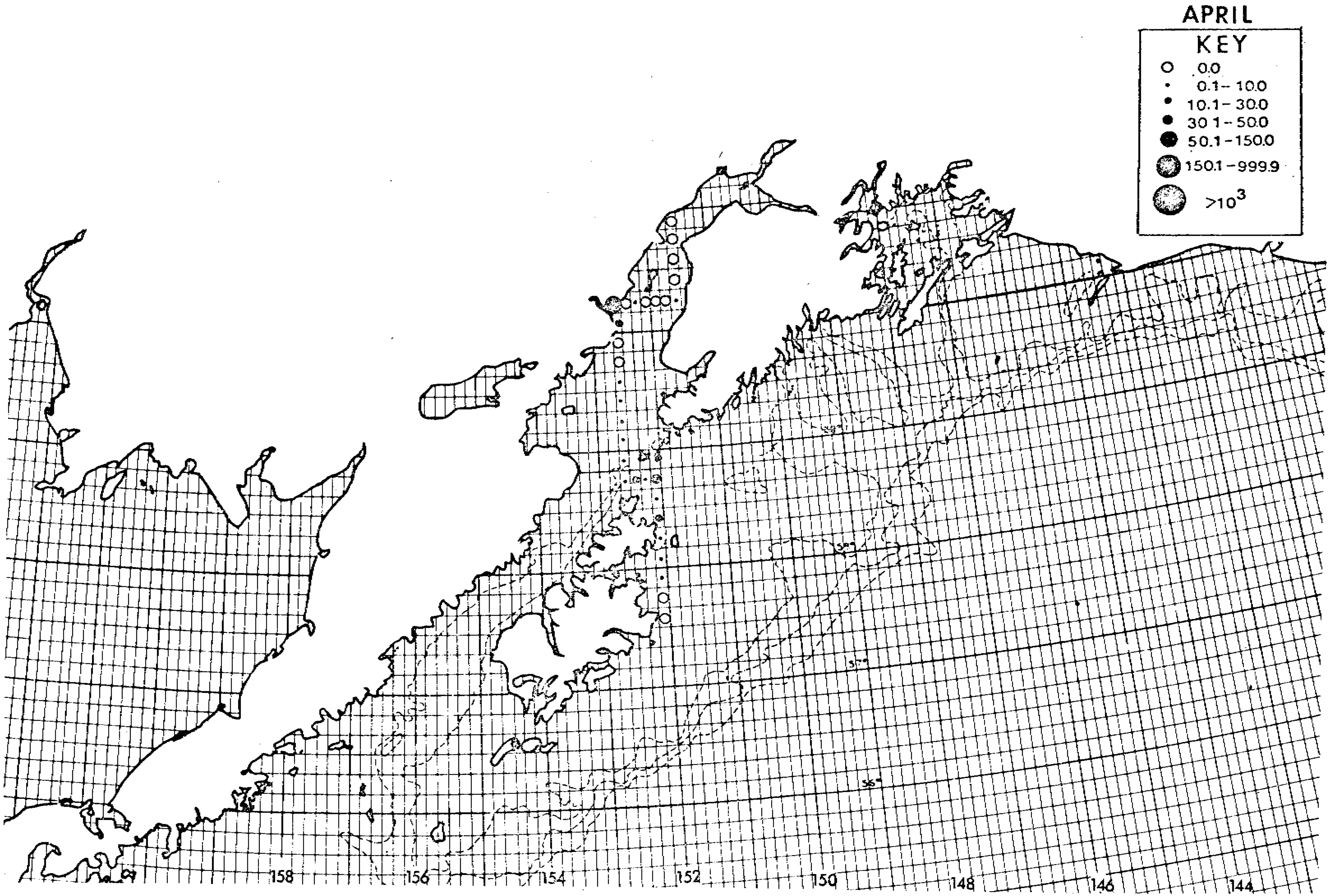
Map 5. Aerial transects showing density of birds per km^2 for all areas surveyed in February, 1976.



Map 6a. Aerial transects showing density of birds per Km² for all areas surveyed in March, 1976.



Map 6b. Aerial transects showing density of birds per Km^2 for all areas surveyed in March, 1976.



Map 7. Aerial transects showing density of birds per Km^2 for all areas surveyed in April, 1976.

QUARTERLY REPORT

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PRELIMINARY CATALOG OF SEABIRD COLONIES

AND

PHOTOGRAPHIC MAPPING OF SEABIRD COLONIES

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July 1, 1976

INTRODUCTION

This report contains revisions of a portion of the preliminary catalog of seabird colonies that was presented in our first annual report of 1 April 1976. The revisions incorporate recently acquired data, which we believe to be of timely importance to both the Bureau of Land Management and the U.S. Fish and Wildlife Service in the development of the environmental impact statement pertaining to oil and gas leasing in the Kodiak Basin. A summary of our activities during the quarter from 1 April through 30 June 1976 is also presented.

The objectives of the two Research Units (RU #338 and 343) covered in this quarterly report are to catalog seabird colonies, providing information about their location, composition, size, and the amount of land occupied, and to obtain a photographic record of the colonies.

STUDY AREA

Information on the location, composition, size, and status of seabird colonies is being actively acquired by us from the Gulf of Alaska to Cape Peirce where field studies associated with Research Units (RU #341 and 342) have allowed us the opportunity to examine unsurveyed or cursorily surveyed areas. Our activities in the northern Bering Sea, Chukchi Sea and Beaufort Sea are passive because of contracting limitations and dependent upon both historic information, OCSEAP cooperators, and other cooperators.

METHODS

Methods are described in our annual report of 1 April 1976.

RESULTS AND DISCUSSION

Status of colonies occurring within the area delineated by the U.S. Geological Survey topographic map "Kodiak 034" (1:250,000 scale) were revised from that which appeared in our Annual Report RU #338/343 of April 1976. New data was collected and reported herein on 6 previously identified colonies and 21 previously unreported colonies. Included in this report are revised Figures 26 and 28 and Table 8 and a new Figure 27b for replacing the corresponding items in the Annual Report.

Cataloging in the Gulf of Alaska, especially from Prince William Sound to False Pass at the southwestern end of the Alaska Peninsula has been materially benefited by surveys from the chartered F/V Nordic Prince which operates there in association with our Research Units #341 and 342. Information on colony status is also being acquired in the immediate vicinity of our site specific study areas (see our Quarterly Report RU #341/342, 1 July 1976).

Catalog information on colonies in the Bristol Bay region will be assembled during the next quarter to meet Bureau of Land Management's call for nominations and comment on Outer Bristol Basin Outer Continental Shelf Lands for possible oil and gas lease sale (#51).

Table 8 continued. Summary of data on seabird colonies: Kodiak Basin, (updated as of July, 1976).

SPECIES	Code No. (88+)	COLONY 034 051	034 052	034 053	034 054	034 055	034 056
Northern Fulmar	0302020100						
Fork-tailed Storm Petrel	0303020100						
Leach's Storm Petrel	0303020200						
Cormorant	0404000000						
Double-crested Cormorant	0404010200						
Pelagic Cormorant	0404010500						E 20
Red-faced Cormorant	0404010600		M 2				E 180
Glaucous Gull	1008010100						
Glaucous-winged Gull	1008010300		E 50	E 100	E 200	E 120	E 60
Herring Gull	1008010800						
Mew Gull	1008011300			P	E 300		
Black-legged Kittiwake	1008030100	E 42					E 30
Red-legged Kittiwake	1008030200						
Sabine's Gull	1008050100						
Arctic Tern	1008070400				E 5,000		
Aleutian Tern	1008070600				E 3,000		
Murre	1010030000						
Common Murre	1010030100						
Thick-billed Murre	1010030200						
Pigeon Guillemot	1010050200	E 10	E 11		M 8		
Ancient Murrelet	1010080100						
Cassin's Auklet	1010090100						
Parakeet Auklet	1010100100						
Crested Auklet	1010110100						
Least Auklet	1010110200						
Whiskered Auklet	1010110300						
Rhinocerous Auklet	1010120100						
Horned Puffin	1010130100				P		M 2
Tufted Puffin	1010140100		M 500	E 900	E 2,500	E 400	E 400
Other			- 1[a]				
Total		52	63	1,000	11,000	620	692

E = estimate, M = minimum estimate, P = present, a = Bald Eagle

Table 8 continued. Summary of data on seabird colonies: Kodiak Basin, (updated as of July, 1976).

SPECIES	Code No. (88+)	COLONY					
		034 044	034 045	034 046	034 047	034 049	034 050
Northern Fulmar	0302020100						
Fork-tailed Storm Petrel	0303020100						
Leach's Storm Petrel	0303020200						
Cormorant	0404000000		400			E 5	
Double-crested Cormorant	0404010200						5
Pelagic Cormorant	0404010500						
Red-faced Cormorant	0404010600						
Glaucous Gull	1008010100						
Glaucous-winged Gull	1008010300					M 15	M 10
Herring Gull	1008010800						
Mew Gull	1008011300						
Black-legged Kittiwake	1008030100	M 3,000		P			M 400
Red-legged Kittiwake	1008030200						
Sabine's Gull	1008050100						
Arctic Tern	1008070400						
Aleutian Tern	1008070600						
Murre	1010030000			P			
Common Murre	1010030100						
Thick-billed Murre	1010030200						
Pigeon Guillemot	1010050200						M 7
Ancient Murrelet	1010080100						
Cassin's Auklet	1010090100						
Parakeet Auklet	1010100100						
Crested Auklet	1010110100						
Least Auklet	1010110200						
Whiskered Auklet	1010110300						
Rhinocerous Auklet	1010120100						
Horned Puffin	1010130100					E 500	M 15
Tufted Puffin	1010140100		130		P	E 1,000	M 175
Other						3[a]	
Total		3,000	530	?	?	1,520	612

E = estimate, M = minimum estimate, P = present, a = Bald Eagle

Table 8 contined. Summary of data on seabird colonies: Kodiak Basin, (updated as of July 1976).

SPECIES	Code No. (88+)	COLONY					
		034 005	034 006	034 007	034 008	034 009	034 010
Northern Fulmar	0302020100						
Fork-tailed Storm Petrel	0303020100						
Leach's Storm Petrel	0303020200						
Cormorant	0404000000				M 8		
Double-crested Cormorant	0404010200						
Pelagic Cormorant	0404010500	E 50	E 20				
Red-faced Cormorant	0404010600	E 50	E 60				E 450
Glaucous Gull	1008010100						
Glaucous-winged Gull	1008010300	E 200	E 40	E 250	E 500		E 24
Herring Gull	1008010800						
Mew Gull	1008011300						
Black-legged Kittiwake	1008030100	E 5,000	E 300	E 200	E 100,000	P	E 150
Red-legged Kittiwake	1008030200						
Sabine's Gull	1008050100						
Arctic Tern	1008070400			E 2,000			
Aleutian Tern	1008070600			P			
Murre	1010030000						
Common Murre	1010030100						E 500
Thick-billed Murre	1010030200						
Pigeon Guillemot	1010050200	E 40	E 40	E 20	E 40		
Ancient Murrelet	1010080100						
Cassin's Auklet	1010090100						
Parakeet Auklet	1010100100						
Crested Auklet	1010110100						
Least Auklet	1010110200						
Whiskered Auklet	1010110300						
Rhinocerous Auklet	1010120100						
Horned Puffin	1010130100	E 200	E 40	P	E 30		s
Tufted Puffin	1010140100	E 80,000	E 200	E 6,000	E 1,000		E 5,000
Other							3[a]
Total		88,040	700	8,470	101,572		6,127

P = present, a = Bald Eagle

Table 8 continued. Summary of data on seabird colonies: Kodiak Basin, (updated as of July 1976).

SPECIES	Code No. (88+)	COLONY 033 001	033 002	034 001*	034 002	034 003	034 004
Northern Fulmar	0302020100						
Fork-tailed Storm Petrel	0303020100						
Leach's Storm Petrel	0303020200						
Cormorant	0404000000	P				100	
Double-crested Cormorant	0404010200						
Pelagic Cormorant	0404010500						
Red-faced Cormorant	0404010600						
Glaucous Gull	1008010100						
Glaucous-winged Gull	1008010300			P			E 50
Herring Gull	1008010800						
Mew Gull	1008011300						P
Black-legged Kittiwake	1008030100			P			E 1,000
Red-legged Kittiwake	1008030200						
Sabine's Gull	1008050100						
Arctic Tern	1008070400						E 700
Aleutian Tern	1008070600						s
Murre	1010030000						
Common Murre	1010030100						
Thick-billed Murre	1010030200						
Pigeon Guillemot	1010050200						M 2
Ancient Murrelet	1010080100						
Cassin's Auklet	1010090100						
Parakeet Auklet	1010100100						
Crested Auklet	1010110100						
Least Auklet	1010110200						
Whiskered Auklet	1010110300						
Rhinocerous Auklet	1010120100						
Horned Puffin	1010130100						s
Tufted Puffin	1010140100		M 2,000		P		E 100
Other							
Total		?	2,000	?	?	1,100	1,852

E = estimate, M = minimum estimate, s = suspected presents, * = status as breeding colony unconfirmed

Table 8 continued. Summary of data on seabird colonies: Kodiak Basin, (updated as of July, 1976).

SPECIES	Code No. (88+)	COLONY 034 057	034 058	034 059	034 060	034 061	034 062
Northern Fulmar	0302020100						
Fork-tailed Storm Petrel	0303020100						
Leach's Storm Petrel	0303020200						
Cormorant	0404000000	E 400					
Double-crested Cormorant	0404010200						
Pelagic Cormorant	0404010500						
Red-faced Cormorant	0404010600		E 120	E 130			
Glaucous Gull	1008010100						
Glaucous-winged Gull	1008010300		E 200		E 300	E 400	M 50
Herring Gull	1008010800						
Mew Gull	1008011300						
Black-legged Kittiwake	1008030100			E 10,000	E 5,500	E 1,000	E 800
Red-legged Kittiwake	1008030200						
Sabine's Gull	1008050100						
Arctic Tern	1008070400						
Aleutian Tern	1008070600						
Murre	1010030000			M 10			
Common Murre	1010030100						
Thick-billed Murre	1010030200						
Pigeon Guillemot	1010050200						
Ancient Murrelet	1010080100						
Cassin's Auklet	1010090100						
Parakeet Auklet	1010100100						
Crested Auklet	1010110100						
Least Auklet	1010110200						
Whiskered Auklet	1010110300						
Rhinocerous Auklet	1010120100						
Horned Puffin	1010130100	E 200					
Tufted Puffin	1010140100	E 2,000			E 1,000		E 1,000
Other					1[a]		2[a]
Total		2,600	320	10,140	6,800	1,400	1,850

E = estimate, M = minimum estimate, P = present, a = Bald Eagle

Table 8 continued. Summary of data on seabird colonies: Kodiak Basin, (updated as of July, 1976).

SPECIES	Code No. (88+)	COLONY 034 063	034 064	034 065	034 066	034 067	034 068
Northern Fulmar	0302020100						
Fork-tailed Storm Petrel	0303020100						
Leach's Storm Petrel	0303020200						
Cormorant	0404000000					E 30	
Double-crested Cormorant	0404010200						
Pelagic Cormorant	0404010500						E 60
Red-faced Cormorant	0404010600						
Glaucous Gull	1008010100						
Glaucous-winged Gull	1008010300	E 100	E 35		E 50	E 50	
Herring Gull	1008010800						
Mew Gull	1008011300						
Black-legged Kittiwake	1008030100	E 500	E 350	E 250		E 600	
Red-legged Kittiwake	1008030200						
Sabine's Gull	1008050100						
Arctic Tern	1008070400						
Aleutian Tern	1008070600						
Murre	1010030000						
Common Murre	1010030100						
Thick-billed Murre	1010030200						
Pigeon Guillemot	1010050200		E 16		E 8	M 12	
Ancient Murrelet	1010080100						
Cassin's Auklet	1010090100						
Parakeet Auklet	1010100100						
Crested Auklet	1010110100						
Least Auklet	1010110200						
Whiskered Auklet	1010110300						
Rhinocerous Auklet	1010120100						
Horned Puffin	1010130100		M 1			M 6	
Tufted Puffin	1010140100		E 600		E 30	E 2,200	
Other			1[a]	3[a]	1[a]	2[a]	
Total		600	919	250	108	2,900	60

E = estimate, M = minimum estimate,

Table 8 continued. Summary of data on seabird colonies: Kodiak Basin, (updated as of July, 1976).

SPECIES	Code No. (88+)	COLONY					
		034 069					
Northern Fulmar	0302020100						
Fork-tailed Storm Petrel	0303020100						
Leach's Storm Petrel	0303020200						
Cormorant	0404000000						
Double-crested Cormorant	0404010200						
Pelagic Cormorant	0404010500						
Red-faced Cormorant	0404010600						
Glaucous Gull	1008010100						
Glaucous-winged Gull	1008010300						
Herring Gull	1008010800						
Mew Gull	1008011300						
Black-legged Kittiwake	1008030100						
Red-legged Kittiwake	1008030200						
Sabine's Gull	1008050100						
Arctic Tern	1008070400						
Aleutian Tern	1008070600						
Murre	1010030000						
Common Murre	1010030100						
Thick-billed Murre	1010030200						
Pigeon Guillemot	1010050200						
Ancient Murrelet	1010080100						
Cassin's Auklet	1010090100						
Parakeet Auklet	1010100100						
Crested Auklet	1010110100						
Least Auklet	1010110200						
Whiskered Auklet	1010110300						
Rhinocerous Auklet	1010120100						
Horned Puffin	1010130100						
Tufted Puffin	1010140100	E 140					
Other							
Total		140					

E = estimated,

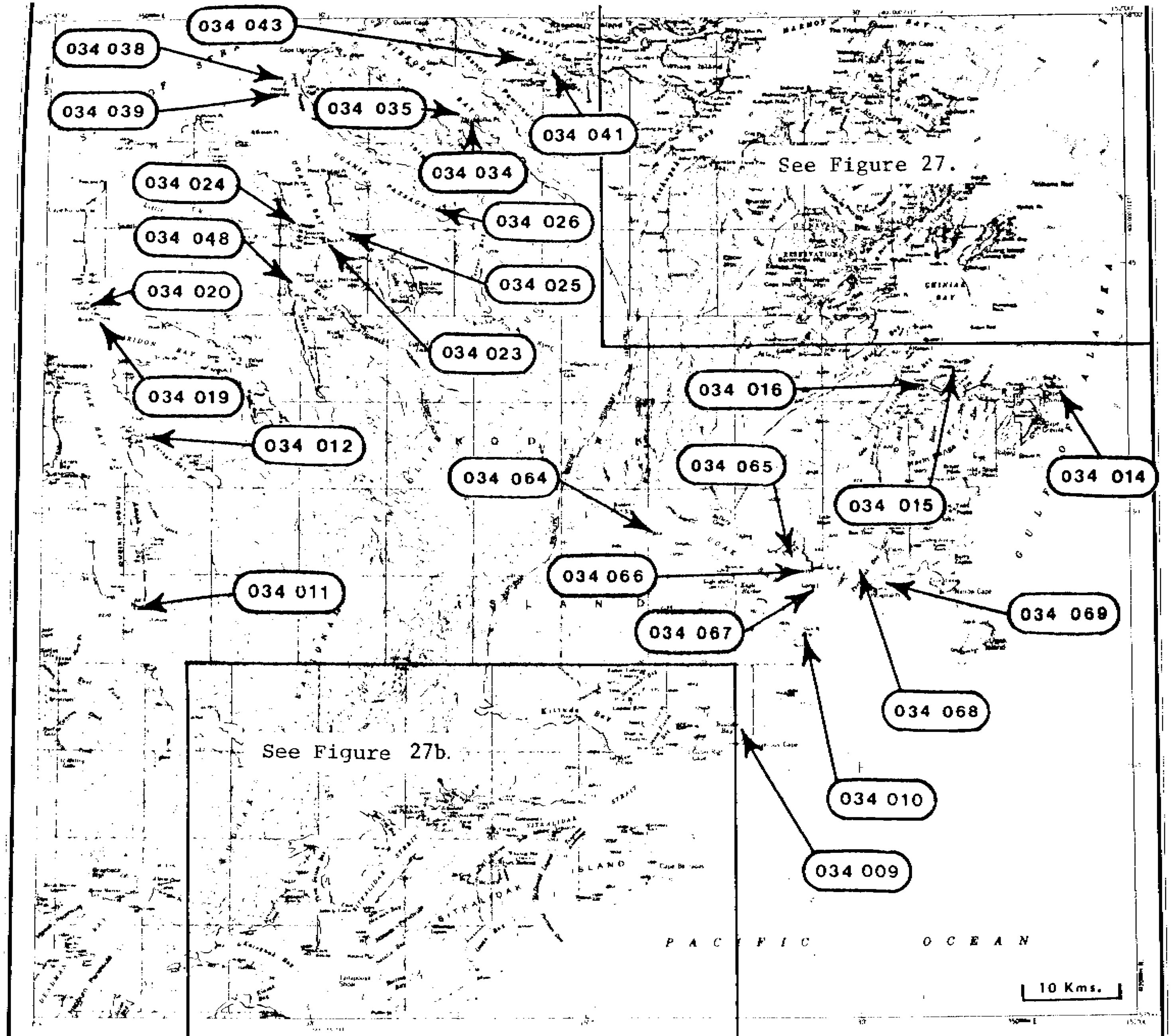

Figure 26. Locations of known seabird colonies in topographic area 034, Kodiak. Updated as of July 1976.

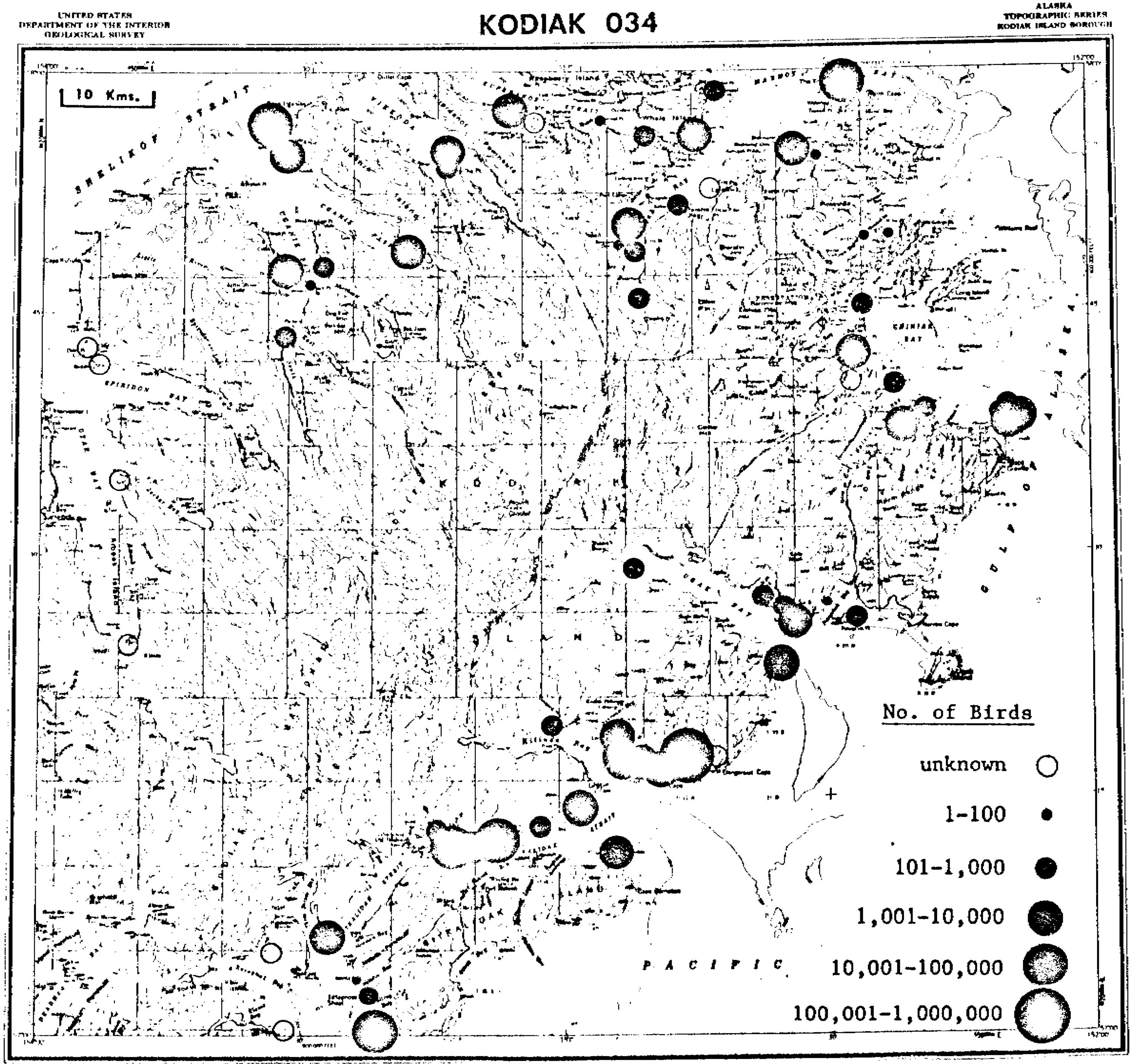

Figure 28. Comparative numbers of seabirds in colonies in topographic area 034. Kodiak.

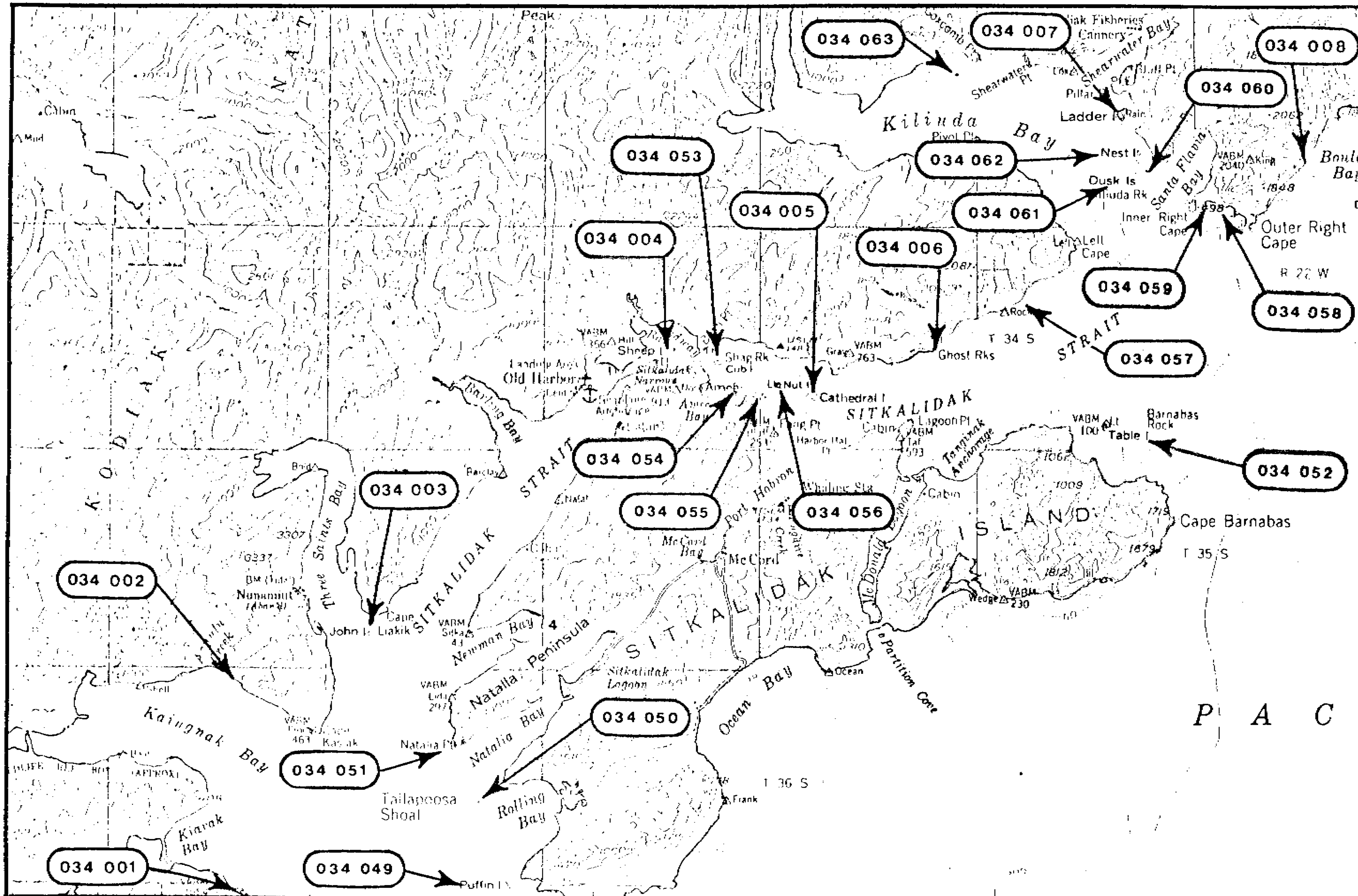

Figure 27b. Enlarged section from topographic area 034, Kodiak, showing locations of known seabird colonies. Updated as of July 1976.

QUARTERLY REPORT

Contract: 01-6-022-11437
Research Unit: RU-339
Reporting Period: April 1, 1976 to
June 30, 1976
Number of Pages: i + 1 p.

REVIEW AND ANALYSIS OF LITERATURE AND UNPUBLISHED DATA ON MARINE BIRDS

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and

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Co-principal Investigators

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July 1, 1976

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 continued to collect and examine source documents for the comprehensive bibliography.

A summary of bird resources in the Beaufort Sea OCS lease sale area was prepared for the Service's response to the Bureau of Land Management's request for environmental data to be used in their deliberations on tract selection and deletion.

Data on birds in the Bristol Bay are also being summarized so that the Bureau of Land Management might use the information in tract selection in that region. This information will be submitted to Bureau of Land Management during the next quarter.

QUARTERLY REPORT

Contract: 01-6-022-11437
Research Unit: RU-340
Reporting Period: April 1, 1976 to
June 30, 1976
Number of Pages: i + 45

MIGRATION OF BIRDS IN ALASKA COASTAL AND MARINE HABITATS SUBJECT TO INFLUENCE BY OCS DEVELOPMENT (RU-340)

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July 1, 1976

INTRODUCTION

This report is a summary of efforts mainly during the quarter from 1 April through 30 June 1976 by U.S. Fish and Wildlife Service personnel, contractees, and collaborators to characterize the migration of birds in those Alaskan waters subject to petroleum development of the outer continental shelf. Information is presented on banding efforts, recent reports of sightings of banded birds, sea watch efforts, and a report of bird migration past Pt. Barrow during the fall of 1975.

The objectives of this research unit are to determine primarily migratory routes and secondarily patterns of seasonal density distribution of marine birds in those coastal and marine habitats of Alaska subject to impacts from outer continental shelf development. There are more than a hundred species of birds regularly frequenting these waters and coastal habitat, and each of those species has one or more populations with their own unique pathways and timing of migration. An understanding of these seasonal movements is necessary for resource managers to develop guidelines and schedule development activities such that adverse impacts do not occur at either critical localities, at critical times, or both. An understanding of affinities between wintering, breeding, summering and migrating populations of birds will permit an evaluation as to the potentially far-reaching effects of adverse impacts that could occur at a specific locality.

STUDY AREA

Contract stipulations limit the study areas to those Alaskan outer continental shelf areas being considered for oil and gas leasing. The U.S. Fish and Wildlife Service will ultimately characterize migration in all coastal regions, but we must place priorities on our regional reporting effort to be in sequence with the leasing schedule. Emphasis of our active acquisition of migration data is from the Gulf of Alaska to the southeastern Bering Sea where the majority of our field and shipboard studies are being conducted. Except for shipboard and aerial surveys, we have no field operations in the northeastern Bering Sea, Chukchi Sea, and Beaufort Sea; and, therefore, migration information from these areas will largely be passively acquired.

METHODS

This study is dependent upon observations of bird occurrence or lack of their occurrence at many locations throughout coastal Alaska throughout the year. Data are, in part, acquired through observations made during other research activities, especially Research Unit #342 dealing with population dynamics of marine birds and Research Unit #337 dealing with seasonal distribution and abundance of birds, from other OCSEAP investigators, and from other cooperators who are not affiliated with OCSEAP programs. Published and unpublished information on seasonal occurrence of birds are incorporated with the currently collected data. Banding data are filed with the U.S. Fish and Wildlife Service, Bird Banding Laboratory, Laurel, Maryland.

RESULTS AND DISCUSSION

Efforts at banding birds, reports of sightings of banded birds, sea watch efforts, and a report of the fall migration of birds near Pt. Barrow are treated in this section.

Bird Banding

A widespread banding effort was initiated by us and OCSEAP-cooperators this quarter throughout coastal Alaska in order to augment band-recovery data that was summarized in our annual report. Our longrange objectives of this banding effort are threefold: (1) to assess population dynamics, (2) to obtain information on migration and homing; and (3) to aid in making behavioral observations at breeding sites. We intend to build populations of known-age birds at several locations throughout Alaska so that meaningful studies of the breeding biology of some of the more common species might be conducted beyond the ephemeral nature of the OCSEAP program. Color marking birds, in addition to banding with standard U.S. Fish and Wildlife Service leg bands, is an essential aspect of this long-range program and the color-marking protocol for all investigators is being coordinated through this office. Banding schedules of birds banded both by our personnel and by OCSEAP-cooperators are typed by our staff for submission to the Bird Banding Laboratory.

Bands and banding supplies were distributed to our field camps and charter vessel. Table 1 lists the sites, field operation number, and personnel where banding was done during this quarter. Additionally, bands were issued to OCSEAP-cooperators Samuel M. Patten, Jr. (RU #96), Lance Craighead (Joseph J. Hickey, RU #38), George L. Hunt, Jr. (RU #83), William H. Drury (RU #237/238), and Peter G. Connors (RU #172). We coordinated color-marking authorization under the banding permit issued to the Alaska Department of Fish and Game for banding done by George J. Divoky in conjunction with RU 330/196.

Sightings of Banded Birds

In our annual report we summarized the recoveries of 20,158 birds that were either banded in Alaska or banded elsewhere but recovered in Alaska. Since that tabulation of 21 January 1976, we have received reports of sightings or recoveries of 12 birds, all glaucous-winged gulls, banded under our Permit #20022 (Table 2). These bandings along with the 78 recoveries between 1938 and 1970, indicate that glaucous-winged gulls raised in the northern Gulf of Alaska and southeastern

Bering Sea will regularly winter as far south as California with a majority of the sightings occurring during migration along the southeastern coast of Alaska and in coastal British Columbia and Oregon. The chronology and location of sightings of these glaucous-winged gulls and other birds of the coastal area will be depicted in the final report.

Sea Watches

"Sea Watches," the methodical collection of index data on bird abundance, were conducted at 14 locations in coastal Alaska extending from Forrester Island in extreme southeastern Alaska (a nonOCSEAP-funded study) to the Yukon River Delta. Sites of these sea watches are the same as for sites of bird banding with data acquisition beginning soon after the camps became established (Table 1).

Bird Migration Near Point Barrow

Rebecca S. Timson spent from 27 August to 16 September 1975, near Point Barrow, Alaska, making observations of migration in an effort to fill a void in information for that particular period. Her report is timely and germane to deliberations pertaining to current oil and gas tract nominations in the Beaufort Sea being considered by the Bureau of Land Management and to oil and gas development of Naval Petroleum Reserve No. 4 (PET 4); and, therefore, it has been included as Appendix A.

Table 1. Log of U. S. Fish and Wildlife Service, Office of Biological Services - Coastal Ecosystem's field operations for the study of marine birds, 1 January to 30 June 1976. The symbol "●" behind the field operation number denotes location of banding and sea watch efforts.

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
8 Jan	76001	Aerial - P2V	UCI, LCI, NWGOA	Craig Harrison, Scott Hatch, Ed Bailey
15-20 Feb	76002	MOANA WAVE	Seattle-Seward	Gerald Sanger, Matt Kirchhoff, Mark Phillips, Dave Hardy
18-20 Feb	76003	Reconnaissance	Middleton I.	John Hall, Kent Wohl (BLM)
20 Feb - 5 Mar	76004	MOANA WAVE	PWS, NEGOA, NWGOA	Matt Kirchhoff
24-27 Feb	76005	DISCOVERER	Seattle-Kodiak	Dave Hardy, Dave Frazer
28 Feb - 8 Mar	76006	Aerial - P2V	BB, SGB, UMB, APS KB, SS, NWGOA, LCI	Craig Harrison, Scott Hatch, Art Sowls
1-13 Mar	76007	DISCOVERER	KB, NEGOA	Dave Frazer
8-12 Mar	76008	SURVEYOR	Seattle-Kodiak	Colleen Handel
8-26 Mar	76009	MOANA WAVE	KB, APS, BB, SGB	Mark Phillips
15-21 Mar	76010	MILLER FREEMAN	Seattle-Kodiak	Gerald Sanger, Susan Bates, Colleen Handel, Mark Rauzon, Ted Schad
16-29 Mar	76011	DISCOVERER	KB, NWGOA, NEGOA, PWS	Matt Kirchhoff
23 Mar - 21 Apr	76012	MILLER FREEMAN	NWGOA, APS, BB, SGB, SCB	Mark Rauzon
29 Mar - 15 Apr	76013	MOANA WAVE	NWGOA, LCI, UCI	Dave Frazer

(Table continued)

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
29-30 Mar	76014	Aerial - P2V	PWS, NEGOA, NWGOA LCI	Craig Harrison, Scott Hatch, Colleen Handel
4 Apr	76015	Aerial - P2V	UCI, LCI, KB, SS, NWGOA	Craig Harrison, Scott Hatch, Mark Phillips
6-13 Apr	76016	DISCOVERER	UCI, LCI, KB, NWGOA, NEGOA, PWS	Craig Harrison
10-26 Apr	76017	SURVEYOR	SGB, BB, KB, APS, NAV	John Hall
13- Apr	76018	DISCOVERER	Leg	Ted Schad
19 Apr - 1 May	76019	MOANA WAVE	NEGOA, NWGOA, KB	Tony DeGange
20 Apr - 27 May	76020 ●	Field Camp	Unimak Pass	Mark Phillips
20 Apr - 13 May	76021	MILLER FREEMAN	NAV, SGB, SCB, OA	Doug Forsell
22 Apr to date	76022 ●	Field Camp	Hinchinbrook I.	David Nysewander, Pete Knudtson
26 Apr to date	76023 ●	Field Camp	Cape Peirce	Margaret Peterson, Marilyn Sigman
29 Apr to date	76024 ●	Field Camp	Semidi Is.	Scott Hatch, Martha Hatch
29 Apr to date	76025 to 49 ●	NORDIC PRINCE	Prince William Snd to Cape Peirce	Art Sowls, Allen Moe, Jerry Ruehle, Don Dumm, Jim Bartonek, Gerald Sanger, Pat Gould, Colleen Handel, John Hall, Sue Bates Pat Baird, et al.
3-5 May	76050	DISCOVERER	NEGOA, KB,	Patrick Gould, Mark Rauzon

(table continued)

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location [1]	Personnel
6-8 May	76051	DISCOVERER	LCI, NWGOA	Patrick Gould, Mark Rauzon
12-20 May	76052	DISCOVERER	KB, NEGOA, PWS NWGOA	Patrick Gould
9 May to date	76053 ●	Field Camp	Forrester I.	Dave Frazer, Earl Possardt, Tony DeGange
11 May to date	76054 ●	Field Camp	Barren Is.	David Manuwal, Dee Boersma, Naomi Manuwal, Mike Amarel, Mary Nerini
16 May to date	76056 ●	Field Camp	Nelson Lagoon	Bob Gill, Paul Jorgenson
17 May - 4 Jun	76057	MILLER FREEMAN	OA, UMB, BB, SGB NAV, APS, SS, NWGOA	Doug Forsell
7 May -	76058	MOANA WAVE	leg	Tony DeGange
20 May to date	76059 ●	Field Camp	Semidi Is.	Galen Burrell, Lora Leschner
20 May to date	76060 ●	Field Camp	Ugaiushak I.	Duff Whele
20 May to date	76061 ●	Field Camp	Ugaiushak I.	Eric Hoberg
20 May to date	76062 ●	Field Camp	Big Koniuji I.	Bob Day
20 May to date	76063 ●	Field Camp	Big Koniuji I.	Tod Schad, Allen Moe
24 May - 3 Jun	76064	SURVEYOR	KB, NEGOA, NWGOA	Patrick Gould, Craig Larson
26 May - 5 Jun	76066	MOANA WAVE	KB, APS, UMB, SGB, BB	Keith Metzner
5-22 Jun	76067	MOANA WAVE	UMB, BB, ECB, SGB, APS, KB	Keith Metzner
25 May - 17 Jun	76068	LINBLAD EXPLORER	SE, SW, SC Alaska	Mark Rauzon

(Table continued).

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
1 Jun to date	76069 ●	Field Camp	Kodiak I.	Matt Dick, Jay Nelson
7-17 Jun	76070	MILLER FREEMAN	Leg IV	Patricia Baird
18-23 Jun	76071	MILLER FREEMAN	Leg, Transit	Patricia Baird
8-12 Jun	76072	Aerial	NB, HB	Craig Harrison
6 Jun to date	76073 ●	Field Camp	Middleton I.	Marshall Howe, Dave Frazer
22 Jun to date	76074	MOANA WAVE	Leg VIII	Doug Forsell
15 Jun to date	76075 ●	Field Camp	Yukon Delta	Bob Jones, Matt Kirchhoff
30 Jun to date	76076 ●	Field Camp	Unimak Pass	Mark Rauzon
9 July	76077	DISCOVERER	Seattle - Kodiak	Keith Metzner
9 July	76078	DISCOVERER	NWGOA	Keith Metzner
14-16 June	76079	NORDIC PRINCE	NEGOA, PWS	John Hall, Art Sowls, Colleen Handel, Beverly Eggen, Kent Wohl
27 April to date	76080	Field Camp	Copper R. Delta	Stan Senner
7 May to date	76081 ●	Field Camp	Wooded Islands	Peter Mickelson, Bud Lenhausen

Table 1. Continued.

1/

APS-Alaskan Peninsula South
BB-Bristol Bay
BCS-British Columbia Shelf
BFT-Beaufort Basin
ECB-Eastern Central Bering Sea
HB-Hope Basin
KB-Kodiak Basin
LCI-Lower Cook Inlet
NaB-Navarin Basin
NB-Norton Basin
NCS-Northern California Shelf
NEGOA-Northeast Gulf of Alaska
NWGOA-Northwest Gulf of Alaska
OA-Oceanic Aleutians
OAPS-Oceanic Alaskan Pen. South
OBC-Oceanic British Columbia
OGOA-Oceanic Gulf of Alaska
ONC-Oceanic Northern California
OO-Oceanic Oregon
OS-Oregon Shelf
OSC-Oceanic Southern California
OSK-Oceanic South Kodiak
OW-Oceanic Washington
PWS-Prince William Sound
SCB-South Central Bering Sea
SCS-Southern California Shelf
SEAS-Southeast Alaska Shelf
SGB-St. George Basin
SS-Shelikof Strait
TNP-Transitional North Pacific
UCI-Upper Cook Inlet
UMB-Umnak Basin
WS-Washington Shelf

Table 2. Summary of encounters of birds banded under Master Station Permit 20022, USF&WS Office of Biological Services, Coastal Ecosystem (permit formerly held by Wildlife Research, Fairbanks).

Band Number	Species	Banding Data		Encounter Data	
096773020	G-w. Gull	Kodiak I.	7/20/75	Astoria, OR	2/20/75
099708148	G-w. Gull	Ugaiushak I.	7/19/74	King Cove, AK	7/07/75
099708195	G-w. Gull	Ugaiushak I.	8/04/74	Homer, AK	9/21/75
099708528	G-w. Gull	Ugaiushak I.	7/08/74	Port Hardy, BC	7/10/75
065767383	G-w. Gull	Cordova area	7/21/75	Sunny Pt., AK	10/04/75
104782273	G-w. Gull	Cordova area	7/21/75	Valdez, AK	8/29/75
104782570	G-w. Gull	Cordova area	7/21/75	Yakutat, AK	10/--/75
104783692	G-w. Gull	Cordova area	7/21/75	Ketchikan, AK	1/20/76
104783574	G-w. Gull	Cordova area	7/21/75	Copper R.Delta, AK	9/01/75
104783754	G-w. Gull	Cordova area	7/21/75	Valdez airport, AK	8/22/75
104783893	G-w. Gull	Cordova area	7/21/75	Valdez airport, AK	8/22/75
065768504	G-w. Gull	Cordova area	7/26/75	Nr Fraser R. MthBC	1/--/76

APPENDIX A

LATE SUMMER MIGRATION AT BARROW, ALASKA 1/

By Rebecca S. Timson
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Office of Biological Services
Coastal Ecosystems
Anchorage, Alaska

Abstract: Migrating birds were observed daily at Barrow, Alaska, 27 August to 16 September 1975. Female and subadult eiders accounted for 95 percent of the estimated flight during the first week, declining to 9 percent in the third week. Other species, notably oldsquaws and loons, occurred in building numbers. First dates of migration included: arctic loons, 30 August; arctic terns, 1 September; Sabine's gulls and red-throated loons, 3 September; black-legged kittiwakes, 4 September; oldsquaws, 5 September. Concurrently there was a cold spell, from 30 August to 8 September, characterized by average daily temperatures below 0°C (32°F) and below normal records for those dates.

The average number of passing migrants was highest during the evening hours. Tailwinds produced the highest counts for eiders, oldsquaws and black brant, while greater numbers of loons and larids were observed during headwinds.

The harvest estimate amounted to 0.3 percent of the migration estimate.

Many thousands of migrating birds funnel over the base of the Point Barrow spit in Alaska, where contemporary Eskimo hunters still pitch tents at Birnirk, the prehistoric site of a seasonal duck camp. For more than a century, ornithologists have made observations from this vantage point. But the first migration study at this location which could be subjected to statistical analysis was conducted by Thompson and Person (1963) as an "after-hours" effort while formally involved in lemming research. Their methods were largely adopted by Johnson (1971), in a thesis project covering both spring and summer eider flights.

As yet, however, no one has made systematic observations during the autumn. Thompson and Person discontinued field work on 1 September, and Johnson on 7 September. This paper is the result of data collected between 27 August and 16 September 1975. While this does not represent a much later examination of the westward migration past Barrow, which can be conspicuous into the first week of November (Flock 1973), still

1/ U.S. Fish and Wildlife Service, Office of Biological Services, Coastal Ecosystems, Anchorage, Alaska, Field Report FW5019.

it yielded very different results than the two earlier studies. It established the importance of the duck pass to species other than king (Somateria spectabilis) and common eiders (Somateria mollissima v. nigra), notably oldsquaws (Clangula hyemalis) and loons (Gavia spp.).

It is questionable whether the observations made in 1975 could be considered typical. Generally during August and September, the ice is well offshore at Barrow and the waters are navigable. However, during the time of this study the ice was probably not more than 1 km from the coastline immediately west of the spit, nor was there a navigable offshore lead. The barges intending to reach Prudhoe Bay were not able to pass east of the spit prior to my departure on 16 September. It was a cold summer. According to U.S. Weather Bureau information, the average temperature in July departed from normal records for that month by -0.6°C (-1.2°F), in August by -1.4°C (-2.9°F), and in the first half of September by -1.5°C (-3.1°F).

Myres (1958) reported eider mortality along the northern coast in association with stormy spring weather in 1958. Barry (1968) estimated that 10 percent of the eider population using the coastal migration route died by starvation in 1964, due to late break-up of the sea ice. The pack ice in 1975 was even more extensive than in 1964, so there is reason to suspect that the eider population suffered a consequent loss. The dramatic year-to-year variability in arctic breeding populations, as described for the Barrow region by Pitelka (1974), is not fully understood. With the advent of oil development in the north it has become important to define these natural fluctuations, in order to be able to assess the actual impact of industrial accidents when they occur. Therefore the field observations detailed in this paper should be considered in relation to the unusual environmental conditions which prevailed in 1975.

METHODS

Following the example of Thompson and Person (1963) and Johnson (1971), most observations were made between Birnirk and Brant Point. However, a few counts occurred at locations between Brant Point and Central Marsh Slough, between Birnirk and Nuwuk (the northernmost point on the Barrow spit), and between Birnirk and the Naval Arctic Research Laboratory. Passing migrants were recorded during half-hour long watches, with the use of 8 x 32-power binoculars. The number of birds per flock was counted or estimated, and identification as to species, sex and age was indicated whenever possible.

Hunter activity was also monitored. The number of hunters present during each observation period was recorded, with one "hunter half-hour" being defined as the presence of a hunter during any part of a half-hour watch. Hunters were assigned to one of the following age groups: (a) 12 - 24 years; (b) 25 - 50 years; and (c) over 50. When there was an opportunity to determine the number of shots fired, the number of birds bagged, and the number of birds crippled or killed but not recovered by a hunting party, this information was also recorded.

Bag checks provided the species, sex, age, and weight of birds taken by hunters. Eskimo hunters typically do not clean their birds before storage; therefore, in the future investigators should shoot their own birds in order to collect digestive tracts for content analysis.

The weather was not reliable enough to make it practical to schedule observation periods at strictly regular intervals. The attempt was made to sample all daylight hours as often as possible.

RESULTS

Species Accounts

Eiders.

During 136 half-hour watches, a total of 34,262 migratory birds were counted passing Barrow, including 14,625 eiders or 43 percent. Eiders accounted for 99.6 percent of the birds counted by Thompson and Person (1963), and 95 percent in Johnson's (1971) study.

The percentage figure for this study is deceptive, however. The field season may be divided into three one-week periods for purposes of analysis: (a) 27 August - 2 September; (b) 3 September - 9 September; (c) 10 September - 16 September 1975. The weeks were not equally sampled. Of the 136 watches, 61 occurred during week one, 52 during week two, and 23 during week three. Fog and snowfall frequently obscured vision to the extent that observations were impossible; during my third week at Barrow the weather was especially incompatible with field work. Increasing hours of darkness also cut into available work time. On 6-7 September, old munitions were being destroyed on the spit and no one was permitted in the vicinity of Birnirk.

The species composition during each week was very different; the coastal eider flight was dwindling, while later migrants appeared in buildling numbers. Since less observations were made during each successibe week, the birds which were becoming increasingly numerous toward the end of the study were under-represented in the overall count. For this reason, percentage comparisons will be based on the estimated total flight of each migrant during the 3-week period.

Eider flights past Barrow are known to continue at least through October. Scattered southbound flocks were noted during that month by Bailey (1948), although they were not numerous. During shipboard observations between 22 September and 18 October 1970, Watson and Divoky (1972) saw only one flock of six eiders from Barrow to Icy

Cape. Most of their sightings of 1,300 eiders occurred farther south in the Chukchi Sea, suggesting that the greater part of the summer flight passes west of Barrow by mid-September.

Thompson and Person (1963) estimated that 740 eiders per hour flew over the Barrow duck pass, between 14 July and 1 September 1953. Johnson's (1971) weekly averages for 13 July to 7 September 1970 ranged from nearly 400 to over 1,000 birds per hour, with 95 percent of these birds being eiders. During the first week of my study the average number of eiders per half-hour was 139, declining to 94 per half-hour in the second week and 55 per half-hour in the third week (Table 1). These results apparently justify Pitelka's (1974) statement that the bulk of the summer eider flight passes Barrow during August.

Species identification was undetermined in 92 percent of all eider sightings during the half-hour watches. Of 1,104 eiders positively identified, 97 percent were king eiders and 3 percent were common eiders. This compares to Johnson's (1971) figures of 95 and 5 percent, respectively. King and common eider females are similar in appearance, and are distinguished only at very close range.

No Steller's (Polysticta stelleri) or spectacled eiders (Somateria fischeri) were recognized in flight. One female spectacled eider was seen on the shore between Nuwuk and Plover Point on 11 September; according to a member of the shorebird research team from University of California at Berkeley (R. Greenberg pers. comm.), this was the first seen at Barrow since early July. Myres (1958) found that spectacled eiders were the most common eider observed migrating inland along the Inaru and Meade Rivers south of Barrow, through total numbers were not high; Steller's eiders were second most common. Johnson (1971) summarized other sources of information on the abundance of these two species along the Arctic coast of Alaska. Pitelka (1974) listed only the Steller's eider as breeding regularly in the Barrow region, with spectacled and king eiders breeding there irregularly.

Only one adult male eider was observed in flight; this was a king eider in high plumage spotted in a flock of 45 birds on 28 August. On 10 September, one male common eider in high plumage was reported resting on the water near Plover Point. Thompson and Person (1963) noted that the male:female ratio shifted from predominantly male to predominantly female between 8 August and 17 August 1953. This reversal took place during the same time span (7 August - 17 August) in 1970 (Johnson 1971).

Young and female eiders were not distinguished in flight. Therefore the first positive identification of young eiders took place 29 August, when one male juvenile (bird-of-the-year) and two female immature king eiders were found in bag checks (Appendix A). In all 25 bag checks, 73 percent of the eiders were adults (47 birds) and subadults accounted for 27 percent (17 birds). Johnson (1971) found only three subadults among 2,182 eiders examined in bag and cache checks. Thompson and Person (1963) did not observe any young eiders. Murdock (1885) first observed birds of the year on 30 August 1882.

Oldsquaws.

Oldsquaws were seen in large feeding flocks throughout the field season, but were not observed in migratory flight until 5 September. On both 4 and 5 September, temperatures were 5.2°C (11°F) below average records for those dates. Flock (1973), in radar evidence of bird movements, noted a mass exodus of birds of unidentified species after a cold spell during the first week of October. It is likely that most of these birds were oldsquaws, which are known to migrate later than eiders (Kortright 1942). Johnson (1971) recorded the first migratory flocks of oldsquaws on 31 August, while Bailey (1948), noticed that many started south around 7 September in 1921.

A total of 14,894 oldsquaws were counted during the half-hour watches between 5 and 16 September 1975, clearly establishing the duck pass at Barrow as an important route for species other than eiders. During the second week of the study oldsquaws averaged 91 birds per half-hour, building to 442 per half-hour in the third week (Table 1). On 13 September many thousands of oldsquaws were feeding, moving back and forth restlessly from one side of the spit to the other. No until evening were their numbers resolved into migrating flocks. Dense fog prevented all but two half-hour watches on the following day, yet more oldsquaws were counted in flight than on any other day (6,770 birds). Two fishermen, Alaska Department of Fish and Game biologist H. Reynolds and NARL animal colony supervisor D. Craighead, reported that a raft of approximately 10,000 oldsquaws was offshore from Brant point in the evening. It took about 5 minutes for the whole flock to lift off the water in a wave-like motion. (D. Craighead pers. comm.).

Watson and Divoky (1974) claimed that oldsquaws remain in the Beaufort Sea well into September, with migration continuing into October in the Chukchi Sea. Gabrielson and Lincoln (1959) noted that oldsquaws will remain near Point Barrow until late October when slush is forming on the ocean. Pitelka's (1974) assertion that most oldsqua pass Barrow during August seems to be unfounded.

Loons.

A total of 3,850 loons were counted during the half-hour watches. With few exceptions, they were observed in summer plumage. All of those identified as yellow-billed loons (*Gavia adamsii*) were observed on 27 August (13 birds). While 3,187 loons were undistinguished, mos were arctic (*Gavia arctica*) or red-throated loons (*Gavia stellata*). Only 629 arctic and 21 red-throated loons were identified specificall a ratio of 30:1. The first positive sighting of arctic loons occurre on 30 August, and in the case of red-throated loons, on 3 September. Loons averaged only 1.1 birds per half-hour during the first week of field work, building to 21.2 and 116.5 birds per half-hour in the second and third weeks, respectively (Table 1).

The slender profiles and loose-knit aggregations of loons were most difficult to observe during conditions of impaired visibility. On 14 September, approximately 700 loons were seen during a half-hour period by Reynolds and Craighead, while they fished offshore from Brant Point in a small boat (D. Craighead pers. comm.). It was very foggy that day and few loons were observed from shore. It is questionable whether or not loons normally fly during hours of darkness; on 9 September it was noted that their numbers fell off abruptly with the failing light.

Loons exhibited great variability in their flight path past Barrow. Only three half-hour watches were conducted between NARL and Birnirk, facing north-northwest, but these observations made it apparent that many more loons were passing Barrow than were crossing overland near Birnirk. This was confirmed by observations at Plover Point. Some loons flew to the landward side of the barrier islands and then crossed the spit; many others flew around both the islands and the spit without crossing land at all. Migrants in the latter case escaped notice during most half-hour watches, which were conducted between Birnirk and Brant Point facing Elson Lagoon. Loons which passed over the spit very far from the duck camp were also missed. In keeping with a habit common to eiders, oldsquaws and black brant (Branta nigricans), loons also did not hesitate to pass over several kilometers of tundra to the south and thus reach the ocean. Such flights were recorded during the half-hour watches unless poor visibility prevented it.

The migratory habits of yellow-billed loons are not well-documented. Sage (1971) described a post-breeding dispersal occurring in late August, when tundra ponds first freeze, while indicating that others remain until late September when the rivers also begin to freeze. Gabrielson and Lincoln (1959) also suggested that the fall migration of this species was a "rather prolonged movement." Bailey (1948) observed a flight of yellow-billed loons offshore from Wainwright during September, with the greatest numbers being assembled in Wainwright Inlet on 20 September.

Most of the arctic loons observed in migration by Bailey (1948) passed Wainwright between 1 and 20 September. He saw hundreds of red-throated loons offshore at Icy Cape on 7 and 8 September, and claimed that this species was scarce both at sea and nearshore at Wainwright after the lagoons froze. Watson and Divoky (1972) believed that most of the loons they observed from the icebreaker Glacier were arctic rather than red-throated loons, and these were mostly within 65 km of land. They saw no loons in the eastern Chukchi after 6 October. Johnson (1971) reported that the first migratory flocks of loons passed Barrow on 3 September. All evidence tends to support the conclusion that the loon flight past Barrow takes place primarily in September.

Black Brant.

Only 400 black brant were counted in flight, with the latest observation occurring on 4 September. Their numbers averaged 5.6 birds per half-hour in the first week, declining to 1.2 in the second and none in the third week (Table 1). Johnson (1971) saw 1,103 black brant between 18 August and 7 September.

Most black brant probably miss Barrow during the fall flight (Pitelka 1974). Gabrielson and Lincoln (1959) claimed that black brant hasten their migratory journeys by taking shortcuts across land, while they are also known to fly via inland river drainages at least occasionally. Flock's (1973) radar data indicated that westward movements of birds unidentified as to species were underway 18 to 56 km south of Barrow on 30 July 1970, and it is possible that some of these birds were black brant but more likely other geese. Bailey (1948) observed their migrations past Wainwright beginning in mid-August, and noted large concentrations at Icy Cape between 6 and 10 September.

Pintail.

Pintails (*Anas acuta*) are occasional migrants past Barrow (Pitelka 1974). Only three flocks were observed, totalling 60 birds; two flocks were sighted on 5 September and one on 6 September. Johnson (1971) counted 59 pintails in flight, and Thompson and Person (1963) counted 46.

Jaegers.

One migratory flock of 24 parasitic jaegers (*Stercorarius parasiticus*) was observed on 31 August; 22 of the birds were in dard phase and 2 in light phase. The number of jaegers moving past Barrow is difficult to determine, since their flight extends inland and a westward drift may begin as early as June (Pitelka 1974). Watson and Divoky (1972) also reported jaegers moving offshore in the eastern Chukchi Sea until late September.

Because it was a relatively productive year for lemmings, pomarine jaegers (*Stercorarius pomarinus*) nested near Barrow in 1975 (Pitelka 1974). Long-tailed jaegers (*Stercorarius longicaudus*) were also seen infrequently, and always singly; duck carcasses, unretrieved by hunters at Birnirk, attracted them.

Larids.

The duck pass also offers an opportunity to watch migrating larids. A total of 200 arctic terns (Sterna paradisaea), 188 Sabine's gulls (Xema sabini), and 21 black-legged kittiwakes (Rissa tridactyla) were counted during the falf-hour watches. An age breakdown was possible for the latter two species. Among the Sabine's gulls, there were 152 adults and 36 immature birds; of the black-legged kittiwakes, 13 were adults and 8 were immature.

Between 30 August and 8 September there occurred a cold spell characterized by average daily temperatures which were 0°C (32°F) or less, and which were below normal compared to U.S. Weather Bureau records for those dates. The weather apparently disrupted the feeding flocks of arctic terns, which previously were common nearshore. On 31 August, no arctic terns were seen at all; then, on 1 September, the first migratory flocks of this species were noticed. On 3 September Sabine's gulls were first observed in flight, followed by black-legged kittiwakes on 4 September.

All three species fly low when passing over land and ice, in contrast to the habits of waterfowl; therefore their movements are not conspicuous except at close range. They passed over the spit at all points along its length, and also flew completely around it, so that the number of these birds recorded during half-hour watches at Birnirk was not representative of the greater numbers migrating past Barrow.

Watson and Divoky (1972) saw no terns between 22 September and 18 October in the eastern Chukchi. Their migration in the Arctic seems to occupy a brief time span, from late August through early September (Gabrielson and Lincoln 1959).

Gabrielson and Lincoln (1959) suggested an offshore migration for Sabine's gulls, and gave 22 October as a late date for this species at Barrow. But Watson and Divoky (1972) proposed a nearshore migration, for the most part passing west of Barrow prior to late September.

Black-legged kittiwakes become less abundant than earlier in the Beaufort Sea during late August and early September, and in the Chukchi during September and October, according to Watson and Divoky (1974). At Icy Cape, Bailey (1948) saw hundreds of migrating kittiwakes between 5 and 7 September. During shipboard observations in the Beaufort Sea, 3 to 15 August, Frame (1973) saw many more black-legged kittiwakes than any other species, while this was one of the least common migrants viewed during my land-based study. An offshore migration is indicated.

Miscellaneous.

Slender-billed Shearwater (Puffinus tenuirostris). My observation of one slender-billed shearwater on 30 August apparently was the first record at Barrow during the summer of 1975. Another sighting on 3 September may have been the same bird. Watson and Divoky (1974) described this species as a sporadic visitor to the Beaufort Sea, probably occurring only when little ice is present. Since the ice was so extensive in 1975, this would explain the lack of an earlier sighting.

Influence on Migratory Movement

Flight Intensity and Wind Conditions.

It was assumed that wind direction would influence waterfowl movements past Barrow. Following Johnson's (1971) example, winds favorable to summer migration were defined as coming from the east-southeast (112°) and any direction within 89° of east-southeast. Winds from all other directions were treated as unfavorable to migration. However, wind speeds of less than 9 knots were considered neutral in effect regardless of their direction. The U.S. Weather Bureau statistics were consulted for accurate records of wind conditions.

The 3-week field season can be considered as 1,008 half-hour segments. During this time there were 390 half-hours accompanied by winds designated as "unfavorable," 468 half-hours with "neutral" wind effect, and 150 half-hours with "favorable" wind effect. Of the 136 half-hour observation periods, 63 occurred during unfavorable winds, 50 during neutral and 23 during favorable winds.

It was demonstrated that winds do affect the migratory flights of waterfowl (Table 2). Eiders averaged 157 birds per half-hour during favorable winds and only 45 per half-hour in unfavorable winds. The highest figure was for neutral winds, with 164 eiders passing per half-hour. The averages were very similar for oldsquaws: 156 birds per half-hour during favorable winds, 50 in unfavorable winds, and 163 in neutral winds.

There was also a strong correlation between favorable wind conditions and black brant movements. During such winds, black brant averaged 7.4 birds per half-hour, dwindling to 0.2 per half-hour in unfavorable winds.

Surprisingly, the movements of loons and larids demonstrated a reverse relationship to wind conditions. Loons averaged 34.7 birds per half-hour during unfavorable winds, 31.1 during neutral winds, and only 4.9 during favorable winds. Sabine's gulls averaged 1.7 birds per half-hour during unfavorable winds, compared to 0.5 in favorable winds. The mean figures for arctic terns were 1.3 birds per half-hour in unfavorable winds, 2.4 during neutral winds, and none during favorable winds. Black-legged kittiwakes were represented by 0.3 birds per half-hour during unfavorable winds and no birds during favorable winds.

"Unfavorable" winds tend to blow loose ice in the direction of the coastline immediately west of Barrow, narrowing the zone of open water adjacent to the shore. This might provide a clue about why more loons and larids were recorded during headwinds than at other times. If loons prefer passage over open water, then their flight path would be "pushed" shoreward during such winds. Given the extensive character of the ice pack, in 1975 unfavorable winds sometimes clogged the limited open water with ice floes. Ivory gulls (Pagophila eburnea), Ross' gulls (Rhodostethia rosea), black-legged kittiwakes and Sabine's gulls are all known to feed on organisms which are close to the surface in areas of sea ice (Watson and Divoky 1972). Field observations during a small-boat trip to Deadman's Island, on 8 September, revealed several flocks of Ross' and Sabine's gulls feeding in areas congested with drifting ice. On 13 September the water west of the spit was especially choked with ice, and amongst the floes were many feeding larids: glaucous gulls (Larus hyperboreus); Ross' gulls; arctic terns; Sabine's gulls; black-legged kittiwakes. The last four species were present in noticeable greater numbers than on previous days when the nearshore waters were ice-free. Several flocks of Sabine's gulls and arctic terns ceased feeding activity while I watched, and flew westward. During shipboard observations, Frame (1973) saw no black-legged kittiwakes when the ice cover was less than an estimated 50 percent, and further reported that they did not leave the ship's wake when the ice cover exceeded 80 percent.

The relationship of ice to the seasonal flight paths of arctic birds is not well-understood. It is possible that I saw more migrating loons and larids during 1975 than would normally be seen by a land-based observer. In more "typical" years, the ice would remain well offshore even during winds which blew shoreward. Data from ships and reconnaissance flights should be correlated with observations made on land, to determine the ice affinities of different species during migration. This would give much insight into the possibilities for year-to-year variability.

Flock Size.

Johnson (1971) reported that wind conditions affected the size of eider flocks; he cited averages of 91 birds per flock in favorable winds, 82 in neutral and 43 in unfavorable winds. My observations did not indicate such a highly significant correlation, either for eiders or for oldsquaws. Average eider flock sizes were 35, 45 and 29 for favorable, neutral and unfavorable winds, respectively. Oldsquaw flock sizes averaged 39, 89 and 34 for the different wind conditions.

Loons also had the largest average flock size, 6.3, during neutral winds. But the difference between flock sizes during unfavorable winds (4.8) and favorable winds (2.6) was significant, and in accord with other figures given for loons (Table 3).

Flock sizes did change in relation to the shifts in species composition which took place. The average eider flock included 41 and

43 birds, respectively, during the first two weeks, and only 20 in the third week. Oldsquaw flocks averaged 33 birds in the second and 75 in the third week. Loon flocks also became progressively larger each week, with mean figures of 2.7, 3.6 and 6.5 birds per flock (Table 3).

While not appearing to strongly affect flock size, wind conditions did influence the numbers of flocks passing per half-hour. The mean figure for eiders during favorable winds was 4.5 flocks per half-hour, compared to 3.7 and 1.6 flocks during neutral and unfavorable winds. In the case of oldsquaws, the averages were 15.3, 2.7 and 2.7 flocks per half-hour, for the different wind types. Loons, with the opposite tendency, averaged 7.2 flocks per half-hour in unfavorable winds, 5.0 in neutral and 1.9 in favorable winds (Table 4).

The overall average flock sizes were 38 for eiders, 54 for oldsquaws, and 5.2 for loons. Of the eider flocks, 93 percent were in groups of 100 birds or less. The largest flock, 280 birds, was noted on 4 September. The largest oldsquaw flock, with 2,300 birds, occurred 14 September. Only 1 percent of all oldsquaw flocks consisted of 300 birds or more, while 89 percent included 100 birds or less (Table 5). In Thompson and Person's (1963) observations, the average eider flock size was 105 birds; 73 percent of all flocks numbered 100 birds or less and 7 percent were of more than 300 birds. Johnson (1971) found that 70 percent of the eiders he saw were in flocks of 100 birds or less, and only 2.6 percent of the flocks exceeded 300 birds.

Flight Intensity and Time of Day.

Thompson and Person (1963) suggested a correlation between the number of migrants in flight and the time of day. To test this hypothesis, the day was divided into four segments: (a) 0601-1200 hours (37 observations); (b) 1201-1800 hours (67 observations); (c) 1801-2400 hours (32 observations); (d) 0001-0600 hours. No half-hour watches fell during the night-time hours of 0001-0600. The morning and evening were less adequately sampled than the afternoon, partly because increasing hours of darkness cut into those time periods.

In calculating averages, it seemed prudent to exclude the four half-hour sample periods which produced over 1,000 birds. All four occurred on 14 and 15 September, and only five watches were conducted during both days combined due to heavy fog. These high counts fell by accident during the evening and morning because of temporarily improved visibility, while it is certain that comparable large numbers of birds passed also in the afternoon.

As determined from all counts except those four, the evening hours (1801-2400) yielded an average of 271 birds per half-hour, compared with 174 per half-hour in the afternoon (1201-1800) and 127 per half-hour in the morning (0601-1200). Frame (1973), during shipboard observations, saw more than three times as many birds during the late afternoon and early evening than during the twilight period (2101-0300). Johnson's (1971) highest figure was for the time period 0001-0600 hours.

Migration Estimates

In the process of estimating the total flight of each species during the 3-week project, the possibility of error was reduced by integrating two factors: wind effect and weekly changes in species composition. Therefore the average number of birds per half-hour during each wind condition was calculated separately for each week, and by expansion of data weekly estimates were determined for each species (Appendix A). This minimized the bias introduced by unequal sampling during the three weeks.

By this method, it was estimated that 412,164 migratory birds passed Barrow between 27 August and 16 September 1975. Roughly five times as many birds were in flight during the third week as compared to the first week. Waterfowl, together with loons, accounted for 407,727 birds or nearly 99 percent of the total; larids and jaegers combined represented the remaining one percent.

A majority of the migrants were oldsquaws, estimated at 240,607 birds during this time span (58 percent). If oldsquaw movements continue through October, at least 800,000 may pass Barrow on their way south.

Eiders were second in abundance, accounting for an estimated 113,160 birds (27 percent). The obesrvations made by Thompson and Person (1963) and Johnson (1971) indicated that between 800,000 and 850,000 adult eiders fly over the duck camp prior to early September; both of their estimates excluded all juveniles as well as some females. Therefore it seems reasonable, as suggested by Barry (1968), Thompson and Person (1963), and Johnson (1971), that a million or more eiders migrate coastally past Barrow.

The loon flight during the three-week period was caluclated to include 50,793 birds (12 percent). All other species accounted for one percent or less of the total flight (Table 6). The estimates were: black brant, 2,740 birds; Sabine's gulls, 2,222; arctic terns, 1,879; pintails, 427; parasitic jaegers, 189; black-legged kittiwakes, 147.

The percentage representation by different species dramatically shifted during the three weeks. Eiders accounted for 95 percent of the flight during the first week, which is comparable to the figures taken from Thompson and Person (1963) and Johnson (1971). During the second week, 43 percent were eiders, declining to 9 percent in the third week.

Oldsquaws were not yet migrating during the first week, but accounted for 44 percent and 74 percent of the flight during the next two weeks, respectively. Loons were responsible for one percent of the estimated total during the first week, jumping to 10 and 15 percent in the following weeks. But when considering only the estimates for migration during unfavorable winds, the percentage of loons was higher, amounting to 4 percent in the first week, 11 percent in the second week, and 84 percent in the third week (Table 6).

Hunting Activity

When observations began on 27 August there were 19 tents at Birnirk. Some were "permanent" structures with heating and cooking facilities, strong wind-breaks, drying racks, etc. Others were erected for short periods of time, notably weekends. Native hunters informed me that many more people used the camp earlier in the summer. School began on 25 August, at which time numerous families strike their tents and return to their residences in town. Johnson (1971) observed as many as 49 tents in the duck camp before school started in 1970.

More than a dozen small motor boats rested on the beach along Elson Lagoon, but these were not once seen in use for the retrieval of birds which fell into the water when shot. Generally the hunter waited for the birds to drift to shore. However, boat travel is popular in association with hunting activity. Duck hunters often would station their boats offshore from Brant Point, especially during peak flights. On 29 August at least a half dozen boats headed east with the purpose of going inland to hunt caribou; duck hunting was typically a planned part of these trips. It would be interesting to see if duck hunting also occurs during the autumn whaling operations in late September, at Nuwuk.

A total of 297 hunter half-hours were recorded during the 136 watches, placing an average 2.2 hunters per half-hour between Birnirk and Brant Point. Thompson and Person (1963), using a longer sample period, noted an average 4.1 hunters per hour during evening watches. Johnson's (1971) evening watches produced an average 5.8 hunters per half-hour. He found that more hunters were present at the duck camp between 1800 and 2400 hours than at other times during the day. This may be regarded in part as a response to greater waterfowl flight intensity in the evening, as opposed to the morning and afternoon hours, and in part as a result of the fact that many Eskimo males must work or attend school during the daytime. Between 27 August and 16 September 1975 the number of hunters averaged 2.9 per half-hour during 1801-2400 hours, 2.4 during 1201-1800 hours, and 1.2 during 0601-1200 hours.

Being generally aware of the effect of wind direction on waterfowl migration, hunters were present in the highest numbers during tailwinds. The mean number of hunters was 5.9 per half-hour in favorable winds, 2.0 in neutral winds, and 1.0 in unfavorable winds.

Hunter success also was shown to be relative to wind conditions. The averages were 0.34 birds harvested per hunter half-hour during unfavorable winds, 0.58 during neutral winds, and 0.69 in favorable winds (Table 7). Johnson's (1971) figures were, in comparison, 0.88, 2.00, and 2.02 for the three kinds of wind. The Thompson and Person (1963) study gave the figure of 1.2 birds harvested per hunter hour, without considering wind categories.

The number of birds harvested included both the birds bagged and the birds shot but not recovered. The observed rate of recovery was 76 percent, or one bird bagged per 1.31 birds shot. The mean number of shots required for each bird bagged was 4.83, translating as a 21 percent efficiency level. For each bird harvested, 3.7 shots were expended. Johnson (1971) reported a lower recovery rate of 60 percent, and a ration of 3.5 shots per bird harvested during the evening watches. Thompson and Person (1963) derived still lower ratios of 3.3 shots per bird bagged, and 2.3 shots per bird harvested. Certainly this does not reflect a decline in shooting capabilities, but more likely it points to a willingness to shoot at eiders while they appeared in dwindling numbers and smaller flocks in September. This indicates a growing recreational value of duck hunting, which is important in addition to the subsistence value.

The harvest estimate is the product of the estimated hunter half-hours, defined by the two variables of wind condition and time of day, and their success rate, defined by wind condition only (Table 7). This resulted in a harvest estimate of 1,143 birds, or 0.3 percent of the estimated waterfowl migration during the three-week study. This is nearer to the harvest total of 0.5 percent given by Thompson and Person (1963) than to Johnson's (1971) one percent figure.

The mean numbers of hunters per half-hour during the unsampled time block, 0001-0600, were assumed to be equal to the averages for 0601-1200 hours. Spot checks indicated that Eskimos did occasionally hunt during hours of darkness. It was not uncommon to see hunters sitting in parked trucks near Elson Lagoon, with their lights on.

Ages were estimated for 197 of the hunters, with the percentage of hunters in each age group closely corresponding to the percentage of these age groups in the native male population of Barrow (Table 8). In contrast, Johnson (1971) found that the percentage of hunters aged 12-24 years significantly exceeded the percentage of men in that age group in the whole population.

In 25 bag checks, a total of 75 birds were examined. King eiders accounted for 85.3 percent of the bagged birds; common eiders, 2.7 percent; oldsquaws, 9.3 percent; pintails and loons, 1.3 percenct each. Johnson (1971) gave the higher figures of 92 percent and 4 percent for the king and common eiders respectively; black brant accounted for another 3 percent.

The average weight for 47 female adult king eiders was 1645 grams; Johnson (1971) gave the higher figure of 1676 grams, while the lower average of 1567 grams was calculated by Thompson and Person (1963). For 17 subadult king eiders, the mean weight was 1535 grams. Two adult female common eiders averaged 1980 compared to 795 grams for the two female adults of this species (Appendix B).

CONCLUSION

Along the northern Alaska coast, the harvest at Barrow is presently the principal source of bird mortality attributable to man. The eider kill probably does not exceed one percent of the total population, while hunting pressure on other species is negligible. Environmental factors still provide the main causes for fluctuations in arctic populations, although this may not remain true for long. With the advent of oil development, there is a new potential for man-made disturbances.

Mortality provoked by variables in weather and ice cover is most likely to occur during spring and summer-fall migrations. This is also the time when the largest numbers of birds would be susceptible to the effects of an industrial accident. Eiders are probably most influenced by natural conditions during the spring, when they are amongst the earliest migrants. Oldsquaws, loons, and larids are later migrants, and their behavior during fall migration has not been well-examined in the Arctic. Watson and Divoky (1972; 1974) produced valuable information about offshore movements at that time of year, in the western Beaufort and eastern Chukchi Seas. But the greatest impact of the oil industry will be in the coastal zone, and it is important to define the behavior of different species in nearshore waters.

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Table 1. Mean number of migrants per half-hour counts near Point Barrow, Alaska, during each of three weeks in 1975.

Species	Mean No. Birds/Half-Hour Count		
	27 Aug-2 Sep	3-9 Sep	10-16 Sep
Eider	138.8	94.0	55.1
Oldsquaw	0	90.8	442.3
Loon	1.1	21.2	116.5
Black Brant	5.6	1.2	0
Pintail	0	1.2	0
Sabine's Gull	0	1.4	5.1
Black-legged Kittiwake	0	0.3	0.2
Arctic Tern	0.2	2.7	2.2
Parasitic Jaeger	0.4	0	0

Table 2. Mean number of migrants per half-hour count near Point Barrow, Alaska, as influenced by different wind conditions, 27 August to 16 September 1975.

Species	Mean No. Birds/Half-Hour		
	Favorable 1/ Winds	Neutral 2/ Winds	Unfavorable 3/ Winds
Eider	157.2	163.5	45.0
Oldsquaw	156.1	163.4	49.7
Black Brant	7.4	4.3	0.2
Pintail	0.9	0	0.6
Loon	4.9	31.1	34.7
Sabine's Gull	0.5	1.4	1.7
Black-legged Kittiwake	0	0.1	0.3
Arctic Tern	0	2.4	1.3
Parasitic Jaeger	0	0.5	0

1/ Wind direction 30°-201°; wind speed 9 knots or more.

2/ Winds from any direction; wind speed less than 9 knots.

3/ Wind direction 202°-32°; wind speed 9 knots or more.

Table 3. Flocking size of eiders, oldsquaws, and loons near Point Barrow, Alaska, by weekly periods and as influenced by wind conditions, 27 August to 16 September 1975.

	Average Flock Size		
	Eider	Oldsquaw	Loon
Time Period			
27 Aug - 2 Sept	41	0	2.7
3-9 Sept	43	33	3.6
10-16 Sept	20	75	6.5
Overall	38	54	5.2
Wind Condition			
Favorable 1/	35	39	2.6
Neutral 2/	45	89	6.3
Unfavorable 3/	29	34	4.8
Overall	38	54	5.2

1/ Wind direction 33°-201; wind speed 9 knots or more.

2/ Winds from any direction; wind speed less than 9 knots.

3/ Wind direction 202°-32°; wind speed 9 knots or more.

Table 4. Number of flocks of eiders, oldsquaws, and loons migrating near Point Barrow, Alaska, during half-hour observation periods as influenced by wind conditions, 27 August to 16 September 1975.

Wind Condition	No. Flocks/Half-Hour Period		
	Eider	Oldsquaw	Loon
Favorable 1/	4.5	15.3	1.9
Neutral 2/	3.7	2.7	5.0
Unfavorable 3/	1.6	2.7	7.2
Overall	2.8	3.7	5.5

1/ Wind direction 33°-201°; wind speed 9 knots or more.

2/ Winds from any direction; wind speed less than 9 knots.

3/ Wind direction 202°-32°; wind speed 9 knots or more.

Table 5. Number of eider and oldsquaw flocks observed in different size ranges, and percentage of flocks in each size range near Point Barrow, Alaska, 27 August to 16 September 1975.

	Eiders		Oldsquaws	
Flock Size Ranges	No. Flocks	Percent	No. Flocks	Percent
0 - 25 Birds	190	49	126	46
26 - 50 "	106	28	73	26
51 - 75 "	42	11	37	13
76 - 100 "	21	5	12	4
101 - 200 "	23	6	23	8
201 - 300 "	3	1	4	2
Over 300 Birds	0	0	2	1
Total	385	100	277	100

Table 6. Species composition of birds migrating near Point Barrow, Alaska, by weekly periods and as influenced by wind condition, 27 August to 16 September 1975.

Species	Percent Compostition			
	Unfavorable 1/ Wind	Neutral 2/ Wind	Favorable 3/ Wind	All Conditions
27 Aug - 2 Sept				
Eider	95	95	95	95
Oldsquaw	0	0	0	0
Black Brant	0	4	5	4
Pintail	0	0	0	0
Loon	4	1	1	1
Sabine's Gull	0	0	0	0
B-l Kittiwake	0	0	0	0
Arctic Tern	1	0	0	1
Par. Jaeger	0	1	0	1
3 - 9 Sept				
Eider	29	71	5	43
Oldsquaw	57	14	90	44
Black Brant	1	1	0	1
Pintail	1	0	2	1
Loon	11	11	3	10
Sabine's Gull	1	1	0	1
B-l Kittiwake	1	1	0	1
Arctic Tern	1	2	0	1
Par. Jaeger	0	0	0	0
10 - 16 Sept				
Eider	10	10	6	9
Oldsquaw	1	79	92	74
Black Brant	0	0	0	0
Pintail	0	0	0	0
Loon	84	11	2	15
Sabine's Gull	3	1	1	1
B-l Kittiwake	1	0	0	1
Arctic Tern	1	1	0	1
Par. Jaeger	0	0	0	0
27 Aug - 16 Sept				
Eider	28	25	42	27
Oldsquaw	35	64	54	58
Black Brant	1	1	2	1
Pintail	1	0	1	1
Loon	35	10	2	12

Table 6. Continued

Species	Percent Compostition			
	Unfavorable 1/ Wind	Neutral 2/ Wind	Favorable 3/ Wind	All Conditions
Sabine's Gull	2	1	1	1
B-l. Kittiwake	1	1	0	1
Arctic Tern	1	1	0	1
Par. Jaeger	0	1	0	1

1/ Unfavorable wind; direction 202°-32°; speed 9 knots or more.

2/ Neutral wind; any direction; speed less than 9 knots.

3/ Favorable winds; direction 33°-201°; speed 9 knots or more.

Table 7. Summary of data used in estimating waterfowl harvests near Point Barrow, Alaska, 27 August to 16 September 1975.

Wind Type	Waterfowl Harvest/ Half-Hour	Time of Day	Stratum Size (No. Half-Hours)	Mean No. Hunters/ Half-Hour	Est. Total Hunter Half-Hours	Est. Waterfowl Harvest
Unfavor-able 1/	0.34	0001-0600	96	0.2	19.2	6.5
		0601-1200	108	0.2	21.6	7.3
		1201-1800	120	1.0	120.0	40.8
		1801-2400	66	2.3	151.8	51.6
Neutral 2/	0.58	0001-0600	132	1.1	145.2	84.2
		0601-1200	102	1.1	112.2	65.1
		1201-1800	96	2.2	211.2	122.5
		1801-2400	138	2.1	289.8	168.1
Favorable 3/	0.69	0001-0600	24	3.4	81.6	56.3
		0601-1200	42	3.4	142.8	98.5
		1201-1800	36	7.4	266.4	183.8
		1801-2400	48	7.8	374.4	258.3

1/ Unfavorable wind; direction 202°-32°; speed 9 knots or more.

2/ Neutral wind; any direction; speed less than 9 knots.

3/ Favorable wind; direction 33°-201°; speed 9 knots or more.

Table 8. Hunting activity of three age groups near Point Barrow, Alaska 27 August to 16 September 1975.

Estimated Hunter Age	Percent of Hunting Activity	Percent of Barrow Native Male Population Over age 12 1/
12 - 24 years	43	41.0
25 - 50 years	41	40.7
Over 50 years	16	18.2

1/ Percentages adapted from the Barrow Comprehensive Development Plan, Alaska State Housing Authority, 1970.

APPENDIX A

Summary of Estimation Procedures for Migration Past Barrow

1A. Eider estimates, for the week 27 August - 2 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable[1]	108	28	38	4,104	
Neutral[2]	126	16	251	31,626	
Favorable[3]	102	17	200	20,400	
					56,130

2A. Eider estimates, for the week 3 September - 9 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	144	22	72	10,368	
Neutral	168	27	120	20,160	
Favorable	24	3	19	456	
					30,984

3A. Eider estimates, for the week 10 September - 16 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	138	13	14	1,932	
Neutral	174	7	131	22,794	
Favorable	24	3	55	1,320	
					26,046

1B. Oldsquaw estimates, for the week 3 September - 9 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	144	22	142	20,448	
Neutral	168	27	23	3,864	
Favorable	24	3	325	7,800	
					32,112

2B. Oldsquaw estimates, for the week 10 September - 16 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	138	13	1.4	193	
Neutral	174	7	1077	187,398	
Favorable	24	3	871	20,904	
					208,495

C. Pintail estimates, for the week 3 September - 9 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	144	22	1.8	259	
Neutral	168	27	0	0	
Favorable	24	3	7.0	168	
					427

1D. Loon estimates, for the week 27 August - 2 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	108	28	1.4	151	
Neutral	126	16	0.5	63	
Favorable	102	17	1.3	133	
					347

2D. Loon estimates, for the week 3 September - 9 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	144	22	26.1	3,758	
Neutral	168	27	18.1	3,041	
Favorable	24	3	12.0	288	
					7,087

3D. Loon estimates, for the week 10 September - 16 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	138	13	120.8	16,670	
Neutral	174	7	150.9	26,257	
Favorable	24	3	18.0	432	
					43,359

1E. Black brant estimates, for the week 27 August - 2 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	108	28	0	0	
Neutral	126	16	10.5	1,323	
Favorable	102	17	10.1	1,030	
					2,353

2E. Black brant estimates, for the week 3 September - 9 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	144	22	0.7	101	
Neutral	168	27	1.7	286	
Favorable	24	3	0	0	
					387

1F. Sabine's gull estimates, for the week 3 September - 9 September, 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	144	22	1.8	259	
Neutral	168	27	1.1	185	
Favorable	24	3	0	0	
					444

2F. Sabine's gull estimates, for the week 10 September - 16 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	138	13	5.0	690	
Neutral	174	7	5.7	992	
Favorable	24	3	4.0	96	
					1,778

1G. Black-legged kittiwake estimates, for the week 3 September 9 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	144	22	0.5	72	
Neutral	168	27	0.2	34	
Favorable	24	3	0	0	
					106

2G. Black-legged kittiwake estimates, for the week 10 September 16 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	138	13	0.3	41	
Neutral	174	7	0	0	
Favorable	24	3	0	0	
					41

1H. Arctic tern estimates, for the week 27 August - 2 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	108	28	0.4	43	
Neutral	126	16	0	0	
Favorable	102	17	0	0	
					43

2H. Arctic tern estimates, for the week 3 September - 9 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	144	22	2.2	317	
Neutral	168	27	3.4	571	
Favorable	24	3	0	0	
					888

3H. Arctic tern estimates, for the week 10 September - 16 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	138	13	1.7	235	
Neutral	174	7	4.1	713	
Favorable	24	3	0	0	
					948

I. Jaeger estimates, for the week 27 August - 2 September 1975.

Wind Effect	Stratum Size	Sample Size	Mean No./ Half-Hour	Stratum Estimate	Total Estimate
Unfavorable	108	28	0	0	
Neutral	126	16	1.5	189	
Favorable	102	17	0	0	
					189

[1]Wind direction 202°-32°; wind speed 9 knots or more.

[2]Winds from any direction; wind speed less than 9 knots.

[3]Wind direction 33°-201°; wind speed 9 knots or more.

APPENDIX B

Data Compiled from Hunter Bag Checks at Barrow

Date	Species	Sex/Age	Weight (Grams)
8/27/75	King Eider	Female/Adult	1700
	King Eider	Female/Adult	1680
8/28/75	King Eider	Female/Adult	1620
	King Eider	Female/Adult	1680
8/29/75	King Eider	Female/Adult	1600
	King Eider	Female/Adult	1900
	King Eider	Female/Adult	1640
	King Eider	Female/Adult	1760
	King Eider	Female/Adult	1700
	King Eider	Female/Adult	1880
	King Eider	Female/Adult	1600
	King Eider	Female/Adult	1620
	King Eider	Female/Adult	1640
	King Eider	Female/Adult	1820
	King Eider	Female/Adult	1720
	King Eider	Female/Adult	1780
	King Eider	Female/Adult	1700
	King Eider	Female/Adult	1800
	King Eider	Female/Adult	1550
	King Eider	Female/Adult	1570
	King Eider	Female/Adult	1700

Appendix II (Continued)

Date	Species	Sex/Age	Weight (Grams)
8/29/75	Arctic Loon	Male/Adult	Not Taken
	King Eider	Female/Immature	1580
	King Eider	Female/Immature	1500
	King Eider	Male/Juvenile	1550
	King Eider	Female/Adult	1580
	King Eider	Female/Adult	1430
8/30/75	King Eider	Female/Immature	1570
	King Eider	Female/Adult	1700
	King Eider	Female/Adult	1620
	King Eider	Female/Adult	1600
	King Eider	Female/Adult	1850
	King Eider	Female/Adult	1720
	King Eider	Female/Adult	1480
	King Eider	Female/Adult	1650
	Common Eider	Female/Adult	2000
	King Eider	Female/Adult	1600
	King Eider	Female/Adult	1680
	King Eider	Female/Immature	1520
	King Eider	Female/Adult	1550
	King Eider	Male/Juvenile	1580
	King Eider	Female/Adult	1580
	King Eider	Male/Immature	1680
	King Eider	Female/Immature	1560

Appendix II (Continued)

Date	Species	Sex/Age	Weight (Grams)
8/30/75	King Eider	Female/Adult	1700
	King Eider	Female/Adult	1400
	King Eider	Female/Adult	1480
	King Eider	Female/Juvenile	1320
	King Eider	Female/Adult	1720
	King Eider	Female/Juvenile	1420
	King Eider	Male/Immature	1540
8/31/75	King Eider	Female/Juvenile	1480
	King Eider	Female/Adult	1520
	King Eider	Female/Adult	1600
	King Eider	Female/Adult	1620
	King Eider	Male/Immature	1620
	Common Eider	Female/Adult	1960
	King Eider	Female/Adult	1620
	King Eider	Female/Adult	1540
9/5/75	King Eider	Female/Immature	1520
	Pintail	Female/Juvenile	500
	King Eider	Female/Adult	1680
	King Eider	Female/Adult	1620
9/6/75	Oldsquaw	Male/Adult	920
	Oldsquaw	Female/Adult	800
	King Eider	Female/Juvenile	1560

Appendix II (Continued)

Date	Species	Sex/Age	Weight (Grams)
9/9/75	King Eider	Female/Adult	1520
9/14/75	King Eider	Male/Juvenile	1590
	King Eider	Female/Immature	1500
	Oldsquaw	Male/Adult	900
	Oldsquaw	Male/Adult	1000
	Oldsquaw	Female/Adult	790
	Oldsquaw	Male/Adult	900
	Oldsquaw	Male/Adult	920
	King Eider	Female/Adult	1600

QUARTERLY REPORT

Contract: 01-5-022-2538
Research Unit: RU-341, RU-342
Reporting Period: April 1, 1976 to
June 30, 1976
Number of pages: i + 16 pp.

FEEDING ECOLOGY AND TROPHIC RELATIONSHIPS OF ALASKAN MARINE BIRDS (RU-341)

AND

POPULATION DYNAMICS OF MARINE BIRDS (RU-342)

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and

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July 1, 1976

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 contains a list of our activities related to these research units primarily during the quarter from 1 April to 30 June 1976 and highlights of certain activities and findings from previous quarters.

STUDY AREA

Activities under these two research units were largely restricted to the Gulf of Alaska and the southeastern Bering Sea. Table 1 lists those field operations where data for these units were collected. Figure 1 shows the locations of the coastal study sites.

In our unilateral effort to avoid duplicating the almost identical efforts by George J. Divoky (RU #330 and 196 were formerly contracted to the U.S. Fish and Wildlife Service), Juan Guzman (RU #239), Wayne Hoffman and Dennis Heineman (RU #108), and George L. Hunt, Jr. (RU #83) we did not participate on many NOAA-operated cruises and, therefore, did not collect birds for our trophic relationship studies in deference to their studies. Because we deferred to these other OCSEAP investigators and because our study sites are from the central Bering Sea south, we have little or no data acquisition under either of these two research units for the northern Bering, Chukchi and Beaufort Seas.

METHODS

See our Annual Reports for RU #341 and 342 of 1 April 1976.

RESULTS

Fourteen field camps were established this quarter from Forrester Island in extreme southeastern Alaska to the outer Yukon River delta (Figure 1). Personnel and the approximate dates of arrival at these field camps are presented in Table 1. Most of these study sites were selected because of the dominant species present, their unique habitat, the potential vulnerability of the locality to impact from OCS activities, or all (see our Annual Report RU #342, Tables 1 and 2, 1 April 1976). Information on both trophic relationships and population dynamics are being collected at most of these sites.

Birds were collected during 15 cruises (Table 1) for determination of food habits. Most of the analyses will be done during subsequent quarters.

A radio network linking field camps at Yukon Delta, Cape Peirce, Big Koniuji, Semidi, Ugaiushak, Barren, Hinchinbrook and Forrester Islands, the F/V Nordic Prince and the Anchorage office, has provided for timely exchange of biological data, a measure of safety and a morale boost to these out-of-the-way sites. Refuge-operated radios at Cold Bay, Bethel, and Adak have assisted in relaying messages when communications less than optimum.

The F/V Nordic Prince, an 85-ft. combination crab-shrimp fishing boat from Tacoma, Washington, began a 120-day charter on 24 April in support of the diverse and far-flung activities under RU #341 and 342. At no additional operational costs, data were acquired in support of projects RU #337, 338 and 343. The Service's Resource Planning contributed $25,000 toward operation of the vessel which aided us in the duration of our field program as well as significantly increasing the acquisition of colony information in support of RU #343. During the quarter, the F/V Nordic Prince was used to establish and supply camps at Hinchinbrook Island, Barren Islands, Semidi Islands, Ugaiushak Island, Big Koniuji Island, Nelson Lagoon, and Cape Peirce.

Our efforts under RU #341 and 342 are being materially enhanced by funding, services and manpower contributed by other U.S. Fish and Wildlife Service programs and other agencies. The Forrester Island study is funded by National Wildlife Refuges (Alaska Area) with logistical support being provided by the Service's Eagle Management Studies program (M/V Curlew from Juneau) and the U.S. Coast Guard (helicopters from Annette Station). Day-to-day administrative assistance and minor but continuous logistical support have been given (by staff of the Kodiak National Wildlife Refuge) to our personnel. Logistical and administrative support has been provided to our personnel at camps on the Yukon Delta and at Cape Peirce by personnel of the Clarence Rhode National Wildlife Range. Resource Planning (Alaska Area) has contributed the assistance of Edgar P. Bailey, who helped establish the Barren Islands camp and assisted in aerial and colony surveys; and it has contributed funds to support operations from the chartered F/V Nordic Prince. Kenton D. Wohl, Bureau of Land Management biologist, has assisted in some of the efforts under these projects and has contributed information to the data bases. Dr. Marshall A. Howe, Chief of the Bird Section of the Service's National Fish and Wildlife Laboratory is assisting us in seabird studies on Middleton Island.

A report of progress on Stan Senner's study of food habits of migrating dunlins and western sandpipers in the Copper River delta area is appended (Appendix A). This study is being conducted through contract with the Alaska Cooperative Wildlife Research Unit.

Table 1. Log of U. S. Fish and Wildlife Service, Office of Biological Services - Coastal Ecosystem's field operations for the study of marine birds, 1 January to 30 June 1976. The symbol "●" behind the field operation number denotes operations in which birds were collected for food habit analyses.

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
8 Jan	76001	Aerial - P2V	UCI, LCI, NWGOA	Craig Harrison, Scott Hatch, Ed Bailey
15-20 Feb	76002	MOANA WAVE	Seattle-Seward	Gerald Sanger, Matt Kirchhoff, Mark Phillips, Dave Hardy
18-20 Feb	76003	Reconnaissance	Middleton I.	John Hall, Kent Wohl (BLM)
20 Feb - 5 Mar	76004	MOANA WAVE	PWS, NEGOA, NWGOA	Matt Kirchhoff
24-27 Feb	76005	DISCOVERER	Seattle-Kodiak	Dave Hardy, Dave Frazer
28 Feb - 8 Mar	76006	Aerial - P2V	BB, SGB, UMB, APS KB, SS, NWGOA, LCI	Craig Harrison, Scott Hatch, Art Sowls
1-13 Mar	76007	DISCOVERER	KB, NEGOA	Dave Frazer
8-12 Mar	76008	SURVEYOR	Seattle-Kodiak	Colleen Handel
8-26 Mar	76009●	MOANA WAVE	KB, APS, BB, SGB	Mark Phillips
15-21 Mar	76010	MILLER FREEMAN	Seattle-Kodiak	Gerald Sanger, Susan Bates, Colleen Handel, Mark Rauzon, Ted Schad
16-29 Mar	76011●	DISCOVERER	KB, NWGOA, NEGOA, PWS	Matt Kirchhoff
23 Mar - 21 Apr	76012●	MILLER FREEMAN	NWGOA, APS, BB, SGB, SCB	Mark Rauzon
29 Mar - 15 Apr	76013	MOANA WAVE	NWGOA, LCI, UCI	Dave Frazer

(Table continued)

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location 1/	Personnel
29-30 Mar	76014	Aerial - P2V	PWS, NEGOA, NWGOA LCI	Craig Harrison, Scott Hatch, Colleen Handel
4 Apr	76015	Aerial - P2V	UCI, LCI, KB, SS, NWGOA	Craig Harrison, Scott Hatch, Mark Phillips
6-13 Apr	76016●	DISCOVERER	UCI, LCI, KB, NWGOA, NEGOA, PWS	Craig Harrison
10-26 Apr	76017	SURVEYOR	SGB, BB, KB, APS, NAV	John Hall
13- Apr	76018	DISCOVERER	Leg	Ted Schad
19 Apr - 1 May	76019●	MOANA WAVE	NEGOA, NWGOA, KB	Tony DeGange
20 Apr - 27 May	76020●	Field Camp	Unimak Pass	Mark Phillips
20 Apr - 13 May	76021●	MILLER FREEMAN	NAV, SGB, SCB, OA	Doug Forsell
22 Apr to date	76022●	Field Camp	Hinchinbrook I.	David Nysewander, Pete Knudtson
26 Apr to date	76023●	Field Camp	Cape Peirce	Margaret Peterson, Marilyn Sigman
29 Apr to date	76024●	Field Camp	Semidi Is.	Scott Hatch, Martha Hatch
29 Apr to date	76025 to 49●	NORDIC PRINCE	Prince William Snd to Cape Peirce	Art Sowls, Allen Moe, Jerry Ruehle, Don Dumm, Jim Bartonek, Gerald Sanger, Pat Gould, Colleen Handel, John Hall, Sue Bates Pat Baird, et al.
3-5 May	76050●	DISCOVERER	NEGOA, KB,	Patrick Gould, Mark Rauzon

(table continued)

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location [1]	Personnel
6-8 May	76051●	DISCOVERER	LCI, NWGOA	Patrick Gould, Mark Rauzon
12-20 May	76052●	DISCOVERER	KB, NEGOA, PWS NWGOA	Patrick Gould
9 May to date	76053●	Field Camp	Forrester I.	Dave Frazer, Earl Possardt, Tony DeGange
11 May to date	76054●	Field Camp	Barren Is.	David Manuwal, Dee Boersma, Naomi Manuwal, Mike Amarel, Mary Nerini
16 May to date	76056●	Field Camp	Nelson Lagoon	Bob Gill, Paul Jorgenson
17 May - 4 Jun	76057●	MILLER FREEMAN	OA, UMB, BB, SGB NAV, APS, SS, NWGOA	Doug Forsell
7 May -	76058●	MOANA WAVE	leg	Tony DeGange
20 May to date	76059●	Field Camp	Semidi Is.	Galen Burrell, Lora Leschner
20 May to date	76060●	Field Camp	Ugaiushak I.	Duff Whele
20 May to date	76061●	Field Camp	Ugaiushak I.	Eric Hoberg
20 May to date	76062●	Field Camp	Big Koniuji I.	Bob Day
20 May to date	76063●	Field Camp	Big Koniuji I.	Ted Schad, Allen Moe
24 May - 3 Jun	76064●	SURVEYOR	KB, NEGOA, NWGOA	Patrick Gould, Craig Larson
26 May - 5 Jun	76066	MOANA WAVE	KB, APS, UMB, SGB, BB	Keith Metzner
5-22 Jun	76067●	MOANA WAVE	UMB, BB, ECB, SGB, APS, KB	Keith Metzner
25 May - 17 Jun	76068	LINBLAD EXPLORER	SE, SW, SC Alaska	Mark Rauzon

(Table continued).

Table 1. (continued).

Date	Field Operation Number	Platform or Type of Study	Location [1]	Personnel
1 Jun to date	76069●	Field Camp	Kodiak I.	Matt Dick, Jay Nelson
7-17 Jun	76070	MILLER FREEMAN	Leg IV	Patricia Baird
18-23 Jun	76071	MILLER FREEMAN	Leg, Transit	Patricia Baird
8-12 Jun	76072	Aerial	NB, HB	Craig Harrison
6 Jun to date	76073●	Field Camp	Middleton I.	Marshall Howe, Dave Frazer
22 Jun to date	76074●	MOANA WAVE	Leg VIII	Doug Forsell
15 Jun to date	76075●	Field Camp	Yukon Delta	Bob Jones, Matt Kirchhoff
30 Jun to date	76076●	Field Camp	Unimak Pass	Mark Rauzon
9 July	76077	DISCOVERER	Seattle - Kodiak	Keith Metzner
9 July	76078	DISCOVERER	NWGOA	Keith Metzner
14-16 June	76079	NORDIC PRINCE	NEGOA, PWS	John Hall, Art Sowls, Colleen Handel, Beverly Eggen, Kent Wohl
27 April to date	76080●	Field Camp	Copper R. Delta	Stan Senner
7 May to date	76081●	Field Camp	Wooded Islands	Peter Mickelson, Bud Lenhausen

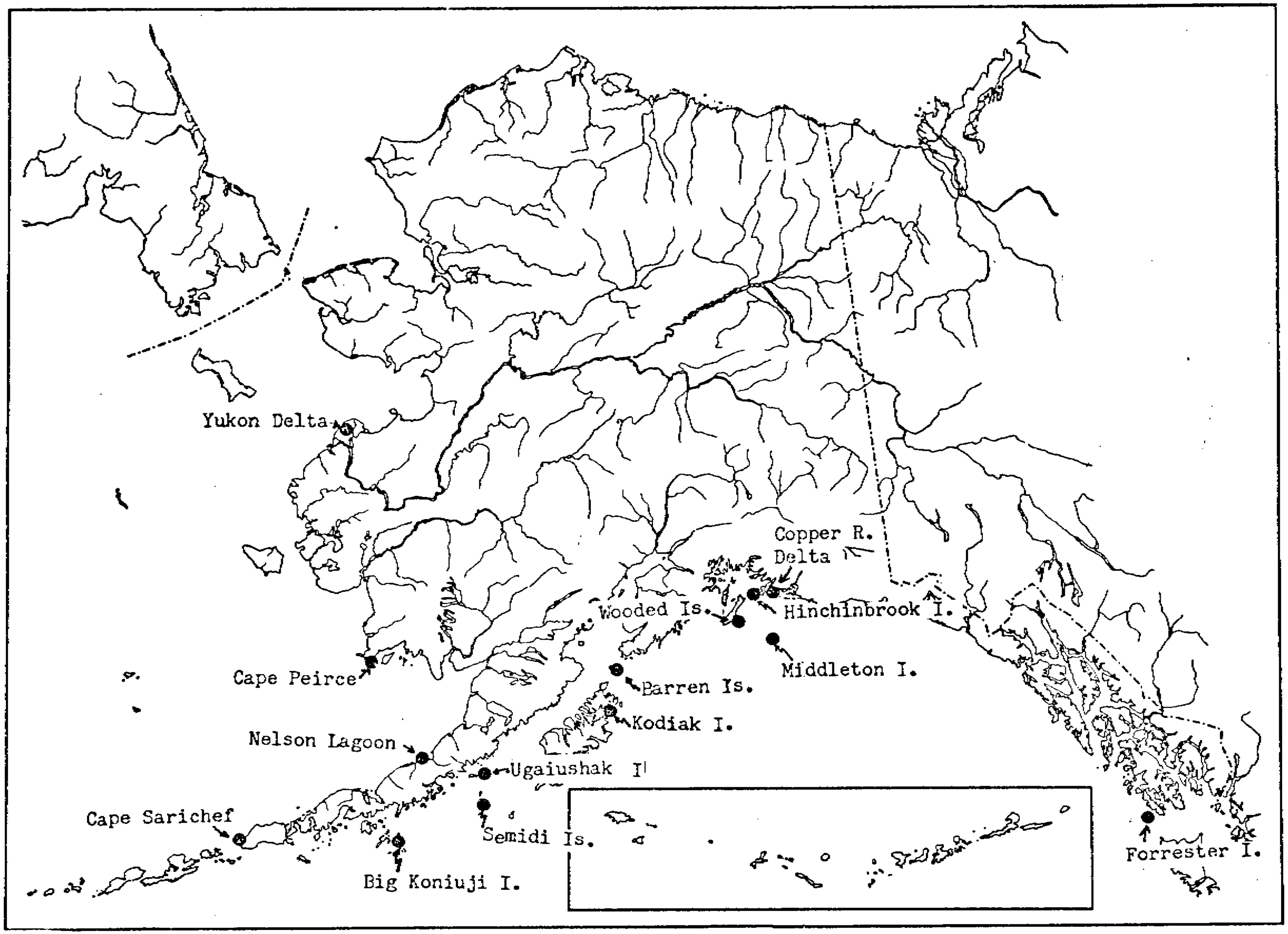

Figure 1. Location of study sites operated by the U. S. Fish and Wildlife Service, OBS-CE, during the quarter from 1 April to 30 June 1976.

APPENDIX A

Project Title:

The food habits of migrating dunlins (Calidris alpina) and western sandpipers (Calidris mauri) in the Copper River Delta area, Alaska

Investigator: Stan Senner
Advisors: Drs. David R. Klein and David Norton
Funding Agency: U.S. Fish and Wildlife Service

Objectives:

1. To determine the diet of shorebirds with principle emphasis on that of dunlins and western sandpipers while they are feeding, primarily on tidal flats. Food habits will be considered in relation to time of year, location within region, daily tide cycles, and intrahabitat utilization.
2. To determine the availability, abundance, and productivity of food items utilized on the tidal flats. The prey species will be considered in relation to time of year, location within region, daily tidal cycles, and intrahabitat distribution.
3. To determine the condition of dunlins and western sandpipers in terms of body fat as they arrive in and leave the region.

Quarter: 1 July - 30 September 1975

Under the sponsorship of the University of Alaska, the investigator and Dr. David Norton conducted preliminary field studies in the Copper River Delta from 2 -5 May, 1975 and from 5 - 10 August, 1975. The purpose of these preliminary studies was to familiarize the investigator with the region and to facilitate the development of a worthwhile project with appropriate field procedures.

Study in the spring focused on the Alaganik-Tiedeman Slough area and Hartney Bay. Shorebirds were relatively scarce in the former although six Calidridine sandpipers were collected as they were feeding on the intertidal mud flats at low tide and nine were collected as they were feeding at thawing freshwater pond margins in the grassy uplands at high tide. Substrate samples were also collected from sites where shorbirds had been feeding in the intertidal mud flats. At Hartney Bay shorebirds were present in good numbers and twenty-one Calidridine sandpipers were collected as they were feeding on the intertidal mud flats with a falling tide. Substrate samples were also collected from sites where shorebirds had been feeding. Stomach contents and organisms filtered from the substrate samples have not been analyzed although we defintely have identifiable organisms including some small Mytilis species and Macoma species (these are from Hartney Bay).

In the spring, migrating shorebirds are largely concentrated in what is basically the only ice-free area, the intertidal mud flats. Fall conditions are much different and our preliminary observations indicate that there are many opportunities for shorebirds to select and utilize different habitats. Fall study included a number of areas and habitat types: Katalla (sandy beach, rocky intertidal, old rocky intertidal, and freshwater lakes and wetlands), Eyak River mouth (intertidal flats), Egg Island (sandy beach, some intertidal mud flats, and inland freshwater ponds and wetlands), and Hartney

1/ As reported in the Alaska Coop. Wildl. Research Unit Quart. Rept. 27(1-4).

Bay (Intertidal mud flats). Calidridine sandpipers were present in significant numbers only in freshwater habitats at Katalla and inland Egg Island and at the intertidal mud flats of Hartney Bay. Two Calidridine sandpipers were collected while feeding at the margin of a freshwater lake at Katalla and three while feeding on the intertidal mud flats at Hartney Bay. Stomach contents of the specimens have not yet been analyzed.

Additionally, the Controller Bay area was surveyed by air. We concluded that it may be a desirable location from which to study birds entering the delta system in the spring.

Reports from the Copper River Delta area indicate that large numbers of shorebirds moved into the area following a storm after 10 August. The investigators were no longer present then.

In September, the investigator commenced course work at the University of Alaska, Fairbanks. Time will be spent in the coming months analyzing stomach contents and substrate samples from the 1975 season and finalizing field procedures and sampling techniques for the 1976 season.

Quarter: 1 October - 30 December 1975

The investigator and Dr. Norton attended the annual meeting of the Pacific Seabird Group at Asilomar, California, from 11-14 December 1975. Preceeding the seabird meeting we participated in a meeting of the principal investigators in OCS projects to discuss data management techniques.

Following these meetings the investigator and Dr. Norton visited the Museum of Vertebrate Zoology at the University of California, Berkeley. Three days were spent examining the museum's collection of dunlins and western sandpipers taken at points ranging from Barrow to Baja. Of special interest were the weights of speciments in migration along the west coats and at the breeding grounds in western and northern Alaska. This information may prove useful in evaluating the significance of the Copper River delta system to migrating shorebirds.

At the University of Alaska, Fairbanks, the investigator continues to work on analysis of the shorebird stomachs collected in the 1975 field season and will report the results in at a later date. The investigator is also continuing to develop plans for the 1976 field season.

Quarter: 1 January - 31 March 1976

Course work at the University was taken and field preparations were made for the coming field season.

Quarter: 1 April - 30 June 1976

Field work covering the spring shorebird migration through the Copper River delta system was conducted from 27 April to 27 May 1976. Most migrational movements of dunlins and western sandpipers through the delta system occurred within this interval.

Two transects, delineated by colored stakes and oriented perpendicularly to the tide line, were established on the mudflats in the upper and middle intertidal zone of Hartney Bay, southwest of Cordova. Their dimensions were 600 m by 50 m and 300 m by 50 m, and both transects were subdivided into 100 m x 50 m zones. A minimal number of mud samples was taken from the transects for analysis of substrate characteristics.

Invertebrate fauna within the transects were sampled on 1 and 25 May. Sampling on these dates should represent invertebrate populations before and after peak shorebirds movements through the area.

Between 3 and 27 May more than 100 hours were spent at Hartney Bay in which bird species were censused within each zone of each transect once each hour. On several dates these hourly censuses spanned 12-hour tide cycles. Feeding western sandpipers and dunlins were collected in different transect zones and at different tidal stages. A total of 31 dunlins and 20 western sandpipers were collected at Hartney Bay. The stomach contents of all specimens were preserved in buffered formalin for analysis by the investigator. Drs. George West and David Norton are utilizing the carcasses in an analysis of the physiological state of the migrants. Weather data and tidal stages were recorded with each census or specimen collected.

Field work was divided between Hartney Bay and a study site on the mudflats at the mouth of the Eyak River south of Cordova. In general, we tried to alternate with 2 days at each location and a day in between for travel and support work.

The Eyak River mudflats was a more difficult site at which to work than Hartney Bay. The vast extent of the mudflats and the distance from a "warm" base-camp to the intertidal zone made conducting hourly censuses on transects appear infeasible. Nevertheless, two transects were established on the mudflats perpendicular to the Eyak River channel. The transects were essentially abandoned a short time later for the reasons mentioned above and because shorebird utilization of this specific site for feeding purposes was virtually nil.

Numerous observations of numbers, species composition, and behavior of shorebirds in the intertidal and upland zone between the Eyak River and the Government Slough were recorded. Sixteen dunlins and 23 western sandpipers were collected as they were feeding on the mudflats at different tidal stages. A small number of invertebrate and substrate samples were collected from a feeding site known to be heavily utilized by many shorebirds. These samples will provide background material to aid in analyzing the stomach contents of the shorebird specimens.

During June, the investigator completed preliminary analyses of the stomach contents of a sample of shorebirds collected in May and August

1975 and of variations in fresh weights of dunlins and western sandpipers collected in May 1976. The results are presented below. Additionally, the investigator and Dr. David Norton are preparing a paper entitled "Shorebird Migration and Oil Development in the Copper River Delta Area" for presentation at the 1976 Alaska Science Conference.

Preliminary Results: Figure 1 locates the sites discussed in this report.

Figures 2 and 3 present a preliminary analysis of the contents of 18 western sandpiper stomachs and 7 dunlin stomachs collected from 2 sites in the delta system in May 1975. The Alaganik slough site is similar in character to the Eyak River mudflats described above. In further work the investigator plans to consider the biomass and size-range of organisims taken by these two shorebird species.

Figure 4 presents whole fresh weights of dunlins and western sandpipers collected at 3 sites across the delta system. Among female dunlins, weight differences between specimens collected at Controller Bay-Bering and Hartney Bay ($P < 0.01$) and the Eyak River and Hartney Bay ($P < 0.025$). The weight differences between female dunlins at Controller Bay-Bering River and Hartney Bay and Eyak River and Hartney Bay, expressed as percentage of mean fresh weights of specimens at the more easterly locations, are 15.9 and 14.1 percents, respectively. The same comparisons for male dunlins are 12.1 and 12.7 percents, respectively.

There were no significant weight differences between dunlins (within the respective sexes) collected at Controller Bay-Bering River and the Eyak River. Nor were there any significant weight differences among western sandpipers (within the respective sexes) located at any of the three locations.

Discussion: In light of the objectives of this project how might the substantial weight differences among dunlins reported above be interpretated? First, it should be noted that more sophisticated analysis of the data is required before serious conclusions may be drawn. No attempt was made to correct the weights for the wing-length variations, nor was any attempt made to correlate weight variations with the tidal stages and times of day at which particular specimens were collected.

Fat is generally considered to be the primary energy source for long-distance migratory flights in birds. Page (1972) found that 80% of the total weight variation in the Semipalmated Sandpiper (*Calidris pusillus*) resulted from variations in the weight of the bird's fat deposits. MacLean (1969) demonstrated that in Pectoral Sandpipers (*Calidris melantos*) a certain body weight and fat complement are required upon arrival at Barrow breeding grounds if reproductive success is to be achieved. Mascher (1966) reported that juvenile, and to a lesser extent adult, Dunlins (*Calidris a. alpina*) gained weight during pauses of several days at the Ledskär Bird Station in their autumn migration through the Baltic Sea area.

Considering this background information a possible explanation for the variations in dunlin weights reported above is suggested.

Northbound migrant dunlins may enter the Copper River Delta system at a number of points ranging from the Controller Bay-Bering River area to the Eyak River, immediately east of the Heney Mountains. The delta system is the first major stopping point in Alaska for many migratory birds. Many shorebirds may have flown direct and non-stop from the Puget Sound region, and, upon arrival, their fat reserves are depleted. (Gerstenberg, 1972, recorded the mean weight of dunlins in the latter half of April -- i.e., prior to flying to Alaska -- at Humboldt Bay, California, as 62.13 g for 3 males and 63.05 g for 2 females. Analysis of the weights of museum specimens already gathered by the investigator will be useful here too.)

The many available feeding sites -- as the dunlins move from east to west across the delta system -- offer opportunities for replenishing fat deposits. Hartney Bay-Orca Inlet represents a last rich feeding opportunity before the migrants depart towards the Yukon-Kuskokwim breeding grounds. One would expect, therefore, that the heaviest birds would be found at the western-most sites in the delta system. The overall picture is that of migration occurring in "pulses" with the delta system providing a (possibly critical) stop-over point at which dunlins may replenish depleted fat reserves and achieve a physiological state of readiness for forthcoming reproductive activities.

This scenario is at best a tentative suggestion which bears further close scrutiny. While we know that shorebirds move from east to west across the system, and that there is no other comparable staging area in the eastern and northern Gulf of Alaska (Islieb and Kessel, 1973, and Senner and Norton field notes, 1975 and 1976), we, as yet, have no direct evidence that the same birds utilizing the Controller Bay-Bering River area are also utilizing Hartney Bay. They might be entirely different subpopulations of birds.

The use of marked birds in order to follow their progress through the delta system would seem an ideal tool to use in elucidating these migratory patterns, though the magnitude of the effort and its associated logistical problems and costs are not encouraging. The investigator expects to benefit from the insights of Pete Islieb, Paul Arneson, and Sam Patten -- all OCS investigators active in the northern Gulf of Alaska -- in examining shorebirds' movements through the delta.

Literature Cited

Gerstenberg, R.H. 1972 A study of shorebirds (Charadrii) in Humboldt Bay, California - 1968 to 1969. Unpubl. MS thesis, Humboldt State Univ. 207 p.

MacLean, S.F. 1969 Ecological determinants of species diversity in arctic sandpipers near Barrow, Alaska. Unpubl. PhD. thesis, Univ. of Calif., Berkeley.

Mascher, Jan W. 1966 Weight variations in resting dunlins (Calidris a. alpina) on autumn migration in Sweden. Bird-Banding 37(1): 1-34

Page, G. and A.L.A. Middleton 1972 Fat deposition during autumn migration in the semipalmated sandpiper. Bird-Banding 43(2): 85-96

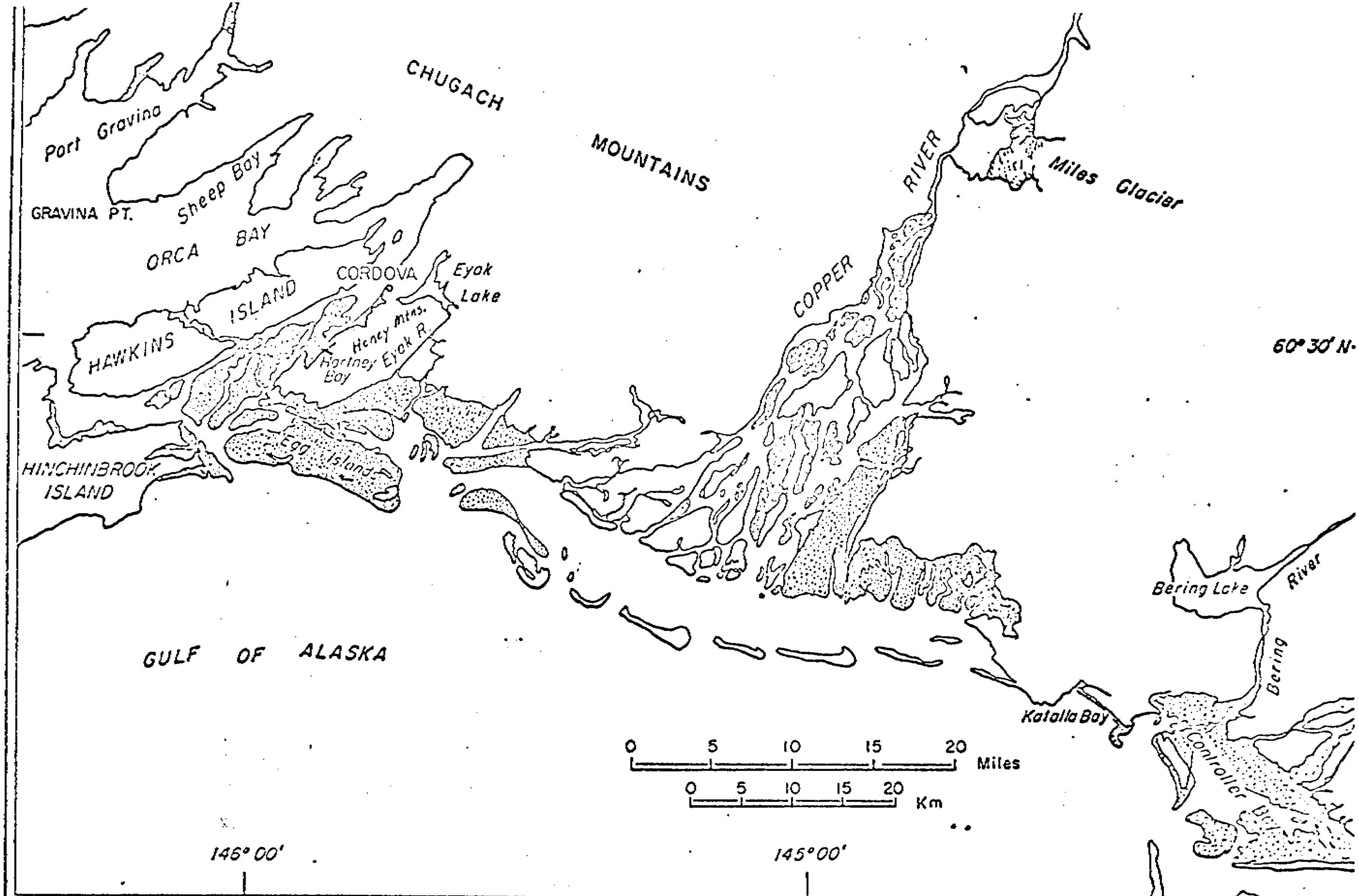

Figure 1. Northern Gulf of Alaska coastline at the mouth of the Copper River showing locations of mudflats exposed at low tide (stippled areas) where migrant shorebirds feed. The wave of spring migration passes from east to west along the coast from Controller Bay to [illegible]

Figure 2. Stomach contents from 12 Western Sandpiper specimens and 7 Dunlin specimens collected at Hartney Bay mudflats, Alaska, May 1975.*

	Bird Species					
	Western Sandpiper			Dunlin		
Item	No. of stomachs with item	frequency (per cent)	Average no. of items per stomach	No. of stomachs with item	Frequency (per cent)	Average no. of items per stomach
Pelecypoda						
<u>Macoma balthica</u>	12	100	5.1	7	100	17.9
<u>Mya</u> spp.	12	100	13.4	7	100	5.9
<u>Mytilus edulis</u>	11	91	1.0	4	57	6.8
Amphipoda						
<u>Corophium salmonis</u>	12	100	2.2	2	28	6.0
<u>Gammaridae</u> spp.				1	14	1.0
Cestoda spp. **				1	14	1.0
Vegetable matter						
unidentified	10	83	+(#*)	4	57	+ (#*)
Grit						
greater than 1 mm	12	100	7.6	7	100	2.1
less than 1 mm	12	100	9.9	7	100	3.4

* Frequencies reported here are not necessarily quite accurate because the contents of some stomachs were combined in the field.

** Probably parasitic on either bird or one of its food items.

#* + indicates presence. Unidentfied vegetable matter has not been quantified.

Figure 3. Stomach contents from 6 Western Sandpiper specimens collected at the Alaganik slough mudflats, Alaska, May 1975.

Item	No. of stomachs with item	frequency (per cent)	Average no. of items per stomach
Gastropoda			
Littorina spp.	1	16	2.0
Amphipoda			
Corophium salmonis	6	100	10.3
Insecta			
Diptera spp. (uniaentified)	2	33	1.0
Nematoda spp. (unidentified)*	3	50	1.0
Vegetable matter			
Bryophyta spp. (unidentfd.)	2	33	+ (#*)
Cyperaceae spp. seeds **	4	66	5.5
unidentified	6	100	+ (#*)
Grit			
greater than 1 mm	6	100	39.3
less than 1 mm	6	100	130.2

* probably parasitic on either bird or food item

** predominately Cyperaceae

#* +indicates presence. Vegetable matter not quantified.

collected concurrently

Figure 4. Mean whole weights in grams of freshly-killed Western Sandpipers and Dunlins at 3 locations in the Copper River delta system, Alaska, April and May 1976.* Sample sizes followed by 95 per cent confidence intervals are in parentheses.

Species and Sex	Location: Controller Bay-Bering River	Eyak River	Hartney Bay
Western Sandpiper			
Male	25.57 (30, ± 0.75)	25.90 (15, ± 1.14)	26.59 (11, ±1.13)
Female	28.94 (17, ±0.78)	28.63 (8, ±1.98)	29.56 (9, ±1.49)
Dunlin			
Male	55.69 (18, ±2.26)	55.43 (7, ±3.31)	62.45 (25, ±2.49)
Female	58.29 (18, ±2.53)	59.22 (9, ±3.61)	67.58 (23, ±2.75)

* Specimens were collected by the investigator or by Dr. David Norton for his related project titled "Nutritional significance of the Copper-Bering River intertidal system to spring migrating shorebirds breeding in western Alaska". All specimens were collected between 27 April and 27 May.

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 27
Quarter Ending -
30 June 1976

AVIAN COMMUNITY ECOLOGY AT TWO SITES ON ESPENBERG PENINSULA IN KOTZEBUE SOUND, ALASKA

Dr. P. G. Mickelson
Principal Investigator
Institute of Arctic Biology
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

To determine the baseline ecology of two geographically close avian breeding sites. To compare the results between sites and insofar as possible and determine the possible effects of oil related pertubations on these areas.

II. Field and Laboratory Activities

A. Field Activities

All personnel associated with this project are currently conducting on site field observations. These persons are not able to be contacted concerning the progress made during the last quarter.

B. Laboratory Activities

None.

III. Results

None presently available.

IV. Problems

It is known that weather delayed the on site studies. The affect of this delay on the total project is not currently known.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 27

PRINCIPAL INVESTIGATOR: Dr. P. G. Mickelson

Data are currently being collected. At the end of this field season, circa September, 1976, an accounting of the data collected, a Schedule of Data Submission and a Data Management Plan will be submitted for negotiation.

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 28
Quarter Ending -
30 June 1976

AVIAN COMMUNITY ECOLOGY OF THE AKULIK - INGLUTALIK RIVER DELTA, NORTON BAY, ALASKA

Dr. G. F. Shields and Mr. L. J. Peyton
Co-Principal Investigators
Institute of Arctic Biology
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

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 and Laboratory Activities

A. Field Activities

Camping equipment and boat were purchased in late May. After this equipment had arrived, the food and other camp supplies were assembled in early June. Departure from Fairbanks was on June 4th by chartered aircraft with arrival at Koyuk, Alaska two hours later. Two plane loads were required to transport the supplies, equipment, and personnel from Fairbanks to Koyuk.

Due to the late departure of the ice out of Norton Bay, the survey party had to remain in Koyuk until June 12th when a reconnaissance was made by boat of the proposed study site. The camp site was selected and the equipment, supplies and personnel moved from Koyuk on June 13, 1976 to high ground near the mouth of the Inglutalik river.

A general survey of the area was made on June 15, 1976 and a study site was selected. June 16 and 17 were used to lay out the study area. June 18 and 19 were used to find and plot the nests of birds using the study area. After the initial establishment of the study area, monitoring routines were established and the study is progressing as was proposed.

B. Laboratory Activities

No activity has taken place in this quarter.

III. Results

No results are available for this quarter.

IV. Problems

Late coastal ice and bad weather delayed the start of this project. We do not feel, at this time, that the study will be permanently affected by this delay.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 28

CO-PRINCIPAL INVESTIGATORS: Dr. G. F. Shields and Mr. L. J. Peyton

Data are currently being collected. At the end of this field season, circa September, 1976, an accounting of the data collected, a Schedule of Data Submission and a Data Management Plan will be submitted for negotiation.

A SEA-CLIFF BIRD SURVEY OF THE CAPE LISBURNE-PT. HOPE COASTLINE, ALASKA

(Contract 03-6-022-35210)

Quarterly Report
30 June, 1976

RENEWABLE RESOURCES CONSULTING SERVICES, Ltd.

Principal Investigators

David G. Roseneau
Alan M. Springer

Prefield organizational activities of this project are closely interwoven with those of a second study ("A Comparative Sea-Cliff Bird Inventory of the Cape Thompson Vicinity, aska" conducted under the same contract, #03-6-022-35210). Prefield work performed to this point other than that reported for the Cape Thompson study (see Quarterly Report, 30 June, 1976) has included primarily obtaining maps of the area and corresponding with Major Eugene R. Culp, USAF Base Commander, Cape Lisburne AFB. Major Culp informed us by letter dated 2 June, 1976, that meals, accommodations and storage space will be available to us during our work there. The cooperation and assistance given by the Air Force has been outstanding in terms of our project.

Under the proposed study plan and scheduly, RRCS investigators will be moved from Cape Thompson to the Lisburne AFB on 15-16 August, 1976. Several discussions have been held among RRCS staff concerning the Cape Lisburne study. These discussions have been directed toward exploring several options which may be available concerning the scheduling of the work in conjunction with obtaining the best scientific data possible. The merit of one option appears worthy of further discussion here. We would like appropriate OCS and NOAA staff to review the following discussion from both scientific and feasibility (i.e. within contractual and scheduling framework) viewpoints.

It has become clear, with regard to the science aspects, that it would be highly advantageous to conduct the Lisburne work during the approximate period of 10 July to 5 August. This would allow the work to be performed during the optimum time for obtaining the best census data on Murres (first one-half of the incubation period - see Nettleship, 1975). Such a scheduling shift would also allow investigators to obtain better, more complete data sets on productivity.

One other factor also appears important: the seasonal weather pattern. By late August to early September, it is possible that earlier-than-usual fall storms could adversely affect the collection of data under the existing schedule. We feel and recommend, therefore, that it would be to OCS's advantage, in terms of the ultimate science product, to consider the option of postponing the Lisburne survey until the appropriate period of the 1977 summer field season. We do not anticipate that such a schedule shift would affect the overall final OCS completion date of 30 September, 1977. In the event such a schedule shift were to be approved, some logistical aspects of the project would be effected. However, these changes would be of a generally small scale. We have checked with Major Culp, Commander, Cape Lisburne AFB (see attached letter), and he has indicated that the over-winter storage of field equipment would be possible at his base.

Concurrently with developing this option, we are continuing to prepare and undertake the Lisburne study on schedule this summer (15 August to 15 September).

Report submitted by co-principal investigators, David G. Roseneau and Alan M. Springer.

David G. Roseneau

FISH, PLANKTON, BENTHOS, LITTORAL

FISH, PLANKTON, BENTHOS, LITTORAL

FISH, PLANKTON, BENTHOS, LITTORAL

FISH, PLANKTON, BENTHOS, LITTORAL

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 29
Quarter Ending -
30 June 1976

THE DISTRIBUTION, ABUNDANCE AND DIVERSITY OF THE EPIFAUNAL BENTHIC ORGANISMS IN TWO (ALITAK AND UGAK) BAYS OF KODIAK ISLAND, ALASKA

Dr. Howard M. Feder
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

A. A qualitative inventory census of dominant benthic invertebrate epifaunal species within the study sites (Alitak and Ugak Bays).

B. A description of spatial distribution patterns of selected benthic invertebrate epifaunal species in the designated study sites.

C. Observations of biological interrelationships between segments of the benthic biota in the designated study areas.

II. Field and Laboratory Activities

A. Ship Schedules and Names of Vessels

6/17/76 - 6/23/76; *F/V Big Valley*.

B. Scientific Party

Stephen C. Jewett - Leg I, Research Assistant, University of Alaska.

C. Methods

Data was obtained in conjunction with the trawling activities of the Alaska Department of Fish and Game on the first of three cruises to be taken in June, July, and August. Stations were occupied with a 400-mesh eastern otter trawl for a distance of one nautical mile for 20 minutes. The invertebrates were separated, enumerated, and weighed according to methodology developed by Feder in his OCS investigations of the Gulf of Alaska and the Bering Sea. All invertebrates were sorted on shipboard, given tentative identifications, counted, weighed, and representative samples of individual species preserved and labeled for final identification at the Institute of Marine Science, University of Alaska in Fairbanks. All species will be assigned Taxon Code numbers after final identification.

Limited biological data (food studies and reproductive notes) were collected. Cluster analyses used with the trawl data from the Gulf of Alaska will be applied where appropriate to data collected. Assessment of the latter computer printouts will be made.

D. Sample Locations

1. Alitak Bay -- from 57° 12.3' lat. 153° 47.5' long. extending southwest to 56° 45' lat. 154° 0.95' long.

2. Ugak Bay - from 57° 28.4' lat. 152° 55.2' long. extending southeast to 57° 25' lat. 152° 23.2'.

E. Data Collected or Analyzed

1. Alitak Bay - 28 stations occupied (station numbers 1-7, 9-29).

2. Ugak Bay - 25 stations occupied (station numbers 1-16, 21-24, 26-30).

III. Results

Invertebrates were identified to the lowest taxon with numbers and weights normally assigned to each taxon. Approximately 95 percent of the invertebrate biomass and species consisted of *Chionoecetes bairdi, Paralithodes camtschotica, Pandolus borealis* and *Pandolus hypsinotus*. Unidentified organisms were preserved for later identification. Some observations of biological interrelationships between segments of the benthis biota were made, i.e., feeding observations on sea stars and Pacific cod. Also, reproductive conditions of selected crabs and shrimps were noted.

Pollutants were recorded in four stations.

A copy of the field notes was forwarded to the office of the Outer Continental Shelf Environmental Assessment Program at Alaska Department of Fish and Game in Kodiak.

IV. Preliminary Interpretation

During the June sampling period diversity and number of organisms was lower than expected. The snow crab, *Chionoecetes bairdi*, dominated the catch with 100 percent frequency occurrence in the 58 stations. Highest catch of snow crab was 154 kg/km at the mouth of Deadman Bay in approximately 150 meters.

Records from the Alaska Department of Fish and Game (ADF&G) show Alitak Bay to be one of the more productive bays for the king crab, *Paralithodes camtschotica*. Fifty percent (50%) of the Alitak Bay stations contained *P. camtschotica* with only nine legal males (<145 mm carapace length) occurring in six stations. During the past annual ADF&G king crab indexing study in July, adult females and juveniles of both sexes have been found here. The current study yielded the same results. It is assumed that the legal males that normally are caught during the commercial season in August and September were not found in the sampling area for one or more reasons: (1) they were in shallower water; (2) they were in untrawlable areas; and/or (3) they were outside of the bay.

Ugak Bay, an area not fished as intensively as Alitak Bay, contained more king crab, specifically legal males.

The catch of pink shrimp, *Pandolus borealis*, generally increased in both bays as the stations progressed seaward and the reciprical pattern was found for the coon-stripe shrimp, *Pandolus hypsinotus*.

V. Problems Encountered, Recommended Changes

In order to completely fulfill the objectives of this study more time must be made available at each station for observations of biological interrelationships between segments of the benthic biota, specifically examination of stomach contents of fishes and crabs.

There is some question concerning which agency (ADF&G or IMS) is to collect information on invertebrate organisms. This matter should be clarified before the July cruise.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 29

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

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
Big Valley 001	6/17/76	6/23/76	8/30/76			

NOTE: [1] Data Management Plan to be submitted in August, 1976.

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 15
Quarter Ending -
30 June 1976

THE DISTRIBUTION, ABUNDANCE, DIVERSITY AND PRODUCTIVITY OF BENTHIC ORGANISMS IN THE BERING SEA

Dr. Howard M. Feder
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

A. Qualitative and quantitative census of dominant species within oil lease sites.

B. Description of seasonal and spatial distribution patterns, with emphasis on assessing patchiness and correlation with micro-habitat.

C. Comparison of species distribution with physical, chemical and geological factors.

D. Observations of biological interrelationships in benthic biota of the study area.

II. Field and Laboratory Activities

A. Ship schedule and names of vessel

1. 29 March - 4 June 1976
2. *R/V Miller Freeman*

B. Scientific Party

Leg I	- Karl Haflinger (Graduate Student)
Leg II	- Karl Haflinger, Max Hoberg (Research Assistant)
Leg III	- Howard Feder (Principal Investigator) William Kopplin (Research Assistant)

C. Methods

1. A van Veen grab was used at biological stations (MB stations) established in the summer of 1975 on board the *R/V Discoverer* (Fig. 1). Five grabs were taken at each station. Aliquots were removed from one grab at each station for sediment-size analysis. All biological material was washed through 1.0 mm mesh screen, and the samples preserved in 10 percent formalin for later laboratory analysis. A pipe dredge (14 x 36 inches) was used at selected stations to (a) determine if the grab was effectively taking most of the species at a sampling site and (b) collect large numbers of clams for age and growth studies in the next project year.

2. A 400 mesh otter trawl was used in conjunction with the NMFS project during Legs I and II. On Leg III trawls were made during daylight hours with one or two drags typically made per working day. All invertebrates were separated, counted, weighed and identified where possible. Voucher specimens were preserved in formalin for taxonomic verification at the University of Alaska. Stomachs of selected fish species and King Crab were examined on board ship, and the contents preserved for further analysis at the biological laboratory, University of Alaska.

D. Sample Locations

All stations on the biological grid (MB stations) that were free of ice were occupied.

E. Data Collected or Analyzed

1. All t stations on the NMFS trawl grid that were occup on Legs I and II were sampled for invertel tes (see Quarterly Report of Demersal Fish Study for details of NMFS station grid). Thirty-four stations were occupied with the van Veen grab.

2. Eighteen additional trawl stations were occupied on Leg III. Forty-four additional stations were occupied with the van Veen grab on Leg III (Fig. 1).

3. A variety of fishes, crabs and sea stars were examined for food content.

4. Pipe dredge samples were taken on most of the stations in the MB grid.

III. Results

A. All grab material has been transferred to the Marine Sorting Center and has been archived there. A portion of these samples and material from the cruise of the *R/V Discoverer* in 1975 will be processed during the current project year.

B. Invertebrate epifauna collected by trawl

1. Approximately ninety (90) species were determined and given provisional taxonomic designations.

2. Samples of all species collected at each trawl station were packaged preserved in buffered formalin and shipped to the University of Alaska in Fairbanks.

3. A large sample of *Neptunea* spp. was collected at each station and frozen. Most of the samples will be examined at the Seward Laboratory for age and growth characteristics.

4. All clams taken at each station were collected and preserved in formalin. The material will be examined at the University of Alaska for age and growth characteristics.

5. A number of species dominated by biomass at one or more stations. These species are in several phyla -- *Porifera* (sponges), *Cnidaria* (sea anemones), *Arthropoda* (*Crustacea*: crabs), *Mollusca* (snails, clams), *Echinodermata* (sea stars, sea cucumbers), and *Chordata* (tunicates or sea squirts). Data on the biomass of king crab and tanner crab can be found in the *Demersal Fish Study Report* prepared by NMFS.

6. An examination of total epifaunal invertebrate biomass indicates that highest values were at stations MB 18A (353 kg), MB 28 (562 kg), MB 37 (589 kg), and MB 46. The dominant species at each of these stations was king crab (MB 18A), tanner crab (MB 28), *Halocynthia* sp. (MB 37), and sea anemones (MB 46).

C. Food studies

1. Invertebrates

Food items utilized by several species of sea stars (primarily *Asterias amurensis*) were identified. Stomachs of *Chionoecetes* spp. and *Paralithodes camtschatica* were examined. Well over 100 stomachs were looked at, and stomach samples were preserved in formalin as well for further study at the University of Alaska. Preliminary stomach examinations made aboard ship indicate that both types of crab have diverse diets composed primarily of infaunal species. Both species appear to scavenge as well as take live prey.

2. Fish food items

The stomachs of limited numbers of some bottom fishes were briefly examined. The fishes looked at were as follows: flathead sole, rock sole, several cottids, Greenland turbot, Alaska plaice, cod, and halibut. Further study will be accomplished in Fairbanks in conjunction with the studies of Dr. R. Smith.

D. Infaunal samples collected by grab and pipe dredge

1. A number of species dominated by biomass at one or more stations.

2. Various clam and/or cockle species dominated in numbers at a variable number of stations (e.g., MB 17, 18, 30, 55, 69, 70, and 46). Samples of the clams from these stations will be available for age and growth studies in the laboratory at Fairbanks.

3. Pipe dredge samples indicated that this gear was penetrating deeper than the van Veen grab. Although large clams and polychaetous annelids were taken in the pipe dredge, few new species were added by this gear. Preliminary comparison of both types of gear tends to demonstrate that the van Veen grab is a valid sampling tool for use at most areas in the Bering Sea.

4. The large samples obtained with the pipe dredge have contributed to (a) the expansion of species distributions and (b) the accumulation of large numbers of clams suitable for age and growth studies.

5. Two sediment samples were taken from each grab station for organic carbon and clay mineral analysis.

6. The majority of stations occupied in 1975 were reoccupied in 1976. Ice and severe fog conditions hampered some of the operations. The more northerly stations were not reoccupied.

IV. Preliminary Interpretation

None at this time.

V. Problems Encountered and Comments

It was not possible to complete the station grid as projected for the following reasons: (1) unseasonable ice cover over much of the northern part of the grid, (2) severe fog conditions, (3) crew member's illness and need to make special trip to St. Paul Island, and (4) loss of one-half day due to severe weather.

The officers and crew of the *R/V Miller Freeman* made it possible for us to accomplish far more than ordinarily would have been possible under the imposed constraints noted above. The *R/V Miller Freeman* is a fine vessel, and its officers and crew should be complimented for their congeniality and competence.

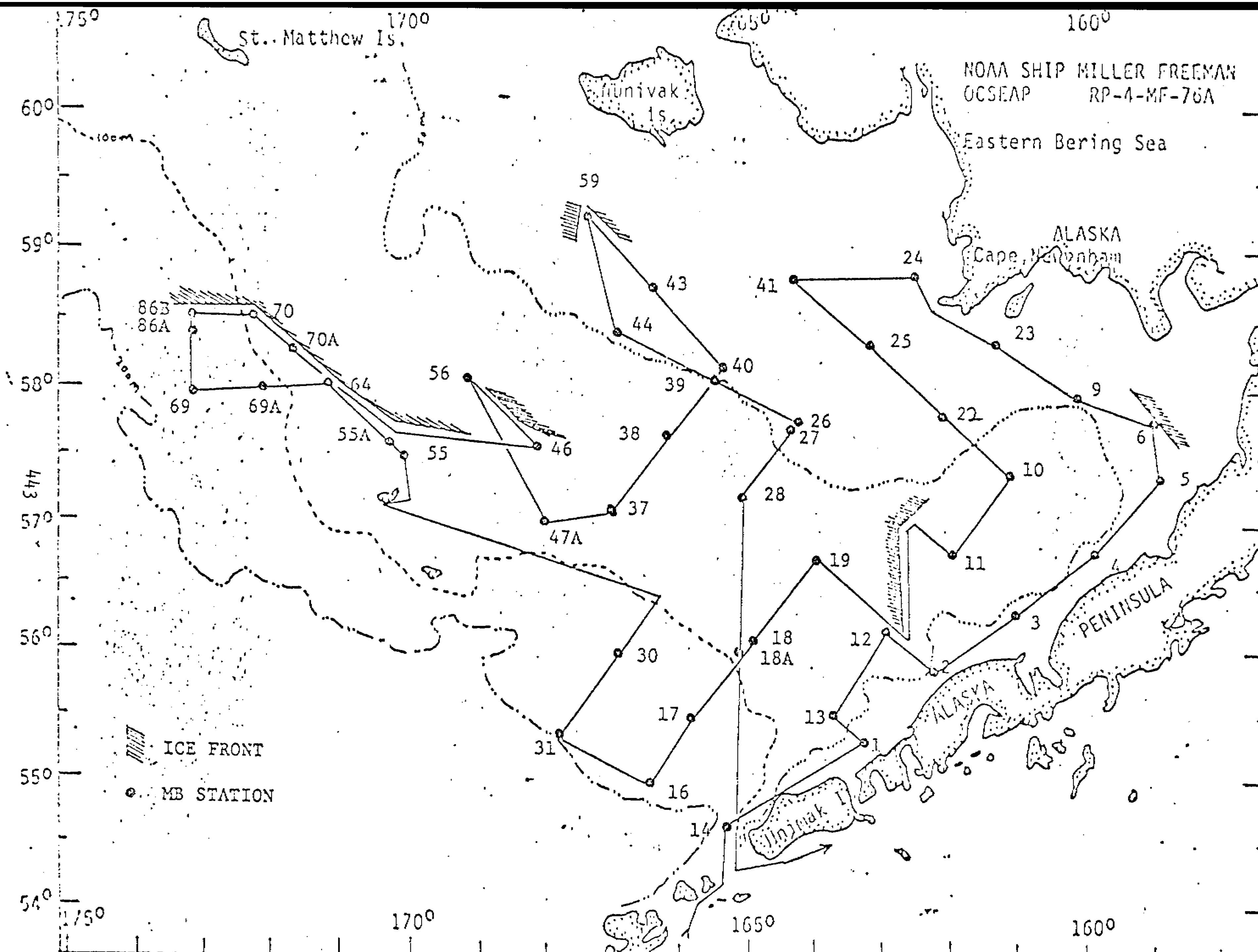

FIGURE 1. SHIP'S TRACK AND MB STATIONS.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 15 R.U. NUMBER: 5/303

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

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		
Discoverer Leg I #808	5/15/75	5/30/75	*	None		
Discoverer Leg II #808	6/2/75	6/19/75	*	None		
Miller Freeman	8/16/75	10/20/75	8/30/76	8/30/76		
Miller Freeman	3/76	6/76	(a)	(a)		

Note: [1] Data Management Plan and Data Format have been approved and are considered contractual.

(a) These materials will be archived. Selected samples will be processed in FY '77.

* That portion of cruise 808 grabs sorted, approximately 1/2 of those taken will be submitted about July 30, 1976. The remainder will receive top priority in FY '77.

QUARTERLY REPORT

Contract No. 03-5-022-68, Task Order 5
Research Unit #6
Reporting Period: 1 April - 30 June 1976
Number of Pages: 15

The distribution, abundance, diversity and productivity of the western Beaufort Sea benthos.

Andrew G. Carey, Jr., Principal Investigator
School of Oceanography
Oregon State University
Corvallis, Oregon 97331

June 25, 1976

Andrew G. Carey, Jr.

I. Task Objectives

A. General nature and scope of the problem

The distribution, abundance, and natural variability of benthic macro-infauna and mega-epifauna will be defined on the southwestern Beaufort Sea continental shelf. Patterns of faunal distributions will be determined and related to features of the benthic environment. Assemblages will be characterized by suitable bio-indices and trends in the data determined. Species groupings will be determined by statistical analyses, and their patterns of distribution defined. Reproductive activity and possible seasonal changes in dominant species populations will be studied by sampling four times per year to obtain basic life history information.

B. Specific objectives

We propose to survey and define the variability of the benthic fauna of the western Beaufort Sea continental shelf from Point Barrow to the Canadian border and to undertake time series studies when appropriate and feasible. Data are to be obtained on the faunal composition and abundance to form base-lines to which potential future changes can be compared. Biological rates, life histories, and species composition can define aspects of the functioning of communities and ecosystems potentially vulnerable to environmental damage by man and can determine the rates at which damaged environments and benthic faunal communities may recover.

Specific objectives include the continuation of studies and analyses to:

(1) Determine the distribution, species composition, numerical density, and biomass of the benthos in the area(s) of interest.

(2) Determine the spatial and seasonal variability of faunal distributions and abundances.

(3) Determine if benthic communities are present and to delimit their geographical and environmental extent.

(4) Determine the degree of correlation of species distributions and of various bio-indices with various aspects of the benthic environment and the oceanography of the region.

(5) Determine the degree of species interaction through the food web.

(6) Determine effect of seasons on reproductive activity and population size structure of dominant species.

II. Research Activities

A. Field Activities

1. Field Trip Schedule

Through the period of 13 May-4 June 1976, members of the benthos group completed the third seasonal arctic field trip (OCS-3). A chartered Bell 205 helicopter owned by ERA was used to occupy stations on the ice.

2. Scientific Party

Dr. Andrew G. Carey	Oregon State University, Party Chief
Gordon R. Bilyard	Oregon State University, Ph.D. candidate
James B. Gish	Oregon State University, Data Manager
Paul A. Montagna	Oregon State University, Research Assistant

3. Field Sampling

On station 4' x 4' hole was cut through the ice, hence there is a need to find suitable ice conditions. During the sample period ice depth seemed to follow a bimodal distribution; either being many feet thick, or only a few inches in thickness. In either case, neither is suitable. If the ice is thick too much time would be required to cut a hole of proper size during the one day sorties. Thin ice would not support the weight of the scientific party, equipment, and tension developed during sampling. To avoid these problems the stations were successfully set up over a crack in the ice between thicker ice floes. Cracks which had refrozen were chosen, as the two floes would not be likely to move during sampling. More care was added toward safety measures. The tripod was set over the fissure and a Smith-McIntyre 0.1 m^2 bottom grab was lowered through the hole with a portable Hydrowinch. Ten samples per station were planned. The salinity, conductivity, and temperature of the water near the bottom was also measured at each station with the KAHLSICO *in situ* salinometer.

An effort was also made to collect amphipods from the bottom for taxonomic analysis and life history studies. At the suggestion of Dr. Ron Atlas, sardines packed in mustard sauce were used as bait in a wire mesh basket trap. The trap was lowered to the bottom upon arrival at the station and left there for the duration of occupancy, approximately two hours. Large number of amphipods were successfully collected.

After the station work was completed the party proceeded back to the Naval Arctic Research Laboratory (NARL) and immediately began sample processing. Two Cascading Multiple Sieve Systems were set up in a hydro hut off the beach at NARL. Using a high water capacity pump, the samples were washed and then preserved with buffered formalin. The samples were then shipped to Oregon State University where further processing and data collection will be completed.

4. Sample localities

Sample stations are located along two station transects, one off Pitt Point and the second off Narwhal Island. Both transects have a bearing of 025° True and are perpendicular to the depth contours. The exact station location is depth dependent. Stations are designated by station line and depth, e.g. PPB-25 is the Pitt Point Benthos 25 meter station. Error limits of ±5% of the desired depth were set. Occasionally, heavy ice conditions prohibited the station location to be within these tolerances. The station position was ascertained by radar fix from the Lonely DEW line station for the Pitt Point transect, and the Oliktok DEW line station for the Narwhal Island transect. Figure 1 shows the station locations.

5. Data Collected

1. Number and types of samples

The Pitt Point transect was successfully completed. Five stations were occupied, and ten samples were taken at each station. For the first time work was begun on the Narwhal Island transect. Since only four days remained in the field trip it was decided that the group would go to Deadhorse, sample as many stations as possible off Narwhal Island, and return to NARL within two days so that the samples could be washed and preserved. Two stations were occupied and six samples were taken at each station. Overall, during OCS-3 seven stations were occupied and sixty-four samples were taken. Table 1 summarizes the data collected during OCS-3.

TABLE 1. List of Stations, Cruise OCS-3

Station Number	Date (1976)	Position	Depth (in M)	Salinity ($^{o}/oo$)	Temp (°C)	Number Samples
PPB-25	17 May	71°11.8'N 152°53.0'W	28.3	29.02	-2.00	10
PPB-40	27 May	71°13.0'N 152°42.0'W	37	30.52	-1.88	10
PPB-55	20 May	71°19.0'N 152°38.5'W	54.6	30.60	-1.75	10
PPB-70	26 May	71°20.0'N 152°37.5'W	70	30.75	-2.00	10
PPB-100	21 May	71°20.5'N 152°36.0'W	101	31.21	-2.00	10
NIB-40	1 June	70°43.5'N 147°00'W	43	28.10	-2.00	6
NIB-55	1 June	70°50.8'N 146°58.0'W	52	28.88	-1.86	6

TABLE 2. Field Log, OCS-3

Date (1976)	Station Number	Flight Time to Station (hrs.)	Station Time (hrs.)	Flight Time to Base (hrs.)	Total (hrs.)
17 May	PPB-25	1.5	5	.8	7.3
19 May	*	.3			
20 May	PPB-55	1.5	3.5	1.0	6.0
21 May	PPB-100	1.7	2.7	1.1	5.5
22 May	*	2.5			
26 May	PPB-70	1.4	2.5	1.0	4.9
27 May	PPB-40	1.4	2.0	.8	4.2
1 June	NIB-55	1.0	2.0	1.0	4.0
1 June +	NIB-40	1.0	2.0	1.0	4.0

* Weather conditions forced a return to base without occupying a station.

B. Laboratory Activities

1. Personnel

a. Budgeted on Task Order Number 5

(1)	Andrew G. Carey, Jr.	Oregon State University School of Oceanography Associate Professor, principal Investigator
	Responsibilities:	Coordination, evaluation, analysis, reporting, and holothurian systematics
(2)	James B. Gish	Oregon State University School of Oceanography, Research Assistant
	Responsibilities to date:	Data management, statistical analysis, and field collection
(3)	R. Eugene Ruff	Oregon State University School of Oceanography, Research Assistant Unclassified
	Responsibilities to date:	Invertebrate reference museum, species list, laboratory personnel, bottom photography and photo analysis, and echinoderm and anthozoan systematics
(4)	Paul H. Scott	Oregon State University School of Oceanography, Research Assistant Unclassified
	Responsibilities to date:	Field equipment, wet weights, sample picking and sorting, molluscan systematics, and field collection
(5)	Part-Time workers: Kamran Malik David Marinos Bruce Milan Patricia Tester Don Ward	
	Responsibilities:	Assist with key punching, sample processing, equipment maintenance, photographic processing, sediment analysis, wet weight measurement.

b. Budgeted on Task Order Number 4

(1)	Gail Erskine	Oregon State University School of Oceanography, Research Assistant Unclassified.

Responsibilities to date:	Sample picking and sorting, gammarid amphipod systematics, annotated Arctic Basin benthos bibliography, taxonomic library, and field collection.
(2) Paul A. Montagna	Oregon State University School of Oceanography, Research Assistant Unclassified. Significantly involved with research for Task Order 5.
Responsibilities to date:	Sample picking and sorting, harpacticoid and tanaid (Crustacea) systematics, laboratory equipment, reference museum, and field collection.

c. Budgeted on other research programs.

(1) Gordon Bilyard	Oregon State University School of Oceanography, NSF Graduate Research Assistant, Ph.D. candidate
Responsibilities to date:	Polychaete systematics, field collection

B. Laboratory Activities - (cont.)

2. Methods

Laboratory Analysis

One hundred twenty Smith-McIntyre grab infaunal samples from three seasonal Arctic field trips (OCS 1-3) are undergoing processing at the Oregon State University benthic laboratory. Analysis of these samples follows a five step, labor intensive proceedure: 1) laboratory washing and sorting of samples into macrofauna (1.0 mm) and large meiofauna (0.42 mm to 1.0 mm), 2) initial picking and sorting of animals into major phyla, 3) determination of wet weights for estimation of numerical density and biomass, 4) counting and re-sorting of samples to finer taxonomic groups and 5) final taxonomic identification. Sixteen samples from OCS-1 have been washed, initially sorted, weighed and are now being resorted into finer taxonomic groups. Systematic study of molluscs, polychaetes and several crustacean groups has begun on the October samples (OCS-1). All 42 samples from the second OCS benthic field trip (OCS-2) have been processed through the initial sorting stage and are at present being weighed for biomass determination. Samples collected in May and June (OCS-3) are now being washed and sorted into size fractions.

New techniques for laboratory sample washing and wet weight determination have been developed this quarter. Previous to this quarter sample washing was an extremely time-consuming procedure and required constant attention of laboratory personnel. A new sample washer was devised in order to decrease time spent on the process and to increase laboratory efficiency. The sample washer is a simple sprinkler system placed over a series of three sieves (apertures of 9.5 mm, 1.00 mm and 0.42 mm). Water is sprinkled over the entire sieve surface, gently washing the sample with a minimum of effort. Samples processed by this method have proved to be very well washed with little or no damage to the animals.

After several months of study and experimentation a technique for wet-weight determination has evolved. A Millipore filtering apparatus is the backbone of the new method. Animals sorted into major phyla are washed directly from the sample vial into the filter apparatus. By slowly applying a vacuum the liquid is gently drained through the apparatus leaving the animals on a tared filter. The filter, with animals, is removed from the Millipore holder and weighed to the nearest 0.1 gram on a Mettler top-loading balance. The invertebrates are then washed directly back into sample vials. Throughout the entire process the animals are never manipulated with forceps or other potentially damaging instruments. Using this technique exposure time (i.e. dessication time) in air is generally less than one minute. Total weighing time for each animal group is approximately four minutes. The advantages of the method include: (1) decreased damage to animals through dessication and manipulation, (2) faster weighing times, and (3) increased precision of results.

Final species identification is still one of the main goals of the OSU benthic group. Systematic analysis of polychaetes, molluscs, and several crustaceans has continued throughout the quarter. Progress in this area remains steady, as laboratory personnel gain expertise within their animal group.

III. Results

A. Field Activities

1. Success of Through-the-Ice Benthic Sampling

The Benthos group is refining the technique for studying the offshore bottom fauna through the arctic ice cap (Table 3). Station equipment and techniques are now thought to be in fine tune. The only obstacle between the objectives and completion of the Narwhal Island transect was weather. It is anticipated that during the fall season when cloud and fog cover does not ground the crew, both transects can be completed in a short period, perhaps ten days. It was noticed that there are distinct seasonal differences in the sampling procedure. This is due mainly to the extreme cold which characterizes the region during most of the year. For example; when the temperatures are below 20°F the bottom grab will ice up as soon as it comes out of the water, and it is a full time job to keep blowtorches operating to de-ice the grab so that it could be cocked and put back into the water as soon as possible. In the milder temperatures of May, this was not a problem. The ice structure is seasonally different, and since a large hole is needed through which to lower the grab, ice thickness and hardness is an important concern. In the fall (October) most of the ice was freshly frozen and about two feet thick, so that the right ice conditions could be found on a given site. In early spring (March), refrozen leads were reasonably abundant. Because of the cold temperatures opened leaks freeze quickly, and ice was characterized by many large cracks, and open leads. Because the temperatures were higher, refrozen leads tended to be only 1"-6" thick, not enough to support the benthic station operations. Pack ice which may be between 3'-10' thick would not be suitable for quickly cutting a large hole during the one day sorties. Left with no alternatives, stations were erected over cracks. Special safety procedures were employed. All the equipment was placed on one side of the crack with the helicopter. The hydro winch was located on the other side of the crack, and one leg of the tripod. If the ice started to move, the tripod could quickly be tipped over to land with the rest of the equipment. The helicopter could then land on the other side briefly to load the winch. To guard against the increased danger of falling into the fissure, boards were placed across it, and lifelines were fastened to the base of the tripod legs.

The benthos group is now confident that a technique has been developed and refined, so that through-the-ice sampling programs can be carried out reliably and successfully, in all seasons.

TABLE 3. Summary of Seasonal Sampling

Cruise	Dates	Number of Stations	Number of samples
OCS-1	7 Oct. - 30 Oct.	3	16
OCS-2	1 March - 21 March	5	42
OCS-3	14 May - 3 June	7	64

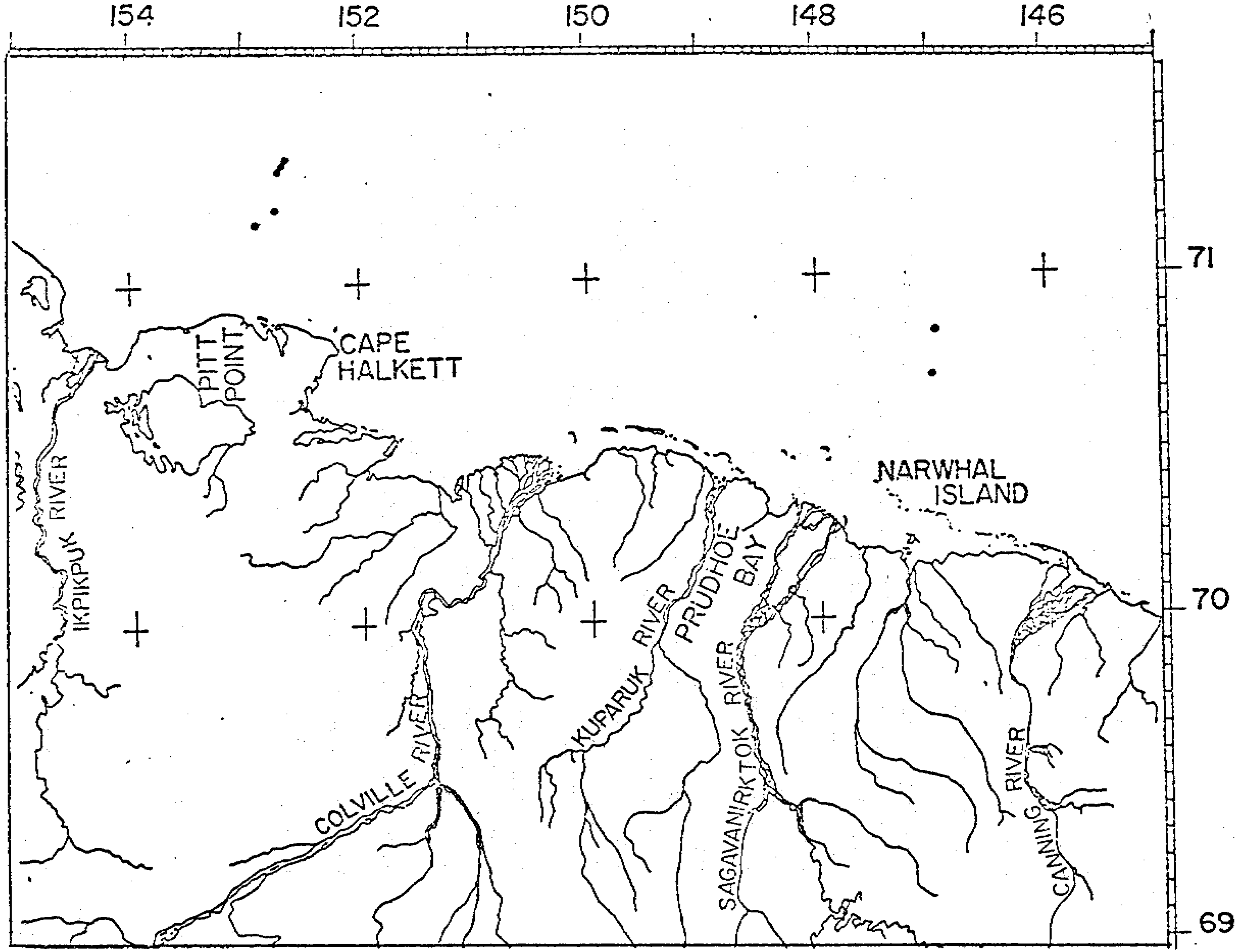

Figure 1. Location of 5 stations occupied on Pitt Point Station Line , and 2 stations on the Narwhal Island Line during the Benthos OCS-3 field trip in May 1976.

B. Laboratory Results

1. Biomass

Wet weights (as outlined in the Methods Section) for six major phyla and one group of miscellaneous phyla have been measured for each sample (Table 1). Major phyla include the annelids, molluscs, arthropods, echinoderms, sipunculids and anthozoans. The miscellaneous group is comprised of Porifera, Rhynchocoela, Priapulida, Branchiopoda, Nematoda, Echiura, Phoronida, Cordata and Hemicordata.

IV. Preliminary Interpretation of Results

It would be premature to discuss interpretations of the results available at present. Sufficient amounts of data have not been processed to allow any statistical conslusions to be drawn.

V. Problems Encountered/Recommended Changes

1. Shallow Stations

Because the shorefast ice extends approximately 17-18 miles over the continental shelf, the 5 and 10 meter stations cannot be occupied. The shorefast ice is too thick to cut a hole in a short period of time. It may be possible for a crew to cut the hole on one day, and return to sample from the hole on the next day. Perhaps a work crew could cut the hole and our crew could sample the following day. Since the ice is shorefast it would be possible to return to the same area, on the second day. It would probably take a full day to cut a 4'x4' hole 6' deep.

2. Data Lag

Processing of samples is a labor intensive task. After the samples arrive at OSU they must be further washed of sediments. Then it is an easier, but time consuming task to pick out all the animals. The biomass of all the major groups is determined, and then the groups are resorted into smaller groups. Finally from the smaller unit groupings, the organisms go to specialists within the lab (some groups are sent to outside specialists), and identified to the species level. Each of these phases requires many man-Hours to complete, so that it is a long time between the day when the samples are taken, and the detailed analysis of the component members of that sample are known (Table 2). Adequate, qualified manpower can derive data from benthic projects on a reasonable schedule.

3. Base Camp Location

During the later part of May, the weather was often poor, with cloud cover almost every day, and fog very often. This greatly inhibited our sampling program, since helicopter flight requires ground and horizon visability. Out ot the sixteen days we were scheduled and prepared to fly, we were grounded on ten. This was compounded by the necessity of first getting to Lonely from Barrow. This required that the weather be good in two locations before we

TABLE 1. OCS-1 Wet weights in grams. PPB = Pitt Point Benthos transect.

Station and SMG #	Animal Group: Annelida	Arthropoda	Mollusca	Miscellaneous	Echinodermata	Sipuncula	Anthozoa
PPB-25							
1082	1.31	0.42	3.20	+	0.12	2.94	-
1083	0.62	1.13	2.63	-	-	-	-
1084	2.03	0.08	2.83	-	-	-	-
1085*	0.80	0.03	3.00	+	-	-	-
1087	0.68	0.02	0.50	+	-	-	-
PPB-55							
1088	1.15	0.92	2.87	0.39	0.21	+	+
1089	1.65	0.24	0.47	0.03	0.30	0.08	0.14
1090	1.44	0.60	0.52	0.07	-	0.04	2.29
1091	0.92	0.89	0.52	0.05	+	+	0.37
1092	0.53	1.64	0.67	+	-	0.04	0.04

TABLE 1 (cont.) OCS-1 Wet weights in grams. PPB = Pitt Point Benthos transect.

	Animal Group						
Station and SMG #	Annelida	Arthropoda	Mollusca	Miscellaneous	Echinodermata	Sipuncula	Anthozoa
PPB-100							
1093	5.22	0.78	0.65	1.05	4.08	0.03	0.11
1094	0.23	0.05	0.08	+	0.33	-	-
1095	6.22	0.42	3.56	0.08	0.03	+	+
1096	2.28	0.57	0.40	+	0.46	+	0.03
1097	0.56	0.19	0.08	+	-	+	-

+ indicates presence without measurable weight

- indicates absence

could fly. Another group staging out of Lonely were able to fly for three days and complete their transect off Pitt Point, while we were grounded due to bad flying conditions in and near Barrow. It should also be mentioned that the flight from Barrow to Lonely requires one hour each way, hence our work day is shortened by two hours. In the fall the shortened day length may cause a party to evacuate a station early due to the approach of dusk. It may also eliminate the possibility of a late morning departure (which may arise due to weather, or mechanical problems), causing the loss of an entire day. Often the day begins at 7:00 A.M. and will not end until midnight, after the samples have been washed and preserved, so the two flying hours come at the expense of rest and/or sleep.

The solution to weather problems and the two additional flying hours is to set up base camp at Lonely. The work base at Lonely must also be portable since it must be moved to Prudhoe Bay for work on the Narwhal Island transect. The work base would require space for setting up two sieving systems, storing samples, and daily maintenance of equipment. At present the large hydro hut (appr. 16'x24') and hut 244 at NARL serve these needs very nicely. Since it may not be possible to move the large hydro hut to Lonely and to Prudhoe Bay, then perhaps large insulated or prefabricated buildings may serve the purpose. Power will be required to light and heat these structures, and a 10-12 kw generator will be needed to run our electric water pump in the sieve system. A large quantity of fuel will be needed to operate the generator. The use of a gasoline engine-driven water pump and an oil stove may be the most feasible approach to these problems.

The work site at Prudhoe Bay may pose an additional problem. Since the bay is very shallow, ice may extend all the way to the bottom, making it difficult to find a place to locate our hydro hut and washing system. It may even be necessary to locate off Narwhal Island. In either case transportation to and from the hydro hut may prove to be difficult.

Table 2. Estimate of Man-hours Expended per Smith-McIntyre Grab Sample to Produce Quantitative Species Data.

Procedure	Man Hours
Sample Collection	2
Field washing and preserving	1.5
Laboratory washing and sorting to size fraction	.5
Initial sorting (average sample x 1 quart)	30
Wet weights	1
Resort to finer taxonomic groups and final counting	8
Final taxonomic identification of common fauna to species for major taxonomic groups	55
TOTAL MAN-HOURS PER SAMPLE	98

VI. Estimates of funds expended. - Task Order 5

NOAA Carey 976 Productivity 6/30/76

	Budget	Spent	Outstanding	Spent This Quarter
Salaries & Wages	42,710	28,762	13,948	7,732
Materials & Services	14,990	17,601	<2,611>	2,005
Travel	6,500	5,067	1,433	183
Equipment	47,617	46,154	1,463	8,134
Payroll Assessment	6,410	4,238	2,172	1,280
Overhead	19,310	13,006	6,304	3,497
TOTAL	137,537	114,828	22,709	22,831

Salaries Committed		Paid	Outstanding
Carey, A.	4,887.	4,887	--
Tester, P.	2,355.	2,355	--
Scott, P. AWA	1,174.	1,174	
Scott, P.	6,300.	6,300	
Ruff, R.E.	5,250.	5,250	
Gish, J.	4,900.	4,900	
Oliver, B.	770.	770	
Secretarial (9.76)	2,610.	--	2,610
Shop		2,348	
Marinos		179	
Milan		143	
Ward		244	
Malik		122	
TOTAL			2,610

QUARTERLY REPORT

Contract No. 03-5-022-68, Task Order 4
Research Unit #7
Reporting Period: 1 April - 30 June 1976
Number of Pages: 10

Summarization of existing literature and unpublished data on the distribution, abundance and life histories of benthic organisms.

Andrew G. Carey, Jr., Principal Investigator
School of Oceanography
Oregon State University
Corvallis, Oregon 97331

June 25, 1976

Andrew G. Carey, Jr.

I. Task Objectives

A. General nature and scope of the problem

The systematics and ecology of Beaufort Sea benthos on the outer continental shelf (OCS) will be summarized and statistically analyzed. Published and unpublished data including those to be obtained from samples, collections, and bottom photographs already in hand at Oregon State University will be evaluated for the type and degree of information needed to describe benthic biotic baselines in the western Beaufort Sea.

B. Specific Objectives

We propose to define: (1) species lists and distributional patterns; (2) patterns and natural variability of distribution and abundance of benthic species, recurrent species groups (and communities) and ecological types; (3) possible correlations of these patterns with features of the benthic environment to determine those features of potential ecological importance in this sub-arctic environment; and (4) the type and degree of information that is needed for describing benthic biotic baselines in the Beaufort Sea.

Summaries and data analyses of the present and future assembled material on the benthos in the Beaufort Sea will provide a basis for evaluating the potential effects of possible oil spills and general environmental pollution caused by the necessary supportive activities by man in this relatively unspoiled environment. Areas for additional study will be identified.

II. Field and Laboratory Activities

A. Ship Schedule

No recent cruises have been undertaken for the purposes of completing Task Order Number 4 of the contract. All research is based on Oregon State University's collections and bottom photographs taken during the U.S. Coast Guard's western Beaufort Sea Ecological cruises (WEBSEC) in 1971 and 1972.

B. Personnel

1. Budgeted on Task Order Number 4

   a. Andrew G. Carey, Jr. — Oregon State University School of Oceanography, Associate Professor, Principal Investigator

   Responsibilities: coordination, evaluating, analysis, reporting, and holothurian systematics. Also, on Task Order No. 5

b. Gail Erskine — Oregon State University School of Oceanography, Research Assistant Unclassified.

Responsibilities to date: sample picking and sorting, gammarid amphipod systematics, annotated Arctic Basin benthos bibliography, taxonomic library, and field collection. Also essential to completion of Task Order No. 5 objectives.

c. Paul A. Montagna — Oregon State University School of Oceanography, Research Assistant Unclassified.

Responsibilities to date: sample picking and sorting, harpacticoid and tanaid (Crustacea) systematics, laboratory equipment, reference museum, and field collection. Also essential to completion of Task Order No. 5 objectives.

2. Other Personnel

a. Gordon Bilyard — Oregon State University School of Oceanography Graduate Research Assistant. Ph.D. candidate. Budgeted on NSF Biological Oceanography research grant, but essential for completion of Task Order 4 objectives.

Responsibilities to date: Polychaete systematics.

b. James B. Gish — Oregon State University Research Assistant Unclassified. Budgeted on Task Order 5 and NOAA/Sea Grant sub-project, but essential for completion of Task Order 4 objectives.

Responsibilities to date: Data management, statistical analysis.

c. R. Eugene Ruff — Oregon State University School of Oceanography, Research Assistant Unclassified. Budgeted on Task Order 5 and NSF grant, but essential for completion of Task Order 4.

Responsibilities to date: Invertebrate reference museum, species list, bottom photography and photographic analysis, echinoderm and anthozoan systematics. Supervision of Benthos laboratories and personnel.

d.	Paul H. Scott	Oregon State University Research Assistant Unclassified. Budgeted on Task Order 5, but essential for completion of Task Order 4 objectives.
	Responsibilities to date:	Wet weights, sample picking and sorting, molluscan systematics.
e.	Part-time worker David Marinos	Oregon State University undergraduate student. Budgeted on Task Order 5 but essential for completion of Task Order 4 objectives.
	Responsibilities:	Photographic processing and printing.

C. Laboratory Methods

1. Systematics of benthic invertebrate fauna

Final taxonomic identification of several animal groups from the 1971 and 1972 Beaufort Sea Ecological Cruises (WEBSEC) continues as a major goal of the OSU benthic laboratory. Infauna from Smith-McIntyre grab samples and epifauna from otter trawl samples are currently under final systematic analysis. Some of the groups being intensively studied are polychaetes and several micro-crustacea.

A summarization of work in progress is found in the following reports.

Microcrustacea

Systematic work is continuing on the identification of microcrustaceans collected on WEBSEC-71. The analysis of Harpacticoida (Copepoda) is almost complete. Specialized taxonomic literature is being compiled at this time to aid ultimate identifications in difficult genera.

Analysis of the order Tanaidacea (Malacostraca) has begun on samples taken during WEBSEC-71. Since this is a new group at the OSU benthic laboratory, progress has been directed to gaining a working familiarity with the order. This work has generally been confined to the collection of systematic literature, so that sorting of the tanaids to the family level can begin.

Meiofauna

Progress in sorting and identification of WEBSEC-71 meiofauna (0.42 to 1.00 mm fraction) is steady. Development of new techniques to decrease sorting time has been initiated this quarter. Several methods for washing samples more thoroughly are under study. This procedure decreases the amount of non-living material to be sorted. Literature to help in systematics of animal groups within the meiofauna is being collected.

2. Photographic Analysis

Laboratory processing and analysis are continuing with the sea floor photographs obtained in the summer of 1972 aboard the ice-breaker GLACIER (WEBSEC-72). More than 3300 stereo pairs of high quality photographs have been selected for initial tabulation from 16 station transects located between Cape Halkett and Pingok Island (see chart). The stations are as follows:

Station Number	Longitude	Latitude	Depth	Camera Run Number	Number Frames
CG 47	70°50.0'N	150°09.0'W	24 m	DSC - 13	>100
CG 48	71°00'N	150°00'W	31 m	DSC - 14	383
CG 49	71°11.5'N	150°00'W	44 m	DSC - 15	361
CG 50	71°12.4'N	150°02.6'W	80 m	DSC - 16	67
GC 51	71°16'N	150°07'W	675 m	DSC - 17	75
GC 52	71°17'N	150°05'W	750 m	Dsc - 18	358
GC 53	71°35.9'N	150°01.9'W	2160 m	DSC - 19	223
GC 55	71°27.5'N	150°58.6'W	850 m	DSC - 21	112
GC 56	71P21.1'N	150°47.2'W	360 m	DSC - 22	253
GC 57	71°18.2'N	150°42'W	350 m	DSC - 23	317
GC 59	71°06'N	150°57'W	25 m	DSC - 25	102
GC 61	70°58.8'N	150°58'W	19 m	DSC - 26	454
GC 62	71°56.2'N	152°16.2'W	1900 m	DSC - 30	142
GC 75	71°12.3'N	149°43'W	195 m	DSC - 32	132
GC 77	71°20.8'N	151°22.5'W	100 m	DSC - 34	>100
GC 78	71°25.2'N	152°13.9'W	145 m	DSC - 35	145

An E.G.&G. deep-sea stereo camera system was used to obtain the underwater photographs. During each lowering, one camera was loaded with black and white film (35 mm Kodak Plus-X) which allowed immediate development on board ship to monitor the operation of the system. Color film (35 mm High-Speed Ektachrome-ER. Type 5257 Daylight) was used in the other camera to provide for maximum contrast between organisms and the sediment as an aid in later tabulations.

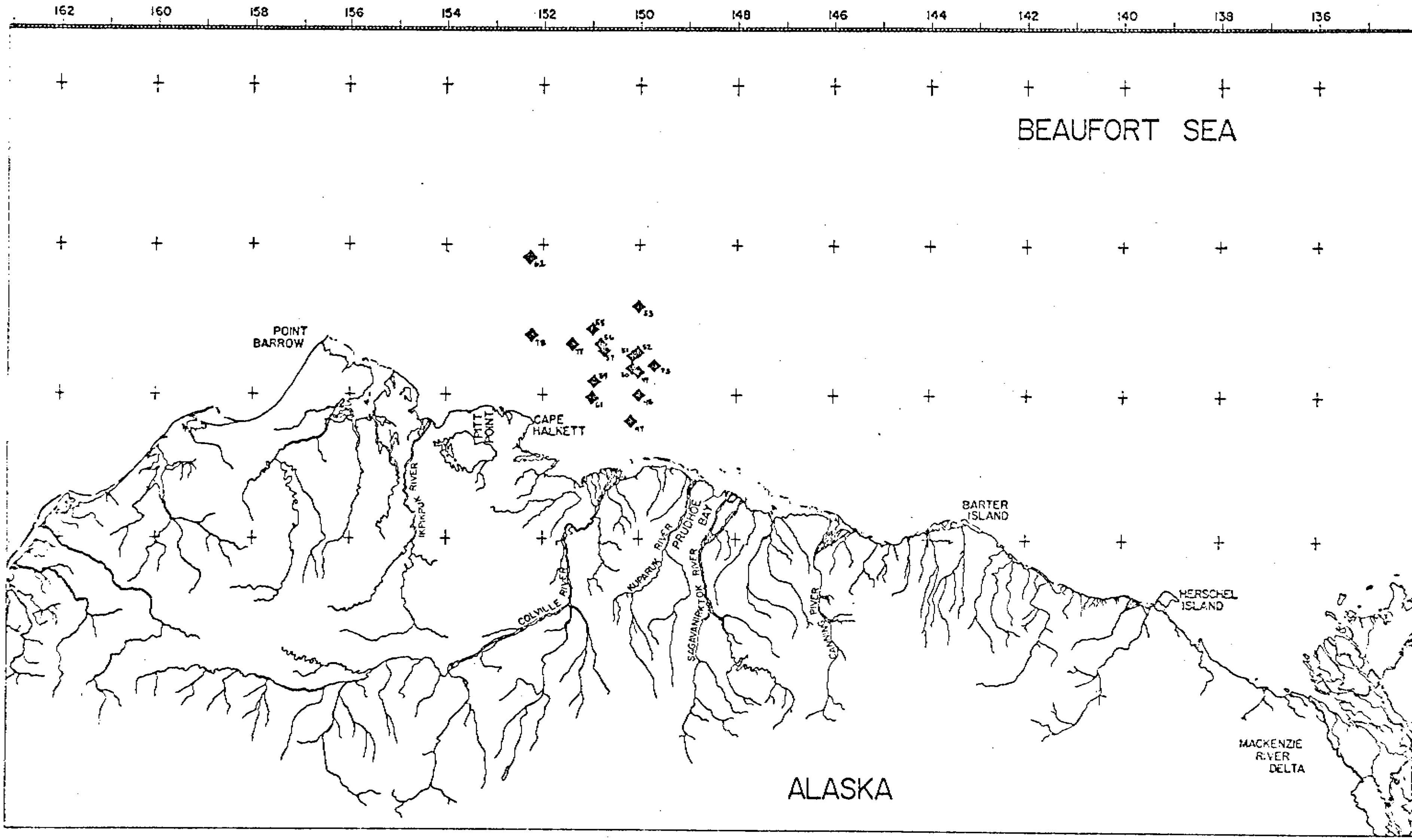

Figure 1. Location of camera stations occupied during WEBSEC-72 from which photographs are being analyzed for quantitative estimates of visible epifaunal numerical abundance.

Accurate interpretation of each pair of stereo photographs, including animal identifications and counts, and calculation of total area, requires a pair of high quality 8x10 prints. Since the cost of color printing is prohibitively high, a technique has been developed at the O.S.U. Benthic Laboratory to create a black and white internegative from the color film-strip. This method entails positioning each frame in front of a high intensity spotlight to monitor a transmitted light meter reading. Since many of the existing color positives are quite dense, corrected exposure values must be set into the camera for use in conjunction with a Honeywell Strobonar Model 202 electronic flash which is slid into position behind the frame. The result is a B/W internegative comparable in quality to the original color positives.

Using the above technique, internegatives of all of the 16 selected station transects have been processed. Prints have been obtained for station CG 62 (1900 m), and the interpretation of these stereo photographs has been initiated.

D. Sample Localities

Details of the sources of Oregon State University sample collections in the western Beaufort Sea and of published and unpublished data are listed in the first yearly report for Task Order Number 4.

The Smith-McIntyre grab samples, otter trawl samples, and bottom photographs came from the Beaufort Sea region between Cape Halkett and Barter Island.

E. Data Collected or Analyzed

Results from Biological samples taken on the USCGC Glacier during the 1971 WEBSEC cruise have been transfered to computer cards and collated with the complementary environmental data collected at the same stations. A multiple correlation analysis will be performed in the near future on this information to determine if any species has a linear relationship to measured environmental characteristics in the area. Correlations among the species will also be studied to compile lists of co-occuring species. To data the Gastropoda, Pelecypoda, Amphipoda, and Cumacea will be included in the analysis, while work is progressing on the Polychaeta and other taxa. A more complete faunal analysis will be undertaken at a later date

III. Results

A. Bibliography of benthic invertebrates of the Arctic basin

References and abstracts collected to date have been recorded on the IBM MagCard II system to facilitate reproduction and correction of the bibliography.

The search for additional references and abstracts is being continued and the final bibliography is in preparation.

B. Taxonomy of benthic fauna

(1) Research has continued this quarter on the systematics of benthic fauna collected during WEBSEC-71 and 72 in the western Beaufort Sea. Emphasis has been placed on the polychaete worms.

(2) Previous identifications of gammarid amphipods are being validated by Dr. Diana Laubitz of the National Museum, Ottawa, Canada and by Dr. Jean Just of the University of Copenhagen. Dr. Laubitz has reported that our collections of Dulichia bispina Gurjanova, 1930 have extended the range of this species; previously it was only known from the White Sea, Kara Sea, and British Columbian waters.

(3) Polychaeta

Taxonomic work on the polychaetous annelids has been continuing at the genus and species level, using a selection of Smith-McIntyre grab samples and Otter trawl samples from WEBSEC 71 and 72. The identifications listed below are tentative, subject to revision and verification.

COSSURIDAE

Cossura longocirrata Webster and Benedict, 1887

CHAETOPTERIDAE

Spiochaetopterus typicus Sars, 1953

Phyllochaetopterus sp.

TROCHOCHAETIDAE

Trochochaeta multisetosa (Oersted, 1843)

DORVILLEIDAE

Dorvillea ? neglecta (Fauvel, 1923)

Dorvillea ? pseudorubrovittatus Berkeley, 1927

NEREIDAE

Nereis zonata Malmgren, 1867

PECTINARIIDAE

Pectinaria (Cistenides) hyperborea (Malmgren, 1865)

ONUPHIDAE

Onuphis (Nothria) conchylega Sars, 1835

Onuphis (Onuphis) quadricuspus Sars, 1872

STERNASPIDAE

Sternaspis scutata (Renier, 1807)

LUMBRINERIDAE

Lumbrineris fragilis (O.F. Muller, 1776)

Lumbrineris ? *minuta* Théel, 1879

Lumbrineris latreille (Audouin and Milne-Edwards, 1833)

NEPHTYIDAE

Aglaophamus malmgreni (Theel, 1879)

Micronephtys minuts (Theel, 1879)

Nephtys ciliata (O.F. Muller, 1789)

Nephtys longosetosa Oersted, 1843

Nephtys paradoxa Malm, 1874

OPHELIIDAE

Ophelina cylindricaudatus (Hansen, 1879)

Ophelina sp.

Polyopthalmus sp.

Travisia forbesii Johnson, 1840

ORBINIIDAE

Scoloplos acutus (Verrill, 1873)

AMPHARETIDAE

Ampharete arctica Malmgren, 1866

Amphicteis gunneri (Sars, 1835)

Melinna cristata (Sars, 1851)

? *Melinna* sp.

? *Sabellides* sp.

An upcoming trip by Gordon Bilyard to the Allan Hancock Foundation (University of Southern California) to work Dr. Kristian Fauchald will clarify many of the "problem animals" encountered to date, and will verify or disprove the presence of suspected new genera and species. The resulting species list will form an acceptable base for ecological analysis of the fauna. Work on the Ampharetidae is presently in progress.

IV. Preliminary interpretation of results

Data are being generated but are not fully analyzed or appropriately summarized to form the basis of further interpretations at this time.

V. Problems encountered

The major problem is derived from the labor intensive nature of research on the species rich benthic invertebrate fauna. With proper time and personnel appropriate progress can be made to derive research products useful to the Bureau of Land Management for the evaluation of potential problems related to the offshore exploration and production of oil and natural gas.

VI. Estimate of Funds Expended - Task Order 4

NOAA Carey 976 Statistics 6/30/76

	Budget	Spent	Balance	Spent This Quarter
Salaries & Wages	26,800	17,335	9,465	5,767
Materials & Services	8,093	3,576	4,517	2,366
Travel	1,750	3,504	<1,754>	3,294
Equipment	6,750	3,900	2,850	--
Payroll Assessment	4,020	2,573	1,447	907
Overhead	12,117	7,839	4,278	2,608
TOTAL	59,530	38,727	20,803	14,942

Salaries Committed		Paid	Outstanding
Carey, A.	3,904.	3,904	--
Erskine, G.	6,480.	6,480	--
Montagna, P.	6,480.	6,480	--
Secretarial	1,600. (9/76)		1,600-
Ocean Shop		471	--
TOTAL		17,335	1,600-

Quarterly Report

R.U. 19/19E
April 1 through June 30
Two pages

SPAWNING HERRING SURVEYS IN THE BERING SEA AND FINFISH RESOURCE SURVEYS IN NORTON SOUND AND KOTZEBUE SOUND

Principal Investigator

LOUIS H. BARTON
Alaska Department of Fish and Game
Commercial Fisheries Division
333 Raspberry Rd.
Anchorage

June 30, 1976

I. Task Objectives

The objectives of these research units are to:

1) Determine the spatial and temporal distribution, species composition and relative abundance of finfishes in the coastal waters of Norton Sound and Kotzebue Sound east of 166 Degrees West Longitude.

2) Determine the timing and routes of juvenile salmon migrations as well as examine age and growth, relative maturity and food habits of important species in Norton Sound and Kotzebue Sound east of 166 Degrees West Longitude.

3) Determine the spatial and temporal distribution and relative abundance of spawning populations of herring and capelin from Unimak Pass to Point Hope.

4) Monitor egg density, distribution and development and document types of spawning substrates of herring and capelin.

5) Monitor the subsistence utilization of fishery resources to local residents.

II. Field Activities

In May, radio and typed news releases were made in selected communities throughout the study area to explain the scope and purpose of the OCS program and to solicit local cooperation on the subsistence utilization studies. These releases were followed by village meetings in June in selected communities to distribute subsistence catch calender forms.

Prior to field investigations (April) the entire coastline of the study area was broken down into census areas for ease in reporting results to EDS.

To date, three mobile two- and three-man crews have been deployed in Norton Sound. Said crews are equipped with various types of fishing gear to sample the pelagic finfishes in the coastal waters. Three two-man crews have been deployed along the Southern Bering Sea coastline to examine primary spawning areas and sample spawning populations of herring and capelin. In addition, approximately 30 herring surveys have been flown throughout the study area and photographs taken for later analysis.

III. Results

Results and work thus far are only qualitative. Data compilation for herring and capelin surveys, both aerial and ground, is not scheduled until spawning activity throughout the study area terminates. This is in view of the extremely large study area to be surveyed, limited personnel and the fact that peak herring spawning activity varies from area to area along the coastline. At the time of this report much herring spawning activity is occurring not only in Norton Sound but also in the Cape Vancouver - Cape Romanzof areas. All census areas have not been surveyed uniformly, but rather opportunistically due to inclimate weather conditions. Ice breakup in the North Bering Sea has attributed to turbid water conditions which also hindered some of the earlier surveys.

No data is available from the pelagic fish crews sampling Norton Sound.

IV. Preliminary Interpretation

It is too early for interpretation of results.

V. Problems/Changes

No major problems have been encountered thus far with the spawning herring surveys. However, as already mentioned, inclimate weather and turbid water conditions have hindered aerial surveys, necessitating that census areas be surveyed on an opportunistic basis.

Problems associated with R.U. 19E have been with start-up difficulties. These problems are being settled in the course of time and have stemed from late funding of the research unit and in turn, arrival of sampling equipment and supplies which had to be purchased, assembled and shipped to remote locations.

VI Estimate of Funds Expended

Unavailable at this time.

Research Unit # 19F

Pelagic and Demersal Fish Assessment in the Lower Cook Inlet Estuary System

James E. Blackburn
Alaska Department of Fish and Game
P.O. Box 686
Kodiak, Alaska 99615

June, 1976

Completion Report for Period, April 1 - June 30, 1976

Prepared for:

National Oceanic and Atmospheric Administration
Environmental Research Laboratories
Boulder, Colorado

Introduction - Task Objectives

This report describes activities, decisions, progress and some preliminary results on Cook Inlet Pelagic and Demersal Fish Studies, Research Unit 19E, from its initial funding in late April 1976 to June 30, 1976. The study area for this project includes lower Cook Inlet from the Forelands to 59° N latitude and west of 152° west longitude, south of Pt. Bede on the Kenai Peninsula.

Task objectives of this project are listed below.

A. Determine the spatial and temporal (May-September) distribution, relative abundance and inter-relationships of the various pelagic and demersal finfish and shellfish species in the study area.

B. Determine when, where, at what rate and in what relative abundance pelagic fish species (primarily salmonids) migrate into and through the study area.

C. Determine the growth rate and food habits of selected pelagic and demersal fish species.

D. Survey the literature to obtain and summarize an ordinal level documentation of commercial catch, stock assessment data, distribution, as well as species and age group composition of various shellfish species in the study area.

E. Survey the literature to inventory and characterize salmon spawning streams as well as timing of fry and smolt migrations.

F. Obtain basic oceanographic and atmospheric data to determine any correlations between these factors and migrations and/or relative abundance of various pelagic and demersal fish and shellfish species encountered.

II Field or Laboratory Activities

As final OCSEAP funding for this project was granted in late April, 1976, activities were necessarily directed toward expediting initiation of field studies: personnel were hired, equipment was ordered and assembled, a vessel was chartered, a data management plan was drafted and approved, operational plans were formalized, sampling sites were selected and actual field sampling was initiated.

On May 4 and 6, 1976, a field trip to streams of northern Kamishak Bay was conducted, supervised by Thomas R. Schroeder of Alaska Department of Fish and Game, to obtain data on reproductive success and outmigration timing of juvenile salmonids. A total of 35 samples were taken in Cottonwood Creek, 25 samples in Iniskin River and 44 samples in Browns Peak Creek.

On May 14, 1976, a Bell Jet Ranger helicopter was chartered with Peter B. Jackson, OCS Coordinator, and Wesley A. Bucher, Assistant Project Leader, aboard. The east and west shorelines of lower Cook Inlet from Port Graham to the Forelands were surveyed for potential beach seine and townet areas. The flight was coordinated with R.U. 24, (Razor Clam Density and Distribution Study). Rodney J. Kaiser, Principal Investigator of R.U. 24, was aboard the helicopter to observe possible areas for future expansion of this study.

Otter trawling stations were initially chosen by gridding the entire study area deeper than ten fathoms (18 M) into one nautical mile squares, and numbering the squares beginning in the northwest corner and progressing west to east and north to south. The study area contained 3,337 square miles, each representing a potential station. The first station was chosen by randomly selecting a number between one and ten, and every 95th square thereafter was chosen systematically as a station, yielding 35 sampling stations. This sampling intensity was based on estimated sampling rate and time available. As initial trawl hauls resulted in torn nets and lost time due to rocky bottom, a field decision was made to redefine the sampling area to exclude obviously untrawlable bottom types. This redefinition of the trawl area to be considered, accomplished with the advice of local fishermen, resulted in a reduction of the size of the total area to 795 mi^2. A second field decision to reduce the total number of stations sampled per survey within this redefined area from 35 to 20 was necessitated by the excessive running time required between stations. Trawl stations within this redefined area (Figure 1) were selected by the same procedure originally employed.

Purse seine locations were tentatively selected at five mile intervals along transect lines (Figure 2) located between major salmon spawning areas. This strategy was chosen to cover lower Cook Inlet and facilitate delineation of in and out migrants of major tributaries. Modification of these stations in the northern portion of the study area is anticipated due to extreme currents and tidal conditions.

The M/V BIG VALLEY was utilized from June 1 through June 14 to otter trawl and transport a beach seine crew between sites in lower Cook Inlet. Aboard at various times were Alaska Department of Fish and Game personnel, Peter Jackson, OCS Coordinator, Jim Blackburn, Principal Investigator, and staff personnel Dave Anderson, Wes Bucher, Bob Mielke, Steve Pint, Don Seagren and Phil Smith. A total of 15 otter trawl samples and 12 beach seine samples were taken at the locations shown on Figure 1. All taxa sampled with trawls and beach seines were identified, enumerated and weighed.

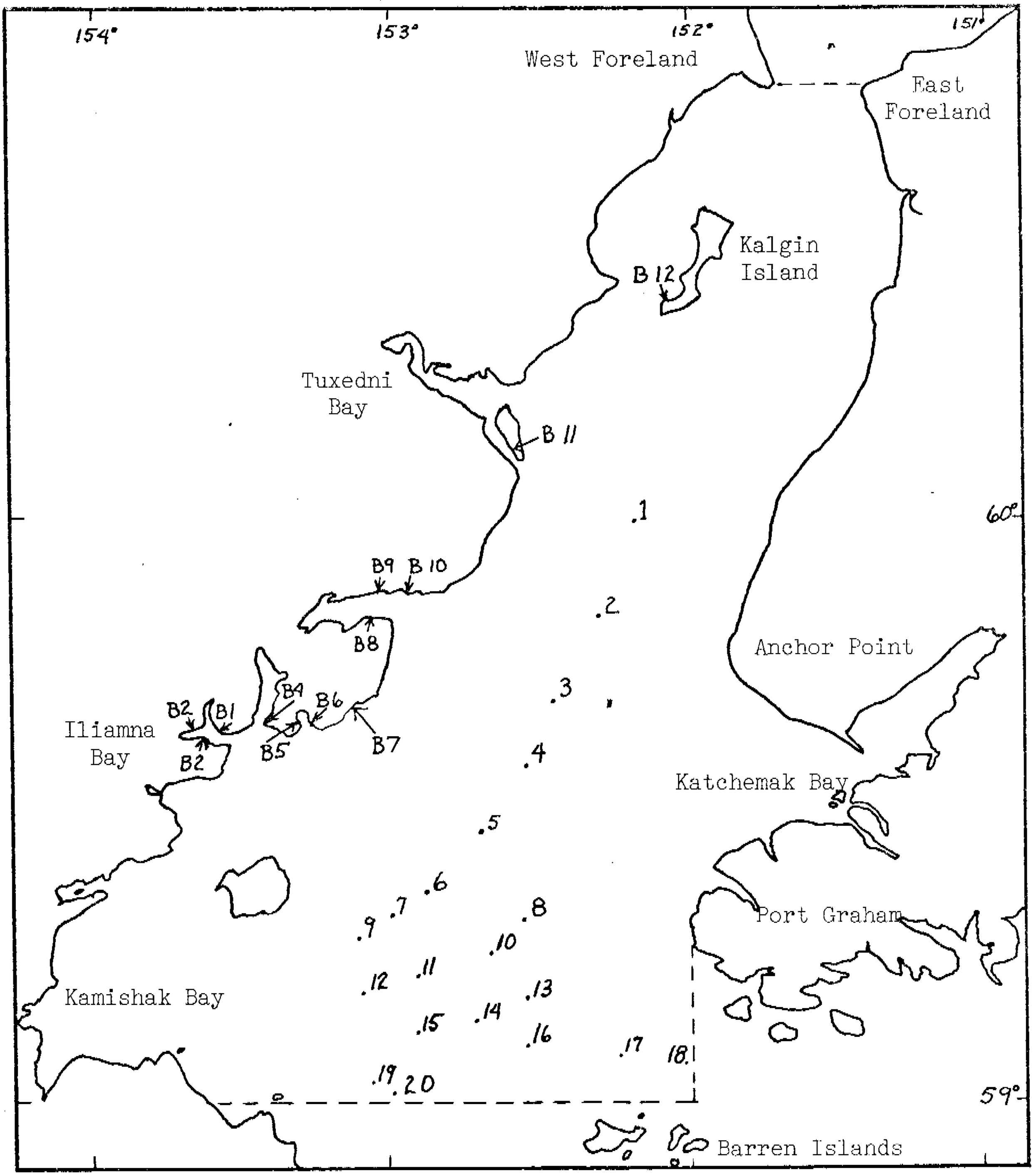

Figure 1. Drawing of lower Cook Inlet showing the boundaries of the study area (dashed lines), beach seine stations 1 to 12 (preceeded by B) and approximate otter trawl stations.

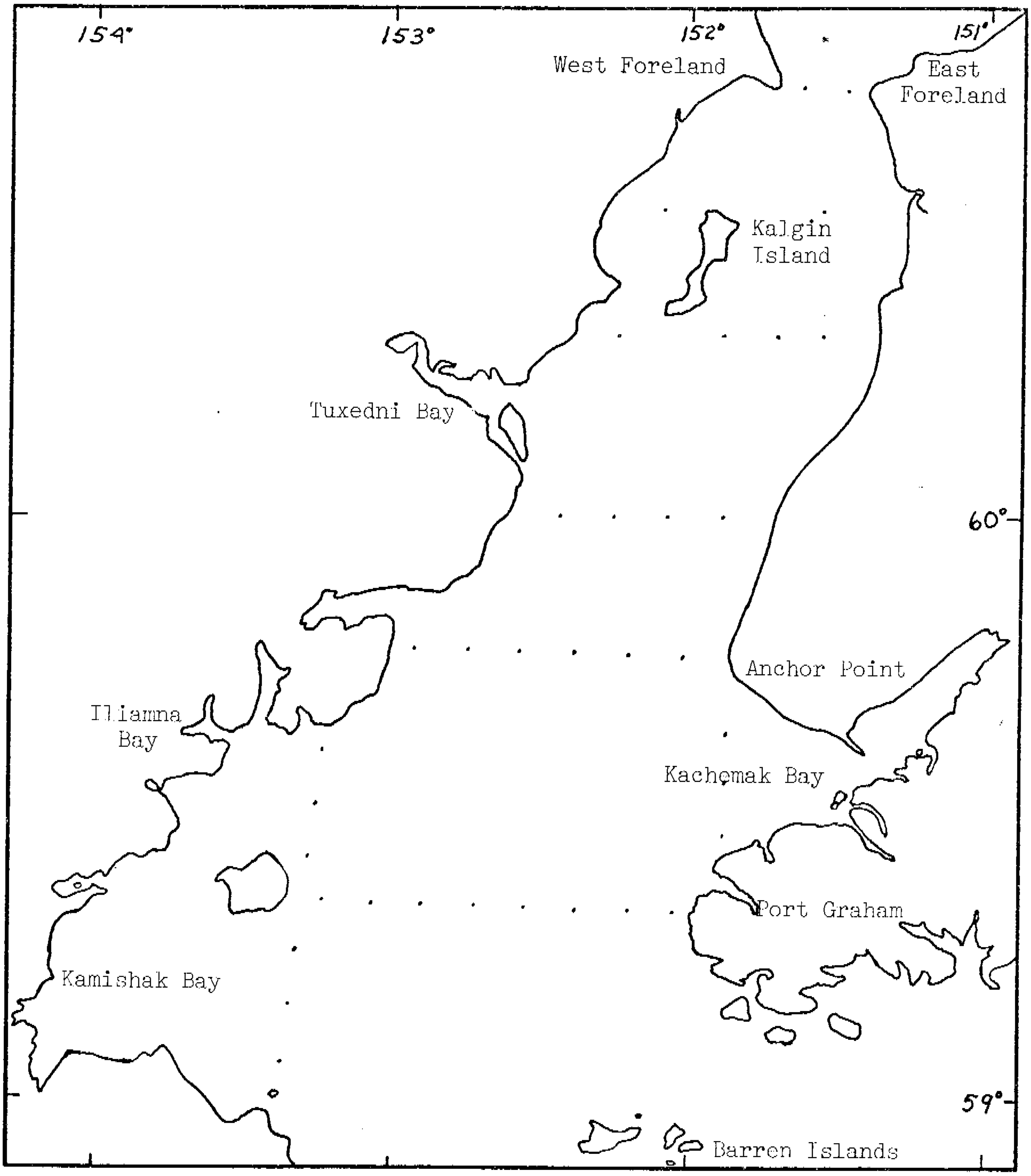

Figure 2. Drawing of lower Cook Inlet showing the proposed power purse seine sampling stations.

Beach seining and townetting operations have continued since June 15 along the east side of the study area, however these data are not available.

Preliminary townetting and beach seining was conducted with borrowed equipment in Kachemak Bay between May 19 and June 22 in cooperation with Coastal Habitat Protection. The purpose of this survey was to assist in determining whether outmigration of juvenile pink salmon (*Oncorhynchus gorbuscha*) from Kachemak Bay has progressed sufficiently to allow the disabled oil platform GEORGE FERRIS to be removed by explosives with negligable affect to this resource. A total of nine surface hauls with a 9'x 9' townet were made in the vicinity of the GEORGE FERRIS; eight hauls were made between May 19 and 25, and one on June 22; three hauls were made at night and hauls were made on all tidal stages. Ten beach seine sets were made at three sites in Coal Bay. For comparative purposes four surface townet hauls were made in Tutka Bay and one in Sadie Cove.

Data from the first trawl survey and from the beach seine survey on the west side of Cook Inlet will be submitted for keypunching and subsequent data processing on June 30, 1976.

III Results

A total of 15 otter trawl hauls were completed from which counts and weights were obtained on 12 and satisfactory gear performance occurred on ten hauls. Catch consisted almost entirely of founders, cod and sculpins (Table 1). The predominant species by weight in order of kilograms caught were tanner crab (*Chionoecetes bairdi*), Pacific cod (*Gadus macrocephalus*), Pacific halibut (*Hippoglossus stenolepis* butter sole (*Isopsetta isolepis*), king crab (*Paralithodes camtschatica*), great sculpin (*Myoxocephalus polyacanthocephalus*), yellowfin sole (*Limanda aspera*), and rock sole (*Lepidopsetta bileneata*). Sculpins were partially unidentified, however most of them were great sculpin and Brown Irish Lord (*Hemilepidotus spinosus*). Differences between areas are not yet reliably apparent.

Twelve beach seine hauls were made in 12 areas on the west side of Cook Inlet and Kalgin Island. A total of 183 Dolly Varden (*Salvelinus malma*) and 11 pink salmon fry were captured with lesser numbers of whitespotted greenling (*Hexagrammos steller* sculpins, starry flounder (*Platichthys stellatus*), whitefish (*Coregonus sp.*) and snake prickleback (*Lumpenus sagitta*). One chum salmon fry (*Oncorhynchus keta*) also was captured. Differences between areas were not yet reliably apparent.

Townetting and beach seining conducted in Kachemak Bay in cooperation with Coastal Habitat Protection in respect to the oil platform GEORGE FERRIS generally yielded few pink salmon fry. The nine townet tows conducted in the vicinity of this platform yielded six pink salmon fry and the five tows in Tutka Bay and Sadie Cove yielded 26 pink salmon fry.

IV Preliminary Interpretation of Results

Data are not yet sufficient to reliably interpret within and between survey differences of species and size composition of demersal fish catches. Beach seine and townet samples yielded few pink salmon fry in any area fished. Work conducted in Kachemak Bay suggested that pink salmon fry had not moved out of the littoral zone by June 22.

Table 1. Cook Inlet trawling preliminary June 1976 data summary

Major Groupings	Total Kgms	% of Total	Number	% of Total	Number of hauls out of 12 the taxa occurred
Flounders	237.90	37.1	924	44.0	12
Crustacea	176.56	27.5	474	22.6	10
Cod	121.24	18.9	147	7.0	10
Sculpins	89.78	14.0	297	14.1	11
Predominant Species					
Tanner crab	118.92	18.6	364	17.3	10
Pacific cod	112.45	17.5	54	2.6	5
Halibut	103.21	16.1	57	2.7	8
Butter sole	67.98	10.6	373	17.8	7
King crab	52.76	8.2	55	2.6	6
Yellowfin sole	22.49	3.5	157	7.5	7
Rock sole	21.48	3.4	170	8.1	8
Alaska pollock	8.68	1.4	91	4.3	6
Sturgeon poacher	7.46	1.2	180	8.6	8
Arrowtooth flounder	4.62	.7	60	2.9	4
Sand fish	3.48	.5	47	2.2	6
Great sculpin*	44.25*	6.9	47*	2.2	7*
Brown Irish Lord*	11.30*	1.8	61*	2.9	5*
Total Catch, 12 tows	640.93	100	2,100	100	

* Conservative figures; all individuals may not have been identified.

Problems Encountered/Recommended Changes

The short time between project funding and field implementation resulted in problems. Personnel were hired and equipment ordered very promptly, however, by early June we had one otter trawl and two beach seines. We had no purse seine, gillnets, or townets. When we encountered rocky bottom and nearly destroyed our only otter trawl we lost several days of boat time. Greater time between funding and field implementation would upgrade future work.

The charter vessel was prepared to begin work on June 1, however due to a mechanical breakdown, the D/V TUSTUMENA was not available to transport our otter trawl and doors to Homer. Thanks to extreme efforts by the Juneau Project Office logistics section, lost vessel time was held to a minimum.

The large size of Cook Inlet together with the numerous study objectives dovetailed together produce some logistical dilemmas. Traveling to and from suitable nightime harbors for each day's sampling cuts into the working time available. Trawl and purse seine schedules can be devised to accomplish a satisfactory level of sampling but coordination with the townet and beach seine crews on the west side of Cook Inlet cuts inordinately into the available time. If the townet/beach seine crew had a boat large enough that they were independent, the amount of data that they, as well as the other phases of the project, could gather would be considerably greater.

Work during July will require careful planning and long hours but good weather may make it unnecessary to travel to a protected anchorage at night, increasing efficiency. This first cruise with all gear will also provide a much better indication of how much can and cannot be accomplished.

Encountering rocky bottom, as previously mentioned, necessitated a reduction of our otter trawl study area from 3,337 to 795 mi^2. This area is, perhaps, conservative and other areas with suitable bottom may be added.

Preliminary Audit of Expenses to Date

A.	Personnel		14.9[1]
	Permanent	6.2	
	Temporary	8.7	
B.	Travel and Subsistence		4.5
C.	Contractual Services		31.6
D.	Commodities[2]		21.6
E.	Equipment		17.3
		TOTAL	89.9
		10% overhead	7.2
		GRAND TOTAL	97.1

[1] Includes benefits
[2] Includes expendable fishing gear, i.e. trawls and seines

OUTER CONTINENTAL SHELF ENERGY ASSESSMENT PROGRAM
(Quarterly Report)

Contract No. : 03-5-022-69

Research Unit No.: 24

Reporting Period: April 11 - June 30, 1976

No. of Pages:

RAZOR CLAM (*Siliqua patula*, Dixon) DISTRIBUTION AND POPULATION ASSESSMENT STUDY

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July 1, 1976

INTRODUCTION

The Pacific razor clam (*Siliqua patula*, Dixon) exists in significant populations over a wide range of surf-swept sandy beaches in the Gulf of Alaska. This single species of mollusk is the most important commercially harvested bivalve in the state, with commercial harvesting dating from 1916 (Nickerson, 1975). As a recreational and subsistance product, the razor clam is second to none and is sought after wherever it occurs.

Comparable baseline information for the species, much less a general uniform study, has been lacking. Knowledge of specie density, distribution, habitat, and biological paramenters are poorly documented over much of the range.

In an attempt to gather baseline data in the Gulf, a razor clam assessment program was initiated through the OCSEAP program in 1975, with work to be done by the Alaska Department of Fish and Game.

This quarterly report will discuss the results of beaches studied April 1 through June 30. Due to impending oil leasing in the Kodiak Island area scheduled for December, 1976, the 1976 field season (April-September) is devoted to beaches between the latitude of Cape Douglas and the longitude of Kilakak Rocks (156° 23').

TASK OBJECTIVES

Objectives of this study are to gather information of razor clam density, distribution, age and growth, and habitat on beaches from Yakutat Bay at 139° west longitude to Unimak Bight on the Alaska Peninsula. Specific objectives of the study are:

1. Investigate all known beaches where razor clams are known to occur, and map each location with regard to the extent of the specie's existance, density, and habitat.

2. Collect and identify all bivalves at each beach and assess density, length and age composition (razor clams only) of each by tide level for the entire low tide terrace.

3. Collect core samples of the substrate by tide level at each beach site to investigate substrate composition and grain size.

4. Combine past and current razor clam data for the Gulf of Alaska areas to assist in formulating the biological parameters of this baseline study.

Secondary objectives will include collection of incidentally captured invertebrates, and investigation of razor clam samples for levels of paralytic shellfish poisoning (PSP) and recording of environmental parameters at each study site.

SCIENTIFIC PERSONNEL

Rodney J. Kaiser, ADF&G, Principal Investigator
Daniel Konigsberg, ADF&G, Project Biologist
Christopher Phillips, NMFS, Biologist
Jesus F. Briones, ADF&G, Fishery Technician

STUDY AREAS

Five major field work units were established early in 1976 in order to systematically approach the sandy-type beaches in the Gulf of Alaska (Figure 1). Each unit was selected as a general geographical area with logistical considerations being a high priority. Timing of the Gulf tract selections and the resulting oil leasing required that Field Unit B (Kodiak Island and adjacent Alaska Peninsula) be the first area of intensive study. Leasing of the Kodiak Island area continental shelf area is scheduled for December, 1976.

Within Unit B, there are 24 known beaches with razor clam populations (Figure 2), though some of these are minor in their contribution and are important only for recreational and subsistence use. Others, however, are of major commercial importance with commercial harvesting dating back to 1922 (Nickerson, 1975).

The seven beaches studied during this quarter's work (April 1 through June 30) include Ocean Bay Beach, Tanner Head Beach, Halibut Bay Beach, Swikshak Beach, Big River Beach, Village Beach, and Hallo Bay Beach. Between June 28-30, Hallo Bay Beach is being investigated and no data is yet available. Additionally, some work remains to be finished at Big River Beach.

Each of the beaches visited can be generally characterized as open, wind-swept, and sandy, exposed to the full wave action of the surf. Varying degrees of the low tide terrace are exposed during minus tide intervals. Length (kilometers), width (meters), of each beach (at station) and slope distance (meters) from the +1 foot to -1 foot level is shown in Table 1.

METHODS AND MATERIALS

Beach Mapping and Photo Documentation

United States Geological Survey maps are used as aides for determining study areas at each beach. Initially the transect location (station) was determined by sighting with a Rangematic Distance Finder towards two prominent landmarks and the distance recorded. It was possible to relocate the station site to within a few meters of the exact location. In the future, a "bench mark" will be placed in the upper beach area above the high tide mark so that the exact location of the station can be relocated. As part of each beach field study, a foot survey is made to determine the extent of the razor clam population by observation of "shows" of clams. Significant rivers and other beach characteristics are noted. A schematic drawing is then made of the beach for future reference.

Photographs are taken to help identify beach characteristics, transect location, and substrate character and type.

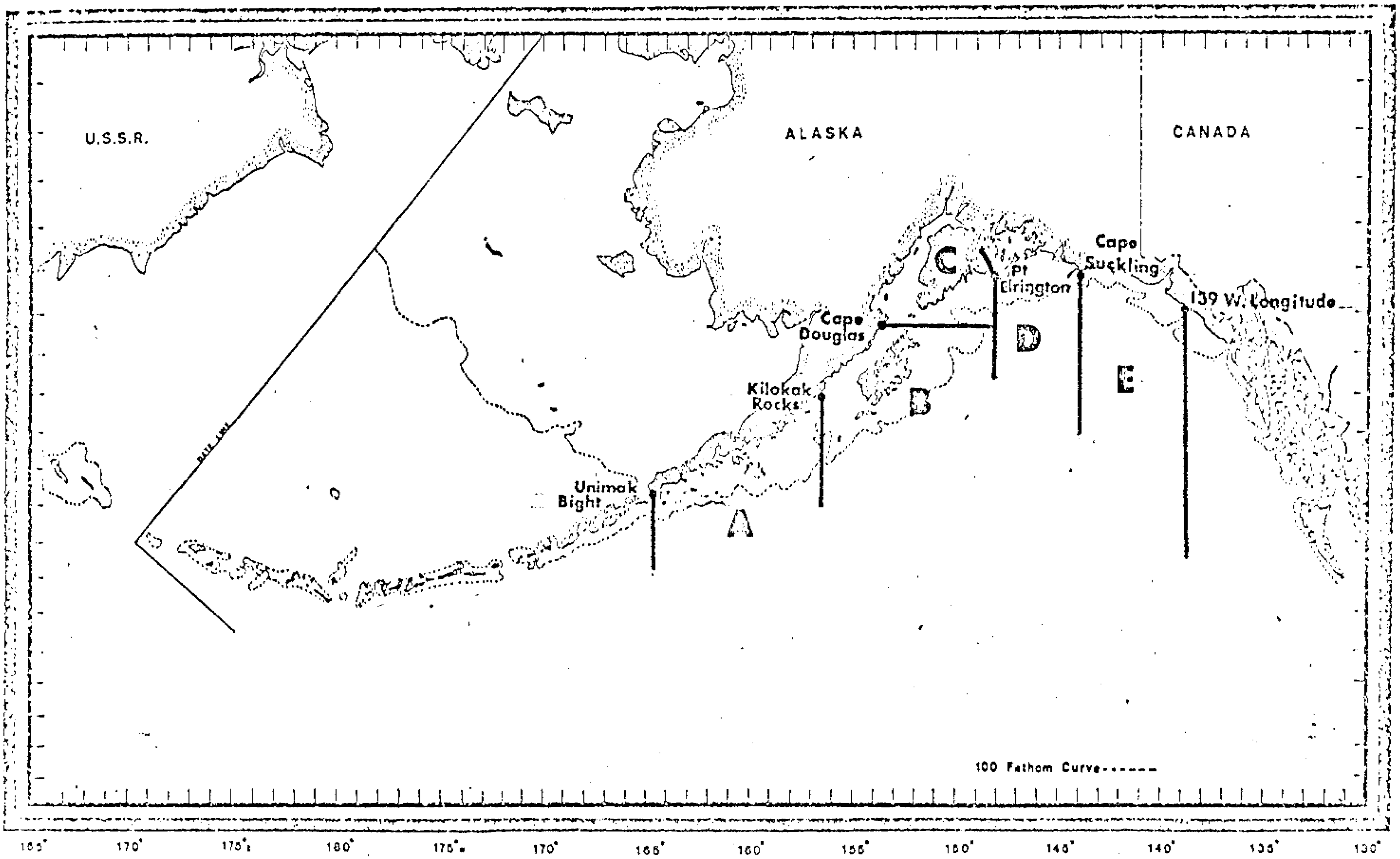
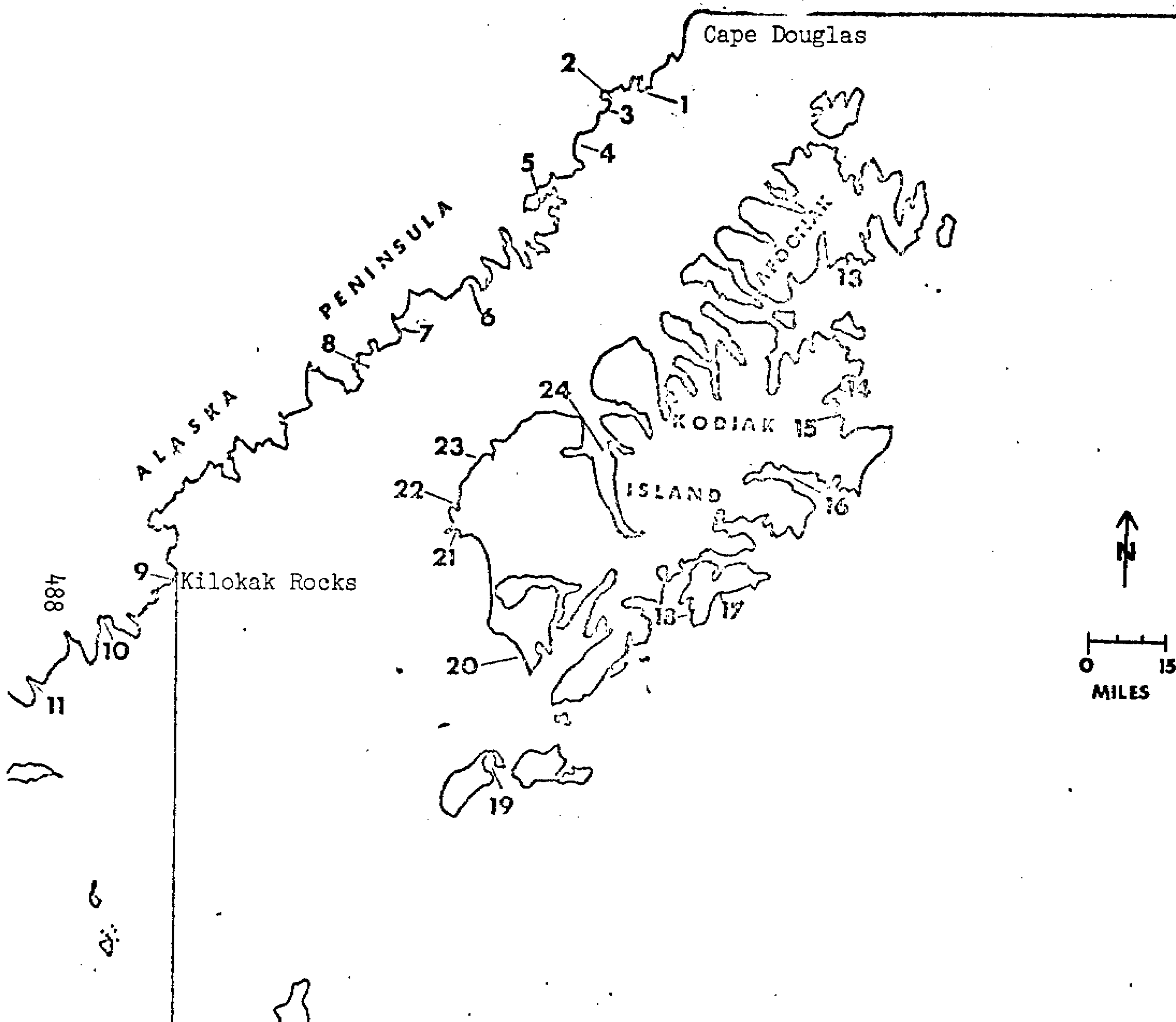


Figure 1. Designated field units for OCSEAP razor clam and bivalve research assessment program in the Gulf of Alaska.



1. Swikshak Beach
2. Big River Beach
3. Village Beach
4. Hallo Bay
5. Kukak Bay
6. Dakavak Bay
7. Kashvik Bay
8. Alinchak Bay
9. Cape Kilokak
10. Chiginagak Bay
11. ntarni Bay
12. Aniakchak Bay
13. Duck Bay
14. Buskin Beach
15. Middle Bay
16. Ugak Bay
    a. Saltrey Cove
    b. Portage Bay
    c. Narrow Cape
17. Ocean Bay
18. Rolling Bay
19. Tugidak
20. Alitak
21. Bumble Bay
22. Halibut Bay
23. Sturgeon Head
24. Uyak Bay

Figure 2. Beaches with known populations of razor clams to be initially surveyed, 1976.

Table 1. Some physical characteristics of razor clam habitat for six Kodiak Island and Alaska Peninsula area beaches studied April 1 - June 30, 1976.

Beach	Approximate Lat. - Long.	Estimated Length of Beach (km)	Width of Beach at Station Site (m)[1]	Slope Distance from +1 to -1 Foot Tide Level (m)
Ocean Bay	57°05' N. Lat. 153°10' W. Long.	4.83	91.20 (-1')	23.79
Tanner Head	56°50' N. Lat 154°14' W. Long	3.38	155.55 (-3')	22.88
Halibut Bay	57°23' N. Lat. 154°14' W.Long.	10.46	114.38 (-1.7')	28.98
Swikshak[2]	58°36' N. Lat. 153°48' W. Long.	7.98	201.91 (-2')	62.83
Village[3]	58°34' N. Lat. 153°52' W. Long.	7.08	383.39 (-4')	234.24
Big River	58°36' N. Lat. 153°53' W. Long.	3.22	Work Incomplete	Work Incomplete

[1] Beach width measured from high tide swash to low tide level indicated in feet within parenthesis.

[2] Swikshak Beach extends undefined for many miles. Measured distance is from mouth of Swikshak River northeast approximately 4 miles to first prominent rocky bluff.

[3] Steep embankment and rock cobble begins just above the zero (0.00') mean low water tide level.

Station Placement

Lack of funds, limitations on manpower, and time have eliminated a completely random approach to station placement. Each station site, when selected, usually takes two minus tide periods (two days) to complete the work, and therefore, only two beaches are worked during a low tide series (approximately five days). With the use of background knowledge from Alaska Department of Fish and Game files, correspondence from commercial diggers, and foot surveys, each beach is examined to determine the extent of the razor clam population. Placement of a station site is then made in an area of "average density".

After the location of the station has been determined, a transit level is used to set up the station, dividing it into tide level increments (by feet). The low tide for the day is determined from a standard tide book, with the low tide level for the day noted and then staked. Using stadia rod, walkie talkies, and transit, each one foot elevation is marked up to and including the +4 foot level when it appears evident that bivalve populations extend above this point.

After establishment of the station the sampling crew moves to the lowest point exposed by the tide and begins sampling. At each marked tide level heavy twine is used to outline a 3 x 21 meter plot. This twine is fastened to four corner stakes defining the study area, and remains in place until all work is completed at that level. Each study plot is aligned parallel to the beach.

Sampling Techniques

In an attempt to gather all sizes of the target species of interest (*Siliqua patula*), as well as most bivalve mollusks and other invertebrates occurring at a particular tide level, two methods of sampling are employed.

First, one grid location is randomly chosen for each of the one third portions (sub area) of the plot. Random coordinates used at the first tide level are then utilized at the remaining tide level plots to be studied for that station.

After the location for study is determined in each sub area, a 1/3 meter square sampling frame, fashioned out of welded 1/4" rod, is placed within the selected one square meter grid. Once in place and held by four corner prongs, all sand is removed to a depth of 1' (.305 meters). This substrate is placed in a sampling wagon specifically constructed for washing subsamples.

The sampling wagon is fashioned out of aluminum with wide low pressure tires. The frame of the wagon unbolts from the rear axle and front steering assembly for transportation in aircraft. The wagon is 6'x 3' and has mounted in the rear a collapsable 2½'x 3'x 18" sampling box. The sides of the box are plywood bolted onto the frame. The bottom of the box is supported with seven crosspieces of aluminum over which is fastened ½" wire mesh. The removable sampling screen of 1.59 mm fiberglass screen rests atop the ½" wire mesh. Sand from two subsamples is dumped into the sampling box atop the sampling screen. The wagon is then pulled close enough to the water to start the pump mounted on the front of the wagon. Salt water is pumped onto the sand to flush the sand through, leaving the juvenile razor clams, incidental mollusks and other invertebrates on top of the sampling screen. After all three subsamples have been washed (nine five-gallon buckets per tide level station), the mollusks and observable invertebrates are picked up by hand or tweezers and stored in plastic bags. The remaining coarse gravel is then bagged after removing big rocks and shells, by lifting the sampling screen out of the box and funneling the contents into a bag. This material is later sorted through for invertebrates that escaped unseen. Worms are then picked out of the sampling screen mesh, the screen is washed and then secured at the bottom of the box. Invertebrates are identifyed back at the laboratory.

In the second method of sampling, all bivalves that are "showing" (principally razor clams) are dug from the entire plot area. The subsamples from the one third portions of the plot and the digging of the entire plot make up the entire sample collected from each tide level.

Environmental Parameters

Environmental parameters are taken after digging is completed. Parameters recorded include salinity, water temperature, air temperature, barometric pressure, wind direction and speed, breaker height, cloud amount, beach type, and substrate type.

Substrate Sampling

Substrate core samples are collected at each tide level of every station researched. Razor clams and other species of mollusks align themselves by tide level, and the grain size of the sand is an important factor in their survival as juveniles and adults. Systematic sampling of the beach by tide level will also give a needed baseline of information by which the impact of potential oil pollutants can be measured.

In the first beaches visited, a circular copper core sampler approximately 25 mm in diameter and 20 cm in length was used. A rubber core plunger was drawn or pulled up the tube drawing the sand with it. However, this core required that the substrate be relatively dry and that it pack well in the tube. Wet and fluidlike sand would not be retained by the samples. An alternative sampler was constructed, using two pieces of angle aluminum 20 cm long by 51 mm wide. These were attached to the shovel forming a rectangular channel open at both ends. The shovel is then immersed vertically into the sand and the core brought up in such a way that the original core is not displaced. All excess sand is then scraped away leaving the "core". Each sample is bagged and labeled for analyses. Each sample is dried and sieved using a Tyler mechanical shaker and differing sieve sizes (Table 2).

TABLE 2.

US Standard Testing Sieves (ASTM-E-11-70) used to analyze sediment core samples

Sieve No.	Mesh Size (Tyler Screen Soak Equiv.)	Opening Size (mm)	Opening Size (inches)	Sand Size[1] Definition	Phi Size ϕ
10	9	2.00	.0787	granule	-1
35	32	.50	.0197	course	+1
60	60	.25	.0098	medium	+2
230	250	.063	.0025	very fine	+4
	Bottom Pan	-	-	silt clay	--

[1]Wentworth (1922) after Udden (1893)

Age Determination (razor clams)

Due to the scope of the study, only razor clams are being aged. Shells are soaked overnight in a 50% solution of clorox to dissolve the periostracum and leave the shell intact with the annual rings clearly distinct in most cases. Aging of the shells is performed by viewing the shell over a light box.

Associated Bivalve Mollusks and Other Invertebrates

All organisms collected at each station are bagged, counted according to tide level, and returned to the laboratory for analysis and identification of genus and species. All bivalve mollusks are measured and mean sizes determined for each tide level at each beach.

RESULTS

Species Analysis

The pacific razor clam (*Siliqua patula*) and its near cousin Dall's razor clam (*Siliqua alta*) was the most abundant genus of bivalves occurring on the beaches studied (Table 3). These two species constituted 83% of the mollusks sampled. Abundant numbers of *Spisula* (surf clams) and *Macoma* clams also were collected, five and ten percent respectively of the total sample. Fifteen species of bivalves were captured during studies April 1 - June 30.

Although the slope and substrate composition varied (Figure 3) from beach to beach, the species *patula* was always the most commonly collected. Specimens were collected from the -1.22 m tide level (-4 ft.) up to and including the +2.14 m (+7 ft.) tide level (Table 4). Razor clams inhabit the entire low tide terrace, but it is unusual for them to occur more than two meters above mean low water (eg. Halibut Bay). Levels of the minus tide series available for digging did not enable the sampling crew to explore many of the lower reaches on many beaches. Razor clams are known to exist 60 meters below the mean low tide (Keen and Coan, 1974).

Mean size for the razor clams (*patula*) appear in Table 5. Relatively few species of invertebrates (other than bivalve mollusks) were encountered during the study. Identification is not complete, but a tentative listing of species for Tanner Head Beach appears in Table 8.

Substrate Analysis

Results of the substrate grain size analysis is only preliminary at this time. Initial samples have been processed for Halibut Bay and Tanner Head beaches. Substrate at Halibut Bay Beach tide levels indicates more than 70% of the sand sieved passed through the #60 sieve (o.25 mm), but was retained by the #250 (.063 mm) sieve. Thus, the beach can be described generally as "very fine" sand. Approximately 10 to 20 percent of the sand analyzed was retained by the #60 sieve ("medium sand").

Table 3. Preliminary identification and total numbers of bivalve mollusks captured by beach.

No. Species Captured

Beach	Siliqua patula	Siliqua alta	Spisula polynyma	Clinocardium corbis	Clinocardium nuttali	Macoma nasuta	Macoma expansa	Macoma balthica	Macoma lama	Mytilis edulis	Macoma yoldiformis	Tellina luta alternidentata
Tanner Head	24		10	3	1	1				1		
Halibut Bay	283	1	7		3		1	2				
Swikshak	118	3	17			1			11			
Village	214	71	11					3	80			2
Big River[1]	155	2	8		1				10			4
Ocean[2]												
TOTAL	794	77	53	3	5	2	1	5	101	1		6

Beach	Tellina sp.	Tresus capex	Gemma gemma
Halibut Bay	1	1	1
TOTAL	1	1	1

[1] Work incomplete. Tide level sites above 0.0 m to be studied June 24 - July 3, 1976.
[2] Unfavorable weather and tide conditions - another site to be selected.

Table 4. Incidental bivalve mollusks captured by tide level and beach. (Does not include genus *Siliqua*)

Beach	Organism (to species)	Tide Level[1] in Meters	No. Captured	Mean Size (mm)
Tanner Head	*Spisula polynyma*	-0.30 (-1)	5	[3]
	" "	0.00 (0)	4	119
	" "	+0.91 (+3)	1	41
	Clinocardium corbis	-0.30 (-1)	3	68
	Macoma nasuta	+0.61 (+2)	1	17
	Clinocardium nuttali	+1.83 (+6)	1	4
	Mytilis edulis	+1.83 (+6)	1	3
Halibut Bay	*Spisula polynyma*	-0.31 (-1)	4	117
	" "	0.00 (0)	1	78
	" "	+0.61 (+2)	1	43
	" "	+0.91 (+3)	1	13
	Tresus capex	-0.30 (-1)	1	206
	Clinocardium nuttali	-0.30 (-1)	1	76
	" "	0.00 (0)	2	111
	Tellina sp.	+1.21 (+4)	1	60
	Macoma expansa	-0.30 (-1)	1	36
	Gemma gemma	0.00 (0)	1	2
	Macoma balthica	+0.61 (+2)	1	6
Swikshak	*Spisula polynyma*	-0.30 (-1)	7	43
	" "	0.00 (0)	6	41
	" "	+0.30 (+1)	1	15
	" "	+1.21 (+4)	3	[3]
	Macoma nasuta	-0.30 (-1)	1	21
	Macoma sp.[2]	-0.30 (-1)	5	21
	" "	0.00 (0)	2	18

Table 4. (Continued).

Beach	Organism (to species)	Tide Level[1] in Meters	No.[1] Captured	Mean Size (mm)
Swikshak	*Macoma sp.*	+0.61 (+2)	2	22
	" "	+1.21 (+4)	2	19
Village	*Spisula polynyma*	-1.22 (-4)	6	[3]
	" "	-0.91 (-3)	2	126
	" "	-0.31 (-1)	5	105
	" "	0.00 (0)	1	58
	Tellina lutea	-1.22 (-4)	1	30
	" "	-0.61 (-2)	1	44
	Macoma sp.[2]	-1.22 (-4)	19	9
	" "	-0.91 (-3)	20	12
	" "	-0.61 (-2)	32	11
	" "	-0.30 (-1)	6	17
	" "	0.00 (0)	3	19
	Macoma balthica	-1.22 (-4)	1	6
	" "	-0.91 (-3)	1	5
	" "	-0.61 (-2)	1	5
	Macoma yoldiformis	-0.91 (-3)	1	9
Big River (incomplete)	*Spisula polynyma*	-0.61 (-2)	5	[3]
	" "	-0.31 (-1)	3	11
	Tellina lutea	-0.61 (-2)	1	41
	" "	-0.31 (-1)	3	38
	Macoma sp.[2]	-0.61 (-2)	5	13
	" "	-0.31 (-1)	4	16
	" "	0.00 (0)	1	16

[1] Tide Level in feet in parenthesis.
[2] Preliminary identification *Macoma lama*
[3] Not available

Table 5. Mean Length of all *Siliqua patula* in mm dug from each tide level station plot

Beach	Tide Level in meters (feet)												
	-1.22 (-4ft)	-0.91 (-3ft)	-0.61 (-2ft)	-0.30 (-1ft)	0.0 (0)	+0.30 (+1ft)	+0.61 (+2ft)	+0.91 (+3ft)	+1.22 (+4ft)	+1.52 (+5ft)	+1.83 (+6ft)	+2.14 (+7ft)	+2.44 (+8ft)
Tanner Head	-	-	-	122	126	118	118	63	117	0	0	-	-
Halibut Bay	-	-	-	120	119	112	94	100	110	93	85	74	0
Swikshak	-	-	-	85	93	102	101	97	66	-	-	-	-
Village	133	140	139	132	130	-	-	-	-	-	-	-	-
Big River	-	-	142	143	157	-	-	-	-	-	-	-	-

Table 6. Pacific razor clams (Siliqua patula, Dixon) captured by tide level and beach, April 1-June 30, 1976.

Tide Level (in meters)

Beach	(-4ft) -1.22	(-3ft) -0.91	(-2ft) -0.61	(-1ft) -0.30	(0ft) 0.0	(+1ft) +0.30	(+2ft) +0.61	(+3ft) +0.91	(+4ft) +1.22	(+5ft) +1.52	(+6ft) +1.83	(+7ft) +2.14	(+8ft) +2.44
Tanner Head				7	10	5	0	1	1	0	0		
Halibut Bay				36	53	32	78	27	21	27	8	1	0
Swikshak				32*	37*	14*	12*	22*	1				
Village	36	61	69*	34	14								
Big River[1]			61	50	44								

* Tide level station plots dug for "shows" on two consecutive days.
[1] Work at tide level sites above 0.0 m incomplete; will be completed June 24 - July 3.

Table 7. Dall's razor clam (Siliqua alta, Dall) captured by tide level and beach, April 1-June 30, 1976.

Tide Level (in meters)

Beach	(-4ft) -1.22	(-3ft) -0.91	(-2ft) -0.61	(-1ft) -0.30	(0ft) 0.0	(+1ft) +0.30	(+2ft) +0.61	(+3ft) +0.91	(+4ft) +1.22	(+5ft) +1.52	(+6ft) +1.83	(+7ft) +2.14	(+8ft) +2.44
Tanner Head				0	0	0	0	0	0	0	0		
Halibut Bay				1	0	0	0	0	0	0	0	0	0
Swikshak				2*	0*	1*	0*	0*	0*				
Village	44	11	13*	3	0								
Big River			1	1	0								

Table 8. Associated vertebrates and invertebrates captured from intertidal plot and subplot sampling at Tanner Head Beach.

Class	Common Name	Taxonomic Nomer	Tide Level in Feet	Quantity
PICIFORMS				
	Pacific Sand Lance	Ammodytes hexapterus	(-1)	1
POLYCHAETA				
	Clam Worm	Nephtys californiensis	(-1 to +6)	17
	Handle-bar Mustache Worm	Spio filicornis	(-1 to +6)	134
	Blood Worm	Euzonus mucronata	(+4)	14
NEMERTEA				
	Hair Worm	Cerebratulus sp.	(-1 to +4)	-
CRUSTACEA				
		Gammaridea haustoriidae Eohaustorius sp.	(+3)	1
		Mysidae archaeomysis sp.	(+2,+3)	9

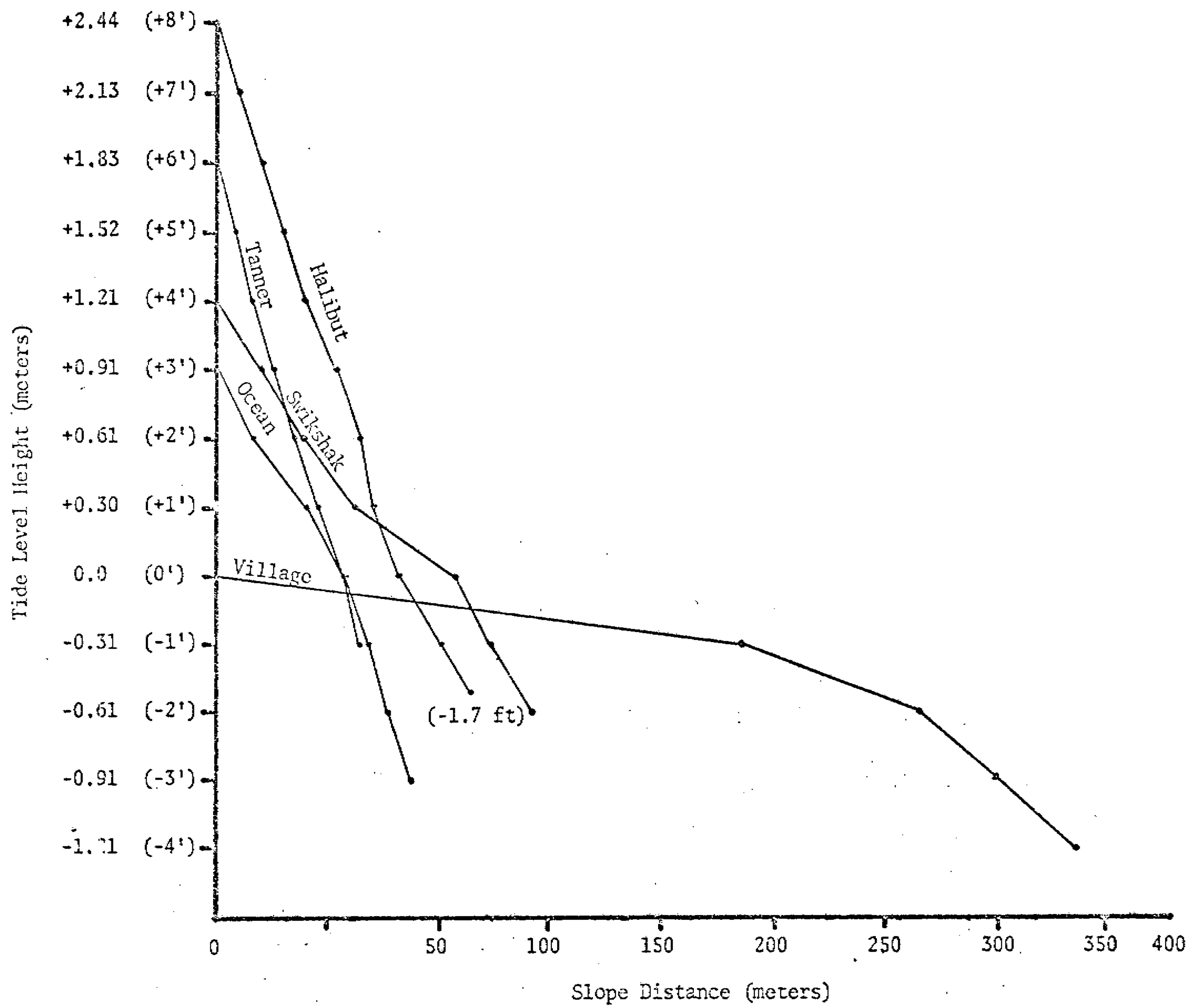


Figure 3. Slope and profile for five beaches as determined at Station site.

Tanner Head Beach substrate exhibited similar large percentages of "very fine" sand. Over 80% of the sand was retained by the #250 sieve, with the exception of the 0, +1, +2, and +3 foot tide levels. These contained from 25 to 61 percent "very fine sand", with most of the remaining substrate classified as "medium".

PRELIMINARY INTERPRETATION OF RESULTS

Interpretation of results at this time is premature due to continued extended trips in the field for data collection. Additionally, only six beaches have been visited since May 18, with varying amounts of data collected.

PROBLEMS AND RECOMMENDATIONS

Most of the problems encountered to date have involved charter logistics and equipment acquisition. This has resulted in less than optimum investigation of some beaches. These are short termed problems and, for the most part, have been solved.

OCSEAP FUNDS EXPENDED

(Razor Clam Distribution and Assessment Study)

11-41-3-402 OCS RAZOR CLAM

	Budget	Expenditure	Balance
100 (Personnel services) Through 5/15/76	$29,100.00	$8,120.93	$20,979.07
200 (Travel)	3,000.00	1,298.23	1,701.77
300 (Contractual)	14,500.00	2,375.88	12,124.12
400 (Commodities)	3,900.00	4,276.01	- 376.01
500 (Equipment)	2,000.00	3,627.24	- 1,627.24
	$52,500.00	$19,698.29	$32,801.71

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RU# 27

NO REPORT SUBMITTED

The principal investigator is in the field.

NOAA 03-5-022-67
Research Unit #58
April 1 - July 1, 1976
5 pages

QUARTERLY REPORT

A Description and Numerical Analysis of the Factors Affecting the Processes of Production in the Gulf of Alaska

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July 7, 1976

Quarterly Report

I. Subtask a. Objective: To conduct a search and present a compilation of available baseline biological and associated physical and chemical data from the Gulf of Alaska (planktonic realm).

A. Data preparation

The major part of the physical, chemical, and biochemical* (including production and standing stock) data are now on cards. Standardization of the data to common units has been completed. Filling out the data set for all cruises has included for each station (if not already determined):

1. Assignment of a geographical code number.
2. Determination of the depth of ocean floor (from bathymetric chart).
3. Assignment of secchi and 1% light depths (from cruises closest in space and time).
4. Determination of depth of mixing (from temperature and salinity profiles).
5. Determination of total zooplankton in upper 150 m (summation of several vertical tows).
6. Integration of chlorophyll *a* and production curves in the euphotic zone.

B. Data quality

The percentage of error on a sub-sample of the data cards already punched was determined: station headers: 1.01%; detail cards: 0.45%. Each station card was checked against the original data report. Detail cards were checked for column errors, sequence errors, and gross digit errors by personal scanning of the data columns on the computer listing. Finally, each variable will be checked for appropriate range by computer before beginning the Analysis of Variance (ANOVA) program. Because percentage of error on detail cards was less than 0.5%, it was thought unnecessary to check them against the original data reports.

C. Tape formation

A preliminary tape of the entire data set will be made and submitted to OSCEAP after the initial ANOVA run. We feel that most of the errors should have been corrected by this time.

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* For the remainder of this report "biochemical data" will refer to all the physical, chemical, and biological data other than phytoplankton species counts.

D. Phytoplankton species data

The primary source of phytoplankton species data is the four years of American Mail Line samples counted by Munson. These data are already on cards of a different format than OCSEAP. Cells/liter were determined as well as carbon/liter, percentage cells/liter, and percentage carbon/liter. The latter three categories are not included in the present OCSEAP format. A new card type will be created to include all the information in OCSEAP format. Collection of additional sources of phytoplankton species data has been completed. Compilation and entry on to cards will begin in July. This data set is much smaller than either the biochemical set or the American Mail Line set.

II. Subtask b. To use the compiled data for a description of the temporal and geographic variation in phytoplankton standing stock (and species), production and related physical and chemical factors.

A. ANOVA program - "Biochemical Data"

System 2000 proved inefficient with large bodies of data, and it could not easily provide the printout we desired. Similarly, canned programs, such as SPSS, do not print out results which could be used for mapping up data as well as for ANOVA. A program for the biochemical data is now being written to meet these criteria, but our project will be delayed while we wait for this program.

The data will be grouped into four seasons (December, January, February; March, April, May; June, July, August; September, October, November). Spring begins in March because, although thermocline development is delayed until April, the critical depth deepens to the mixed depth in March.

The data will also be grouped into 6 depth intervals (0-10 m, 10.5-25 m, 25.5-50 m, 50.5-100 m, 100.5-150 m, >150 m) and 28 geographical zones.

There are 17 years of data.

The program represents a four-way factorial cross with missing data and unequal cell frequency. All factors are fixed.

We have chosen to run a large number of one-way ANOVA models to test variation between years, between seasons, and between areas. The result will be a map for each variable in each depth interval for each season (192 maps).

B. Phytoplankton species program

A separate program is being written for the phytoplankton counts from American Mail Line samples, because the format and printout requirements are different from those of the biochemical data. Data from each of 20 geographic zones will be averaged to describe the distribution and dominance of 80 phytoplankton species. Historical data other than American Mail Line counts will be added manually to the distribution maps.

C. Data presentation

Station points have already been plotted on a Mercator projection (see Annual Report), not the university transverse Mercator. We have not used one of the five base maps because plotting began in January and because none of them covers our area (west to 180°W and south to 42°N). For internal consistency, we intend to present our results on our map. These results will not be contours, but will be the mean, range, and standard deviation presented within each of 28 geographic zones (5° x 10°). These results can easily be transferred to a university transverse Mercator at a later date. Such a transfer will be more efficient after we have interpreted the results of the ANOVA program and know which variables are meaningful to map. At that time, some contouring may be possible.

III. Subtask c. Objective: to use the data from Station "P" in a model of phytoplankton productivity and to test the sensitivity of the model to changes in physiological constants and external parameters.

A. Standard run

A standard run simulating the chlorophyll distribution with depth and time at Station "P" is nearly complete. The model includes the top 150 m of the water column and runs for one year.

B. Variations

The work to date has shown, qualitatively, that the chlorophyll distribution is highly sensitive to grazing pressures in the summer and is more evenly dependent on production, physical processes and grazing in the winter. This dependence will be analyzed quantitatively through systematic variation of the important parameters.

C. Final report

A final report describing the model and the sensitivity analysis will be provided.

Estimated expenses through June 30, 1976

Salaries	$20,360
Employee benefits	2,500
Equipment	970
Materials and services	5,100
Travel and per diem	350
Indirect costs	9,000
Total	$38,280

		FY 1976					FY 1977	
	Major Milestones / Activities	July 1	Oct 2	Jan 3	April 4	July 5	Oct 1	Jan. 2
1	Production standing stock, physical & chemical features							
2	Data compiled							
3	Standardization and computations completed							
4	Data on cards							
5	Cards corrected							
6	ANOVA program written							
7	ANOVA program run							
8	Preliminary analysis and array							
9	Data on magnetic tape							
10	Preparation of visual presentation of results							
11	Final written report							
12	Phytoplankton species data							
13	Data compiled							
14	Data on cards and corrected							
15	Sorting program written							
16	Sorting program run							
17	Data on magnetic tape							
18	Preparation of visual presentation of results							
19	Final written report							
20	[illegible] Simulation							
21	Standard run							
22	Variations							
23	Final report							
24								

Activity -- |————| Start End

Milestone: Planned △
Completed ▲

OCSEAP QUARTERLY REPORT

Contract #R7120811 and R7120812
Research Unit #64/354
Reporting Period: April 1, 1976 to June 30, 1976

REVIEW OF LITERATURE AND HISTORICAL DATA ON NON-SALMONID PELAGIC FISHERIES RESOURCES OF THE EASTERN BERING SEA AND GULF OF ALASKA

Co-Principal Investigators
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June 25, 1976

REVIEW OF LITERATURE AND HISTORICAL DATA ON NON-SALMONID PELAGIC FISHERIES RESOURCES OF THE EASTERN BERING SEA AND GULF OF ALASKA

I. Task Objectives

A. Review and summarize the published and unpublished scientific literature on the distribution, abundance, life histories and population dynamics of non-salmonid pelagic fishes of the eastern Bering Sea and the Gulf of Alaska.

B. Examine and summarize unpublished research vessel survey and commercial fishery data on the distribution, abundance and size composition of the subject species.

C. Prepare data report on records of the distribution, abundance and size composition of the subject species.

D. Prepare an annotated bibliography and a narrative report which collates results of studies undertaken under objectives (A) and (B) and describes, within the constraints of the available data, observed temporal and spatial variations in the distributions of the subject species.

II. Background

The geographic areas of interest and the types/scope of information to be included in the review remain the same as reported in the separate Progress Report of October 24, 1975 for RU #64 and RU #354 and the Annual Report of March 26, 1976. As a result of a contract review with Dr. Jay Quast, OCSEAP office, Juneau, during the last quarter, however, we modified the list of prospective subject species to include Bathylagids and Myctophids.

A. Geographic Coverage

1. Eastern Bering Sea -- The area being considered extends from 52° to 60° N. lat. and from 180° long. to the Alaskan coast.

2. Gulf of Alaska -- The area extends from the central Gulf of Alaska coastline south and east to 52° N. lat. and 135° W. long., respectively.

Examination of unpublished catch records is essentially confined to these areas. The literature review work is also limited to these areas except where the only available information on a species is found in literature from other areas.

B. Species Coverage

The final species list is attached as Appendix A. The previous list was modified by the addition of literature and data on Myctophid and Bathylagid fishes because of their value as forage or potential forage fishes. Not all species of fish on the list in Appendix A are found in both geographic areas, but species will be discussed in the narrative review according to the amount of information available.

C. Subject Areas

An outline for the final narrative report was completed during the quarter (see Appendix B). The final report will include synoptic information from the literature on the life history, distribution and abundance, and (where applicable) population dynamics and fisheries for the subject species. It will also include records of the data on distribution, abundance and size composition obtained from the examination of unpublished data files. As mentioned in the March 1976 Annual Report, for most species little or no information will be available on many of the items listed. This is because data were collected on an incidental basis using sampling gears not designed to capture the subject species. In addition, most of the species are unexploited and the fishery statistics on harvested species are generally poor in terms of both quantity and quality. The outline for the narrative report thus indicates the ideal coverage we will attempt as completely as possible.

D. Personnel Actions

Ms. Janet Wall, who worked on literature review studies, transferred out of RU 64/354 at the end of May. She is expected to return to the research unit early in July.

III. Results of Review of Literature and Data

A. Literature Review Studies

Review of the literature is considered essentially completed, although occasional references to Myctophids and Bathylagids, which were added as subject species when the literature search was nearly finished, are being gathered and reviewed. More than 1,200 references have been examined since the project began. Of these, 200 have been retained for the annotated bibliography. Those references, plus another 250 which discuss general life histories, biology, geography and other background information but are not necessarily specific to the subject areas will be used in writing the proposed narrative review.

The review of computer printouts of the OASIS bibligraphies from three files was completed. Biological Abstracts files from 1964-75 (400 citations) yielded 36 new relevant references, Biological Information Retrieval System files for 1972-1975 (336 citations) yielded 35 new references, and Oceanic Abstracts files from 1964 to present (291 citations) gave 36 new references.

B. Data Records

A list of the majority of sources inventoried was included in the Annual Report (March 26, 1976). A number of sources have been eliminated because of inadequate sampling or reporting of catches of the species of concern and incomplete or obviously erroneous recording of sampling and catch information.

During the current quarter the search for, and evaluation of, sampling records was essentially completed. All acceptable records have been located and verified for completeness and accuracy. Appropriate records have been selected and reformatted from their original raw data form into OCSEAP formats.

Records currently on coding sheets number over 12,500. These represent over 5,200 haul records complete with gear and catch information. More than 7,000 hauls have been included (some summarized) covering the entire study area and executed with a variety of fishing gears.

Under current scheduling, records will be keypunched and will be subjected to further processing and analysis during the forthcoming quarter.

IV. Preliminary Interpretation of Results

No attempt has been made to date to prepare any conclusions or analyses because some literature review is still in progress and the data reformatting is incomplete. The total amount of catch data and literature on most non-salmonid pelagic fishes is limited, however, and information on composition, distribution, and ecological relations will be available for only a few species.

V. Problems Encountered

The suggestion by Dr. Jay Quast, Juneau OCSEAP office, that we add Myctophids to our species coverage delayed completion of the literature review and data assembly. Because the species lists submitted in October 1975 and March 1976 were received by OCSEAP without comment, we assumed the list was acceptable and proceeded accordingly. The late request to include Myctophids and other possible forage fishes necessitated a special search for literature and data on the subject species. In some instances, we had to re-examine references we had already scanned for other species.

Another problem encountered was the poor quality of card punching by the data processing contractor from data we furnished. An attempt to re-verify and correct punched records resulted in considerable time delays. We shall have to resubmit approximately 40% of the data for re-processing, causing further delays in preparations for finalizing the analysis.

The impact of these delays cannot be estimated at present but we plan to meet the September 30 final report deadline unless further unexpected problems occur.

APPENDIX A

Species List of Non-salmonid Pelagic Fishes

Lamnidae
    Basking shark (*Cetorhinus maximus*)
    Salmon shark (*Lamna ditropis*)

Carcharhinidae
    Blue shark (*Prionace glauca*)

Squalidae
    Spiny dogfish (*Squalus acanthias*)

Clupeidae
    Shad (*Alosa sapidissima*)
    Pacific herring (*Clupea harengus pallasi*)

Osmeridae
    Pond smelt (*Hypomesus olidus*)
    Surf smelt (*Hypomesus pretiosus*)
    Capelin (*Mallotus villosus* or *M. catervarius*)
    Boreal smelt (*Osmerus eperlanus*)
    Rainbow smelt (*Osmerus mordax*)
    Longfin smelt (*Spirinchus thaleichthys*)
    Eulachon (*Thaleichthys pacificus*)

Bathylagidae

Myctophidae

Scomberesocidae
    Pacific saury (*Cololabis saira*)

Carangidae
    Jack mackerel (*Trachurus symmetricus*)

Bramidae
    Pacific pomfret (*Brama japonica*)

Trichodontidae
    Pacific sandfish (*Trichodon trichodon*)

Zaproridae
    Prowfish (*Zaprora silenus*)

Ammodytidae
    Pacific sand lance (*Ammodytes hexapterus*)

Scombridae
    Chub mackerel (*Scomber japonicus*)
    Albacore tuna (*Thunnus alalunga*)

Hexagrammidae
    Atka mackerel (*Pleurogrammus monopterygius*)
    (*Pleurogrammus azonus*)

APPENDIX B

OUTLINE FOR NARRATIVE REPORT

Resources of Non-salmonid Pelagic Fishes of the
Eastern Bering Sea and Gulf of Alaska --
A Review of Literature and Data

I. Introduction

   A. The OCSEAP Program and need for information

   B. Objectives of report

   C. Scope of coverage

   D. Limitations of report

II. Description of areas

   A. Eastern Bering Sea

   B. Gulf of Alaska

III. The non-salmonid pelagic fish resources (arranged in taxonomic order)

   A. Identification

   B. Distribution

      1. General distribution in North Pacific Ocean, Bering Sea, and Gulf of Alaska.

      2. Specific distribution in the eastern Bering Sea

      3. Specific distribution in the Gulf of Alaska

      4. Determinants of distribution

   C. Life history

      1. Reproduction

      2. Nutrition and growth

      3. Predators and competitors -- mortality due to predation

      4. Parasites and diseases

      5. Physiology -- respiration rates, oxygen demands, hardiness, sources of unique proteins or amino acids, etc.

      6. Behavior

D. Population structure and dynamics

1. Sex ratios in population
2. Size composition (from sampling and catches)
3. Age composition (" " " ")
4. Abundance and density
5. Recruitment
6. Mortality
7. Population/community/ecosystem relations

E. Fishing

1. History of the fishery
2. Catches

F. Conservation and management regulations

G. Potential contribution to domestic and international economy

H. Suggestions for future research

---- (REPEAT A-H FOR EACH SPECIES OR GROUP) ----

IV. Summary

V. Literature cited

- - - - - - - - - - - - - -

NOTE: 1. An annotated bibliography will be a separate publication.

2. The data base used in the narrative report will be presented in a separate appendix.

QUARTERLY REPORT

Contract #
Research Units 78/79
Reporting Period April 1 - June 30, 1976
Number of Pages 52

BASELINE/RECONNAISSANCE CHARACTERIZATION, LITTORAL BIOTA, GULF OF ALASKA AND BERING SEA

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July 1, 1976

I. Task Objectives

There are two objectives in this study: to determine the distribution of the major habitat types (sandy, muddy, rocky, etc.) along the coastline; and to determine the densities and distribution of biotic populations within these habitat types.

There are several phases to each objective. The distribution of habitat types is being determined by visual reconnaissance methods from fixed wing aircraft. Additional information utilizing aerial photography and multispectral scanning methods is being produced in cooperation with NASA and the Environmental Research Institute of Michigan.

The distribution of organisms within habitat types is being determined by field parties from the Auke Bay Fisheries Laboratory (ABFL), with logistical assistance from the Pacific Marine Center. Additional projects include an extensive literature survey, a study of the accumulation of biotic debris in the "drift zone," the estimation of variability between sampling areas, and more intensive studies at a few sites which may receive major impact from oil exploration in the eastern Gulf of Alaska.

II. Field Activities

April

Activity I:

A. Field Trip Schedule: April 11-19. Charter helicopter (High Life Helicopter Co., Bell 206-B).

B. Scientific Party: Zimmerman, Gnagy, Fujioka, Palmisano, Mattson, Romm - NMFS; Powell - USCG; Smith - High Life.

C. Methods:

1. At Cape Hinchinbrook and Cape St. Elias--intertidal sampling and ecological reconnaissance.

2. At Hook Point, Egg Island, Softuc Spit, Controller Bay, Boswell Bay--sand and mud sampling for habitat reconnaissance study.

D. Sample Localities: Rocky intertidal areas near Cape Hinchinbrook and Cape St. Elias lighthouses, sandy and muddy sites on Hinchinbrook Island and Copper River area.

E. Data Collected:

1. Rocky sites--17 quantitative samples analyzed for dominant biomass, 17 quantitative samples collected for further analysis, 75 algal enumerations.

2. Sandy sites--75 quantitative samples collected and preliminarily analyzed.

3. Muddy sites--32 quantitative samples collected for further analysis.

Activity II:

A. Field Trip Schedule: April 20-23.

B. Scientific Party: Palmisano, Romm (NMFS).

C. Methods: Drift zone analysis.

D. Sample Localities: Cape Yakataga.

E. Data Collected: Five one-kilometer beach sections analyzed daily for accumulation of biotic drift.

Activity III:

A. Field Trip Schedule: April 18-28. Charter vessel HUMDINGER.

B. Scientific Party: Rosenthal, Lees (Dames and Moore--Contract with NMFS).

C. Methods: Quantitative sampling and qualitative observation of seasonal densities of dominant subtidal organisms.

D. Sample Localities: La Touche Point, Zaikof Bay, Macleod Harbor (Prince William Sound).

E. Data Collected: Several quantitative collections and photographs documenting seasonal occurrences of dominant organisms. See Appendix I for example of data analysis.

May

Activity I:

A. Field Trip Schedule: May 1-15; May 21-31. Charter airplane (Kodiak Western, Amphibious Grumman Widgeon).

B. Scientific Party: Sears (NMFS).

C. Methods: Aerial reconnaissance.

D. Sample Localities: Kodiak Island, Outer Prince William Sound, Alaska Peninsula.

E. Data Collected: Completed aerial intertidal habitat survey of Kodiak Island and other areas in central and western Alaska.

Activity II:

A. Field Trip Schedule: April 17-24.

B. Scientific Party: Palmisano (NMFS).

C. Methods: Drift zone analysis.

D. Sample Localities: Middleton Island, Yakutat.

E. Data Collected: At each site five one-kilometer beach sections were analyzed daily for accumulation of drift.

Activity III:

A. Field Trip Schedule: May 11-17. Charter airplane (Kodiak Western).

B. Scientific Party: Phillips (NMFS), Konigsberg, Technician (ADF&G).

C. Methods: Sample sandy beaches for razor clams and associated fauna.

D. Sample Localities: Kodiak Island, Ocean Beach, Rolling Bay.

E. Data Collected: Several large quantitative samples sieved and analyzed for biota. Razor clam results reported separately by ADF&G.

Activity IV:

A. Field Trip Schedule: May 10-21. NOAA ship SURVEYOR.

B. Scientific Party: Zimmerman, Gnagy, Romm, Koski, Fujioka, Mattson, Laux, Budke, Ellis, Barr, Calvin (NMFS).

C. Methods: Intertidal and subtidal surveys were conducted as part of reconnaissance-level study of Kodiak Island and to verify the aerial survey.

D. Sample Localities: Southern Kodiak Island from Ugak Island to Cape Iktolik; 11 intertidal sites, 10 subtidal sites.

E. Data Collected: Intertidal--210 quantitative samples, 353 samples enumerated for percent cover of algae and dominant invertebrates. Subtidal--several hundred measurements of size and weight of large kelps, 58 quantitative quadrat samples.

June

Activity I:

A. Field Trip Schedule: June 8-14. Charter vessel PERRY.

B. Scientific Party: Zimmerman, Fujioka, Palmisano, Brodersen, Gnagy, Taylor (NMFS); Van Hyning (Nerka Inc.).

C. Methods: Enumerate and delineate biological intertidal zonation in order to provide ground truth for multi-spectral scanning overflights.

D. Sample Localities: La Touche Point, Zaikof Bay, Cape Yakataga.

E. Data Collected: The overflights were postponed until late June. Ground truth studies provided detailed information on the location and density of algal cover for later comparison with aerial survey information.

Activity II:

A. Field Trip Schedule: June 1-31. Charter airplane (Kodiak Western, Amphibious Grummon Widgeon).

B. Scientific Party: Sears (NMFS).

C. Methods: Aerial reconnaissance.

D. Sample Localities: Aleutian Islands, Bristol Bay, northern Bering Sea.

E. Data Collected: Essentially completed aerial intertidal habitat survey for entire Alaska coastline from Yakutat to Cape Prince of Wales.

Activity III:

A. Field Trip Schedule: June 5-20. NOAA ship SURVEYOR.

B. Scientific Party: Merrell, Myren, Hopson, Romm, Laux, Mattson, Todd, Barr, Ellis, Calvin (NMFS).

C. Methods: Intertidal and subtidal surveys were conducted as part of a reconnaissance-level study of the St. George Basin and to verify the aerial survey.

D. Sample Localities: Pribilof Islands, Unimak Pass area westward to Unalaska and eastward to Izembek Lagoon; 12 intertidal sites and six subtidal sites.

E. Data Collected: Intertidal--219 quantitative samples, 160 samples enumerated for percent cover of algae and dominant invertebrates. Aerial survey of Pribilof Islands intertidal habitats completed. Subtidal--General reconnaissance and collection of organisms for species analysis. Quantitative comparative data on biomass and numbers of marine macrophytes.

Activity IV:

A. Field Trip Schedule: June 9-16. Charter airplane (Kodiak Western).

B. Scientific Party: Phillips (NMFS), Konigsberg, Technician (ADF&G).

C. Methods: Sample sandy beaches for razor clams and associated fauna.

D. Sample Localities: Kodiak Island, Tugidak, Halibut Bay, Bumble Bay.

E. Data Collected: Several large quantitative sand samples sieved and analyzed for biota. Razor clam data to be reported separately by ADF&G.

Activity V:

A. Field Trip Schedule: June 25-31. Charter airplane (Kodiak Western).

B. Scientific Party: Phillips (NMFS), Konigsberg, Technician (ADF&G).

C. Methods: Sample sandy beaches for razor clams and associated biota.

D. Sample Localities: Kodiak Island and Alaska Peninsula area--Kukak Bay and Hallo Bay.

E. Data Collected: Several large quantitative sand samples sieved and analyzed for biota. Razor clam data to be reported separately by ADF&G.

Activity VI:

A. Field Trip Schedule: June 16-25 (approximately). Charter vessel HUMDINGER.

B. Scientific Party: Rosenthal, Rosenthal, Lees (Dames and Moore, contract with NMFS).

C. Methods: Quantitative sampling and qualitative observations of seasonal densities among dominant subtidal organisms.

D. Sample Localities: La Touche Point, Zaikof Bay, Macleod Harbor (Prince William Sound).

E. Data Collected: Several quantitative collections and photographs documenting seasonal occurrences of dominant organisms.

III. & IV. Results and Preliminary Interpretation

During the month of March 1976, meetings were held between OCSEAP representatives and NMFS littoral biologists. At this meeting the geographic areas of emphasis were redefined and priorities were adjusted to conform to upcoming lease schedules. The OCSEAP office also requested a downgrading of the scientific level from a baseline study to a survey/reconnaissance-oriented study. Following these meetings the greatest emphasis has been placed on the Kodiak and St. George Basin lease areas, with less emphasis on northeastern Gulf of Alaska.

A. Aerial Survey

The aerial survey of intertidal habitats of Kodiak Island was completed in May and the data are being worked into plates suitable for a reference atlas. Fig. 1 is a nearly completed prototype made from data collected in the Trinity Islands.

During June the habitat flights were essentially completed and now include the entire area from Yakutat in the eastern Gulf of Alaska to the Islands of the Four Mountains in the Aleutian Islands, and to Cape Prince of Wales in the northern Bering Sea, including most of the offshore major island groups.

B. Intertidal Reconnaissance Studies

1. April

Work during April emphasized sampling of sandy and muddy beaches in the Copper River area and development of methodology for more extensive studies in FY 77.

Three sandy sites, one muddy site, and one combined sand-mud site were sampled quantitatively and 124 samples were collected for further analysis. The sandy sites, as expected, had extremely low diversity, numbers of individuals, and biomass. Most one-liter samples contained no living macro-organisms, indicating that very large quantities of sand would have to be sieved for statistically valid estimates.

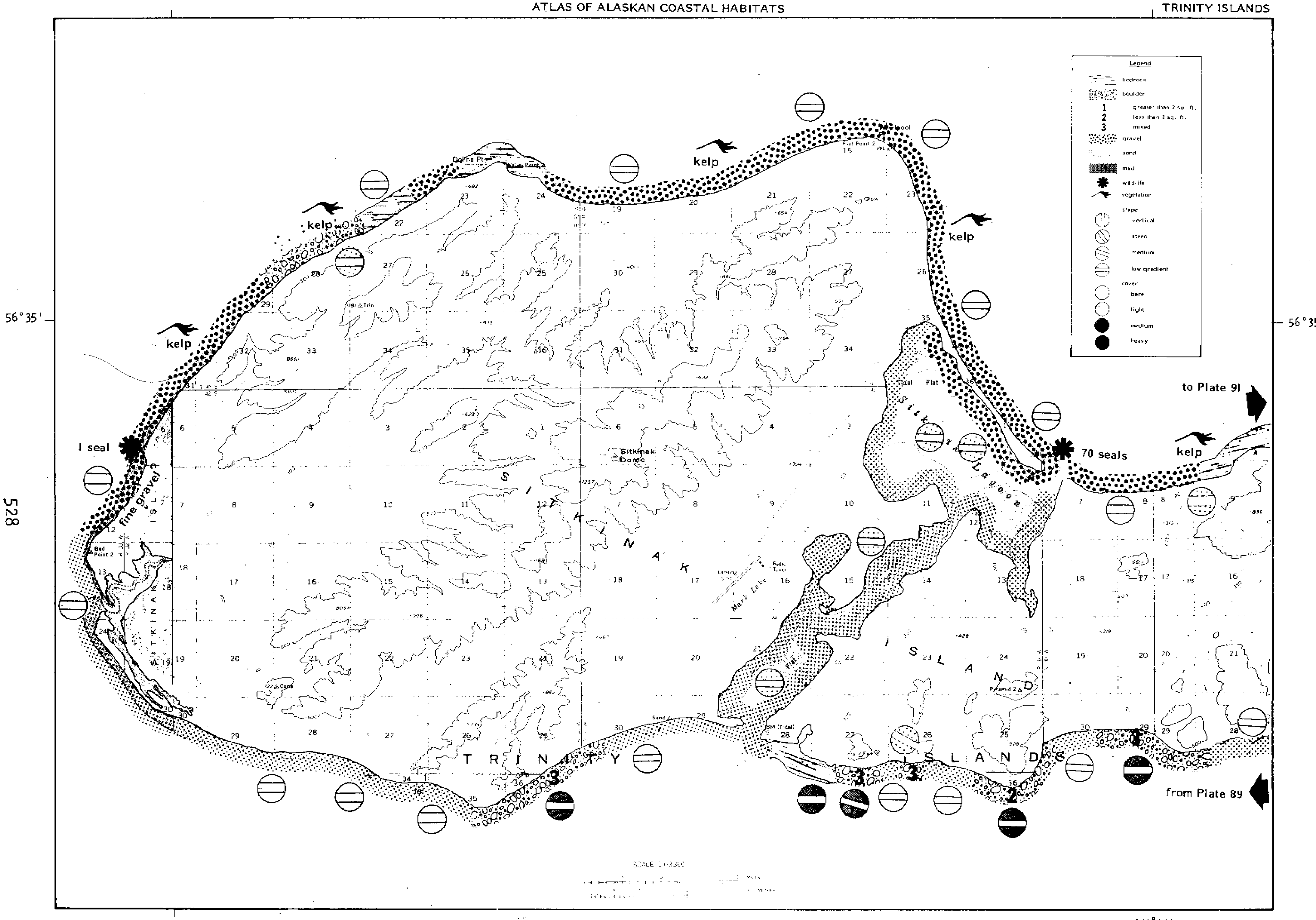


Figure 1.--Prototype plate for the atlas of Alaskan intertidal habitats.

Many of the areas in Controller Bay and near the mouth of the Copper River are listed on USGS and USC&GS charts as being muddy. We found, however, that these areas were predominantly sand with small mud inclusions. Populations of infauna were small and no samples had more than a few grams of living material. This habitat appeared to be transitional between the almost barren pure sand beaches and the biologically rich muddy areas. When samples were examined they were found to contain occasional nereid or sabellid worms or Macoma balthica.

In well-protected areas, such as Boswell Bay (Hinchinbrook Island), there were small pockets of fine-grained mud. These contained diverse and rich groups of molluscs and annelids. In Boswell Bay the molluscan genus Mya dominated the samples.

Rocky sites near the Cape Hinchinbrook and Cape St. Elias lighthouse were examined as possible future monitoring sites. The St. Elias site was found to have very flat topography and contain much standing water in the form of tide pools. These phenomena tended to diminish the normal zonation and organisms usually found only in lower tidal zones were found living in pools near the upper levels.

2. May

Eleven sites in the southern Kodiak area were studied during a May cruise aboard the NOAA vessel SURVEYOR. Aerial reconnaissance data were used to select sites. These data were found to be quite accurate in predicting the intertidal substrates we would encounter.

Although rocky habitats predominate in south Kodiak, several other categories were studied to obtain data from a full range of habitat types. The following habitats were examined quantitatively: one mud, two gravel, two small boulder, two large boulder, one bedrock, and combinations of mixed boulder and bedrock, large boulder and bedrock, and large boulder and sand. Several sand beaches were also studied during this period by a NMFS biologist working in conjunction with the ADF&G razor clam research unit based in Kodiak.

Highest diversity and number of species were found at the large boulder sites. Apparently these sites provide the greatest number of small habitats (rock faces, backs, sides, overhangs, etc.). The density of cover and diversity decreased with boulder size. At small boulder sites very small populations were found and most of the organisms were recently settled.

Smooth bedrock sites had very dense algal populations but invertebrate numbers were much lower than at the large boulder sites. Gravel areas contained very few living organisms, although large populations of amphipods were occasionally found near tide level. Sandy beaches also contained very little biota although occasional populations of razor clams and nemertean and polychaete worms were found. Muddy areas, although comparatively rare, contained large populations of infaunal molluscs and annelids.

3. June

Twelve intertidal sites in the St. George Basin, Bering Sea, were studied during the June 5-20 cruise of the SURVEYOR. Aerial reconnaissance data from 1975 were used to select some general sites, and again proved accurate. Locations of sampling included: Cape Sennett on Unimak Pass; in the Pribilof Islands, Garden Cove and High Bluffs on St. George Island, Otter Island, and English Bay and Northeast Cape on St. Paul Island; Eider Point on Unalaska Island; Cape Lupin on Unimak Island; and Applegate Cove and Moffett Lagoon in the Izembeck Lagoon eelgrass habitat.

Emphasis was on the Pribilofs, where the world's largest fur seal population breeds, and on Izembeck Lagoon, with the world's largest eelgrass beds and black brandt waterfowl populations. Bedrock sampling was deemphasized, and effort was concentrated on boulder, sand, and mud habitats.

In the Pribilofs, the major factor limiting intertidal biotic populations was found to be ice stress. Ice had disappeared only within the previous two weeks, so ice-scoured substrates were depauperate. In crevices and between large boulders protected from physical effects of ice, luxuriant communities of several-year-old invertebrates and perennial macrophytes flourished. Amphipods were abundant in the surf zone of wave-stressed sand beaches on St. Paul.

Several gray whales were observed feeding in shallow water in English Bay, St. Paul Island, and inside Izembeck Lagoon at high tide. These opportunistic observations were from the SURVEYOR's helicopter, en route from the ship to intertidal sites. The whales could be clearly observed pumping mouthfuls of bottom material in plumes from the sides of the mouth. One mouthful required several pumping sequences, with blowing (breathing) between ejection of discarded mud. Since hydrocarbons sometimes become bound in bottom sediments, oil contamination of shallow water whale feeding areas could affect the whales.

C. Subtidal Studies

NMFS

1. May

Four NMFS subtidal biologists participated in a cruise of the SURVEYOR in the Kodiak Island area. Ship's divers also aided in the collection of algae during each dive.

Ten sites were examined and nine were sampled quantitatively; 58 one-quarter square meter quantitative samples were collected. Several hundred length, width, and weight measurements were made on all of the *Laminaria* kelp encountered in the samples. Biomass estimates indicated that the large kelp populations are luxuriant in this area and productivity is high.

2. June

Three NMFS subtidal biologists participated in a cruise of the SURVEYOR in the southern Bering Sea and Pribilof Islands area. The primary objective of this work was to collect as many of the different species of macrophytes and associated invertebrates encountered as possible. Previous research has indicated that several of the species occurring in this area may be either new to science or else they do not occur elsewhere on the American continent.

A secondary objective was to collect quantitative samples of Laminaria and estimate biomass of quadrats. Nine sites were visited during the June period and 56 quantitative quadrat collections were made. Several hundred species collections were also made.

Dames and Moore

The subtidal studies being carried out by Dames and Moore, under contract to NMFS, have centered on the Hinchinbrook Entrance and Montague Strait areas of the Eastern Gulf. The research was started in July 1975 and is continuing through July 1976. A report of work completed through April 1, 1976 has been prepared and several copies will be submitted to the OCSEAP office (Juneau) with this report.

D. Sample Sorting, Data Submission, and Data Workup

To date approximately 425 of 1,300 samples collected in 1975 have been analyzed under contract with the University of Alaska Sorting Center. Until March 1976 we had been placing the data received on computer tape. When the data from a complete cruise were assembled the tape was submitted to NOOC for data storage.

In March, OCSEAP required that we change our submission methods. Since the newly-defined lease areas no longer conform to the old cruise areas (e.g. the southern Bering Sea area has been segregated into the St. George and Bristol Bay Lease Areas) data are now being submitted quarterly rather than by completed cruises.

Data received from the Sorting Center are first checked for discrepancies and then card-punched. They are then processed through two preliminary computer programs, one tabular and one graphic, to give us a quick look at densities and relationships (See Table 1 and Figs. 2-5).

Following these preliminary steps data are analyzed for significant

Table 1.--Example of preliminary data output from computer analysis of sorted intertidal samples.

BIOTIC DENSITIES OF INTERTIDAL ORGANISMS FROM THE EASTERN GULF OF ALASKA
FALL 1974

STATION NBR: 8 ZAIKOF BAY DATE: 9/13/74
LATITUDE: 60 17 90 N LONGITUDE: 147 0 0 W
STATION INVESTIGATED FOR 3.7 HOURS BEGINNING AT 12:00 IN TIME ZONE: +10
CATALOG NBR: AB740462 ZONE/TRANSECT: SUBSTRATE: NO INFORMATION
PHOTOGRAPH NBR: METER NBR: SURFACE TOPOGRAPHY: NO INFORMATION
SAMPLING TIME: 13:50 ARROW NBR: Z 5 GEAR: NESTED QUADRAT
ELEVATION: 1.36 METERS QUADRAT SIZE: .1250 SQUARE METERS SEDIMENT VOLUME: 0. LITERS

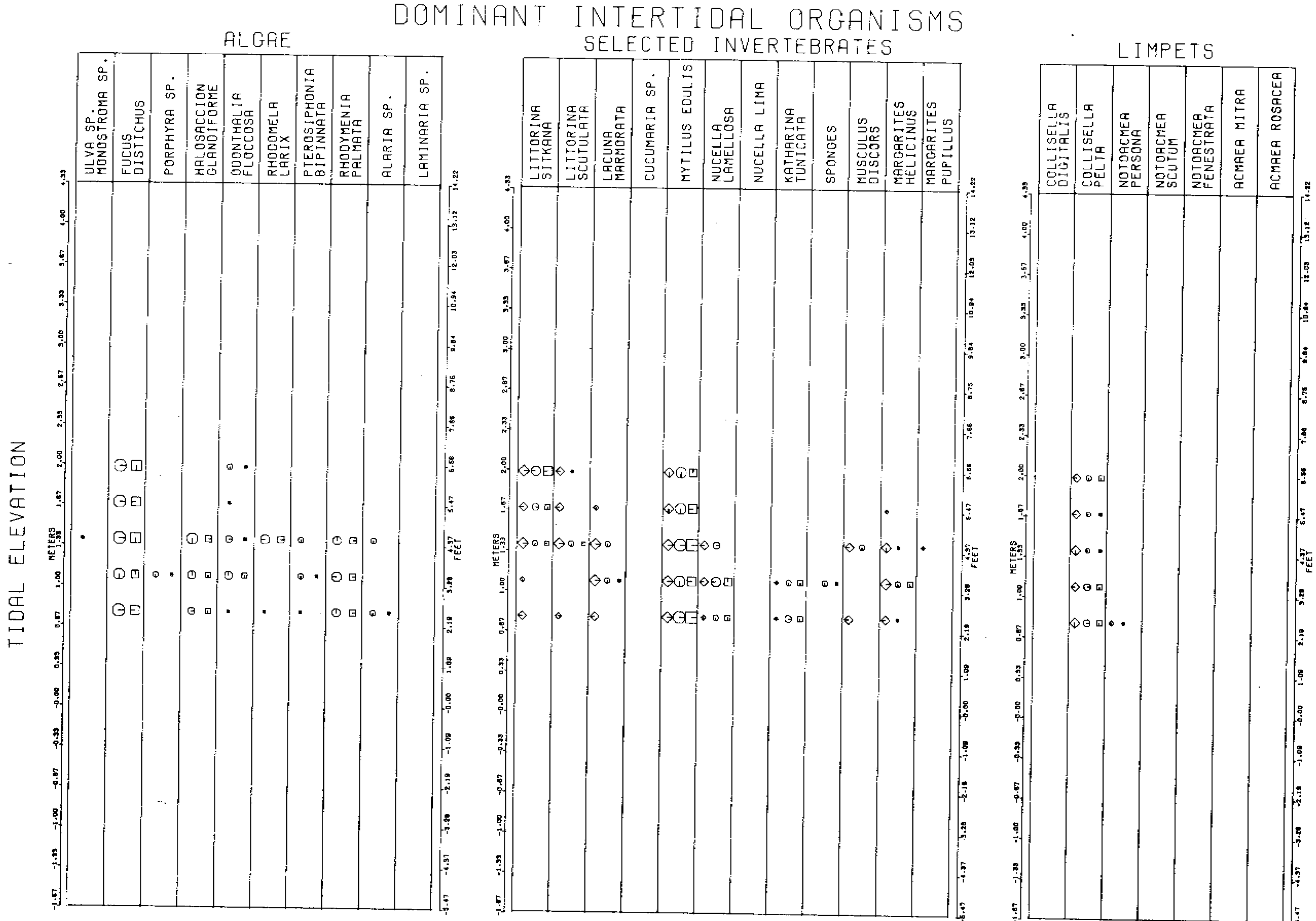
SPECIES IDENTIFICATION	SEX	CONDITION	COVRG	COUNT	WET WEIGHT (GRAMS)	DRY WEIGHT (GRAMS)
CHLOROPHYTA						
MONOSTROMA SP	ND	FRAG		1	.134	0.
MONOSTROMA FUSCUM	ND				.567	0.
ULVA SP	ND				1.140	.199
RHIZOCLONIUM RIPARIUM	ND				1.633	0.
CLADOPHORA SERIACEA	ND				0.	0.
BACILLARIOPHYCEAE						
BACILLARIOPHYCEAE	ND				.013	0.
PHAEOPHYTA						
PHAEOPHYTA	ND	FRAG		1	.395	0.
ECTOCARPUS SIMULANS	ND				.089	0.
ECTOCARPUS SIMULANS	ND				.074	0.
PYLAIELLA LITTORALIS	ND				.006	0.
PYLAIELLA LITTORALIS	ND	FRTL			0.	0.
LEATHESIA DIFFORMIS	ND				.948	0.
SORANTHERA ULVOIDEA	ND				7.743	.424
LAMINARIA YEZOENSIS	ND				3.263	0.
ALARIA PRAELONGA	ND			18	36.459	5.301
FUCUS DISTICHUS	ND			3	178.200	48.800
RHODOPHYTA						
RHODOPHYTA	ND	FRAG		1	.021	0.
ERYTHROTRICHIA CARMEA	ND				0.	0.
CRYPTOSIPHONIA WOODII	ND				1.004	0.
CONSTANTINEA SUBULIFERA	ND				4.334	.964
BOSSIELLA CHILOENSIS	ND	FRAG		1	.028	0.
CORALLINA FRONDISCENS	ND				.687	0.
AHNFELTIA PLICATA	ND				.679	0.
IRIDAEA SP	ND	FRAG		1	2.127	0.
IRIDAEA CORNUCOPIAE	ND				0.	0.
IRIDAEA HETEROCARPA	ND				10.619	3.643
HALOSACCION GLANDIFORME	ND				81.762	7.850
RHODYMENIA PALMATA	ND				20.236	5.022
ANTITHAMNION SP	ND				.012	0.
PTILOTA FILICINA	ND				.025	0.
NEOPTILOTA ASPLENIOIDES	ND				[illegible]	[illegible]

NEOPTILOTA HYPNOIDES	ND			.120	0.
TOKIDADENDRON BULLATA	ND			5.629	.990
PHYCODRYS SP	ND			.785	0.
POLYSIPHONIA SP	ND			3.915	.315
POLYSIPHONIA PACIFICA	ND			.902	0.
PTEROSIPHONIA BIPINNATA	ND			2.807	0.
RHODOMELA LARIX	ND			39.278	5.226
ODONTHALIA FLOCCOSA	ND	FRAG	1	9.252	0.
ODONTHALIA WASHINGTONIENSIS	ND			35.396	6.301
TURBELLARIA					
TURBELLARIA	ND		1	.011	0.
TURBELLARIA	ND		9	.057	0.
RHYNCHOCOELA					
RHYNCHOCOELA	ND		10	.530	0.
RHYNCHOCOELA	ND	FRAG	1	.167	0.
ANNELIDA					
POLYCHAETA	ND		2	.001	0.
HARMOTHOE IMBRICATA	ND		12	.044	0.
ANAITIDES MACULATA	ND		14	.007	0.
ETEONE PACIFICA	ND		97	.155	0.
EULALIA VIRIDIS	ND		2	.029	0.
TYPOSYLLIS ALTERNATA	ND		2	.007	0.
TYPOSYLLIS PULCHRA	ND		266	.181	0.
EXOGONE GEMMIFERA	ND		2	.001	0.
EXOGONE LOUREI	ND		2	.001	0.
SPHAEROSYLLIS HYSTRIX	ND		3	.001	0.
NEREIS SP	ND		46	.058	0.
NEREIS PROCERA	ND		2	.061	0.
PLATYNEREIS BICANALICULATA	ND		59	.571	0.
SPHAERODORIDIUM GRACILIS	ND		2	.003	0.
LUMBRINERIDAE	ND	FRAG	1	.001	0.
SPIO FILICORNIS	ND		35	.054	0.
CAULLERIELLA SP	ND		9	.001	0.
PHERUSA PAPILLATA	ND		1	.003	0.
OPHELIIDAE	ND		4	.001	0.
ARMANDIA BREVIS	ND		6	.004	0.
CAPITELLA CAPITATA	ND		1	.002	0.
PSEUDOSABELLIDES LITTORALIS	ND		352	.935	0.
SPIRORBIS SPIRILLUM	ND		881	.223	0.
MOLLUSCA					
POLYPLACOPHORA	ND	IMTR	1	.001	0.
MYTILUS EDULIS	ND		631	.200	0.
MUSCULUS DISCORS	ND		3	.865	0.
DACRYDIUM SP	ND		3	.003	0.
PROTOTHACA STAMINEA	ND		5	.029	0.
HIATELLA ARCTICA	ND		46	.066	0.
THRACIA SP	ND	IMTR	5	.002	0.
GASTROPODA	ND		11	.035	0.

COLLISELLA PELTA	ND		52	.048	0.
MARGARITES HELICINUS	ND		155	.156	0.
LACUNA MARMORATA	ND		8032	.237	0.
NUCELLA CANALICULATA	ND		2	.042	0.
NUCELLA LAMELLOSA	ND		6	.957	0.
SEARLESIA DIRA	ND		2	1.395	0.
MITRELLA TUBEROSA	ND		1	.012	0.
MITRELLA GOULDI	ND		398	1.419	0.
ODOSTOMIA SP	ND		20	.016	0.
DIAPHANA MINUTA	ND		34	.065	0.
ARACHNIDA					
HALACARIDAE	ND		8	.004	0.
PYCNOGONIDA					
PHOXICHILIDIUM QUADRADENTATUM	ND		2	.017	0.
CRUSTACEA					
CAMPYLASPIS AFFINIS	ND		66	.009	0.
PENTIDOTEA WOSENSENSKII	ND		2	.153	0.
SPHAEROMATIDAE	ND		1	.003	0.
MUNNA SP	ND		2	.001	0.
AMPHIPODA	ND		6	.002	0.
AMPITHOE SP	ND		19	.193	0.
AMPITHOE RUBRICATOIDES	ND		37	.080	0.
COROPHIUM SP	ND		1	.001	0.
MELITA SP	ND	IMTR	1	.001	0.
HYALE RUBRA FREQUENS	ND		101	.091	0.
PARALLORCHESTES OCHOTENSIS	ND		55	.698	0.
PARAPLEUSTES NAUTILUS	ND		62	.062	0.
METOPELLOIDES SP	ND		10	.009	0.
CALLIANASSA SP	ND		7	.011	0.
	ND		3	.197	0.
PUGETTIA GRACILIS	ND		54	10.630	0.
CANCER OREGONENSIS	ND		2	1.451	0.
INSECTA					
DIPTERA	ND	IMTR	9	.001	0.
CHIRONOMIDAE	ND		5	.001	0.
BRYOZOAN					
BRYOZOAN	ND		1	.068	0.
ECHINODERMATA					
ASTEROIDEA	ND	IMTR	2	.020	0.
LEPTASTERIAS SP	ND	IMTR	80	.410	0.
STRONGYLOCENTROTUS DROEBACHIENSI	ND		1	.265	0.

Figures 2-5.--Examples of preliminary data output from computer analysis of sorted intertidal samples.

DOMINANT INTERTIDAL ORGANISMS

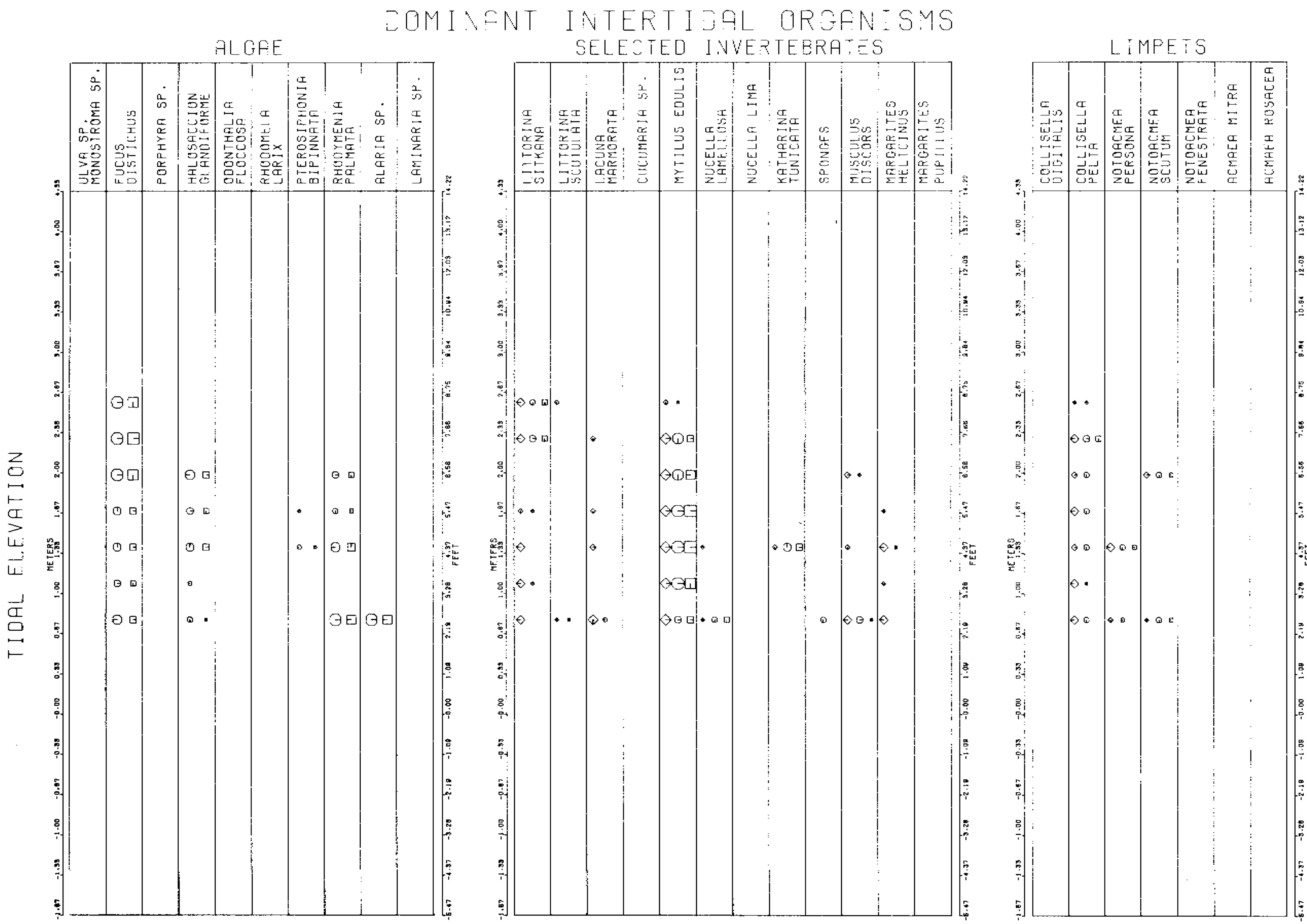


STATION: ZAIKOF BAY
DATE: 74/ 9/13
LATITUDE: 60 17 90 N
LONGITUDE: 147 00 00 W
OBSRV. RANGE: 0.7M TO 2.0M

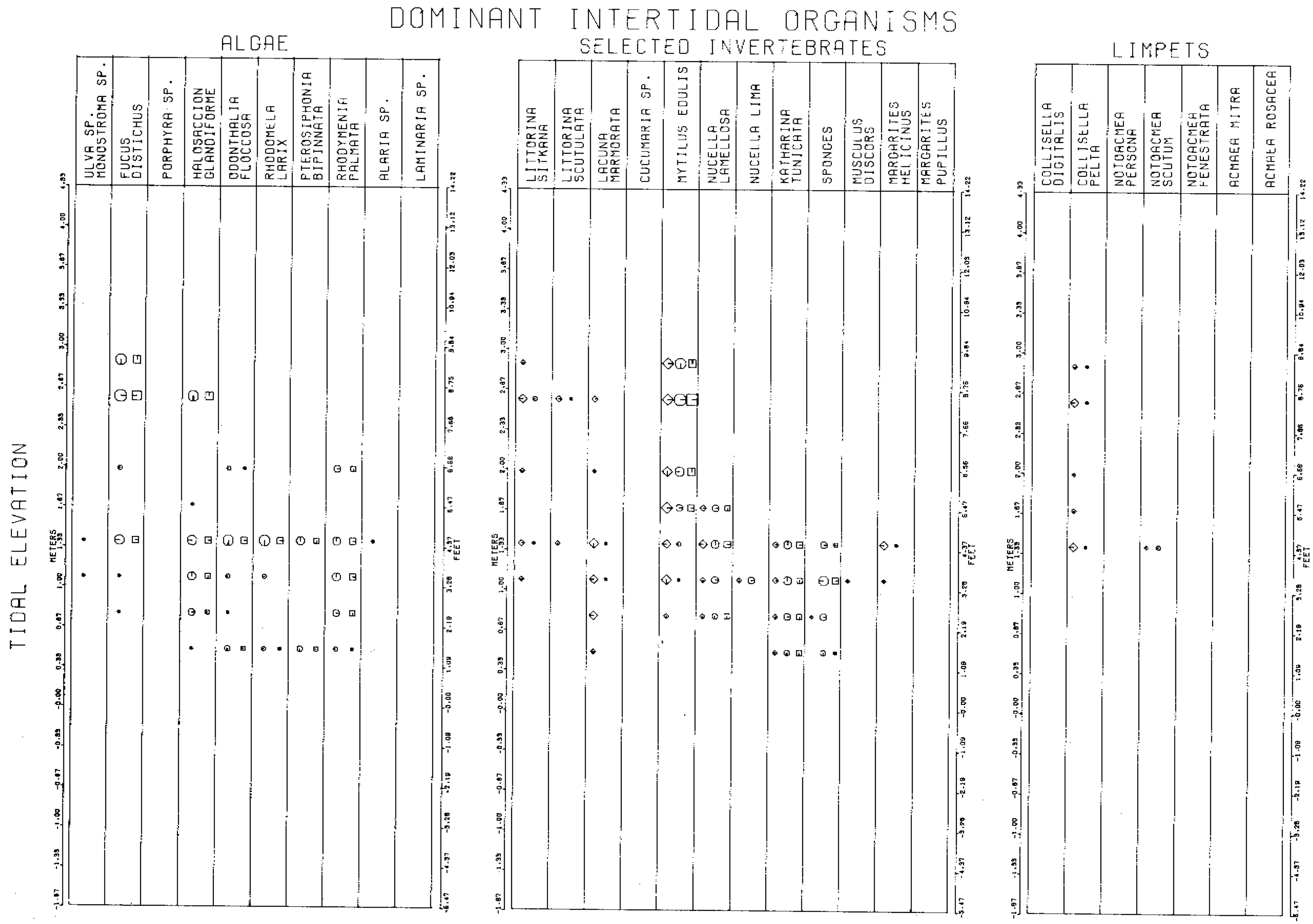
COUNT OF INDIVIDUALS KEY
FRAGMENT
1
2-5
6-10
11-25
26-100
101-250
>250

WET WEIGHT KEY UNITS=GRAMS
0.1-.50
.51-1.0
1.1-5.0
5.1-20.0
20.1-50.0
50.1-100.0
100.1-250.0
>250

DRY WEIGHT KEY UNITS=GRAMS
0.1-.50
.51-1.0
1.1-5.0
5.1-20.0
20.1-50.0
50.1-100.0
100.1-250.0
>250



STATION: SQUIRREL BAY
DATE: 74/ 9/13
LATITUDE: 59 59 80 N
LONGITUDE: 148 8 40 W
OBSRV. RANGE: 0.7M TO 2.6M



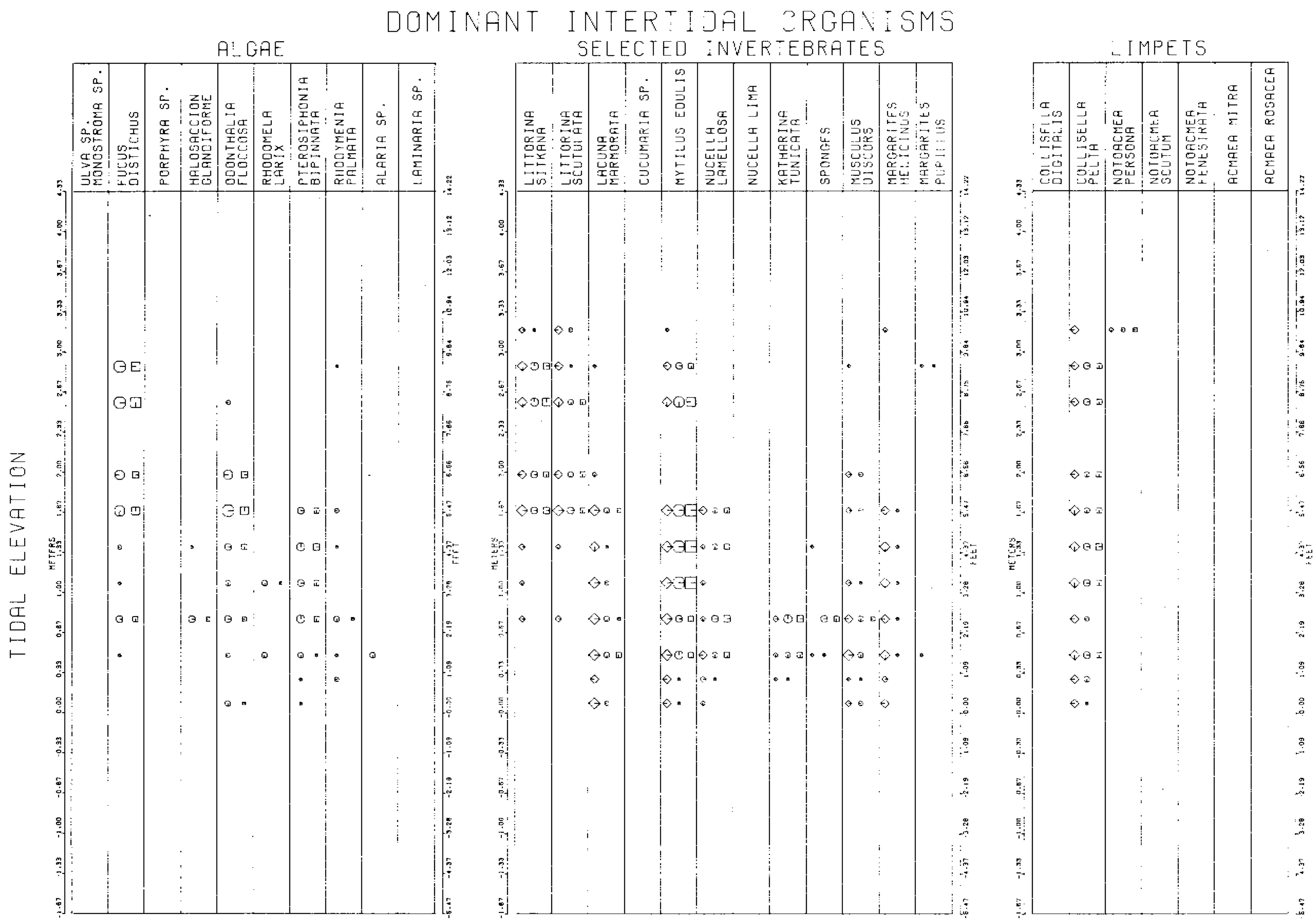
STATION: ANCHOR COVE
DATE: 74/ 9/16
LATITUDE: 59 59 70 N
LONGITUDE: 149 6 0 W
OBSRV. RANGE: 0.4M TO 2.9M

COUNT OF INDIVIDUALS KEY
·FRAGMENT
1
2-5
6-10
11-25
26-100
101-250
>250

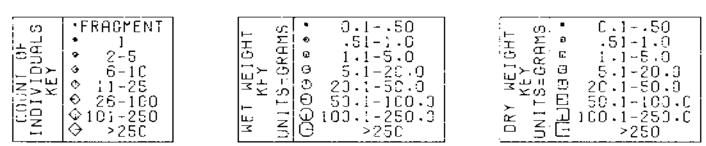
WET WEIGHT KEY UNITS=GRAMS
0.1-.50
.51-1.0
1.1-5.0
5.1-20.0
20.1-50.0
50.1-100.0
100.1-250.0
>250

DRY WEIGHT KEY UNITS=GRAMS
0.1-.50
.51-1.0
1.1-5.0
5.1-20.0
20.1-50.0
50.1-100.0
100.1-250.0
>250

DOMINANT INTERTIDAL ORGANISMS



STATION: MCLEOD HARBOR
DATE: 74/ 9/17
LATITUDE: 59 53 40 N
LONGITUDE: 147 47 70 W
OBSRV. RANGE: -0.3M TO 3.0M



relationships and mathematically compared with data from other sites. Finally, the processed data are analyzed and reports are prepared for publication.

E. Drift Zone Studies

The one-year study of the accumulation of drift biota on eastern Gulf of Alaska beaches has been completed. The results and interpretations are contained as a separate report in Appendix 1. One or more formal publications will be based on this report.

V. Problems Encountered

The constant change in objectives and priorities from the OCSEAP office has greatly delayed progress. We are often unable to carry out even the most rudimentary of plans in the face of constantly changing requests. Some examples follow.

In January we were asked to submit our final report in March 1976 instead of October 1976. This shift meant a complete change in our long-term planning, personnel assignments, data analysis schedules, etc. All of the activities which were progressing toward a deadline nine months away, suddenly had less than two months to be completed.

In March we were again asked to completely revise our plans and scheduling. Instead of the mutually agreed upon baseline study which had been appropriate a year ago, OCSEAP suddenly asked for a new reconnaissance-level survey. Geographic areas were changed from EGOA, WGOA, etc., to new regions such as the Kodiak Basin or the St. George Basin.

All of our work up to March had been developing through the Northeastern Gulf (NEGOA) region into other areas. Following the March meetings the NEGOA region was given lowest priority. New October and November 1976 deadlines were requested for Kodiak and St. George Basin reports. March and April 1977 deadlines were requested for Bristol Bay and Norton Sound reports. This meant that for the one-year period from March 1976 to March 1977 OCSEAP was requesting two quarterly reports, two annual reports, and four other major reports on Kodiak, St. George, Bristol Bay, and Norton Sound. This list of activities does not include the preparation of a revised 1976 proposal which was requested at the March meetings.

Some field activities have also suffered from the changes and lack of communication. Because the Boulder office failed to follow up on a contract which they had verbally offered to the Environmental Research Institute of Michigan (ERIM), the aerial scanning program was almost cancelled. ERIM, in fact, requested the cancellation and the Boulder office accepted without even contacting NWFC which had, in the meantime, made extensive plans to carry out one part of the work including vessel charter and hiring of necessary field party staff.

The changes we recommend to solve these problems are simple: provide the managerial input before the contracts are let rather than part way through the program; and stick to agreed-upon schedules.

VI. Estimate of Funds Expended During Quarter*

Salaries	$60.1k
Travel	24.8
Contracts	42.8
Equipment and Supplies	4.9
Other Direct Costs	4.3
Support	22.4
Total	$159.3k

*Does not include ship and aircraft logistics provided by OCSEAP.

Appendix 1.

Results of a seasonal study of the accumulation of drift zone biota in the eastern Gulf of Alaska. July 1975 - June 1976.

by J. F. Palmisano

ABSTRACT

A one-year seasonal study of beached drift biota was conducted at three study localities in the eastern Gulf of Alaska. Results, expressed as daily accumulation rates per km for individual species, revealed that invertebrate hard parts (i.e. shells and carapaces) and algal remains were the most commonly occurring marine organisms. Accumulation of drift biota at each study area was considered light to moderate during all seasons sampled. Intact live and newly dead animals (primarily jellyfish and a few sea birds and small nearshore fishes) occurred but were scarce. Only skeletal remains of marine mammals were found. Algal drift ranged from fragments to entire plants and consisted of fresh and decomposed material. Composition of drift biota varied with study locality and apparently reflected biota of adjacent communities. Seasonal variation in abundance and composition was noted and was suspected to be related to changes in both environmental conditions and life history stages of the drift biota involved.

INTRODUCTION

Oil and gas development on the outer continental shelf of the Gulf of Alaska could result in increased mortality rates of marine organisms and a corresponding increase in the amounts of beached drift biota. The objectives of the following study are: (1) to determine species composition of drift biota currently occurring at the high tide zone (drift zone) in the eastern Gulf of Alaska, (2) to determine the present rate of accumulation of drift species, and (3) to note the presence and relative abundance of nearshore biota (i.e. sea birds and marine mammals) likely to be adversely affected by petroleum-related development.

STUDY AREA

Study sites at Yakutat, Cape Yakataga, and Middleton Island were chosen because they are on open coasts adjacent to proposed oil and gas lease sites, and because air service and housing facilities are available. All are low gradient sand and gravel beaches. The Yakataga study area is bisected by a rock reef, and the Middleton site is bordered by rock reefs.

METHODS

Each study site was divided into five successive 1-km lengths and permanently marked with paint, survey flagging, and a numbered sign. Sites were sampled each season for three to five consecutive days at high tide. Only visible drift biota were recorded (i.e. no attempt was made to uncover items buried under windrows of drift, sand, or rocks). To insure valid counts all items encountered were destroyed, marked, or collected. This procedure and the practice of removing drift biota from the area between low water and the storm beach on the first day of each seasonal visit permitted an estimate of daily accumulation rates per km.

The numbers of all drift animals found along the shore were recorded. If a species was too numerous or too small to quickly enumerate, it was subsampled in a randomly selected 100-m section in at least one of the 1-km study transects.

Individual animal weights and lengths were recorded if possible. Shells and carapaces of invertebrates were measured when intact but only vertebrate samples were weighed.

Algal drift was difficult to enumerate because of the problem of identifying individual plants. The kelp *Nereocystis luetkeana*, which has one "float" at the apex of its stipe, was enumerated by counting beached floats. The accumulation rate of this kelp was arbitrarily used as a crude but helpful index of the rate of algal accumulation. Estimates were made of the dominant species of algae in the drift as well as the biomass of total daily accumulation.

All study sites were photographed seasonally. A complete list was made of each animal and plant species (both drift and alive) encountered each day in or adjacent to each km of shoreline traversed. Daily accumulation rates per km are presented for only those species with a seasonal mean of two or more individuals per km per day during at least one season sampled.

Daily weather data were collected at each study locality during each visit. Air and ocean surface temperatures were recorded with a hand-held thermometer. Wind direction was determined with a hand-held compass. Other weather data, such as wind speed, cloud cover, etc., were estimated.

RESULTS

Drift biota at the three study areas were characterized by invertebrate hard parts (shells and carapaces) and algal remains (Table 1); accumulations were light to moderate during all seasons sampled (Table 2). Intact live and newly dead animals (primarily jellyfish and a few sea birds and small nearshore fishes) occurred but were scarce; only skeletal remains of marine mammals were found (Table 3). Algal drift consisted of fresh and decomposed material and ranged from fragments to entire plants.

Total number of drift animals was greatest at Yakutat while Middleton Island had the greatest amount of algal drift. Cape Yakataga consistently had the least amount of drift biota. Dead sea birds were most abundant at all three areas during winter. During spring there was a large accumulation of tanner crab (*Chionoecetes bairdi*) and Dungeness crab (*Cancer magister*) carapaces at Cape Yakataga and of young bull kelp (*Nereocystis luetkeana*) at Middleton Island.

Yakutat: Drift biota at Yakutat (Table 4) was characterized by empty razor clam (*Siliqua patula*) shells, Dungeness crab carapaces, and unidentified jellyfish. Table 5 shows the numbers and mean daily accumulation rates per km of shoreline of the most abundant species found during all seasons sampled. Very little drift algae occurred at Yakutat. Although no measurements were made, total daily accumulation was estimated at less than 5 kg (wet weight) during all seasons sampled. Accumulation was greatest during summer and bull kelp and *Macrocystis integrifolia* were the dominant species.

Cape Yakataga: Drift biota at Cape Yakataga (Table 6) was characterized by invertebrate remains, i.e. sponges, razor clam shells, worm tubes (*Eudistylia* sp.), and Dungeness crab carapaces. Daily accumulation rates per km of shoreline of the most abundant species are presented in Table 7. Accumulation of drift algae was estimated at less than 2 kg (wet weight) per day during all seasons sampled. *Fucus distichus* was the most abundant algae found.

Middleton Island: Drift biota at Middleton Island (Table 8) was characterized by algal and invertebrate remains. Table 9 shows the numbers and mean daily accumulation rates per km of shoreline of the most abundant species. *Laminaria* spp. followed by bull kelp and *Cymathere triplicata* were the most abundant algae during all seasons sampled. Daily accumulation rates of bull kelp appeared to be directly related to the rate of accumulation of algal drift. Autumn and spring accumulation rates of drift algae were estimated at hundreds of kg (wet weight) per day and the winter rate was estimated at tens of kg (wet weight) per day. Invertebrate remains were characterized by limpet (Acmaea mitra) and snail (Fusitriton oregonensis) shells.

Tables 10, 11, and 12 give the species and relative numbers of sea and shore birds and marine mammals observed adjacent to the study localities during all seasons sampled. Air and ocean surface temperatures and weather data are listed in Tables 13, 14, and 15. Field activities and sample collections are summarized in Tables 16 and 17.

DISCUSSION

Composition of drift biota at each study locality apparently reflected the biota of adjacent communities. For example, drift biota at Yakutat, primarily razor clams and Dungeness crabs, were representative of sand habitats while those at Middleton Island, mostly kelp, were representative of rock areas. The paucity of intact animals suggested that mortality rates were in balance with scavenging and decomposition rates and that no unusually large die-offs had occurred.

Seasonal variations in drift composition reflected life history changes of the biota involved and seasonal changes in the physical environment. For example, reduction in numbers of organisms such as jellyfish and bull kelp reflected natural decline of annual species. An increase in numbers of sponges, tube worms, and sea birds from summer to winter suggested winter mortality of longer-lived species. Other factors such as ocean currents, wind patterns, severity of weather and interactions between drift species and their prey, predators, and competitors may also have affected the composition, quantity, and accumulation rates of drift biota in the eastern Gulf of Alaska.

Table 1.--Composition (in percent) of drift biota occurring at three study localities between August 15, 1975 and May 24, 1976 based on an estimate of percent cover and biomass.

Drift Item	Eastern Gulf of Alaska Study Locality		
	Yakutat	Cape Yakataga	Middleton Island
Algae	1	1	99
Invertebrates	98	98	<1
Fish	<0.5	<0.5	<0.5
Sea birds	<0.5	<0.5	<0.5
Marine mammals	<0.5	<0.5	<0.5
Other	<0.1	0	0

Table 2.--Number[a] of marine animals (exclusive of Hydrozoa, Bryozoa, and Ascidiacea) found in beached drift at three study localities during summer and autumn 1975 and winter and spring 1976 in the eastern Gulf of Alaska.

	Yakutat				Cape Yakataga			Middleton Island		
SUMMER 1975	August				September[b]			September[b]		
Date	18	19	20		5			6		
Invertebrates	1,067	803	423		Present			Present		
Fish	0	0	3		Absent			Absent		
Birds	0	0	0		Absent			Absent		
Mammals	0	1	0		Absent			Absent		
Daily total	1,067	804	425		----			----		
Seasonal total		2,296			----			----		
AUTUMN 1975	November				December			December		
Date	5	6	7	8	2	3	4	10	11	12
Invertebrates	635	371	1,246	1,216	25	37	27	4	2	2
Fish	1	0	1	2	1	5	3	0	0	0
Birds	0	0	1	0	0	1	0	0	0	0
Mammals	0	0	0	0	1	0	0	0	0	0
Daily total	636	371	1,248	1,218	27	43	30	4	2	2
Seasonal total		3,473				100			8	
WINTER 1976	February				February			February		
Date	22	23	24	25	11	12	13	17	18	19
Invertebrates	947	515	869	478	29	224	60	36	97	70
Fish	0	0	0	1	0	1	0	0	0	0
Birds	0	1	0	1	0	0	0	5	1	1
Mammals	0	1	0	0	0	0	1	0	0	0
Daily total	947	517	869	480	29	225	61	41	98	71
Seasonal total		2,813				315			210	
SPRING 1976	May				April			May		
Date	22	23	24		21	22	23	18	19	20
Invertebrates	688	380	534		170	305	208	20	14	26
Fish	2	2	1		0	1	1	0	0	0
Birds	0	0	0		0	0	0	0	0	0
Mammals	0	0	0		0	0	0	0	0	0
Daily total	690	382	535		170	306	209	20	14	26
Seasonal total		1,607				685			66	

[a] Exclusive of first-day counts (see Methods).

[b] Reconnaissance visit only, no numerical data collected.

Table 3.--Number*, total (T), and grand total (GT) of live or newly dead intact marine animals found in beached drift at three study localities during summer (S) and autumn (A) 1975 and winter (W) and spring (Sp) 1976.

Organisms	Yakutat					Cape Yakataga				Middleton Island				
	S	A	W	Sp	T	A	W	Sp	T	A	W	Sp	T	GT
INVERTEBRATES														793
Aurelia spp.	457	235	2	1	695	0	0	0	0	1	0	3	4	699
Ctenophora	14	3	0	12	29	0	0	0	0	0	1	0	1	30
Lepus spp.	3	0	6	0	9	0	0	0	0	0	8	6	14	23
Idothea sp.	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Crangon sp.	0	1	0	0	1	0	0	0	0	0	0	0	0	1
Cancer magister	2	0	0	8	10	0	0	0	0	0	1	0	1	11
Cryptochiton stelleri	0	0	0	0	0	0	0	0	0	1	6	2	9	9
Macoma sp.	0	0	0	0	0	0	0	1	1	0	0	0	0	1
Siliqua patula	0	2	1	0	3	0	0	0	0	0	0	0	0	3
Notoacmea persona	0	0	0	0	0	0	0	2	2	0	0	0	0	2
Dermasterias imbricata	0	0	0	0	0	0	0	0	0	0	2	1	3	3
Solaster dawsoni	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Henricia sp.	0	0	0	0	0	0	0	0	0	0	1	1	2	2
Strongylocentrotus drobachiensis	0	0	0	0	0	0	0	4	4	0	0	3	3	7
FISH														17
Theragra chalcogramma	1	2	0	1	4	0	0	0	0	0	0	0	0	4
Trichodon trichodon	2	3	1	4	10	0	0	2	2	0	0	0	0	12
Ammodytes hexapterus	0	0	0	1	1	0	0	0	0	0	0	0	0	1
SEA BIRDS														26
Phalacrocorax pelagicus	0	0	0	0	0	0	0	0	0	0	2	3	5	5
Uria aalge	0	0	2	0	2	0	7	0	7	0	9	0	9	18
Lunda cirrhata	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Mergus serrator	0	0	1	0	1	0	0	0	0	0	0	0	0	1
Larus glaucescens	0	0	0	0	0	1	0	0	1	0	0	0	0	1
Total	479	246	13	27	765	1	7	9	17	2	32	20	54	836

* Inclusive of first-day counts (see Methods).

Table 4.--List of drift biota found at Yakutat, Alaska study locality during summer (S) and autumn (A) 1975, and winter (W) and spring (Sp) 1976.

Algae

Enteromorpha clathara - S

Enteromorpha linza - S

Ulva sp. - S, Sp

Spongomorpha sp. - Sp

Desmarestia aculeata - S, Sp

Laminaria sp. - A, Sp

Nereocystis luetkeana - S, A, W, Sp

Macrocystis integrifolia - S, W, Sp

Alaria fistulosa - S, W, Sp

Alaria praelonga - S, W, Sp

Egregia menziesii - W

Fucus distichus - S, A, W, Sp

Porphyra sp. - S, A, Sp

Prionitis lanceolata - S

Halosaccion glandiforme - S, W, Sp

Rhodymenia palmata - S, Sp

Invertebrates

Porifera - Sp

Aurelia spp. - S, A, W, Sp

Ctenophora - S, A, Sp

Eudistylia sp. - Sp

Balanus cariosus - S

Balanus glandula - S

Lepus anatifera - S, W

Lepus hilli - S

Invertebrates (continued)

Crangon sp. - A

Cancer magister - S, A, W, Sp

Chionoecetes bairdi - Sp

Mytilus edulis - S, A, Sp

Mytilus californianaus - S

Macoma balthica - S, A, W, Sp

Macoma expansa - S, A, W, Sp

Siliqua patula - S, A, W, Sp

Spisula falcata - S, A, W, Sp

Spisula polyneura - S

Semele rubropicta - S

Pholadidae - A

Notoacmea persona - S

Notoacmea scutum - S, Sp

Fusitriton oregonensis - A

Nucella lamellosa - S

Neptunea sp. - S, Sp

Fish

Theragra chalcogramma - S, A, Sp

Trichodon trichodon - S, A, W, Sp

Ammodytes hexapterus - Sp

Amphibian

Aspidospondyli - S

Birds

Mergus serrator - W

Uria aalge - W

Mammals

Cetacea - S, A

Pinnipedia - W

Table 5.--Number and mean accumulation rate per kilometer for drift biota with a seasonal mean of two or more individuals per kilometer per day during at least one season sampled from summer 1975 to spring 1976 at Yakutat, Alaska study locality (N.D. = no data).

	Razor clam shells (Siliqua patula)				Dungeness crab carapaces (Cancer magister)				Jellyfishes (Aurelia spp.)			
SUMMER (Aug., 1975)												
Date	18	19	20		18	19	20		18	19	20	
Km 1	303	183	138		16	3	2		8	28	54	
Km 2	189	102	N.D.		5	5	N.D.		0	14	N.D.	
Km 3	280	223	N.D.		17	18	N.D.		3	31	N.D.	
Km 4	177	109	139		12	9	4		5	31	N.D.	
Km 5	45	32	33		6	1	1		1	3	42	
Daily mean/Km	189.8	129.8	103.3		11.2	7.2	2.3		3.4	21.4	65.3	
Seasonal mean/Km	----	150.2	----		----	7.6	----		----	24.6	----	
AUTUMN ('ov., 1975)												
Date	5	6	7	8	5	6	7	8	5	6	7	8
Km 1	155	30	209	269	5	1	0	0	9	2	9	14
Km 2	154	90	338	380	0	2	3	0	15	3	11	25
Km 3	169	123	405	339	2	1	2	0	11	10	12	15
Km 4	82	41	129	93	1	2	1	0	9	14	7	8
Km 5	29	42	71	100	0	1	0	0	1	7	0	0
Daily mean/Km	117.8	65.2	230.4	236.2	1.6	1.4	1.2	0	9.0	7.2	7.8	12.4
Seasonal mean/Km	--------	162.4		---------	--------	1.1		---------	--------	9.1		---------

Table 5.--Number and mean accumulation rate per kilometer for drift biota with a seasonal mean of two or more individuals per kilometer per day during at least one season sampled from summer 1975 to spring 1976 at Yakutat, Alaska study locality (N.D. = no data) (Continued).

	Razor clam shells (*Siliqua patula*)				Dungeness crab carapaces (*Cancer magister*)				Jellyfishes (*Aurelia* spp.)			
WINTER (Feb., 1976)												
Date	22	23	24	25	22	23	24	25	22	23	24	25
Km 1	212	N.D.	199	135	0	0	0	2	1	0	0	0
Km 2	293	253	275	125	0	0	0	1	0	0	0	0
Km 3	218	242	201	60	0	0	0	0	0	0	0	0
Km 4	175	N.D.	147	113	1	0	0	0	0	0	0	0
Km 5	6	N.D.	17	12	0	0	0	0	1	0	0	0
Daily mean/Km	180.8	247.5	168.8	89.0	0.2	0	0	0.6	0.4	0	0	0
Seasonal mean/Km	-------- 157.8 ---------				-------- 0.2 ---------				-------- 0.1 ---------			
SPRING (May, 1976)												
Date	22	23	24		22	23	24		22	23	24	
Km 1	98	22	61		6	0	1		0	0	0	
Km 2	97	68	71		2	7	2		0	0	0	
Km 3	179	75	153		12	4	3		0	0	0	
Km 4	157	94	123		6	7	5		0	0	1	
Km 5	90	65	79		4	9	9		0	0	0	
Daily mean/Km	124.2	64.8	97.4		6.0	5.4	4.0		0	0	0.2	
Seasonal mean/Km	---- 95.5 ----				---- 5.1 ----				---- 0.1 ----			

Table 6.--List of drift biota found at Cape Yakataga, Alaska study locality during autumn (A) 1975 and winter (W) and spring (Sp) 1976.

Algae

Ulva sp. - Sp

Laminaria groenlandica - A, W, Sp

Laminaria longipes - A

Laminaria sp. - A, W, Sp

Nereocystis luetkeana - A

Macrocystis integrifolia - W

Alaria praelonga - W, Sp

Fucus distichus - A, W, Sp

Iridaea sp. - W, Sp

Rhodymenia palmata - A, W, Sp

Invertebrates

Porifera - A, W, Sp

Hydrozoa - A, W, Sp

Bryozoa - A, W, Sp

Eudistylia sp. - A, W, Sp

Balanus cariosus - A, W

Balanus nubulis - W, Sp

Balanus glandula - Sp

Cancer magister - A, W, Sp

Cancer oregonensis - A, Sp

Chionoecetes bairdi - A, W, Sp

Amphineura - A, Sp

Mytilus edulis - A, W, Sp

Mytilus californianus - Sp

Invertebrates (continued)

Macoma balthica - Sp

Siliqua patula - A, W, Sp

Spisula falcata - A, W, Sp

Pholadidae - A, W

Entodesma saxicola - Sp

Notoacmea persona - A, W, Sp

Fusitriton oregonensis - W

Nucella lima - Sp

Nucella lamellosa - W

Nucella sp. (egg cases) - A, W

Buccinum baeri - Sp

Searlesia dira - Sp

Neptunea sp. - A, W, Sp

Strongylocentrotus drobachiensis - W, Sp

Cucumaria sp. - A

Ascidacea - A, W, Sp

Fish

Pleurotremata - Sp

Rajidae - A, Sp

Rajidae - (egg cases) - W, Sp

Trichodon trichodon - Sp

Ophiodon elongatus - A, W, Sp

Hippoglossus stenolepis - A

Platichthys stellatus - W

Table 6.--List of drift biota found at Cape Yakataga, Alaska study locality during autumn (A) 1975 and winter (W) and spring (Sp) 1976 (continued).

Fish (continued)

Cottidae - Sp

Fish eggs - Sp

Birds

Larus glaucescens - A

Uria aalge - W

Mammals

Eumetopias jubata - A, W

Phoca vitulina - Sp

Table 7.--Number and mean accumulation rate per kilometer for drift biota with a mean of two or more individuals per kilometer per day during at least one season sampled from autumn 1975 to spring 1976 at Cape Yakataga, Alaska study locality.

	Finger sponges (Porifera)			Razor clam shells (*Siliqua patula*)			Worm tubes (*Eudistylia* sp.)			Dungeness crab carapaces (*Cancer magister*)		
AUTUMN (Dec., 1975)												
Date	2	3	4	2	3	4	2	3	4	2	3	4
Km 1	0	0	0	0	12	5	0	0	4	0	2	0
Km 2	0	3	0	2	1	6	4	2	0	1	0	1
Km 3	2	1	1	0	2	1	3	0	0	1	1	1
Km 4	0	0	0	0	1	0	3	0	0	1	0	0
Km 5	0	0	0	5	0	0	0	0	0	0	0	0
Daily mean/Km	0.4	0.8	0.2	1.4	3.2	2.4	2.0	0.4	0.8	0.6	0.6	0.4
Seasonal mean/Km	----	0.5	----	----	2.3	----	----	1.1	----	----	0.5	----
WINTER (Feb., 1976)												
Date	11	12	13	11	12	13	11	12	13	11	12	13
Km 1	0	90	2	10	20	35	0	23	3	1	4	2
Km 2	0	21	3	2	2	1	1	1	1	0	3	1
Km 3	0	1	1	1	14	6	0	6	0	0	0	0
Km 4	0	0	0	0	1	0	0	0	0	0	0	0
Km 5	0	0	0	0	0	0	0	0	0	0	0	0
Daily mean/Km	0	22.4	1.2	2.6	7.4	8.4	0.2	6.0	0.8	0.2	1.4	0.6
Seasonal mean/Km	----	7.9	----	----	6.1	----	----	2.3	----	----	0.7	----
SPRING (Apr., 1976)												
Date	21	22	23	21	22	23	21	22	23	21	22	23
Km 1	0	0	0	19	35	21	0	0	1	66	227	76
Km 2	2	0	0	4	3	6	2	0	0	1	0	2
Km 3	5	2	4	5	15	43	2	3	0	2	2	0
Km 4	0	0	5	0	0	0	0	0	0	0	0	0
Km 5	0	0	0	6	0	0	0	0	0	1	1	1
Daily mean/Km	1.4	0.4	1.8	6.8	10.6	14.0	0.8	0.6	0.2	14.0	46.0	15.8
Seasonal mean/Km	----	1.2	----	----	10.4	----	----	0.5	----	----	25.3	----

Table 8.--List of drift biota found at Middleton Island, Alaska study locality during autumn (A) 1975 and winter (W) and spring (Sp) 1976.

Algae

Ulva sp. - W, Sp

Spongomorpha sp. - Sp

Desmarestia aculeata - A, W, Sp

Laminaria groenlandica - A

Laminaria sp. - A, W, Sp

Pleurophycus gardneri - Sp

Cymathere triplicata - A, W, Sp

Costaria costata - Sp

Nereocystis luetkeana - A, W, Sp

Macrocystis integrifolia - A, W

Alaria fistulosa - W, Sp

Alaria praelonga - A, W, Sp

Fucus distichus - W, Sp

Porphyra sp. - Sp

Corallinaceae - W, Sp

Gigartina expasperata - Sp

Iridaea sp. - W, Sp

Halosaccion glandiforme - W, Sp

Rhodymenia palmata - A, W, Sp

Ptilota sp. - W, Sp

Invertebrates

Porifera - A, W

Hydrozoa - A, Sp

Actinaria - A, Sp

Invertebrates (continued)

Ctenophora - W

Bryozoa - A, W, Sp

Eudistylia sp. - W

Balanus nubulis - W

Lepus anatifera - W, Sp

Idothea sp. - W

Cancer magister - A, W, Sp

Telmessus sp. - Sp

Mopalia sp. - W

Cryptochiton stelleri - A, W, Sp

Musculus sp. - W

Mytilus edulis - W, Sp

Mytilus californianus - Sp

Protothaca staminea - W

Saxidomus giganteus - A, W, Sp

Pholadidae - Sp

Entodesma saxicola - W

Acmaea mitra - A, W, Sp

Notoacmea persona - W, Sp

Littorina sp. - W

Fusitriton oregonensis - A, W, Sp

Nucella sp. (egg cases) - W

Searlesia dira - W

Neptunea sp. - Sp

Dermasterias imbricata - A, W, Sp

Table 8.--List of drift biota found at Middleton Island, Alaska study locality during autumn (A) 1975 and winter (W) and spring (Sp) 1976 (continued).

Invertebrates (Continued)

Solaster dawsoni - Sp

Henricia sp. - W, Sp

Strongylocentrotus drobachiensis - W, Sp

Strongylocentrotus franciscanus - Sp

Ascidiacea - A, W, Sp

Fish

Rajidae (egg case) - W

Blennioidea (eggs) - Sp

Birds

Phalacrocorax pelagicus - W, Sp

Uria aalge - W

Lunda cirrhata - W

Mammals

Eumetopias jubata - W

Table 9.--Number and mean accumulation rate per kilometer for drift biota with a seasonal mean of two or more individuals per kilometer per day during at least one season sampled from autumn 1975 to spring 1976 at Middleton Island, Alaska study locality.

	Bull kelp floats (*Nereocystis luetkeana*)			White-cap limpet shells (*Acmaea mitra*)			Oregon triton shells (*Fusitriton oregonensis*)		
AUTUMN (Dec., 1975)									
Date	10	11	12	10	11	12	10	11	12
Km 1	11	2	3	0	0	0	0	0	0
Km 2	29	0	7	0	0	0	0	0	0
Km 3	2	1	9	0	0	0	0	0	0
Km 4	2	10	2	0	0	0	0	0	0
Km 5	1	3	15	2	0	0	0	0	0
Daily mean/Km	9.0	3.2	7.2	0.4	0	0	0	0	0
Seasonal mean/Km	----	6.5	----	----	0.1	----	----	0	----
WINTER (Feb., 1976)									
Date	17	18	19	17	18	19	17	18	19
Km 1	10	3	2	1	0	0	1	0	2
Km 2	4	6	6	0	1	1	0	1	5
Km 3	0	5	4	0	0	0	0	1	1
Km 4	0	0	0	0	15	8	0	14	3
Km 5	0	3	0	14	25	16	5	14	10
Daily mean/Km	2.8	3.4	2.4	3.0	8.2	5.0	1.2	6.0	4.2
Seasonal mean/Km	----	2.9	----	----	5.4	----	----	3.8	----
SPRING (May, 1976)									
Date	18	19	20	18	19	20	18	19	20
Km 1	0	66	1025	0	2	1	0	1	0
Km 2	0	256	3	0	0	0	0	0	0
Km 3	0	1300	106	3	0	0	0	0	0
Km 4	0	0	1	2	1	6	0	0	0
Km 5	0	0	0	8	4	14	0	0	0
Daily mean/Km	0	324.4	227.0	2.6	1.4	4.2	0	0.2	0
Seasonal mean/Km	----	183.8	----	----	2.7	----	----	0.1	----

Table 10.--Largest single sighting of sea and shore birds adjacent to Yakutat study locality during summer and autumn 1975 and winter and spring 1976.

Species	Summer	Autumn	Winter	Spring
Pelagic cormorant (Phalacrocorax pelagicus)	5	3	0	2
Canada goose (Branta canadensis)	25	0	0	0
White-fronted goose (Anser albifrons)	0	0	0	75
Common scoter (Oidemia nigra)	100	3	0	30
Merganser (Mergus sp.)	0	1	1	0
Bald eagle (Haliaeetus leucocephalus)	3[a]	1[b]	3[c]	3[c]
Hawk (Accipitridae)	0	1	0	0
Whimbrel (Numenius phaeopus)	0	0	0	12
Black turnstone (Arenaria melanocephala)	0	0	0	1
Rock sandpiper (Erolia ptilocnemis)	37	3	0	0
Glaucous-winged gull (Larus glaucescens)	34[d]	3[e]	4[f]	32[d]
Black-legged kittiwake (Rissa tridactyla)	5	2	3	0
Sabin's gull ? (Xema sabini)	1	0	0	0
Arctic tern (Sterna paradisaea)	1	0	0	17
Aleutian tern (Sterna aleutica)	1	0	0	0
Steller's jay (Cyanocitta stelleri)	0	0	0	2
Common raven (Corvus corax)	0	0	1	0
Crow (Corvus sp.)	0	1	0	5
Varied thrush (Ixopeus naevius)	0	2	0	0

[a] 2 mature, 1 immature

[b] mature

[c] 1 mature, 2 immature

[d] juveniles, subadults, and adults present

[e] 2 mature, 1 immature

[f] 3 mature, 2 immature

Table 11. Largest single sighting of sea and shore birds and marine mammals adjacent to Cape Yakataga study locality during autumn 1975 and winter and spring 1976.

Species	Autumn	Winter	Spring
Birds			
Mallard (Anas platyrhynchos)	0	0	3
Red-breasted merganser (Mergus serrator)	0	1	0
Common scoter (Oidemia nigra)	0	4	80
Bald eagle (Haliaeetus leucocephalus)	1[a]	3[b]	2[c]
Black turnstone (Arenaria melanocephala)	0	90	0
Rock sandpiper (Erolia ptilocnemis)	1	25	0
Glaucous-winged gull (Larus glaucescens)	8	5	89[d]
Common raven (Corvus corax)	0	2	2
Mammals			
Gray whale (Eschrichtus glaucus)	0	0	8
Harbor seal (Phoca vitulina)	0	0	1

[a] immature

[b] 2 immature, 1 mature

[c] 1 immature

[d] immature and mature present

Table 12.--Largest single sighting of sea and shore birds and marine mammals adjacent to Middleton Island study locality during autumn 1975 and winter and spring 1976.

Species	Autumn	Winter	Spring
Birds			
Pelagic cormorant (Phalocrocorax pelagicus)	8	3	100
Mallard (Anas platyrhynchos)	37	33	2
Common goldeneye (Bucephala clangula)	25	4	0
Bufflehead (Bucephala albeola)	27	22	0
Harlequin duck (Histrionicus histrionicus)	25	76	2
Red-breasted merganser (Mergus serrator)	1	0	0
Rough-legged hawk (Buteo lagopus)	0	1	0
Bald eagle (Haliaeetus leucocephalus)	3[a]	4[b]	0
Semipalmated plover (Charadrius semipalmatus)	0	0	6
Black turnstone (Arenaria melanocephala)	25	175	0
Rock sandpiper (Erolia ptilocnemis)	100	150	0
Red phalarope (Phalaropus fulicarius)	0	0	4
Glaucous-winged gull (Larus glaucescens)	2[c]	65[d]	16[d]
Black-legged kittywake (Rissa tridactyla)	2	1	1,000's
Common murre (Uria aalge)	0	0	45
Tufted puffin (Lunda cirrhata)	3	0	5
Mammals			
Harbor seal (Phoca vitulina)	2	2	4
Steller sea lion (Eumetopias jubata)	2	13	300-500

[a] 1 mature, 2 immature

[b] 2 mature, 2 immature

[c] 1 mature, 1 immature

[d] mature and immature present

Table 13.--Surface-water and air temperatures (°C), wind speed (direction and rate in kilometers per hour), and sky conditions at Yakutat, Alaska study locality during summer and autumn 1975 and winter and spring 1976.

Date	Temperature Water	Temperature Air	Wind	Sky
SUMMER 1975 (August)				
15	13	14	E, 28	Cloudy
16	12	18	Calm	Cloudy
17	12	14	SE, 46	Rain
18	12	15	SE, 6	Cloudy
19	12	13	Calm	Rain
20	12	12	Calm	Cloudy
AUTUMN 1975 (November)				
3	5	-1	E, 11	Snow
4	5	1	Calm	Snow
5	6	0	SE, 13	Snow
6	5	-4	Calm	Clear
7	5	-2	E, 6	Cloudy
8	5	-1	E, 3	Cloudy
WINTER 1976 (February)				
21	3	0	E, 18	Cloudy
22	2	-1	E, 40	Snow
23	2	0	E, 51	Snow
24	2	-2	SE, 29	Cloudy
25	2	-6	Calm	Cloudy
SPRING 1976 (May)				
21	6	6	Calm	Cloudy
22	6	6	SE, 5	Cloudy
23	6	5	E, 3	Cloudy
24	6	6	Calm	Clear

Table 14.--Surface-water and air temperatures (°C), wind speed (direction and rate in kilometers per hour), and sky conditions at Cape Yakataga, Alaska study locality during autumn 1975 and winter and spring 1976.

Date	Temperature Water	Temperature Air	Wind	Sky
AUTUMN 1975 (December)				
1	3	-11	Calm	Clear
2	3	-7	Calm	Clear
3	3	-9	Calm	Cloudy
4	3	-5	Calm	Cloudy
WINTER 1976 (February)				
10	2	-2	Calm	Cloudy
11	2	-1	Calm	Cloudy
12	2	1	E, 10	Snow
13	2	2	Calm	Snow
SPRING 1976 (April)				
20	6	6	E, 5	Clear
21	5	7	Calm	Cloudy
22	6	8	Calm	Cloudy
23	6	9	SE, 5	Cloudy

Table 15.--Surface-water and air temperatures (°C), wind speed (direction and rate in kilometers per hour), and sky conditions at Middleton Island, Alaska study locality during autumn 1975 and winter and spring 1976.

Date	Temperature Water	Temperature Air	Wind	Sky
AUTUMN 1975 (December)				
9	4	-6	E, 24	Snow
10	3	-4	Calm	Clear
11	2	-6	Calm	Clear
12	2	-6	N, 28	Clear
WINTER 1976 (February)				
16	2	2	E, 40	Cloudy
17	2	2	E, 8	Clear
18	2	1	E, 8	Cloudy
19	2	2	E, 40	Cloudy
SPRING 1976 (May)				
17	6	10	SE, 43	Cloudy
18	6	8	SE, 26	Cloudy
19	6	5	SE, 51	Rain
20	6	6	SE, 26	Rain

Table 16.--Field activities of drift zone study at three major Alaska study localities from August 15, 1975 to May 24, 1976.

Date	Activity
August 15-20	Summer study at Yakutat
September 5	Reconnaissance of Cape Yakataga
September 6	Reconnaissance of Middleton Island
November 3-8	Autumn study at Yakutat
November 11-12	Flights to Cape Yakataga cancelled due to bad weather; no facilities available at Middleton Island. Returned to Auke Bay.
December 1-4	Autumn study at Cape Yakataga
December 9-12	Autumn study at Middleton Island
February 10-13	Winter study at Cape Yakataga
February 16-19	Winter study at Middleton Island
February 21-25	Winter study at Yakutat
April 20-23	Spring study at Cape Yakataga
May 17-20	Spring study at Middleton Island
May 21-24	Spring study at Yakutat

Table 17.--Number and types of samples collected and observations conducted during drift zone studies at three study localities during summer (S) and autumn (A) 1975 and winter (W) and spring (Sp) 1976 in the eastern Gulf of Alaska.

Data type	Yakutat				Middleton Island			Cape Yakataga		
	S	A	W	Sp	A	W	Sp	A	W	Sp
1-kilometer walks[a]	23	26	22	20	20	20	20	20	20	20
Marine algal samples	13	4	7	1	8	15	4	6	7	1
Marine invertebrate samples	18	11	7	3	10	25	6	18	19	7
Marine fish samples	2	2	1	6	0	0	1	3	2	7
Marine bird samples	0	0	2	0	0	3	3	1	1	0
Marine mammal samples	4	1	1	0	0	1	0	1	1	0
Amphibian samples	1	0	0	0	0	0	0	0	0	0
Live bird observations[b]	23	26	22	20	20	20	20	20	20	20
Live mammal observations[b]	0	0	0	0	4	4	4	0	0	12
Daily weather observations	6	6	5	4	4	4	4	4	4	4

[a] Return trip (I.E. distance back and forth) counted as one walk.

[b] Per 1-km of shoreline walked.

ANNUAL OCS PROGRESS REPORT

AN ECOLOGICAL ASSESSMENT OF
SUBLITTORAL PLANT COMMUNITIES IN THE
NORTHERN GULF OF ALASKA
FOR NOAA,
NATIONAL MARINE FISHERIES SERVICE

EO
AN

DAMES & MOORE
JOB NO. 6797-001-20

Anchorage, Alaska
April 16, 1976

National Marine Fisheries Service
P. O. Box 155
Auke Bay, Alaska 99821

Attention: Dr. Steven Zimmerman

Gentlemen:

Annual OCS Progress Report
An Ecological Assessment of
Sublittoral Plant Communities
In the Northern Gulf of Alaska

This letter transmits 10 copies of the "Annual OCS Progress Report, An Ecological Assessment of Sublittoral Plant Communities in the Northern Gulf of Alaska" for the National Marine Fisheries Service. This report presents data collected during 1975-76. The final field survey under the current contract is scheduled for June 1976.

Yours very truly,

DAMES & MOORE

R. H. Winn
Managing Principle-Anchorage

Richard J. Rosenthal
Marine Biologist

Dennis C. Lees
Marine Biologist

RHW/RJR/DCL/mb

Attachments

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

LIST OF APPENDICES (cont)

LIST OF APPENDICES (cont)

ANNUAL PROGRESS REPORT
ECOLOGICAL ASSESSMENT OF SUBLITTORAL PLANT COMMUNITIES IN THE NORTHERN GULF OF ALASKA
FOR
NATIONAL MARINE FISHERIES SERVICE, AUKE BAY FISHERIES LABORATORY

INTRODUCTION

This progress report presents the results of our subtidal baseline investigation that was initiated in July, 1975, in conjunction with the National Marine Fisheries Service's intertidal program for the northeastern Gulf of Alaska. Three locations were selected by the Auke Bay Fisheries Laboratory for inclusion in the OCS littoral program: (1) Latouche Point, Latouche Island; (2) Macleod Harbor, Montague Island; and (3) Zaikof Bay, Hinchinbrook Entrance (Figure 1).

The National Marine Fisheries Service established intertidal baseline monitoring sites in each of the previously mentioned locations during 1974-75. Our task was to expand the biological data acquisition in each location by extending the sphere of observation into the sublittoral zone adjacent to the shoreline. Sampling and observations were to be made while diving at depths from the intertidal-subtidal fringe to about 30 m below the sea surface.

On July 22, 1975, we began the summer OCS field work in Prince William Sound and returned to the three stations in mid-September 1975; late November, 1975; and early March, 1976. To date, our observations have spanned 3 seasons from summer through winter. The final survey under the current contract is scheduled for the month of June 1976.

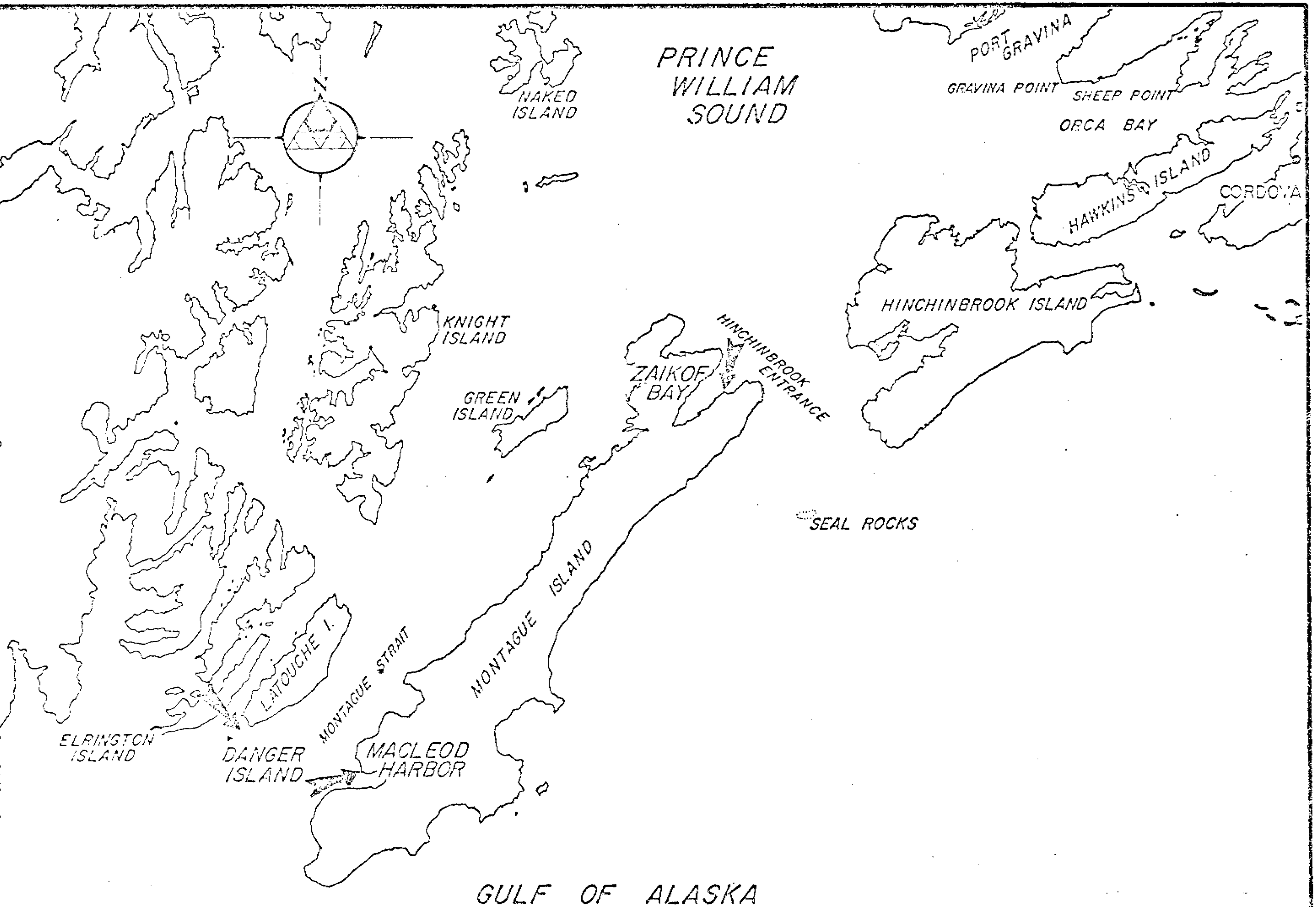

PRINCE WILLIAM SOUND
PORT GRAVINA
GRAVINA POINT
SHEEP POINT
ORCA BAY
HAWKINS ISLAND
CORDOVA
NAKED ISLAND
KNIGHT ISLAND
GREEN ISLAND
HINCHINBROOK ISLAND
HINCHINBROOK ENTRANCE
ZAIKOF BAY
SEAL ROCKS
MONTAGUE ISLAND
MONTAGUE STRAIT
LATOUCHE I.
ELRINGTON ISLAND
DANGER ISLAND
MACLEOD HARBOR
GULF OF ALASKA
N

Figure 1

TASK OBJECTIVES

The purpose of this study is to provide an inventory of the biological resources and ecological composition of 3 sublittoral sites in the northeastern Gulf of Alaska. In these areas, we have identified the characteristic plants and animals and determined the approximate biomass and composition by size class of selected species. The seasonal and spatial distribution, frequency of occurrence and relative abundance of the predominant organisms have been described where possible.

These areas are to be sampled at least once during each of the 4 seasons of the current fiscal year. At the conclusion of the 1st year of study, permanent transects and quadrats will be established at each location so that seasonal periodicity in the sublittoral algal communities can be determined.

METHODOLOGY AND STATISTICAL ANALYSIS

Most of the observations reported in this progress report were made while SCUBA diving. Our normal procedure has been to spend between 3 to 4 days working at each site. Casual observations dealing with usage of the littoral zone by birds and mammals has been made either in route to, or while anchored on station.

As a base of operation for field studies in the northern gulf coast region we maintain a project office in Cordova. Movement to the OCS sites and living accommodations while in the field are provided by the M.V. Humdinger, a 36' commercial fishing boat that is equipped for diving and nearshore research.

Numerical information has been gathered from specific locations in the sublittoral zone. Several types of quantitative data have been collected about the conspicuous species present at each site. Included are estimates of relative abundance (density-number of individual per square meter), measurements of linear size (length, width, apereture width, etc.) and weight (wet or dry weight of soft tissue). Transects have been used at both predetermined and random locations on the sea floor. The transects varied in dimensions depending on the topographical features of the sea floor. Usually the transects were run along a specific isobath, however, due to the physical heterogenety of these sites some change in depth and substrate type was almost always encountered.

Methods for estimating percent cover, or the amount of surface area occupied by particular taxon or group varied. The surface canopy was estimated visually. Estimates of percent cover for subsurface canopies were obtained from replicated 0.25 square meter quadrats that were either placed randomly, or stratified in such a way that a particular habitat or microhabitat was sampled within the macrophyte zone. These data have been analyzed using a graphic method developed by terrestrial ecologists for handling data for shrubs and lichens (Nash, 1975). This will assist in describing the present conditions at each study site, and will permit examination of the differences between sites. Biomass estimates have been generated for selected species at the study sites as a first step toward estimating consumption rates and to provide information on temporal variations in population structure at specific sites. In addition to these biological data, water depth, type(s) of underlying substrate and a general description of each habitat type are also recorded.

We have employed several statistical techniques in data analysis. Size-frequency data have been compared with the Kolmogorov-Smirnov two-sample test (Siegel, 1956). Differences in density and biomass data generally are compared using the Student's t-test or analysis of variance methods (Sokal and Rohlf, 1969). Most of the biomass data has been reconstructed by using the size-frequency data in conjunction with site-specific size-weight regressions.

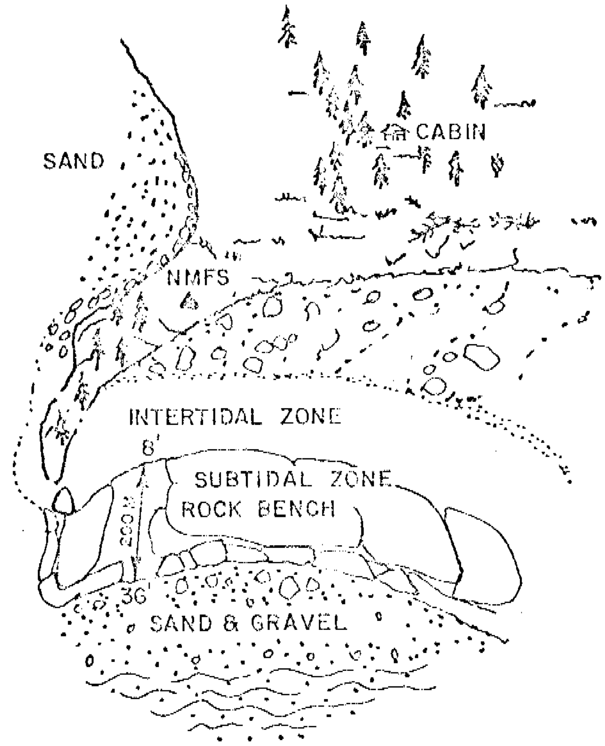
Population structure has been examined using a series of equations based on Brody-Bertalanffy growth curves (Ebert, 1973). This method, especially applicable to survey work, uses easily gathered size data to produce useful first aproximations of growth and mortality rates, and also generates a life table.

DESCRIPTION OF THE STUDY SITES

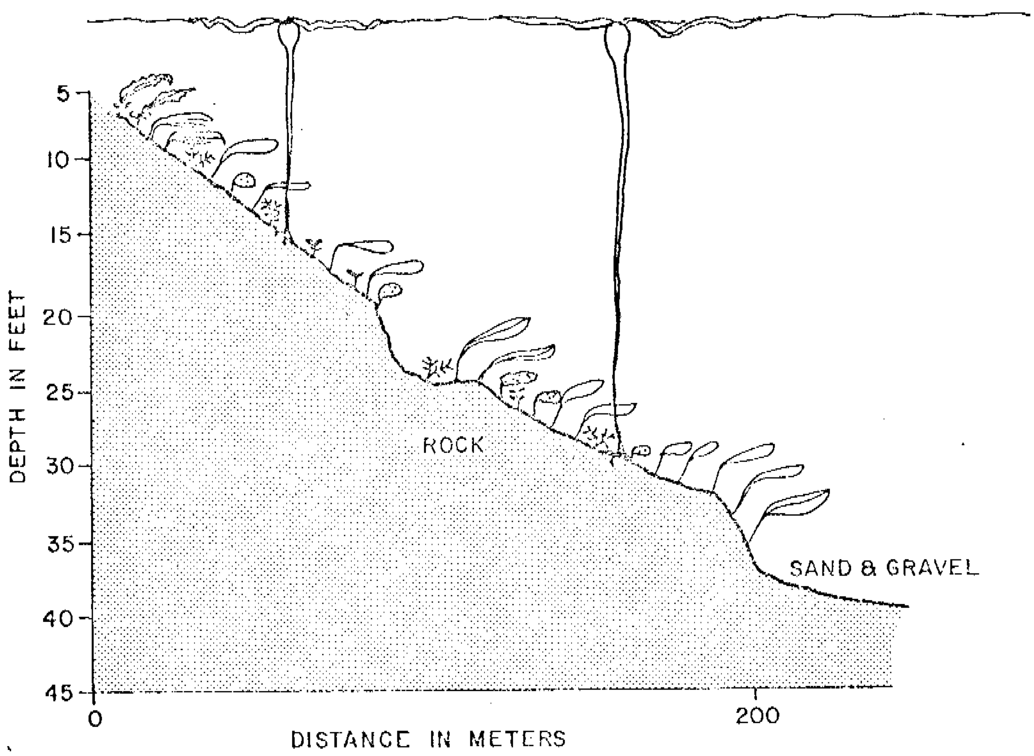
LATOUCHE POINT

The rocky sub al bench that extends off the southwest end of Latouche Island is approximately 200 m wide in the vicinity of the NMFS intertidal station. These measurements were made from the intertidal-subtidal fringe to a point where the rock and unconsolidated sediments merge (Figure 2). Beyond the rock bench the sea floor becomes relatively homogeneous; the bottom being composed mainly of course sand and shell debris. Ripple marks in the sand parallel the shoreline. A 9-10 m change in depth was recorded between these two ecotones.

During the summers of 1974 (Rosenthal, unpublished data) and 1975, (this study) a large bed of bull kelp *Nereocystis luetkeana* was observed growing around Danger Island and on the extensive shoal area off Latouche Point. The entire area was covered with an extremely heavy growth of algae. The vegetative understory beneath this surface canopy was multi-layered. *Laminaria groenlandica* was the most abundant brown alga in the understory complex; other conspicuous browns were *Laminaria yezoensis*; *Agarum cribrosum*; *Pleurophycus gardneri* and *Cymathere triplicata*. Underneath this vegetative layer was another algal canopy composed of foliose and peltate reds and scattered clumps of articulated corallines. Encrusting algae, such as *Lithothamnion*, *Ralfsia* and *Hildenbrandia* grew on most of the cobbles and boulders.



(A)



(B)

LATOUCHE POINT

DRAWING OF THE STUDY SITE (A)
AND THE SUBTIDAL VEGETATIVE CANOPIES (B)

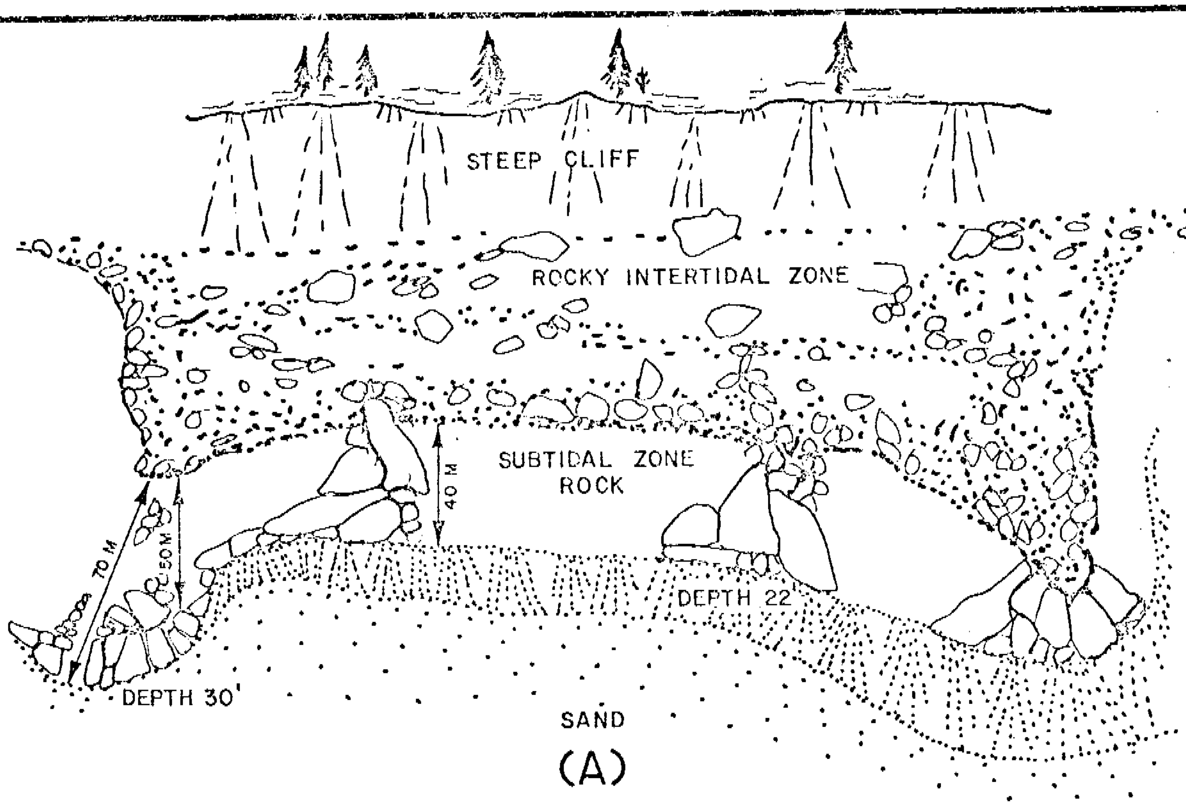
FIGURE 2

MACLEOD HARBOR

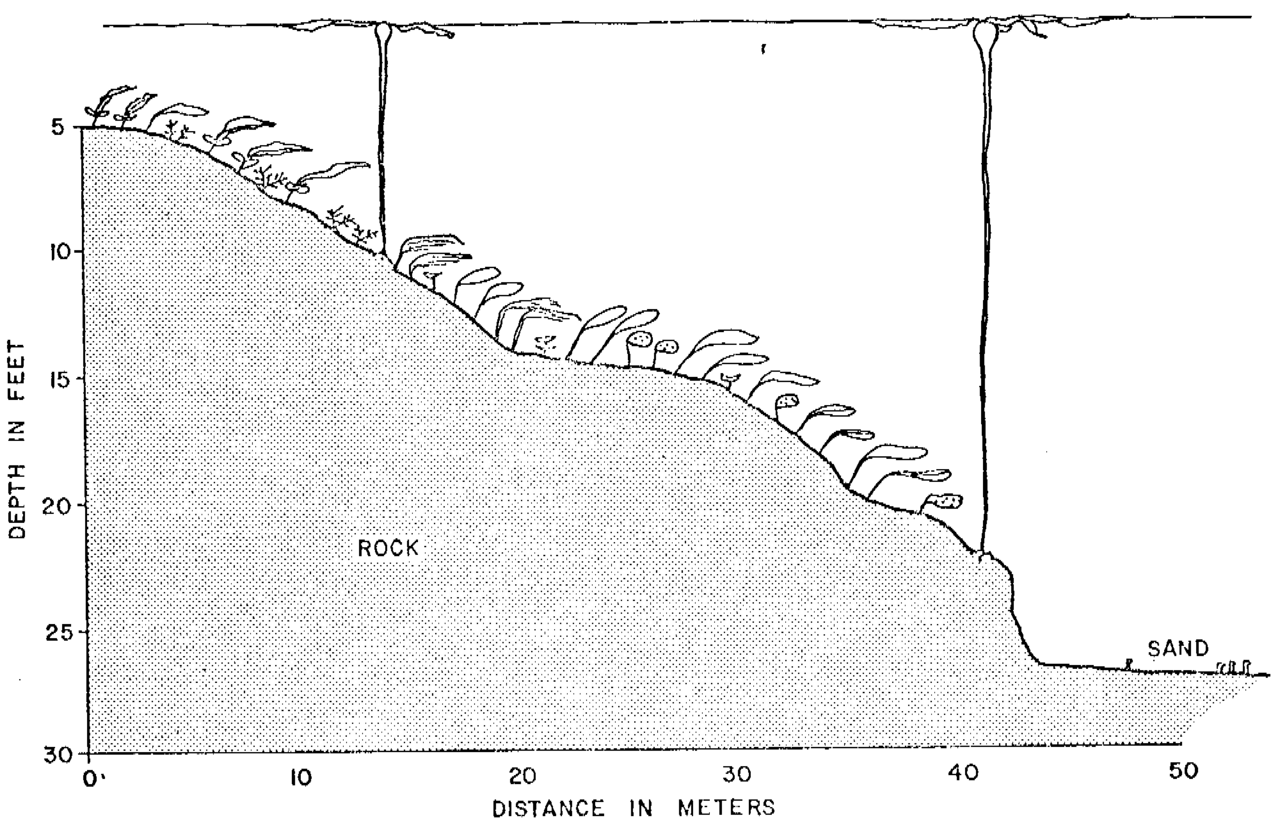
Macleod Harbor, situated on the southwest end of Montague Island is semiprotected from the Gulf of Alaska; however, it does receive some ocean swell and storm surf. The northern shoreline from the entrance at Point Woodcock to about midway into the harbor is rocky and irregular. The southwest coast of Montague Island was raised by as much as 30 feet during the Good Friday Earthquake of 1964 (Plafker, 1969). One effect of the quake was to separate the pre-earthquake littoral zone from the post earthquake shoreline.

At present, the shoreline at this site is characterized by a band of solid substratum composed of boulders and cobbles (Figure 3). Steeply sloping rocky cliffs overlook the NMFS intertidal station in Macleod Harbor. A number of exposed low profile ridges, extend from shore into the shallow subtidal. Between these ridges or fingers of rock are broad surge channels. The sublittoral zone in this part of Macleod Harbor is composed of a narrow band of bedrock approximately 40 to 70 m wide. Seaward of the rock, at depths ranging between 6 and 9 m below the sea surface, the sea floor was comprised of sand, silt and moderate amounts of shell material. The surface of the sand was covered by a thin layer of diatoms; sulfur bacteria spotted numerous areas of the bottom. About 5 m seaward of the rock-sand interface was a bed of tubicolous polychaetes, the most conspicuous of which was a large maldanid with a thick walled sandy tube.

The sublittoral algal association comprised several layers. Scattered patches of bull kelp formed a thin surface canopy on the sea surface during the summer. The second canopy level was composed of *Pleurophycus*, *Laminaria groenlandica* and *L. yezoensis*. A third algal layer consisted of *Agarum*, *Cymathere*, *Desmarestia* spp. and *Costaria costata*. Below the kelp guild were the fleshy, erect reds, *Opuntiella californica*, *Callophyllis* spp., *Membranoptera dimorpha* and *Ptilota filicina*. The final vegetative layer included the rock encrusting forms: *Corallina* spp., *Lithothamnion*, *Ralfsia*, and *Hildenbrandia*.



(A)



(B)

MACLEOD HARBOR

DRAWING OF THE STUDY SITE (A)
AND THE SUBTIDAL VEGETATIVE CANOPIES (B)

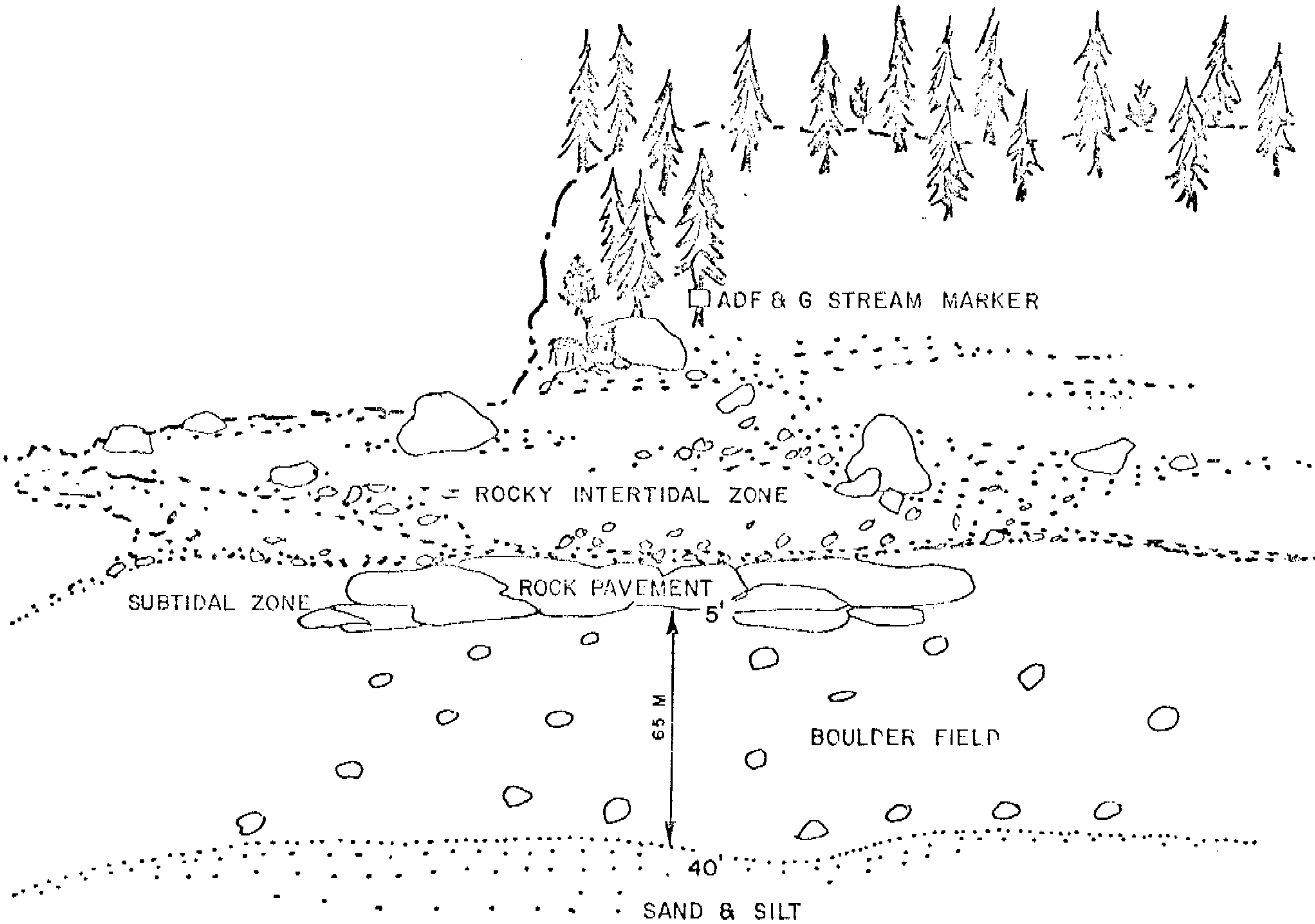
FIGURE 3

ZAIKOF BAY

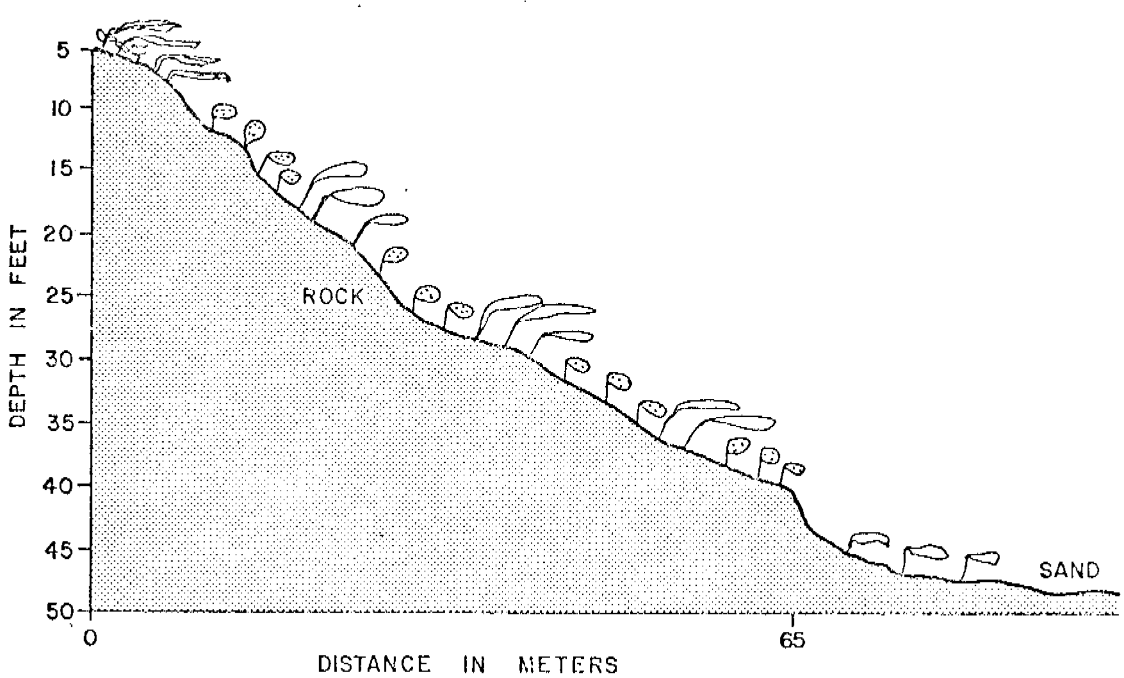
Zaikof Bay is located on the northeast end of Montague Island. The mouth of the bay is 2.5 miles wide and is situated on the west side of Hinchinbrook Entrance. The shoreline is heavily wooded with Sitka Spruce and Hemlock; the beach is narrow and rocky. The inner confines of the bay are generally protected from ocean swell; however at times the surface waters are exposed to gale force southeasterly winds. The NMFS intertidal site is located on a rocky promontory on the south side of the bay. An Alaska State Department of Fish & Game stream marker serves as a landmark for our sublittoral work. Below the tree line the beach is composed of cobbles and large boulders.

The shallow sublittoral zone appears to be a continuum of the exposed portion of the beach. At the intertidal-subtidal fringe the substratum is pavement rock; below this point is a boulder field interspersed with sand and shell material (Figure 4). A fine layer of silt covered most of the solid substratum and marine vegetation during the 3 seasons of observation. At a depth of approximately 10-12 m below the sea surface the band of rock stopped and was replaced by sand and silt. Shell debris, particulary those of the clams Saxidomus, Mya and Humilaria were common in this location.

Rockweed, Fucus distichus, formed the most conspicuous algal belt in the high intertidal zone during 1975. The sublittoral algal assemblage was generally confined to the boulder field, although scattered kelp plants were found growing on the soft bottom attached to shells and small stones. Agarum was the numerical dominant in the macrophyte zone. Other conspicuous algae were Laminaria spp., Rhodymenia, Constantinia and Callophyllis. Encrusting and articulated corallines were shallow in distribution. Most were found just below the intertidal zone on rock pavement. This site is more protected than the other 2 locations. Indications of this habitat difference are the silt deposition and the assemblage of macro-algae. For example, two important members of the kelp guild in the other OCS stations are Nereocystis and Pleurophycus. Neither one of these plants was found in the course of our field work at Zaikof Bay.



(A)



(B)

ZAIKOF BAY

DRAWING OF THE STUDY SITE (A)
AND THE SUBTIDAL VEGETATIVE CANOPIES (B)

FIGURE 4

THE MACROPHYTE COMMUNITY

The rocky sublittoral zone in the northern Gulf of Alaska is visually dominated by marine vegetation down to a depth of about 30 m. The term macrophyte is generally used when referring to the large, attached marine plants such as the seaweeds and seagrasses. Marine plant communities are highly diverse, and are known to be among the more productive systems on earth (McRoy, 1973; Mann, 1973). For example, Mann (1973) estimated the average primary production in the seaweed zone off Nova Scotia to be 1750 g C/m^2/ yr. Additional data by Westlake (1963) indicate that the annual production of seaweeds (1000 to 2000 g C/m^2/yr.) is about 10 times as great as planktonic algae. Since these figures apply only to a narrow zone adjacent to the land, the estimates are even more important when evaluating the contribution of the seaweeds to the production of carbon in Prince William Sound, a marine ecosystem dominated by its lengthy shoreline and extensive macrophyte zone.

ALGAL ASSEMBLAGE

The floristic components of sublittoral algal assemblages in southern Alaska have received very little attention. Recently, Rosenthal and Barilotti (1973), and Dayton (1975) provided descriptive information on kelp bed ecosystems off the west coast of Chichagof Island, Alexander Archipelago and Amchitka Island in the Aleutian Chain. To date, however, there has been no published research on the sublittoral plant communities of the northern Gulf of Alaska.

In 1913, the U. S. Department of Agriculture conducted a survey of the kelp beds of Alaska (Cameron, 1915). This investigation was primarily designed to inventory the kelp beds of southern Alaska, i.e., the location, size, kind and estimated yield of existing beds. The importance of this information to present day researchers is to provide an historical record of the exact location of some of the beds in the state. As an example, 2 of the OCS study sites, Macleod Harbor and the southwest end of Latouche Island, are listed in the kelp bed inventory (Rigg, 1915).

The most complete descriptive study of macro-algae from the north Gulf coast - Prince William Sound region was done by Johansen (1971). During this study a total of 33 shoreline stations were occupied in Prince William Sound approximately 15 months after the earthquake of March 27, 1964. However, all of the collections and observations were made in the intertidal zone, and no information was obtained from the sublittoral waters of the Sound.

The subtidal association of macrophytes at each of the study sites was multi-layered, or composed of separate vegetative canopies. Dur- the surveys described in this report we collected, and tentatively identified 62 taxa of macro-algae in these locations (Table 1). Both Latouche Point and Macleod Harbor have a floating canopy composed of bull kelp, Nereocystis. The sea-surface canopies in both locations underwent dramatic oscillations in areal cover with the change in season. One reason for this oscillation is that Nereocystis is an annual plant, and as such, all growth takes place during one year. Although some individual plants persist for more than 1 year, most have been lost by winter. In both of these sites we observed a loss of tissue material in the floating blades of Nereocystis during the fall survey (1975). Nereocystis formed an extensive "summer canopy" off the southwest end of Latouche Island during 1974 and 1975. Attached bull kelp was found distributed from the intertidal-subtidal fringe to approximately 20 m below the sea surface off neighboring Danger Island.

The stands of Nereocystis in Macleod Harbor were much less extensive than those off Latouche, most fringed the shoreline and grew at depths of less than 10 m. The study site at Zaikof Bay contained no attached bull kelp during the 3 seasons of observation.

Below this floating vegetative layer was a second canopy level composed of perennial kelps: Laminaria spp. and Pleurophycus gardneri. Pleurophycus was not observed at Zaikof Bay. At Latouche Island, Laminaria groenlandica was the most frequently encountered species in the kelp assemblage (Appendix A), ranging in abundance between 0 and 6 individuals /0.25

square meter. Cover estimates in these same quadrats ranged between 0 to 95 per cent. Laminaria yezoensis, distinguished by having a discoid holdfast, was less abundant at all 3 sites; its pattern of distribution was highly aggregated. At Macleod Harbor and Zaikof Bay, L. yezoensis was more abundant in the shallower part of the subtidal zone. Easily recognized by the wide midrib, Pleurophycus is the least abundant member of this kelp guild. It tends to grow in areas of higher relief, i.e., on top of boulders or on exposed ridges.

The third algal canopy was dominated by Agarum cribrosum. Agarum was common at all 3 stations. Usually its density increased with depth and/or became more abundant in some of the quieter parts of the Sound. In Zaikof Bay, Agarum was the most abundant brown alga (Table 2). Agarum has a shorter stipe than either Laminaria spp. or Pleurophycus and so it usually grows closer to the substratum. There was an inverse relationship between the relative abundance and percent cover of Laminaria and Agarum, in which Laminaria decreased and Agarum increased with depth (Appendix C). Dayton (1975) suggested that in shallow water Laminaria competition suppresses the growth of Agarum. Further, Vadas (1968) demonstrated Agarum was "distasteful" to sea urchins. He said this accounted for the increase in the abundance of Agarum with depth through increased grazing pressure on other coexisting algae. Over the past 3 years we have seen no avoidance of Agarum by sea urchins to justify the "distasteful" hypothesis proposed by Vadas. In some areas (the Alexander, Archipelago and Kachemak Bay, Lower Cook Inlet) sea urchins graze heavily upon Agarum. Also, in the northern Gulf Coast - Prince William Sound region where sea urchins are a minor numerical component of the kelp ecosystem, the vertical distribution of kelps is the same as in the state of Washington.

Occasionally Costaria, Desmarestia , and Cymathere occur in this 3rd canopy layer; usually however, these plants are shallower in vertical distribution than Agarum.

Growing beneath the kelps were foliose and peltate reds. The genera Constantinea, Opuntiella, Callophyllis, Membranoptera and Rhodymenia were visual dominants in the red algae guild. The more bush-like red algal Ptilota filicina, was another conspicuous member of the near bottom canopy layer. Beneath the erect reds were rock encrusting forms such as Lithothamnion; Corallina; Bossiella, Ralfsia and Hildenbrandia. The calcareous and encrusting algae were common to each site, although they appeared to be more abundant at Latouche Point.

FAUNAL ASSEMBLAGES

MARINE VERTEBRATES

Usage of these inshore areas by fishes, birds and mammals was recorded incidental to the other work. To date, we have observed 32 taxa of fishes in the 3 sites (Table 3). Bottom dwelling forms such as the pleuronectids, cottids, hexagrammids and scorpaenids were the most prominent members of the icthyofauna in the sublittoral zone. Most of these sightings were made during the summer and fall of the year. Fish become very uncommon in the study areas during the winter.

Water-related birds feed along the shoreline, or dive for marine plants and animals adjacent ot these shores. Of the more conspicuous water birds(Table 4), a few are transitory and others such as the mallard duck, Anas ? platyrhynchos, a known migrant, was observed during each seasonal visit to Latouche Point. Isleib and Kessel (1973) have presented the most complete work on birds in the north Gulf coast - Prince William Sound Region. Latouche Island, Montague Strait, Macleod Harbor and Zaikof Bay are listed in the text as geographical localities for avian censuses and observation.

The marine mammals are an important component of the north Gulf coast marine ecosystem. Historically, they were used as a source of food and clothing by the native inhabitants of Prince William Sound (de Laguna, 1956). At the turn of the 18th century, the Sound became an important center of the sea otter trade in the north Pacific. Despite intense exploitation during the next 100 years, remnant groups of sea otter survived in more isolated regions of the northern Gulf. Some of the earliest sightings following the exploitation period occurred in the vicinity of Latouche Island (Pitcher, in press).

During 1973 and 1974, the Alaska Department of Fish & Game conducted censuses of harbor seals, Steller sea lions and sea otters in these waters. Observations of other marine mammals were recorded incidentally. Current research studies by the U. S. Fish & Wildfife Service in Prince William Sound involves sea otter population dynamics and seasonal ecological information in otter habitats.

Sea otter, harbor seal and Steller sea lion have been sighted at all 3 OCS study sites (Table 4). By far the most ubiquitous member of this group, and possibly the most important marine mammal in the macrophyte ecosystem is the sea otter. At present the total population in the Prince William Sound region was estimated to be about 5,000 animals (Pitcher, in press). Estes and Palmisano (1974) present evidence on the way the sea otter structures nearshore plant communities in Alaska.

EPIBENTHIC INVERTEBRATES

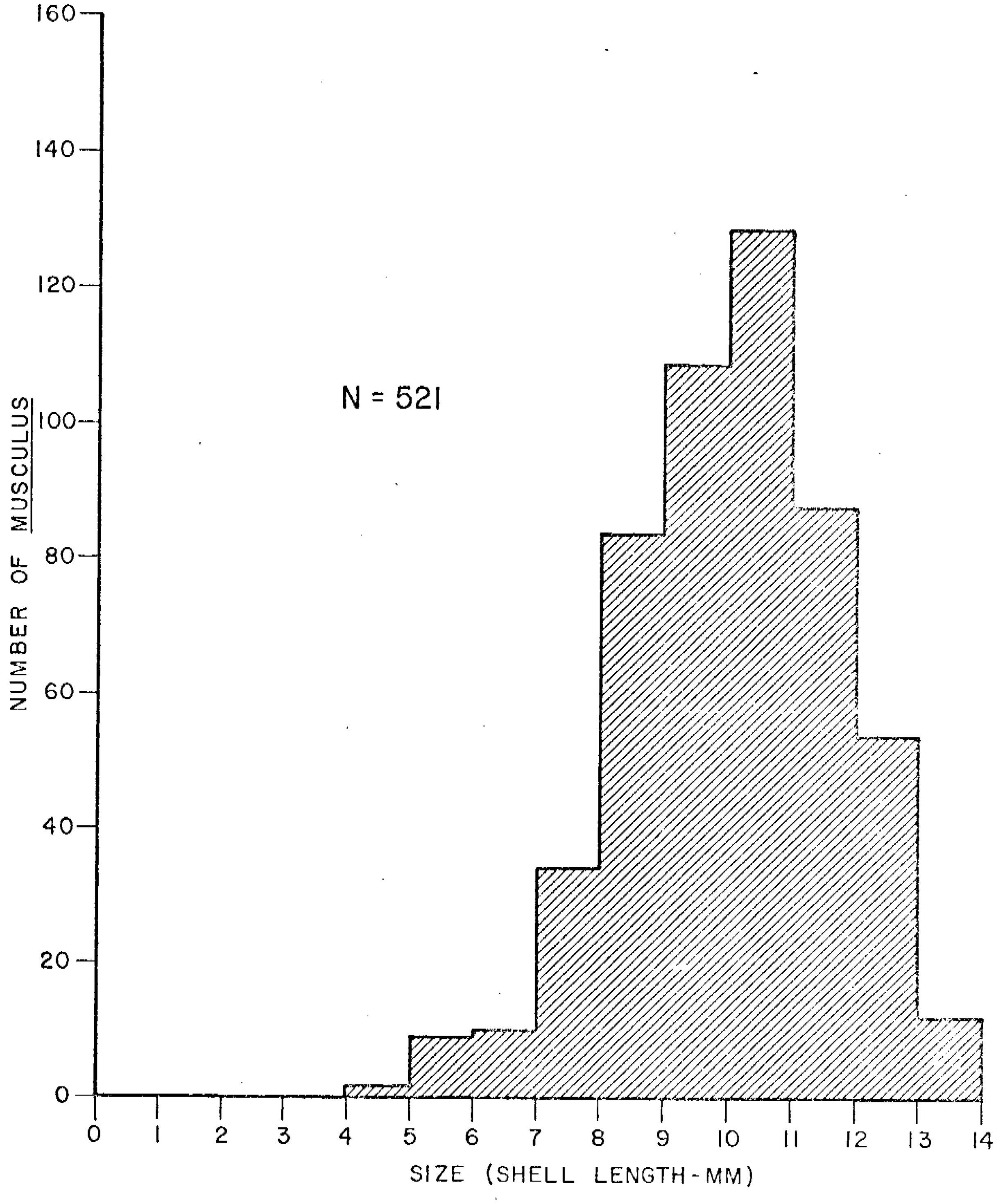
Within the 3 study areas 185 taxa of macroinvertebrates were either identified or categorized for future identification (Table 5). Of all the groups that were seen, the mollusks were represented by the greatest number of species. Except for genus *Musculus*, the molluscan members of the community appeared to be a minor component of the epifaunal biomass. From the percent cover estimates, the sessile forms such as sponges, bryozoans and tunicates are much more common than the other animals living on the rock substrate.

The macrophytic understory provides food and cover for the animal components of the system; it also serves as living substrate for plants and animals. For example, small mussels of the genus *Musculus* are conspicuous members of the sublittoral algal assemblages in the northern Gulf. Large populations of *Musculus* covered extensive portions of the shallow subtidal zone during the summers of 1974 and 1975. *Musculus* was found attached to the marine vegetation; and adhering to the rock substratum. Some of the understory kelps were totally covered by living Musculus. One 0.25 square meter quadrat from Latouche Point containing 2 laminarian kelps, included 521 Musculus ?vericosa(Figure 5), individuals with shell lengths ranging from 4 mm to 13 mm. Newly settled spat (less than 3 mm) were also attached to these kelps, but were not included in the histogram. No doubt, Musculus contributes appreciable amounts of energy to secondary consumers such as sea stars, snails, fishes and even sea otters, which we have repeatedly observed certain members of this group feeding on Musculus within the OCS study sites.

Shell debris at the base of the reef at Macleod Harbor indicate that Musculus populations have thrived in this area in the recent past. Few adult specimens have been observed during the past 2 surveys. Heavy sets of juveniles have been observed and collected from macrophytes in the shallow subtidal regions. Size structure of the population at these times is virtually indistinguishable(Table 6). It is significant that during the four months of winter, it appears there was no growth. These organisms probably feed mainly on phytoplankton, and that food source is extremely scarce during the winter months in northern waters. Heavy sets of spat were observed at numerous locations along the gulf of Alaska during the summer and fall. Available substrate for adults is reduced drastically by fall storms and loss of vegetative canopies.

A larger species Musculus ?laevigata occupies a considerably different niche and has adopted a substantially different life strategy. It lives in byssus nests on the vertical faces of rocks and in kelp holdfasts. Both substrates are considerably more dependable, and the population contains a large proportion of adults (Figure 6), which brood tremendous numbers of eggs within the nest until the juveniles are at least 0.5 mm long. A length -weight regression for the winter population is presented in Figure 7.

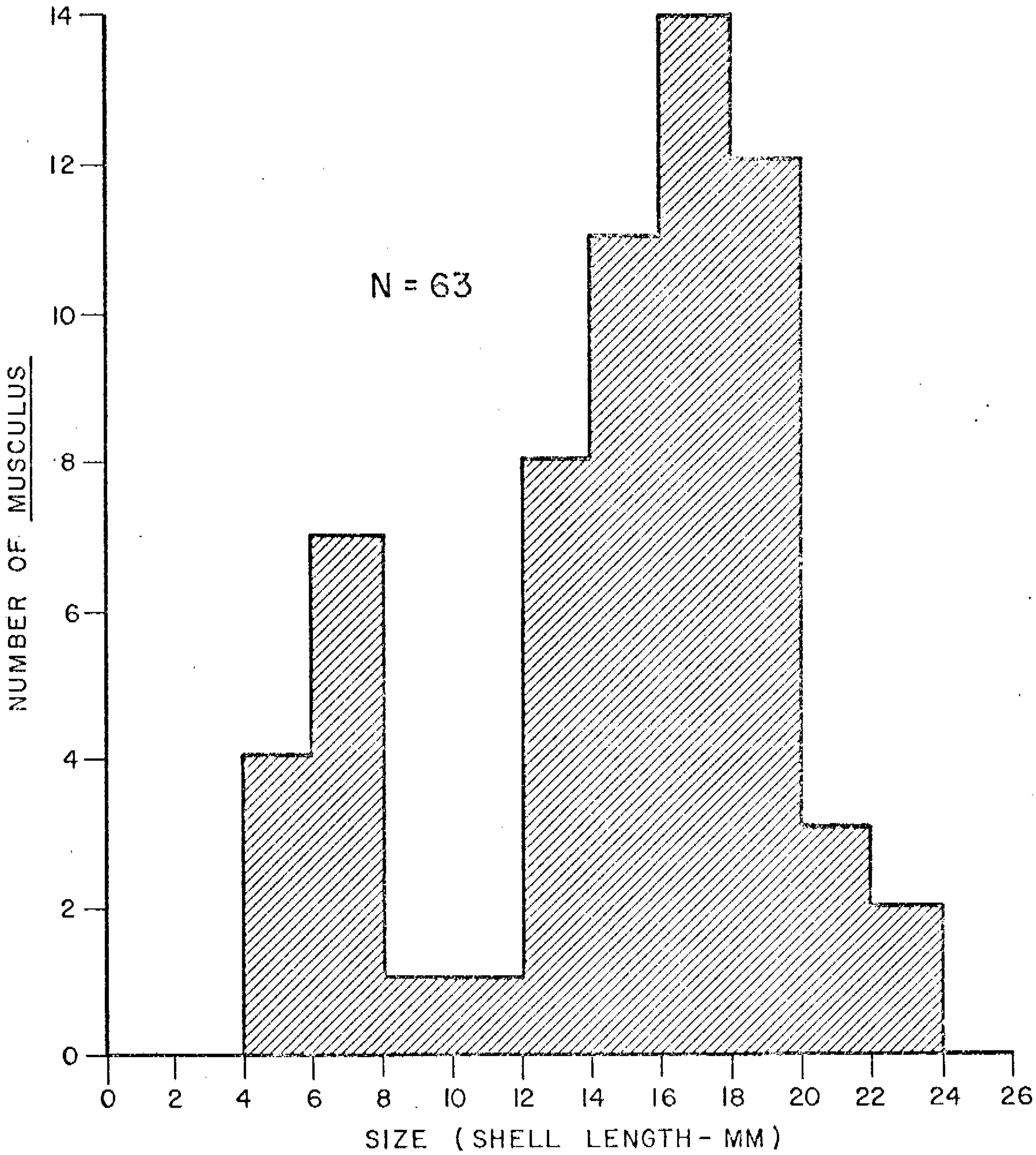
A number of other species utilize the macrophyte resource for food or as sites of attachment. For example, the limpet, Collisella instabilis has only been found on the taller statured understory kelps. In this case the kelp provides both food and cover to the snail. Round serpulid worms and



MUSCULUS

MUSCULUS SIZE CLASS DISTRIBUTIONS
FROM A SUBTIDAL .25 M^2 QUADRAT OFF LATOUCHE ISLAND

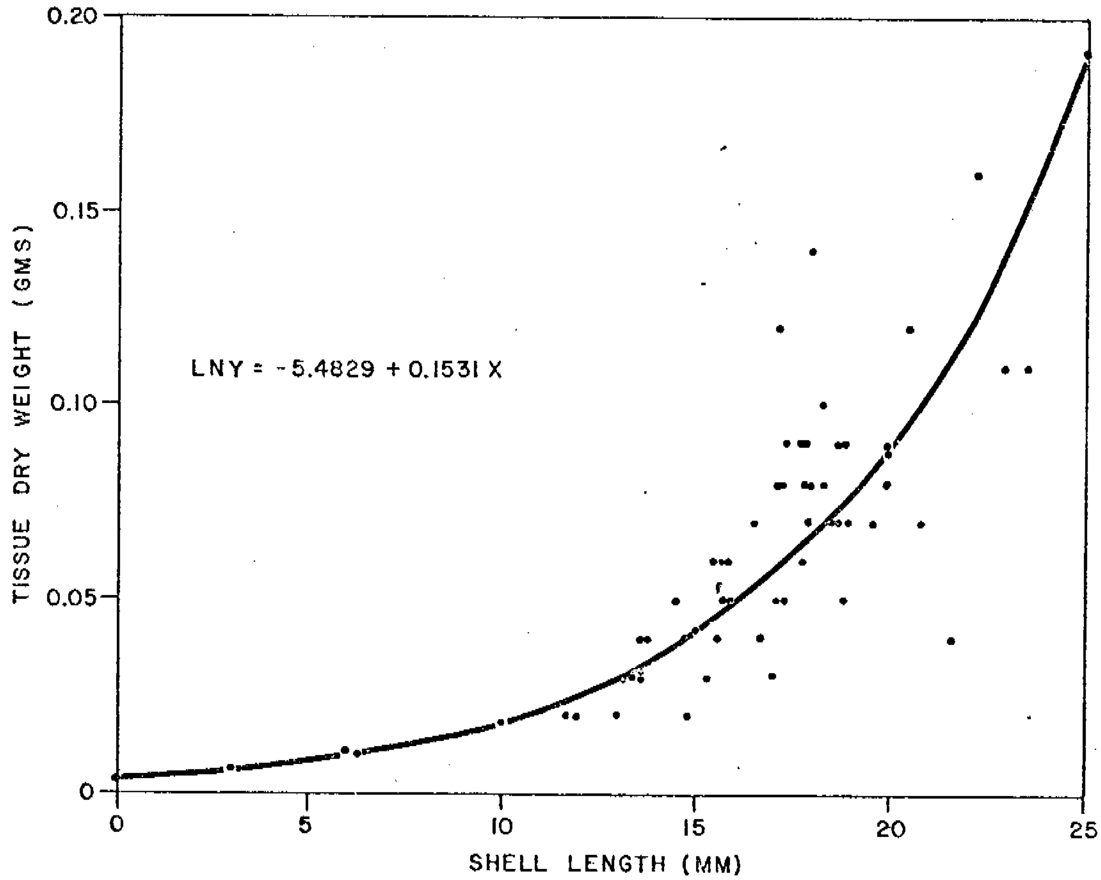
FIGURE 5



MUSCULUS ? LAEVIGATA

COLLECTED FROM THE SUBTIDAL ZONE IN ZAIKOF BAY

FIGURE 6



A SAMPLE OF

MUSCULUS ? LAEVIGATA

POPULATION FROM ZAIKOF BAY

3/20/76

FIGURE 7

encrusting bryozoans spend the entire life cycle following the initial settling stage attached to the plants. Hermit crabs, decorator crabs and gammarid amphipods browse upon the fronds or blades. Hermit crabs, particularly the genus Pagurus are visual dominants in this guild. During the summer of 1974 a nudibranch, Melibe leonina literally covered the kelp understory in Zaikof Bay and neighboring Rocky Bay (Rosenthal, unpublished data), and was common in all of the subtidal locations we visited in the Sound during 1974; however in 1975-76 this same nudibranch was only seen in one OCS site - Zaikof Bay.

Beneath the dense growth of marine vegetation, another living mat is comprised of more cryptic forms or sessile invertebrates such as sponges, hydroids, bryozoans and tunicates. Within the interstices of the kelp holdfasts were small snails, sea stars and brittle stars. One of these, the brittle star Ophiopholis aculeata, has a highly aggregated distribution pattern; it was common in all 3 study sites.

Most of these animals are either suspension or deposit feeders and the amount of organic material that must be available to support the vast amount of biomass in these nearshore systems is certainly impressive. Most important sources of food materials are probably macrophytes and terrestrial plant debris.

Highly motile invertebrates such as snails and sea stars move along the bottom beneath the vegetative understories. Most are found on rocky substrate or in sand areas adjacent to more solid substrate. Occasionally, sea stars climb on the attached kelps, usually in search of food such as Musculus. The young of Pycnopodia helianthoides, Crossaster papposus and Evasterias troschelii are commonly found on the blades of the kelp plants.

Sea stars are visual dominants in the benthic communities of the northern Gulf coast region. Feeding behavior of the common species in the northeast Pacific has been adequately described by Mauzey, Birkeland and Dayton (1968). Because this group is such an important predator in the sublittoral zone, we have spent a great deal of time estimating relative abundance, population size structure and gathering information on the foraging behavior of the most common species. To date, 1147 square meters of sea floor has been quantitatively sampled by band transects in the 3 OCS study sites.

At Latouche Point, 435 square meters were sampled within sublittoral zone (Table 7). The sun star, *Pycnopodia helianthoides* was the most abundant species; density estimates ranged between 0 to 0.36 individuals per square meter of sea floor. The second most abundant species was the blood star, *Henricia leviuscula*.

In Macleod Harbor we have sampled 470 square meters of sea floor with transects since September 14, 1975 (Table 8). Within the sublittoral zone, estimated density of *Pycnopodia helianthoides* ranged between 0 and 0.80 individuals per square meter; mean density was 0.26 individuals/square meter. The leather star, *Dermasterias imbricata* was the second most abundant member of the asteroid guild in Macleod; density estimates ranged between 0 and 0.20 individuals/square meter, and mean density was 0.03 individuals/square meter(Table 9).

At Zaikof Bay, *Pycnopodia* was again the numerical dominant in the 242 square meters of sea floor surveyed by belt transect (Table 2). Estimates of density ranged from 0.18 individuals/square meter to 0.90 individuals/square meter; *Henricia* was second, with a mean density of 0.07 individuals/square meter and *Crossaster papposus* was third in relative abundance at this site(Table 10).

Sea urchins were rarely seen in the 3 study sites. However, occassionally we found a *Strongylocentrotus drobachiensis* in the kelp, or observed a highly cryptic *S. franciscanus* under a rock or ledge area at Latouche Point.

SEASONAL PERIODICITY

Knowledge of seasonal periodicity in the macrophyte assemblages of the northern Gulf coast is sketchy at this time. One seasonal change that is obvious to even the casual observer is the oscillation in the dimensions of the surface canopies of bull kelp. These floating canopies usually reach peak development and cover considerable areas of the sea floor during the summer months. Nereocystis is an annual, that reaches great size in a single season. Most of the growth takes place during the spring and early summer. Fertile plants have been observed as early as April 24, 1975; peak canopy development was reached by late summer. When mature, zoosporangial sori fall out of the blade. The sori drift to the bottom as a unit and release of zoospores apparently follows soon after. A few juvenile Nereocystis sporophytes were observed in Macleod Harbor during early March (1976).

Cohorts of adult Nereocystis growing adjacent to one another occasionally become entangled. Other plants, detached by storms and strong water motion drift through the stands of kelp and become entangled with the attached plants. Mutual entanglement results, thereby leading to further mortality in the kelp bed. This same source of kelp mortality was described by Rosenthal, Clarke and Dayton(1974) in the stands of giant kelp off the coast of southern California. Since herbivore grazing is of minor importance in the OCS study areas, the major causes of kelp mortality are probably physical detachment, and old age or senility.

The understory canopies undergo similar changes in areal cover and standing crop, however some species such as Laminaria are perennials; the individual plants persist for two or more years. Laminaria sequentially sheds the blade and renews it during the same year. For example, 26% (n=86) of the 329 Laminaria examined on the transects at Latouche (Table 11)and 42% of the plants in the quadrats had lost their fronds (blades) during the November 1975 survey. By March 1976, most of the Laminaria had undergone complete blade renewal. During the fall, Laminaria spp. lose the blades and a great deal of drift material is present at these sites. The blades erode away and fall to the bottom; surge channels or bathymetric lows in the rocky substrate serve as collection points of the drift material. The process of blade renewal had a significant change in the laminarian canopy, permitting more available light to reach the sea floor. Kelp germination was apparent during the late fall and winter of 1975-1976. The growth strategies of these kelps are also different. For example, *Laminaria* was observed to grow rapidly in the winter off Nova Scotia (Mann, 1973), whereas *Nereocystis* appeared to grow only during spring and summer in British Columbia (Scagel, 1947).

Drift macrophytes are a source of food for herbivores, much of this is consumed by suspension and deposit feeders. Bacterial breakdown is the final fate of the decaying macrophytes. The accumulation of heavy drift during the fall is coincidental with the reduction of phytoplankton in the water column. Apparently the suspension feeders rely upon this food when the planktonic forms are rare in the shallow waters of southern Alaska.

Contributions of primary producers appear highly seasonal in nearshore systems. Phytoplankton availability ranges from high in summer to low in winter. Many macrophytes (e.g.) *Nereocystis*, *Laminaria* spp., and *Zostera marina* release large quantities of plant material into nearshore and estimarine systems in the fall. Several other species maintain high standing crops throughout the year. The contribution of terrestrial plant communities is probably important both in fall and spring, but essentially ceases during the winter.

Macro-invertebrate herbivores were uncommon in the study areas. However, smaller forms such as isopods and gammarid amphipods probably are significant consumers of algae. The major consumers of nonplanktonic plant material are probably suspension and deposit feeders that are dependent on macerated plant debris. Most are relatively unselective, except in terms of food particle size. It appears that food availability is fairly dependable for these organisms and the feeding category develops high, diverse, apparently stable standing crops. Suspension and deposit feeders include such diverse organisms as tunicates, sea cucumbers, serpulid polychaetes, many clams, bryozoans and sponges.

Some filter-feeders demonstrate high selectivity for phytoplankton, which is a highly seasonal food supply. The significance of such seasonability is unclear, but may result in periodic increases in susceptibility to environmental perturbations.

TABLE 1
TENTATIVE LIST OF MACROPHYTES
COLLECTED AT THE OCS STUDY SITES

	LOCATION
Chlorophyta	
Codium fragile	L
Enteromorpha linza?	M;Z
Enteromorpha sp.	Z
Halicystis ovalis	L
Monostroma fuscum ?	L;M;Z
Monostroma sp.	L;M;Z
Spongomorpha species	M
Ulva sp.	Z
Phaeophyta	
Agarum cribrosum	L;M;Z
Alaria pylaii ?	L
Alaria marginata ?	L;M;Z
Chordaria flagelliformis	
Costaria costata	L;M
Cymathere triplicata	L;M
Desmarestia ligulata	L;M;Z
Desmarestia viridis	L;M;Z
Fucus distichus	L;M;Z
Laminaria groenlandica	L;M;Z
Laminaria saccharina	M;Z
Laminaria yezoensis	L;M;Z
Melanosiphon intestinalis	
Nereocystis luetkeana	L;M
Pleurophycus gardneri	L;M
Ralfsia species	L;M;Z
Scytosiphon lomentaria	Z
Sphacelaria subfusca ?	M
Rhodophyta	
Bossiella orbigniana	L;M
Bossiella sp.	L;M;Z
Callophyllis edentata	L;M
Callophyllis flabellulata	L;M
Callophyllis sp.	L;M;Z
Clathromorphum circumscriptum ?	L
Constantinea simplex	L;M;Z
Constantinea subulifera	L;M;Z
Corallina vancouveriensis	L;M;Z
Cryptopleura sp.	L
Delesseria decipiens	L;M
Euthora sp.	M
Gigartina species	L;M;Z
Halosaccion glandiforme	L;M;Z
F: cryptonemiaceae	L
Iridea sp.	L

TABLE I (Cont.)

	LOCATION
Rhodophyta (cont.)	
Kallymenia oblongifructa ?	L;M
Lithothamnion sp. ?	L;M;Z
Membranoptera dimorpha	L;M;Z
Membranoptera multiramosa ?	L
Microcladia borealis	L;M
Odonthalia floccosa	M;Z
Odonthalia kamtschatica	L;M;Z
Opuntiella californica	L;M;Z
Phycodrys sp.	L;M
Polyneura latissima	L
Polysiphonia species	L;M;Z
Porphyra nereocystis ?	L:M
Pterosiphonia bipinnata	Z
Ptilota filicina	L;M;Z
Ptilota tenius	L;M
Rhodoglossum affine	M
Rhodymenia palmata	L;M;Z
Rhodymenia pertusa	L;M;Z
Schizymenia sp.	L;M;Z
Stenogramme interrupta	Z

Location Symbols:

L = Latouche Point
M = Macleod Harbor
Z = Zaikof Bay

TABLE 2

DENSITY ESTIMATES OF SOME DOMINANT BROWN ALGAE AT ZAIKOF BAY.

Taxon	Nov. 23, 1975	Nov. 24, 1975
Nereocystis	0	0
Laminaria spp.	39 $.78/m^2$	43 $1.72/m^2$
Agarum	172 $3.44/m^2$	53 $2.12/m^2$
Cymathere	0	0
Pleurophycus	0	0
Area Sampled:	25 x 2m	25 x 1m
Depth:	11-12m	12-13m
Substrate Type:	Rock	Rock-Sand Interface

TABLE 2 (Cont.)

DENSITY ESTIMATES OF SOME DOMINANT BROWN ALGAE AT ZAIKOF BAY

Taxon	March 20, 1976	March 20, 1976	March 20, 1976
Nereocystis	0	0	0
Laminaria groenlandica	23 2.3/m^2	33 3.3/m^2	14 1.4/m^2
Laminaria yezoensis	0	0	12 1.2/m^2
Agarum	52 5.2/m^2	59 5.9/m^2	82 8.2/m^2
Cymathere	0	0	0
Pleurophycus	0	0	0
Area Sampled:	10 x 1m	10 x 1m	10 x 1m
Depth:	10.5m	7.5m	4.5m
Substrate Type	Boulder	Boulder	Boulder w/Pavem

TABLE 3

FISHES OBSERVED IN THE THREE STUDY SITES DURING 1975

COMMON NAME	SCIENTIFIC NAME	LOCATION
Rock greenling	Hexagrammos lagocephalus	L;M;Z
White spotted greenling	Hexagrammos stelleri	M;Z
Kelp greenling	Hexagrammos decagrammus	L;M;Z
Masked greenling	Hexagrammos octogrammus	L;M
Lingcod	Ophiodon elongatus	L
Great sculpin	Myoxocephalus polyacanthocephalus	M;Z
Buffalo sculpin	Enophrys bison	M
Blackfin sculpin ?	Malacottus kincaidi	M
Red irish lord	Hemilepidotus hemilepidotus	L:M
Brown irish lord	Hemilepidotus spinosus	L
Northern sculpin ?	Icelinus borealis	L
Grunt sculpin	Rhamphocottus richardsoni	L
Silverspotted sculpin	Blepsias cirrhosus	M
Pacific staghorn sculpin	Leptocottus armatus	M
sculpins, unid.	f: cottidae	L;M;Z
Sturgeon poacher	Agonus acipenserinus	Z
Pacific spiny lumpsucker	Eumicrotremus orbis	Z
Black rockfish	Sebastes melanops	L;M;Z
Copper rockfish	Sebastes caurinus	L;M
Yellowtail rockfish	Sebastes flavidus	L
rockfishes, unid.	f: scorpaenidae	L;M;Z
Searcher	Bathymaster signatus	L
Northern ronquil	Ronquilus jordani	L;M;Z
Starry flounder	Platichthys stellatus	M
Yellowfin sole	Limanda aspera	M;Z
Pacific halibut	Hippoglossus stenolepis	L
Snake prickleback ?	Lumpenus sagitta	M
prickleback, unid.	f: stichaeidae	L;M;Z
Gunnel, unid.	f: pholidae	L;M;Z
Pipe fish, unid.	f: syngnathidae	L
Pacific tomcod	Microgadus proximus	L;M;Z
Sand lance	Ammodytes hexapterus	L

Location Symbols:

L = Latouche Point
M = Macleod Harbor
Z = Zaikof Bay

TABLE 4

A LIST OF BIRDS AND MAMMALS OBSERVED
AT THE OCS STUDY SITES DURING 1975-76

WATER BIRDS

COMMON NAME	SCIENTIFIC NAME	LOCATION
Harlequin duck	*Histrionicus histrionicus*	L;Z
White-winged scoter	*Melanitta deglandi*	L;M;Z
Oldsquaw	*Clangula hyemalis*	M;Z
Mallard duck	*Anas platyrhynchos*	L
Greater scaup	*Aythya marila*	M;Z
Barrow's glodeneye	*Bucephala islandica*	M;Z
Cormorant	*Phalacrocorax* sp.	L
Black-legged kittiwake	*Rissa tridactyla*	L
Glaucous-winged gull	*Larus glaucescens*	L;M;Z
Grebe	*Podiceps* sp.	M
Common murre	*Uria aalge*	L
Murrelet	*Brachyramphus* sp.	L;M;Z
Pigeon guillemot	*Cepphus columba*	L
Black oyster catcher	*Haematopus bachmani*	L;M

MAMMALS

Sea otter	*Enhydra lutris*	L;M;Z
Land otter	*Lutra canadensis*	L
Harbor seal	*Phoca vitulina*	L;M;Z
Steller sea lion	*Eumetopias jubata*	L;M;Z
Harbor porpoise	*Phocoena phocoena*	M
Killer whale	*Orcinus orca*	L

Location Symbols:

L = Latouche Point
M = Macleod Harbor
Z = Zaikof Bay

TABLE 5

MACROINVERTEBRATES COLLECTED OR OBSERVED WITHIN THE PERIMETER OF EACH STUDY SITE*

PORIFERA	LOCATION
Cliona celata	L;Z
Suberites ficus	L;M;Z
Ophlitaspongia pennata ?	L
orange encrusting sponge	L;M
Leucosolenia sp. ?	L
Xestospongia vanilla ?	L;M
Mycale adhaerens ?	M
white globose sponge	L
yellow spatter sponge	L;M
syconid sponge, white	L
yellow encrusting, canaliculate	L
red globular sponge	Z
white globular sponge	L;M

CNIDARIA	
Abietinaria sp.	L;M;Z
Plumularia sp.	L;M
Sertularella sp.	L;M
Eudendrium	L
Campanularia verticillata	L
Obelia sp.	L
Metridium senile	L;M;Z
Tealia crassicornis	L;M;Z
Tealia sp.	L;M;Z
§*Stomphia*	M;Z
Anthopleura xanthogrammica	L;M
unid anemone, pink	L
Aglaeophenia sp.	L
Ptilosarcus gurneyi	M;Z
Gersemia rubiformis	L
Hydractinia sp.	Z
scyphistomas, unid.	L;M
Halcampa sp.	M
campanulariidae	Z
Lafoea sp.	M;Z
Haliclystus sp.	M

NEMERTEA	
unid. species, orange	Z

MOLLUSCA	
Katherina tunicata	L;M;Z

TABLE 5. (Cont.)

MACROINVERTEBRATES COLLECTED OR OBSERVED
WITHIN THE PERIMETER OF EACH STUDY SITE*

MOLLUSCA (Cont.)	LOCATION
Tonicella spp.	L;M;Z
Cryptochiton stelleri	L;M;Z
Placiphorella velata	L;M;Z
Mopalia spp.	L;M;Z
Ischnochiton mertensii	L;M;Z
Puncturella multistriata	L;M;Z
Diadora aspera	L;M
Crepipatella lingulata	L;M;Z
Cryptobranchia concentrica	M;Z
Collisella instabilis	L;M;Z
Acmaea mitra	L;M;Z
Fusitriton oregonensis	L;M;Z
Trichotropis cancellata	L;M;Z
Trichotropis sp.	M;Z
Margarites sp.	L;M;Z
Calliostoma ligatum	L;M;Z
Calliostoma annulatum	L
Velutina laevigata	L;Z
Velutina sp. ?	L
Natica sp.	L;Z
Lacuna sp. ?	L;Z
Olivella baetica	M;Z
Nassarius mendicus ?	M
Ceratostoma nuttallii	M
Ocenebra	L;Z
Trophon muticostata	L;M
Amphissa columbiana	L;M;Z
Searlesia dira	L;M;Z
Turridae unid.	M
Neptunea lirata	Z
Volutharpa sp. ?	Z
Thais canaliculata	M;Z
Thais lamellosa	L;M;Z
Aglaja ocelligera	M;Z
Gastropteron pacificum	L;M;Z
Hermissenda crassicornis	L;M;Z
Triopha carpenteri	L;M
Dendronotus dalli	L
Tochuina tetraquetra	L
Melibe leonina	L;Z
Dendronotus spp.	L;M
Diaulula sandiegensis	L
Cadlina luteomarginata	L;M
Cadlina sp.	M
Archidoris odneri	L;M
Anisodoris nobilis	L
Pododesmus macroschisma	L;M;Z

TABLE 5 (Cont.)

MACROINVERTEBRATES COLLECTED OR OBSERVED WITHIN THE PERIMETER OF EACH STUDY SITE*

MOLLUSCA (Cont.)	LOCATION
Pecten caurinus (shells)	M
Chlamys spp.	L;M
Hiatella arctica	L
Modiolus modiolus	L;M
Musculus laevigata ?	L;M;Z
Musculus vericosa	L;M;Z
Mytilus edulis	L;M;Z
Tellina sp.	M
Clinocardium nuttalli	M
Clinocardium ciliatum	Z
Lyonsia californica	L;M;Z
Saxidomus giganteus	M;Z
Thracia trapezoides	Z
Mya truncata	Z
Entodesma saxicola	L;Z
Protothaca staminea	M;Z
Macoma spp.	M;Z
Humilaria kennerlyi	L;Z
Octopus sp.	L;Z
ANNELIDA	
Serpula vermicularis	L;M;Z
Eudistylia vancouveri	Z
serpulidae	L;M;Z
sabellidae	L
Myxicola sp. ?	L;Z
Cistenides brevicoma ?	M;Z
Onuphidae, unid.	M;Z
Maldanidae, unid.	M;Z
Abarenicola sp.	M
Chone sp.	M
ARTHROPODA	
Balanus nubilus	L;Z
Balanus spp.	L;M;Z
mysidacea, unid.	L;M;Z
Pandalus danae	M;Z
hippolytidae, unid.	L;M;Z
gammaridea, unid.	L;M;Z
Hapalogaster mertensii	L
Cryptolithodes sitchensis	L
Phyllolithodes papillosus	Z

TABLE 5 (Cont.)

MACROINVERTEBRATES COLLECTED OF OBSERVED WITHIN THE PERIMETER OF EACH STUDY SITE*

ARTHROPODA (Cont.)	LOCATION
Pagurus ochotensis	M;Z
Pagurus spp.	L;M;Z
Pylopagurus sp. ?	Z
Elassochirus gilli	L;M;Z
Elassochirus tenuimanus	L;M
Oregonia gracilis	L;M
Chionocetes bairdi	Z
Pugettia richii	L;M;Z
Hyas lyratus	M
Telmessus cheiragonus	L;Z
Crangon sp.	M
Cancer oregonensis	L;M;Z
BRYOZOA	
Heteropora spp.	L;M;Z
Tricellaria gracilis	L;M;Z
Microporina borealis	L;M;Z
Dendrobeania murrayana	L;M;Z
Membranipora spp.	L;M;Z
Phidolopora pacifica	L;Z
Hippodiplosia insculpta	L
Flustrella gigantea	Z
Lichenopora sp.	L;M
Scrupocellaria sp. ?	L;M
Bugula sp.	L
Victorella sp. ?	M
Myriozoum subgracile	M
Alcyonidium polyoum ?	M;Z
BRACHIOPODA	
Terebratalia transversa	L;M;Z
ECHINODERMATA	
Ophiopholis aculeata	L;M;Z
Amphiodia occidentalis	M
Leptasterias sp.	Z
Pteraster tesselatus	L
Dermasterias imbricata	L;M;Z
Henricia leviuscula	L;M;Z

TABLE 5 (Cont.)

MACROINVERTEBRATES COLLECTED OR OBSERVED WITHIN THE PERIMETER OF EACH STUDY SITE*

ECHINODERMATA (Cont.)	LOCATION
Henricia sp.	L
Orthasterias koehleri	L;M:Z
Pisaster ochraceus	L;M;Z
Evasterias troschelii	L;M;Z
Pycnopodia helianthoides	L;M;Z
Crossaster papposus	L;M;Z
Solaster stimpsoni	L;M;Z
Solaster dawsoni	L;Z
Tosiaster arcticus	L
Strongylocentrotus droebachiensis	L;M;Z
Strongylocentrotus franciscanus	L
Parastichopus californicus	Z
Psolus chitonoides	L
Cucumaria miniata	L;M;Z
UROCHORDATA	
Styela montereyensis	L
Chelyosoma productum	L;Z
Corella willmeriana	L;M;Z
Halocynthia igaboja	L;Z
Boltenia villosa	L;M
Cnemidocarpa finmarkiensis	L;M;Z
Metandrocarpa taylori	L;M;Z
Didemnum sp. ?	L;M;Z
Synoicum sp. ?	L;M
Pycnoclavella sp. ?	L
Aplidium spp.	L;M
green colonial	L
red, convoluted colonial	Z
gray-black colonial	L
can-o-corn tunicate	L
Distaplia occidentalis ?	L;M;Z
magenta, shiny colonial	Z

Location Symbols:

L = Latouche Point
M = Macleod Harbor
Z = Zaikof Bay

* This list is only tentative and is not intended to be complete.

TABLE 6

MUSCULUS VERRUCOSA FROM THE SUBLITTORAL ZONE IN MACLEOD HARBOR

November 1975		March 1976	
Size (mm)	Number	Size (mm)	Number
1	0	1	1
2	33	2	44
3	103	3	160
4	20	4	19
5	1	5	1
	184		225

x = 2.94
s.d = 0·55

x = 2.89
s.d = 0.55

Kolmogorov-Smirnov two sample test

Accept null hypothesis:
No significant difference between the 2-populations

TABLE 7

DENSITY ESTIMATES OF SOME ECHINODERMS FROM
THE SUBTIDAL ZONE AT LATOUCHE POINT

Taxon	Sept.17,1975	Sept.17,1975	Sept.17,1975	Sept.17,1975	Sept.17,1975
Pycnopodia	4 0.16/m^2	5 0.33/m^2	9 0.36/m^2	1 0.04/m^2	0
Dermasterias	0	0	1 0.04/m^2	1 0.04/m^2	0
Orthasterias	1 0.04/m^2	0	2 0.08/m^2	0	0
Crossaster	2 0.08/m^2	0	1 0.04/m^2	0	0
Solaster	1 0.04/m^2	0	0	0	0
Henricia	9 0.36/m^2	3 0.20/m^2	0	1 0.04/m^2	0
Strongylocentrotus	1 0.04/m^2	0	1 0.04/m^2	0	1 0.06/m^2
Area Sampled:	25 x 1m	15 x 1m	25 x 1m	25 x 1m	15 x 1m
Depth:	12m	9-11m	9-11m	9m	9m

TABLE 7 (Cont.)

DENSITY ESTIMATES OF SOME ECHINODERMS FROM THE SUBTIDAL ZONE AT LATOUCHE POINT

Taxon	Sept. 17, 1975	Sept. 17, 1975	Nov. 26, 1975	Nov. 26, 1975	Nov. 26, 1975
Pycnopodia	3 0.12/m^2	5 0.20/m^2	1 0.06/m^2	1 0.06/m^2	0
Dermasterias	2 0.08/m^2	0	0	0	1 0.02/m^2
Orthasterias	0	3 0.12/m^2	1 0.06/m^2	1 0.06/m^2	0
Crossaster	0	1 0.04/m^2	1 0.06/m^2	2 0.13/m^2	4 0.08/m^2
Solaster	0	0	0	0	0
Henricia	3 0.12/m^2	6 0.24/m^2	2 0.13/m^2	1 0.06/m^2	1 0.02/m^2
Strongylocentrotus	0	3 0.12/m^2	1 0.06/m^2	0	0
Area Sampled:	25 x 1m	25 x 1m	15 x 1m	15 x 1m	25 x 2m
Depth:	9m	12m	12m	12m	13-14m

TABLE 7 (Cont.)

DENSITY ESTIMATES OF SOME ECHINODERMS FROM
THE SUBTIDAL ZONE AT LATOUCHE POINT

Taxon	March 17,1976	March 17,1976
Pycnopodia	$0.02/m^2$ [2]	$0.11/m^2$ [11]
Dermasterias	$0.01/m^2$ [1]	$0.05/m^2$ [5]
Orthasterias	$0.03/m^2$ [3]	$0.02/m^2$ [2]
Crossaster	0	$0.01/m^2$ [1]
Solaster	0	0
Henricia	0	$0.16/m^2$ [16]
Strongylocentrotus	0	$0.01/m^2$ [1]
Area Sampled:	50 x 2m	50 x 2m
Depth:	8-11m	3-8m

TABLE 8

DENSITY ESTIMATES OF SOME DOMINANT KELPS AT MACLEOD HARBOR. ESTIMATES WERE DERIVED FROM BAND TRANSECTS OF DIFFERENT LENGTHS

Taxon	Sept. 15, 1975	Sept. 15, 1975	Sept. 15, 1975
Nereocystis	0	0	23 0.46/m^2
Laminaria spp.	83 16.6/m^2	71 14.2/m^2	not counted
Agarum	35 7.0/m^2	13 2.6/m^2	not counted
Cymathere	0	0	not counted
Pleurophycus	5 1.0/m^2	14 2.8/m^2	not counted
Area Sampled:	10 x .5m	10 x 5m	25 x 2m
Depth:	7-8m	7-8m	5m
Substrate Type:	Rock & Kelp	Rock & Kelp	Rock

TABLE 8 (Cont.)

DENSITY ESTIMATES OF SOME DOMINANT KELPS AT MACLEOD HARBOR. ESTIMATES WERE DERIVED FROM BAND TRANSECTS OF DIFFERENT LENGTHS

Taxon	March 13, 1976	March 13, 1976	March 15, 1976
Nereocystis	0	0	0
Laminaria spp.	42 2.80/m^2	31 3.10/m^2	36 5.14/m^2
Agarum spp.	28 1.87/m^2	30 3.00/m^2	12 1.71/m^2
Cymathere	0	0	0
Pleurophycus	0	18 1.80/m^2	2 0.28/m^2
Area Sampled:	15 x 1m	10 x 1m	7 x 1m
Depth:	10m	4.5m	7.5-8.5m
Substrate Type:	Rock & Sand	Rock	Rock & Sand

TABLE 9

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT MACLEOD HARBOR

Taxon	Sept. 14, 1975	Sept. 14, 1975	Sept. 14, 1975
Pycnopodia	7 $0.14/m^2$	3 $0.12/m^2$	5 $0.33/m^2$
Dermasterias	0	1 $0.04/m^2$	1 $0.06/m^2$
Orthasterias	0	0	1 $0.06/m^2$
Crossaster	0	0	0
Solaster	0	0	0
Henricia	0	0	1 $0.06/m^2$
Pisaster	0	0	0
Evasterias	0	0	0
Strongylocentrotus	0	0	0
Area Sampled:	25 x 2m	25 x 1m	15 x 1m
Depth:	6-7m	12m	8m
Substrate Type:	Rock & Sand	Sand & Rock	Rock Outcrop

TABLE 9 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT MACLEOD HARBOR

Taxon	Sept. 14, 1975	Sept. 15, 1975	Sept. 15, 1975
Pycnopodia	1 $0.06/m^2$	1 $0.04/m^2$	0
Dermasterias	0	1 $0.04/m^2$	0
Orthasterias	0	0	0
Crossaster	0	0	0
Solaster	0	0	0
Henricia	0	0	0
Pisaster	0	0	0
Evasterias	0	0	0
Strongylocentrotus	0	0	1 $0.2/m^2$
Area Sampled:	15 x 1m	25 x 1m	10 x .5m
Depth:	5m	12m	7-8m
Substrate Type:	Rock	Sand & Rock	Rock & Kelp

TABLE 9 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT MACLEOD HARBOR

Taxon	Sept. 15, 1975	Sept. 15, 1975	Sept. 15, 1975
Pycnopodia	13 $0.26/m^2$	6 $0.24/m^2$	4 $0.16/m^2$
Dermasterias	2 $0.04/m^2$	0	0
Orthasterias	0	0	0
Crossaster	0	0	0
Solaster	0	0	0
Henricia	1 $0.02/m^2$	0	0
Pisaster	0	0	0
Evasterias	0	0	0
Strongylocentrotus	0	0	0
Area Sampled:	50 x 1m	25 x 1m	25 x 1m
Depth:	7-11m	6m	3-5m
Substrate Type:	Rock & Sand	Rock & Kelp	Rock & Kelp

TABLE 9 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT MACLEOD HARBOR

Taxon	Nov. 29, 1975	Nov. 29, 1975	Nov. 30, 1975
Pycnopodia	18 $0.72/m^2$	8 $0.80/m^2$	15 $0.38/m^2$
Dermasterias	1 $0.04/m^2$	2 $0.20/m^2$	2 $0.05/m^2$
Orthasterias	0	3 $0.30/m^2$	3 $0.08/m^2$
Crossaster	0	0	0
Solaster	0	0	0
Henricia	0	1 $0.10/m^2$	2 $0.05/m^2$
Pisaster	0	0	0
Evasterias	0	0	1 $0.03/m^2$
Strongylocentrotus	0	0	0
Area Sampled:	25 x 1m	10 x 1m	40 x 1m
Depth:	6-7m	3-4m	9m
Substrate Type:	Rock & Sand	Rock	Rock & Sand

TABLE 9 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT MACLEOD HARBOR

Taxon	Nov. 30, 1975	Nov. 30, 1975	March 13, 1976
Pycnopodia	4 0.40/m^2	0	12 0.80/m^2
Dermasterias	1 0.10/m^2	0	0
Orthasterias	0	0	0
Crossaster	0	0	1 0.06/m^2
Solaster	0	0	0
Henricia	3 0.30/m^2	0	1 0.06/m^2
Pisaster	0	12 1.2/m^2	0
Evasterias	1 0.10/m^2	0	0
Strongylocentrotus	0	0	0
Area Sampled:	10 x 1m	10 x 1m	15 x 1m
Depth:	6-7m	1-2m	10m
Substrate Type:	Rock	Rock	Rock & Sand

TABLE 9 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT MACLEOD HARBOR

Taxon	March 13, 1976	March 14, 1976	March 14, 1976
Pycnopodia	1 0.10m^2	10 0.20m^2	5 0.33m^2
Dermasterias	0	4 0.08/m^2	1 0.06/m^2
Orthasterias	1 0.10/m^2	1 0.02/m^2	0
Crossaster	0	0	0
Solaster	0	0	0
Henricia	0	1 0.02/m^2	0
Pisaster	0	0	0
Evasterias	0	0	0
Strongylocentrotus	0	0	0
Area Sampled:	10 x 1m	50 x 1m	15 x 1m
Depth:	5m	2-7m	10m
Substrate Type:	Rock	Rock	Rock & Sand

TABLE 9 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT MACLEOD HARBOR

Taxon	March 15, 1976
Pycnopodia	10 0.20/m^2
Dermasterias	0
Orthasterias	1 0.02/m^2
Crossaster	0
Solaster	0
Henricia	1 0.02/m^2
Pisaster	0
Evasterias	0
Strongylocentrotus	0

Area Sampled:	50 x 1m
Depth:	3-9m
Substrate Type:	Rock

TABLE 10

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT ZAIKOF BAY

Taxon	Nov. 23, 1975	Nov. 23, 1975	Nov. 23, 1975
Pycnopodia	19 $0.38/m^2$	5 $0.25/m^2$	12 $0.48/m^2$
Dermasterias	2 $0.04/m^2$	0	1 $0.04/m^2$
Orthasterias	3 $0.06/m^2$	1 $0.05/m^2$	1 $0.04/m^2$
Crossaster	2 $0.04/m^2$	2 $0.05/m^2$	1 $0.04/m^2$
Solaster	1 $0.02/m^2$	1 $0.03/m^2$	0
Henricia	1 $0.02/m^2$	3 0.07	4 $0.16/m^2$
Pisaster	0	0	0
Evasterias	3 $0.06/m^2$	1 $0.03/m^2$	2 $0.08/m^2$
Strongylocentrotus	0	0	0
Area Sampled:	25 x 2m	20 x 2m	25 x 1m
Depth:	11-12m	10-11m	6-7m
Substrate Type:	Rock	Rock & Sand	Rock

TABLE 10 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT ZAIKOF BAY

Taxon	Nov. 24, 1975	Nov. 24, 1975	March 19, 1976
Pycnopodia	16 $0.64/m^2$	4 $0.18/m^2$	11 $0.22/m^2$
Dermasterias	0	0	0
Orthasterias	0	1 $0.05/m^2$	5 $0.10/m^2$
Crossaster	0	4 $0.18/m^2$	4 $0.08/m^2$
Solaster	0	1 $0.05/m^2$	0
Henricia	1 $0.04/m^2$	2 $0.09/m^2$	5 $0.10/m^2$
Pisaster	0	0	0
Evasterias	2 $0.08/m^2$	0	7 $0.14/m^2$
Strongylocentrotus	0	0	1 $0.02/m^2$
Area Sampled:	25 x 1m	22 x 1m	50 x 1m
Depth:	12-13m	7-8m	7-12m
Substrate Type:	Rock & Sand	Rock	Rock

TABLE 10 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT ZAIKOF BAY

Taxon	March 20, 1976	March 20, 1976	March 20, 1976
Pycnopodia	8 0.80/m^2	3 0.30/m^2	9 0.90/m^2
Dermasterias	0	0	0
Orthasterias	1 0.10/m^2	1 0.10/m^2	0
Crossaster	1 0.10/m^2	1 0.10/m^2	0
Solaster	0	0	0
Henricia	1 0.10/m^2	0	1 0.10/m^2
Pisaster	0	0	0
Evasterias	0	2 0.20/m^2	0
Strongylocentrotus	0	0	0
Area Sampled:	10 x 1m	10 x 1m	10 x 1m
Depth:	10.5m	8m	4.5m
Substrate Type:	Rock & Sand	Rock	Rock

TABLE 11

DENSITY ESTIMATES OF SOME DOMINANT MACROPHYTES AT LATOUCHE POINT. ESTIMATES WERE DERIVED FROM BAND TRANSECTS OF DIFFERENT LENGTHS

Taxon	Sept. 17, 1975	Sept. 17, 1975	Nov. 26, 1975
Nereocystis	3 $0.12/m^2$	0	0
Laminaria spp.	116 $4.64/m^2$	251 $10.04/m^2$	84 (15)* $6.60/m^2$
Agarum	37 $1.48/m^2$	49 $1.96/m^2$	40 $2.67/m^2$
Pleurophycus	7 $0.28/m^2$	7 $0.28/m^2$	0
Constantinea	not counted	not counted	16 $1.07/m^2$
Opuntiella	not counted	not counted	8 $0.53/m^2$
Ptilota	not counted	not counted	17 $1.13/m^2$
Area Sampled:	25 x 1m	25 x 1m	15 x 1m
Depth:	12m	12m	12m
Substrate Type:	Rock	Rock	Rock & Sand

TABLE 11 (Cont.)

DENSITY ESTIMATES OF SOME DOMINANT MACROPHYTES AT LATOUCHE POINT. ESTIMATES WERE DERIVED FROM BAND TRANSECTS OF DIFFERENT LENGTHS

Taxon	Nov. 26, 1975	Nov. 26, 1975	Nov. 27, 1975
Nereocystis	0	1 0.06/m²	14 0.93/m²
Laminaria spp.	74 (10)* 5.60/m²	171 (61)* 15.47/m²	not counted
Agarum	26 1.73/m²	25 1.67/m²	not counted
Pleurophycus	0	2 0.13/m²	not counted
Constantinea	24 1.60/m²	10 0.67/m²	not counted
Opuntiella	16 1.07/m²	34 2.27/m²	not counted
Ptilota	6 0.40/m²	31 2.07/m²	not counted
Area Sampled:	15 x 1m	15 x 1m	15 x 1m
Depth:	14m	7m	7-8m
Substrate Type:	Rock & Sand	Rock	Rock

TABLE 11 (Cont.)

DENSITY ESTIMATES OF SOME DOMINANT MACROPHYTES AT LATOUCHE POINT. ESTIMATES WERE DERIVED FROM BAND TRANSECTS OF DIFFERENT LENGTHS

Taxon	March 18, 1976	March 18, 1976
Nereocystis	0	0
Laminaria spp.	126 12.6/m^2	83 8.30/m^2
Agarum	14 1.40/m^2	4 0.40/m^2
Pleurophycus	16 1.60/m^2	9 0.90/m^2
Constantinea	not counted	not counted
Opuntiella	not counted	not counted
Ptilota	not counted	not counted
Area Sampled:	10 x 1m	10 x 1m
Depth:	10m	8m
Substrate Type:	Rock & Sand	Rock & Gravel

*Number in parenthesis indicates these plants had shed their blade.

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APPENDIX A

TABLE 1
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL BENCH
JULY 26, 1975

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Agarum	30%(2)	25%(2)	30%(1)	20%(1)
Laminaria	40%(7)	20%(2)	30%(2)	15%(1)
Ptilota	2%(1)	1%(1)	15%(1)	0
encrusting coralline	45%	60%	80%	95%
Constantinea	8%(2)	0	0	5%(1)
articulated coralline	5%(3)	30%(10)	40%(13)	15%(7)
Opuntiella	0	5%(1)	5%(1)	0
foliose red (unid.)	5%	2%	0	0
Musculus	(2)	(1)	(1)	0
Microporina	1%	5%	5%	0
clavate ascidian	1%	2%	5%	1%
pagurids	(7)	(4)	(7)	(3)
Cryptolithodes	0	(1)	0	0
Abietinaria	0	0	1%(1)	0
Lichenopora	0	0	1%	1%
Tricellaria	0	0	2%	1%
orange globular sponge	(1)	0	0	0
Tonicella	0	0	0	(1)
encrusting sponge	0	0	(1)	0

Depth: 10m

Substratum: Rock Surface

APPENDIX A (Cont.)

TABLE 2
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, ON ROCK PAVEMENT
NOVEMBER 26, 1975

Cover and Composition:

Taxon	Percent Cover (number of individuals)			
	No. 1	No. 2	No. 3	No. 4
Agarum	15%	50%(2)	60%(4)	15%(2)
Laminaria	10%(3)	70%(2)	25%(1)	40%(2)
Ptilota	20%(4)	4%(2)	25%(1)	5%(1)
encrusting coralline	90%	65%	50%	50%
Constantinea	0	2%(3)	0	0
articulated coralline	10%(5)	25%(8)	2%(4)	15%(8)
Opuntiella	0	0	2%(1)	0
Hildenbrandia	0	0	1%	0
Membranoptera	0	0	0	2%
foliose red (unid.)	0	2%	1%	0
Musculus sp.	0	(3)	(7)	0
clavate ascidian	1%	1%	0	0
(Rhynchozoon)	1%	1%	0	0
Tricellaria	2%	2%	3%	5%
Fusitriton	(1)	0	0	0
Strongylocentrotus	0	(1)	0	0
Orthasterias	0	0	0	(1)
Boltenia	0	0	0	(1)
Microporina	0	0	0	1%

APPENDIX A (Cont.)

TABLE 2 (Cont.)

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Dendrobeania	0	2%	0	4%
Amphissa	0	0	0	(3)
pagurids	(2)	(2)	(2)	(4)
yellow spatter sponge	0	0	0	2%

Depth: 12m

Substratum: Rock Surface

APPENDIX A (Cont.)

TABLE 3
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, ON ROCK PAVEMENT
NOVEMBER 26, 1975

Cover and Composition:

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Agarum	0	0	40%(2)	0	0
Laminaria	50%(2)(5)*	10%(2)*	5%(2)*	60%(2)	95%(5)(1)*
Ptilota	2%(1)	10%(1)	0	1%(1)	0
encrusting coralline	80%	25%	90%	95%	40%
Constantinea	0	1%(1)	0	0	2%(2)
articulated coralline	20%(8)	0	15%(9)	15%(6)	0
Opuntiella	5%(3)	0	5%(1)	0	5%(2)
foliose red (unid.)	5%	5%	2%	0	0
(*Rhynchozoon*)	5%	1%	0	0	0
Styela	(1)	0	0	0	0
yellow spatter sponge	3%	0	2%	0	0
Cancer oregonensis	0	(1)	0	0	0
Trichotropis	5	0	0	0	0
encrusting sponge	0	1%	2%	0	0
clavate ascidian	0	5%	2%	1%	0
pagurids	(1)	0	0	0	0
serpulidae	(2)	0	(1)	(1)	0
syconid sponge	(1)	0	0	0	0

APPENDIX A (Cont.)

TABLE 3 (Cont.)

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4	No. 5
Tonicella	(1)	0	0	0	0
orange globular sponge	0	0	1%	1%	0
white globular sponge	0	0	1%	0	0

Depth: 7-8m

Substratum: Rock Bench

*= Plants undergoing perinnation

APPENDIX A (Cont.)

TABLE 4
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT
NOVEMBER 27, 1975

Cover and Composition:

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Agarum	40%(3)	25%(0)	0	25%(1)	15%
Laminaria (discoid)	0	0	0	20%(1)	30%(2)
Laminaria	10%	40%(3)(1)*	40%(4)	20%	30%(3)(2)*
laminarian holdfast	30%	35%	40%	40%	40%
Hildenbrandia	30%	10%	2%	10%	5%
Bossiella	10%(4)	5%(2)	0	2%(1)	1%(1)
Corallina	0	2%(1)	0	0	15%(4)
foliose red (unid.)	2%	1%	2%	6%	2%
Microporina	5%	5%	3%	35%	40%
yellow spatter sponge	3%	0	0	3%	1%
white globular sponge	0	0	0	(1)	0
Dendrobeania	0	0	1%	1%	2%
(*Rhynchozoon*)	5%	0	0	0	0
Eudendrium	1%(3)	1%(1)	1%(3)	0	0
clavate ascidian	1%	0	2%	2%	1%
serpulidae	0	0	0	(1)	0
syconid sponge	0	0	0	0	1%
Acmaea mitra	(1)	0	0	0	0
Lichenopora	0	0	1%(2)	2%(1)	0

APPENDIX A (Cont.)

TABLE 4 (Cont.)

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4	No. 5
Abietinaria	2%(1)	1%(1)	0	1%(1)	2%(2)
chiton (unid.)	0	(1)	0	0	0
gravel	25%	50%	80%	25%	20%
Tricellaria	1%	0	0	3%	5%
Balanus (white)	(1)	0	0	0	0
Musculus	(1)	0	0	0	(10)
Crossaster	0	0	(1)	0	0
Fusitriton	0	0	(1)	0	0
Trichotropis	0	0	0	(1)	0
pagurids	0	0	0	0	(1)
Heteropora	0	0	0	(1)	0
Styela	0	0	0	0	(1)
white spatter sponge	0	0	0	1%	0
Ptilota	0	0	0	2%	0
(Rhodymenia)	0	0	0	0	1%(2)

Depth: 10-12m

Substratum: Boulders, Gravel and Rock Pavement

APPENDIX A (Cont.)

TABLE 5
QUADRAT DATA (¼ sq m) FROM
A ROCKY SLOPE AT LATOUCHE POINT
NOVEMBER 27, 1975

Cover and Composition:

Taxon	No. 1	No. 2	No. 3	No. 4
	Percent Cover (number of individuals)			
Agarum	15%	0	10%(1)	0
Laminaria (discoid)	40%(2)	5%	30%(2)	0
Laminaria	40%(2)	0	30%(3)*	40%(3)(3)*
Bossiella	8%(4)	0	0	0
Corallina	5%(4)	5%(1)	1%(1)	8%(5)
Ptilota	1%(1)	1%(1)	1%(1)	1%(1)
Constantinea	2%(1)	0	0	0
foliose red (unid.)	0	2%	2%	3%
encrusting coralline	80%	80%	75%	90%
Hildenbrandia	0	0	10%	0
Microporina	40&	10%	30%	30%
syconid sponge	0	0	0	(1)
Musculus	(8)	0	0	(8)
Triopha	0	(1)	0	0
serpulidae	0	0	(1)	0
clavate ascidian	1%	1%	1%	0
Tricellaria	1%	1%	1%	0
Dendrobeania	0	0	1%	1%
pagurids	0	(3)	0	(1)

APPENDIX A (Cont.)

TABLE 5 (Cont.)

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Heterotopora	0	0	0	1%
Diodora	0	0	(1)	0
Calliostoma	0	0	0	(1)
yellow spatter sponge	0	0	2%	1%

Depth: 12-14m

Substratum: Rock Surface

APPENDIX A

TABLE 6
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 16, 1976

Cover and Composition:

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	50%(1)*	40%	20%	50%
Laminaria groenlandica	0	(2)	(1)	(3)
Laminaria (juveniles)	(3)	0	(10)	0
Agarum	20%(2)	25%(2)	25%	25%(2)
Pleurophycus	0	0	20%(1)	10%(1)
encrusting corraline	80%	80%	95%	90%
Ptilota	0	20%(1)	10%(1)	0
Constantinea	0	15%(3)	2%(1)	0
Rhodymenia	6%	5%	0	2%
Corallina	4%	20%	20%	25%
Bossiella	2%	2%	5%	0
Hildenbrandia	0	2%	0	2%
Ralfsia	0	5%	0	0
Microporina	5%	10%	0	0
Lichenopora	2%	0	0	0
Distaplia ?	2%	0	0	0
Synoicum ?	1%	10%	2%	2%
gray colonial ascidian	1%	2%	1%	0
orange encrusting	1%	1%	0	0
Abietinaria	1%	0	0	0
orange globular ascidian	0	2%	0	0

APPENDIX A (Cont.)

TABLE 6
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 16, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Tricellaria	0	0	0	1%
Eudendrium	0	0	0	1%
Amphissa	0	(1)	(1)	0
Velutina ?	0	(1)	0	0
Acmaea mitra	0	0	(2)	0
Rhynchoezoon	0	0	0	1%
pagurids	0	(4)	(1)	(1)
Henricia	0	(1)	0	0
Ophiopholis	0	0	present	0
unid. gastropod (red)	0	0	0	(1)

Location: Off NMFS Transect

Depth: 9m

Substratum: Pavement w/Boulders

* = Total Laminarian Cover for Quadrat

APPENDIX A

TABLE 7
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

Cover and Composition:

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	50%(1)*	80%(8)	35%	20%(1)
Laminaria groenlandica	(1)	0	(3)	0
Laminaria (juveniles)	0	(2)	0	0
Pleurophycus	0	0	25%(3)	20%
encrusting coralline	40%	50%	30%	50%
Ptilota	1%	2%	5%	2%
Constantinea	5%(1)	0	2%(1)	0
Rhodymenia	0	0	0	5%
Corallina	15%	15%	8%	15%
Bossiella	1%	4%	0	0
Hildenbrandia	0	0	0	0
Ralfsia	2	0	10%	0
Opuntiella	20%	0	0	12%
Delesseria	1%	0	1%	5%
Microporina	5%	2%	2%	1%
Lichenopora	0	1%	1%	0
Synoicum	5%	2%	15%	10%
gray colonial ascidian	15%	2%	10%	2%
orange encrusting sponge	2%	0	0	1%
Abietinaria	0	0	0	0
Tricellaria	0	0	0	1%

APPENDIX A (Cont.)

TABLE 7
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
orange colonial ascidian	0	0	0	1%
green colonial ascidian	0	2%	2%	0
unid. gastropod (red)	0	0	0	(1)
serpulidae	0	(1)	(5)	0
pagurids	0	0	(2)	(5)
Rhynchozoon	0	0	0	0
Henricia	0	0	(1)	0
Ophiopholis	0	present	present	present
yellow globose sponge	0	0	0	1%
Musculus	0	0	0	0
Lacuna	0	present	present	0
Styela	0	0	(2)	0
Searlesia	0	0	0	(1)
Margarites	0	0	0	(1)
Heteropora	0	0	0	0
Trophon	0	0	(2)	0
Placiphorella	(1)	0	0	0
Cancer sp.	0	(1)	0	0

APPENDIX A (Cont.)

TABLE 7
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
decorator crab	0	0	0	(1)
Entodesma	0	0	0	0

Location: South of NMFS Site

Depth: 8-9m

Substratum: Pavement w/Boulders

* = Total Laminarian Cover in Quadrat

APPENDIX A (Cont.)

TABLE 8
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

Cover and Composition:

	Percent Cover (number of individuals)		
Taxon	No. 5	No. 6	No. 7
Laminaria yezoensis	40%(2)*	50%(2)	60%
Laminaria groenlandica	(1)	(1)	0
Laminaria (juveniles)	(3)	(2)	(13)
Pleurophycus	10%(2)	20%(1)	0
encrusting coralline	40%	70%	50%
Ptilota	2%	10%	0
Constantinea	0	0	2%
Rhodymenia	2%	5%	0
Corallina	2%	15%	4%
Bossiella	0	0	3%
Hildenbrandia	2%	0	0
Ralfsia	0	0	0
Opuntiella	10%	20%	5%
Delesseria	2%	2%	0
Microporina	15%	0	4%
Lichenopora	1%	1%	1%
Synoicum	6%	8%	6%
gray colonial ascidian	15%	8%	30%
orange encrusting sponge	1%	1%	2%
Abietinaria	0	0	2%

APPENDIX A (Cont.)

TABLE 8
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 5	No. 6	No. 7
Tricellaria	0	0	0
orange colonial ascidian	0	0	0
green colonial ascidian	0	4%	1%
Tonicella	0	2%	2%
unid. gastropod (red)	0	0	0
serpulidae	0	0	0
pagurids	(2)	(12)	(6)
Rhynchozoon ?	0	0	1%
Henricia	0	0	0
Ophiopholis	present	present	0
yellow globose sponge	0	0	0
Musculus	0	0	present
Lacuna	0	0	0
Styela	0	0	0
Searlesia	(1)	0	0
Margarites	0	0	0
Heteropora	1%	0	0
Trophon	0	0	(1)
Placiphorella	0	0	0

APPENDIX A (Cont.)

TABLE 8
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAT
MARCH 17, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 5	No. 6	No. 7
Cancer oregonensis	0	0	0
decorator crab	0	0	0
Entodesma	(1)	0	0

Location: South of NMFS Site

Depth: 7-8m

Substratum: Pavement w/Boulders

* = Total Laminarian Cover in Quadrat

APPENDIX A

TABLE 9
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 18, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals)			
	No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	25%(1)*	40%(1)	60%	5%
Laminaria groenlandica	0	(1)	(1)	0
Laminaria (juvenile)	0	0	(8)	(4)
Pleurophycus	0	10%(2)	0	15%
Agarum	10%	0	0	0
encrusting coralline	40%	60%	50%	70%
Ptilota	40%	15%	20%	15%
Constantinea	16%(2)	0	0	5%
Rhodymenia	0	0	0	0
Corallina	40%	30%	40%	40%
Bossiella	1%	0	0	1%
Hildenbrandia	1%	0	0	0
Ralfsia	0	5%	0	0
Opuntiella	0	0	0	0
Delesseria	0	0	0	1%
Alaria (*marginata*)	0	15%	0	20%(1)
Membranoptera	0	0	0	0
Lichenopora	0	1%	0	0
Synoicum ?	20%	5%	5%	1%
Distaplia	5%	5%	0	0

APPENDIX A (Cont.)

TABLE 9
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 18, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 5	No. 6	No. 7	No. 8
Laminaria yezoensis	70%*	50%	75%(1)	60%(1)
Laminaria groenlandica	(2)	(0)	(5)	(2)
Laminaria (juvenile)	0	(2)	0	0
Pleurophycus	0	25%(1)	0	30%(2)
Agarum	0	25%(1)	10%(2)	0
encrusting coralline	60%	50%	80%	45%
Ptilota	25%	0	5%	20%
Constantinea	30%	0	0	8%
Rhodymenia	0	0	0	2%
Corallina	40%	20%	25%	8%
Bossiella	10%	5%	0	2%
Hildenbrnadia	0	0	0	0
Ralfsia	0	0	0	0
Opuntiella	0	5%	5%	0
Delesseria	0	8%	1%	1%
Alaria (*marginata*)	0	0	0	0
Membr amptera	0	0	0	2%
Lichenopora	0	1%	1%	1%
Synoicum	2%	0	5%	5%
Distaplia	10%	5%	2%	0

APPENDIX A (Cont.)

TABLE 9
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 18, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
orange encrusting sponge	2%	1%	0	8%
Tricellaria	1%	0	1%	0
Didemnam ?	0	0	0	0
Chelyosoma	0	0	0	0
Styela	0	0	0	0
orange colonial ascidian	1%	0	0	0
Leucosolenia ?	0	0	1%	0
Lacuna	0	present	present	0
yellow encrusting sponge	0	0	2%	0
Acmaea mitra	(1)	0	0	(3)
Searlesia	0	0	0	(2)
Tonicella	0	0	0	(2)
serpulidae	0	0	0	present
Ophiopholis	0	present	0	0
pagurids	0	0	0	0
Margarites	0	0	0	0

Location: Off NMFS Site

Septh: 5-6m

Substratum: Rock Bench

* = Total Laminarian Cover in Quadrat

APPENDIX A (Cont.)

TABLE 9
QUADRAT DATA (¼ sq m) FROM
LATOUCHE POINT, SUBTIDAL
MARCH 18, 1976

Cover and Composition:

	Percent Cover (number of individuals)			
Taxon	No. 5	No. 6	No. 7	No. 8
orange encrusting sponge	3%	0	0	1%
Tricellaria	0	1%	1%	1%
Didemnum ?	1%	3%	0	0
Chelyosoma	0	0	1%(1)	0
Styela	0	0	0	0
orange colonial ascidian	0	0	0	0
Leucosolenia	0	0	0	0
Lacuna	0	0	present	0
yellow encrusting sponge	0	0	0	0
Acmaea mitra	0	(2)	(2)	(1)
Searlesia	(1)	(1)	0	0
Tonicella	0	(3)	(1)	0
serpulidae	0	0	0	present
Ophiopholis	0	present	0	0
pagurids	0	(4)	(2)	(2)
Margarites	0	(2)	0	0

Location: Off NMFS Site

Depth: 6-10m

Substratum: Rock Bench w/Boulders

* = Total Laminarian Cover in Quadrat

APPENDIX B

TABLE 1
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Laminaria w/haptera	4%(25)	15%	50%(6)	90%(3)
Laminaria w/discoid	5%(25)	15%(5)	10%(3)	0
Cymathere triplicata	0	30%(7)	0	0
Desmarestia viridis	0	20%	0	0
Ptilota	0	0	0	5%(1)
Opuntiella californica	0	0	0	5%(1)
Constantinea	0	1%(1)	2%(3)	0
Hildenbrandia sp.	1%	0	0	0
Bossiella	0	0	0	2%
Corallina	0	0	5%	2%
foliose red (unid.)	1%	1%	2%	5%
Ralfsia	0	0	0	0
encrusting coralline	70%	5%	40%	20%
Musculus sp.	25%	20%	40%	10%
Tonicella	(3)	0	0	0
Acmaea mitra	(4)	0	0	0
Dendrobeania	1%	0	1%	1%
Sertularella	1%	0	0	0
Plumularia sp.	1%	0	0	0
Microporina borealis	0	0	5%	15%
serpulidae	10%	0	0	0

APPENDIX B (Cont.)

TABLE 1
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
orange encrusting sponge	1%	0	2%	0
yellow spatter sponge	0	0	5%	2%
Tricellaria sp.	0	0	0	5%
Pycnopodia	(1)	0	(1)	0
Didemnum ?	0	0	0	1%
corn ascidian	0	0	0	1%(1)
Distaplia	0	0	0	2%(1)
paqurids	0	0	0	0
white colonial ascidian	0	0	0	0
Synoicum ? (clavate ascidian)	0	0	0	0
Balanus sp. (ribbed)	0	0	0	(1)
Sand	25%	50%	0	25%

Location: - 200m S.E. NMFS Station

Depth: 5m

Substratum: Rocky promontory

APPENDIX B

TABLE 2
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

Cover and Composition:

	Percent Cover (number of individuals)	
Taxon	No. 1	No. 2
Laminaria w/haptera	40%(4)	20%(4)
Laminaria w/discoid hold	20%(5)	20%(5)
Cymathere triplicata	5%(2)	0
Constantinea	2%(3)	0
Corallina	5%(2)	0
foliose red (unid.)	10%	1%
Ralfsia pacifica	1%	0
encrusting coralline	20%	10%
Musculus	20%	25%
Tonicella	0	(1)
Dendrobeania	1%	0
Microporina borealis	5%	1%
yellow spatter sponge	5%	0
Pycnopodia	(1)	0
pagurids	(3)	0
Distaplia	0	0
white colonial ascidian	1%(1)	0
Sand		

Location: 200m S.E. NMFS Station

Depth: 5m

Substratum: Rocky promontory

APPENDIX B

TABLE 3
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2
Laminaria w/haptera	90%(3)(1)*	100(13)(4)*
Laminaria w/discoid hold	(2 holdfasts)	5%(2)
Agarum	0	10%(1)
Corallina	2%(1)	0
encrusting coralline	80%	80%
foliose red (unid.)	2%	0
Musculus sp.	1%	0
Tonicella	(3)	0
Acmaea mitra	(3)	(2)
Dendrobeania	0	(3)
Sertularella	0	3%
Microporina	15%	15%
Pycnopodia	(1)	(2)
pagurids	0	(5)
Cryptobranchia concentrica	0	(5)
Synoicum ? (clavate ascidian)	0	1%
Rhynchozoon sp.	1%	3%
Crepipatella lingulata	6%	5%
yellow spatter sponge	1%	1%

Location: ~ 200m S.E. NMFS Station

Depth: 6-7m

Substratum: Rock - Boulder

APPENDIX B

TABLE 4
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

Cover and Composition:

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Agarum	50%	15%(1)	25%(3)
Laminaria	0	10%(2)	50%(3)
Alaria	0	10%	0
encrusting coralline	70%	50%	40%
Hildenbrandia	20%	30%	20%
Didemnum ?	3%	5%	2%
yellow spatter sponge	15%	5%	5%
Sertularella	1%	0	2%
Scrupocellaria ?	1%	0	present
Microporina	50%	50%	30%
(*Rhynchozoon*)	5%	1%	2%
Musculus (nestling)	(1)	(1)	0
Tonicella	(3)	(1)	(1)
Serpulidae	(1)		
Trichotropis	(3)	(1)	(1)
Metandrocarpa	0	present	0
Synoicum ? (clavate ascidian)	present	0	present
Crepipatella	(1)	(1)	(1)

Location: Rock Projection - Off NMFS Station

Depth: 10m

Substratum: Rockface

APPENDIX B

TABLE 5
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE S.E. OF NMFS SITE
MACLEOD HARBOR, NOVEMBER 29, 1975

(No. 1) Depth 9m; Edge of Reef - Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(3)
Agarum	(2)
algal debris	20%
Microporina	45%
Dendrobeania	5%
Didemnum ?	2%

(No. 2) Depth 9m; Edge of Reef - Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(2)
algal debris	15%
Microporina*	20%

(No. 3) Depth 9m; Edge of Reef - Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
Laminaria (juv.)	(2)
algal debris	10%
encrusting coralline	15%
Pycnopodia	(1)
Trophonopsis	(1)

(No. 4) Depth 9m; Edge of Reef - Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(3)
Microporina	5%
Pycnopodia	(1)
Hippodiplosia	present

* covered by epiphytes

APPENDIX B (Cont.)

TABLE 5
HAPHAZARD QUADRAT CASTS (¼ sq m)
THE SUBLITTORAL ZONE S.E. OF NMFS SITE
MACLEOD HARBOR, NOVEMBER 29, 1975

(No. 5) Depth 10m; Edge of Reef - Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
Agarum	(1)
algal litter	(10%)
Microporina	20%
Dendrobeania	2%
Pycnopodia	(1)

(No. 6) Depth 5m; Block Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(1)(8)*
Opuntiella	(1)
Constantinea	(1)
encrusting coralline	30%
Didemnum	5%
Tonicella	(1)
Thais lamellosa	(1)
Boltenia	(1)

(No. 7) Depth 3m; Block Rock

Taxon	Percent Cover (number of individuals)
Opuntiella	(4)
encrusting coralline	80%
Microporina	60%
Didemnum	5%
Tricellaria	2%
Heteropora	5%
Dermasterias	(1)

(No. 8) Depth 3m; Block Rock

Taxon	Percent Cover (number of individuals)
Laminaria (juv.)	(12)
Laminaria	(1)*
Opuntiella	10%(1)
encrusting coralline	80%
Microporina	25%

TABLE 5
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE S.E. OF NMFS SITE
MACLEOD HARBOR, NOVEMBER 29, 1975

(No. 9) Depth 5m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(7)
encrusting coralline	50%
Musculus (spat)	heavy on Laminaria
Dendrobeania	2%
barnacle test debris	10%

(No. 10) Depth 10m; Sand & Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(5)(1)*
Microporina	15%
Pycnopodia	(1)

(No. 11) Depth 10m; Sand & Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(3)
Agarum	(1)
Microporina	10%

(No. 12) Depth 10m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
Agarum	(1)
Microporina	15%
Dendrobeania	2%
sea peach	(2)

(No. 13) Depth 12m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
Agarum	(1)
algal litter	2%
Microporina	30%

* = Plants under going perinnation

APPENDIX B

TABLE 6
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE OFF NMFS SITE
MACLEOD HARBOR, NOVEMBER 30, 1975

(No. 1) Depth 11m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
algal debris	50%
Microporina	5%

(No. 2) Depth 11m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(4)
Agarum	(1)
Laminaria (juv.)	(1)
encrusting coralline	25%
Microporina	25%
Tricellaria	2%

(No. 3) Depth 11m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(2)
Agarum	(1)
algal debris	5%
encrusting coralline	20%
Microporina	30%
corn ascidian	2%

(No. 4) Depth 11m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(2)
algal debris	5%
Microporina	10%

(No. 5) Depth 11m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(2)

TABLE 6
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE OFF NMFS SITE
MACLEOD HARBOR, NOVEMBER 30, 1975

(No. 5) Depth 11m; Rock & Sand

Taxon	Percent Cover (number of individuals)
algal debris	15%
encrusting coralline	10%

(No. 6) Depth 7m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria	(2)
Agarum	(4)
Opuntiella	(2)
Hildenbrandia	5%
encrusting coralline	85%
Ralfsia	present
Microporina	60%
Lichenopora	2%
Evasterias	(1)

(No. 7) Depth 7m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(4)
encrusting coralline	75%
Microporina	50%
Henricia	

(No. 8) Depth 7.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
Agarum	(1)
encrusting coralline	60%
Microporina	15%
Amphissa	(1)

APPENDIX B (Cont.)

TABLE 6
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE OFF NMFS SITE
MACLEOD HARBOR, NOVEMBER 30, 1975

(No. 9) Depth 7.5m; Rock

Taxon	Percent Cover (number of individuals)
Hildenbrandia	15%
encrusting coralline	30%
Microporina	20%
Heteropora	2%

(No. 10) Depth 7.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria discoid	(1)
Laminaria (juv.)	(2)
encrusting corraline	60%
Ralfsia	2%
Abietinaria	2%
Tricellaria	20%
Tonicella	(1)

(No. 11) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(2)
Laminaria	(3)*
Laminaria (juv.)	(3)
Agarum (juv.)	(1)
encrusting corallines	70%
Heteropora	5%
Microporina	20%
Opuntiella	10%(2)

(No. 12) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria (discoid)	(1)
Agarum	(3)
Hildenbrandia	20%
encrusting coralline	80%
Dendrobeania	5%
Microporina	60%

APPENDIX B (Cont.)

TABLE 6
HAPHAZARD QUADRAT CASTS (¼sq m) FROM
THE SUBLITTORAL ZONE OFF NMFS SITE-
MACLEOD HARBOR, NOVEMBER 30, 1975

(No. 13) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria (discoid)	(1)
Laminaria	(1)
Agarum	(2)
Opuntiella	(2)
encrusting coralline	70%
Hildenbrandia	10%
Calliostoma	(1)
Microporina	25%
Alcyonidimn	5%

(No. 14) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(3)*
Agarum	(1)
Laminaria (juv.)	(2)
Opuntiella	(1)
Constantinea	(1)
Hildenbrandia	20%
encrusting coralline	60%
Microporina	25%
Calliostoma	(2)

(No. 15) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(2)*
Laminaria (juv.)	25%(8)
encrusting coralline	70%
Hildenbrandia	5%
Microporina	30%
Tricellaria	5%
corn ascidian	2%
Amphissa	(3)

APPENDIX B (Cont.)

TABLE 6
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE OFF NMFS SITE
MACLEOD HARBOR, NOVEMBER 30, 1975

(No. 16) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(2)(3)*
Laminaria (juv.)	(6)
encrusting coralline	70%
Opuntiella	(1)
Microporina	20%
Dermasterias	(1)
solitary ascidian (orange)	(2)

(No. 17) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(1)(2)*
Laminaria (juv.)	(13)
Opuntiella	(1)
Hildenbrandia	10%
encrusting coralline	60%
Microporina	20%
Henricia	(1)
Acmaea mitra	(1)

(No. 18) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria (juv.)	(1)
Opuntiella	(3)
Hildenbrandia	10%
encrusting coralline	70%
Microporina	20%
corn ascidian	2%
Pycnopodia	(1)
solitary ascidian (grey)	(1)

(No. 19) Depth 3.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(8)

APPENDIX B (Cont.)

TABLE 6
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE OFF NMFS SITE
MACLEOD HARBOR, NOVEMBER 30, 1975

(No. 19) Depth 3.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria (juv.)	(7)
Hildenbrandia	15%
encrusting coralline	60%
Tricellaria	5%
Microporina	5%
Metantrocarpa	5%

(No. 20) Depth 3.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(3)(2)*
Laminaria (juv.)	(19)
encrusting coralline	70%
Hildenbrandia	10%
Opuntiella	(1)
Microporina	10%
Tonicella	(1)
Dendrobeania	5%
Abietinaria	10%

APPENDIX B

TABLE 7
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
MARCH 13, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3
Laminaria groenlandica	(13)	(16)	90%(6)
Agarum	(1)	(1)	0
encrusting coralline	60%	70%	70%
Corallina	0	0	0
Bossiella	0	15%	0
Hildenbrandia	present	present	30%
Opuntiella	0	(2)	0
Microporina	0	15%	0
Distaplia ?	0	5%	0
Serpulidae	(2)	0	0
Tonicella	0	(1)	0
Musculus	present	present	present
pagurids	0	(2)	0

APPENDIX B (Cont.)

TABLE 7
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
MARCH 13, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 4	No. 5
Laminaria groenlandica	40%(12)	60%(7)
Agarum	25%(2)	0
encrusting coralline	60%	60%
Corallina	10%	0
Bossiella	0	10%
Hildenbrandia	20%	0
Opuntiella	0	0
Microporina	1%	0
Distaplia ?	0	0
Serpulidae	0	0
Tonicella	0	0
Musculus	present	present
pagurids	0	0

Location: NMFS Site

Depth: 3-5m

Substratum: Surge Channel w/Bedrock

APPENDIX B

TABLE 8
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
MARCH 14, 1976

Cover and Composition:

Taxon	No. 1	No. 2	No. 3
	Percent Cover (number of individuals)		
Laminaria spp.	0	25%(4)	50%(3)
Costaria (juveniles)	5%(1)	5%(1)	0
Alaria(marginata)	50%(3)	60%(1)	10%
Constantinea	0	15%(3)	0
Rhodymenia	15%	5%	15%
Corallina	1%	40%	0
Bossiella	0	40%	2%
encrusting coralline	80%	30%	60%
Membranoptera spp.	0	60%	0
Phycodrys sp.	10%	0	10%
Thais canaliculata	0	(1)	(4)
Distaplia ?	0	1%	1%
yellow sponge	0	0	2%
serpulidae	0	0	(1)
pagurids	0	0	(5)
orange encrusting sponge	1%	0	0
Dendrobeania	0	0	0
diatom film	25%	0	25%
Musculus	present	present	present
Tonicella	0	0	(3)

APPENDIX B (Cont.)

TABLE 8
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
MARCH 14, 1976

Cover and Composition:

Taxon	No. 4	No. 5	No. 6
	Percent Cover (number of individuals)		
Laminaria spp.	5%(1)	60%(5)	80%(14)
Costaria (juveniles)	2%(3)	5%(3)	0
Alaria (*marginata*)	80%(1)	0	0
Constantinea	10%(6)	2%(1)	0
Rhodymenia	20%	5%	2%
Corallina	20%	1%	0
Bossiella	20%	0	0
encrusting coralline	30%	40%	60%
Membranoptera spp.	0	0	0
Phycodrys sp.	0	5%	10%
Thais canaliculata	0	0	0
Distaplia ?	0	1%	0
yellow sponge	0	1%	0
serpulidae	0	0	0
pagurids	0	0	0
orange encrusting sponge	0	0	2%
Dendrobeania	0	0	1%
diatom film	0	50%	50%
Musculus	present	present	present
Tonicella	0	(2)	0

Location: NMFS Site
Depth: 3-5m
Substratum: Rock

APPENDIX B

TABLE 9
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
MARCH 15, 1976

Cover and Composition:

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Laminaria yezoensis	0	(1)	0
Laminaria groenlandica	10%(3)*	60%(6)	75%(8)
Agarum	60%(5)	15%	15%
Rhodymenia	1%	0	2%
encrusting corallines	75%	60%	50%
Corallina	3%	1%	2%
Bossiella	8%	3%	3%
Delesseria	0	5%(1)	1%
Opuntiella	0	5%	10%
Hildenbrandia	0	10%	1%
Ralfsia	0	10%	0
Distaplia ?	3%	15%	15%
Microporina	0	1%	0
Tonicella	0	(2)	0
Searlesia	0	0	0
Metandrocarpa	0	5%	0
pagurids	(2)	(10)	(5)
Musculus (juveniles)	present	present	present
Dendrobeania	1%	1%	2%
serpulidae	(1)	0	0
Acmaea mitra	0	(2)	(1)

APPENDIX B (Cont.)

TABLE 9
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
MARCH 15, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3
Crepipatella	present	0	0
Cryptobranchia	0	present	present
Lichenopora	0	1%	0
Puncturella	0	0	(1)
Pycnopodia	0	0	0

Location:

Depth: 6m

Substratum:

* = Total Laminarian Cover In Quadrat

APPENDIX B

TABLE 10
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
MARCH 15, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 4	No. 5	No. 6
Laminaria yezoensis	(5)	(2)	(2)
Laminaria groenlandica	40%(6)	25%(3)	25%(1)
Agarum	5%	0	5%
Rhodymenia	0	1%	1%
encrusting corallines	60%	30%	50%
Corallina	8%	1%	2%
Bossiella	8%	0	1%
Delesseria	0	0	0
Opuntiella	0	0	0
Hildenbrandia	0	2%	0
Ralfsia	1%	0	0
Distaplia ?	7%	0	1%
Microporina	0	0	0
Tonicella	(1)	0	(2)
Searlesia	0	(1)	(1)
Metandrocarpa	0	0	0
pagurids	(6)	(4)	0
Musculus (juveniles)	present	present	present
Dendrobeania	0	0	0
serpulidae	(2)	0	0
Acmaea mitra	0	(1)	0

APPENDIX B (Cont.)

TABLE 10
QUADRAT DATA (¼ sq m) FROM
MACLEOD HARBOR, SUBTIDAL
MARCH 15, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 4	No. 5	No. 6
Crepipatella	present	0	0
Cryptobranchia	0	present	present
Lichenopora	0	0	0
Puncturella	(1)	0	0
Pycnopodia	0	0	(1)

Location:

Depth:

Substratum:

* = Total Laminarian Cover In Quadrat

APPENDIX C

TABLE 1
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3
Laminaria yezoensis	0	0	(1)
Laminaria groenlandica	25%(3)	0	25%(1)
Laminaria (juveniles)	0	0	0
Agarum	70%(1)	25%	15%(2)
Constantinea	2%	1%	0
Ralfsia	30%	10%	0
encrusting coralline	30%	20%	15%
Hildenbrandia	5%	5%	0
filamentous reds	1%	1%	0
Microporina	3%	2%	5%
pagurids	(2)	0	(4)
Heteropora	0	0	0
Trichotropis	0	0	(1)
serpulidae	0	10%	0
Flustrella	1%	2%	1%
Distaplia	2%	0	0
Margarites	0	0	0
Archidistoma	0	2%	1%
orange globular ascidian	0	0	0
Cnemidocarpa	(1)	0	0

APPENDIX C (Cont.)

TABLE 1
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3
Tonicella	(2)	(2)	(1)
Musculus (nestling)	(2)	0	0
Cryptobranchia	present	present	0
Trichotropis	0	0	(1)
Puncturella	(1)	0	0
Fusitriton	0	0	(1)
Ocenebra	(1)	0	(3)
Ophiopholis	present	0	0
Strongylocentrotus	0	0	(1)
Balanus sp.	5%	12%	10%

APPENDIX C (Cont.)

TABLE 1
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 4	No. 5
Laminaria yezoensis	0	0
Laminaria groenlandica	25%(2)	15%
Laminaria (juveniles)	0	(1)
Agarum	10%	75%(3)
Constantinea	0	0
Ralfsia	5%	0
encrusting coralline	30%	20%
Hildenbrandia	20%	25%
filamentous reds	3%	0
Microporina	5%	(3)
pagurids	(2)	(3)
Heteropora	1%	0
Trichotropis	(2)	0
serpulidae	(1)	0
Flustrella	15%	5%
Distaplia	0	1%
Margarites	(1)	(1)
Archidistoma	1%	0
orange globular ascidian	8%	7%
Cnemidocarpa	0	0

APPENDIX C (Cont.)

TABLE 1
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

Cover and Composition:

	Percent Cover (number of individuals)	
Taxon	No. 4	No. 5
Tonicella	(2)	(1)
Musculus	0	0
Cryptobranchia	present	present
Trichotropis	(2)	0
Puncturella	0	0
Fusitriton	0	0
Ocenebra	(1)	0
Ophiopholis	0	0
Strongylocentrotus	0	0
Balanus sp.	15%	2%

Location: NMFS Site

Depth: 9-10m

Substratum: Boulder Field

APPENDIX C

TABLE 2
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals)			
	No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	4	0	0	0
Laminaria groenlandica	10%	25%	25%(1)	40%(1)
Laminaria (juveniles)	0	0	(2)	(2)
Agarum	60%(4)	0	25%(2)	50%(5)
Constantinea	10%	20%	10%	1%
Ralfsia	40%	40%	10%	25%
encrusting coralline	40%	40%	50%	65%
Corallina	15%	15%	10%	15%
Bossiella	0	2%	0	2%
Ptilota	0	0	20%	20%
Rhodymenia	0	0	0	5%
Microporina	40%	15%	20%	10%
Flustrella	5%	0	0	0
orange globular ascidian	0	0	2%	0
Didemnum ?	0	0	0	1%
Metandrocarpa	0	0	1%	0
pagurids	0	(3)	(3)	(3)
Balanus sp.	0	1%	1%	0
Ophiopholis	present	present	0	0
Tonicella	(1)	0	0	0

APPENDIX C (Cont.)

TABLE 2
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Pododesmus	0	0	0	(2)
Amphissa	0	(2)	0	0
Lacuna	present	0	present	present
Searlesia	0	(3)	0	0
Voluthárpa ?	0	(1)	0	0
Myxicola	(3)	0	0	0
serpulidae	(9)	(16)	(2)	(3)

Location: NMFS Site

Depth: 4-5m

Substratum: Pavement Rock

APPENDIX D

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq m) AT
LATOUCHE POINT
NOVEMBER 27, 1975

(No. 1) Depth 11.5m; Rock Surface w/Boulders

Taxon	Percent Cover (number of individuals)
Laminaria	(2)
Agarum	(2)
Opuntiella	(1)
encrusting coralline	60%
Microporina	20%
Henricia	(2)

(No. 2) Depth 11.5m; Rock Surface

Taxon	Percent Cover (number of individuals)
Laminaria	(2)
Agarum	(2)
Ptilota	(1)
encrusting coralline	70%
Tonicella	(2)
Trophonopsis	(1)

(No. 3) Depth 11.5m; Boulder

Taxon	Percent Cover (number of individuals)
Laminaria (stipe)	(1)
Laminaria (juv. sporophytes)	(2)
Agarum	(2)
Ptilota	(1)
encrusting coralline	50%
Hildenbrandia	25%
Constantinea	(1)

(No. 4) Depth 12m; Rock Surface

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
Agarum	(1)
Opuntiella	(1)
Constantinea	(2)
Bossiella	2%
Corallina	5%

TABLE 1 (Cont.)

(No. 5) Depth 12.5m; Gravel

Taxon	Percent Cover (number of individuals)
Laminaria (juv. sporophytes)	(2)
Odonthalia	5%(2)

(No. 6) Depth 12.5m; Gravel

Taxon	Percent Cover (number of individuals)
Kallymenia	10%(1)

(No. 7) Depth 12m; Rock Surface

Taxon	Percent Cover (number of individuals)
Laminaria	(3)
Agarum	(2)
Ptilota	(3)
Opuntiella	(1)
Constantinea	(1)
Hildenbrandia	15%
Ralfsia	10%
Bossiella	2%
encrusting coralline	75%
Henricia	(1)

(No. 8) Depth 12.5m; Gravel

Taxon	Percent Cover (number of individuals)
Laminaria (juv. sporophytes)	(4)
Kallymenia	(1)

(No. 9) Depth 12.5m; Sand and Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
Agarum	(1)
Opuntiella	(1)
Ptilota	10%(1)
Hildenbrandia	20%

APPENDIX D (Cont.)

TABLE 1 (Cont.)

(No. 10) Depth 12.5m; Sand & Rock

Taxon	Percent Cover (number of individuals
Laminaria (juv. sporophyte)	(1)
Agarum	(1)
Constantinea	(1)

(No. 11) Depth 12.5m; Flat Rock & Gravel

Taxon	Percent Cover (number of individuals
Laminaria	(2)
Agarum	(2)
Constantinea	(2)
Ptilota	(1)
Bossiella	10%
Corallina	5%

(No. 12) Depth 12m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria (stipe)	(1)
Laminaria	(1)
Agarum	(4)
Hildenbrandia	40%
Opuntiella	(1)
Bossiella	2%
Corallina	2%
Styela	(1)
encrusting coralline	50%
Henricia	(2)

(No. 13) Depth 12.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria	(1)
Laminaria (juv. sporophyte)	(1)
Hildenbrandia	20%

APPENDIX D (Cont.)

TABLE 1 (Cont.)

(No. 14) Depth 12.5m; Sand & Rock

Taxon	Percent Cover (number of individuals
Ptilota	5%(1)
Fusitriton	(1)

APPENDIX D

TABLE 2
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE OFF LATOUCHE POINT
MARCH 16, 1976

(No. 1) Depth 10m; Gravel

Taxon	Percent Cover (number of individuals)
0	0

(No. 2) Depth 10m; Rock & Gravel

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(3)
Pleurophycus	(1)
Ptilota	5%
Constantinea	10%(3)
Membranoptera	10%(1)
Delesseria	10%
Ralfsia	5%
Rhodymenia	10%
Bossiella	5%
encrusting corallines	50%
Calliostoma	(1)

(No. 3) Depth 10m; Rock & Gravel

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria (juveniles)	(3)
Constantinea	10%(3)
unid. filimentous brown	10%
encrusting corallines	20%
Acmaea mitra	(1)

(No. 4) Depth 10m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(3)
Laminaria yezoensis	(1)
Laminaria (juveniles)	(2)
Ptilota	5%
Constantinea	10%(3)
encrusting coralline	60%
Ralfsia	5%
Corallina	30%

APPENDIX D (Cont.)

TABLE 2

HAPHAZARD QUADRAT CASTS (¼ sq m) FROM THE SUBLITTORAL ZONE OFF LATOUCHE POINT MARCH 16, 1976

(No. 5) Depth 10m; Gravel

Taxon	Percent Cover (number of individuals)
Constantinea	10%(2)

(No. 6) Depth 9m; Gravel & Sand

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Laminaria yezoensis	(1)
Opuntiella	5%(1)

(No. 7) Depth 9m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Laminaria yezoensis	(3)
Laminaria (juveniles)	(1)
Agarum	(2)
Rhodymenia	15%
Ptilota	5%
Delesseria	10%
Constantinea	2%(1)
encrusting corallines	70%
Calliostoma	(1)

(No. 8) Depth 9m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria (juveniles)	(6)
Agarum	(1)
Rhodymenia	5%
Ptilota	20%
Delesseria	10%
encrusting corallines	85%
Corallina	15%

APPENDIX D (Cont.)

TABLE 2
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE OFF LATOUCHE POINT
MARCH 16, 1976

(No. 9) Depth 9m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Pleurophycus	(4)
Rhodymenia	(2)
Ptilota	10%
Delesseria	15%
Callophyllis	10%
encrusting corallines	5%
	70%

(No. 10) Depth 9m; Rock & Gravel

Taxon	Percent Cover (number of individuals)
Agarum	(1)
Rhodymenia	10%
Delesseria	2%
encrusting corallines	20%
Corallina	10%

(No. 11) Depth 9m; Rock & Gravel

Taxon	Percent Cover (number of individuals)
Constantinea	5%
Ptilota	10%
Delesseria	5%
Membranoptera	20%
encrusting corallines	25%
Acmaea mitra	(1)

(No. 12) Depth 9m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Agarum	(1)
Constantinea	10%(1)
Ptilota	5%
Rhodymenia	5%
Monostroma	2%
Ralfsia	5%
encrusting corallines	25%
Corallina	2%

APPENDIX D (Cont.)

TABLE 2
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM
THE SUBLITTORAL ZONE OFF LATOUCHE POINT
MARCH 16, 1976

(No. 13) Depth 9m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(3)
Laminaria yezoensis	(2)
Laminaria (juveniles)	(3)
Ptilota	2%
Rhodymenia	5%
encrusting corallines	50%
Acmaea mitra	(1)
Calliostoma	(1)

APPENDIX D

TABLE 3
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM THE SUBLITTORAL ZONE AT LATOUCHE POINT SEPTEMBER 17, 1975

(No. 1) Depth 11m; Boulder Field and Gravel

Taxon	Percent Cover (number of individuals)
Laminaria	50%(6)
Constantinea	20%(7)
Ptilota	present
Membranoptera	15%(1)
encrusting coralline	50%
Hildenbrandia	2%
Corallina	5%
Acmaea mitra	(1)
clavate ascidian	1%
pagurids	(3)
Musculus	present

(No. 2) Depth 11m; Gravel Bed

Taxon	Percent Cover (number of individuals)
Laminaria	70%
Pleurophycus	20%
fleshy reds (unid.)	10%
Hildenbrandia	5%
encrusting coralline	present

(No. 3) Depth 11; Boulder and Gravel

Taxon	Percent Cover (number of individuals)
Laminaria	15%
Agarum	40%(1)
Constantinea	20%(4)
Corallina	20%
foliose red (unid.)	1%
encrusting coralline	60%
Balanus nubilus	(1)
Musculus	present
pagurids	(2)
Tonicella	(1)
Chelyosoma	(1)
Scrupocellaria	1%

APPENDIX E

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq.m) FROM THE SUBLITTORAL ZONE OFF NMFS SITE, MACLEOD HARBOR
MARCH 14, 1976

(No. 1) Depth 8m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria (juvenile)	(14)
Pleurophycus	(1)
Agarum	(1)
Microcladia	2%
Hildenbrandia	10%
Constantinea	2%
Bossiella	5%
encrusting corallines	60%
Tonicella	(1)
Pycnopodia	(1)

(No. 2) Depth 8m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria (juveniles)	(2)
Agarum	(4)
Opuntiella	10%
Delesseria	2%
Corallina	2%
encrusting corallines	80%
Tonicella	(1)
Musculus	present

(No. 3) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria yezoensis	(2)
Laminaria (juveniles)	(5)
Agarum	(8)
Pleuropytous	(2)
Opuntiella	2%(1)
Hildenbrandia	20%
encrusting corallines	80%
Ralfsia	5%
Callophyllis	2%
Tonicella	(2)
Pycnopodia	(1)
Musculus	present

APPENDIX E (Cont.)

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM THE
SUBLITTORAL ZONE OFF NMFS SITE, MACLEOD HARBOR
MARCH 14, 1976

(No. 4) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(4)
Laminaria (juveniles)	(8)
Agarum	(2)
Hildenbrandia	15%
Bossiella	5%
Corallina	10%
encrusting corallines	80%
Musculus	present

(No. 5) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(3)
Laminaria (juveniles)	(3)
Agarum	(5)
Pleurophycus	(3)
Delesseria	5%
Opuntiella	10%
Callophyllis	10%
Corallina	2%
encrusting corallines	85%
Tonicella	(1)
Acmaea mitra	(1)
Musculus	present

(No. 6) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(5)
Agarum	(1)
Rhodymenia	5%
Opuntiella	10%(1)
Delesseria	15%
Hildenbrandia	10%
Ralfsia	5%
Corallina	5%
encrusting corallines	70%
Acmaea mitra	(1)
Musculus	present

APPENDIX E (Cont.)

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM THE SUBLITTORAL ZONE OFF NMFS SITE, MACLEOD HARBOR
MARCH 14, 1976

(No. 7) Depth 3m; Rock

Taxon	Percent Cover (number of individuals)
Delesseria	15%
diatom scum	80%

(No. 8) Depth 3m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(5)
Delesseria	10%
Corallina	10%
encrusting corallines	75%

(No. 9) Depth 4m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(3)
Laminaria (juveniles)	(10)
Pleurophycus	(2)
Costaria (juveniles)	(3)
Constantinea	5%(1)
Odonthalia	2%
Delesseria	5%
encrusting corallines	70%
Musculus	present

APPENDIX E

TABLE 2
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM THE
SUBLITTORAL ZONE OFF NMFS SITE, MACLEOD
HARBOR, MARCH 14, 1976

(No. 1) Depth 7m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(3)
Laminaria yezoensis	(11)
Laminaria (juveniles)	(4)
Corallina	10%
Rhodymenia	2%
encrusting corallines	10%
Tonicella	(1)
Musculus	present

(No. 2) Depth 7m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(4)
Laminaria yezoensis	(1)
Laminaria (juveniles)	(4)
Agarum	(1)
encrusting corallines	15%
Musculus	present

(No. 3) Depth 7m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Laminaria yezoensis	(8)
Laminaria (juveniles)	(2)
Opuntiella	5%(1)
Rhodymenia	5%(3)
Corallina	5%
encrusting corallines	80%
Tonicella	(1)
Musculus	present

(No. 4) Depth 7m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria yezoensis	(1)

APPENDIX E (Cont.)

TABLE 2
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM THE SUBLITTORAL ZONE OFF NMFS SITE, MACLEOD HARBOR, MARCH 14, 1976

(No. 4) Cont.

Taxon	Percent Cover (number of individuals)
Laminaria (juveniles)	(8)
Agarum	(1)
Rhodymenia	2%
Constantinea	2%
encrusting corallines	50%
Delesseria	2%
Musculus	present

(No. 5) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Laminaria yezoensis	(5)
Laminaria (juveniles)	(10)
Agarum	(2)
Microcladia	5%
Delesseria	2%
encrusting corallines	80%
Opuntiella	2%
Ralfsia	5%
Acmaea mitra	1
Musculus	present

(No. 6) Depth 6m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(6)
Laminaria (juveniles)	(10)
Agarum	(1)
Opuntiella	5%
Microcladia	2%
Ralfsia	2%
Hildenbrandia	2%
Musculus	present

(No. 7) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(15)

APPENDIX E (Cont.)

TABLE 2
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM THE SUBLITTORAL ZONE OFF NMFS SITE, MACLEOD HARBOR, MARCH 14, 1976

(No. 7) Cont.

Taxon	Percent Cover (number of individuals)
Laminaria yezoensis	(6)
Laminaria (juveniles)	(20)
Hildenbrandia	10%
Delesseria	2%
encrusting corallines	50%
Musculus	present

(No. 8) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(5)
Laminaria (juveniles)	(10)
Delesseria	5%
Hildenbrandia	50%
Rhodymenia	2%
Opuntiella	5%
Bossiella	10%
encrusting corallines	60%

(No. 9) Depth 4m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(8)
Laminaria (juveniles)	(10)
Opuntiella	15%
Microcladia	20%

(No. 10) Depth 6m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria (juveniles)	(9)
Opuntiella	10%
Delesseria	5%
Hildenbrnadia	10%
encrusting corallines	65%
Musculus	present
Pycnopodia	(1)

APPENDIX E (Cont.)

TABLE 2
HAPHAZARD QUADRAT CASTS (¼ sq m) FROM THE SUBLITTORAL ZONE OFF NMFS SITE, MACLEOD HARBOR, MARCH 14, 1976

(No. 11) Depth 5m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Laminaria yezoensis	(1)
Laminaria (juveniles)	(25)
encrusting corallines	15%
Musculus	present

(No. 12) Depth 5m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria (juveniles)	(4)
Agarum	(2)
Rhodymenia	5%
Opuntiella	2%
encrusting corallines	20%
Musculus	present
Pycnopodia	(1)

(No. 13) Depth 6m; Rock & Sand

Taxon	Percent Cover (number of individuals)
Laminaria groelandica	(3)
Laminaria yezoensis	(1)
Laminaria (juveniles)	(12)
Nereocystis (juveniles)	(3)
Opuntiella	2%
encrusting corallines	30%
Musculus	present

APPENDIX F

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq m)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 1) Depth 10.5m; Sand, Shell Debris & Silt

Taxon	Percent Cover (number of individuals)
Laminaria (juvenile)	(1)
Rhodymenia	2%(2)
diatom scum	80%

(No. 2) Depth 10.5m; Sand & Silt

Taxon	Percent Cover (number of individuals)
Laminaria (juveniles)	(3)
unid. foliose red	(1)
diatom scum	90%
Orthasterias	(1)

(No. 3) Depth 10.5m; Sand & Silt

Taxon	Percent Cover (number of individuals)
diatom scum	80%
shell debris	20%

(No. 4) Depth 10m; Rock & Shell Debris

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Rhodymenia	(1)
Desmarestia	(1)
unid. filamentous reds	2%

(No. 5) Depth 9m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(1)
Constantinea	1(5%)
Callophyllis	10%
Flustrella	5%
Microporina	30%
Evasterias	(1)

APPENDIX F (Cont.)

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq m)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 5) Cont.

Taxon	Percent Cover (number of individuals)
Ischnochiton	
pagurids	
unid. cottid	

(No. 6) Depth 8.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Agarum	(3)
Callophyllis	2%
encrusting corallines	30%
Microporina	25%
Pycnopodia	(2)

(No. 7) Depth 8.5m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(5)
Callophyllis	2%
encrusting corallines	25%
Microporina	30%
Balanus	40%
Calliostoma	(2)

(No. 8) Depth 8.5m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(1)
Callophyllis	2%
Microporina	15%
Balanus	60%
Heteropora	5%

(No. 9) Depth 7.5m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(1)

APPENDIX F (Cont.)

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq m)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 9) Cont.

Taxon	Percent Cover (number of individuals)
Callophyllis	5%
encrusting coralline	15%
Flustrella	5%
Microporina	5%
Balanus	25%
Calliostoma	(1)
Ischnochiton	(1)
Puncturella	(1)

(No. 10) Depth 8m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria (juveniles)	(2)
Agarum	(2)
Callophyllis	5%
encrusting coralline	60%
Microporina	10%
Flustrella	2%
Evasterias	(1)
Trichotropis	present

(No. 11) Depth 8m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Agarum	(1)
Callophyllis	5%
encrusting coralline	40%
Flustrella	5%
Balanus	2%
Trichotropis	(4)

(No. 12) Depth 6.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(4)
Agarum	(3)

APPENDIX F (Cont.)

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq m)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 12) Cont.

Taxon	Percent Cover (number of individuals)
Callophyllis	2%
encrusting corallines	75%
Microporian	10%
Dendrobeania	2%
Flustrella	5%
Pycnopodia	(1)
Musculus (nestling)	present

(No. 13) Depth 7m; Rock & Sehll Debris

Taxon	Percent Cover (number of individuals)
Agarum	(4)
Callophyllis	5%
Microporina	10%
Balanus	20%

(No. 14) Depth 4.5m; Rock & Shell Debris

Taxon	Percent Cover (number of individuals)
Laminaria yezoensis	(1)
Laminaria groenlandica	(4)
Laminaria (juveniles)	(3)
Agarum	(5)
Rhodymenia	2%(1)
Odonthalia	5%
encrusting corallines	60%
Dendrobeania	2%
Balanus	30%

(No. 15) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Agarum	(6)
Rhodymenia	5%
Constantinea	(2)
unid. filamentous reds	20%

APPENDIX F (Cont.)

TABLE 1
HAPHAZARD QUADRAT CASTS (¼ sq m)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 15) Cont.

Taxon	Percent Cover (number of individuals)
Hildenbrandia	5%
encrusting corallines	80%

(No. 16) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Agarum	(6)
Rhodymenia	5%
Constantinea	1%(2)
unid. filamentous reds	20%
Hildenbrnadia	5%
encrusting corallines	80%

(No. 17) Depth 3m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria yezoensis	(2)
Agarum	(2)
Rhodymenia	15%
Ptilota	30%
Corallina	5%
encrusting corallines	85%

APPENDIX F

TABLE 2
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL
MARCH 19, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 4	No. 5
Laminaria yezoensis	15%	20%
Laminaria groenlandica	0	0
Laminaria (juviniles)	0	(2)
Agarum	50%(2)	25%(7)
Constantinea	0	1%
Ralfsia	15%	10%
encrusting coralline	10%	20%
Hildenbrandia	25%	0
Corallina	1%	2%
filamentous red	2%	10%
Microporina	20%	15%
Didemnum	0	1%
pagurids	(2)	(2)
Heteropora	0	2%
Trichotropis	0	0
serpulidae	(2)	(7)
Flustrella	5%	2%
yellow sponge	0	0
Disaplia ?	0	1%
Margarites	(1)	0

APPENDIX F (Cont.)

TABLE 2
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL
MARCH 19, 1976

Cover and Composition:

	Percent Cover (number of individuals)	
Taxon	No. 4	No. 5
Abietinaria	0	0
Lacuna	0	0
Cancer oregonensis	0	0
Archidistoma	8%	5%
Cnemidocarpa	0	0
Tonicella	(2)	0
Phyllolithodes	0	(1)
Balanus sp.	10%	20%

Location: NMFS Site

Depth: 6-7m

Substratum: Boulder Field

APPENDIX F

TABLE 3
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL
MARCH 19, 1976

Cover and Composition:

Taxon	Percent Cover (number of individuals)		
	No. 1	No. 2	No. 3
Laminaria yezoensis	0	25%(3)	0
Laminaria groenlandica	0	0	0
Laminaria (juveniles)	0	(2)	0
Agarum	90%(6)	15%(7)	80%(5)
Constantinea	0	6%	0
Ralfsia	5%	0	10%
encrusting coralline	30%	5%	15%
Hildenbrandia	0	0	0
Corallina	0	0	0
filamentous res	6%	4%	5%
Microporina	0	1%	10%
Didemnum ?	1%	0	0
pagurids	(6)	(3)	(1)
Heteropora	0	0	0
Trichotropis	(1)	(1)	(1)
serpulidae	(2)	(5)	(1)
Flustrella	5%	2%	10%
yellow sponge	2%	0	0
Distaplia ?	1%	0	5%
Margarites	(1)	0	0

TABLE 3
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL
MARCH 19, 1976

Cover and Composition:

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Abietinaria	5%	0	0
Lacuna	present	0	0
Cancer oregonensis	(1)	0	0
Archidistoma ?	2%	0	0
Cnemidocarpa	(1)	0	0
Tonicella	0	0	0
Phyllolithodes	0	0	0
Balanus sp.	15%	8%	40%

Location: NMFS Site

Depth: 6-7m

Substratum: Boulder Field

APPENDIX F

TABLE 4
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL ZONE
NOVEMBER 24, 1975

Cover and Composition:

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Laminaria	30%(5)	40%(4)	20%(2)	10%(1)
Agarum	40%(2)	10%(2)	20%(2)	40%(1)
(Microcladia)	1%	1%	3%	2%
encrusting corallines	30%	40%	15%	40%
Ralfsia pacifica	0	10%	0	0
Hildenbrandia	5%	0	15%	5%
Microporina borealis	5%	10%	2%	2%
Flustrella sp.	5%	5%	5%	0
Distaplia smithi ?	5%(1)	0	0	0
pagurids	(5)	(3)	(1)	(1)
Didemnum	1%	0	0	0
Dendrobeania	1%	0	0	0
Puncturella multistriata	0	0	0	(1)
chiton (unid)	(2)	(2)	(1)	(2)
Calliostoma ligatum	(1)	0	0	0
Cancer oregonensis	0	0	0	(1)
Heteropora sp.	0	2%	0	0
Crepipatella lingulata	(1)	0	0	0

APPENDIX F (Cont.)

TABLE 4
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL ZONE
NOVEMBER 24, 1975

Cover and Composition:

Taxon	Percent Cover (number of individuals)			
	No. 1	No. 2	No. 3	No. 4
globose red sponge	(2)	0	(3)	0
colonial ascidian (convoluted)	0	2%	2%	0

Location: 100m off NMFS Transect

Depth: 7-8m

Substrate Type: Boulder, Cobble & Shell debris

APPENDIX F

TABLE 5
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL
NOVEMBER 23, 1975

Cover and C osition:

Taxon	Percent Cover (number of individuals)				
	No. 1	No. 2	No. 3	No. 4	No. 5
Laminaria	0	5%	30%(2)	5%	25%(1)
Agarum	20%(1)	0	20%(1)	5%(1)	40%(2)
Constantinea	1%(1)	0	0	0	0
Ralfsia	15%	20%	10%	20%	15%
encrusting coralline	80%	60%	90%	80%	80%
Hildenbrandia	0	0	1%	0	1%
(Microcladia)	0	0	0	1%	0
Microporina borealis	40%	20%	25%	15%	50%
Didemnum	1%	1%	1%	5%	1%
pagurids	(2)	(2)	(5)	(1)	(1)
Heteropora sp.	1%	5%	1%	1%	5%
Phidolopora pacifica	1%	1%	1%	1%	5%
Cryptobranchia concentrica	(1)	0	0	0	0
Rhynchozoon sp.	1%	0	0	0	0
Trichotropis cancellata	0	(1)	0	(1)	0
Crossaster papposus	0	(1)	0	0	0
serpulidae	0	(4)	(2)	(1)	(1)
Crepipatella lingulata	0	(1)	(0)	(1)	0
Acmaea mitra	0	0	(1)	0	0
Flustrella	0	0	2%	35%	0

APPENDIX F (Cont.)

TABLE 5
QUADRAT DATA (¼ sq m) FROM
ZAIKOF BAY, SUBTIDAL
November 23, 1975

Cover and Composition:

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Pycnopodia helianthoides	0	0	(1)	0	0
Hydroida (unid.)	1%	1%	0	5%	1%
Dendrobeania	0	0	0	1%	0
Thais lamellosa	0	0	0	0	(2)
globular red sponge	(1)	0	(1)	0	0

Location: 100m offshore - NMFS Transect

Depth: 10-16m

Substratum: Rock Outcropping

QUARTERLY REPORT

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Plankton of the Gulf of Alaska - Ichthyoplankton

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1 July 1976

Departmental Concurrence:

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REF: A76-57

I. Task Objectives

The task of primary emphasis is to determine the seasonal density distributions and environmental requirements for principal species of ichthyoplankton in the Gulf of Alaska.

II. Field Activities

A. Ship schedules, Personnel

1. *Discoverer* - RP-4-DI-76A, Leg III, 06-13 Apr 1976.

Personnel:

Kendra Daly, Assistant Oceanographer, Department of Oceanography, University of Washington
Michael Tomlinson, Assistant Oceanographer, Department of Oceanography, University of Washington

2. *Discoverer* - RP-4-DI-76A, Leg V, 05-09 May 1976

Personnel:

Kendra Daly, Assistant Oceanographer, Department of Oceanography, University of Washington
Michael Tomlinson, Assistant Oceanographer, Department of Oceanography, University of Washington

3. *Discoverer* - RP-4-DI-76A, Leg VII, 22-30 May 1976

Personnel:

Kendra Daly, Assistant Oceanographer, Department of Oceanography, University of Washington
Tom Kaperak, Helper, Department of Oceanography, University of Washington
Margaret Altemus, Helper, Department of Oceanography, University of Washington

These cruises were aboard NOAA ship *Discoverer* (OSS 02) (Fig. 1a, b, c). The vessel has an overall length of 303 feet, a beam of 52 feet, and a draft of 18 feet (displacement is 3,805 L.T.). Propulsion is provided by two counter-rotating fixed-pitch propellers, each driven by a 2500 shp electric motor. The practical RPM range for each shaft is 20 to 140. The speed ranged from 2 (steerage maintained) to 16 knots. Located in a transverse tunnel through the bow is a 400 hp bow thruster capable of developing 10,000 pounds thrust. This is used to maintain a constant heading at low speed in adverse wind and sea conditions. Four 1150 kw diesel generators supply D.C. power to the main propulsion system and bow thruster. Nets were deployed from E deck. The dredge and trawl winch and the hydro winch for this work are located on F deck.

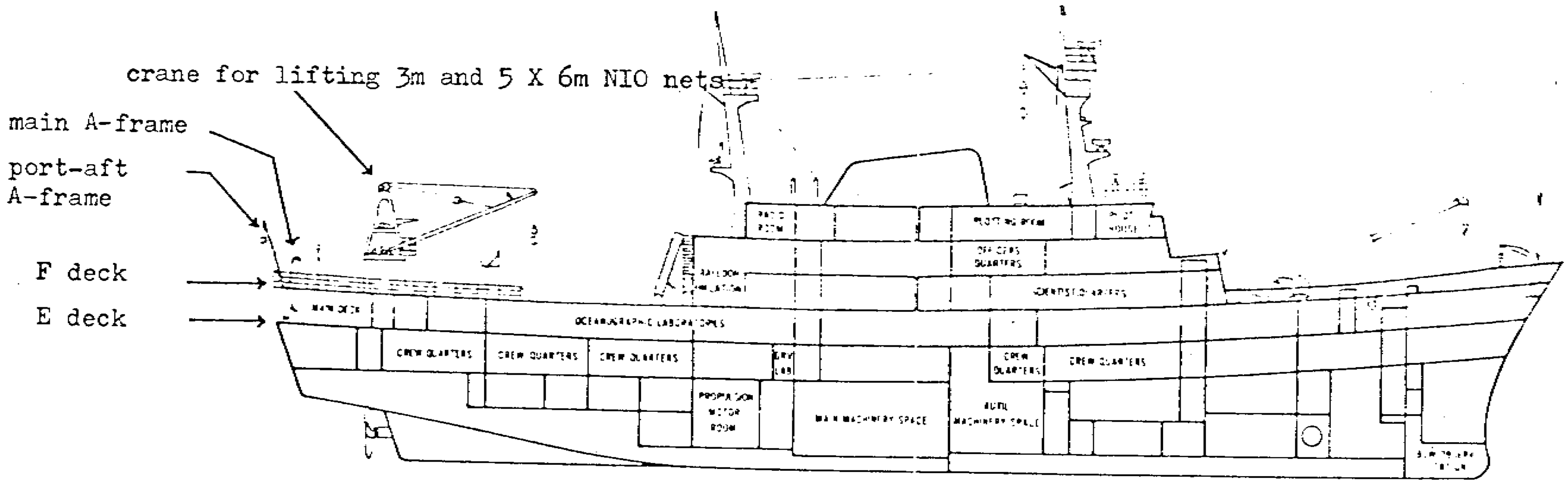

Fig. 1a. Profile plan of NOAA ship *Discoverer*, OSS 02.

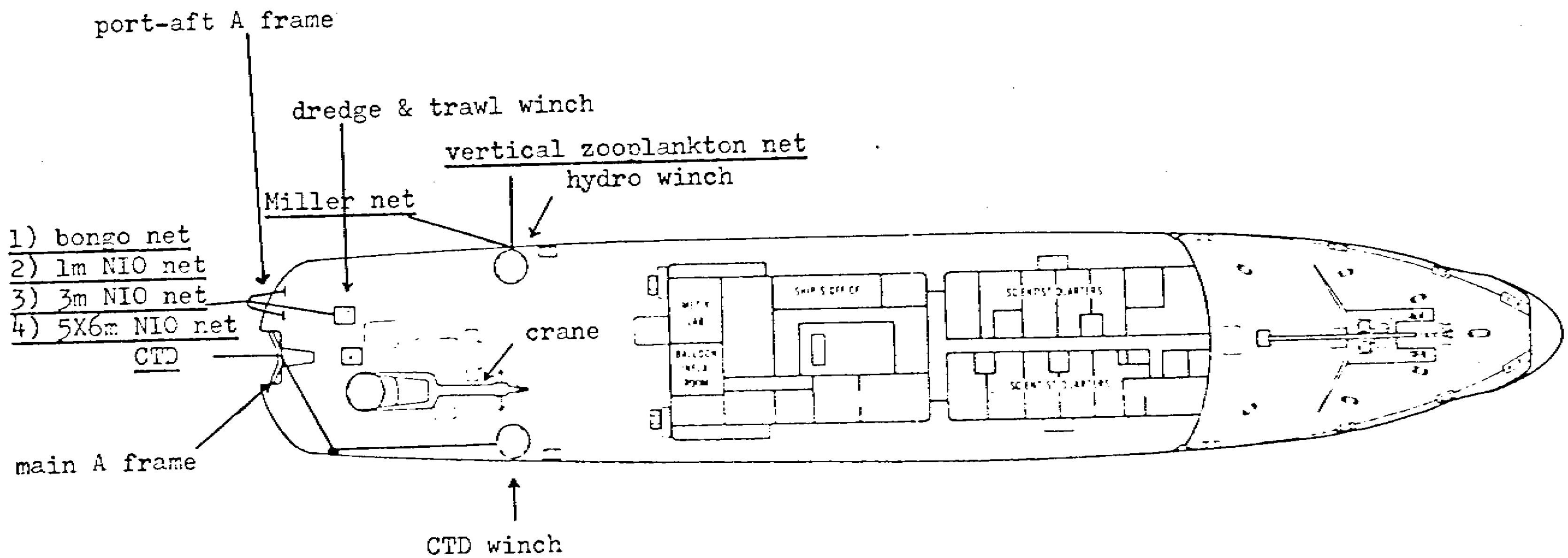

Fig. 1b. F Deck, *Discoverer*.

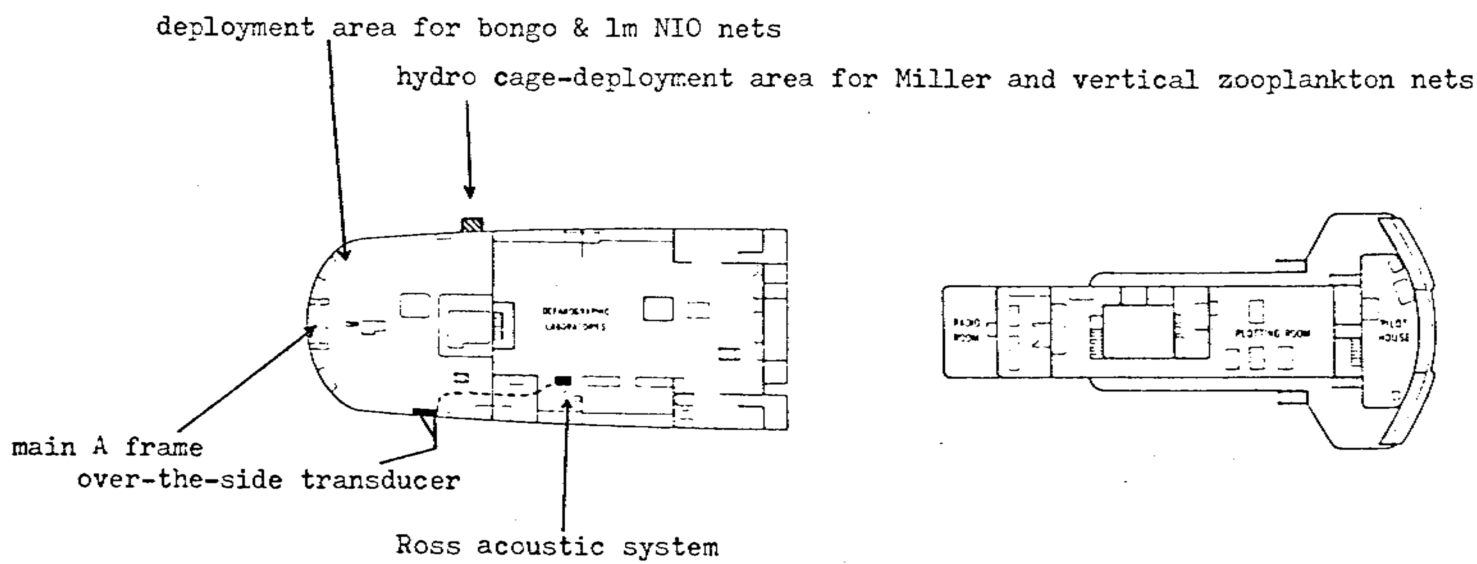

Fig. 1c. E Deck, *Discoverer*.

B. Methods

All stations were located in Lower Cook Inlet, the open Gulf of Alaska, or Prince William Sound (Figs. 2-4, Tables 1-3). During Leg III, the proposed station 12 was not occupied. Station 6 in Kachemak Bay was occupied for 26 hours, station 11 in the open Gulf for 8 hours, and station 13 in Prince William Sound for 21 hours. Stations 2 and 5 were occupied twice, the second occupation being designated 2a and 5a. The stations designated 4a and 11a were PMEL vertical zooplankton stations. Station 4a was occupied at local midnight and 11a at local apparent noon. The remaining stations were occupied on the average for 3 to 4 hours each. The seas were calm with overcast skies, snow, and rain; 15-knot winds prevailed.

During Leg V, station 6 in Kachemak Bay was occupied for 9.5 hours. Station 5 was occupied twice, the second occupation designated as 5a. This station 5 was located further north than station 5 of Leg III. This was an attempt to sample a gyre reported by the Alaska Department of Fish and Game to be an Alaskan king crab nursery. The station designated 8a was a PMEL vertical zooplankton station occupied at local midnight. All other stations were occupied once for approximately 2 to 3 hours, with the exception of station 10. This station was occupied briefly due to adverse sea conditions. Seas ranged from calm to 20 feet with winds as high as 50 knots. The weather varied from rain and snow to clear.

During Leg VII, station 9 was abandoned before any samples were taken due to adverse sea conditions. The stations designated 6a and 14a were PMEL vertical zooplankton stations. Both stations were occupied at local midnight. Station 6 in Kachemak Bay was occupied for 24 hours, station 13 in Prince William Sound for 22 hours, and station 11 in the open Gulf for 12 hours. The remaining stations were occupied for an average of 1 to 2 hours each. The seas varied from calm to 7 feet, with winds up to 40 knots. The weather was mostly clear or partly cloudy, and occasionally overcast with some rain.

The continuous acoustic surveys were conducted using a Ross 200A Fine Line Echosounder system operating with a frequency of 105 kHz. A towed 10° transducer mounted in a 2 foot V-fin depressor was used during Leg III until the housing was destroyed during the towing operation. Thereafter and during Leg V, the transducer was lowered approximately 2 m below the surface whenever the vessel was stopped. During Leg VII, a transducer that was smaller in diameter, had a wider beam and was slightly more efficient than the Ross transducer used during the previous cruises, was mounted in a V-fin depressor. It was lowered over the side while on station, and towed during the net hauls and on one transect between stations 5a and 6. Transceiver problems ended the use of the echosounder system at station 6 during Leg VII. The incoming signal was recorded on a paper chart marked with station number, date, time (GMT), and other pertinent information. If a layer was present, during Legs III and V the incoming signal was also recorded on magnetic tape for later digitizing and analysis at the University of Washington. Magnetic tape records were made at

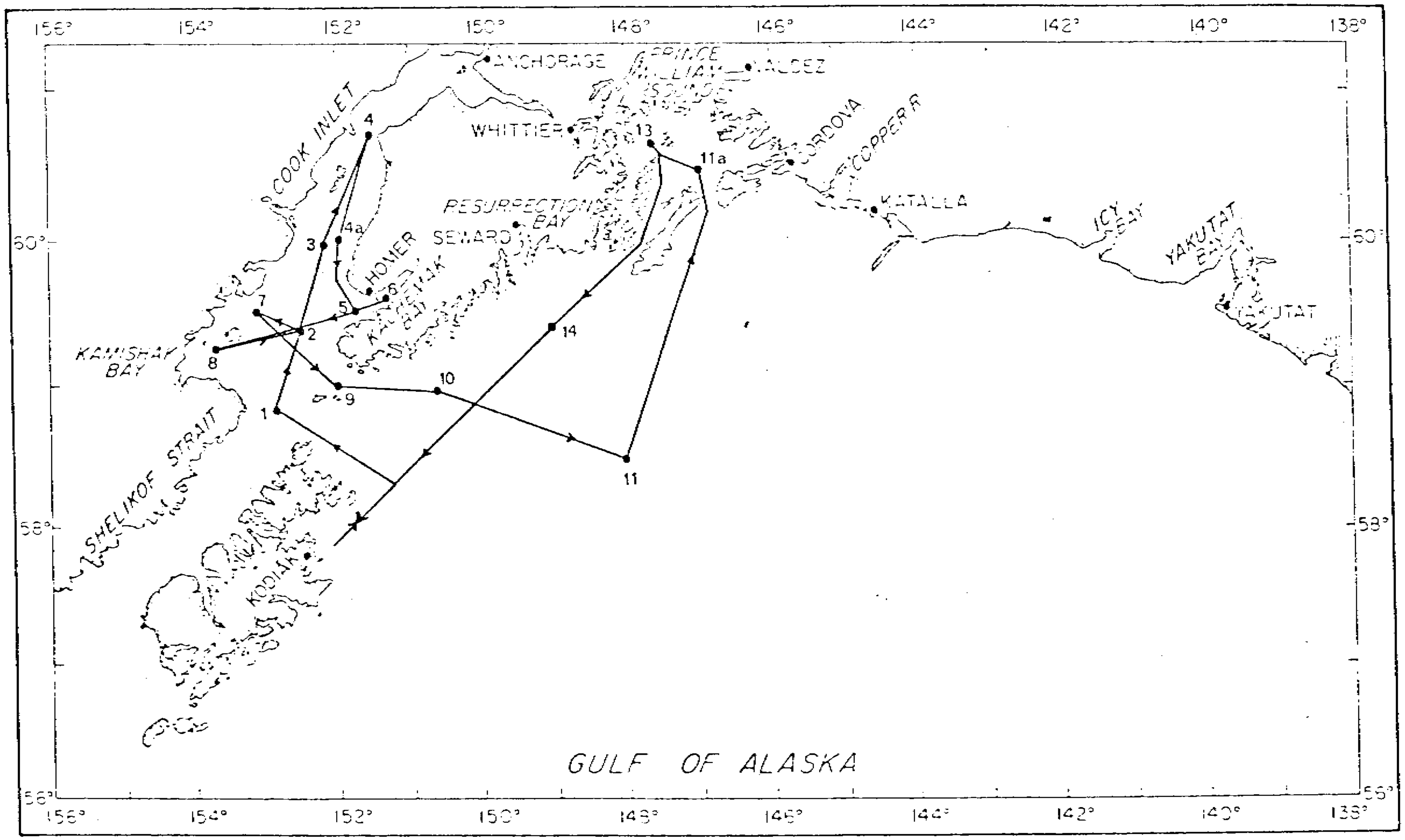

Fig. 2. Station locations, *Discoverer*, 06-13 Apr 1976.

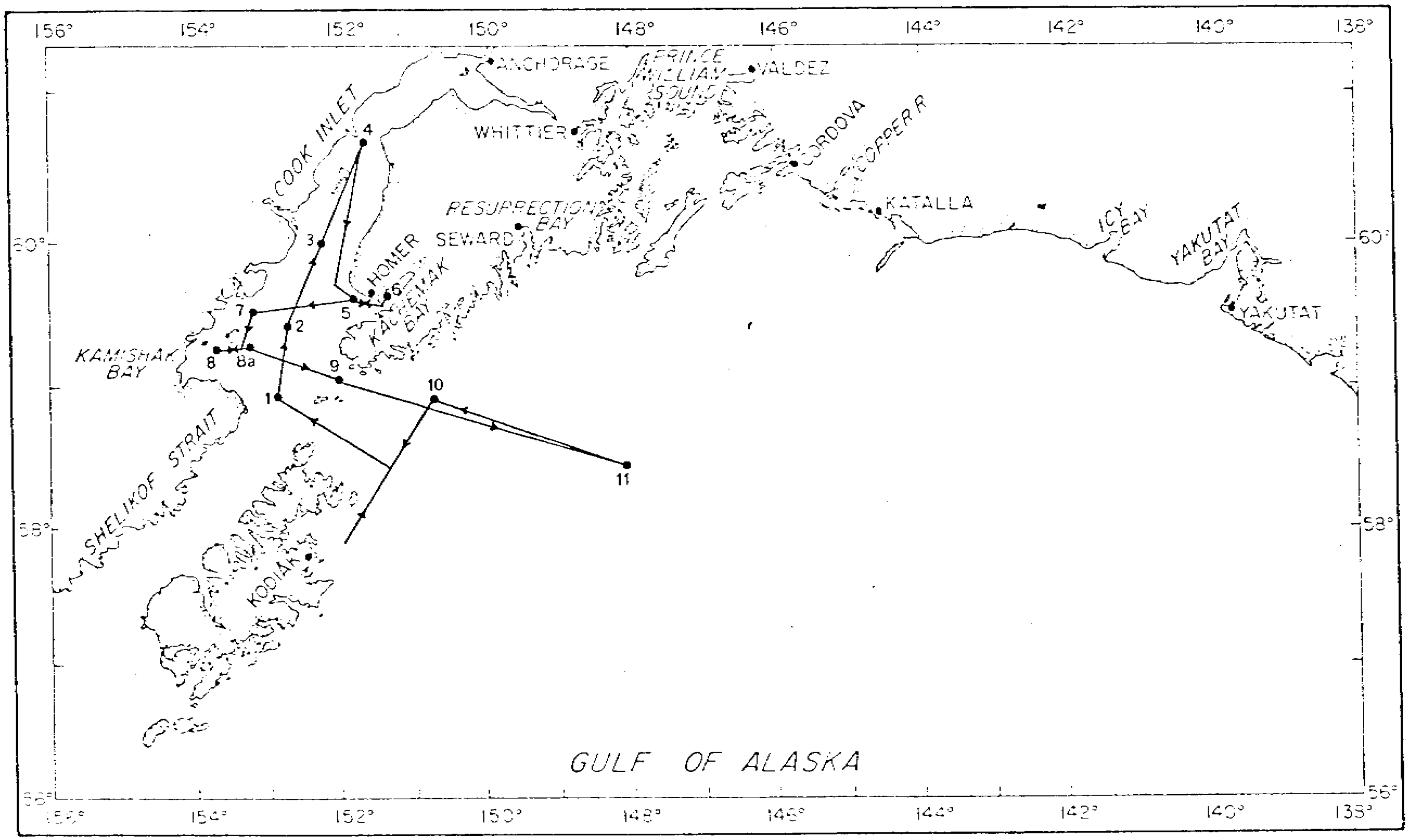

Fig. 3. Station locations, *Discoverer*, 05-09 May 1976.

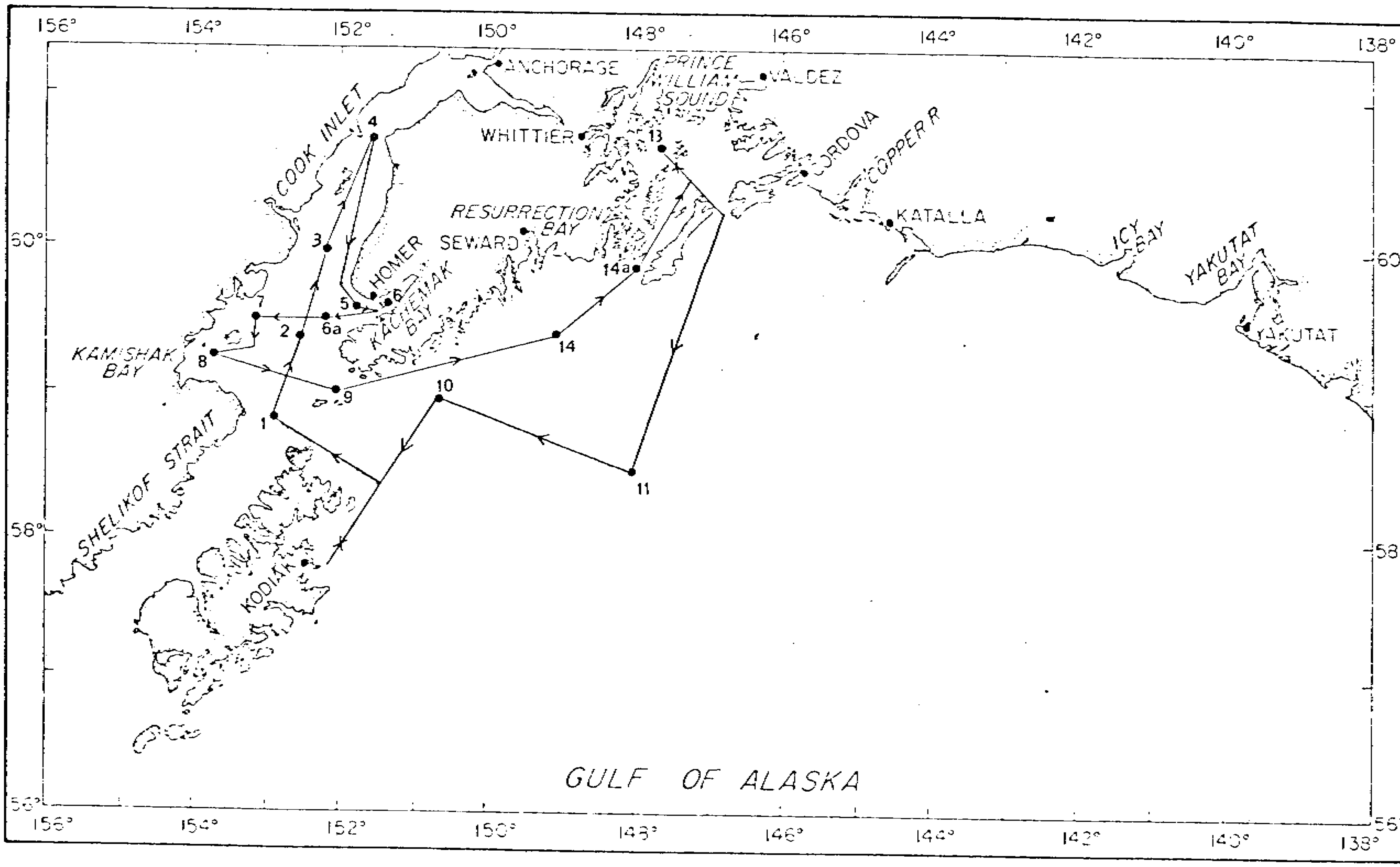

Fig. 4. Station locations, *Discoverer*, 22-30 May 1976.

Table 1. Station Locations, Leg III

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	58° 53.0'	152° 52.0'	170	Shelikof Strait
2	59° 23.0'	152° 38.6'	70	Lower Cook Inlet
3	59° 58.0'	152° 11.0'	80	Lower Cook Inlet
4	60° 40.5'	151° 35.0'	60	Lower Cook Inlet
4a	60° 02.8'	151° 59.1'	50	Lower Cook Inlet
5	59° 31.4'	151° 45.2'	110	Kachemak Bay
6	59° 36.5'	151° 19.0'	80	Kachemak Bay
7	59° 29.9'	153° 10.0'	40	Lower Cook Inlet
8	59° 14.5'	153° 39.5'	30	Kamishak Bay
9	59° 01.7'	151° 57.7'	210	Gulf of Alaska
10	58° 51.1'	150° 39.5'	130	Gulf of Alaska
11	58° 26.0'	148° 06.0'	1460	Gulf of Alaska
11a	60° 27.4'	146° 58.4'	390	Prince William Sound
13	60° 41.5'	147° 40.9'	720	Prince William Sound
14	59° 23.7'	149° 05.4'	200	Gulf of Alaska

Table 2. Station locations, Leg V

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	58° 52.5'	152° 47.4'	180	Shelikof Strait
2	59° 22.9'	152° 39.5'	70	Lower Cook Inlet
3	59° 59.4'	152° 11.0'	65	Lower Cook Inlet
4	60° 40.0'	151° 37.7'	95	Lower Cook Inlet
5	59° 34.8'	151° 47.8'	40	Kachemak Bay
5a	59° 34.6'	151° 47.3'	40	Kachemak Bay
6	59° 37.1'	151° 19.0'	80	Kachemak Bay
7	59° 30.0'	153° 10.0'	35	Lower Cook Inlet
8	59° 14.2'	153° 40.3'	35	Kamishak Bay
8a	59° 14.8'	153° 11.5'	60	Lower Cook Inlet
9	59° 02.0'	151° 58.6'	200	Gulf of Alaska
10	58° 51.8'	150° 38.0'	130	Gulf of Alaska
11	58° 23.3'	148° 02.0'	1600	Gulf of Alaska

Table 3. Station locations, Leg VII

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	58° 52.6'	152° 47.0'	177	Shelikoff Strait
2	59° 23.6'	152° 38.1'	68	Lower Cook Inlet
3	59° 59.5'	152° 11.5'	68	Lower Cook Inlet
4	60° 41.5'	151° 37.5'	100	Cook Inlet
5a	59° 34.65'	151° 47.0'	47	Outer Kachemak Bay
6	59° 36.6'	151° 19.1'	77	Inner Kachemak Bay
6a	59° 35.8'	152° 01.9'	49	Lower Cook Inlet
7	59° 29.4'	153° 09.6'	38	Lower Cook Inlet
8	59° 13.6'	153° 37.6'	32	Kamishak Bay
14	59° 24.3'	149° 05.3'	203	Gulf of Alaska
14a	59° 51.65'	148° 02.9'	125	Prince William Sound
13	60° 42.2'	147° 40.6'	695	Prince William Sound
11	58° 23.9'	148° 05.5'	1385	Gulf of Alaska
10	58° 51.9'	150° 40.3'	131	Gulf of Alaska

stations 4, 5a, and 6 during Leg VII. Emphasis was placed on the 0 to 50 fm range but depths to 200 fms were examined as well. Of particular interest were layers of zooplankton, ichthyoplankton, or nekton.

Zooplankton and ichthyoplankton were sampled with a nonclosing 1-m NIO net in horizontal or double oblique tows, a bongo net in a double oblique tow, or a Miller net in a horizontal tow. A towing speed of 2-3 knots was attempted for the NIO and bongo nets while the Miller nets were towed at 12 knots.

The bongo net consisted of a double-mouthed frame (each mouth with an inside diameter of 60 cm and a mouth area of 0.2827 m^2) made of fiber glass and weighing 95 lbs; a 100-lb weight was also attached to this net. A 505-μm mesh net with an open area ratio (OAR) of 8:1 and a 333-μm mesh net, 8:1 OAR, were attached to the frame. A TSK flowmeter was mounted in the mouth of each net to estimate the volume of water filtered. A third TSK mounted on the outside of the frame was used to detect differences in calculated water volumes due to clogging of the nets. A bathykymograph (BKG) was attached to the frame to determine the depth of tow. Double oblique tows required deployment at 50 m/min, a 30-sec soaking time, and retrieval at 20 m/min. A towing speed of 2-4 knots was typical for this vessel. The sampling depth for double oblique tows was usually 200 m following standard MARMAP procedures. In shallower water, the net was placed as close to the bottom as possible without endangering the net. Several subtractive hauls were made whenever such hauls were deemed valuable for determining the constituency of a layer.

The 1-m NIO net had an open area ratio (OAR) of 4:1 with 471-μm mesh. A bathykymograph (BKG) was attached to determine depth and a TSK flowmeter was mounted on the top bar to determine the volume of water filtered. The mouth area when fishing is 1 m . Double oblique tows required deployment at 50 m/min, a 30-sec soaking time, and retrieval at 20 m/min. Horizontal tows were made by deploying and retrieving at approximately 50 m/min with an appreciably longer time spent fishing at depth. Horizontal tows were used for sampling layers seen with the echosounder. The initial fishing depth of the net was determined by the product of the cosine of the wire angle and the amount of wire out. The actual depth was determined with a BKG.

Samples were either placed in 500 or 1000-ml bottles which were filled 3/4 full of sea water. The 500-ml sample was preserved with 25 ml of 100% formalin and 10 ml of saturated sodium borate solution; these quantities were doubled for 1000-ml bottles. A label was filled out and inserted in the jar, the jar was filled close to the brim with sea water, and the jar was capped and sealed with plastic electrical tape for storage.

Nekton capable of avoiding the smaller nets were, in part, sampled with 3-m and 5 x 6-m NIO nets. These tows were double oblique or horizontal. Surface and sub-surface organisms were sampled underway with a Miller net with 571-μm mesh. These samples were preserved in the same manner as the zooplankton samples.

C. Sample localities and tracklines

For sample localities and ship tracklines see Figs. 2-4.

D. Data collected or analyzed

1. The number and kinds of net hauls and the acoustic survey summary are given in Tables 4-7 for Leg III, 8-9 for Leg V, and 10-11 for Leg VII.

2. The number and kinds of net hauls analyzed are given in Tables 12-14.

3. Miles of trackline:

Leg	Kilometers
III	1800
V	1200
VII	1700

III. Results

A. Leg III

The original intention was to have a continuous acoustic survey utilizing the transducer mounted in a towed body. After the destruction of the towed body between stations 1 and 2, the transducer was lowered whenever the vessel was stopped. Twelve of the 13 stations were surveyed with a total of 2,609 minutes of chart records and 120 minutes of magnetic records. Sampling with bongo nets and 1-m NIO nets revealed large numbers of copepods normally invisible to the echosounder. Larger fish could be seen below 160 m during the day with an upward shift toward night.

Both the 1-m NIO net and the bongo net were successful in catching ichthyoplankton and confirmed what the acoustic system was detecting at stations 6 and 13. Large quantities of zooplankton were collected when the layers were sampled.

The 5 x 6-m and 3-m NIO nets were somewhat more difficult to use because of their size and the returns were relatively small. The 5 x 6-m NIO net caught some shrimp and smelt between stations 3 and 4 in Cook Inlet during the day while the 3-m NIO net and the bongo net caught myctophids at night at station 11 in the open Gulf.

The fish eggs and larvae have been sorted and identified from these samples (Tables 12-14).

Table 4. UW Haul Summary Sheet, Leg III

Bongo Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered (m^3)	Mesh size (μm) 505	Mesh size (μm) 333
7 Apr	0844	1	1	58° 53.0'	152° 52.0'	[1]	350	1	1
7 Apr	1620	2	2	59' 23.0'	152° 38.6'	[2]	79	1	1
7 Apr	2239	3	2	59° 58.0'	152° 11.0'	[1]	106	1	1
8 Apr	0440	4	1	60° 40.5'	151° 35.0'	[1]	95	1	1
8 Apr	1520	5	3	59° 31.4'	151° 45.2'	[1]	272	1	1
8 Apr	1635	6	1	59° 36.5'	151° 19.0'	[1]	208	1	1
9 Apr	0155	6	5	59° 36.5'	151° 19.0'	[1]	353	1	1
10 Apr	0810	7	1	59° 29.9'	153° 10.0'	[1]	64	1	1
10 Apr	1536	9	2	59° 01.7'	151° 57.7'	[1]	612	1	1
10 Apr	2134	10	1	58° 51.1'	150° 39.5'	105	359	1	1
11 Apr	1307	11	2	58° 26.0'	148° 06.0'	130	365	1	1
12 Apr	0355	13	2	60° 41.5'	147° 40.9'	190	657	1	1
12 Apr	1448	13	4	60° 41.5'	147° 40.9'	310	1186	1	1

[1] BKG spring not calibrated

[2] BKG not used

Table 5. UW Haul Summary Sheet, Leg III

1-m NIO Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Tow* Type	Volume Filtered (m^3)	Mesh size 571 μm
7 Apr	0926	1	2	58° 53.0'	152° 52.0'	1	DO	--	1
7 Apr	1639	2	3	59° 23.0'	152° 36.6'	1	DO	536	1
7 Apr	2217	3	1	59° 58.0'	152° 11.0'	80	DO	413	1
8 Apr	0456	4	2	60° 40.5'	151° 35.0'	35	DO	456	1
8 Apr	1507	5	2	59° 31.4'	151° 45.2'	1	DO	659	1
8 Apr	1650	6	2	59° 36.5'	151° 19.0'	60	DO	481	1
9 Apr	0115	6	4	59° 36.5'	151° 19.0'	1	DO	975	1
9 Apr	0210	6	6	59° 36.5'	151° 19.0'	55	HZ	2920	1
9 Apr	1657	6	7	59° 36.5'	151° 19.0'	1	HZ	1079	1
9 Apr	1828	6	8	59° 36.5'	151° 19.0'	65	HZ	--	1
10 Apr	1515	9	1	59° 01.7'	151° 57.7'	1	HZ	--	1
10 Apr	2243	10	2	58° 51.1'	150° 39.5'	100	DO	1634	1
12 Apr	0224	13	1	60° 41.5'	147° 40.9'	20	HZ	~1100	1
12 Apr	0632	13	3	60° 41.5'	147° 40.9'	1	DO	723	1
12 Apr	1640	13	5	60° 41.5'	147° 40.9'	10	HZ	877	1

* Tow type: HZ - horizontal

DO - double oblique

[1] BKG not calibrated

Table 6. UW Haul Summary Sheet, Leg III

Miscellaneous Net Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Net	Tow Type	Duration (sec)
7 Apr	2310	3	3	59° 58.0'	152° 11.0'	50	5 x 6-m NIO	DO	5700
10 Apr	1607	9	3	59° 01.7'	151° 57.7'	0	Miller	HZ	1800
11 Apr	0631	11	1	58° 26.0'	148° 06.0'	35	3-m NIO	HZ	4560

Note: Ship speed for 5 x 6-m and 3-m NIO nets varied from 3 to 4 knots, dropping to dead slow for retrieval. Ship speed was approximately 12 knots for the Miller net.

Table 7. UW Acoustic Survey Summary

Date (1976) (GMT)	Time (GMT)	Station	Total Recording Time (min)	Magnetic Recording Time (min)	Comments
7 Apr	0224	--	419	5	Experimenting w/ V-fin depressor
7 Apr	0845	1	25	10	
7 Apr	1340	--	50	--	V-fin depressor destroyed
7 Apr	2055	3	58	10	XDCR 2 m below surface, layer at 37 m
8 Apr	0515	4	20	--	
8 Apr	1402	5	30	21	
8 Apr	1737	6	178	15	Layers at 27, 49, and 68 m; layers eventually disappeared.
9 Apr	0005	6	437	36	Layer on bottom during day, night layers at 18, 37, and 73 m and migrating
9 Apr	2030	5a	40	--	
10 Apr	0235	8	60	--	Some fish evident
10 Apr	0608	2a	37	--	
10 Apr	0832	7	73	--	
10 Apr	1420	9	32	2	
10 Apr	2015	10	107	--	Intermittent fish layer
11 Apr	0531	11	237	--	Fish layer
11 Apr	2205	11a	50	--	
12 Apr	0114	13	736	21	Layer 0-30 m
13 Apr	0510	14	20	--	Loose connection 0-50 fms range switch

Table 8. UW Haul Summary Sheet, Leg V

Bongo Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered (m^3)	Mesh size (μm) 505	Mesh size (μm) 333
6 May	1325	1	1	58° 52.5'	152° 47.4'	170	605	1	1
6 May	1552	2	1	59° 22.9'	152° 39.5'	50	242	1	1
6 May	2117	3	1	59° 59.4'	152° 11.0'	65	280	1	1
7 May	0259	4	1	60° 40.0'	151° 37.7'	75	260	1	1
7 May	1030	5	2	59° 34.8'	151° 47.8'	20	244	1	1
7 May	1312	6	1	59° 37.1'	151° 19.0'	75	182	1	1
7 May	1709	6	2	59° 37.1'	151° 19.0'	65	263	1	1
8 May	0020	5a	1	59° 34.6'	151° 47.3'	25	116	1	1
8 May	0402	7	1	59° 30.0'	153° 10.0'	35	--	1	1
8 May	0734	8	1	59° 14.2'	153° 40.3'	32	116	1	1
8 May	1315	9	1	59° 02.0'	151° 58.6'	120	546	1	1
9 May	0145	11	1	58° 23.3'	148° 02.0'	195	795	1	1

Table 9. UW Acoustic Summary

(1976) (GMT)	Time (GMT)	Station	Total Recording Time (min)	Magnetic Recording Time (min)	Comments
6 May	1210	1	70	7	Layer 18-82 m
6 May	1630	2	25	5	Some fish evident
6 May	2010	3	66	5	Fish, 18 m to bottom (75 m)
7 May	0215	4	32	5	Fish, zooplankton targets
7 May	0905	5	77	--	Near supposed ADF&G gyre
7 May	1230	6	230	10	Strong layer 18 to 73 m, little diel migrations, fish larvae and euphausids in nets
7 May	2350	5a	13	5	Some fish targets, zoea (?) in nets
8 May	0335	7	23	5	Some fish targets
8 May	0705	8	19	5	Some fish targets
8 May	0910	8a	13	5	Some fish targets, large zooplankton (?)
8 May	1230	9	34	7	Layer (?)
8 May	2320	11	130	7	Bubbles create interference

Table 10. UW Haul Summary Sheet, Leg VII

Bongo Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered (m^3)	Mesh size (μm) 505	Mesh size (μm) 333
24 May	0732	1	1	58° 52.6'	152° 47.0'	150	652	1	1
25 May	1150	2	1	59° 23.6'	152° 38.1'	50	216	1	1
25 May	1607	3	1	59° 59.5'	152° 11.5'	63	170	1	1
25 May	2217	4	1	60° 41.5'	151° 37.5'	78	252	1	1
26 May	0541	5a	2	59° 34.65'	151° 47.0'	47	149	1	1
26 May	0835	6	1	59° 36.6'	151° 19.1'	90	221	1	1
26 May	1928	6	3	59° 36.6'	151° 19.1'	67	212	1	1
27 May	0056	6	4	59° 36.6'	151° 19.1'	61	174	1	1
27 May	0708	6	7	59° 36.6'	151° 19.1'	60	193	1	1
27 May	1300	7	1	59° 29.4'	153° 09.6'	28	156	1	1
27 May	1701	8	1	59° 13.6'	153° 37.6'	20	87	1	1
28 May	0536	14	1	59° 24.3'	149° 05.3'	173	707	1	1
28 May	1831	13	1	60° 42.2'	147° 40.6'	246	1055	1	1
28 May	2248	13	2	60° 42.2'	147° 40.6'	530	2250	1	1
29 May	1029	13	3	60° 42.2'	147° 40.6'	200	1114	1	1
30 May	0253	11	1	58° 23.9'	148° 05.5'	206	797	1	1
30 May	0813	11	2	58° 23.9'	148° 05.5'	212	764	1	1
30 May	1813	10	1	58° 51.9'	150° 40.3'	102	348	1	1

Table 11. UW Acoustic Survey Summary

Date (1976) (GMT)	Time (GMT)	Station	Total Recording Time (min)	Magnetic Recording Time (min)	Comments
25 May	0050	--	60	--	Testing new V-fin depressor and SDCR
25 May	0659	1	56	--	Interference within system masking sonic trace
25 May	1015	2	62	--	Ross still not working properly
25 May	1525	3	115	--	Elec. Tech. checking Ross
25 May	2041	4	109	5	Ross working again, however most of the trace is masked by internal interference --or possibly reading great turbidity in the water column
26 May	0435	5a	45	5	Some fish targets evident
26 May	0550	5a-6	94	--	Sonic transect from sta 5a to 6; possible fish, zooplankton layer rising to concentrate in the 0-50 m depth range
26 May	0729	6	607	5	Trace has deteriorated; return signals are masked by internal noise in the system
26 May	1755	6	--	--	Ross off, no trace recording; Elec. Tech. checked system; output tubes and replacements went out, therefore no signal was being generated

Table 12. Summary of taxonomic categories of fish eggs, larvae, young and adults found in Bongo, 1-m, 3-m, and 5 x 6-m NIO net samples collected in the Gulf of Alaska, *Discoverer* cruise, 6-13 April 1976

A total of 44 samples contained 3,103 fish eggs and 6,800 fish and larvae that were examined. The eggs were distributed into 4 families, 7 genera and 2 species. The fish were distributed into 10 families, 14 genera and 11 species:

Family Ammodytidae

188 larvae Sandlances *Ammodytes* sp.

Family Argentinidae

35 eggs Argentine *Argentina* sp.

Family Bathylagidae

10 eggs Northern smoothtongue *Leuroglossus stilbius schmidti* Rass
626 larvae Northern smoothtongue *Leuroglossus stilbius schmidti* Rass

Family Bothidae

1,920 eggs Lefteye flounders *Citharichthys* sp.

Family Cottidae

1 adult Marbled sculpin *Oligocottus rimensis* (Greeley)
1 larva sculpin genus? species?

Family Gadidae

865 eggs Alaska pollock *Theragra chalcogramma* (Pallas)
5,569 larvae Alaska pollock *Theragra chalcogramma* (Pallas)
1 young Pacific tomcod *Microgadus proximus* (Girard)

Family Liparidae

2 young Marbled snailfish *Liparis dennyi* Jordan and Starks

Family Myctophidae

28 larvae Smallfin lanternfish *Stenobrachius leucopsarus* (Eigenmann and Eigenmann)
125 young Smallfin lanternfish *Stenobrachius leucopsarus* (Eigenmann and Eigenmann)
1 larva Lanternfish *Triphoturus* sp.
13 larvae Lanternfish genus? species?

Table 12. (cont.)

Family Osmeridae

11 larvae Capelin *Mallotus villosus* Müller
6 young Capelin *Mallotus villosus* Müller
3 larvae Longfin smelt *Spirinchus thaleichthys* (Ayres)
189 young Longfin smelt *Spirinchus thaleichthys* (Ayres)
1 adult Candlefish *Thaleichthys pacificus* (Richardson)

Family Pleuronectidae

92 eggs Rex sole *Glyptocephalus* sp.
11 eggs Lemon sole *Limanda* sp.
143 eggs Starry flounder *Platichthys stellatus* (Pallas)
25 eggs Flathead sole *Hippoglossoides* sp.
1 larva Pacific halibut *Hippoglossus stenolepis* Schmidt

Family Scorpaenidae

18 larvae rockfishes *Sebastes* sp.

Family Zoarcidae

1 young Pallid eelpout *Lycodapus mandibularis* Gilbert

15 larvae unidentified

Table 13. Number of fish eggs and larvae at each station. Count was from whole sample unless indicated otherwise.

Gulf of Alaska Bongo Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae
7 Apr	0844	1	1	333	0	4
7 Apr	0844	1	1	505	0	2
7 Apr	1620	2	2	333	0	0
7 Apr	1620	2	2	505	0	0
7 Apr	2239	3	2	333	1	3
7 Apr	2239	3	2	505	2	1
8 Apr	0440	4	1	333	0	0
8 Apr	0440	4	1	505	0	0
8 Apr	1520	5	3	333	0	1
8 Apr	1520	5	3	505	4	5
8 Apr	1635	6	1	333	5	3
8 Apr	1635	6	1	505	0	4
9 Apr	0155	6	5	333	15	7
9 Apr	0155	6	5	505	12	7
10 Apr	0810	7	1	333	16	1
10 Apr	0810	7	1	505	16	2
10 Apr	1536	9	2	333	7	16
10 Apr	1536	9	2	505	2	13
10 Apr	2134	10	1	333	1	2
10 Apr	2134	10	1	505	1	1
11 Apr	1307	11	2	333	1	13
11 Apr	1307	11	2	505	8	8
12 Apr	0355	13	2	333	123[a]	1,046[a]
12 Apr	0355	13	2	505	253[b]	1,840[b]
12 Apr	1448	13	4	333	69[c]	221[c]
12 Apr	1448	13	4	505	417[d]	1,014[d]

1-m NIO Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae
7 Apr	0926	1	2	571	0	2
7 Apr	1639	2	3	--	0	2
7 Apr	2217	3	1	--	1	9

Table 13 (cont.).

1-m NIO Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (m)	Eggs	Fish or Larvae
8 Apr	0456	4	2	--	0	1
8 Apr	1507	5	2	--	2	13
8 Apr	1650	6	2	--	7	16
9 Apr	0115	6	4	--	12	25
9 Apr	0210	6	6	--	28	105
9 Apr	1657	6	7	--	6	17
9 Apr	1828	6	8	--	21	14
10 Apr	1515	9	1	--	1	11
10 Apr	2243	10	2	--	2	4
12 Apr	0224	13	1	--	99[a]	1,470[a]
12 Apr	0632	13	3	--	1,920[e]	4[e]
12 Apr	1640	13	5	--	57[d]	630[d]

Miscellaneous Net Tows

Date	Time	Station	Haul	Net	Eggs	Fish or Larvae
7 Apr	2310	3	3	5 x 6-m NIO	--	194
10 Apr	1607	9	3	Miller	0	0
11 Apr	0631	11	1	3-m NIO	0	107

[a] Approximately 1/4 of the sample was sorted for fish eggs and larvae. The count reported here is from 1/4 sample. After sorting, the subsample was returned to the whole sample.

[b] Approximately 1/2 of the sample was sorted for fish eggs and larvae. The count reported here is from 1/2 sample. After sorting, the subsample was returned to the whole sample.

[c] Total sample had 9-1000 ml jars; settling volume for whole sample was 4.8 liters. Approximately 126 ml was taken from one jar to sort for fish eggs and larvae. The count represents 1/38 sample.

[d] The sample was split three times using a Cooney-Halstead plankton splitter (Cooney unpublished). 1/8 sample sorted for fish eggs and larvae yielded 422 eggs and 1,027 larvae. After sorting, the subsample was returned to whole sample.

[e] Total sample included three four-liter jars, two of the three jars were broken in transit. Settling volume for one jar was 2.4 liters. Sample jar was hand shaken and approximately 116 ml settled volume, approximately 1/60 of the sample, was sorted. The count was 1,920 eggs and 3 larvae for 1/60 sample. The subsample was stored separately.

Table 14. Identification of Fish Eggs and Larvae by Station

Gulf of Alaska Bongo Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
7 Apr	0844	1	1	333	0	4	1 larva[a] 31.00 mm[b] the Capelin[c] *Mallotus villosus* Müller 1 young 44.00 mm *Mallotus villosus* 1 larva 4.50 mm Smallfin lanternfish. *Stenobrachius leucopsarus* (Eigenmann & Eigenmann) 1 larva 8.20 mm the Sandlance *Ammodytes* sp.
7 Apr	0844	1	1	505	0	2	1 young 45.00 mm *Mallotus villosus* 1 larva 7.70 mm *Ammodytes*
7 Apr	2239	3	2	333	1	3	1 egg 1.14 mm the Starry flounder *Platichthys stellatus* (Pallas) 3 larvae 7.00 mm *Ammodytes* sp.

[a] All specimens are classified into four main categories: eggs include all stages of eggs prior to hatching; larvae include newly hatched and all stages prior to metamorphosis; young include fish after metamorphosis to acquisition of adult fin rays and adult body configuration; adults include fish that are sexually mature.

[b] Eggs and fish are measured to the nearest mm; all eggs and larvae under 50.00 mm are measured under the microscope using a calibrated micrometer eye piece. Fish longer than 50.00 mm are measured with a metric ruler. Egg measurement is the diameter of the egg. When there are more than three eggs, the largest and the smallest are measured. Larvae are measured for notochord length when the specimens lack hypural elements; they are measured for standard length when the hypural plate has formed. Notochord length is from the snout tip to the end of the notochord; standard length is from the snout tip to the end of the hypural plate. When there are more than three fish, notochord or standard lengths of the smallest and the largest are recorded.

[c] The common name is presented for the first time for each species; thereafter only the scientific name is recorded.

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

Gulf of Alaska Bongo Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
7 Apr	2239	3	2	505	2	1	2 eggs 1.10 mm *Platichthys stellatus* 1 larva 7.00 mm *Ammodytes* sp.
8 Apr	1520	5	3	333	0	1	1 larva 9.00 mm Rockfish *Sebastes* sp.
8 Apr	1520	5	3	505	4	5	4 eggs 1.10 mm *Platichthys* sp. 4 larvae (8.00-9.00 mm) *Sebastes* sp. 1 larva 7.00 mm damaged probably *Ammodytes* sp.
8 Apr	1635	6	1	333	5	3	5 eggs 1.03 mm probably *Platichthys stellatus* 1 larva 14.00 mm Myctophidae 2 larvae 4.80, 5.60 mm *Ammodytes* sp.
8 Apr	1635	6	1	505	0	4	1 larva 28.00 mm *Mallotus villosus* ½ head 8+ mm Myctophidae 2 larvae 4.80, 6.10 mm *Ammodytes* sp.
9 Apr	0155	6	5	333	15	7	1 egg 1.36 mm *Glyptocephalus* sp. 14 eggs 1.03 mm *Platichthys* sp. 1 larva 16.00 mm Myctophidae 6 larvae (6.00-8.00 mm) *Ammodytes* sp.
9 Apr	0155	6	5	505	12	7	11 eggs 1.10 mm *Platichthys stellatus* 1 egg 1.40 mm *Glyptocephalus* sp. 1 larva 17.80 mm Myctophidae 6 larvae (4.80-7.50 mm) *Ammodytes* sp.

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

Gulf of Alaska Bongo Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (um)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
10 Apr	0810	7	1	333	16	1	16 eggs 1.03 *Platichthys stellatus* ? 1 larva 5.00 mm *Ammodytes* sp.
10 Apr	0810	7	1	505	16	2	16 eggs 1.03 mm *Platichthys stellatus* 2 larvae 6.00 mm *Ammodytes* sp.
10 Apr	1536	9	2	333	1	16	1 egg 1.10 mm *Platichthys* ? 2 larvae 35.00, 42.00 mm *Mallotus villosus* 1 young 45.00 mm *Mallotus villosus* 7 larvae approximately 4.00 mm Pollock *Theragra chalcogramma* (Pallas) 1 larva 6.00 mm *Ammodytes* sp. 5 larvae (3.20-7.00 mm) elongate, damaged and unidentified
10 Apr	1536	9	2	505	2	13	2 eggs 1.44 *Glyptocephalus* sp. 5 larvae (4.00-4.4 mm) *Theragra chalcogramma* 1 larva 9.00 mm *Leuroglossus stilbius schmidti* 4 larvae (4.00-6.00 mm) unidentified 3 young (40.00-43.00 mm) *Mallotus villosus*

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

Gulf of Alaska Bongo Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
10 Apr	2134	10	1	333	1	2	1 egg 1.20 mm *Platichthys* ?
							1 larva 5.00 mm Myctophidae
							1 larva 5.00 mm with 2 dorsal bands unidentified
10 Apr	2134	10	1	505	1	1	1 egg 1.20 mm *Platichthys stellatus*
							1 larva 4.00 mm *Ammodytes* sp.
11 Apr	1307	11	2	333	1	12	1 egg *Platichthys*
							4 larvae 6.00 mm *Stenobrachius leucopsarus*
							9 young (19.00-36.00 mm) *Stenobrachius leucopsarus*
11 Apr	1307	11	2	505	8	8	8 eggs (0.70-0.98 mm) *Limanda* sp.
							1 larva 13.00 mm Pacific halibut *Hippoglossus stenolepis* Schmidt
							7 young (21.00-50.00 mm) *Stenobrachius leucopsarus*
12 Apr	0355	13	2	333	123[d]	1,046[d]	3 eggs (2.40-3.10 mm) *Hippoglossoides* sp.
							119 eggs (1.24-1.40 mm) *Theragra chalcogramma*
							1 egg 1.56 mm Argentine *Argentina* sp.
							135 larvae (7.24-10.50 mm) Northern smooth-tongue *Leuroglossus stilbius schmidti* Rass
							830 larvae (approx. 5.0-6.0 mm) *Theragra chalcogramma*
							1 larva 10.00 mm unidentified

[d] Approximately ¼ of the sample was sorted for fish eggs and larvae. The count reported here is from ¼ sample. After sorting, the subsample was returned to the whole sample.

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

Gulf of Alaska Bongo Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
12 Apr	0355	13	2	505	253[e]	1,840[e]	3 eggs (2.44-3.10 mm) *Hippoglossoides* sp.
							9 eggs (1.68-1.80 mm) *Argentina* sp.
							240 eggs (1.20-1.30 mm) *Theragra chalcogramma*
							1,515 larvae (4.0-8.0 mm) *Theragra chalcogramma*
							324 larvae (7.0-11.0 mm) *Leuroglossus stilbius schmidti*
							1 larva 7.0 mm *Triphoturus* sp.
12 Apr	1448	13	4	333	69[f]	212[f]	2 eggs (1.90-2.00 mm) *Argentina* sp.
							67 eggs (1.20-1.30 mm) *Theragra chalcogramma*
							198 larvae (4.00-6.00 mm) extensively damaged *Theragra chalcogramma*
							14 larvae (8.00-10.00 mm) *Leuroglossus stilbius schmidti*

[e] Approximately 1/2 of the sample was sorted for fish eggs and larvae. The count reported here is from 1/2 sample. After sorting, the subsample was returned to the whole sample.

[f] Total sample had 9-32 oz. jars; settling volume for whole sample was 4.8 litres. Approximately 126 ml was taken from one jar to sort for fish eggs and larvae. The count represents 1/38 sample.

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

Gulf of Alaska Bongo Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
12 Apr	1448	13	4	505	417[g]	1,014[g]	3 eggs (2.72-3.00 mm) *Hippoglossoides* sp.
							23 eggs (1.60-1.75 mm) *Argentina* sp.
							10 eggs (1.60-1.75 mm) *Leuroglossus stilbius schmidti*
							381 eggs (1.20-1.35 mm) *Theragra chalcogramma*
							1 young 115.0 mm Pallid eelpout *Lycodapus mandibularis* Gilbert
							102 larvae (5.6-10.0 mm) *Leuroglossus stilbius schmidti*
							909 larvae (3.0-5.6 mm) *Theragra chalcogramma*
							2 larvae 6.00, 11.00 mm unidentified

[g] The sample was split three times using a Cooney-Halstead plankton splitter (Cooney unpublished). 1/8 sample sorted for fish eggs and larvae yielded 422 eggs and 1,027 larvae. After sorting, the subsample was returned to whole sample.

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

1-m NIO Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
7 Apr	0910	1	2	571	0	2	2 larvae 5.00, 7.00 mm *Ammodytes* sp.
7 Apr	1639	2	3	---	0	2	1 larvae 9.00 mm *Sebastes* sp. 1 larva 5.00 mm *Ammodytes* sp.
7 Apr	2217	3	1	---	1	9	1 egg 1.10 mm *Platichthys* sp. 9 larvae 7.00 mm *Ammodytes* sp.
8 Apr	0417	4	2	---	0	1	1 larva 6.00 mm *Ammodytes* sp.
8 Apr	1507	5	2	---	2	13	2 eggs 1.10 mm *Platichthys* sp. 2 larvae 28.00, 31.00 mm *Mallotus villosus* 4 larvae (11.00-14.00 mm) Myctophidae 2 larvae 8.00 mm *Sebastes* sp. 5 larvae (5.00-6.00 mm) *Ammodytes* sp.
8 Apr	1650	6	2	---	7	16	7 eggs 1.03 mm *Platichthys* sp. 1 larva 18.00 Myctophidae 15 larvae (4.40-6.80 mm) *Ammodytes* sp.
9 Apr	0115	6	4	---	12	25	8 eggs 1.10 mm *Platichthys* sp. 4 eggs 1.40 mm probably *Glytocephalus* sp. 4 larvae (32.00-40.00 mm) *Mallotus villosus* 20 larvae (4.00-7.20 mm) *Ammodytes* sp.

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

<u>1-m NIO Tows, Leg III</u>

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
9 Apr	0210	6	6	571	28	105	28 eggs (1.03-1.10 mm) *Platichthys* sp.
							3 larvae 25.0, 25.10, 28.00 mm Longfin smelt *Spirinchus thaleichthys*
							21 larvae (10.00-16.00 mm) *Stenobrachius leucopsarus*
							79 larvae (5.00-6.00 mm) *Ammodytes* many damaged
							1 larva 5.60 mm Cottidae
							1 larva 13.00 mm unidentified
9 Apr	1657	6	7	---	6	17	5 eggs 1.03 mm *Platichthys* sp.
							1 egg 1.40 mm *Glyptocephalus* sp.
							15 larvae (5.60-7.20 mm) *Ammodytes* sp.
							2 larvae 16.50 mm *Stenobrachius leucopsarus*
9 Apr	1828	6	8	---	21	14	19 eggs 1.03 mm *Platichthys* sp.
							2 eggs 1.40 mm *Glyptocephalus*
							1 larva 30.00 mm *Mallotus villosus*
							13 larvae (5.00-6.00 mm) *Ammodytes* sp. some badly damaged
10 Apr	1515	9	1	---	1	11	1 egg 1.10 mm *Platichthys* sp.
							9 larvae (5.00-10.00 mm) *Sebastes* sp.
							1 whole + ½ tail larvae damaged Myctophidae

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

1-m NIO Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (um)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
10 Apr	2243	10	2	---	2	4	1 egg 1.40 mm *Glyptocephalus*
							1 egg 0.96 mm *Limanda* sp.
							1 larva 11.00 mm *Sebastes* sp.
							1 larva 4.40 mm *Theragra chalcogramma*
							1 larva 6.00 mm w/c two dorsal bars unidentified similar to larva in st. #10, haul 1.
							1 larva 3.40 mm Myctophidae
12 Apr	0224	13	1	---	99[h]	1,470[h]	12 eggs (2.95-3.95 mm) *Hippoglossoides* sp.
							2 eggs 0.80 mm *Limanda* sp.
							80 eggs 1.40 mm *Glyptocephalus*
							5 eggs (1.32-1.37 mm) *Theragra chalcogramma*
							1,470 larvae (5.00-6.00 mm) *Theragra chalcogramma*
12 Apr	0632	13	3	---	1,920[i]	4[i]	1,920 eggs (1.20-1.30 mm) w/c one 0.16 mm oil globule *Citharichthys* ?
							4 larvae (4.00-5.00 mm) *Theragra chalcogramma*

[h] Approximately 1/4 of the sample was sorted for fish eggs and larvae. The count reported here is from 1/4 sample. After sorting, the subsample was returned to the whole sample.

[i] Total sample included three one-gallon jars, two of the three jars were broken in transit. Settling volume for one jar was 2.4 litres. Sample jar was hand shaken and approximately 116 ml settled volume, approximately 1/60 of the sample, was sorted. The count was 1,920 eggs and 3 larvae for 1/60 sample. The subsample was stored separately.

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

1-m NIO Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
12 Apr	1640	13	5	---	57[j]	630[j]	4 eggs (3.00-3.60 mm) *Hippoglossoides* sp.
							53 eggs (1.28-1.36 mm) *Theragra chalcogramma*
							630 larvae (4.80-5.50 mm) *Theragra chalcogramma*

[j] The sample was split three times using a Cooney-Halstead plankton splitter (Cooney unpublished). 1/8 sample sorted for fish eggs and larvae yielded 422 eggs and 1,027 larvae. After sorting, the subsample was returned to the whole sample.

Table 14 (cont.). Identification of Fish Eggs and Larvae by Station

Gulf of Alaska Miscellaneous Net Tows, Leg III

Date (1976) (GMT)	Time (GMT)	Station	Haul	Depth (m)	Net	Eggs	Fish or Larvae	Identification of Fish or Larvae
7 Apr	2310	3	3	50	5 x 6-m NIO	0	194	189 (46.00-106.00 mm) Longfin smelt *Spirinchus thaleichthys*
								1 65.00 mm adult Marbled sculpin *Oligocottus rimensis* (Greeley)
								1 90.00 mm young Pacific tomcod *Microgadus proximus* (Girard)
								2 65.00 mm young Marbled snailfish *Liparis dennyi* Jordan and Starks
								1 185.00 mm adult Candlefish *Thaleichthys pacificus* (Richardson)
11 Apr	0631	11	1	35	3-m NIO	0	109	109 young Smallfin lanternfish *Stenobrachius leucopsarus* (Eigenmann and Eigenmann)

B. Leg V

Twelve stations were surveyed acoustically with a total of 732 minutes of chart records and 66 minutes of magnetic records. Station 10 was not surveyed due to high sea and wind conditions. Fish were evident at every station with apparent high concentrations at stations 1, 3, and 6. Records from stations 9 and 11 were of poor quality due to increasing seas and excessive maneuvering of the ship in an effort to maintain position. There may be a scattering layer at station 9.

Phytoplankton was present in every bongo net sample. At times the quantity was sufficient to partially clog the nets. Noticeable amounts of ichthyoplankton were caught in the bongo nets at stations 1, 5, and 6. Two bongo samples at station 6 appeared to be predominantly ichthyoplankton. These samples were obtained at approximately 0830 (ADT). Zoea were apparent, particularly during the second occupation of station 5 located in the vicinity of the gyre reported by the Alaska Department of Fish and Game. Other stations yielded some euphausids, large shrimp, and copepods, usually in concentrations too small to make any appreciable trace on the Ross echosounder chart record.

The 1-m vertical ring net with 73-μm mesh (4:1 OAR) caught large amounts of phytoplankton at stations 5 and 6 which obscured all other organisms in the sample. Sorting is required before anything can be said about these samples.

The 1-m NIO net sample at station 6 was not obviously different from the bongo net samples taken at that station.

C. Leg VII

The new V-fin depressor and transducer were tested while underway for station 1. They were deployed over the starboard side of the ship utilizing the outboard towing device. To test the effect of interference generated by the ship's propeller on the Ross system and the stability of the V-fin depressor, the ship's speed was slowly increased to 8 knots and then to 10 knots. At all times only the port propeller was in use to help reduce interference. The V-fin depressor towed well at all speeds and did not need any adjustment. The chart recorder showed some interference that increased with the speed of the ship. A total of 1,137 minutes of chart records was made. Only the recordings at station 5a and the transect between stations 5a and 6, a total of 180 minutes, will be usable due to internal interference in the Ross system. Fifteen minutes of magnetic tape records were made.

IV. Preliminary interpretation of results

A. Leg III

Fish targets, either singly or in layers, appear to be abundant in the open Gulf of Alaska and Lower Cook Inlet (excluding station 6, Kachemak Bay). Any zooplankton present were invisible to the 105 kHz echosounder due to size, physical characteristics, or concentration. Definite zooplankton layers were evident at station 6 in Kachemak Bay. These layers were fished both with 1-m NIO nets in double oblique and horizontal tows and bongo nets in double oblique tows. The layer proved to be primarily euphausids. This layer underwent the expected diurnal vertical migration. Fish layers, some more defined than others, also followed this diurnal cycle. Stations 11a and 13 located in Prince William Sound revealed a strong surface-to-40 m layer during the entire day-night cycle. Some changes such as a slight thinning or irregular vertical distributions were seen during the day but the layer appeared to be fairly constant.

The 3-m and 5 x 6-m NIO nets tested during this cruise might be more effective if a more powerful winch capable of retrieving nets at ship speeds of 4 knots was available.

Due to the large diameter of the hydro-wire and the absence of a V-fin depressor, the Miller net was only tried once. It is too early to say how the ship's speed of 12 to 15 knots affected the sample.

B. Leg V

Stations 1 and 3 showed a marked increase in zooplankton over Leg III. A strong fish and possible zooplankton scattering layer at station 6, Kachemak Bay, underwent no appreciable vertical migration during the 9.5 hours of occupation (0330 to 1305 ADT). This contrasts sharply with the migrations seen during the 26 hour occupation of station 6 , during Leg III.

C. Leg VII

Ichthyoplankton was caught at almost every station. There was still a fair amount of phytoplankton at many stations, however net clogging was not a problem as on the previous cruise. More large shrimp were caught at several stations than had been caught before. Stations 11 and 13 had appreciable differences in quantity between the day and night net hauls to 200 m.

The 1-m vertical ring net with 73-μm mesh (4:1 OAR) caught large amounts of phytoplankton at station 5a that visually obscured all other organisms in the sample as on the previous cruise. The vertical tow at station 6 caught chaetognaths, shrimp, euphausids, copepods and fish, crab and shrimp larvae.

QUARTERLY REPORT

Research Unit #156/164b
Reporting Period:
1 Apr 76 - 30 Jun 76

6 p.

INITIAL ZOOPLANKTON INVESTIGATIONS IN LOWER COOK INLET AND ADJACENT AREAS OF THE GULF OF ALASKA SHELF

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30 June 1976

I. TASK OBJECTIVES

A. General scope of the study

Zooplankton are important components of the environment in terms of volume, in terms of their roles in the ecosystem, and in terms of probable sensitivity to the kinds of development anticipated on the Alaska OCS. Zooplankton are necessary for the maintenance of fish, shellfish, and other living resources. Zooplankton are also important in the movement and concentration of environmental contaminants. In the northeastern Pacific, particularly its estuaries and coastal seas, relatively little is known of the distribution and abundance, seasonal cycles, or vertical distributions and migrations of zooplankton. Assessments of these factors are necessary for the study of ecological processes relevant to environmental problems.

B. Specific objectives

The objectives of this project are to determine the seasonal distribution and abundance of zooplankton in selected areas of the Gulf of Alaska, especially Lower Cook Inlet. Particular attention is being given to the distributions of copepods (the most abundant net-plankton and the key grazers), amphipods and euphausids (important food for fishes), chaetognaths (key carnivores), larval decapods, and some other groups. All major taxa are enumerated as such whether or not the individual species can be identified. This work will lead to development of a monitoring strategy. Also, it will ultimately contribute to an ecosystem model by defining pathways and amounts of energy or material flow and indicating the relative importance of the several populations.

II. FIELD AND LABORATORY ACTIVITIES

A. Field studies

This quarter we have taken 3 cruises to the Lower Cook Inlet region of the Alaskan

Shelf. These cruises, all on NOAA DISCOVERER, were 6-13 April, 5-9 May, and 24-30 May (Figures 1-3). The first and third cruises included a transect across the open shelf and into another inshore area, for comparative purposes. On each of these cruises, the project was represented by Mr. Douglas B. Dey, Oceanographer. Mr. Dey was responsible for the collecting of samples and data.

B. Methods

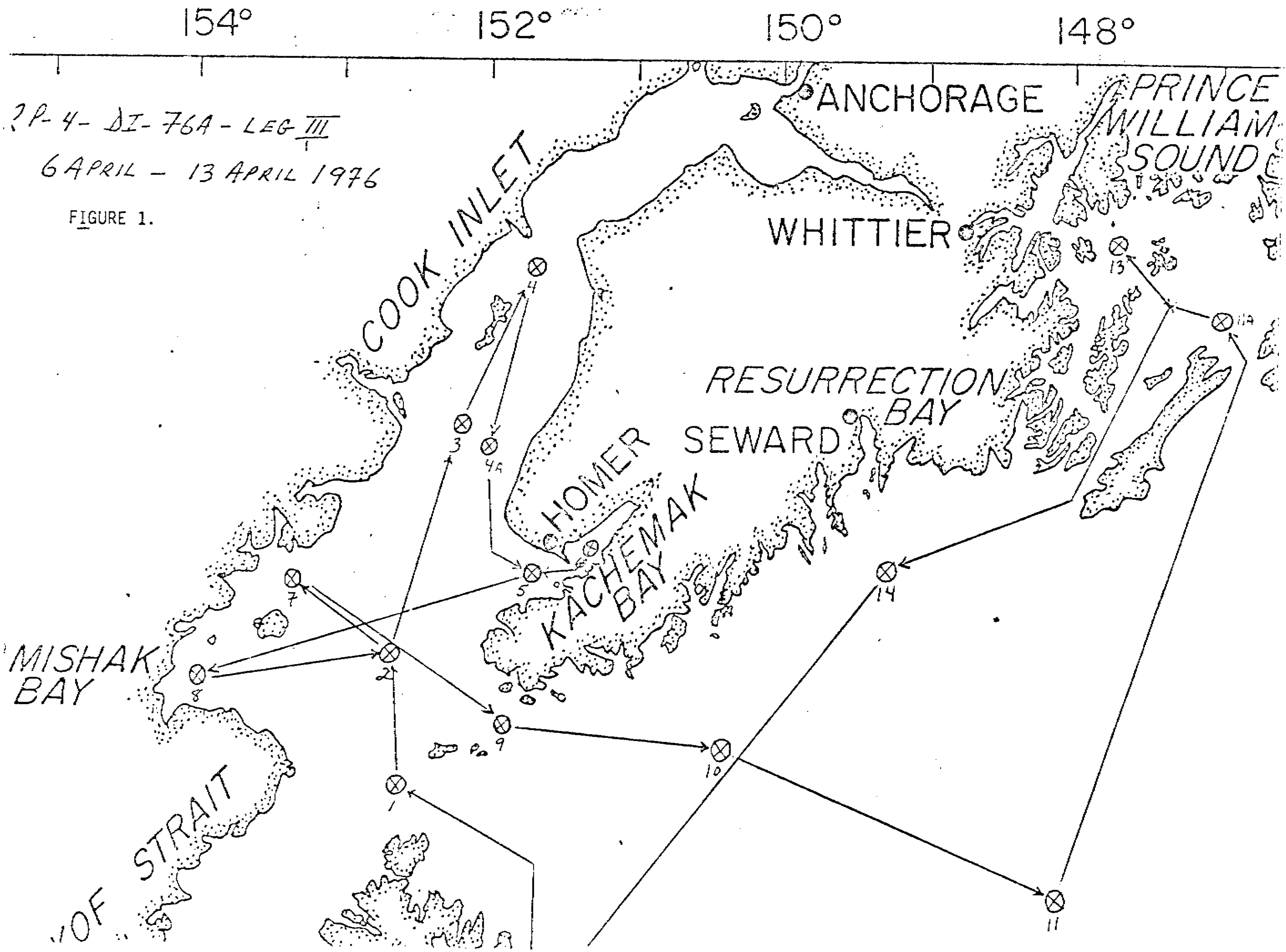
On the 3 cruises zooplankton was sampled at noon and midnight with closing ring nets of 60 cm diameter and 211 micron mesh. These nets were hauled vertically through strata of varying thicknesses, obtaining discrete samples, depth permitting, as follows: 25-0 m; 50-25 m; 100-50 m; 300-100 m; 500-300 m; the bottom-500 m. In addition, at each station samples were obtained with a bongo net. The distribution of the samples between the cruises is as follows:

	Vertically Hauled Net	Bongo Net	
Cruise 1 (April)	51	26	
Cruise 2 (May)	17	22	
Cruise 3 (May)	43	28	
	111	76	(187 Total)

Volume of water sampled was estimated as the product of wire length and the area of the net, assuming that filtration was 100% There was little evidence of mesh clogging.

In the laboratory, each zooplankton sample is allowed to settle overnight in a graduated cylinder and the settled volume of the sample is recorded. The large or otherwise conspicuous organisms are then removed and enumerated. The smaller organisms are identified and enumerated from a subsample.

Laboratory analyses have proceeded primarily on the samples from the first 2 cruises. Most of those samples have been sorted to major groups.


RP-4-DI-76A - LEG III
6 APRIL - 13 APRIL 1976
154°
152°
150°
148°
ANCHORAGE
PRINCE WILLIAM SOUND
WHITTIER
COOK INLET
RESURRECTION BAY
SEWARD
HOMER
KACHEMAK BAY
MISHAK BAY
OF STRAIT
1
2
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4A
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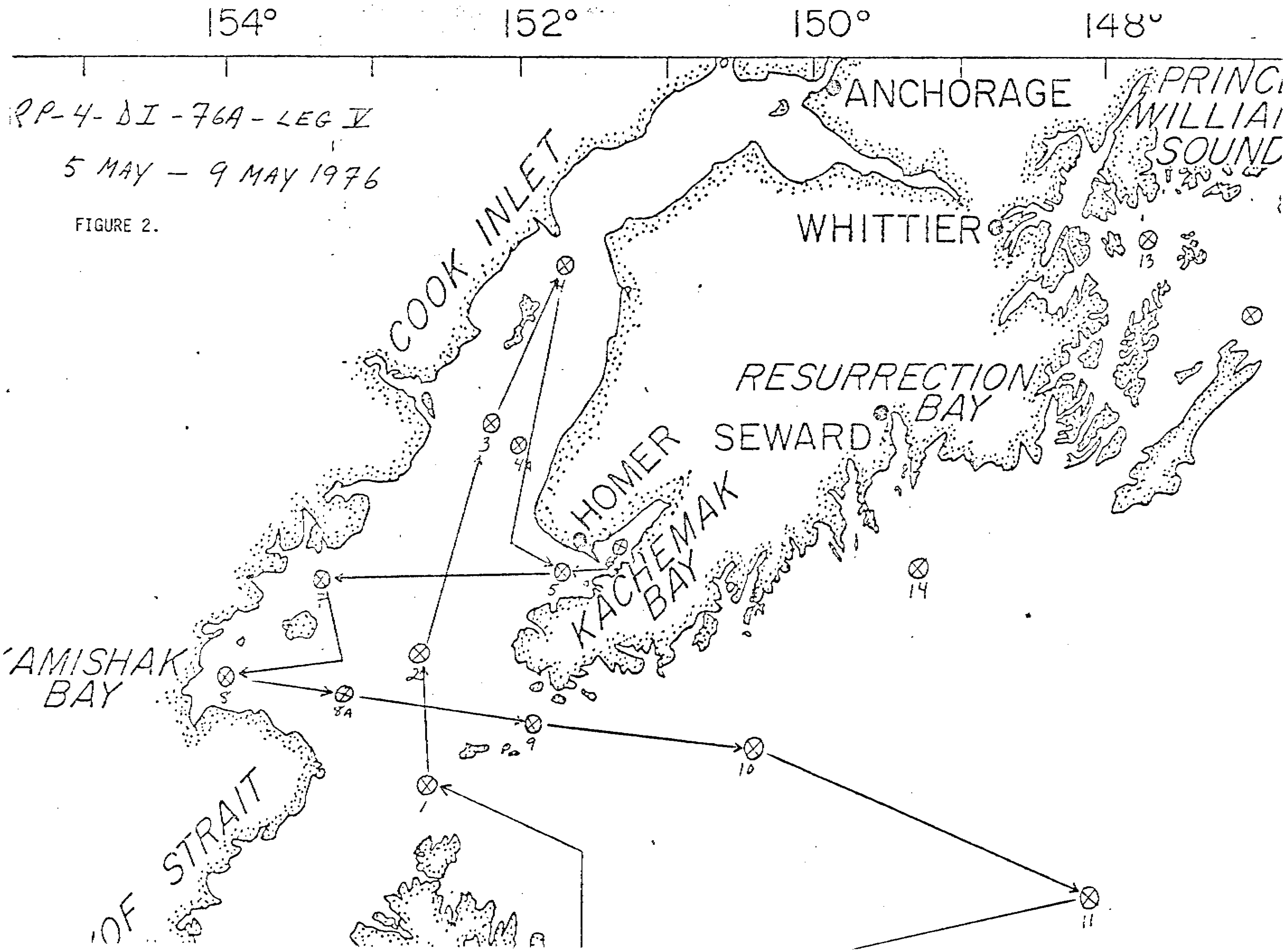
11A
13
14

FIGURE 1.



154°
152°
150°
148°
RP-4-DI-76A-LEG V
5 MAY – 9 MAY 1976
ANCHORAGE
PRINC
WILLIA
SOUND
WHITTIER
COOK INLET
RESURRECTION BAY
SEWARD
HOMER
KACHEMAK BAY
AMISHAK BAY
OF STRAIT
1
2
3
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4A
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7
8
8A
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11
13
14

FIGURE 2.

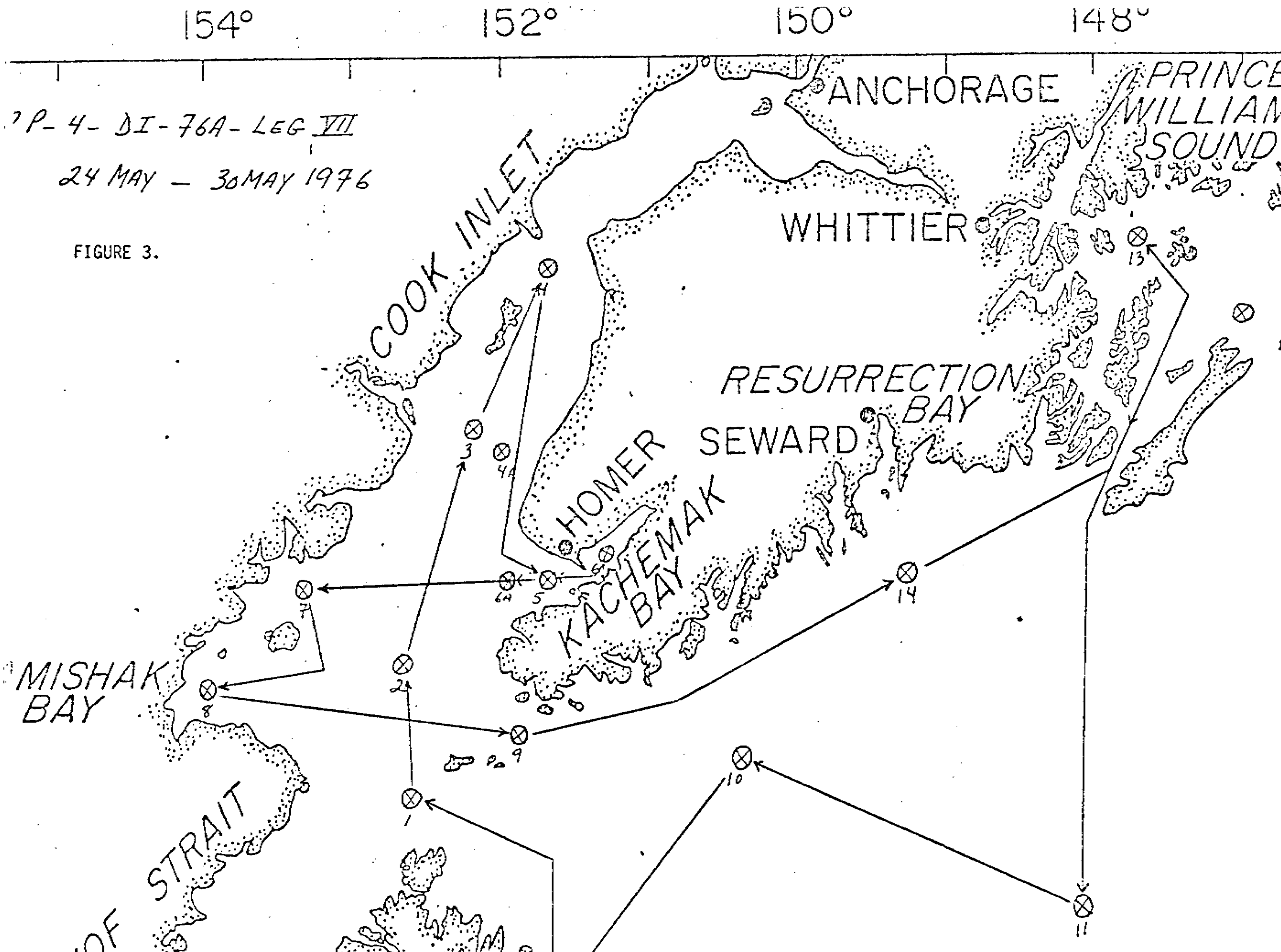
154°
152°
150°
148°
P-4-DI-76A-LEG VII
24 MAY - 30 MAY 1976
COOK INLET
ANCHORAGE
PRINCE WILLIAM SOUND
WHITTIER
RESURRECTION BAY
SEWARD
HOMER
KACHEMAK BAY
MISHAK BAY
STRAIT
OF
1
2
3
4A
5
6A
7
8
9
10
11
13
14

FIGURE 3.

III. RESULTS

It is too soon to make general comments about the quantitative nature and distribution of the zooplankton within Lower Cook Inlet. Zooplankton volumes tended to be somewhat higher in Kachemak Bay compared to similar times on the open shelf. In all areas, there was an increased volume in the 0-25 m layer at night.

Quarterly Report

Research Unit #156/164 C

Reporting Period:

April - June, 1976

PHYTOPLANKTON AND PRIMARY PRODUCTIVITY IN THE NORTHEAST GULF OF ALASKA

Jerry D. Larrance

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Seattle, Washington 98105

July 1, 1976

I. TASK OBJECTIVES

The primary objective of the work accomplished during the past quarter was to determine the time succession of primary production, phytoplankton standing stocks and species during the spring in lower Cook Inlet and Prince William Sound. This work has been modified from the original task concerning phytoplankton and primary production which involved broad scale surveys in the Gulf of Alaska.

II. FIELD ACTIVITIES

A. Field Trip Schedule

Date	Ship
April 6 - April 13	DISCOVERER
May 5 - May 9	DISCOVERER
May 24 - May 30	DISCOVERER

B. Scientific Party

Leg III

David A. Tennant, PMEL, Biological Oceanographer

Alexander J. Chester, PMEL, Biological Oceanographer

Laurie Jarvela, PMEL, Biological Oceanographer

Phylis Thoreson, no affiliation, Bio-technician

Leg V

David A. Tennant, PMEL, Biological Oceanographer

Alexander J. Chester, PMEL, Biological Oceanographer

Phyllis Thoreson, no affiliation, Bio-technician

Kenneth Klingberg, Shoreline Community College, Seattle, Bio-technician

Leg VII

David A. Tennant, PMEL, Biological Oceanographer

Alexander J. Chester, PMEL, Biological Oceanographer

Phyllis Thoreson, no affiliation, Bio-technician

Thomas Baker, Shoreline Community College, Seattle
Bio-technician

C. Methods

Phytoplankton and microzooplankton were captured in five and ten-liter Niskin bottles attached to a Rosette sampler. A CTD sensor was attached to the Rosette sampler facilitating vertical profiles.

Ten depths between the surface and fifty meters depth were sampled routinely to ascertain pigment and nutrient concentrations and phytoplankton abundance and species identity. Stations 7 and 8 were sampled to about 30 meters depth.

Primary production was measured by simulating _in situ_ conditions and by incubating samples _in situ_. Deck incubators constructed of acrylic tubing wrapped at intervals with cloth layers which passed the same amount of light as that reaching the water sampled were used. A Secchi disk and an underwater quantum sensor were used to determine the light penetration within the water column. Eight light depths (92%, 61%, 46%, 24%, 11%, 5.4%, 1.5% and 1%) were sampled and incubated once or twice a day. Incubation time was from sunrise to local apparent noon (LAN) and from LAN to sunset. Production was determined by the Carbon-14 method. Carbonate alkalinity and pH were determined for the assimilation calculation. Samples were counted in a Packard®1/2425 liquid scintillation spectrometer.

Chlorophyll a and phaeopigment concentrations were determined by fluorometric techniques described in Strickland and Parsons (1968) and Yetsch and Menzel (1963). Modifications to the basic techniques were applied so that a smaller sample volume could be used and more complete extraction of pigments could be obtained. Seawater was filtered through glass-fiber filters onto which a few mg $MgCO_3$ was applied. The filter was placed in a centrifuge tube with 10 ml of 90% distilled acetone and sonicated for 1 min using a Megason Sonic Disintegrator®2/. The samples were then refiltered and the fluorescence of the filtrate was determined according to the standard techniques. All pigment analyses were conducted immediately after sampling.

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1. ®Packard Instrument Corp., 2200 Warrenville Rd., Downers Grove, Illinois.

2. ®Ultrasonic Instruments, International, Ltd., Farmingdale, New York.

Phytoplankton cells were preserved in a 1% sodium acetate-buffered formalin solution and returned to Seattle for examination. Abundance and identity of the cells were determined by the Utermöhl (1931) inverted microscope technique.

Water was frozen in polyethylene bottles and returned to Seattle for nutrient determination. Nitrate, nitrite, phoshate, ammonia and silicate were determined by the Auto Analyzer®[1] method at the University of Washington, Department of Oceanography.

Incident solar radiation was measured with a pyranometer and a quantum sensor, both connected to strip-chart recorders. One of the recorders was fitted with a mechanical integrator which readout provided solar energy per unit time.

D. Sample Localities (Fig. 1)

E. Data collected or analyzed (Table 1).

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1. ®Technicon Instrument Corp., Terrytown, New York

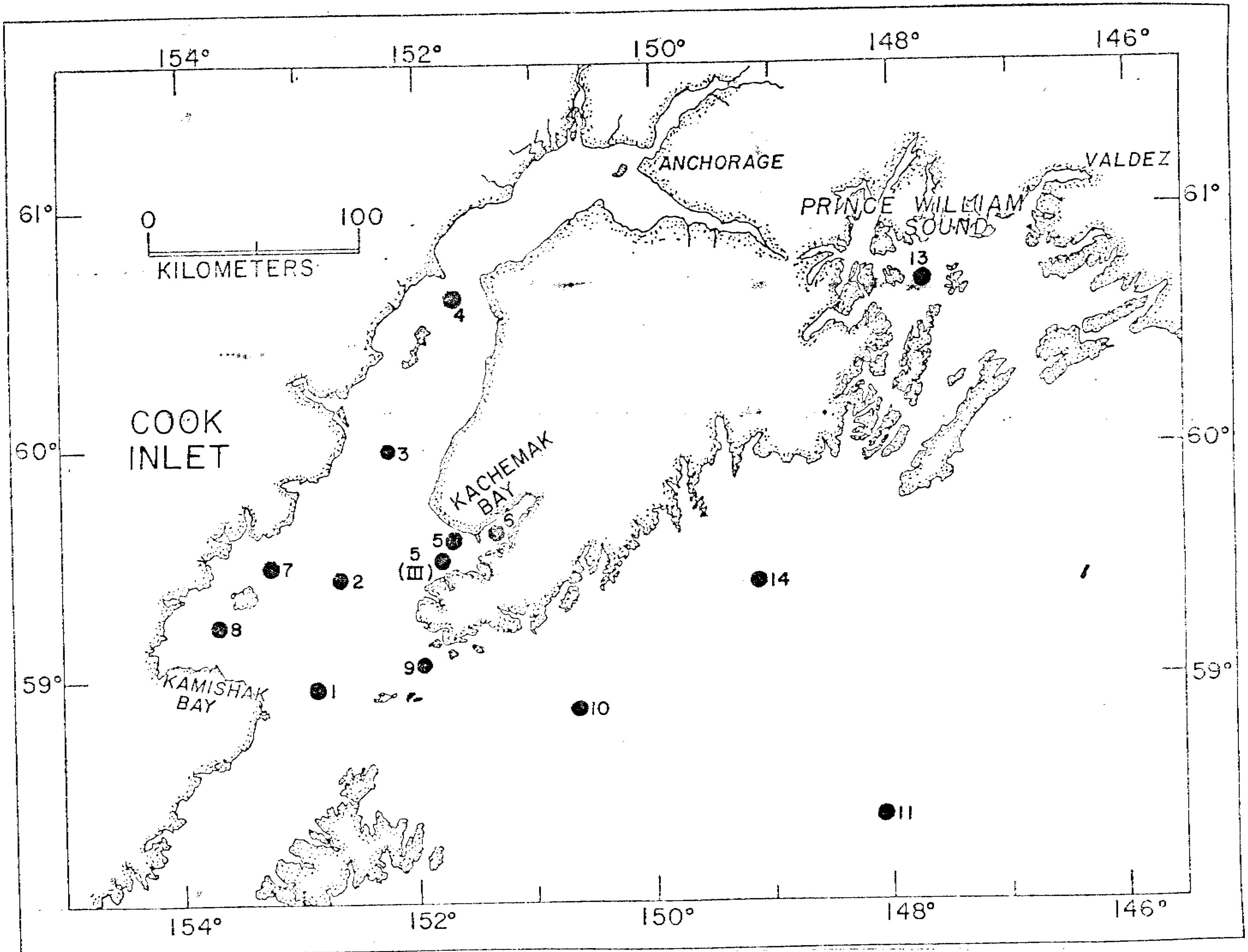

Figure 1. Sample localities. The location of Station 5 was different on Leg III than on

Table I - Number and type of samples and analyses from Cruise RP-4-DI-76A Legs III, V and VII

Sample Type	No. of Samples	No. of Analyses	Cruise Leg No.
Incident solar radiation (pyranometer)	6 (days)	6 (days)	III
	3 (days)	3 (days)	V
	6½ (days)	6½ (days)	VII
Incident solar radiation (quantum sensor)	6 (days)	6 (days)	III
	3 (days)	3 (days)	V
	6½ (days)	6½ (days)	VII
Water transparency (quantum sensor)	6	6	III
	4	4	V
	12	12	VII
Water Transparency (Secchi disk)	10	10	III
	7	7	V
	5	5	VII
Conductivity-temperature-depth (CTD)	28	28	III
	14	14	V
	24	24	VII
Surface chlorophyl a (*in vivo*)	6 (days)	6 (days)	III
	3 (days)	3 (days)	V
	6½ (days)	6½ (days)	VII
Chlorophyll a	265	265	III
	136	136	V
	233	233	VII
Phaeopigments	265	265	III
	136	136	V
	233	233	VII
Nutrients	265	265	III
	127	127	V
	233	233	VII
Phytoplankton I.D. and abundance	219	15	III
	127	0	V
	180	0	VII
Microzooplankton I.D. and abundance	20	0	III
	24	0	V
	28	0	VII

Table I (continued)

Sample Type	No. of Samples	No. of Analyses	Cruise Leg No.
Primary Production (*in situ*)	24	24	III
Primary Production (simulated (*in situ*)	264	264	III
	147	147	V
	192	192	VII
pH/alkalinity	17	17	III
	4	4	V
	6	6	VII

III. RESULTS AND INTERPRETATION

A summary of the data available is listed in Table 2. Chlorophyll _a_ was uniformly low in lower Cook Inlet and on the shelf (<37 mg/m^2)in April, but moderate amounts occurred in Prince William Sound (130 mg/m^2). By early May, chlorophyll had roughly tripled and was especially high in the Kachemak Bay area (200-300 mg/m^2). Chlorophyll continued to increase through May and averaged about 160 mg/m^2 in lower Cook Inlet.

The most turbid water was usually correlated with the lower chlorophyll values. The highest chlorophyll concentrations were consistently found in Kachemak Bay while the lower values occurred at the northernmost station (4) in Cook Inlet and on the western side in Kamishak Bay.

The water appeared to contain large amounts of glacial flour and other terrigenous suspended particles in the lower chlorophyll areas. This pattern suggests that the strong tidal circulation known to occur in Cook Inlet acts to maintain much of the inorganic suspended material in the western portion of the lower inlet during ebb tides (aided perhaps by coriolis effect) while "cleaner" replacement water is introduced more in the eastern area.

The inverse correlation of chlorophyll and suspended matter would be consistent with light controlled primary production. The terrigenous material apparently limits the penetration of most of the light energy to the upper few meters with a concommitant depression of production. In early May, productivity in Kamishak

Table 2. Data Summary from Cruise RP-4-DI-76A

Legs III, V and VII

Leg/ Station	Chlorophyll *a* (mg/m^2)	Phaeopigments (mg/m^2)	Carbon Assimilation (mg C/m^2 day)	Incident Radiation (ly/day)	1% Light Depth (m)
III/1	20.5	6.3	55.3	111	41
2	17.1	6.2			
3	17.8	8.2	42.7	111	8
4	21.0	38.2			
5	23.9	8.8	910.6	186	35
6A	18.1	11.3			
6B	19.1	8.7	245.9	186	18
6C	19.4	7.3			18
6D	19.6	7.6			18
6E	19.6	7.8			
6F	16.5	7.9	217.2	145	18
6G	15.8	5.6			
5A	36.3	5.4	883.2	145	22
8	9.4	4.8			
2A	25.8	8.3			
7	8.8	3.0	43.8	237	4
9	22.5	5.2			
10	32.8	5.8	750.8	237	30
11A	26.5	5.0			
11B	24.7	4.4			
11C	23.2	4.9	388.8	140	30
13A	108.1	21.6			
13B	81.7	10.0			
13C	75.5	20.2			
13D	130.0	14.4	836.4	66	12
13E	89.5	20.1			
13F	121.7	12.6	1188	66	12
14	19.7	4.8			
V/1	51.0	8.0	557.7	298	27
2	48.5	5.4			
3	26.4	9.3	113.2	298	4.1
4	12.3	21.4			1
5	153.1	3.0			
6A	317.5	9.3	8048	582	8
6B	251.1	8.6			
6C	310.4	9.0	3845	582	8
5A	222.9	2.1			
7	33.5	0.7			
8	30.4	2.4			
9	25.0	10.4	259	312	16
11	26.9	4.5			19
10	155.3	23.8			

Table 2 continued

Leg/ Station	Chlorophylla (mg/m^2)	Phaeopigments (mg/m^2)	Carbon Assimilation (mg C/m^2 day)	Incident Radiation (ly/day)	1% Light Depth (m)
VII/1	112.4	32.0			
2	226.5	16.3			17
3	96.9	12.6			6
4	22.6	20.6			1
5	245.6	37.3			10
6A	148.8	16.4			
6B	285.0	16.3			
6C	224.8	14.9			
6D	384.5	9.0			11
6E	236.2	21.5			
6F	203.7	9.6			
7	66.5	1.7			
8	92.3	1.4			
14	75.6	11.6			14
13A	217.4	43.4			
13B	116.3	18.2			16
13C	177.2	27.2			14
13D	237.5	37.3			
13E	134.7	43.7			
11A	30.7	4.8			35
11B	69.4	5.9			
11C	62.1	8.8			
10	138.0	10.6			

Bay was 44 mg/m^2 with a 1% light depth of only 4m (Table 2) and comparable values in Kachemak Bay were about 910 mg/m^2 and 22 or 35m even though incident radiation during the days of measurement was less in Kachemak than in Kamishak.

One more striking feature that should be mentioned is that the phaeopigment/chlorophyll ratios at station 4 (northernmost in Cook Inlet) were greater than 0.9 (on a m^2 basis). Normally, as in the remainder of this data set, these ratios are small fractions. The large ratios at station 4 may be an effect of pollutants near the active oil drilling areas just north of this location. Further investigation of this possibility would seem desirable to explore the possibility of using phaeopigment/chlorophyll ratios as indicators of chronic oil pollution.

Unidentified microflagellates dominated the phytoplankton populations at all stations in early April except those in Cook Inlet. Species of Thalassiosira were dominant at most locations in Cook Inlet and included T. gravida, T. pacifica, T. decipiens, and T. rotula. Melosira sulcata was dominant at station 4 where the anomolous phaeophytin/chlorophyll ratio occurred.

IV. PROBLEMS

The only severe problem encountered was the failure of the SURVEYOR to meet the scheduled cruise date. This was rectified adequately by provision of the DISCOVERER.

V. ESTIMATE OF FUNDS EXPENDED: $132K

REFERENCES

Strickland, J. D. H. and T. R. Parsons (1968). A Practical Handbook of Seawater Analysis. Queen's Printers, Ottawa, 311 pp.

Utermöhl, H. (1931). Neue Wege in der quantitativen Erfassung des Planktons. Verh. int. Verein, theor. angew. Limnol. 5: 567-596.

Yentsch, C. S. and D. W. Menzel (1963). A method for the determination of phytoplankton chlorophyll and phaeophytin by fluorescence. Deep-Sea Res. 10: 221-231.

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 13
Quarter Ending -
30 June 1976

ZOOPLANKTON AND MICRONEKTON STUDIES IN THE BERING - CHUKCHI/BEAUFORT SEAS

Dr. R. Ted Cooney
Associate Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

This research addresses six (6) tasks (or parts thereof) pertaining to zooplankton and micronekton in the Bering - Chukchi/Beaufort Seas.

A. A-9; describe the food dependencies of commonly occurring species of pelagic fishes as this task applies to dielly migrating bathypelagic species samples with bongo nets and NIO Tucker mid-water trawls.

B. A-22; summarize the existing literature and unpublished data on the transfer of synthesized organic matter of zooplankton and micronekton (including ichthyoplankton).

C. A-23; determine seasonal density distributions and environmental requirements of principal species of zooplankton, micronekton, and ichthyoplankton.

D. A-24; identify pathways of matter (energy) transfer between synthesizer and consumers.

E. A-25; identify and characterize critical regions and habitats required by egg and larval stages of fish and shellfish species.

F. A-31; determine the relationships of zooplankton and micronekton populations to the edge of the seasonal icepack as it occurs in the Bering and Chukchi Seas.

II. Field or Laboratory Activities

A. Ship Schedule

Legs I and II of the *Surveyor* cruise beginning in mid-March examined the edge of the seasonal ice pack as it occurred in the southeastern Bering Sea. Stations were occupied both over the shelf in ice-free water, and well inside the edge zone.

B. Scientific Party

1. Leg I: R. Ted Cooney, Ken Coyle, T. Nishiyama.

2. Leg II: Ken Coyle, Pat Wagner.

C. Methods

Details of the methodology are listed in an OCSEP program work statement "Environmental Assessment of the Alaska Continental Shelf" No.3, *Fish, Plankton, Benthos, and Littoral*; pp. 89 - 103.

D. Sample Localities

Station locations and cruise tracklines have been described in detail in the cruise report submitted for this effort; *Surveyor*, Legs I and II, March - April, 1976.

E. Data Collected or Analysed

Number and type of samples/observations

1. 91 1-m net tows
2. 17 2-m NID Tucker trawls
3. 25 acoustic recordings.

III Results

This was the first real attempt to examine the southern ice-edge zone prior to and during the spring bloom. In mid-March, the open water plankton and micronekton communities south of the ice and over deep water were sparse. Beginning at the shelf break and running shoreward into the edge zone, the animal plankton appeared to be more abundant, particularly well to the east of the Pribilof Islands where a single species of calonoid copepod, *Calanus marshallae* was dominate. Although chlorophyll was practically undetectable in the water column, these large copepods obviously contained material in their guts. Divers reported concentrations of euphausiids in the upper 10 m under the ice and in leads during the daylight hours; euphausiids were taken in some Trucker trawl tows. Fish eggs were extremely abundant at some locations well within the ice zone. Acoustic records disclosed the presence of both large discrete targets (possibly Alaska pollock) and mid-water and near-bottom scattering layers.

During Leg II, following a week of "down-time" in Kodiak, the vessel returned to the edge zone and documented the spring bloom.

IV. Preliminary Interpretation of Results

One surprise was the accumulation of large numbers of birds and marine mammals in the edge zone well in advance of the annual plankton bloom. Gut analyses indicated that these higher trophic levels were feeding on micronekton and small fishes which were overwintering as adults or juveniles. Thus, some selected products of the previous year's bloom period provide food for seasonal migrants utilizing this region in the late winter and early spring.

The question of the survival of pelagic fish eggs drifting north with the receding ice pack was not resolved. In the very cold water next to and under the ice, the incubation period is expected to be quite long (several weeks at the least) so that eggs spawned early in the season at the shelf break probably hatch far to the north. Our continuing study of the edge ecosystem will examine this problem in more detail.

V. Problems Encountered/Recommended Changes

The officers and crew of the NOAA vessel *Surveyor* were interested in the work and always helpful. However, the ship is very poorly equipped for routine oceanography and/or fishery biology. If this ship is to continue working the ice zone, the capability for putting gear over the side for both vertical and horizontal towing must be improved. Also provision must be made for cold weather operations, including water for rinsing nets and metering devices that are not consistantly frozen. These details are admittedly "picky" but none-the-less define the limitations of otherwise very routine observations.

On the whole, the ship *Surveyor* is an adequate platform for seasonal ice work, and with the helicopter aboard, a very flexible working vessel.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 13 R.U. NUMBER: 156/164

PRINCIPAL INVESTIGATOR: Dr. R. T. Cooney

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		
Discoverer Leg I #808	5/15/75	5/30/75	8/30/76		
Discoverer Leg II #808	6/2/75	6/19/75	8/30/76		
Discoverer Leg I #810	8/9/75	8/28/75	7/30/76		
Miller Freeman #815	11/10/75	11/26/75	7/30/76		
Contract #03-5-022-34	Last	Year	submitted		
Surveyor 001/2	3/76	4/76	9/30/76		

Notes: [1] Data Management Plan has been approved and made contractual. Format has been received and approved by all parties.

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 1
Quarter Ending -
30 June 1976

PHYTOPLANKTON STUDIES IN THE BERING SEA

Dr. Vera Alexander
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

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. Secondly, to assess the levels of phytoplankton productivity in the southeast Bering Sea during the ice-free season in order to compare seasonal activity, and also to look at the role of the shelfbreak and Aleutian upwelling in Bering Sea production dynamics. The seasonal role of algae growing in the underside of the ice is also included in the study.

II. Field Activities

A. A cruise in the Bering Sea was undertaken aboard the *Surveyor* during March and April 1976. The dates for Leg I were March 14 - April 2 and for Leg II -- April 12 - April 30, port to port. Phytoplankton study stations were occupied from March 16 to March 31 and again from April 15 to April 26. During Leg I helicopter operations were provided for ice sampling beyond reach of the ship's capabilities in the ice pack.

B. On Leg I phytoplankton investigations were conducted by David Brickell, Carl Tobin and Marilyn Sigmund. Leg II personnel included Dr. R. J. Barsdate, David Brickell, Margie Young, and Lewis Molot. All are associated with the Institute of Marine Science, University of Alaska, Fairbanks. David Brickell was responsible for field data collection and Dr. R. J. Barsdate for experimental work.

C. Samples were collected either by ice coring operations or rosette sampler with Niskin bottles and processed as described in the recent annual report. Preliminary experiments were begun to evaluate energy transfers from the phytoplankton population to the higher trophic level zooplankton using a Coulter counter method to observe changes in the particle size/volume distribution of the endemic phytopopulation when exposed to selected zooplankters.

The continuing main effort was to observe the initiation of the receding ice edge bloom which had been observed on Cruise 808 (*Discoverer*, May 1975) and to study the oceanographic conditions existing prior to the intense phytoplankton bloom occurring at the receding ice edge. Since the rate of primary productivity is particularly great at the receding ice edge it is necessary to have an estimate of the duration of this accelerated rate of production in order to provide a reasonable estimate of annual productivity of the Bering Sea.

D. On Leg I, the sampling area encompassed the ice edge area from approximately 57°N 168.5°W (east of the Pribilofs) to approximately 50°N 164°W and the open water south of this area to the near vicinity of the Aleutian Islands. On Leg II, the east-west range was extended along the ice edge to approximately 56.5°N 174°W to approximately 56°N 163° W. Nearly all sampling on Leg II occurred near to the ice edge.

E. During the recent *Surveyor* cruise (March-April 1976) a total of 40 oceanographic stations were occupied for phytoplankton research. In addition two ice stations were selected for coring operations.

A summary of samples collected for analysis follows:

Type	Number
Chlorophyll	318
Nutrient	346 each to be analyzed for five different parameters
Primary productivities (^{14}C)	120
Preserved phytoplankton	204
Ice cores	30
Grazing experiments	12

Since much of the oceanographic research was done on a not-to-interfere basis with marine mammal observations, miles of trackline indicates little regarding out work and we were not given that information.

The current status of all samples collected on all OCS cruises to date follows:

1. Nutrient analyses for Cruise 808 (*Discoverer*, May 1975) Cruise 810 (*Discoverer*, August 1975) and Cruise 815 (*Miller Freeman*, November 1975) are completed. Nutrient analyses for Cruise SU 001 (*Surveyor*, March-April 1976) are in progress.

2. Nutrient analyses for the Beaufort Sea (Morita and Atlas) are completed and the results have been sent to the two principal investigators.

3. Chlorophyll data for all cruises has been completed.

4. Phytoplankton counts and identifications for all earlier cruises are completed and are in progress for the more recent *Surveyor* cruise.

5. Alkalinity data for all cruises is complete.

6. Phytoplankton primary productivity samples (^{14}C) have been counted and photosynthetic rates calculated for all cruises except *Surveyor*, March-April 1976, which are now in progress.

III. Results

Preliminary data indicate that the major production activity on the Bering Sea shelf is in the form of a bloom following the receding ice in spring. At all other times of investigation the standing crop of phytoplankton and photosynthetic rates are low with nutrient supply appearing to be the limiting factor in production. The timing of the *Surveyor* Cruise (March-April 1976) was opportune since during Leg I (March) the waters near the ice edge were not very productive whereas during Leg II (April) the spring bloom phenomenon had begun. We have data, therefore, indicating conditions prior to the production pulse of spring. Furthermore, by observing the initiation of the bloom, we have a better grasp of its duration-information needed to estimate the annual production.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 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	7/30/76	submitted	None	None
Discoverer Leg II #808	6/2/75	6/19/75	7/30/76	submitted	None	None
Discoverer Leg I #810	8/9/75	8/28/75	7/30/76	submitted	None	None
Miller Freeman #815	11/10/75	11/26/75	7/30/76	submitted	None	None
Surveyor Su/001/2	3/76	4/76	9/30/76	9/30/76	None	None

Note: [1] Data Management Plan and data Formats have been approved and are considered contractual.

Quarterly Report

Research Unit 174
April 1 - June 30, 1976
2 pp.

Baseline Studies of Demersal Resources of the Northern Gulf of Alaska Shelf and Slope: An Historical Review

Lael L. Ronholt
Northwest Fisheries Center
National Marine Fisheries Service

June 28, 1976

I. Task Objectives

   A. Provide an historical perspective on the demersal fish and shellfish resources residing in the continental shelf and slope waters of the Gulf of Alaska between the Semidi Islands and Yakutat Bay.

   B. Provide growth and age composition information in selected demersal fish species of importance to man as food resources.

II. Laboratory Activities

   A. No field trips scheduled

   B. No scientific party

   C. Methods

      1. Historical data are being analyzed to determine species occurrence and composition, average CPUE, and present contribution to the biomass available to the sampling gears.

      2. Foreign fisheries catch statistics

         a. Japanese catch statistics tabulated by the following regions:

            (1) 157°W - 154°W longitude

            (2) 154°W - 151°W longitude

            (3) 151°W - 148°W longitude

            (4) 148°W - 144°30'W longitude

            (5) 144°30'W - 144°W longitude

         b. Russian catch statistics are being tabulated by:

            (1) Western Gulf of Alaska - west of 147°W longitude

            (2) Eastern Gulf of Alaska - east of 147°W longitude and north of 54° latitude

      3. Domestic catch statistics from 1969-75 are being tabulated to demonstrate catch trends and principal fishing grounds by the following regions:

a. 157°W - 154°W Chirikof

b. 154°W - 151°W Kodiak

c. 151°W - 148°W Kenai

d. 148°W - 144°30'W Prince William Sound

e. 144°30'W - 140°W Yakutat

f. Shelikof Straits

4. IPHC and NMFS 1961-63 survey data and recent NMFS survey data have been entered onto disc files. Future analysis of these data will include distributional charts, average CPUE's, and biomass estimates by depths and geographic areas. Average CPUE's will be calculated on logarithmic transformation of the data for between-years comparisons of stock status.

5. Growth data will be analyzed using methods described by Von Bertalanffy.

D. No sampling

E. No data collection

III. Results

A. Historical data analyses have been 80% completed.

B. Foreign fisheries catch statistic tabulations are 30% completed.

C. Domestic catch statistic tabulations are 40% completed.

D. Distributional species charts, biomass estimates and average CPUE analyses are now being completed.

IV. Preliminary interpretation of results

A. Not applicable

V. Problems encountered - None

Quarterly Report

Contract No.
Research Unit No. 175
Reporting Period: April 1-
June 30, 1976
No. of pages: 18

Baseline Studies of Demersal Resources of the Eastern Bering Sea Shelf and Slope

Principal Investigators: Walter T. Pereyra, Ph.D.,
Jerry E. Reeves, Ph.D., and Richard G. Bakkala

Northwest Fisheries Center
National Marine Fisheries Service
2725 Montlake Boulevard East
Seattle, Washington 98112

June 28, 1976

Introduction

Research Unit 175, Baseline Studies of Demersal Resources of the Eastern Bering Sea Shelf and Slope, consists of two tasks. Task A-13 concerns itself with the summarization of pertinent biological literature and historical data from the eastern Bering Sea. Task A-14 is concerned with the collection and analyses of data on demersal resources of the eastern Bering Sea in the fall, 1975, and spring, 1976. These studies are conducted by personnel from the Resource Assessment and Conservation Engineering Division of the Northwest Fisheries Center, National Marine Fisheries Service, Seattle, and the Kodiak Laboratory, NWFC. The primary funding comes from the NWFC MARMAP Program.

This quarterly report summarizes progress in each task from April 1-June 30, 1976. For a more detailed overview, the reader is referred to the annual report for Research Unit 175 submitted to OCSEAP March 24, 1976.

Task A-13

I. Task Objectives

Summarize existing literature and unpublished data on the distribution, abundance, and productivity of demersal fish, shellfish, and other epibenthic organisms.

II. Laboratory Activities

A. Ship or field schedule - none.

B. Key personnel

1. Jean Dunn, Northwest Fisheries Center, responsible for summarization of demersal fish literature of the eastern Bering Sea. Richard Bakkala and Dr. Gary Smith, NWFC, responsible for analyses and summarization of historical data from the study area.

2. Dr. Jerry Reeves, Doyne Kessler, and Richard MacIntosh, NWFC, Kodiak Laboratory, responsible for summarization of shellfish literature and historical data from the eastern Bering Sea.

C. Methods

1. Biological literature concerning the distribution, abundance, productivity, and life history of target species of groundfish and shellfish in the study area are searched, catalogued, annotated and summarized.

2. Unpublished data on the distribution, abundance, and productivity of target species of groundfish and shellfish are collected, analyzed, and summarized for use as a historical data base and for comparison with existing data bases.

D. Sample localities/ship or aircraft tracklines

Not applicable.

E. Data collected or analyzed

1. Summarization of pertinent biological literature on eleven species

of demersal fishes of the eastern Bering Sea was continued at the NWFC, Seattle. Draft species synopses were completed for yellowfin sole, rock sole, flathead sole, Pacific cod, Greenland halibut, arrowtooth flounder, and Alaska plaice. Summarization of these synopses is in progress as is summarization of rockfish, pollock, halibut, and sablefish literature.

2. An essentially complete listing of pertinent biological literature on king and Tanner crab, consisting of over 1,100 references, has been compiled at the NWFC, Kodiak. These papers are presently being summarized as is the pertinent literature on snails.

3. Pertinent historical data from the eastern Bering Sea are being examined at the NWFC, Seattle. The following data sets have been converted, standardized, and stored in disk format:

   a. International Pacific Halibut Commission Survey Data, eastern Bering Sea, 1963, 1965-1975: 1,155 trawl records; 9,926 species catch records.

   b. NMFS Crab-Groundfish Survey Data, eastern Bering Sea, 1971-75: 664 trawl records; 14,616 species catch records.

   c. Japanese Research Vessel Survey Data, eastern Bering Sea, 1966-71: 861 trawl records; 9,075 species catch records.

   Some additional editing is required in data sets b and c.

The following computer programs have been developed for processing historical data:

   a. A general program (SEL10) for selective retrieval of catch data for individual species or multi-species groups, calculation of catch-per-unit-effort measures, and transfer of information for plotting maps of CPUE.

   b. A general program (RANK1) for selective retrieval of catch data, that orders the species list by frequency of occurrence, total numbers, total weight, CPUE measures, and mean size.

III. Results

A. Analyses of historical data sources in progress or completed by Richard Bakkala and Dr. Smith include:

1. Computer-drawn maps showing standardized groundfish catches to assess year-to-year variations in the distributions and abundances of major species (see examples in Figures 1 and 2 for two of the data sources).
2. Year-to-year variations of relative species composition and abundance of major species in standard areas are presently being assessed. Preliminary analyses of one data set (Halibut Commission, 1963-75) show large (1-2 orders of magnitude) variations in apparent abundance between years, that for some species are apparently related to year-to-year environmental variations and trends in fishing effort. The concordance between different data sets has not yet been evaluated.

B. Analyses of historical data on commercial species of crab are in progress at NWFC, Kodiak Laboratory, by Dr. Jerry Reeves and Doyne Kessler. Computer plots of crab distributions, apparent relative abundances, and tabular listings of catches have been prepared.

IV. Preliminary interpretation of results

As the final report is due at the end of the next quarter, no further interpretation of results is included.

V. Problems encountered/recommended changes

None.

VI. Estimate of funds expended

No OCSEAP funds expended; all activites of this task supported by NMFS funds in this quarter.

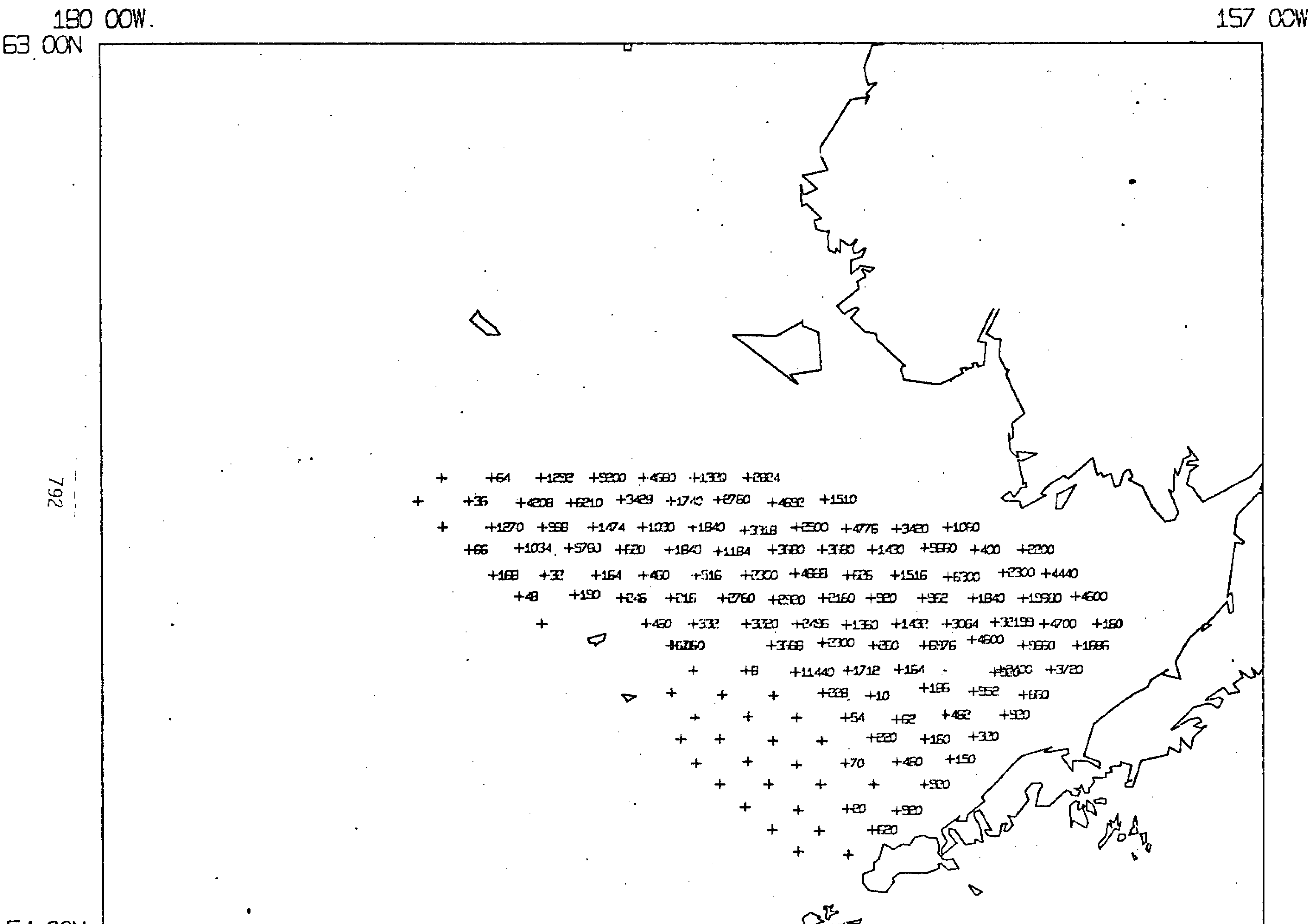

Figure 1.--Example of computer plot of species distribution from Japanese research vessel surveys that will be used in final OCSEAP report. This plot illustrates the distribution of yellowfin sole as indicated by the 1966 survey (+ indicates station position; number following '+' indicates CPUE in 1/10 kg/hr; '+' with no number following indicates zero catch for this species).

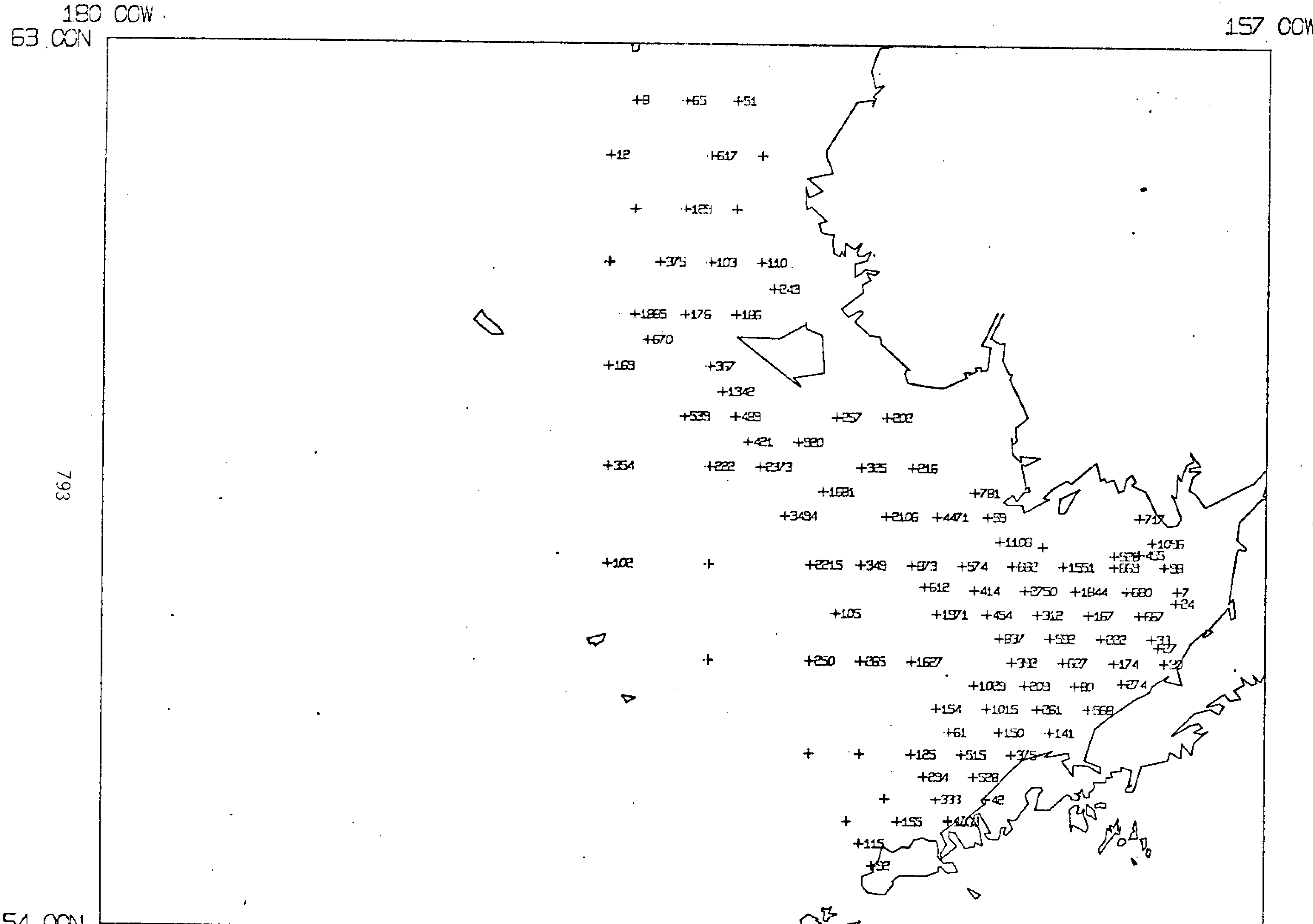

Figure 2.--Example of computer plot of species distribution from International Pacific Halibut Commission research surveys to be used in final OCSEAP report. This plot illustrates the distribution of yellowfin sole as indicated by the 1967 survey (+ indicates station position; number following '+' indicates CPUE in 1/10 kg/km; '+' with no number following indicates zero catch for this species).

Task A-14

I. Task Objectives

Determine the distribution and abundance of demersal fish, shellfish, and other epibenthic organisms in the eastern Bering Sea. Estimate the productivity, length, weight, and age distribution of selected demersal fish and shellfish. Develop growth models and provide a data base against which subsequent changes in these parameters may be compared.

II. Field or Laboratory Activities

A. Ship schedule, 1976

1. Anna Marie (chartered), April 5-July 1 (Seattle to Seattle)
2. Pat San Marie (chartered), April 8-July 1 (Seattle to Seattle)
3. Miller Freeman (NOAA), March 28-May 13
4. Oregon (NOAA), May 24-June 30 (OCSEAP portion; survey continues until August).

B. Scientific party

1. Anna Marie: Steven Hughes, Jean Dunn, and Norman Parks, Scientists-in-Charge, two other biologists and seven technicians, all of NWFC.
2. Pat San Marie: Fred Wathne, Thomas Dark, and Robert Wolotira, (SIC), two other biologists and seven technicians, all of NWFC.
3. Miller Freeman: Richard Bakkala, and Kenneth Waldron (SIC), Joo Yeoul Lim (visiting Korean scientist), two biologists, and six technicians, all of NWFC.
4. Oregon: Craig Forrest and Richard MacIntosh, (SIC), one biologist and four technicians, all of NWFC.

C. Methods

The survey utilized standard (on the Oregon) and modified (on the other vessels) 400-mesh Eastern otter trawls fished for one-half hour periods.

Catch composition was determined by weight and numbers and, for selected species, data were collected on size, sex, age and weight. Vertical water temperature profiles were obtained by XBT probes (Anna Marie, Miller Freeman and Oregon).

Six days of comparative fishing were conducted between the Oregon and Pat San Marie to adjust catches for differences in fishing power. Comparative fishing among the Miller Freeman, Anna Marie and Pat San Marie was conducted during last year's survey.

D. Sample localities

Vessel tracklines are shown in Figures 3-5.

E. Data collected or analyzed

1. Spring 1976 survey

Approximately 500 stations were successfully occupied by the four vessels.

Data from all four vessels are now being keypunched and will be screened for errors by diagnostic computer programs.

As this year's survey was completed only last week, no analyses nor results are yet available.

2. Fall 1975 survey

Primary emphasis this reporting period has been placed on the analysis of data collected during the fall 1975 survey of the eastern Bering Sea.

The NWFC, Seattle, handles analysis of demersal fish data collected during the surveys. Led by Dr. Donald Gunderson, the group involved in field data analysis, except community analysis, includes Stephen Kaimmer and Mark Wilkins, with the assistance of our computer programming staff of Ralph Mintel, Bruce Gibbs, and Katherine Larson.

Present focus is on analyses of age-length data, length-weight data, comparative tow data, catch-per-unit-of-effort data and biomass data.

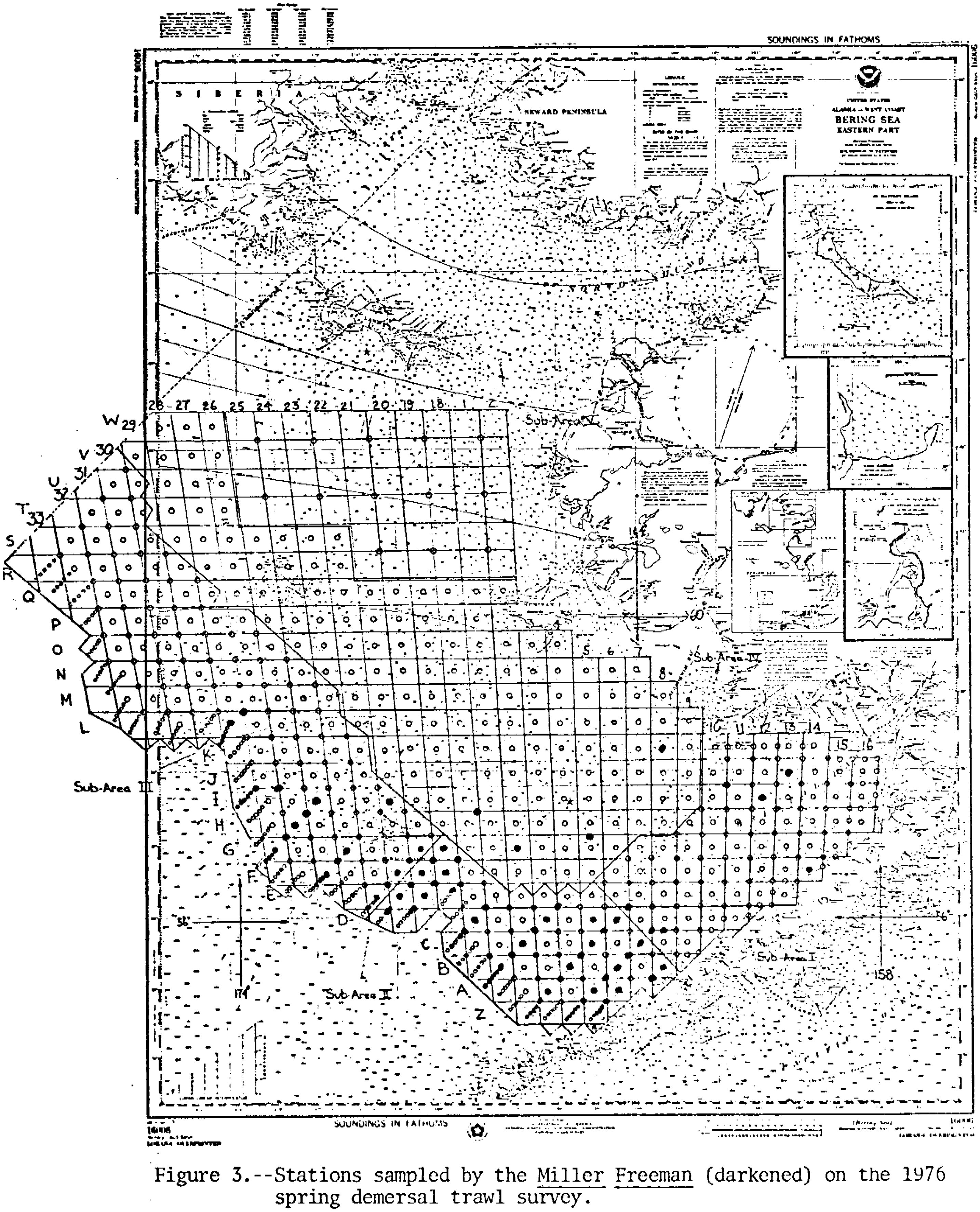

Figure 3.--Stations sampled by the Miller Freeman (darkened) on the 1976 spring demersal trawl survey.

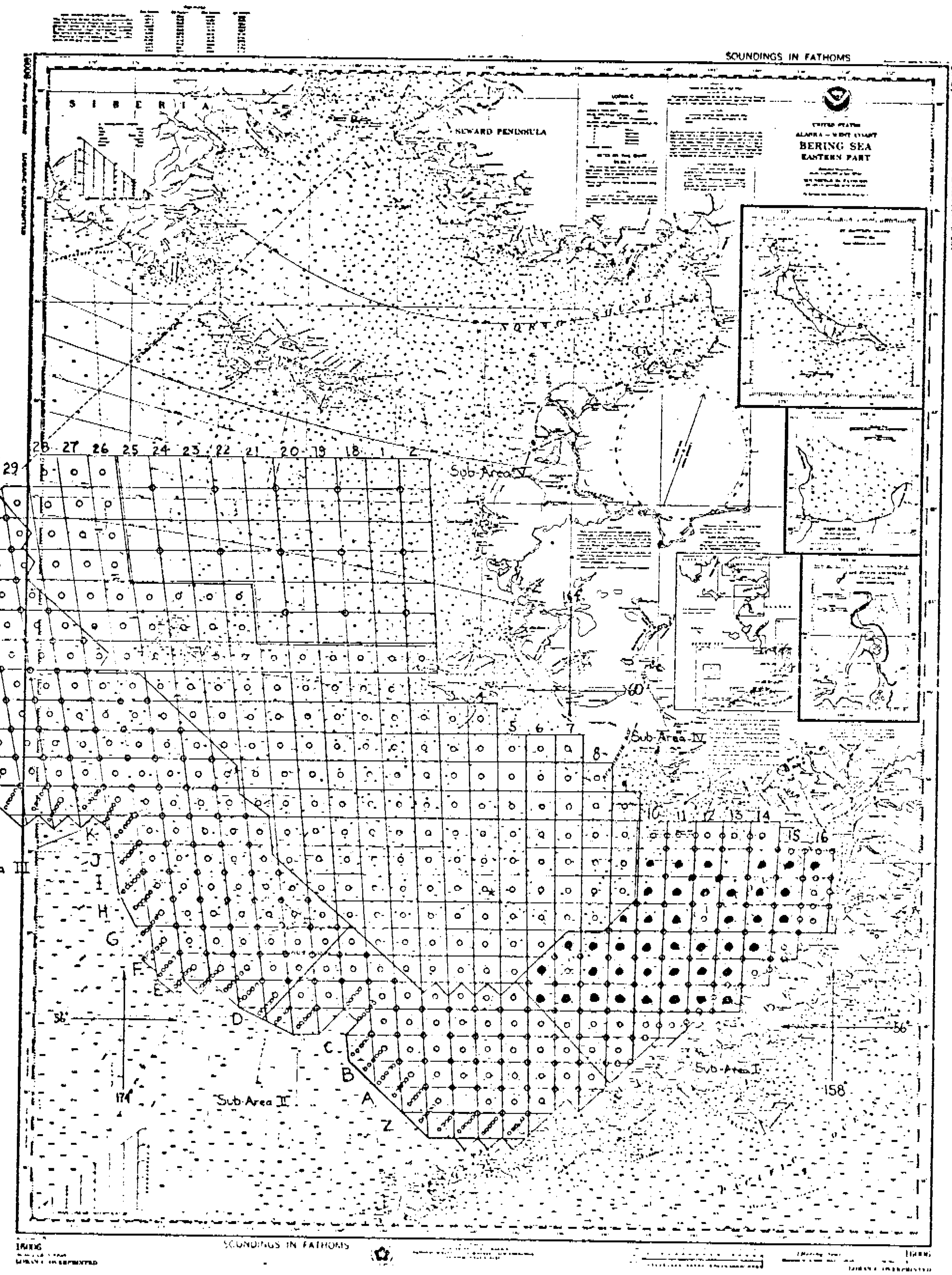

Figure 4.--Stations sampled by the Oregon (darkened) during the 1976 spring demersal trawl survey.

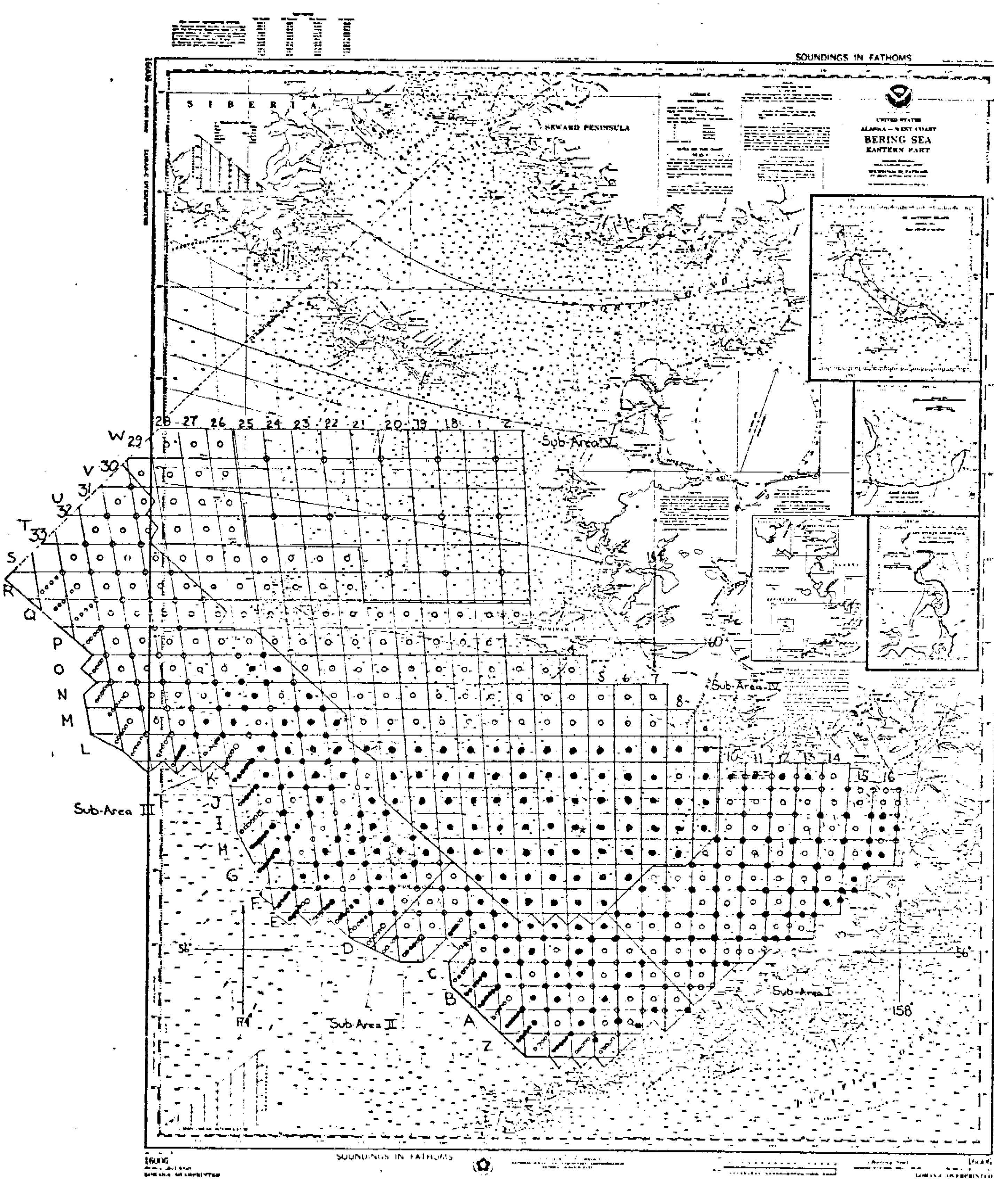

Figure 5.--Stations sampled by the charter vessels Anna Marie and Pat San Marie (darkened) during the 1976 spring demersal trawl survey.

The quantities of data collected during the fall 1975 survey were listed in our annual report to OCSEAP.

Dr. Gary Smith is investigating species associations from the 1975 baseline survey catches. A series of recurrent grouping programs (REGROUP, CONNEX, STATION) were updated and converted for use on the University of Washington CDC 6400 computer by Dr. Smith. Auxilliary programs were developed for disk data transfer and plotting distributional maps of group occurrences.

The Kodiak Laboratory, NWFC, handles analysis of crab and snail data collected during the 1975 and 1976 baseline surveys. This group, led by Dr. Jerry Reeves, includes Richard Bartlett, Richard MacIntosh, and Doyne Kessler, plus technical assistance.

The present focus of the Kodiak group involved in OCSEAP/MARMAP surveys is analysis of the 1975 baseline survey data. All data are on tape, and emphasis is on analysis of the distribution, apparent abundance, size, shell, and egg condition of king and Tanner crab. Similar distribution and abundance analyses are proceeding on snail data.

III. Results

Because of the mass of data generated during the 1975 baseline survey of the eastern Bering Sea (approximately 170,000 ADP cards - see OCSEAP annual report for 1976), we discuss here only certain highlights of on-going analyses.

Dr. Donald Gunderson and Bruce Gibbs have completed a major computer program that is being used to analyze the fall, 1975 Bering Sea data. The program was designed to estimate biomass, population size, and size composition for each sampling stratum and for all strata combined. Variances and confidence intervals are computed for both biomass and population estimates. The program was designed to carry out these calculations for various conditions of data availability: (1) having data on numbers and weight caught and size composition for each haul; (2) having data on weight caught and size composition for each haul; (3)

having data on numbers and weight caught for each haul; and (4) having weight data for all hauls but numbers for only some hauls.

Dr. Gunderson completed the analysis of comparative tow data from 1975. Analysis of variance suggested that the duration of haul (30 vs. 60 minutes) had no significant effect on catch per mile.

Estimates of fishing power coefficients are listed in Table 1.

Table 1.--Estimates of fishing power coefficients by vessel and species.

	SPECIES					
	Pollock (all sizes)	Small Pollock	Large Pollock	Rock Sole	Tanner Crab	King Crab
Miller Freeman	1.00	1.00	1.00	1.00	1.00	1.00
Anna Marie	0.75	0.52	0.79	0.65	0.66	0.70
Pat San Marie	0.57	0.34	0.61	0.76	0.75	1.05

Analysis of variance showed a significant between-vessel difference in the catch per mile for each of the species listed, although 95% confidence limits around the individual estimates of fishing power coefficients overlapped considerably. The size composition of the fish taken differed very little between vessels, and significant differences were found only for pollock. Because of this, separate sets of fishing power coefficients were estimated for large and small pollock. Between-vessel differences in the size or sex composition of king and Tanner crabs were non-significant. Between-vessel differences in the catch per mile of flathead sole and yellowfin sole did not begin to approach significance, and consequently are not presented above.

Steve Kaimmer and Dr. Gunderson completed analysis of length-weight data collected during the fall 1975 baseline survey in the eastern Bering Sea (Kaimmer and Gunderson, MS 1976).

A total of 5,681 length and weight measurements were taken from six species during the 1975 survey. Analysis of the covariance of weight on length regressions demonstrated significant variation for most species between otolith areas and sex groupings. However, errors of weight predictions due to pooling of all area-sex groupings for each species, in terms of maximum percent deviation of pooled prediction versus predictions based on area-sex specific regressions, were usually less than 10%. For purposes of general length-weight keys these deviations are acceptable, and length-weight parameters for these species (Table 2) are treated for areas and sexes combined.

Table 2.--Parameters for the relation $W = al^b$ for converting length (l) in cm to weight (W) in either grams or pounds.

	Factor a		Exponent b
	For weight in grams	For weight in pounds	
Walleye pollock	.0075	1.65×10^{-5}	2.977
Pacific cod	.0052	1.15×10^{-5}	3.222
Yellowfin sole	.0113	2.49×10^{-5}	2.998
Alaska plaice	.0122	2.69×10^{-5}	3.021
Flathead sole	.0035	$.772 \times 10^{-5}$	3.296
Rock sole	.0078	1.72×10^{-5}	3.136

Based on the following equations, obtained by pooling the data for all sexes and areas, the estimated weights for 5 cm size classes of six demersal fishes are shown in Table 3.

Walleye pollock $W = .0075\ l^{2.977}$

Pacific cod $W = .0052\ l^{3.222}$

Yellowfin sole $W = .0113\ l^{2.998}$

Alaska plaice $W = .0122\ l^{3.021}$

Flathead sole $W = .0035\ l^{3.296}$

Rock sole $W = .0078\ l^{3.136}$

Table 3.--Estimated weight-at-length for six species of groundfish in the eastern Bering Sea, fall 1975.

	Weight (g)					
Length (cm)	Pollock	Cod	Alaska plaice	Yellowfin sole	Flathead sole	Rock sole
10				11.2		10.7
15	23.8			37.9	26.3	38.0
20	56.0			89.9	68.0	93.8
25	108.8	166.0	204.0	175.4	141.8	188.8
30	187.3	298.7	353.8	303.0	258.6	334.5
35	296.3	490.9	563.6	481.1	429.8	542.4
40	441.0	754.8	843.7	717.9	667.5	824.4
45	626.1	1,103.2	1,204.2		984.1	1,192.8
50	856.8	1,549.1				
55	1,137.9	2,106.0				
60	1,474.4	2,787.5				
65	1,871.1	3,607.5				
70	2,333.0					
75	2,865.0					
80						

Mark Wilkens has been engaged in analyses of age-length data from the 1975 baseline survey. Preliminary results suggest that growth rates of pollock, rock sole, and flathead sole differ substantially over the survey area, and that more than one age-length key must be used for these species. Between-area differences in mean length-at-age were not significant for yellowfin sole and Alaska plaice, and a single age-length key for the entire survey area can be used for these species.

Age-length data for cod were not available for fish older than 4 years, so that useful age-length keys cannot be constructed for this species. The data available suggest that between-area differences in cod growth are slight, however.

Computer plots of catch per unit of effort in kilograms per kilometer fished have been produced for most of the principal demersal fish species captured in 1975. These plots are being produced in a 16 X 21-inch Mercator projection format, for use with a standard base map indicating coastlines with margins marked in latitude and longitude. Bottom temperature, bottom depth, and surface temperature contours are also available on overlays that can be used with the base map.

The plots for each species distribution will be presented in two formats. The first will be computer-drawn plots of actual catch weights in numbers (kg/km) as shown in Figure 6; the second will be contoured and shaded to illustrate areas of catch concentrations for each species.

Station positions will be indicated on all plots and areas of zero catch will be indicated by either the absence of a catch number adjacent to a station (on the first plot) or the absence of shading (on the second plot).

In addition to plots of catches of individual species, plots will be included in similar format for total roundfish, total rockfish, total flatfish, total fish catch, total invertebrate catch and total catch overall.

Contour plots of bottom depth in meters and surface and bottom temperatures in degrees centigrade will be produced in the same format. The final size of all plots will be 8 by 11 inches.

Dr. Gary Smith has examined the species composition for the fall 1975 baseline survey. A total of 249 taxa occurred in the 538 standard station trawls, of which 14 taxa accounted for 80% of the total catch by weight.

In a preliminary analysis of species associations, an objective recurrent grouping procedure has been applied to the 1975 trawl data by Dr. Smith. The initial analysis was restricted to 46 taxa that were considered reliably and consistently identified; 23 of these taxa formed five major species groups. The occurrences of these groups appear to characterize five different regions of the

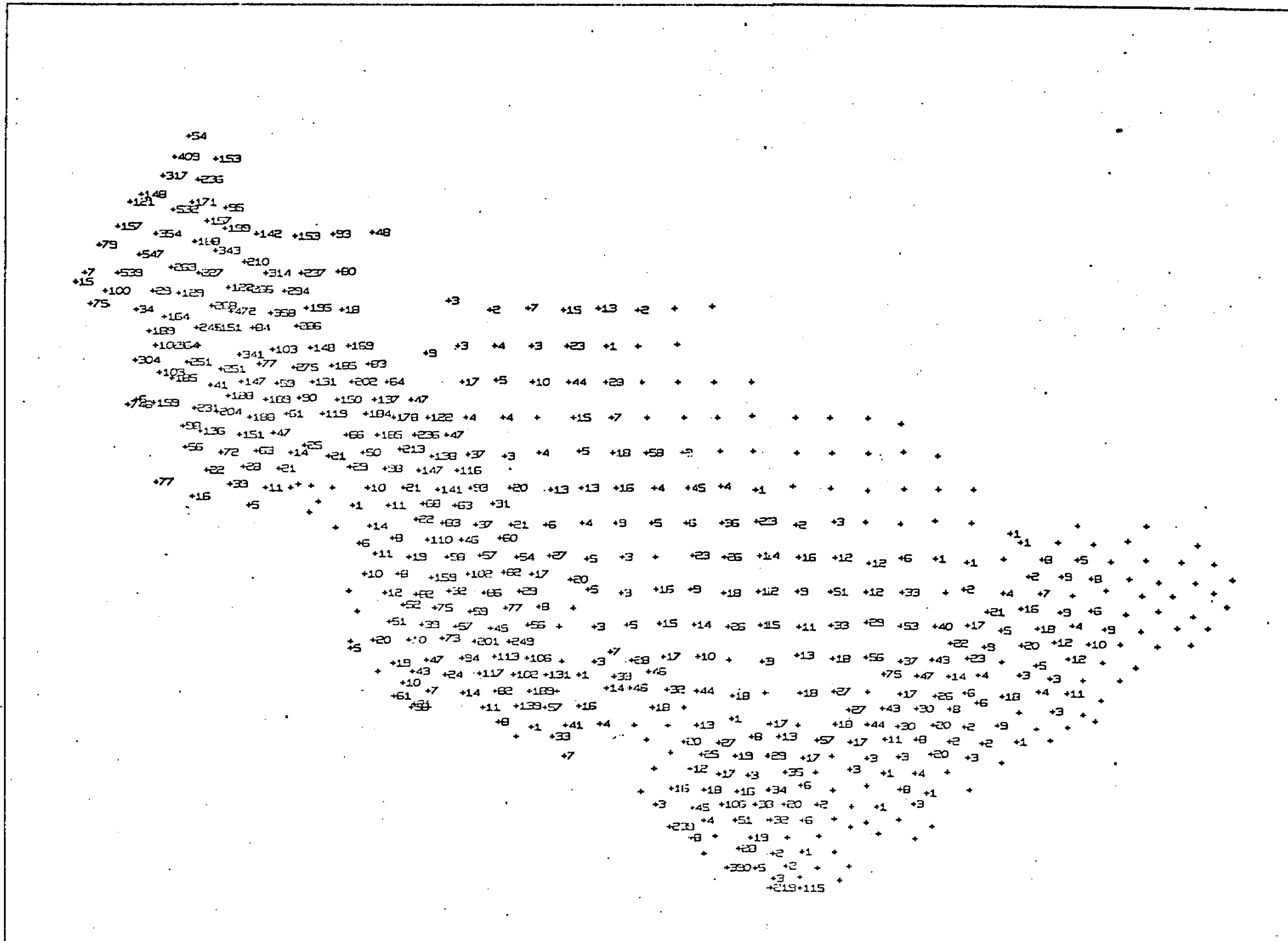

Fig 6-- Example of computer - plot of species distribution for Greenland Halibut, summer - fall 1975 baseline survey data (+ indicates station position; number following '+' indicates CPUE in 1/10 kg/km; '+' with no number following indicates zero catch for this species).

eastern Bering Sea shelf. Multi-species analyses will necessarily be limited to taxa (primarily commercial species) with well-described and consistently applied taxonomy. Taxonomic limitations will prohibit any analysis of species diversity.

V. Problems encountered/recommended changes

The primary problem encountered during this spring's baseline survey was the abnormal ice coverage in the Bering Sea. This caused changes in planned cruise tracks and restricted vessel operations through April and May. By early June, however, the ice had receded sufficiently to allow the vessels to cover the entire survey area planned for this spring.

VI. Estimate of funds expended

OCSEAP funds expended this quarter totaled $25,400. NWFC base funding expended on this study far exceeded expenditure of OCSEAP funds.

Annual Report

Contract #03-5-022-69
Research Unit #233
Reporting Period - July 1975 -
1 March 1976

Beaufort Sea Estuarine Fishery Study

Principal Investigator:

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1 April 1976

This is an interim report which presents preliminary information and results for the use of the OCSEAP. No material contained may be quoted in external reports without written permission of the author.

I. Introduction

Petroleum exploration and development is rapidly increasing throughout the nearshore areas of the Beaufort Sea. Already, the demands by industry for construction material, gravel sources, fresh water, and transportation avenues are substantial. Alterations of the physical environment resulting from water and gravel removal or the construction of roads and causeways are imminent. Knowledge of fish in the Beaufort Sea is minimal.

The objectives of this study are to determine the distribution and relative abundance of the various species of fish occupying the nearshore environs of the Beaufort Sea. Correlating important life history data with knowledge of habitat needs, we hope to obtain baseline information that can be used to direct the activities of people and industry in the proposed lease area.

Specifically, the objectives of the study are:

A. To determine the seasonal distribution, relative abundance, size and species composition, growth rates, feeding habits and reproductive capabilities of Beaufort Sea nearshore fishes in the area from the Colville to the Canning rivers and between shore and the barrier islands, including river deltas.

B. To determine migration patterns and timing of these fishes.

C. To identify critical habitats including spawning, overwintering, feeding, rearing and migration areas.

D. To determine the interrelationship of Arctic fishes to lower food-web organisms.

E. To determine the present rate of exploitation of the anadromous fishes of the area and to monitor changes in this usage as development of the areas petroleum resource progresses.

II. Current state of knowledge

Prior to the accelerated interest and development in the Arctic by major oil companies, there have been few investigations of the fishes in the Beaufort Sea. The Alaska Department of Fish and Game (Roguski and Komarek, 1970) initiated a study to assess the environmental characteristics and fish species in coastal waters of the Arctic National Wildlife Range. The following year, a four year investigation of the waters draining into Prudhoe Bay was initiated (Yoshihara 1972, 1973 and Furniss 1974, 1975). These past investigations emphasized the life histories and distributions of anadromous species with special emphasis on Arctic char. Other fisheries studies on North Slope drainages were conducted by McCart, Craig and Bain (1972) and Johnson (1975). With the advent of designing and proposing utility corridors to transport natural gas south of the

Arctic, several more investigations were initiated, many of which stressed the life history and biology of fish in their freshwater habitats of North Slope drainages. More recently, fisheries investigations have been centered along the northern coastlines of Alaska and Canada. Furniss (1975) investigated the age, growth, fecundity, species composition and distribution of fishes in Prudhoe Bay. Griffiths and Craig et al. (1975) conducted a site specific study of the fishes in Nunaluk Lagoon, along the Arctic coast of the Yukon Territory. Griffiths et al., (1976) conducted a similar study at Barter Island, and other investigators have conducted studies aimed at evaluating the importance of the Mackenzie (Percy, Eddy and Munro, 1974) and Colville (Kogl and Schell. 1975) river deltas to Arctic Ocean fish. Studies of overwintering fish in the Arctic have been directed towards the larger bodies of fresh water, including river deltas (Mann, 1975; Kogl and Schell, 1975) and spring areas or unfrozen pockets of river water under thick ice (Furniss, 1976; Craig and McCart, 1974). These studies have led to a much greater understanding of the habitat requirements and life histories of Arctic fishes; however, much remains to be understood of these fishes during their occupation of the shallow nearshore environments along the Beaufort Sea coast.

III. Study area

The OCS Beaufort Sea studies encompass an area between the eastern margin of Harrison Bay and Flaxman Island, a linear distance of approximately 102 miles (163 km) (Fig. 1). Centrally located along this stretch of coastline is Prudhoe Bay, the development and staging area for North Slope oil fields and the beginning of the Trans Alaska oil pipeline. A barrier island system consisting of raised pebble reefs extends intermittently along the entire length of the study area. These islands, lying from 1/2 to 12 miles (1-16 km) offshore, tend to prevent large quantities of fresh water and nutrients entering the Beaufort Sea from readily mixing with the cooler, more saline waters of the Arctic Ocean. They also shelter the mainland coastline from pack ice during the summer months, thus providing a low salinity, relatively ice free lagoon system inhabited by several species of anadromous, freshwater or marine fish throughout much of the year. Physical features of the mainland coastline include river deltas, spits, shallow bays, and narrow pebble or fine sediment beaches. Direct wave action and thermal erosion of permanently frozen shore banks produce local beaches composed of humus and decayed vegetation. Sharp variations in water temperatures and salinities were noted, both between short distances and with time, during the open water season (Table 1). Physiographic and environmental characteristics of the Beaufort Sea and coast are described by Namtvedt, et al. (1974) and State of Alaska, Division of Policy Development and Planning (1975).

IV. Sources, methods and rationale of data collection

A. Methods of capture and observations

Multifilament graduated mesh sinking gill nets measuring 125' x 6' and consisting of five 25' panels of 1/2" through 2 1/2" square mesh were used most extensively for capturing and sampling fish. Multifilament gill nets measuring 25' x 3' and consisting of single mesh sized from 1/2" to 1 1/2" were used for capturing fish during under-ice surveys.

Beach seines measuring 100' x 4' were used to sample fish in confined locations within small bays and lagoons, and along exposed beaches where water was sufficiently shallow to allow the seaward end of the seine to be maneuvered on foot.

Fyke traps were operated at two locations within Prudhoe Bay. Traps were 20' in length overall and were supported by five "D" shaped, 3/4" aluminum tube frames. Two troats measuring 10" in diameter were located at the first and third frames. Netting was 1/2" square mesh knotless nylon. The fyke traps were anchored in approximately 4' of water and were attached to shore by a 150' center lead. Two 25' x 4' wings funneled fish into the first frame.

A try trawl measuring 12' in width and constructed on 3/4" square measure knotted nylon mesh was used to sample fish offshore.

Hook and line sampling was employed to capture fish in river deltas and under the ice.

An underwater closed circuit television system was experimented with under the ice in the Sagavanirktok River Delta to determine its usefulness for detecting and observing overwintering fish occupying isolated pockets of unfrozen water. The system is sold by Hydro Products, Box 2528, San Diego, California. The operation employed the use of the following five components:

1. Underwater television camera with 12.5 mm optics.

2. High resolution 9" monitor

3. Gas discharge lamp ballast.

4. 250 watt Thallium iodide lamp.

5. Portable 115V power source.

Rotary wing aircraft were used for transporting field personnel and gear and for monitoring movements of fish along the coastline and into river deltas.

Arctic char over 200 mm in fork length, which were not sampled, were tagged with numbered spaghetti tags. Ciscos over 200 mm were tagged with Floy FD-67 internal anchor tags and those under 200 mm were "fin clipped" to indicate location of capture.

A YSI meter was used to determine water temperature, salinity and conductivity.

B. Processing of fish

Fish samples were preserved in 10% formalin or frozen and sent to Fairbanks via commercial airlines for further laboratory analysis. All samples were grouped by date and location. Fish were weighed to the nearest gram on a triple-beam balance. Fork lengths were measured to the nearest milimeter. Sex and stage of maturity were determined by examining gonads.

Fecundity counts were determined by displacing a volume of water with a known quantity of eggs. The total number of eggs was then calculated using the quantity of water displaced by the entire ova mass.

Arctic char, Arctic cod and fourhorn sculpins were aged by reading otoliths wetted in zylene. Scales were used to age all other species. Scales used for age determination were cleaned and impressed on 20 mil acetate. A Bausch and Lomb microprojector was used to read the scales.

Selected fish stomachs were slit and preserved in 10% formalin. The gut contents were later examined, sorted and identified.

C. Data management

All data collected thus far have been recorded on one of three different data collection forms of our own design. A preliminary data management plan for this project has been prepared and submitted. At the time of this writing, the OCSEAP data management format is in the final stages of completion and upon receipt our initial data batches will be submitted for computer punching and storage on magnetic tape.

V. Results

A. Species composition and relative abundance

Thirty sampling sites were established between Point Sorensen (long 148° 49' lat 70° 24') and Brownlow point (long 145° 53' 70° 10') in the eastern one-half of the study area (Fig. 2). An attempt was made to sample all of the dominant habitat types within this area. These include outer islands, nearshore islands, spits, points, bays, lagoons, and river deltas. Salinity, temperature, conductivity, and depth of water were recorded at each station.

A total of 1,264 fish representing six families and thirteen species has been captured. Following is a list of the species captured from Point Sorensen east to Brownlow Point:

Scientific name:	Common name:	Species Abbreviation:
Salmonidae		
Salvelinus alpinus	Arctic char	AC
Coregonus sardinella	least cisco	LCI
C. autumnalis	Arctic cisco	ACI
C. nasus	broad whitefish	BWF
C. pidschian	humpback whitefish	HWF
Thymallus arcticus	Arctic grayling	GR
Osmeridae		
Osmeris mordax	boreal smelt	BSM
Mallotus villosus	capelin	CAP
Gadidae		
Boreogadus saida	Arctic cod	ACD
Eleginus gracilis	saffron cod	SCD
Cottidae		
Myoxocephalus quadricornis	fourhorn sculpin	FSC
Pleuronectidae		
Liopsetta glacialis	Arctic flounder	AFL
Liparidae		
Liparis sp.	snail fish	LIP

Gill nets were the most extensively used method of capture; however, it became obvious late in the season that the use of gill nets was not conducive to the capture of gadioids, liparids, and the early life stages of salmonids. Fyke traps were subsequently stationed at several locations in Prudhoe Bay and proved more effective at catching the above mentioned species. Table 1 compares total catches of all species by the major types of gear used during the open water season.

Beach seines, effectively captured fish on shallow waters; however, adverse weather conditions and wave activity frequently prohibited their use. A shrimp try trawl was used in Prudhoe Bay. Transects were run for twenty minutes with the lead line of the trawl riding on the bottom. Larval and early life stages of Arctic cod, capelin and liparids dominated the offshore trawl catches.

The most widespread group of fishes captured along the coast were the salmonids. Arctic char were captured at 74% of the gill net stations. Arctic cisco and least cisco were captured at 65% and 37% of the stations respectively. Least cisco, however, were captured in the greatest abundance followed by Arctic cisco and Arctic char. Marine species represented 45% of the total catch.

Catch data showed a more widespread distribution for adult Arctic char and Arctic cisco than for other anadromous species. Arctic char and Arctic cisco were captured at all of the barrier island stations except sta 018-75, as well as along mainland sites. Least cisco showed a greater affinity for nearshore areas throughout the study area. Adult broad whitefish and humpback whitefish were only captured in and near the Kuparuk and Sagavanirktok River deltas. Immature broad whitefish, however, feed and migrate along the coastline inhabitating shallow bays and lagoons as far east as Foggy Bay; 100 miles (160 km) east of the Colville River, the only known spawning habitat for broad whitefish within the study area.

1. Arctic char

Arctic char, found along the entire northern coast of Alaska are the object of a traditional subsistence and expanding sport fishery. Several recent investigations have been conducted on the life history of Arctic char in major North Slope drainages (Yoshihara, 1972, 1973; Furniss, 1974, 1975; McCart and Craig, 1973 and Griffiths and Craig et al. 1975).

Anadromous Arctic char enter the Beaufort Sea at spring break-up and remain in the coastal waters until mid-July to September; at which time they again return to fresh water to spawn. The major Arctic char spawning drainage within the study area is the Sagavanirktok River.

Once in marine waters, char migrate and feed along the coastline and barrier island system. Tag recoveries made along the Beaufort Sea coast (Furniss, 1975) indicate that char from the Sagavanirktok River utilize the nearshore areas between Point Barrow and Barter Island.

One hundred and thirty-two Arctic char were captured throughout the study area, 86% of which were processed for meristic and life history data. Char ranged in size from 170 mm to 685 mm with a length mode occurring between 520 mm to 529 mm. The mean fork length of char in the study area was 427 mm (n=116).

Char varied from 3 to 12 years in age, with the majority between 7 and 9. Age-length frequency data agreed closely with that found by Yoshihara (1972) for Sagavanirktok River char. The sex ratio of Arctic char captured within the study area was skewed in favor of females. The female to male ratio of 116 Arctic char was 2:1. Similar disproportions in sex ratios of char were observed by Furniss (1975), Glova and McCart (1974), and others.

A total of 30 char stomachs was collected from fish taken at various locations within the study area. Of the guts collected, 36% were empty. The food items were identified and grouped by frequency of occurrence. No attempt was made to determine the "fullness" of the gut. Following is a list of the food items in decending order of frequency, omitting those stomachs that were empty:

Amphipods	95%
Cod (*B. saida*)	42%
Mysids	32%
Isopods	11%

The final analysis of food habits for all species has not been made at this time.

2. Arctic cisco.

Arctic cisco is one of the most common and widely distributed fish found between the Colville and Mackenzie rivers. They are utilized by local residents in the coastal subsistence fishery and in a small commercial fishery at the Colville River delta. Arctic cisco life history data are discussed by Craig and McCart (1975) and Hatfield, Stein et al. (1972).

Two hundred and twenty-two Arctic cisco were captured during the summer of 1975. Fork lengths ranged from 115 mm to 390 mm, with a mode occurring between 320 and 329 mm. The mean fork length for the total sample was 315 mm (n=158). Ages varied from 1 through 8 years. Seventy-two percent of the sample consisted of immature fish of age class VI. Only 3% of the sample was made up by age classes I, II and VIII. The female to male sex ratio of Arctic cisco was 0.9:1 (n=140).

Fifteen Arctic cisco stomachs were collected within the study area. All of stomachs examined contained food. Following is a list of the gut contents in descending order of frequency:

Mysids	60%
Amphipods	53%
vegetation/detritus	40%

3. Least cisco.

Least cisco were the most frequently captured coregonid within the study area. The absence of least cisco in catches along the outer barrier islands suggests that this species has a strong affinity for the brackish waters of the mainland coastline. Life history aspects of least cisco are described by Mann, 1974; Kendel et al., 1974; Percy et al., 1974 and others.

A total of 302 least cisco was captured during 1975. Fork lengths ranged from 105 mm to 360 mm with a mean of 263 mm (n=201). A length mode was observed between 310 mm and 319 mm. Ages varied from 1 through 11 years. Mature fish of age class VII or greater represented 55% of the sample. The ratio of females to male was 2.9:1 (n=192). Mature females collected in mid-August had egg diameters ranging from 1.0 mm to 1.3 mm and fecundities from 17,500 to 25,500.

Twelve least cisco stomachs have been examined from fish taken during 1975. Of the twelve, one was empty. Following is a list of the gut contents in descending order of frequency, omitting the empty stomach:

Mysids	91%
Amphipods	45%
Dipterans (adult)	27%
Isopods	9%
vegetation/detritus	9%

4. Broad whitefish.

Broad whitefish were distributed along the mainland coast between the Kuparuk River delta and the eastern boundary of Foggy Bay. Adult broad whitefish were only captured in the deltas of the Kuparuk and Sagavanirktok rivers; however, juveniles appear to forage along the coastline in areas further removed from the influence of these larger rivers.

Thirty-three broad whitefish were captured during 1975. Fork lengths ranged from 100 mm to 555 mm with a mean of 300 mm. Ages varied from 1 through 13 years. Age classes V through VIII were absent in the sample. Forty-five percent of the fish captured were in age class III (175 to 230 mm). The ratio of females to male was .86:1.

Four of the seven broad whitefish stomachs that were examined were empty. All of the remaining stomachs contained chironomid larva, and one also contained amphipods.

5. Humpback Whitefish.

Only three humpback whitefish were captured during 1975. The humpback whitefish were captured west of the Sagavanirktok River delta and were female potential spawners. The mean fork length was 433 mm and ages were 10, 12 and 13 years.

6. Fourhorn Sculpins.

The fourhorn sculpin is a common species throughout the study area. It occupies nearly all available habitats and was captured off several of the outer barrier islands, as well as in the low salinity waters of the major river deltas. Some life history aspects of fourhorn sculpin in the Beaufort Sea are discussed by Griffiths et al., (1975).

One hundred and twelve fourhorn sculpins captured in the study area ranged in size from 50 to 228 mm with a mean of 125 mm. A bimodal length distribution was observed with peaks occurring between 100 and 109 mm and 160 mm to 169 mm.

Ages of fourhorn sculpin varied from 1 through 7 years with the majority of fish captured in age classes II and III.

Sculpins within the study area feed primarily on immature isopods and amphipods. Two of eight guts examined contained the remains of juvenile Arctic cod (B. saida).

7. Arctic Cod.

Arctic cod, commonly referred to as "tom cod" by residents of the North Slope, are sought for both human consumption and for animal food by coastal residents. They also constitute a major food source for marine birds, mammals and Arctic fish. Cod were seasonally abundant in the study area; however, this variability in abundance may reflect the use of inappropriate capture gear throughout much of the open water season. Various life history aspects of Arctic cod are discussed by Quast (1970).

Four hundred and eighteen Arctic cod ranging in size from 20 mm through 193 mm were captured during 1975. Cod averaged 120 mm in fork length and ranged from young-of-the-year through 3 years of age. The female to male ratio of 119 cod was 1.7:1.

The examination of twelve stomachs indicated that cod feed primarily on mysids.

8. Smelt.

Two species of smelt were captured in the study area during 1975. Capelin were gill netted along exposed gravel beaches from Stump Island to Foggy Bay. Catches of smelt were low and sporadic. The presence of young-of-the-year capelin in trawl catches in Prudhoe Bay suggests they may spawn in the near vicinity.

A single Boreal smelt was captured in a fyke trap along the western border of Prudhoe Bay.

9. Liparids.

An as yet unidentified species of the genus Liparus was captured throughout Prudhoe Bay. Adults as well as young-of-the-year and early life stages were captured by bottom trawling in 8-10' of water.

10. Arctic flounder.

Only two Arctic flounder were captured during 1975. Both specimens were captured on western boundary of Prudhoe Bay by gill net.

VI. Conclusions

The following conclusions are based on information available to date:

A. Information dealing with the life histories of fish inhabiting the Beaufort Sea is minimal.

B. Species diversity within the study area is low.

C. The anadromous species within the study area migrate and concentrate along the shallow, nearshore water of the mainland coast.

D. The most frequently caught and wide ranging anadromous species within the study area are least cisco, Arctic cisco and Arctic char.

E. Adult broad and humpback whitefish seldom range beyond the influence of the largest streams draining into the study area.

F. The presence of larval Arctic cod, capelin and fourhorn sculpins suggests that these species spawn in the coastal marine or estuarine waters of the study area.

VII. Summary of 4th Quarter operations and future field work

The fourth quarter of this study was spent collating data obtained during the 1975 field season. Preparations for a fish resource computer format were concluded and field observations of activities in Prudhoe Bay were made monthly. The use of a closed circuit underwater television camera for identifying and observing overwintering fish was explored in December and this system is now being used in the Sagavanirktok and Kuparuk River deltas as well as in Prudhoe Bay.

Field studies will continue through break-up, at which time activities will be concentrated in the western half of the study area. A tag and recapture effort will be conducted to identify migration patterns and timing of fish moving along the coast as well as the seasonal abundance of fish at permanent capture sites. Life history and food habits information will be added to that obtained during 1975. An emphasis will be placed on the early life stages of fish species inhabiting the Beaufort Sea to aid in identifying and delineating spawning and rearing habitats.

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Table 1. Temperature, salinity and conductivity at capture stations between Point Sorensen and Brownlow Point, Beaufort Sea, 1975.

Station No*	West Longitude	North Latitude	Date of Capture	Water Temp. °C	Salinity, PPT	Conductivity μmhos
002-75	148° 32'	70° 22'	8/1	4°	12.0	12,000
003-75	147° 45'	70° 15'	8/2	5.5°	4.5	4,900
007-75	145° 56'	70° 10'	8/12	3.5°	13.5	14,000
008-75	146° 11'	70° 12'	8/12	4°	14.0	14,000
009-75	145° 53'	70° 10'	8/12	3.5°	15.0	14,000
010-75	146° 23'	70° 11'	8/12	5.5°	14.5	15,000
011-75	146° 45'	70° 10'	8/12	6.0°	14.0	14,500
012-75	146° 34'	70° 13'	8/12	6.0°	14.0	15,000
013-75	147° 03'	70° 09'	8/13	7.0°	13.0	14,000
014-75	147° 14'	70° 12'	8/13	9.0°	4.0	5,000
015-75	147° 04'	70° 18'	8/13	6.0°	15.0	15,000
016-75	147° 32'	70° 12'	8/13	9.5°	12.5	14,500
017-75	147° 46'	70° 13'	8/13	11.5°	11.0	13,500
018-75	147° 55'	70° 27'	8/14	2.0°	14.0	13,000
019-75	148° 14'	70° 28'	8/14	2.5°	13.0	12,000
020-75	148° 35'	70° 25'	8/14	5.0°	11.5	12,000
021-75	148° 38'	70° 24'	8/14	6.5°	10.0	11,000
022-75	148° 49'	70° 24'	8/14	7.0°	9.0	9,500
023-75	148° 32'	70° 22'	8/21	5.0°	13.5	14,000
024-75+	148° 18'	70° 19'	9/17	2.5°	14.5	14,000
025-75++	148° 18'	70° 19'	9/17	2.0°	15.5	14,500

Table 1. (continued)

Station No*	West Longitude	North Latitude	Date of Capture	Water Temp. °C	Salinity PPT	Conductivity μmhos
026-75	145° 56'	70° 10'	9/24	-1.0°	18.5	15,500
027-75	146° 11'	70° 12'	9/24	-1.0°	18.5	15,500
029-75	146° 25'	70° 14'	9/24	-1.0°	17.0	14,500
030-75	146° 45'	70° 10'	9/24	-1.0°	14.0	12,000
031-75	147° 10'	70° 13'	9/24	-1.0°	18.5	15,500
034-75	147° 34'	70° 12'	8/18	4.5°	9.0	9,500
038-75	148° 32'	70° 22'	8/21	5.0°	10.5	11,000
041-75	148° 32'	70° 22'	8/24	3.5°	17.0	17,000

* See Fig. 3 for mapped locations of capture stations.
\+ West side of old causeway.
++ East side of old causeway.

Figure 1. Map of the State of Alaska showing Beaufort Sea study area.

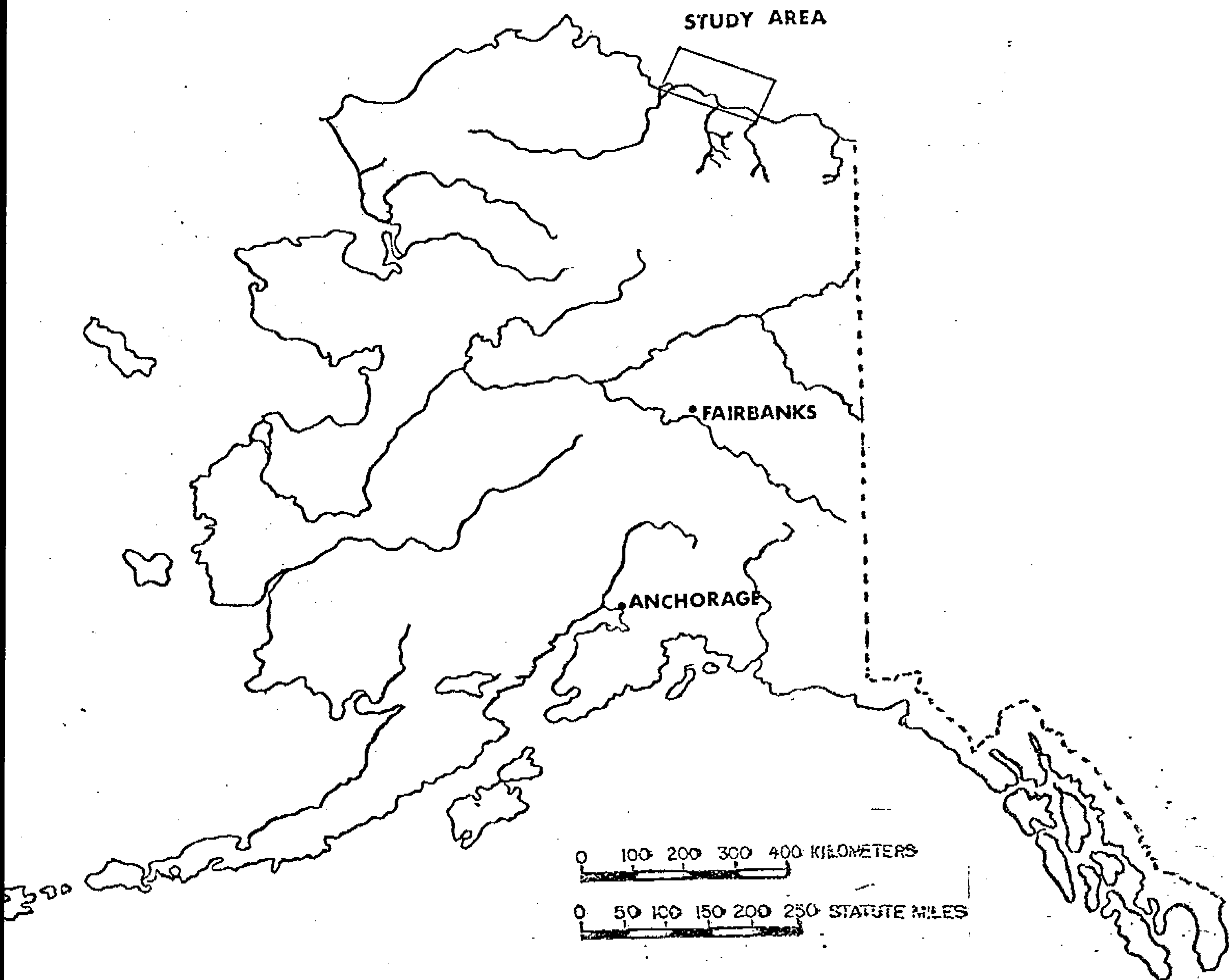
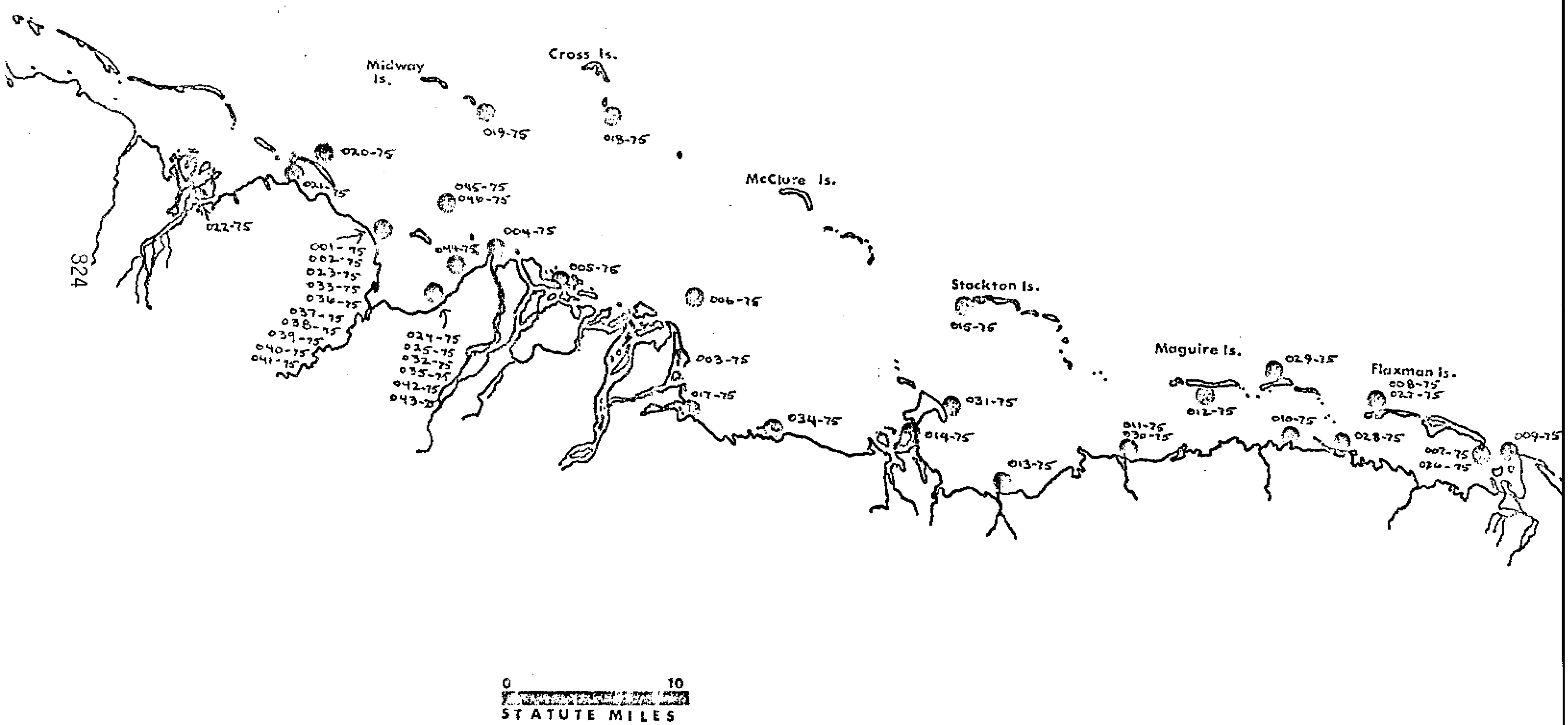


Figure 2. Capture site locations in eastern one-helf of study area, 1975.



QUARTERLY REPORT

Contract 03-5-022-65
Task Order Number 20
Quarter Ending -
June 30, 1976

THE DISTRIBUTION, ABUNDANCE, DIVERSITY, AND PRODUCTIVITY OF BENTHIC ORGANISMS IN THE GULF OF ALASKA

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June 30, 1976

QUARTERLY REPORT

I. Task Objectives

A. Inventory and census of dominant species.

B. Description of spatial and seasonal distribution patterns of selected species.

C. Provide comparison of dominant species distribution with physical, chemical, and geological factors.

D. Provide preliminary observations of biological interrelationships between selected segments of benthic marine communities.

GRAB PROGRAM

II. Field and Laboratory Activities

A. Ship schedules and names of vessels

1. 17-27 March 1976 *R/V Discoverer*
2. 30 March - 15 April 1976 *R/V Moana Wave*

B. Scientific Party

1. *R/V Discoverer*
Grant E. M. Matheke (Research Assistant and Graduate)
Elissa Mannheimer (Assistant)

2. *R/V Moana Wave*

H. M. Feder (Principal Investigator)
William Kopplin (Research Assistant)
Stephan Jewett (Research Assistant)

C. Methods

1. *R/V Discoverer* Cruise and Northeast Gulf data

a. 188 van Veen grab samples were collected at 43 stations, five samples were collected at all stations, unless weather and/or substrate conditions were unsatisfactory. Ten grab samples were taken at station 57. This station appears to occupy a transitional position between an outer group of shelf break stations and an inner group of stations. See Annual Report. At least one sediment sample was collected at each station for grain size analysis.

b. Laboratory analysis at the Marine Sorting Center, University of Alaska has been completed on 122 samples collected during the USNS *Silas Bent* cruise.

58 samples remain to be analyzed from that cruise. Samples collected on the *R/V Discoverer* Cruises of 10-16 October 1975, 23 Novenber - 8 December 1975 and 17-27 March 1976 remain to be analyzed.

c. A grab simulation program and Q mode factor analysis has been modified for use with the output file of the Marine Sorting Center Data List and the results of these analyses will be available shortly. Programs are presently being written for Principal Coordinates Analysis of the benthic survey data.

2. *R/V Moana Wave* and lower Cook Inlet data

a. A 0.1 m^2 van Veen grab was used on all stations. Five replicates were taken at most stations. Fewer grabs were taken at some stations due to inclement weather and/or unfavorable substrate composition.

b. A separate sediment sample was taken from one grab at each station for sediment size analysis.

c. A pipe dredge (14 x 36 inches) was used at each station when seas and weather permitted. This gear was used for two reasons: 1) To determine if the van Veen grab was adequately sampling deeper-situated species, and 2) To collect large numbers of clams for future age-growth work.

d. Laboratory analysis of the grab material will be accomplished at the Marine Sorting Center, University of Alaska. The pipe-dredge material will be examined in the Institute of Marine Science Biological Laboratory.

D. Sample Localities

1. Northeast Gulf

The following stations on the standard station grid of the Gulf of Alaska lease area were taken during the *R/V Discoverer* Cruise of 17-27 March 1976: 1-7; 25-33; 39-44; and 48-59. Additional stations were occupied to increase the coverage of the area: stations 60-63, 68, and 69. (For locations see Fig. 1)

2. Cook Inlet

Sixty-nine stations were occupied within Cook Inlet from the southern tip of Kalgin Island to the Barren Islands with a variety of gear (Table I).

TABLE I

OCEANOGRAPHIC OPERATIONS SUMMARY

Station #	Lat.	Long.	Depth	Operations
Ø1	60° 01.5'	152° 01'	51	G, PD, B
Ø2	60° 03.0'	151° 49'	34	G, PD, B
Ø3	60° 03.0'	152° 10'	49	G, PD, B
Ø4	59° 46.2	152° 55'	26	G, PD, B, HC
Ø5	59° 46.5'	152° 44.5'	36	G, PD, B
Ø6	59° 46.3'	152° 34.2'	35	G, PD, B
Ø7	59° 46.0'	152° 23.0'	90	G, PD, B
Ø8	59° 46.1	152° 13.0'	58	G, PD
10	59° 33'	153° 24'	25	G, B, HC, PD, AT
11	59° 33'	153° 14'	29	G, B, HC, BT, PD
12	59° 33'	153° 04'	37	G, B, HC, PD, BT
13	59° 34'	152° 54'	42	G, B, BT, PD
14	59° 34'	152° 44'	59	G, B
15	59° 33'	152° 34'	68	G, PD
16	59° 33'	152° 24'	59	G, B, PD
17	59° 09'	152° 04'	117	G, B, PD
18	59° 10'	152° 14'	133	G, B
19	59° 10'	152° 24'	100	G, B, PD
20	59° 10'	152° 34'	113	G, B
21	59° 10.3'	152° 45'	139	G, B
22	59° 10'	152° 54'	139	B, PD
23	59° 33'	152° 14'	61	G, B, PD, CD, AT
24	59° 33'	152° 04'	40	G, PD, AT
25	59° 33'	151° 54'	53	G, B, PD, CD
26	60° 03'	152° 21'	52	G, B, PD, HC
28	59° 55'	152° 10'	72	G, B, PD
29	59° 54.6'	152° 00'	40	G, B, PD
30	59° 34'	151° 44'	72	G, B, PD, HC
31	59° 22'	152° 10'	90	G, B, PD
32	59° 22.1	152° 22.2'	82	G, B, PD
33	59° 21.9'	152° 34.5'	71	G, B, PD
34	59° 22.2	152° 22.2'	78	G, B, PD
36	60° 20'	151° 36.9'	31	G, B, PD
37	60° 20'	151° 46'	27	G, B, PD

TABLE I

OCEANOGRAPHIC OPERATIONS SUMMARY

(continued)

Station #	Lat.	Long.	Depth	Operations
40	59° 22.7'	153° 07.3'	53	G, PD
41	59° 15.8'	153° 20'	42	G, PD
42	59° 15.5'	153° 33'	35	G, B, PD, AT
43	59° 15.4'	153° 40'	31	G, PD, AT
44	59° 10'	153° 23.7'	35	G
45	59° 10'	153° 13.5'	67	B, PD
46	59° 10'	153° 04'	102	G, B, PD
52	59° 40'	152° 00'	34	G, PD
53	59° 37.6'	151° 50'	32	AT, CD
55	59° 00'	153° 09.4'	137	G, AT, PD
56	59° 00'	153° 00'	155	G, AT, PD
58	59° 00'	152° 40'	151	G, AT, PD
59	59° 00'	152° 30'	152	G, PD
60	59° 08'	152° 20'	116	G, PD
61	59° 34'	153° 10'	35	OT
62	59° 37'	153° 02'	35	OT
63	59° 35'	153° 05'	36	OT
64	59° 30'	153° 15.7'	33	OT
65	59° 26.2'	153° 19'	33	OT
69	59° 41.6'	151° 08.9'	59	OT

OT = Otter trawl
AT = Agassiz trawl
BT = Beam trawl
CD = Clam dredge
PD = Pipe dredge
G = van Veen grab
HC = Haps Corer
B = Niskin bottle/salinity/temp.

III. Results

A. Northeast Gulf

1. Additional material is now being processed at the Sorting Center (see Methods).

   Cluster analyses for grab data are in progress with new programs being tested.

B. Cook Inlet

1. In-depth, intensive sampling was accomplished on many of these stations with gear chosen to sample the infauna quantitatively and qualitatively and the epifauna qualitatively.

2. A sediment sample was taken at each of the benthic stations for size-frequency analysis.

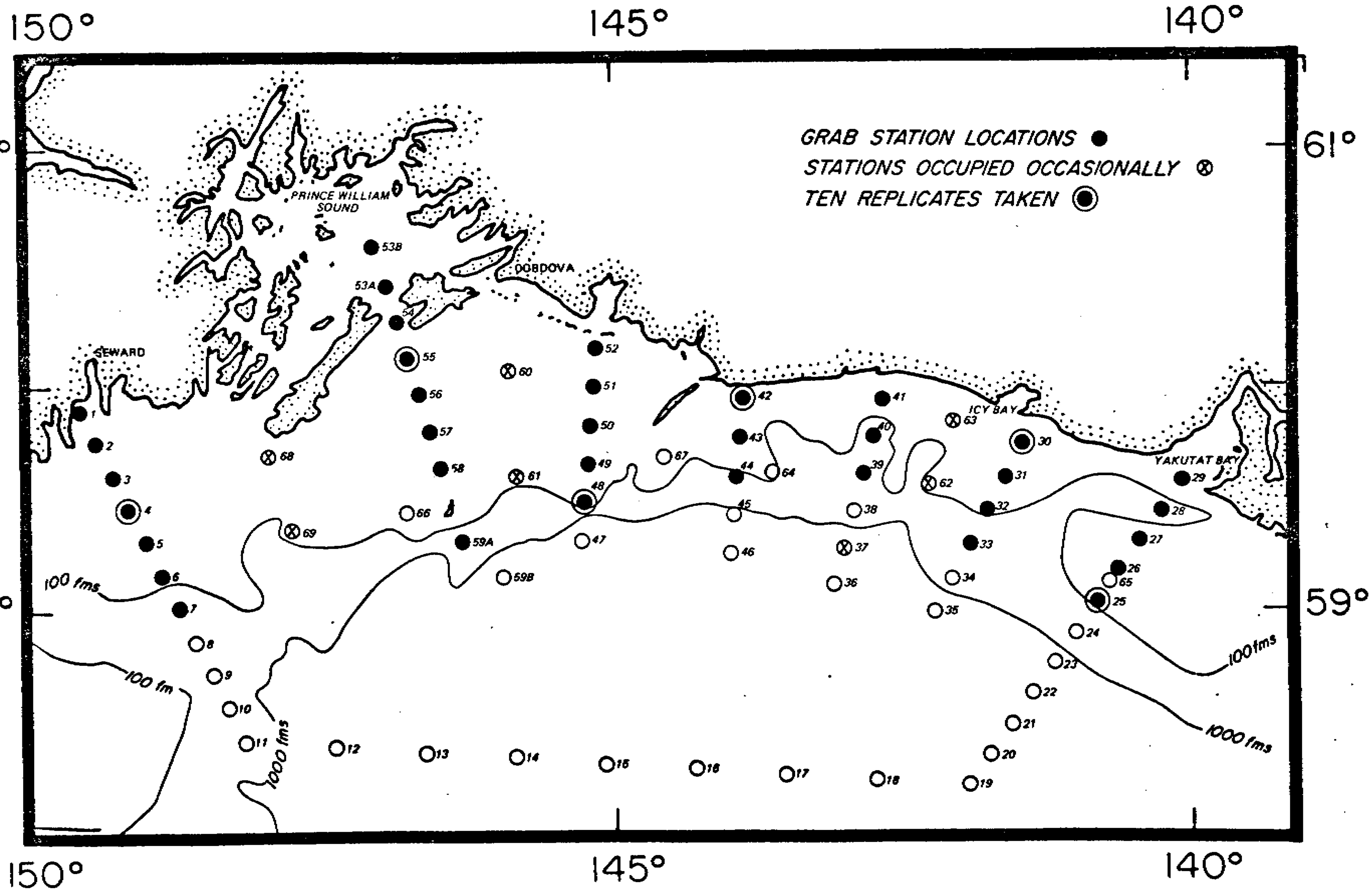
3. Qualitative notes were maintained for the horizontal dispersion of volcanic debris found at some of the stations.

4. Detailed field notes were maintained, and data compiled for the development of a preliminary (although tentative in many of its taxonomic aspects) report shortly after the completion of the cruise.

5. Five species of clams, each of which demonstrated distinct annuli that should make it possible to accomplish age and growth history studies, were found. The species were tentatively identified as *Clinocardium nuttallii*, *Glycymeris subsobsoleta*, *Cardita* (=*Cyclocardia*), *Tellina nuculoides*, and *Macoma* sp. The clam *Tellina* was extremely abundant at the mouth of Kachemak Bay.

6. A number of critical biological areas were identified - most important ones appeared to be adjacent to the Barren Islands (large numbers of very young *Chionoecetes bairdi*).

7. The location of aggregations of species of biological interest was extremely valuable, and these aggregations suggest good regions for the development of monitoring stations. Some of these species with rather restricted distributions, but with large numbers of individuals at specific stations, are the horse mussel *Modiolus* sp., the sand dollar *Dendraster* sp., the sea urchin *Strongylocentrotus* sp., the snail *Fusitriton oregonensis*, several species of hermit crabs, *Neptunea lyrata*, several species of crangonid shrimps, several species of pandalid shrimps, *Nuculana* sp., the crab *Oregonia gracilis*, and the crab *Hyas lyratus*.



GRAB STATION LOCATIONS
STATIONS OCCUPIED OCCASIONALLY
TEN REPLICATES TAKEN
PRINCE WILLIAM SOUND
CORDOVA
SEWARD
ICY BAY
YAKUTAT BAY
100 fms
100 fm
1000 fms
100 fms
1000 fms
150°
145°
140°
61°
59°

8. A number of quantitative stations were occupied, and can probably be used to integrate with the network of quantitative stations already occupied in the Gulf of Alaska in our other studies there.

9. Grab and pipe dredge material is being processed at present (see Methods).

IV. Preliminary Interpretation of Results

The results of cluster analysis of all the data collected from July 1974 to May 1975 show the same basic trends delineated by the preliminary analyses discussed in the Annual Report. Two major station groups were delineated. One was composed of stations located near the shelf break which characteristically had sediments of a larger grain size than other stations. The other group of stations was composed of stations located closer to shore and characterized by fine sediments. Stations located geographically between these major station groups appeared to occupy an intermediate position between them in terms of species composition and abundance.

V. Problems Encountered and Comments

None. The two ships used this past quarter, *R/V Discoverer* and *R/V Moana Wave*, were excellent and the officers and crew of these vessels were most effective.

<u>TRAWL PROGRAM</u>

II. Field and Laboratory Activities

A. Ship schedules and names of vessels

1. March 30 - April 15, 1976
2. *R/V Moana Wave*

B. Scientific Party

Howard M. Feder (Principal Investigator)
William Kopplin (Research Assistant)
Stephen Jewett (Research Assistant)

C. Methods

a. Thirty-minute tows were made with beam, otter and Agassiz trawls. Invertebrate samples were sorted, weighed and/or counted, identified or assigned a type number and preserved for later examination.

b. Samples were returned for examination at the University of Alaska. Laboratory analysis has not been completed as yet.

D. Sample Locations

Trawling activities were accomplished at the same stations used for grab and pipe-dredge activities.

III. Results

Presently the benthic invertebrates and vertebrates collected by trawl from Cook Inlet are being processed and evaluated. This involves confirming or identifying specimens not assessed in the field. Preliminary identifications were conducted on shipboard laboratories in conjunction with black and white and color photographs.

IV. Preliminary Interpretation of Results

See Annual Report. No new interpretations at present.

V. Problems Encountered

No serious problems. I would recommend that some type of non-skid material be placed on the after deck of the *R/V Moana Wave* if this vessel is to be used next winter.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 20 R.U. NUMBER: 281

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

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	
Silas Bent Leg I #811	8/31/75	9/14/75	9/30/76	None	
Discoverer Leg IV #812	10/8/75	10/16/75	(a)	None	
North Pacific	4/25/75	8/7/75.	None	submitted	
Discoverer #816	11/23/75	12/2/75	(b)	None	
Contract #03-5-022-34	Last	Year	submitted		
Moana Wave	3/30/76	4/15/76	8/1/76		
Discoverer 001	3/17/76	3/27/76	(c)		

Note: [1] Data Management Plan and Data Formats have been approved and are considered contractual.

(a) Only samples for Kodiak area were processed. These data will be submitted with L.C.I. data from Moana Wave cruise.

(b) Selected samples being sorted. Data will be submitted along with Silas Bent data.

(c) Selected samples will be processed in FY '77.

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 10
Quarter Ending -
30 June 1976

SUMMARIZATION OF EXISTING LITERATURE AND UNPUBLISHED DATA ON THE DISTRIBUTION, ABUNDANCE AND PRODUCTIVITY OF BENTHIC ORGANISMS OF THE GULF OF ALASKA AND BERING SEA

Dr. Howard M. Feder
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

A. A summary of existing data, published and unpublished, for the Gulf of Alaska and the Bering Sea.

B. Access to and loan of archived material from both of the above areas.

C. Workup of archived data and material.

II. Field and Laboratory Activities

Methods:

1. Literature survey using standard library search techniques has been undertaken. Plans are underway to utilize literature searching organizations: some correspondence will be initiated.

2. Correspondence will be initiated to locate archived data and material.

III. Results

A bibliography has been essentially compiled for the Gulf of Alaska and Bering Sea. At the present time, the Chukchi Sea literature is being added.

IV. Preliminary Interpretations

Not applicable.

V. Problems Encountered

Not applicable.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 10 R.U. NUMBER: 282/301

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

Progress on this study has indicated that there is little data in a form suitable for submission using available EDS Format (Benthic Organisms). It is suggested that the following information products be accepted; (1) key word bibliography (available in next quarter); (2) distribution maps, which would be available as they are produced; however, the total applicable information available could not be converted into this media prior to December 1976.

The bibliography will be ready for submission on or about July 31, 1976. The distribution maps will be started as soon as the proper base maps are received from OCSEAP.

The delay on the bibliography is due to the addition of information for the Chukchi Sea. We await approval of a funding request for this additional work.

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 21
Quarter Ending -
30 June 1976

FOOD AND FEEDING RELATIONSHIPS IN THE BENTHIC AND DEMERSAL FISHES OF THE GULF OF ALASKA AND BERING SEA

Dr. Ronald L. Smith
Associate Professor of Zoology
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

Objectives for this quarter include acquisition of additional specimens from the Bering Sea for stomach analysis and continuation of analyses of existing collections.

II. Field and Laboratory Activities

Specimens were collected on Legs I and II of the *Miller Freeman* cruise in the Bering, Spring, 1976. Further analyses of stomach contents from existing collections were performed.

III. Results

Additional collections completed this quarter include:

sturgeon poacher	212
capelin	181
Pacific cod	149
pollock	148
Greenland halibut	140
Alaska plaice	116
rocksole	114
herring	104
wattled eelpout	99
longnose dab	86
Glymnocanthus sp.	73
rainbow smelt	63
yellowfin sole	60
warty poacher	59
unidentified cottids	50
arrowtooth flounder	34
sandfish	30
blackfin eelpout	30
searcher	31
Triglops	29
halibut	28
starry flounder	20
other species	70

Sorting, preliminary analysis and identifications have been completed on approximately 500 arrowtooth flounders, 250 rex sole, and 250 pollock. Work has begun on the Greenland halibut.

IV. Problems Encountered

Our supplies of formalin, buffer and isopropyl alcohol have been exhausted. Without additional supplies, curation of material presently on hand will not be possible.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 21 R.U. NUMBER: 284

PRINCIPAL INVESTIGATOR: Dr. R. L. Smith

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			
North Pacific	4/25/75	8/7/75	(a)			
Miller Freeman	8/16/75	10/20/75	(a)			
Miller Freeman	3/76	6/76	(a)			

Note: [1] Data Management Plan has been approved and made contractual. We await receipt and approval, by all parties, of necessary Data Format.

(a) Selected species will be examined, it is unlikely that any data will be submitted prior to FY '77.

QUARTERLY REPORT

RU # 285

Contract 03-5-022-56
Task Order Number 22
Quarter Ending -
30 June 1976

PREPARATION OF ILLUSTRATED KEYS TO SKELETAL REMAINS AND OTOLITHS OF FORAGE FISHES

Dr. James Morrow
Professor of Zoology
Department of Biology
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

To prepare illustrated keys to the skeletal remains and otoliths of the forage fishes of the Gulf of Alaska/Bering Sea.

II. Field and Laboratory Activities

A. Field Activities

Material from Leg I of the *Miller Freeman* Bering Sea cruise was received in good condition. Otoliths have been removed from all specimens. X-ray photographs were taken of approximately 25 species from this collection. They have been filed for possible future use in studies of skeletal structures. To date, trawl material from Legs II and III of the *Miller Freeman* Bering Sea cruise has not been received.

On 16 June the principal investigator travelled to Long Beach, California, and spent three days working with Dr. J·hn Fitch. Dr. Fitch provided a great deal of constructive criticism of the otolith key, as well as information on important characteristics of otoliths. Study of his collection was most rewarding. Dr. Fitch has agreed to lend otolith material to supplement that taken from OCSEAP trawl catches and to contribute to the revised version of the key. On the return trip to Fairbanks, one day was spent in Seattle with Ken Waldron, Jack Lalanne and Hiro Kajimura of NMFS, discussing the otolith key. Dr. Kajimura lent otoliths of 15 species which either were not present or were but poorly represented in our collection.

B. Laboratory Activities

See Results.

III. Results

A preliminary version of the key to otliths was completed. At this time, the key includes 65 species. More will be added as additional material becomes available. Copies of the key were mailed on 14 May to the OCSEAP Juneau Project Office and to several principal investigators, with a request that concerned principal investigators use the key and provide comments and criticisms for its improvement.

Pen and ink drawings of the otoliths of all species available at the present time have been prepared and will be included in the final version. Additional drawings will be made of new material as it becomes available.

IV. Problems Encountered

None.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 22 R.U. NUMBER: 285

PRINCIPAL INVESTIGATOR: Dr. J. E. Morrow

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

QUARTERLY REPORT

RU # 318
Contract 03-5-022-56
Task Order Number 9
Quarter Ending -
30 June 1976

PREPARATION OF ILLUSTRATED KEYS TO SKELETAL REMAINS AND OTOLITHS OF FORAGE FISHES

Dr. James Morrow
Professor of Zoology
Department of Biology
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

To prepare illustrated keys to the skeletal remains and otoliths of the forage fishes of the Beaufort Sea.

II. Field and Laboratory Activities

A. Field Activities

On 16 June the principal investigator travelled to Long Beach, California, and spent three days working with Dr. John Fitch. Dr. Fitch provided a great deal of constructive criticism of the otolith key, as well as information on important characteristics of otoliths. Study of his collection was most rewarding. Dr. Fitch has agreed to lend otolith material to supplement that taken from OCSEAP trawl catches and to contribute to the revised version of the key. On the return trip to Fairbanks, one day was spent in Seattle with Ken Waldron, Jack Lalanne and Hiro Kajimura of NMFS, discussing the otolith key. Dr. Kajimura lent otoliths of 15 species which either were not present or were but poorly represented in our collection.

B. Laboratory Activities

See Results.

III. Results

A preliminary version of the key to otliths was completed. At this time, the key includes 65 species. More will be added as additional material becomes available. Copies of the key were mailed on 14 May to the OCSEAP Juneau Project Office and to several principal investigators, with a request that concerned principal investigators use the key and provide comments and criticisms for its improvement.

Pen and ink drawings of the otoliths of all species available at the present time have been prepared and will be included in the final version. Additional drawings will be made of new material as it becomes available.

IV. Problems Encountered

None.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 9 R.U. NUMBER: 318

PRINCIPAL INVESTIGATOR: Dr. J. E. Morrow

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

QUARTERLY REPORT

Contract 03-5-022-56
Task Order Number 16
Quarter Ending -
30 June 1976

LITERATURE SEARCH ON DENSITY DISTRIBUTION OF FISHES OF THE BEAUFORT SEA

Dr. James Morrow
Professor
Department of Biology
University of Alaska
Fairbanks, Alaska 99701

June 30, 1976

QUARTERLY REPORT

I. Task Objectives

To prepare a comprehensive annotated bibliography of the density and distribution of the fishes of the Beaufort Sea.

II. Field and Laboratory Activities

A. Field Activities

Ms. Pfeiffer, our bibliographer has spent the last two months visiting libraries in Juneau, Alaska and Seattle, Washington. She has searched in the libraries of the Alaska Department of Fish & Game, the U.S.F.& W.S., State of Alaska, and the University of Washington.

B. Laboratory Activities

No activity this quarter.

III. Results

No results for this quarter. When Ms. Pfeiffer returns, the information she has gathered will be integrated with existing information and the final bibliography will be compiled.

IV. Problems

No problems were encountered this quarter.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: June 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 16 R.U. NUMBER: 348

PRINCIPAL INVESTIGATOR: Dr. J. E. Morrow

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

QUARTERLY REPORT

Contract #: 03-5-022-67-TA9 #4
Research Unit #: 349
Reporting Period: 1 April 1976 - 30 June 1976
Number of Pages: 3

Alaskan Marine Ichthyoplankton Key

T. Saunders English
Department of Oceanography
University of Washington
Seattle, Washington 98195

1 July 1976

Departmental Concurrence:

Francis A. Richards
Associate Chairman for Research

REF: A76-58

I. Task Objectives

The task of primary emphasis is A25b--to develop an ichthyoplankton key to aid identification of the ichthyoplankton occurring in Alaskan waters. Other objectives are to:

A. Locate and describe archived samples,

b. Make recommendations for a field sampling program,

C. Participate in sorting, identification, and analysis.

II. Field or Laboratory Activities.

Most of the activity this quarter has been to identify ichthyoplankton from samples collected in Lower Cook Inlet, Prince William Sound, and the Gulf of Alaska. This material will be used when the final key to ichthyoplankton is constructed. A reference collection containing life history stages of the commercially valuable fish species is being compiled as the samples are sorted and identified.

Bibliographic activities continue with the acquisition of new reference material, especially from the Canadian Beaufort Sea project. New references are given on pp. 2-3.

Information and pictures of fish eggs and larvae from 98 fish families have been obtained. This material, along with information already available, will be used to construct a picture key to the fish eggs and larvae in Alaskan waters.

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Contract 03-5-022-81
Research Unit 356
April 1 to June 30, 1976
7 pages

QUARTERLY REPORT

LITTORAL SURVEY OF THE BEAUFORT SEA

Principal Investigator, A. C. Broad

Western Washington State College

June 30, 1976

I. TASK OBJECTIVES: Work continued on our Work Statement Task 5, data analysis and identification of collected material. On April 23-25, the Principal Investigator and the Programmer met in Juneau with Representatives of R. U. 79, N.O.D.C., A.D.F.G., and others to integrate data collection and reporting. On May 10-17, the Laboratory Supervisor was in Fairbanks to coordinate with personnel of the University of Alaska Museum on species identification. On June 4, we were informed that our proposal to extend our research to include the Chukchi Sea (Reconnaisance Characterization of the Littoral Biota, Beaufort and Chukchi Seas) was funded in the amount of $70,000. On June 9, the amount of $10,473 (available after July 1) was added to this. Plans and preparations for the 1976 field season were largely completed by the end of the quarter.

II. FIELD OR LABORATORY ACTIVITIES:

A. Ship or field trip schedule: None.

B. Scientific Party:

1. Principal Investigator

   A. C. Broad -- on salary June 15-30.

2. Laboratory Supervisor

   Helmut Koch -- May 1 - June 30.

3. Programmer:

   Gregg Petrie -- April 1 - June 30; 8 hrs/week.

4. Laboratory Assistants

   Helmut Koch -- April 1-30; 20 hrs/week.

   Mark Bertness -- April 1 - June 30; 25 hrs/week.

Susan Broad -- April 15 - June 30; 20 hrs/week.

Marilyn Hamilton -- April 15 - June 15; 10 hrs/week.

Walter Michener -- April 15 - June 30; 15 hrs/week.

David Cormany -- April 15 - June 30; 8 hrs/week.

Paul Cassidy -- April 26 - June 14; 4 hrs/week.

C. Methods

1. Laboratory analysis (sorting and identification) of samples collected in 1975 continued.

2. Integration of data management system with R. U. 79 was essentially completed. The task of re-reporting our 1975 data in the revised format remains.

D. Sampling localities -- not applicable.

E. Data collected or analyzed

1. No data collected

2. The 1975 samples were 80% analyzed at the end of the quarter.

3. No tracklines were run.

III. RESULTS: A tentative species list, based on about 80 percent analysis of the 1975 Beaufort Sea samples of marine invertebrates follows.

IV. INTERPRETATION OF RESULTS: No new interpretation of results is made.

V. PROBLEMS ENCOUNTERED: We continue to be troubled by the unanticipated magnitude of the task of sorting samples, but have made substantial progress by employing more laboratory assistants. We are, none the less, behind schedule in this task.

VI. ESTIMATE OF FUNDS EXPENDED[1]

Budget category	Amount Budgeted	Amount Spent	Amount Remaining
Salary, Principal	14,065	5,771	8,294
Salary, Associates	21,463	8,290	13,173
Salary, other	31,000	22,000	9,000
Student work-study	--	52	52
Fringe	8,875	3,798	5,077
Travel	9,000	7,026	1,974
Card Punch	600	209	391
Supply	--	834	834
Overhead	8,500	4,063	4,437
	$93,503[1]	$52,043	$41,460[1]

[1]Based on original contract for Littoral Survey of the Beaufort Sea only. This contract was increased by $80,473 to permit extension into the Chukchi Sea during the Summer of 1976.

Tentative Species List

Amphipoda

Acanthostephia behringiensis
Acanthostephia incarinata
Rozinante sp. (fragilis?)
Monoculodes sp.
Monoculodes packardi (?)
Monoculodes schneideri (?)
Monoculodes minutus (?)
Monoculopsis longicornis
Aceroides latipes
Paroediceros propinquus
Paroediceros lynceus
Parathemisto libellula
Parathemisto abyssorum
Oediceros saginatus
Onisimus botkini
Onisimus affinis
Pseudalibrotus litoralis
Pseudalibrotus glacialis
Gammarus setosa
Gammarus locusta (?)
Gammarus wilkitzkii (?)
Gammarus zaddachi
Pontoporeia affinis
Pontoporeia femorata
Gammaracanthus loricatus
Apherusa glacialis
Apherusa megalops
Hyperia medusarum hylstrix
Pseudalibrotus birulai (?)

Tentative Species List (continued)

Oligochaetes - Enchytraeidae Tubificidae

Halacaridae - Marine mites

Rhyncocoela - Nemertea

Tardigrada - Hybsibius sp.

Porifera - Hymeniacidon assimilis
Leuconia ananas
Haliclona gracilis

Priapula - Halicriptus spinulosus
Priapulus caudatus

Foraminifera - Ammotium cassis

Diplostraca - Daphnidae; Daphnia sp. (?)

Notostraca - Triops sp. (?) Apus sp. (?)

Anostraca - Artemia sp. (?)

Ostracoda - Ostracods

Copepoda - Calanoida Harpacticoida
Limnocalanus sp.
Eurytoma canadensis

Mysidacea - Mysis relicta

Euphausiacea - Thysanoessa raschi

Hydrozoa - Operularella c.f. O. lacerata (See also p. 6)

Tentative Species List (continued)

Collembola - marine springtails

Chironomidae - Paraclunio alaskensis
Saunderia sp.

Paguridae - Paguridae zoea

Ascidiacea - Molgula griffithsii

Hydrozoa - Bougainvillidae - Perigonimus yoldia-arcticae
Tubulariidae - Tubularia (indivisa?)

Cumacea - Diastylis sp.

Isopoda - Saduria entomon

Chaetognatha - Sagitta elegans

Ectoprocta - Eucratea loricata

Nematoda - marine nematodes

Polychaeta - Etenone longa
Scolecolepides arctius
Capitellidae
Pygospio sp. (elegans?)
Spio mimus
Sphaerodoropsis minutum
Fabricia sp.
Ampharete vega
Spirorbis sp.

Gastropoda - Amauropsis purpurea
Neptunea heros
Plicifusus kroyeri
Beringius (?) sp.
Colus sp.

Tentative Species List (continued)

Pelecypoda - Astarte borealis
Astarte montegui
Liocyma fluctuosa
Cyrtodaria kurriana
Musculus discors

Teleostei - Gadidae
Boreogadus saida

Cottidae
Myoxocephalus quadricornis
Myoxocephalus sp.

ALGAE

Stictyosiphon tortilis

Delesseriaceae

Laminaria sp.

Enteromorpha sp.

Ulothrix sp.

Pylaiella sp.

Rhodomenia sp.

QUARTERLY REPORT

Contract #: 03-5-022-67-TA2 #4
Research Unit #: 359
Reporting Period: 1 April 1976 - 30 June 1976
Number of Pages: 87

Beaufort Sea Plankton Studies

T. Saunders English
Rita A. Horner

Department of Oceanography
University of Washington
Seattle, Washington 98195

30 June 1976

Departmental Concurrence:

Francis A. Richards
Associate Chairman for Research

REF: A76-59

I. Task Objectives

The two tasks of primary emphasis are A-23 and A-24: to determine seasonal density distribution and environmental requirements of principal species of phytoplankton, zooplankton, and ichthyoplankton, and to determine seasonal indices of phytoplankton production, including the sea ice flora. The task of secondary emphasis is to summarize the existing literature, unpublished data, and archived samples.

II. Field or Laboratory Activities--Prudhoe Bay

A. There has been no field program this quarter.

B. Laboratory activities.

The primary productivity samples collected at Prudhoe Bay in September 1975 have been counted and the primary productivity calculated.

C. Methods.

Filters containing the radioactive phytoplankton were analyzed using a Packard Tri-Carb Liquid Scintillation Spectrometer with Aquasol (New England Nuclear) as the scintillation cocktail.

Calculations were done according to the equations in Strickland and Parsons (1968).

D. Sample localities.

Sample localities are given in Figs. 1 and 2.

E. Data analyzed.

Sixty-eight (68) primary productivity samples were analyzed.

III. Results

Results of the primary productivity experiments are given in Tables 1 and 2 along with temperatures, salinity, nutrient and chlorophyll *a* concentrations. Standing stock as total number of cells per liter is given for Prudhoe Bay stations (Table 2).

Primary productivity ranged from 0.01-2.97 $mgCm^{-3}hr^{-1}$; standing stock ranged from 6.8-742.8 x 10^3 cells per liter.

IV. Preliminary Interpretation of Results

In general, the highest primary productivity is near the bottom and inside Prudhoe Bay. This is in contrast to that reported by Horner et al. (1974) where the highest productivity occurred in deeper water out near the barrier islands. Chlorophyll *a* and primary productivity were not always high at the same station. Variations in the numbers and kinds of

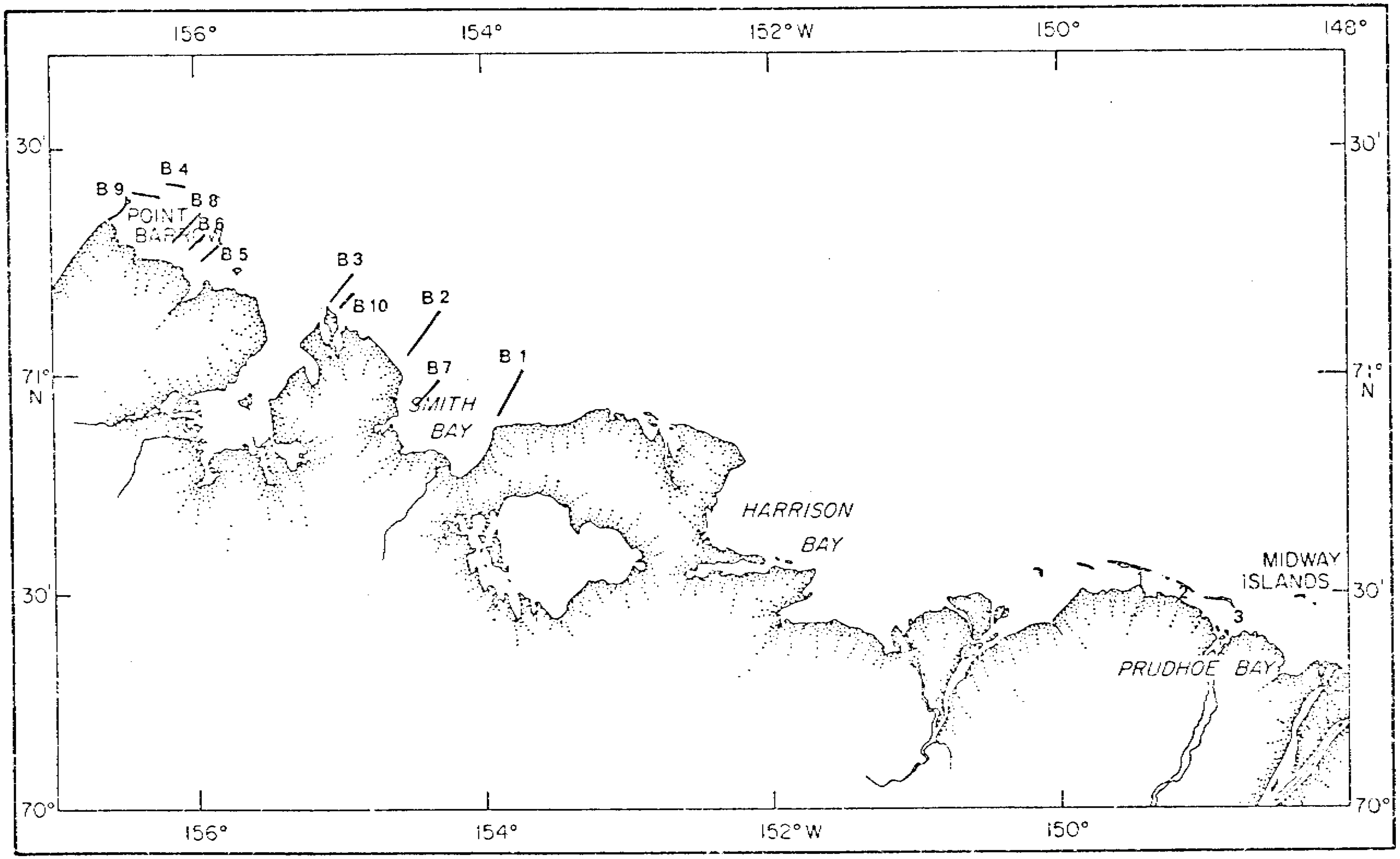

Fig. 1. Transects, August 1975, Prudhoe Bay stations 1-3

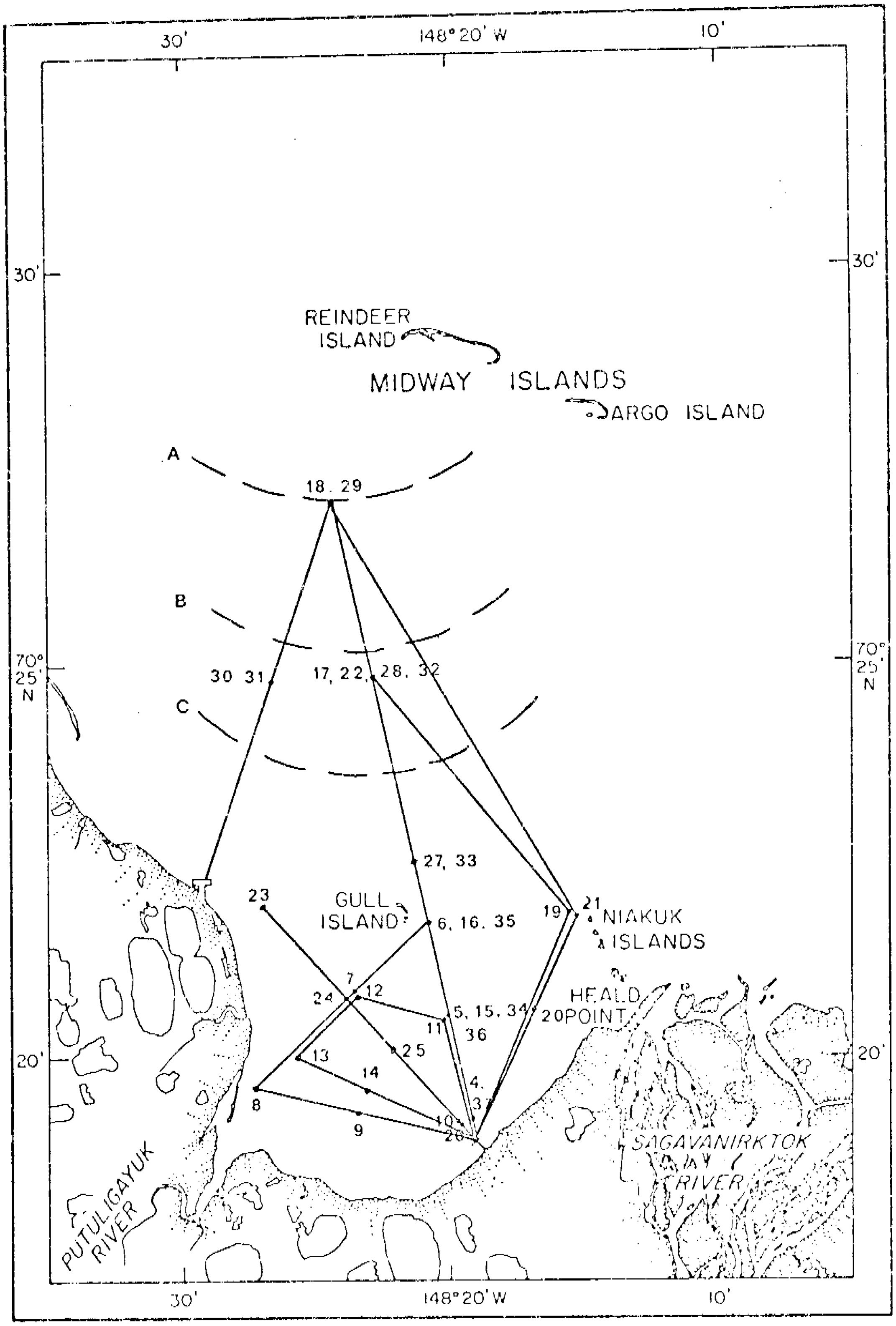

Fig. 2. Station locations, Prudhoe Bay, September 1975. A is ice edge 10 Sep; B is ice edge 11 Sep; C is ice edge 14 Sep.

Table 1. Temperature, salinity, nutrient concentrations, chlorophyll *a* concentrations, and primary productivity at the Barrow transects during August 1975

Date	Station Number, Depth (m)	T (°C)	S °/oo	PO_4	Si	NO_3	NO_2	NH_3	chl *a* (mg m^{-3})	primary productivity (mgC$m^{-3}hr^{-1}$)
15 Aug 75	B-1-0	3.0	16.13	0.38	6.82	0.00	0.03	0.00	0.42	0.06
15 Aug 75	B-2-0	3.0	23.54	0.18	2.89	0.02	0.03	1.06	0.43	0.20
15 Aug 75	B-3-0	3.0	30.28	0.33	5.50	0.01	0.02	0.21	0.21	0.15
15 Aug 75	B-4-0	3.0	12.85	0.82	14.78	2.17	0.10	0.63	0.46	0.28
27 Aug 75	B-5-0-S[a]	0.0	13.07	0.35	3.55	0.12	0.08	0.63	0.29	0.22
	B-5-0-E	0.0	26.85	0.24	2.45	0.16	0.07	0.63	0.30	0.84
27 Aug 75	B-6-0-S	-0.2	20.83	0.43	4.89	0.05	0.01	1.06	0.12	0.44
	B-6-0-E	-0.2	b	0.39	4.95	0.04	0.02	0.21	0.35	
27 Aug 75	B-7-0-S	3.0	24.94						1.01	
	B-7-0-E	3.0	24.49							
27 Aug 75	B-8-0-E	-0.5	31.79	0.40	5.00	0.10	0.02	0.63	0.36	0.73
27 Aug 75	B-9-0-S	0.5	22.56	0.17	2.01	0.19	0.01	0.21	0.22	0.35
	B-9-0-E	0.5	25.91	0.27	3.49	0.10	0.04	1.06	0.24	0.74
29 Aug 75	B-9-0-S	1.8	24.87	0.26	1.41	0.06	0.05	0.84	0.44	0.87
	B-9-15-S	1.8	25.45	0.27	2.16	0.15	0.07	1.50	0.70	1.01

[a] S indicates samples collected at the start of the transect; E indicates samples collected at the end of the transect.

[b] No salinity sample was collected at the end of the transect, therefore productivity was not calculated.

Table 2. Temperature, salinity, nutrient concentrations, chlorophyll a concentrations, primary productivity, and standing stock at Prudhoe Bay stations during September 1975

Date	Station Number Depth (m)	T (°C)	S°/oo	PO_4	Si	NO_3	NO_2	NO_3	chl a (mg m^{-1})	primary productivity ($mgCm^{-3}hr^{-1}$)	Total Number of Cells/liter (x 10^3)
8 Sep 75	P-10-0	0.8	17.19	0.22	4.72	0.20	0.05	0.85	0.88	0.15	46.0
	P-10-6	0.8	13.41	0.29	5.65	0.35	0.05	0.84	0.63	0.12	
8 Sep 75	P-11-0	-0.8	12.57	0.47	20.20	1.19	0.11	1.82	0.44	0.02	96.0
	P-11-7	-0.4	19.15	0.36	10.91	0.24	0.06	0.62	0.79	0.20	146.0
8 Sep 75	P-12-0	-0.5	12.46	0.45	15.91	1.15	0.11	1.15	0.47	0.03	158.0
	P-12-8	-0.2	19.42	0.63	8.92	0.15	0.05	1.04	1.22	0.22	
8 Sep 75	P-13-0	-0.4	12.52	0.49	20.71	0.86	0.13	1.70	0.52	0.08	52.8
	P-13-6	-0.2	16.81	0.36	14.48	0.40	0.10	1.39	0.61	a	
8 Sep 75	P-14-0	-1.0	11.65	0.28	20.22	0.92	0.09	2.03	0.35	0.03	308.0
	P-14-5	-0.5	17.69	0.38	8.33	0.23	0.01	0.74	0.85	0.16	267.2
10 Sep 75	P-15-0	0.5	16.07	0.17	14.35	0.11	0.00	1.03	0.56	0.02	
	P-15-5	0.2	17.68	0.40	15.45	0.59	0.28	2.17	0.95	a	
10 Sep 75	P-16-0	1.0	17.52	0.27	15.61	0.10	0.07	1.26	0.42	a	
	P-16-4	0.8	18.03	0.51	14.15	0.15	0.09	2.65	0.82	0.03	341.2
10 Sep 75	P-17-0	0.8	22.62	0.53	14.22	0.27	0.12	2.57	0.46	0.01	
	P-17-23	0.5	23.09	0.72	11.80	0.56	0.09	1.23	0.61	0.02	50.4
10 Sep 75	P-18-0	1.2	23.37	0.50	11.47	0.14	0.07	0.93	0.28	0.01	24.0
	P-18-30	0.5	24.96	0.70	10.17	0.82	0.10	1.47	0.47	0.01	9.2
10 Sep 75	P-19-0	1.2	21.46	0.45	12.17	0.42	0.14	1.17	0.25	0.01	
	P-19-11	1.0	22.13	0.61	12.49	0.33	0.08	1.30	0.51	0.02	

[a] The dark bottle count was higher than the average of the light bottle counts.

Table 2. (continued)

Date	Station Number Depth (m)	T (°C)	S°/oo	PO_4	Si	NO_3	NO_2	NO_3	chl a (mg m^{-1})	primary productivity (mgCm^{-3}hr^{-1})	Total Number of Cells/liter (x 10^3)
11 Sep 75	P-20-0	1.5	15.49						0.86	0.03	325.2
	P-20-7	1.2	18.36						1.79	0.04	
11 Sep 75	P-21-0	1.2	16.23						0.82	0.02	194.0
	P-21-8	1.2	17.71						0.80	0.02	385.0
11 Sep 75	P-22-0	1.2	23.17						0.61	0.04	
	P-22-19	1.2	23.19						0.55	0.03	97.2
13 Sep 75	P-23-0	2.5	19.66	0.47	9.64	0.13	0.26	2.52	0.47	1.87	595.9
	P-23-5	2.3	20.00	0.46	8.97	0.26	0.46	2.40	1.22	2.53	144.8
13 Sep 75	P-24-0	2.2	20.49	0.45	10.77	0.54	0.28	1.03	0.80	2.46	341.6
	P-24-7	2.2	20.83	0.47	10.33	0.15	0.29	0.67	2.91	2.97	348.0
13 Sep 75	P-25-0	1.9	19.57	0.21	11.26	0.80	0.80	1.25	0.80	1.13	742.8
	P-25-8	2.2	20.69	0.29	10.42	0.38	1.10	0.94	0.69	2.28	574.8
13 Sep 75	P-26-0	1.8	17.01	0.19	8.24	0.05	0.07	1.06	0.64	1.74	503.6
	P-26-6	1.8	18.90	0.28	11.03	0.32	1.05	1.01	0.69	2.67	399.6
14 Sep 75	P-27-0	2.2	17.49	0.03	13.01	0.09	0.13	2.18	0.34	0.56	542.0
	P-27-5	1.8	21.06	0.56	11.25	0.03	0.09	0.21	2.26	1.67	
14 Sep 75	P-28-0	1.5	19.31	0.16	12.64	0.03	0.13	0.21	1.05	0.29	
	P-28-20	0.3	23.53	1.09	11.20	0.28	0.27	0.21	0.74	0.45	
14 Sep 75	P-29-0	0.3	21.76	0.45	9.96	0.12	0.15		0.25	0.24	
	P-29-19	0.0	23.59	1.31	11.25	0.21	0.36		0.78	0.37	6.8
14 Sep 75	P-30-0	1.9	17.26	0.33	13.83	0.04	0.18		0.17	0.51	637.2
	P-30-6	0.6	22.80						2.33	1.07	162.8
16 Sep 75	P-31-0	2.2	17.60						0.64	1.93	386.2
	P-31-15	1.4	20.87						0.74	1.98	

Table 2. (Continued)

Date	Station Number Depth (m)	T (°C)	S°/₀₀	PO_4	Si	NO_3	NO_2	NO_3	chl a (mg m^{-1})	primary productivity ($mgCm^{-3}hr^{-1}$)	Total Number of Cells/liter (x 10^3)
16 Sep 75	P-32-0	1.2	22.22						1.18	1.77	
	P-32-20	1.1	22.26						0.70	1.38	
16 Sep 75	P-33-0	1.9	20.77						0.36	1.05	
	P-33-15	1.5	21.27						0.74	1.11	216.4
16 Sep 75	P-34-0	2.0	14.57						0.63	1.45	
	P-34-7	3.0	18.69						0.88	2.48	
16 Sep 75	P-35-0	2.1	20.07						0.70	0.02	
	P-35-6	2.0	20.09						0.88	0.01	
16 Sep 75	P-36-0	2.0	20.07						0.38	0.01	
	P-36-7	1.7	20.10						0.55	0.03	
16 Sep 75	P-37-0	2.0	19.92						0.74	0.03	
	P-37-5	2.0	19.93						0.51	0.01	

cells present does not account for this variability. At station P-24-7, with the highest productivity, small species of the genus *Chaetoceros* comprised 80%, pennate diatoms 15%, and flagellates 5% of the total number of cells. At station P-16-4, where the primary productivity was only 0.03 $mgCm^{-3}hr^{-1}$, *Chaetoceros* spp. comprised 70%, pennate diatoms 25%, and flagellates 5% of the total population.

The species of phytoplankton found in Prudhoe Bay in September 1975 also differs from that reported by Horner et al. (1974), possibly because of the adverse ice conditions in 1975.

II. Field and Laboratory Activities--AIDJEX

E. Data collected or analyzed.

1. Data collected:

Type	Number
Net zooplankton	994
Phytoplankton standing stock	209
Chlorophyll *a*	1,096
Primary productivity	2,941
Nitrates	272
Particulate Carbon	44

2. Data analyzed:

Type	Number	Display
Net zooplankton	20	Table 7, Figs. 7-10
Phytoplankton standing stock	0	
Chlorophyll *a*	825	Table 3, Figs. 3, 4
Primary productivity	2,941	Tables 3-6, Figs. 4-6
Nitrates	272	
Particulate Carbon	0	

III. Results

A. Nitrates: Nitrate observations were presented and discussed in the Annual Report, 1 April 1976.

B. Chlorophyll *a*: Chlorophyll *a* observations were presented and discussed in the Annual Report, 1 April 1976. They are presented again (Table 3, Figs. 3 and 4) for comparison with ^{14}C assimilation observations

C. Primary productivity: The 2,941 ^{14}C assimilations were made under four basic experimental regimes: depth profiles, replication experiments, graduated light series, and *in situ* incubations. All four categories of assimilations have been counted, but only the first three have undergone preliminary data analysis and will be presented in this report.

1. Depth profiles: The standard depth profile (Table 3) was comprised of 125 ml water samples from 3, 5, 10, 15, 20, 25, 30, 35, 40,

Table 3. Depth Series ^{14}C Assimilation Experiments

Explanation of Table Values:

1.	Date:	Month, day, year of experiment
2.	Standard:	Total activity (microcuries) added to water sampled
3.	Time:	Duration (hours) of incubation
4.	Eff:	Liquid scintillation external standard (e.g. 13) and resultant percentage counting efficiency (e.g. 75.6)
5.	Depth:	Depth (m) of water sampled
6.	Light:	Light intensity (microeinsteins $m^{-2}sec^{-1}$) in incubation box during experiment
7.	Assim:	Light, dark, and net assimilation ($mgCm^{-3}hr^{-1}$)
8.	Chl *a*:	Measured chlorophyll *a* (mg m^3) of incubated water sample
9.	Normalized:	Assimilation normalized on chlorophyll and assimilation normalized on light intensity

Table 3 (cont.)

DATE 6/ 6/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.12	.01	.11	.06	1.91	.00099
5	118	.13	.01	.12	.06	1.98	.00101
10	120	.09	.01	.08	.09	.85	.00044
15	121	.22	.01	.21	.08	2.62	.00173
20	120	.13	.01	.12	.09	1.32	.00099
25	119	.21	.01	.20	.06	3.41	.00172
30	110	.19	.01	.18	.05	3.60	.00164
35	112	.17	.01	.16	.08	2.03	.00145
40	114	.17	.01	.16	.11	1.47	.00142
45	116	.16	.01	.15	.08	1.85	.00127
50	117	.18	.01	.17	.09	1.92	.00147
60	116	.06	.01	.05	.06	.83	.00043

DATE 6/ 8/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.12	.01	.11	.09	1.23	.00036
5	118	.09	.01	.08	.10	.80	.00068
10	120	.09	.01	.08	.10	.80	.00067
15	121	.14	.01	.13	.09	1.46	.00108
20	120	.10	.01	.09	.08	1.16	.00077
25	119	.15	.01	.14	.11	1.29	.00120
30	110	.16	.01	.15	.08	1.84	.00134
35	112	.11	.01	.10	.06	1.75	.00094
40	114	.12	.02	.10	.08	1.25	.00047
45	116	.13	.01	.12	.09	1.34	.00104
50	117	.11	.01	.10	.08	1.25	.00086
60	116	.01	.01	.00	.04	.02	.00001

DATE 6/11/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.10	.02	.08	.08	.99	.00069
5	118	.18	.02	.17	.08	2.09	.00142
10	120	.18	.01	.16	.08	2.05	.00137
15	121	.24	.01	.23	.09	2.50	.00186
20	120	.20	.01	.19	.08	2.34	.00156
25	119	.18	.01	.17	.07	2.36	.00139
30	110	.17	.02	.15	.07	2.14	.00136
35	112	.16	.02	.14	.07	1.95	.00122
40	114	.13	.01	.12	.07	1.64	.00101
45	116	.19	.02	.17	.08	2.09	.00144
50	117	.15	.01	.14	.08	1.77	.00121
60	116	.07	.01	.06	.04	1.59	.00058

Table 3 (cont.)

DATE 6/14/75 STANDARD 7.70 MC/AMP TIME 6.0 HR FFF 14/75.9

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.13	.02	.11	.05	2.29	.00099
5	118	.14	.01	.13	.06	2.09	.00106
10	120	.13	.01	.12	.06	1.93	.00097
15	121	.15	.01	.14	.06	2.35	.00117
20	120	.14	.01	.13	.06	2.11	.00106
25	119	.16	.01	.15	.07	2.09	.00123
30	110	.16	.01	.14	.06	2.37	.00129
35	112	.15	.02	.13	.07	1.84	.00115
40	114	.18	.01	.17	.07	2.47	.00151
45	116	.13	.01	.11	.06	1.91	.00099
50	117	.17	.01	.16	.06	2.67	.00137
60	116	.08	.01	.07	.06	1.15	.00060

DATE 6/17/75 STANDARD 7.70 MC/AMP TIME 6.0 HR FFF 36/74.3

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.09	.01	.08	.07	1.10	.00066
5	118	.12	.02	.11	.06	1.81	.00092
10	120	.12	.01	.11	.05	2.16	.00090
15	121	.11	.01	.09	.07	1.34	.00078
20	120	.13	.01	.12	.05	2.33	.00097
25	119	.12	.02	.10	.05	1.97	.00083
30	110	.12	.02	.10	.04	2.53	.00092
35	112	.15	.01	.14	.05	2.75	.00123
40	114	.11	.01	.10	.04	2.38	.00094
45	116	.13	.01	.12	.05	2.38	.00103
50	117	.14	.01	.13	.06	2.09	.00107
60	116	.14	.01	.13	.08	1.62	.00112

DATE 6/20/75 STANDARD 7.70 MC/AMP TIME 6.0 HR FFF 33/75.7

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.07	.02	.05	.03	1.63	.00042
5	119	.08	.02	.06	.04	1.55	.00053
10	120	.09	.02	.08	.03	2.54	.00063
15	121	.09	.01	.08	.03	2.76	.00068
20	120	.11	.01	.10	.03	3.25	.00091
25	119	.12	.01	.11	.03	3.63	.00092
30	110	.15	.02	.13	.03	4.41	.00120
35	112	.18	.01	.17	.04	4.34	.00155
40	114	.17	.01	.16	.04	3.94	.00133
45	116	.16	.01	.14	.05	2.87	.00124
50	117	.16	.01	.14	.06	2.39	.00123
60	116	.21	.01	.20	.08	2.45	.00169

Table 3 (cont.)

DATE 6/23/75 STANDARD 7.70 MC/AMP TIME 5.8 HR EFF 27/78.4

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.08	.02	.06	.04	1.55	.00054
5	118	.07	.02	.05	.04	1.18	.00040
10	120	.07	.02	.06	.02	2.90	.00048
15	121	.07	.02	.06	.03	1.85	.00046
20	120	.07	.02	.05	.03	1.78	.00045
25	119	.06	.01	.05	.03	1.76	.00044
30	110	.07	.01	.06	.02	3.24	.00059
35	112	.09	.01	.08	.03	2.74	.00073
40	114	.09	.01	.07	.03	2.49	.00066
45	116	.10	.01	.09	.03	2.80	.00073
50	117	.13	.01	.12	.03	3.85	.00099
60	116	.16	.01	.15	.05	2.97	.00128

DATE 6/26/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 25/79.3

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.07	.02	.05	.03	1.76	.00046
5	118	.05	.01	.04	.02	2.11	.00036
10	120	.04	.02	.03	.02	1.40	.00023
15	121	.07	.01	.06	.02	2.78	.00045
20	120	.07	.02	.06	.02	2.97	.00049
25	119	.06	.01	.05	.02	2.39	.00040
30	110	.07	.01	.06	.02	2.90	.00053
35	112	.14	.01	.13	.02	6.51	.00116
40	114	.08	.01	.07	.02	3.29	.00058
45	116	.10	.01	.09	.03	3.06	.00079
50	117	.12	.01	.11	.03	3.76	.00097
60	116	.10	.01	.09	.05	1.70	.00073

DATE 6/29/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.06	.02	.04	.02	2.12	.00037
5	118	.05	.01	.04	.01	3.99	.00034
10	120	.05	.02	.03	.01	3.09	.00026
15	121	.10	.01	.08	.01	8.37	.00069
20	120	.06	.02	.04	.01	3.67	.00031
25	119	.09	.01	.08	.01	8.24	.00059
30	110	.07	.02	.06	.01	5.53	.00050
35	112	.07	.01	.05	.01	5.41	.00042
40	114	.07	.02	.05	.02	2.35	.00041
45	116	.11	.01	.09	.02	4.63	.00080
50	117	.15	.01	.13	.04	3.30	.00113
60	116	.12	.01	.11	.05	2.26	.00097

DATE 7/ 2/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 34/75.9

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.08	.02	.06	.02	2.84	.00049
5	118	.07	.01	.06	.02	3.11	.00053
10	120	.05	.01	.04	.01	4.04	.00034
15	121	.06	.01	.05	.01	5.27	.00044
20	120	.07	.01	.06	.03	1.92	.00048
25	119	.05	.01	.04	.03	1.30	.00033
30	110	.07	.01	.05	.01	5.40	.00049
35	112	.07	.01	.06	.02	3.11	.00056
40	114	.08	.01	.07	.04	1.76	.00062
45	116	.11	.01	.10	.04	2.57	.00088
50	117	.14	.01	.13	.04	3.16	.00108
60	116	.13	.01	.12	.11	1.07	.00101

DATE 7/ 5/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.09	.02	.07	.03	2.38	.00062
5	118	.11	.01	.09	.03	3.10	.00079
10	120	.09	.02	.08	.02	3.75	.00063
15	121	.09	.02	.07	.03	2.45	.00061
20	120	.10	.01	.08	.03	2.75	.00069
25	119	.10	.02	.08	.03	2.64	.00067
30	110	.08	.01	.07	.03	2.32	.00063
35	112	.10	.01	.08	.04	2.11	.00075
40	114	.11	.02	.09	.04	2.23	.00078
45	116	.16	.02	.14	.06	2.31	.00120
50	117	.23	.01	.21	.05	4.26	.00182
60	116	.29	.01	.28	.07	3.98	.00240

DATE 7/ 8/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.06	.02	.04	.01	4.13	.00036
5	118	.08	.02	.06	.01	5.99	.00051
10	120	.06	.02	.04	.01	3.92	.00033
15	121	.06	.02	.04	.01	4.40	.00036
20	120	.05	.02	.03	.01	3.16	.00026
25	119	.08	.01	.06	.01	6.21	.00052
30	110	.07	.01	.05	.01	5.45	.00050
35	112	.11	.01	.09	.02	4.71	.00084
40	114	.09	.02	.08	.04	1.96	.00069
45	116	.22	.01	.20	.05	4.06	.00175
50	117	.27	.02	.25	.08	3.18	.00217
60	116	.30	.01	.29	.12	2.40	.00249

Table 3 (cont.)

DATE 7/11/75 STANDARD 7.50 MC/AMP TIME 6.5 HR EFF 33/75.7

DEPTH	LIGHT	ASSIM (MGC/M3/HR)			CHL A	NORMALIZED	
(M)	(ME/M2/S)	L	D	N	(MG/M3)	A/C	A/L
3	116	.09	.02	.07	.03	2.32	.00060
5	118	.09	.02	.08	.03	2.53	.00064
10	120	.05	.02	.03	.03	1.06	.00026
15	121	.09	.02	.07	.03	2.47	.00061
20	120	.11	.02	.09	.03	3.10	.00078
25	119	.12	.02	.11	.04	2.64	.00092
30	110	.10	.01	.09	.03	3.00	.00082
35	112	.11	.01	.09	.03	3.12	.00084
40	114	.11	.02	.09	.03	3.08	.00081
45	116	.16	.02	.14	.04	3.40	.00117
50	117	.28	.02	.27	.06	4.45	.00228
60	116	.31	.02	.30	.13	2.30	.00258

DATE 7/14/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 28/77.9

DEPTH	LIGHT	ASSIM (MGC/M3/HR)			CHL A	NORMALIZED	
(M)	(ME/M2/S)	L	D	N	(MG/M3)	A/C	A/L
3	116	.05	.01	.04	.01	3.52	.00030
5	118	.05	.01	.04	.01	3.53	.00030
10	120	.06	.01	.05	.01	5.06	.00042
15	121	.09	.01	.07	.02	3.70	.00061
20	120	.08	.01	.07	.02	3.30	.00055
25	119	.09	.02	.07	.02	3.66	.00062
30	110	.09	.01	.08	.02	3.76	.00068
35	112	.10	.01	.09	.03	2.84	.00076
40	114	.10	.01	.09	.03	3.05	.00080
45	116	.12	.02	.10	.04	2.51	.00086
50	117	.14	.01	.13	.05	2.63	.00113
60	116	.22	.01	.21	.08	2.58	.00178

DATE 7/17/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH	LIGHT	ASSIM (MGC/M3/HR)			CHL A	NORMALIZED	
(M)	(ME/M2/S)	L	D	N	(MG/M3)	A/C	A/L
3	116	.06	.02	.04	.01	4.07	.00035
5	118	.07	.01	.06	.01	5.96	.00051
10	120	.06	.01	.05	.01	4.56	.00038
15	121	.05	.01	.03	.01	3.42	.00028
20	120	.05	.01	.04	.01	3.82	.00032
25	119	.07	.02	.05	.01	4.89	.00041
30	110	.07	.01	.06	.02	2.85	.00052
35	112	.08	.01	.07	.02	3.52	.00063
40	114	.10	.02	.08	.03	2.71	.00071
45	116	.19	.01	.17	.05	3.46	.00149
50	117	.35	.01	.33	.12	2.77	.00284
60	116	.32	.01	.31	.16	1.92	.00265

DATE 7/20/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 32/76.

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.06	.02	.04	.01	4.12	.00036
5	118	.06	.02	.04	.01	4.12	.00035
10	120	.07	.01	.06	.01	5.54	.00046
15	121	.07	.01	.06	.01	5.62	.00046
20	120	.07	.01	.05	.01	5.44	.00045
25	119	.08	.01	.06	.02	3.13	.00053
30	110	.10	.01	.09	.02	4.43	.00081
35	112	.08	.01	.07	.02	3.38	.00060
40	114	.11	.01	.09	.03	3.06	.00090
45	116	.09	.01	.08	.04	1.95	.00067
50	117	.11	.01	.10	.05	1.98	.00085
60	116	.29	.01	.28	.14	2.01	.00242

DATE 7/23/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 35/74.5

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.04	.02	.03	.01	2.74	.00024
5	118	.04	.01	.02	.01	2.47	.00021
10	120	.04	.01	.03	.01	2.81	.00023
15	121	.05	.02	.04	.01	3.51	.00023
20	120	.06	.02	.03	.01	3.46	.00029
25	119	.06	.01	.04	.02	2.25	.00028
30	110	.06	.02	.05	.02	2.28	.00042
35	112	.08	.02	.06	.02	2.99	.00053
40	114	.08	.01	.06	.02	3.13	.00055
45	116	.08	.02	.06	.03	1.97	.00051
50	117	.07	.01	.06	.04	1.50	.00051
60	116	.39	.01	.38	.26	1.47	.00329

DATE 7/26/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.04	.02	.02	.01	1.95	.00017
5	118	.05	.01	.03	.01	3.42	.00029
10	120	.04	.01	.03	.01	3.02	.00025
15	121	.04	.02	.02	.01	1.68	.00014
20	120	.04	.02	.02	.01	1.97	.00016
25	119	.06	.01	.04	.01	4.42	.00037
30	110	.06	.02	.04	.01	3.67	.00033
35	112	.08	.01	.07	.02	3.51	.00063
40	114	.08	.01	.07	.02	3.44	.00060
45	116	.09	.01	.07	.02	3.48	.00060
50	117	.09	.02	.07	.03	2.45	.00063
60	116	.43	.01	.42	.19	2.22	.00364

Table 3 (cont.)

DATE 7/29/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 30/77

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.12	.02	.10	.01	9.59	.00083
5	118	.06	.02	.04	.01	4.22	.00036
10	120	.10	.01	.08	.02	4.11	.00069
15	121	.08	.01	.06	.01	6.30	.00052
20	120	.09	.01	.08	.02	3.94	.00066
25	119	.10	.01	.08	.03	2.80	.00071
30	110	.07	.01	.06	.03	2.01	.00055
35	112	.08	.01	.07	.03	2.30	.00062
40	114	.09	.01	.08	.03	2.52	.00066
45	116	.09	.02	.07	.04	1.73	.00060
50	117	.10	.01	.09	.04	2.15	.00074
60	116	.52	.02	.50	.24	2.10	.00435

DATE 8/ 1/75 STANDARD 6.95 MC/AMP TIME 5.0 HR EFF 24/78

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.07	.02	.05	.01	5.45	.00047
5	118	.05	.01	.04	.02	1.99	.00034
10	120	.07	.02	.05	.01	4.96	.00041
15	121	.06	.02	.05	.01	4.63	.00038
20	120	.08	.03	.05	.02	2.66	.00044
25	119	.11	.02	.09	.03	2.87	.00072
30	110	.08	.02	.06	.02	2.95	.00054
35	112	.08	.02	.06	.03	2.06	.00055
40	114	.10	.01	.09	.04	2.15	.00075
45	116	.14	.01	.12	.06	2.06	.00107
50	117	.38	.02	.36	.23	1.57	.00309
60	116	.20	.02	.19	.15	1.25	.00162

DATE 8/ 4/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 19/77

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.06	.02	.04	.02	2.03	.00035
5	118	.05	.02	.03	.02	1.43	.00024
10	120	.08	.02	.06	.01	5.64	.00047
15	121	.06	.01	.04	.02	2.25	.00027
20	120	.09	.02	.07	.03	2.45	.000[illegible]
25	119	.09	.02	.08	.02	3.84	.00065
30	110	.06	.01	.05	.02	2.36	.000[illegible]
35	112	.06	.01	.05	.03	1.65	.00[illegible]
40	114	.06	.01	.05	.04	1.15	.0[illegible]
45	116	.10	.02	.08	.08	1.03	.0[illegible]
50	117	.11	.02	.10	.09	1.07	.0[illegible]
60	116	.36	.01	.34	.20	1.72	.0[illegible]

Table 3 (cont.)

DATE 8/ 7/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 36/74.3

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.05	.02	.03	.02	1.65	.00028
5	118	.05	.02	.03	.01	2.60	.00022
10	120	.07	.01	.06	.01	6.16	.00051
15	121	.11	.02	.09	.03	2.99	.00074
20	120	.15	.01	.14	.06	2.27	.00113
25	119	.08	.01	.07	.04	1.63	.00055
30	110	.09	.02	.07	.03	2.23	.00061
35	112	.10	.02	.08	.04	1.95	.00070
40	114	.09	.02	.07	.04	1.78	.00063
45	116	.15	.01	.14	.06	2.28	.00118
50	117	.09	.01	.08	.06	1.27	.00065
60	116	.28	.01	.27	.13	2.07	.00232

DATE 8/10/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 31/76.6

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.11	.02	.09	.03	2.81	.00073
5	119	.08	.02	.07	.03	2.21	.00056
10	120	.08	.02	.06	.04	1.39	.00046
15	121	.09	.01	.08	.03	2.52	.00062
20	120	.10	.02	.09	.03	2.89	.00072
25	119	.11	.02	.09	.04	2.24	.00075
30	110	.14	.02	.12	.03	4.11	.00112
35	112	.09	.02	.07	.03	2.39	.00064
40	114	.09	.02	.08	.04	1.93	.00068
45	116	.11	.01	.09	.05	1.86	.00090
50	117	.20	.02	.18	.08	2.28	.00156
60	116	.23	.02	.22	.11	1.96	.00186

DATE 8/10/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
46	116	.10	.02	.08	.07	1.17	.00071
48	118	.20	.02	.18	.10	1.77	.00150
50	120	.19	.02	.18	.11	1.61	.00148
52	121	.24	.02	.22	.10	2.22	.00183
54	120	.25	.02	.23	.10	2.26	.00189
56	119	.23	.02	.21	.10	2.13	.00179
58	110	.19	.01	.18	.08	2.24	.00163
60	112	.17	.01	.16	.09	1.79	.00144
62	114	.16	.01	.14	.09	1.57	.00124
64	116	.15	.01	.14	.10	1.37	.00119
80	117	.07	.01	.06	.06	1.02	.00052
100	116	.04	.01	.03	.04	.60	.00021

Table 3 (cont.)

DATE 8/13/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 28/77.9

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.11	.02	.09	.02	4.47	.00077
5	118	.12	.02	.10	.02	4.93	.00094
10	120	.13	.02	.11	.02	5.54	.00092
15	121	.11	.02	.09	.02	4.27	.00071
20	120	.11	.02	.09	.03	2.99	.00075
25	119	.10	.02	.08	.03	2.82	.00071
30	110	.13	.02	.11	.04	2.77	.00101
35	112	.13	.02	.11	.06	1.83	.00098
40	114	.20	.01	.18	.09	2.03	.00160
45	116	.36	.02	.34	.19	1.81	.00296
50	117	.50	.02	.48	.29	1.65	.00409
60	116	.17	.02	.15	.08	1.87	.00129

DATE 8/16/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 28/77.9

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.14	.02	.12	.03	4.04	.00105
5	118	.12	.02	.10	.02	5.00	.00095
10	120	.10	.02	.08	.03	2.72	.00068
15	121	.17	.02	.15	.05	3.05	.00126
20	120	.16	.02	.14	.04	3.57	.00119
25	119	.19	.02	.17	.04	4.18	.00141
30	110	.13	.01	.12	.04	2.96	.00108
35	112	.14	.01	.13	.07	1.81	.00113
40	114	.17	.02	.16	.05	3.12	.00127
45	116	.18	.02	.16	.06	2.67	.00139
50	117	.21	.02	.19	.07	2.74	.00164
60	116	.44	.02	.42	.18	2.36	.00366

DATE 8/19/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 24/75.2

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.07	.02	.05	.01	5.08	.00044
5	118	.07	.02	.05	.02	2.50	.00042
10	120	.07	.02	.05	.01	4.53	.00038
15	121	.07	.02	.05	.02	2.54	.00042
20	120	.08	.02	.06	.02	2.81	.00047
25	119	.09	.02	.07	.02	3.60	.00060
30	110	.08	.01	.06	.03	2.14	.00059
35	112	.09	.02	.07	.03	2.26	.00061
40	114	.11	.01	.10	.05	1.98	.00087
45	116	.20	.01	.19	.10	1.88	.00162
50	117	.28	.02	.27	.14	1.91	.00233
60	116	.16	.01	.14	.09	1.58	.00123

DATE 8/22/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.09	.02	.07	.03	2.35	.00061
5	118	.07	.02	.06	.02	2.85	.00048
10	120	.07	.02	.05	.02	2.41	.00040
15	121	.09	.02	.07	.02	3.59	.00059
20	120	.12	.02	.10	.04	2.53	.00094
25	119	.11	.02	.09	.04	2.29	.00077
30	110	.10	.02	.08	.03	2.64	.00072
35	112	.10	.01	.08	.03	2.75	.00074
40	114	.12	.01	.10	.04	2.61	.00091
45	116	.16	.01	.15	.07	2.13	.00129
50	117	.24	.02	.21	.11	1.95	.00194
60	116	.20	.01	.19	.09	2.07	.00161

DATE 8/25/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 31/76.6

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.08	.02	.06	.02	3.11	.00064
5	118	.08	.02	.06	.02	3.01	.00051
10	120	.08	.02	.06	.02	3.15	.00052
15	121	.09	.02	.07	.02	3.32	.00055
20	120	.08	.02	.06	.02	3.06	.00051
25	119	.11	.02	.10	.03	3.20	.00081
30	110	.12	.02	.10	.03	3.44	.00094
35	112	.12	.02	.10	.03	3.46	.00093
40	114	.14	.02	.12	.05	2.46	.00102
45	115	.24	.02	.23	.07	3.24	.00195
50	117	.31	.02	.29	.11	2.66	.00251
60	116	.29	.02	.27	.15	1.78	.00230

DATE 8/29/75 STANDARD 7.55 MC/AMP TIME 6.1 HR EFF 36/74.3

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.10	.02	.08	.03	2.62	.00069
5	118	.08	.02	.06	.03	2.13	.00054
10	120	.09	.02	.07	.03	2.48	.00062
15	121	.09	.02	.07	.03	2.39	.00059
20	120	.10	.02	.08	.03	2.75	.00069
25	119	.10	.02	.08	.03	2.68	.00068
30	110	.10	.02	.09	.04	2.17	.00079
35	112	.12	.01	.11	.05	2.14	.00095
40	114	.14	.02	.12	.05	2.36	.00103
45	116	.18	.02	.16	.06	2.67	.00139
50	117	.20	.02	.19	.08	2.30	.00157
60	116	.20	.01	.19	.08	2.27	.00157

Table 3 (cont.)

DATE 8/31/75 STANDARD 7.55 MC/AMP TIME 6.0 HR FFF 21/77.8

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.09	.02	.07	.02	3.49	.00060
5	118	.10	.02	.08	.02	4.24	.00072
10	120	.09	.02	.07	.02	3.39	.00057
15	121	.09	.02	.07	.04	1.74	.00058
20	120	.11	.02	.09	.04	2.28	.00076
25	119	.09	.02	.07	.03	2.33	.00059
30	110	.09	.01	.08	.04	1.89	.00069
35	112	.14	.02	.12	.04	3.03	.00108
40	114	.24	.02	.23	.06	3.80	.00200
45	116	.30	.02	.28	.12	2.36	.00244
50	117	.34	.02	.33	.19	1.71	.00278
60	116	.26	.02	.25	.13	1.89	.00212

DATE 9/ 3/75 STANDARD 7.55 MC/AMP TIME 6.0 HR FFF 21/77.8

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.09	.02	.07	.03	2.46	.00064
5	118	.07	.02	.05	.03	1.67	.00043
10	120	.07	.02	.05	.03	1.74	.00043
15	121	.10	.02	.09	.05	1.67	.00069
20	120	.10	.02	.08	.05	1.66	.00069
25	119	.08	.02	.06	.03	1.96	.00049
30	110	.11	.02	.10	.04	2.44	.00089
35	112	.10	.01	.08	.04	2.09	.00075
40	114	.10	.01	.08	.04	2.11	.00074
45	116	.15	.02	.14	.05	2.77	.00119
50	117	.20	.02	.18	.08	2.28	.00156
60	116	.21	.02	.19	.13	1.44	.00162

DATE 9/ 6/75 STANDARD 7.55 MC/AMP TIME 6.0 HR FFF 15/76.2

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.10	.01	.09	.02	4.60	.00079
5	118	.10	.01	.08	.03	2.71	.00069
10	120	.08	.02	.06	.03	2.02	.00051
15	121	.09	.01	.07	.03	2.46	.00061
20	120	.09	.01	.07	.02	3.56	.00059
25	119	.10	.02	.08	.04	2.08	.00070
30	110	.10	.01	.09	.04	2.22	.00081
35	112	.11	.01	.10	.04	2.44	.00087
40	114	.13	.01	.11	.04	2.83	.00093
45	116	.23	.01	.21	.05	4.27	.00184
50	117	.23	.02	.21	.10	2.13	.00182
60	116	.27	.02	.25	.12	2.05	.00212

Table 3 (cont.)

DATE 9/ 9/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 26/78.8

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.12	.02	.11	.04	2.70	.00093
5	118	.11	.02	.10	.05	1.92	.00081
10	120	.10	.02	.08	.04	2.00	.00067
15	121	.09	.02	.07	.04	1.77	.00059
20	120	.14	.02	.12	.04	3.12	.00104
25	119	.11	.02	.09	.03	2.87	.00072
30	110	.13	.01	.12	.03	3.84	.00105
35	112	.12	.02	.10	.04	2.56	.00091
40	114	.17	.02	.15	.04	3.86	.00135
45	116	.17	.02	.15	.06	2.54	.00131
50	117	.19	.01	.18	.08	2.20	.00150
60	116	.22	.02	.20	.09	2.22	.00172

DATE 9/12/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.19	.02	.17	.05	3.32	.00143
5	118	.15	.02	.13	.05	2.53	.00107
10	120	.17	.02	.15	.06	2.44	.00122
15	121	.12	.02	.10	.04	2.55	.00084
20	120	.12	.02	.10	.04	2.60	.00087
25	119	.14	.02	.12	.04	3.05	.00103
30	110	.15	.01	.13	.04	3.33	.00121
35	112	.15	.01	.13	.04	3.32	.00119
40	114	.18	.02	.17	.06	2.80	.00147
45	116	.21	.02	.19	.09	2.12	.00165
50	117	.20	.02	.18	.09	2.00	.00154
60	116	.19	.02	.17	.07	2.47	.00149

DATE 9/15/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.16	.02	.14	.06	2.32	.00120
5	118	.13	.01	.12	.04	3.00	.00102
10	120	.10	.02	.08	.04	2.05	.00068
15	121	.11	.02	.09	.03	2.84	.00070
20	120	.12	.02	.10	.04	2.51	.00084
25	119	.10	.02	.08	.03	2.78	.00070
30	110	.11	.01	.10	.04	2.49	.00091
35	112	.12	.01	.11	.05	2.23	.00100
40	114	.17	.01	.16	.08	1.95	.00137
45	116	.29	.01	.28	.12	2.30	.00238
50	117	.34	.01	.33	.14	2.34	.00280
60	116	.13	.01	.12	.09	1.29	.00100

Table 3 (cont.)

DATE 9/18/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH	LIGHT	ASSIM (MGC/M3/HR)			CHL A	NORMALIZED	
(M)	(ME/M2/S)	L	D	N	(MG/M3)	A/C	A/L
3	116	.16	.02	.14	.05	2.80	.00121
5	118	.15	.02	.13	.06	2.22	.00113
10	120	.12	.02	.11	.04	2.70	.00090
15	121	.12	.02	.10	.04	2.43	.00090
20	120	.12	.01	.11	.02	5.26	.00088
25	119	.13	.02	.11	.03	3.69	.00093
30	110	.17	.01	.15	.04	3.80	.00138
35	112	.18	.01	.17	.04	4.20	.00150
40	114	.17	.02	.15	.05	3.03	.00133
45	116	.18	.01	.16	.05	3.29	.00142
50	117	.24	.02	.22	.09	2.48	.00191
60	116	.16	.02	.14	.08	1.77	.00122

DATE 9/21/75 STANDARD 7.55 MC/AMP TIME 6.3 HR EFF 14/75.9

DEPTH	LIGHT	ASSIM (MGC/M3/HR)			CHL A	NORMALIZED	
(M)	(ME/M2/S)	L	D	N	(MG/M3)	A/C	A/L
3	116	.21	.02	.19	.04	4.66	.00161
5	118	.19	.02	.17	.05	3.44	.00146
10	120	.20	.02	.19	.05	3.62	.00151
15	121	.19	.02	.17	.05	3.34	.00138
20	120	.17	.02	.15	.05	3.02	.00126
25	119	.18	.01	.16	.05	3.23	.00136
30	110	.13	.02	.11	.05	2.20	.00100
35	112	.12	.01	.11	.05	2.25	.00100
40	114	.15	.01	.14	.05	2.82	.00124
45	116	.16	.01	.15	.07	2.16	.00130
50	117	.21	.02	.20	.08	2.46	.00168
60	116	.16	.01	.14	.08	1.80	.00124

DATE 9/24/75 STANDARD 7.55 MC/AMP TIME 6.5 HR EFF 13/75.6

DEPTH	LIGHT	ASSIM (MGC/M3/HR)			CHL A	NORMALIZED	
(M)	(ME/M2/S)	L	D	N	(MG/M3)	A/C	A/L
3	116	.14	.02	.12	.05	2.39	.00103
5	118	.14	.02	.12	.05	2.39	.00101
10	120	.12	.02	.10	.05	2.06	.00086
15	121	.12	.02	.10	.05	2.04	.00084
20	120	.13	.02	.11	.05	2.14	.00089
25	119	.12	.02	.11	.05	2.15	.00091
30	110	.13	.02	.11	.05	2.19	.00099
35	112	.15	.01	.14	.06	2.31	.00124
40	114	.14	.02	.12	.06	2.00	.00105
45	116	.19	.01	.17	.07	2.46	.00149
50	117	.15	.01	.14	.10	1.36	.00116
60	116	.14	.01	.13	.07	1.81	.00119

Table 3 (cont.)

DATE 9/27/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.15	.02	.13	.04	3.30	.00114
5	118	.13	.02	.12	.04	2.93	.00099
10	120	.12	.02	.10	.04	2.38	.00079
15	121	.10	.01	.09	.04	2.18	.00072
20	120	.11	.01	.10	.04	2.43	.00081
25	119	.11	.01	.09	.04	2.35	.00079
30	110	.13	.01	.12	.04	2.91	.00106
35	112	.12	.01	.11	.04	2.84	.00102
40	114	.11	.01	.10	.05	1.92	.00084
45	116	.10	.01	.09	.06	1.53	.00079
50	117	.10	.01	.09	.06	1.47	.00075
60	116	.09	.02	.07	.05	1.36	.00059

DATE 9/30/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH (M)	LIGHT (ME/M2/S)	ASSIM (MGC/M3/HR) L	D	N	CHL A (MG/M3)	NORMALIZED A/C	A/L
3	116	.16	.01	.15	.04	3.74	.00129
5	118	.15	.01	.14	.04	3.47	.00117
10	120	.14	.01	.13	.04	3.27	.00109
15	121	.15	.01	.14	.04	3.50	.00116
20	120	.14	.02	.11	.04	2.81	.00094
25	119	.14	.01	.13	.04	3.22	.00108
30	110	.15	.01	.14	.04	3.48	.00127
35	112	.16	.01	.15	.04	3.66	.00131
40	114	.15	.02	.13	.06	2.17	.00114
45	116	.10	.01	.09	.06	1.44	.00074
50	117	.11	.02	.09	.07	1.35	.00081
60	116	.09	.01	.08	.05	1.63	.00070

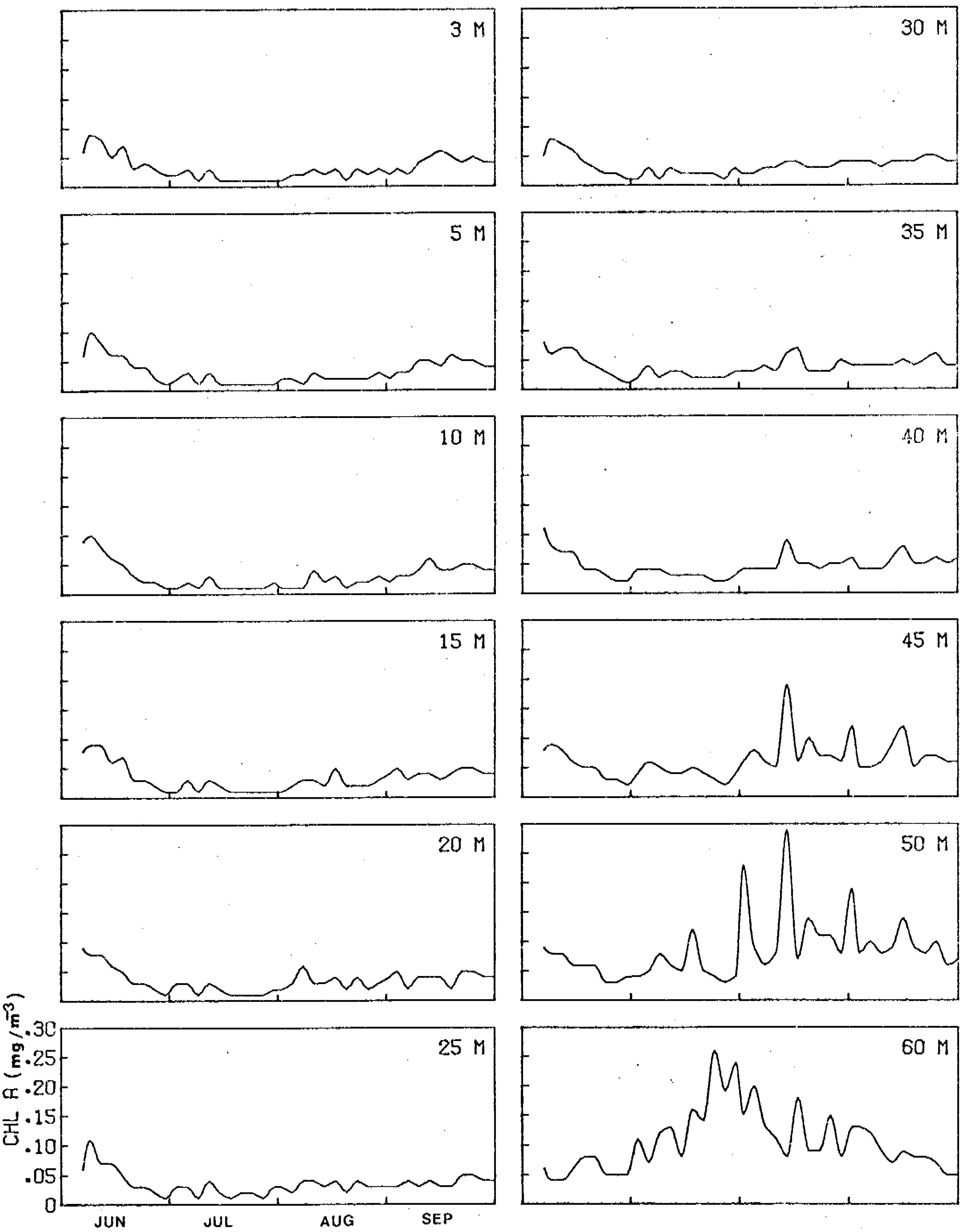

Fig. 3. Chlorophyll *a* (mg m^{-3}) measured at depths indicated during the summer of 1975.

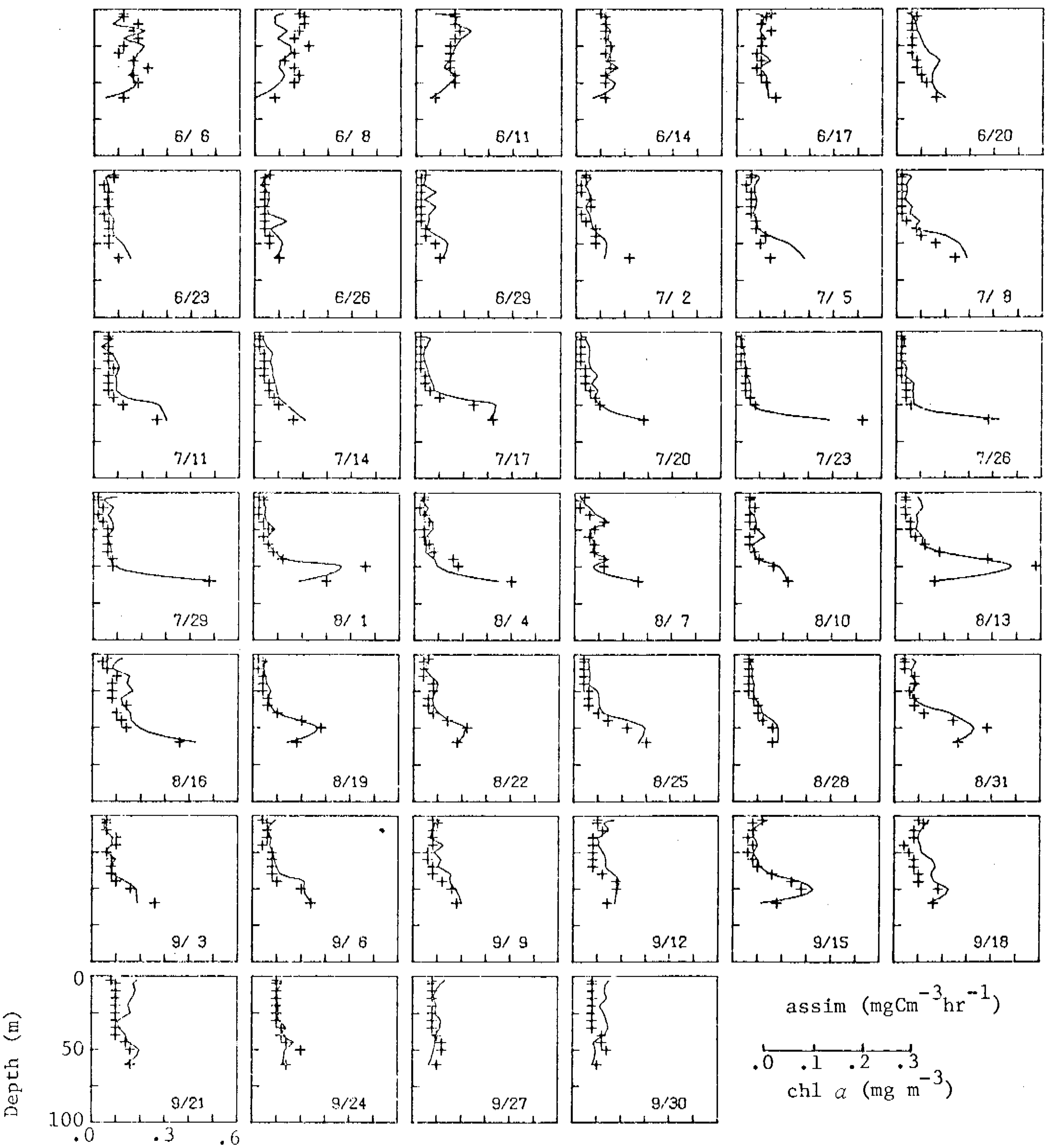

Fig. 4. Chlorophyll a (mg m^{-3}) depth profile (3-60 m) overlaid on net ^{14}C assimilation (mgCm^{-3}hr^{-1}) depth series for month and day indicated (+) chl a. (-) assim.

45, 50, and 60 m, inoculated with 6-7 microcuries of ^{14}C, as sodium bicarbonate, and placed in an incubation box for 6 hours with artificial light intensities averaging about 117 microeinsteins $m^{-2}sec^{-1}$ as measured with a LI-COR-185 (Lambda Instruments Corporation) quantum meter.

The assimilation at any particular depth (Fig. 5), when followed over time, closely resembles the chlorophyll *a* time series pattern (Fig. 3). In the upper 40-45 m, peak net assimilations of 0.1-0.2 $mgCm^{-3}hr^{-1}$ were found in early June. A secondary increase occurred in mid-to-late September. By late June, assimilation in the upper 40 m had decreased to below 0.1 $mgCm^{-3}hr^{-1}$ and remained low through August.

The major summer increase in assimilation occurred at 50-60 m during late July and August with peak assimilation being recorded at 0.48 $mgCm^{-3}hr^{-1}$ at 50 m on 13 August, and 0.50 $mgCm^{-3}hr^{-1}$ at 60 m on 29 July. In general, assimilation at these depths decreased after mid-August.

These assimilation values are not those occurring at depth, but represent the photosynthesis of the standing crop under constant high light conditions. They, therefore, represent the assimilation potential, not the actual *in situ* assimilation. A close correlation exists between assimilation and chlorophyll *a* values in time (Figs. 3 and 5) and depth (Fig. 4). The assimilation number (carbon uptake divided by chlorophyll) varies considerably, but generally is between 2.0 and 3.0 (Table 3).

2. Replication experiments: Every 7-10 days from 3 July on, 4 sequential water samples were taken from a particular depth, with 2 assimilation experiments run on each of the 4 samples. The eight samples were incubated for 6 hours at about 117 microeinsteins $m^{-2}sec^{-1}$. Ten of these replications at each of 4 depths (5, 10, 20, and 30 m) were run during the summer. The results (Table 4) have been used to establish a basic variability associated with repeated sampling of the water column and to place 95% confidence intervals on the estimate of the mean (Fig. 6). The confidence intervals were calculated using $\bar{X}_{n\,=\,8} \pm t_{.05,\ 7df}\sqrt{\frac{MSE}{n}}$ where $t_{.05,\ 7df} = 2.365$, MSE is the error mean square (Table 5) and n = 8 replicates.

3. Graduated light series: Water samples drawn from a particular depth (5, 10, 20 and 30 m, infrequently from 60 m), were exposed to a series of graduated light intensities (Table 6) by fitting each bottle with mesh screens of various pore sizes. Ten different light intensities plus a dark bottle comprised the series. The absolute assimilations have been subjected to a preliminary analysis wherein the highest assimilation recorded for a series was used to normalize the other assimilation rates. The resultant percentages depict the light intensity at which the greatest photosynthesis usually occurred. The majority of maximum assimilations took place at full light (117 microeinsteins $m^{-2}sec^{-1}$) or at 74% of that (87 microeinsteins $m^{-2}sec^{-1}$). Manifestations of photosynthetic inhibition at full light, especially for samples taken

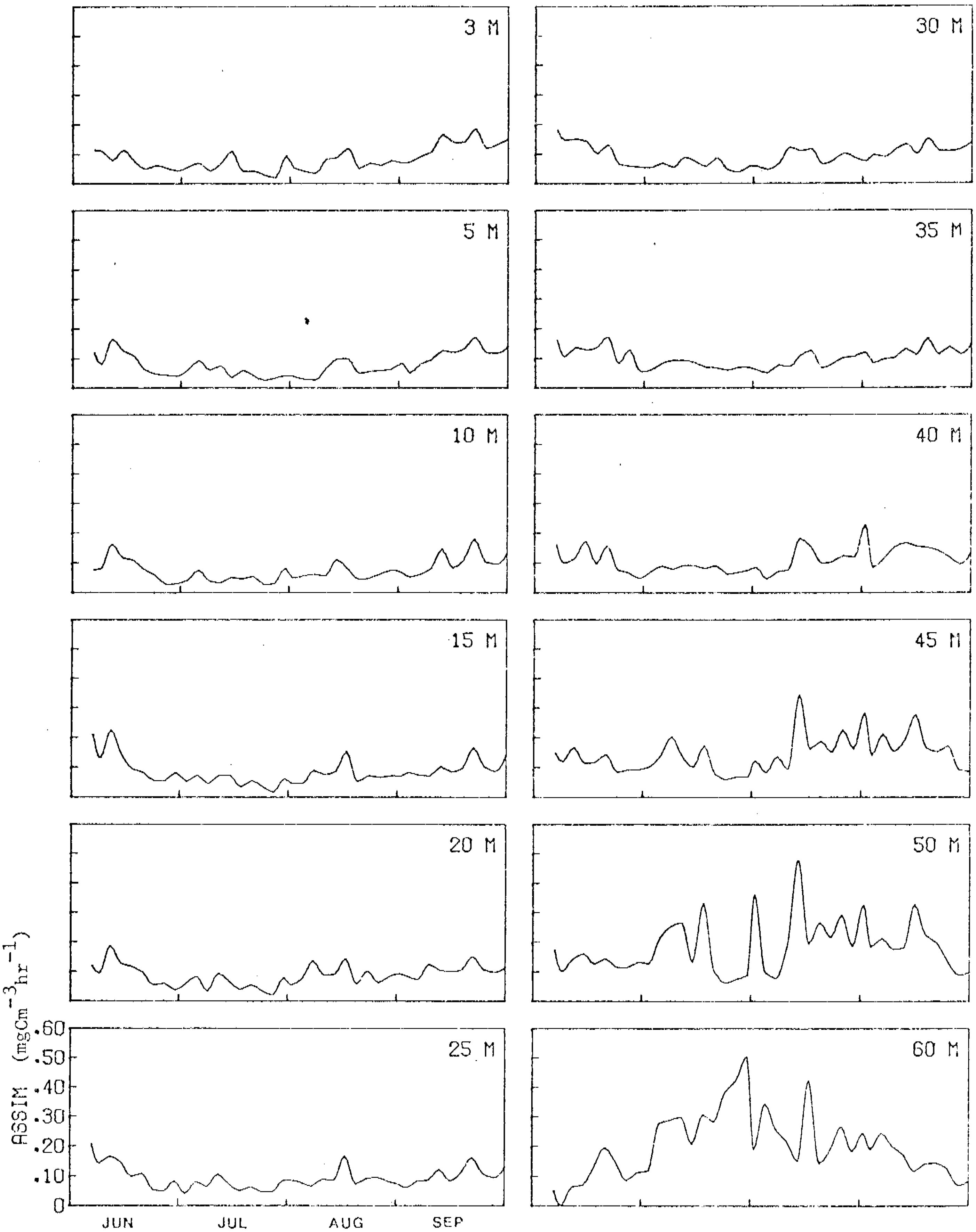

Fig. 5. Net ^{14}C assimilation (mgCm^{-3}hr^{-1}) measured on water samples taken from depths indicated and incubated under constant light during summer of 197[illegible].

Table 4. Results of Replicated ^{14}C Assimilation Experiments

Explanation of Table Values:

1.	Date:	Month, day, year of experiment
2.	Standard:	Total activity (microcuries) added to water sample
3.	Time:	Duration (hours) of incubation
4.	Eff:	Liquid scintillation external standard (e.g. 14) and resultant percentage counting efficiency (e.g. 75.9)
5.	Depth:	Depth (m) of water sampled
6.	Replicate assimilation:	Light, dark, and net assimilation ($mgCm^{-3}hr^{-1}$) for 8 experiments on water samples from same depth. (Darks were not replicated.)
7.	Mean net assimilation	Mean of 8 experiments ($mgCm^{-3}hr^{-1}$)
8.	Standard deviation:	Pertains to above 8 data values
9.	Standard error:	Pertains to mean of above 8 data values $\sqrt{\text{Std dev}/8}$
10.	Coefficient of variation:	Pertains to above 8 data values, the mean divided by standard deviation times 100%

Table 4 (cont.)

DATE 7/ 3/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.038	.038	.044	.037	.029	.047	.042	.036
DARK	.014	.014	.014	.014	.014	.014	.014	.014
NET	.025	.024	.031	.023	.015	.033	.029	.023

MEAN NET ASSIMILATION .0252 MGC/M3/HR
STANDARD DEVIATION .0056 MGC/M3/HR
STANDARD ERROR (N=8) .0020 MGC/M3/HR
COEFFICIENT OF VARIATION 22.10

DATE 7/ 3/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.044	.035	.039	.040	.034	.036	.042	.052
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.031	.022	.026	.027	.021	.023	.029	.039

MEAN NET ASSIMILATION .0273 MGC/M3/HR
STANDARD DEVIATION .0059 MGC/M3/HR
STANDARD ERROR (N=8) .0021 MGC/M3/HR
COEFFICIENT OF VARIATION 21.76

DATE 7/ 4/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.063	.062	.022	.061	.056	.059	.060	.068
DARK	.014	.014	.014	.014	.014	.014	.014	.014
NET	.049	.048	.008	.047	.042	.045	.047	.054

MEAN NET ASSIMILATION .0424 MGC/M3/HR
STANDARD DEVIATION .0142 MGC/M3/HR
STANDARD ERROR (N=8) .0050 MGC/M3/HR
COEFFICIENT OF VARIATION 33.51

DATE 7/ 4/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.043	.051	.074	.072	.053	.052	.085	.080
DARK	.014	.014	.014	.014	.014	.014	.014	.014
NET	.029	.038	.060	.058	.040	.038	.071	.066

MEAN NET ASSIMILATION .0500 MGC/M3/HR
STANDARD DEVIATION .0156 MGC/M3/HR
STANDARD ERROR (N=8) .0055 MGC/M3/HR
COEFFICIENT OF VARIATION 31.22

Table 4 (cont.)

DATE 7/12/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.078	.060	.050	.048	.048	.040	.062	.054
DARK	.017	.017	.017	.017	.017	.017	.017	.017
NET	.061	.044	.034	.031	.031	.023	.046	.038

MEAN NET ASSIMILATION .0385 MGC/M3/HR
STANDARD DEVIATION .0115 MGC/M3/HR
STANDARD ERROR (N=8) .0041 MGC/M3/HR
COEFFICIENT OF VARIATION 30.00

DATE 7/12/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.043	.035	.036	.042	.035	.036	.046	.049
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.028	.020	.021	.027	.020	.021	.031	.034

MEAN NET ASSIMILATION .0254 MGC/M3/HR
STANDARD DEVIATION .0055 MGC/M3/HR
STANDARD ERROR (N=8) .0019 MGC/M3/HR
COEFFICIENT OF VARIATION 21.65

DATE 7/13/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.9

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.045	.043	.050	.051	.059	.055	.057	.055
DARK	.018	.018	.018	.018	.018	.018	.019	.018
NET	.027	.025	.032	.033	.041	.037	.039	.037

MEAN NET ASSIMILATION .0339 MGC/M3/HR
STANDARD DEVIATION .0055 MGC/M3/HR
STANDARD ERROR (N=8) .0019 MGC/M3/HR
COEFFICIENT OF VARIATION 16.09

DATE 7/13/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.068	.078	.049	.058	.094	.101	.054	.056
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.053	.064	.034	.043	.080	.086	.040	.041

MEAN NET ASSIMILATION .0576 MGC/M3/HR
STANDARD DEVIATION .0178 MGC/M3/HR
STANDARD ERROR (N=8) .0063 MGC/M3/HR
COEFFICIENT OF VARIATION 30.91

Table 4 (cont.)

DATE 7/21/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 30/77.0

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.039	.031	.041	.041	.037	.036	.048	.043
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.026	.017	.027	.027	.023	.023	.035	.030

MEAN NET ASSIMILATION .0261 MGC/M3/HR
STANDARD DEVIATION .0052 MGC/M3/HR
STANDARD ERROR (N=8) .0018 MGC/M3/HR
COEFFICIENT OF VARIATION 19.97

DATE 7/21/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.035	.038	.031	.033	.031	.037	.033	.039
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.022	.025	.018	.020	.018	.024	.020	.026

MEAN NET ASSIMILATION .0216 MGC/M3/HR
STANDARD DEVIATION .0032 MGC/M3/HR
STANDARD ERROR (N=8) .0011 MGC/M3/HR
COEFFICIENT OF VARIATION 14.65

DATE 7/22/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 30/77.0

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.025	.025	.035	.032	.052	.036	.044	.046
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.011	.012	.021	.019	.039	.023	.031	.033

MEAN NET ASSIMILATION .0235 MGC/M3/HR
STANDARD DEVIATION .0098 MGC/M3/HR
STANDARD ERROR (N=8) .0035 MGC/M3/HR
COEFFICIENT OF VARIATION 41.63

DATE 7/22/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 30/77.0

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.062	.057	.070	.058	.078	.050	.080	.099
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.047	.042	.055	.043	.063	.035	.065	.084

MEAN NET ASSIMILATION .0544 MGC/M3/HR
STANDARD DEVIATION .0160 MGC/M3/HR
STANDARD ERROR (N=8) .0057 MGC/M3/HR
COEFFICIENT OF VARIATION 29.43

Table 4 (cont.)

DATE 7/30/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.044	.036	.042	.055	.022	.050	.058	.045
DARK	.014	.014	.014	.014	.014	.014	.014	.014
NET	.030	.022	.027	.041	.008	.036	.044	.031

MEAN NET ASSIMILATION .0298 MGC/M3/HR
STANDARD DEVIATION .0115 MGC/M3/HR
STANDARD ERROR (N=8) .0041 MGC/M3/HR
COEFFICIENT OF VARIATION 38.59

DATE 7/30/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.056	.039	.051	.065	.101	.061	.048	.041
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.041	.024	.036	.049	.086	.046	.033	.026

MEAN NET ASSIMILATION .0424 MGC/M3/HR
STANDARD DEVIATION .0195 MGC/M3/HR
STANDARD ERROR (N=8) .0069 MGC/M3/HR
COEFFICIENT OF VARIATION 46.02

DATE 7/31/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.074	.053	.136	.076	.138	.159	.172	.197
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.058	.037	.120	.061	.123	.143	.157	.182

MEAN NET ASSIMILATION .1102 MGC/M3/HR
STANDARD DEVIATION .0522 MGC/M3/HR
STANDARD ERROR (N=8) .0185 MGC/M3/HR
COEFFICIENT OF VARIATION 47.41

DATE 7/31/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.061	.083	.071	.055	.088	.059	.084	.078
DARK	.012	.012	.012	.012	.012	.012	.012	.012
NET	.049	.071	.059	.042	.075	.047	.072	.066

MEAN NET ASSIMILATION .0601 MGC/M3/HR
STANDARD DEVIATION .0128 MGC/M3/HR
STANDARD ERROR (N=8) .0045 MGC/M3/HR
COEFFICIENT OF VARIATION 21.32

Table 4 (cont.)

DATE 8/ 9/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.106	.098	.083	.097	.111	.115	.089	.105
DARK	.014	.014	.014	.014	.014	.014	.014	.014
NET	.093	.085	.070	.083	.097	.102	.075	.091

MEAN NET ASSIMILATION .0869 MGC/M3/HR
STANDARD DEVIATION .0111 MGC/M3/HR
STANDARD ERROR (N=8) .0039 MGC/M3/HR
COEFFICIENT OF VARIATION 12.74

DATE 8/ 9/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.127	.086	.098	.097	.105	.105	.088	.069
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.112	.071	.083	.082	.090	.090	.073	.054

MEAN NET ASSIMILATION .0817 MGC/M3/HR
STANDARD DEVIATION .0169 MGC/M3/HR
STANDARD ERROR (N=8) .0060 MGC/M3/HR
COEFFICIENT OF VARIATION 20.69

DATE 8/ 3/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.147	.127	.182	.137	.171	.190	.196	.172
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.133	.112	.168	.122	.157	.175	.181	.158

MEAN NET ASSIMILATION .1507 MGC/M3/HR
STANDARD DEVIATION .0254 MGC/M3/HR
STANDARD ERROR (N=8) .0090 MGC/M3/HR
COEFFICIENT OF VARIATION 16.84

DATE 8/ 8/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.047	.058	.044	.052	.104	.103	.076	.061
DARK	.016	.016	.016	.016	.016	.016	.016	.016
NET	.032	.043	.029	.036	.089	.087	.061	.046

MEAN NET ASSIMILATION .0527 MGC/M3/HR
STANDARD DEVIATION .0238 MGC/M3/HR
STANDARD ERROR (N=8) .0084 MGC/M3/HR
COEFFICIENT OF VARIATION 45.16

Table 4 (cont.)

DATE 8/18/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.049	.054	.071	.052	.057	.060	.065	.057
DARK	.014	.014	.014	.014	.014	.014	.014	.014
NET	.035	.040	.057	.038	.043	.046	.051	.042

MEAN NET ASSIMILATION .0441 MGC/M3/HR
STANDARD DEVIATION .0071 MGC/M3/HR
STANDARD ERROR (N=8) .0025 MGC/M3/HR
COEFFICIENT OF VARIATION 16.19

DATE 8/18/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.042	.041	.040	.030	.044	.042	.054	.050
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.028	.026	.026	.015	.030	.028	.039	.035

MEAN NET ASSIMILATION .0282 MGC/M3/HR
STANDARD DEVIATION .0071 MGC/M3/HR
STANDARD ERROR (N=8) .0025 MGC/M3/HR
COEFFICIENT OF VARIATION 25.32

DATE 8/17/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.085	.066	.071	.078	.075	.096	.098	.094
DARK	.016	.016	.016	.016	.016	.016	.016	.016
NET	.069	.050	.054	.062	.059	.079	.082	.077

MEAN NET ASSIMILATION .0666 MGC/M3/HR
STANDARD DEVIATION .0121 MGC/M3/HR
STANDARD ERROR (N=8) .0043 MGC/M3/HR
COEFFICIENT OF VARIATION 18.21

DATE 8/17/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.088	.068	.075	.079	.084	.095	.111	.075
DARK	.018	.018	.018	.018	.018	.018	.018	.018
NET	.070	.050	.056	.061	.065	.077	.093	.057

MEAN NET ASSIMILATION .0662 MGC/M3/HR
STANDARD DEVIATION .0138 MGC/M3/HR
STANDARD ERROR (N=8) .0049 MGC/M3/HR
COEFFICIENT OF VARIATION 20.84

Table 4 (cont.)

DATE 8/27/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 36/74.3

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.054	.062	.076	.061	.062	.056	.073	.070
DARK	.018	.018	.018	.018	.018	.018	.018	.018
NET	.036	.044	.059	.044	.044	.038	.055	.053

MEAN NET ASSIMILATION .0467 MGC/M3/HR
STANDARD DEVIATION .0081 MGC/M3/HR
STANDARD ERROR (N=8) .0029 MGC/M3/HR
COEFFICIENT OF VARIATION 17.27

DATE 8/27/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 36/74.3

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.113	.123	.126	.117	.156	.117	.147	.111
DARK	.017	.017	.017	.017	.017	.017	.017	.017
NET	.096	.106	.109	.100	.139	.100	.130	.094

MEAN NET ASSIMILATION .1092 MGC/M3/HR
STANDARD DEVIATION .0166 MGC/M3/HR
STANDARD ERROR (N=8) .0059 MGC/M3/HR
COEFFICIENT OF VARIATION 15.18

DATE 8/26/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 31/76.6

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.121	.081	.122	.102	.117	.128	.112	.131
DARK	.020	.020	.020	.020	.020	.020	.020	.020
NET	.101	.062	.102	.082	.097	.108	.092	.111

MEAN NET ASSIMILATION .0944 MGC/M3/HR
STANDARD DEVIATION .0160 MGC/M3/HR
STANDARD ERROR (N=8) .0057 MGC/M3/HR
COEFFICIENT OF VARIATION 16.96

DATE 8/26/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 36/74.3

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.065	.060	.107	.092	.083	.092	.107	.091
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.050	.045	.092	.077	.068	.078	.092	.076

MEAN NET ASSIMILATION .0722 MGC/M3/HR
STANDARD DEVIATION .0173 MGC/M3/HR
STANDARD ERROR (N=8) .0061 MGC/M3/HR
COEFFICIENT OF VARIATION 23.97

Table 4 (cont.)

DATE 9/ 5/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.095	.098	.110	.135	.191	.127	.135	.127
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.080	.083	.095	.120	.176	.112	.120	.113

MEAN NET ASSIMILATION .1123 MGC/M3/HR
STANDARD DEVIATION .0301 MGC/M3/HR
STANDARD ERROR (N=8) .0106 MGC/M3/HR
COEFFICIENT OF VARIATION 26.78

DATE 9/ 5/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.116	.125	.101	.088	.096	.121	.084	.088
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.103	.113	.089	.075	.083	.109	.071	.075

MEAN NET ASSIMILATION .0898 MGC/M3/HR
STANDARD DEVIATION .0163 MGC/M3/HR
STANDARD ERROR (N=8) .0058 MGC/M3/HR
COEFFICIENT OF VARIATION 18.17

DATE 9/ 4/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 21/77.8

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.086	.070	.085	.096	.078	.083	.104	.091
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.071	.055	.070	.081	.063	.068	.089	.076

MEAN NET ASSIMILATION .0718 MGC/M3/HR
STANDARD DEVIATION .0103 MGC/M3/HR
STANDARD ERROR (N=8) .0036 MGC/M3/HR
COEFFICIENT OF VARIATION 14.37

DATE 9/ 4/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 19/77.3

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.073	.068	.108	.110	.100	.118	.109	.102
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.058	.053	.093	.095	.085	.102	.094	.087

MEAN NET ASSIMILATION .0836 MGC/M3/HR
STANDARD DEVIATION .0181 MGC/M3/HR
STANDARD ERROR (N=8) .0064 MGC/M3/HR
COEFFICIENT OF VARIATION 21.68

Table 4 (cont.)

DATE 9/14/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.109	.124	.133	.196	.170	.127	.193	.171
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.096	.111	.120	.183	.157	.113	.179	.158

MEAN NET ASSIMILATION .1395 MGC/M3/HR
STANDARD DEVIATION .0335 MGC/M3/HR
STANDARD ERROR (N=8) .0119 MGC/M3/HR
COEFFICIENT OF VARIATION 24.03

DATE 9/14/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.131	.080	.114	.115	.100	.184	.111	.110
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.118	.067	.101	.101	.087	.171	.097	.097

MEAN NET ASSIMILATION .1047 MGC/M3/HR
STANDARD DEVIATION .0303 MGC/M3/HR
STANDARD ERROR (N=8) .0107 MGC/M3/HR
COEFFICIENT OF VARIATION 28.97

DATE 9/13/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.109	.121	.096	.097	.097	.107	.106	.101
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.095	.107	.083	.083	.083	.094	.093	.088

MEAN NET ASSIMILATION .0907 MGC/M3/HR
STANDARD DEVIATION .0084 MGC/M3/HR
STANDARD ERROR (N=8) .0030 MGC/M3/HR
COEFFICIENT OF VARIATION 9.31

DATE 9/13/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.113	.125	.107	.114	.100	.117	.092	.096
DARK	.014	.014	.014	.014	.014	.014	.014	.014
NET	.099	.111	.093	.100	.086	.103	.078	.082

MEAN NET ASSIMILATION .0938 MGC/M3/HR
STANDARD DEVIATION .0111 MGC/M3/HR
STANDARD ERROR (N=8) .0039 MGC/M3/HR
COEFFICIENT OF VARIATION 11.86

Table 4 (cont.)

DATE 9/29/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH 5 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.159	.173	.136	.129	.166	.164	.167	.160
DARK	.015	.015	.015	.015	.015	.015	.015	.015
NET	.143	.158	.120	.113	.151	.149	.152	.145

MEAN NET ASSIMILATION .1413 MGC/M3/HR
STANDARD DEVIATION .0160 MGC/M3/HR
STANDARD ERROR (N=8) .0056 MGC/M3/HR
COEFFICIENT OF VARIATION 11.29

DATE 9/29/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH 10 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.145	.145	.164	.165	.166	.167	.172	.164
DARK	.011	.011	.011	.011	.011	.011	.011	.011
NET	.134	.134	.153	.154	.155	.156	.161	.153

MEAN NET ASSIMILATION .1561 MGC/M3/HR
STANDARD DEVIATION .0102 MGC/M3/HR
STANDARD ERROR (N=8) .0036 MGC/M3/HR
COEFFICIENT OF VARIATION 6.82

DATE 9/28/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 10/74.8

DEPTH 20 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.115	.123	.124	.140	.119	.135	.144	.097
DARK	.013	.013	.013	.013	.013	.013	.013	.013
NET	.102	.110	.111	.127	.106	.123	.131	.084

MEAN NET ASSIMILATION .1117 MGC/M3/HR
STANDARD DEVIATION .0152 MGC/M3/HR
STANDARD ERROR (N=8) .0054 MGC/M3/HR
COEFFICIENT OF VARIATION 13.64

DATE 9/28/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 11/75.1

DEPTH 30 M REPLICATED ASSIMILATION (MGC/M3/HR)

LIGHT	.098	.098	.096	.117	.125	.104	.16[illegible]	.122
DARK	.014	.014	.014	.014	.014	.014	.014	.014
NET	.084	.084	.083	.104	.112	.091	.14[illegible]	.108

MEAN NET ASSIMILATION .1018 MGC/M3/HR
STANDARD DEVIATION .0221 MGC/M3/HR
STANDARD ERROR (N=8) .0078 MGC/M3/HR
COEFFICIENT OF VARIATION 21.74

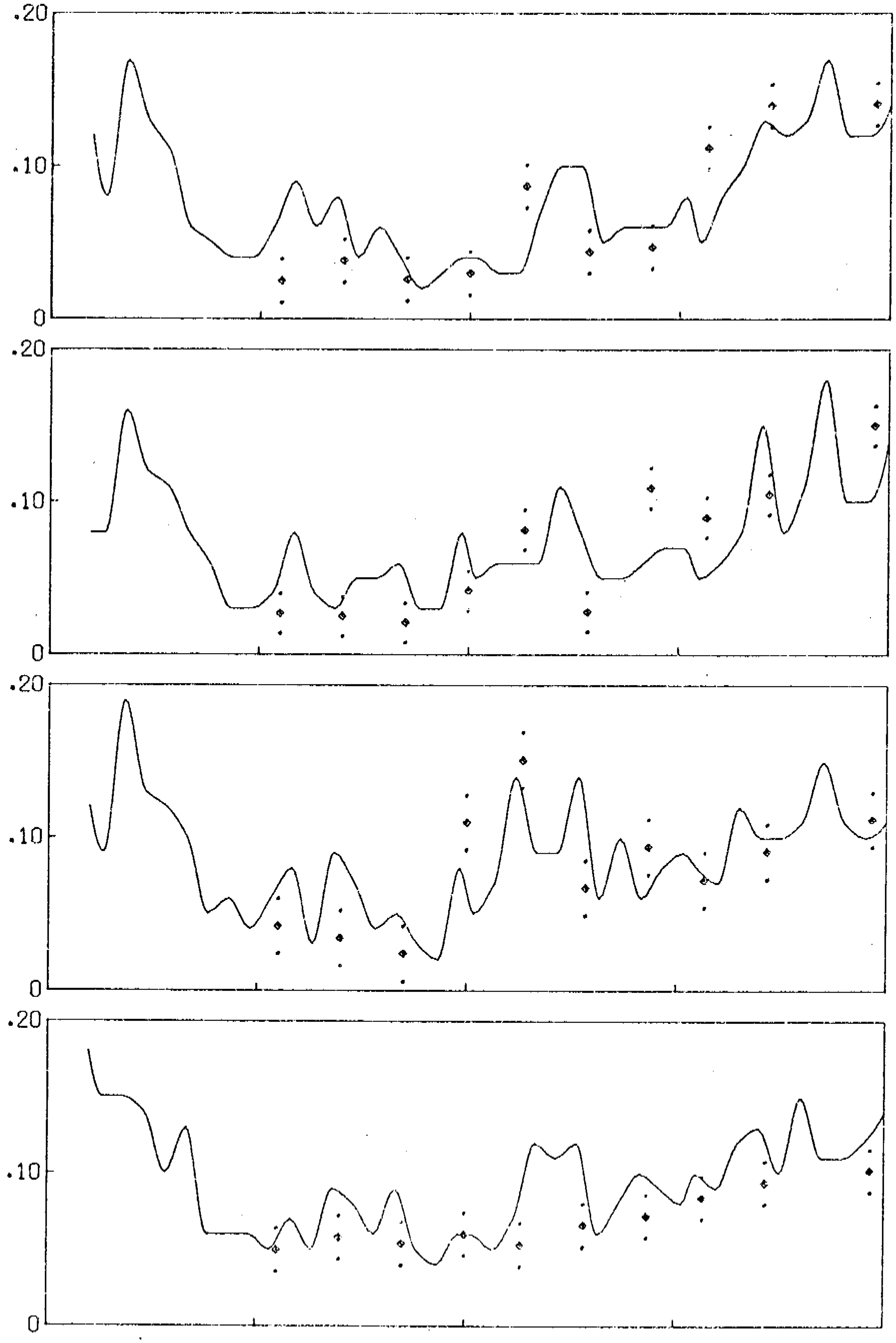

Fig. 6. Results of the replicated ^{14}C assimilation experiments (expressed as the mean (n = 8) ± 2 standard error) overlaid on results of depth series assimilation ($mgCm^{-3}hr^{-1}$) for 5, 10, 20, and 30 m.

Table 5. One-way analysis-of-variance of 10 assimilation experiments, 8 replications per experiment, at each of 4 depths.

Depth	Source	df	SS	MS	F
5 m	Between	9	.15820	.017600	61.37
	Within	70	.02000	.000286	
	Total	79	.1782		
10 m	Between	9	.14643	.016270	68.66
	Within	70	.01659	.000237	
	Total	79	.16302		
20 m	Between	9	.11376	.012640	27.85
	Within	70	.03177	.000454	
	Total	79	.14553		
30 m	Between	9	.023819	.002647	8.89
	Within	70	.020840	.000298	
	Total	79	.044659		

Table 6. Results of Graduated Light Series ^{14}C Assimilation Experiments.

Explanation of Table Values:

1.	Date:	Month, day, year of experiment
2.	Standard:	Total activities (microcuries) added to water sample
3.	Time:	Duration (hours) of incubation
4.	Eff:	Liquid scintillation external standard (e.g. 12) and resultant percentage counting efficienc (e.g. 75.4)
5.	Depth:	Depth (m) of water sample
6.	Dark Assim:	Dark bottle assimilation ($mgCm^{-3}hr^{-1}$)
7.	Light:	Light intensity (microeinsteins $m^{-2}sec^{-1}$) in incubation box during experiment
8.	Max:	Light intensity expressed as percentage of maximum light in box (i.e., % of 117 microeinsteins $m^{-2}sec^{-1}$)
9.	Assim:	Light, net assimilation ($mgCm^{-3}hr^{-1}$) and net assimilation normalized on, and expressed as a percentage of, the maximum net assimilation that occurred during the experiment
10.	Normalized:	Net assimilation normalized on light intensity

Table 6 (cont.)

DATE 6/ 9/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 12/75.4

DEPTH 10. M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	3	.00268
5.0	4	.03	.02	10	.00362
7.0	6	.04	.02	13	.00345
10.0	8	.05	.04	21	.00396
17.0	14	.08	.07	37	.00407
19.0	16	.10	.09	49	.00484
22.0	19	.12	.10	55	.00473
57.0	49	.17	.16	86	.00285
87.0	74	.16	.15	80	.00175
117.0	100	.20	.19	100	.00162

DATE 6/ 9/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	N	MAX	NORMALIZED A/L
2.0	2	.01	.00	1	.00067
5.0	4	.03	.02	10	.00308
7.0	6	.04	.02	16	.00353
10.0	8	.06	.05	32	.00488
17.0	14	.07	.06	41	.00362
19.0	16	.09	.08	52	.00415
22.0	19	.09	.08	55	.00374
57.0	49	.16	.15	100	.00264
87.0	74	.15	.13	86	.00153
117.0	100	.15	.14	90	.00115

DATE 6/10/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	2	.00167
5.0	4	.04	.03	16	.00546
7.0	6	.04	.03	20	.00428
10.0	8	.06	.05	32	.00490
17.0	14	.08	.07	46	.00392
19.0	16	.09	.08	52	.00417
22.0	19	.11	.09	63	.00430
57.0	49	.15	.14	94	.00250
87.0	74	.16	.15	100	.00174
117.0	100	.16	.15	96	.00125

Table 6 (cont.)

DATE 6/13/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.01	.00	1	.00067
5.0	4	.02	.01	11	.00241
7.0	6	.03	.02	17	.00277
10.0	8	.04	.03	24	.00267
17.0	14	.07	.06	51	.00334
19.0	16	.08	.06	57	.00338
22.0	19	.08	.07	59	.00298
57.0	49	.11	.10	88	.00172
87.0	74	.12	.11	100	.00128
117.0	100	.11	.10	90	.00085

DATE 6/12/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.03	.02	14	.00936
5.0	4	.03	.02	13	.00349
7.0	6	.04	.03	18	.00363
10.0	8	.05	.04	27	.00368
17.0	14	.07	.05	43	.00350
19.0	16	.08	.07	53	.00384
22.0	19	.10	.08	61	.00380
57.0	49	.11	.10	72	.00175
87.0	74	.15	.14	100	.00158
117.0	100	.14	.12	90	.00106

DATE 6/12/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.01	.00	3	.00133
5.0	4	.01	.00	1	.00013
7.0	6	.02	.01	9	.00133
10.0	8	.04	.02	23	.00240
17.0	14	[illegible]	.03	25	.00157
19.0	16	[illegible]	.03	29	.00161
22.0	19	.05	.03	32	.00154
57.0	49	.10	.06	[illegible]	.00146
87.0	74	.12	.10	100	.00120
117.0	100	.11	[illegible]	[illegible]	[illegible]

Table 6 (cont.)

DATE 6/13/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	M	MAX	A/L
2.0	2	.01	.00	1	.00067
5.0	4	.02	.01	9	.00187
7.0	6	.03	.01	14	.00209
10.0	8	.03	.02	18	.00187
17.0	14	.04	.03	32	.00196
19.0	16	.06	.05	45	.00242
22.0	19	.05	.04	41	.00191
57.0	49	.10	.08	82	.00148
87.0	74	.11	.10	95	.00113
117.0	100	.11	.10	100	.00088

DATE 6/15/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	M	MAX	A/L
2.0	2	.01	.00	0	.00000
5.0	4	.01	.01	11	.00107
7.0	6	.02	.01	20	.00133
10.0	8	.02	.01	31	.00147
17.0	14	.03	.02	46	.00129
19.0	16	.04	.03	56	.00140
22.0	19	.03	.02	41	.00088
57.0	49	.05	.04	77	.00064
87.0	74	.06	.05	99	.00054
117.0	100	.06	.05	100	.00040

DATE 6/15/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	M	MAX	A/L
2.0	2	.01	.00	2	.00067
5.0	4	.02	.01	9	.00147
7.0	6	.02	.01	15	.00181
10.0	8	.03	.01	18	.00147
17.0	14	.04	.03	33	.00157
19.0	16	.05	.04	49	.00210
22.0	19	.05	.04	43	.00161
57.0	49	.09	.07	90	.00130
87.0	74	.09	.08	99	.00093
117.0	100	.09	.09	100	.00070

Table 6 (cont.)

DATE 6/16/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.01	.00	0	.00000
5.0	4	.02	.01	8	.00120
7.0	6	.02	.01	15	.00161
10.0	8	.03	.02	25	.00179
17.0	14	.04	.03	42	.00180
19.0	16	.05	.04	54	.00206
22.0	19	.05	.04	54	.00178
57.0	49	.09	.07	100	.00128
87.0	74	.08	.07	96	.00081
117.0	100	.08	.07	96	.00060

DATE 6/16/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	8	.00271
5.0	4	.02	.01	12	.00162
7.0	6	.03	.02	22	.00222
10.0	8	.03	.02	29	.00203
17.0	14	.05	.04	58	.00239
19.0	16	.06	.05	67	.00246
22.0	19	.05	.04	52	.00166
57.0	49	.06	.05	71	.00087
87.0	74	.07	.05	76	.00061
117.0	100	.08	.07	100	.00060

DATE 6/18/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	12	.00338
5.0	4	.02	.01	20	.00230
7.0	6	.02	.01	17	.00145
10.0	8	.03	.01	26	.00149
17.0	14	.04	.03	50	.00171
19.0	16	.05	.04	67	.00206
22.0	19	.05	.04	63	.00166
57.0	49	.07	.05	92	.00094
87.0	74	.07	.06	97	.00065
117.0	100	.07	.06	100	.00050

Table 6 (cont.)

DATE 6/18/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	9	.00304
5.0	4	.02	.01	12	.00162
7.0	6	.03	.01	21	.00213
10.0	8	.03	.02	22	.00156
17.0	14	.05	.04	53	.00219
19.0	16	.05	.04	53	.00196
22.0	19	.06	.05	65	.00209
57.0	49	.08	.06	92	.00114
87.0	74	.08	.07	94	.00076
117.0	100	.08	.07	100	.00060

DATE 6/19/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 36/74.8

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	13	.00406
5.0	4	.03	.02	30	.00365
7.0	6	.03	.02	28	.00242
10.0	8	.03	.02	33	.00196
17.0	14	.04	.03	49	.00175
19.0	16	.05	.04	60	.00189
22.0	19	.05	.03	56	.00154
57.0	49	.07	.06	100	.00106
87.0	74	.06	.05	87	.00060
117.0	100	.07	.06	94	.00049

DATE 6/19/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	3	.00168
5.0	4	.03	.02	14	.00336
7.0	6	.04	.03	23	.00384
10.0	8	.04	.03	25	.00309
17.0	14	.07	.06	52	.00364
19.0	16	.08	.07	58	.00368
22.0	19	.09	.08	65	.00351
57.0	49	.12	.11	90	.00184
87.0	74	.13	.12	100	.00136
117.0	100	.13	.11	96	.00097

Table 6 (cont.)

DATE 6/21/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 27/78.4

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.01	.00	1	.00032
5.0	4	.01	.00	0	.00000
7.0	6	.02	.01	18	.00129
10.0	8	.02	.01	22	.00110
17.0	14	.03	.02	38	.00114
19.0	16	.04	.03	61	.00163
22.0	19	.04	.02	43	.00100
57.0	49	.06	.04	86	.00077
87.0	74	.06	.05	96	.00056
117.0	100	.06	.05	100	.00044

DATE 6/22/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 27/78.4

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	3	.00097
5.0	4	.02	.00	6	.00077
7.0	6	.03	.01	15	.00138
10.0	8	.03	.02	28	.00174
17.0	14	.04	.03	44	.00163
19.0	16	.04	.02	38	.00126
22.0	19	.04	.03	41	.00117
57.0	49	.07	.05	82	.00091
87.0	74	.08	.06	100	.00073
117.0	100	.07	.05	86	.00046

DATE 6/22/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 27/78.4

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	9	.00258
5.0	4	.02	.00	8	.00090
7.0	6	.02	.01	12	.00101
10.0	8	.03	.02	27	.00155
17.0	14	.05	.03	52	.00175
19.0	16	.04	.03	49	.00149
22.0	19	.05	.03	60	.00155
57.0	49	.07	.05	93	.00093
87.0	74	.07	.06	99	.00065
117.0	100	.07	.06	100	.00049

Table 6 (cont.)

DATE 6/24/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 27/78.4

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	13	.00258
5.0	4	.03	.01	27	.00219
7.0	6	.03	.01	34	.00194
10.0	8	.03	.01	27	.00110
17.0	14	.03	.01	37	.00087
19.0	16	.03	.02	40	.00085
22.0	19	.04	.02	60	.00109
57.0	49	.05	.04	100	.00070
87.0	74	.05	.04	100	.00046
117.0	100	.05	.04	97	.00033

DATE 6/24/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 27/78.4

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	8	.00161
5.0	4	.01	.00	0	.00000
7.0	6	.02	.00	10	.00055
10.0	8	.02	.00	6	.00032
17.0	14	.03	.01	39	.00087
19.0	16	.03	.01	32	.00065
22.0	19	.03	.02	49	.00085
57.0	49	.05	.04	98	.00066
87.0	74	.04	.03	80	.00035
117.0	100	.05	.04	100	.00033

DATE 6/25/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 27/78.4

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	3	.00065
5.0	4	.02	.01	13	.00129
7.0	6	.02	.01	21	.00147
10.0	8	.03	.01	30	.00148
17.0	14	.04	.03	61	.00175
19.0	16	.04	.02	50	.00129
22.0	19	.05	.04	76	.00170
57.0	49	.05	.03	71	.00061
87.0	74	.06	.05	100	.00056
117.0	100	.05	.04	76	.00032

Table 6 (cont.)

DATE 6/25/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.01	.00	1	.00032
5.0	4	.02	.00	5	.00064
7.0	6	.02	.01	15	.00129
10.0	8	.03	.01	19	.00116
17.0	14	.04	.03	51	.00178
19.0	16	.04	.03	48	.00152
22.0	19	.05	.03	55	.00149
57.0	49	.06	.05	75	.00079
87.0	74	.07	.05	92	.00064
117.0	100	.07	.05	100	.00051

DATE 6/27/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.01	.00	2	.00064
5.0	4	.02	.01	15	.00180
7.0	6	.03	.01	19	.00165
10.0	8	.03	.02	28	.00167
17.0	14	.03	.02	31	.00110
19.0	16	.05	.04	66	.00207
22.0	19	.04	.02	33	.00102
57.0	49	.07	.06	92	.00097
87.0	74	.04	.02	39	.00027
117.0	100	.07	.05	100	.00051

DATE 6/27/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	8	.00129
5.0	4	.02	.01	24	.00154
7.0	6	.03	.01	40	.00184
10.0	8	.02	.01	28	.00090
17.0	14	.03	.01	44	.00083
19.0	16	.03	.02	52	.00088
22.0	19	.03	.01	42	.00061
57.0	49	.04	.03	94	.00053
87.0	74	.04	.03	85	.00032
117.0	100	.05	.03	100	.00028

Table 6 (cont.)

DATE 6/28/75 STANDARD 7.70 UC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	15	.00322
5.0	4	.02	.00	9	.00077
7.0	6	.03	.01	23	.00175
10.0	8	.03	.01	31	.00135
17.0	14	.04	.02	50	.00122
19.0	16	.04	.02	50	.00115
22.0	19	.04	.02	51	.00102
57.0	49	.06	.04	99	.00076
87.0	74	.05	.04	94	.00047
117.0	100	.06	.04	100	.00037

DATE 6/28/75 STANDARD 7.70 UC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	20	.00386
5.0	4	.02	.00	8	.00064
7.0	6	.02	.01	16	.00101
10.0	8	.03	.01	38	.00148
17.0	14	.04	.03	66	.00151
19.0	16	.04	.03	70	.00146
22.0	19	.05	.04	93	.00167
57.0	49	.05	.04	90	.00062
87.0	74	.05	.04	97	.00044
117.0	100	.05	.04	100	.00034

DATE 6/30/75 STANDARD 7.70 UC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	5	.00100
5.0	4	.01	.00	4	.00027
7.0	6	.02	.00	6	.00032
10.0	8	.02	.01	25	.00050
17.0	14	.02	.01	35	.00067
19.0	16	.02	.01	29	.00062
22.0	19	.03	.01	41	.00052
57.0	49	.05	.03	100	.00056
87.0	74	.04	.03	81	.00030
117.0	100	.04	.03	[illegible]	.00023

Table 6 (cont.)

DATE 6/30/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.01	.00	0	.00000
5.0	4	.01	.00	8	.00027
7.0	6	.01	.00	14	.00048
10.0	8	.01	.00	15	.00027
17.0	14	.02	.01	62	.00063
19.0	16	.02	.01	58	.00053
22.0	19	.02	.01	53	.00045
57.0	49	.03	.02	83	.00027
87.0	74	.03	.02	88	.00018
117.0	100	.03	.02	100	.00015

DATE 7/ 1/75 STANDARD 7.70 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	13	.00233
5.0	4	.02	.00	11	.00080
7.0	6	.03	.01	40	.00200
10.0	8	.03	.02	58	.00207
17.0	14	.03	.02	55	.00114
19.0	16	.04	.02	62	.00116
22.0	19	.03	.02	58	.00094
57.0	49	.05	.03	94	.00058
87.0	74	.05	.03	98	.00040
117.0	100	.05	.04	100	.00030

DATE 7/ 1/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	20	.00274
5.0	4	.01	.00	12	.00053
7.0	6	.02	.01	20	.00078
10.0	8	.02	.01	37	.00103
17.0	14	.03	.02	83	.00137
19.0	16	.02	.02	73	.00108
22.0	19	.03	.02	71	.00095
57.0	49	.04	.03	100	.00069
87.0	74	.04	.03	98	.00031
117.0	100	.04	.03	95	.00022

Table 6 (cont.)

DATE 7/ 3/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.01	.00	3	.00034
5.0	4	.02	.01	26	.00137
7.0	6	.02	.01	23	.00083
10.0	9	.02	.01	36	.00096
17.0	14	.03	.02	56	.00089
19.0	16	.02	.01	31	.00043
22.0	19	.03	.02	59	.00072
57.0	49	.04	.03	100	.00047
87.0	74	.04	.03	97	.00030
117.0	100	.04	.02	92	.00021

DATE 7/ 3/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 14/75.9

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.01	.00	0	.00000
5.0	4	.02	.01	22	.00137
7.0	6	.03	.01	40	.00176
10.0	8	.02	.01	18	.00055
17.0	14	.02	.01	31	.00056
19.0	16	.02	.01	29	.00047
22.0	19	.02	.01	36	.00050
57.0	49	.04	.02	78	.00042
87.0	74	.04	.03	82	.00029
117.0	100	.04	.03	100	.00026

DATE 7/ 4/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 25/74.8

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.03	.01	25	.00625
5.0	4	.04	.03	51	.00514
7.0	6	.06	.04	84	.00605
10.0	8	.04	.02	48	.00243
17.0	14	.05	.03	63	.00188
19.0	16	.06	.05	90	.00241
22.0	19	.05	.03	58	.00133
57.0	49	.07	.05	100	.00089
87.0	74	.06	.04	86	.00051
117.0	100	.06	.05	89	.00039

Table 6 (cont.)

DATE 7/ 6/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	6	.00138
5.0	4	.02	.00	8	.00069
7.0	6	.03	.01	27	.00168
10.0	8	.03	.01	23	.00097
17.0	14	.04	.02	47	.00118
19.0	16	.04	.03	61	.00139
22.0	19	.04	.02	42	.00082
57.0	49	.05	.03	73	.00054
87.0	74	.06	.04	100	.00049
117.0	100	.04	.03	60	.00022

DATE 7/ 6/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	14	.00310
5.0	4	.02	.00	10	.00083
7.0	6	.02	.01	24	.00147
10.0	8	.03	.01	29	.00124
17.0	14	.03	.02	36	.00097
19.0	16	.03	.02	45	.00105
22.0	19	.03	.02	37	.00072
57.0	49	.05	.04	85	.00065
87.0	74	.05	.04	97	.00048
117.0	100	.06	.04	100	.00037

DATE 7/ 6/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	21	.00241
5.0	4	.01	.00	3	.00014
7.0	6	.02	.00	12	.00039
10.0	8	.02	.01	35	.00083
17.0	14	.02	.01	30	.00040
19.0	16	.02	.01	33	.00047
22.0	19	.03	.01	58	.00059
57.0	49	.03	.02	75	.00030
87.0	74	.04	.02	100	.00026
117.0	100	.04	.02	100	.00019

Table 6 (cont.)

DATE 7/ 7/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 33/75.2

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	II	MAX	NORMALIZED A/L
2.0	2	.02	.01	13	.00275
5.0	4	.02	.00	5	.00041
7.0	6	.02	.00	8	.00049
10.0	8	.02	.00	7	.00028
17.0	14	.02	.01	22	.00053
19.0	16	.03	.02	48	.00105
22.0	19	.04	.02	52	.00097
57.0	49	.05	.04	93	.00068
87.0	74	.06	.04	100	.00047
117.0	100	.06	.04	100	.00035

DATE 7/ 7/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	II	MAX	NORMALIZED A/L
2.0	2	.01	.00	7	.00103
5.0	4	.01	.00	0	.00000
7.0	6	.02	.00	9	.00039
10.0	8	.01	.00	7	.00021
17.0	14	.02	.01	29	.00052
19.0	16	.02	.01	29	.00047
22.0	19	.02	.01	38	.00053
57.0	49	.03	.02	73	.00040
87.0	74	.04	.03	96	.00034
117.0	100	.04	.03	100	.00026

DATE 7/ 9/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 5 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	II	MAX	NORMALIZED A/L
2.0	2	.02	.01	14	.00307
5.0	4	.02	.01	32	.00273
7.0	6	.02	.00	8	.00049
10.0	8	.02	.00	6	.00027
17.0	14	.03	.01	22	.00056
19.0	16	.03	.01	21	.00047
22.0	19	.03	.01	22	.00043
57.0	49	[illegible]	[illegible]	71	.00054
87.0	74	[illegible]	.04	95	.00047
117.0	100	[illegible]	[illegible]	100	.00037

Table 6 (cont.)

DATE 7/ 9/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	9	.00206
5.0	4	.02	.00	5	.00041
7.0	6	.02	.00	6	.00039
10.0	8	.02	.00	6	.00027
17.0	14	.03	.01	31	.00081
19.0	16	.03	.02	37	.00087
22.0	19	.03	.02	43	.00087
57.0	49	.05	.03	68	.00053
87.0	74	.06	.04	100	.00051
117.0	100	.06	.04	97	.00037

DATE 7/10/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	0	.00000
5.0	4	.04	.02	34	.00412
7.0	6	.03	.02	28	.00235
10.0	8	.03	.01	20	.00117
17.0	14	.04	.02	41	.00145
19.0	16	.04	.02	34	.00108
22.0	19	.04	.02	35	.00103
57.0	49	.07	.05	90	.00094
87.0	74	.08	.06	93	.00067
117.0	100	.08	.06	100	.00051

DATE 7/10/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	0	.00009
5.0	4	.02	.01	11	.00109
7.0	6	.03	.02	33	.00224
10.0	8	.02	.01	15	.00073
17.0	14	.04	.02	31	.00116
19.0	16	.03	.01	26	.00065
22.0	19	.04	.02	60	.00087
57.0	49	.07	.05	100	.00044
87.0	74	.05	.03	73	.00040
117.0	100	.05	.04	77	.00031

Table 6 (cont.)

DATE 7/12/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 5 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.03	.02	30	.00905
5.0	4	.02	.00	5	.00067
7.0	6	.03	.02	27	.00239
10.0	8	.02	.00	8	.00047
17.0	14	.04	.02	35	.00126
19.0	16	.03	.01	24	.00078
22.0	19	.04	.03	43	.00119
57.0	49	.07	.05	79	.00085
87.0	74	.07	.05	85	.00059
117.0	100	.08	.06	100	.00052

DATE 7/12/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	36	.00503
5.0	4	.02	.00	14	.00080
7.0	6	.02	.01	24	.00096
10.0	8	.03	.01	48	.00134
17.0	14	.03	.02	64	.00106
19.0	16	.02	.01	31	.00046
22.0	19	.03	.02	60	.00076
57.0	49	.04	.03	95	.00047
87.0	74	.04	.02	81	.00026
117.0	100	.04	.03	100	.00024

DATE 7/13/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 28/77.9

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	4	.00233
5.0	4	.02	.00	0	.00000
7.0	6	.03	.01	13	.00200
10.0	8	.03	.01	13	.00140
17.0	14	.03	.01	8	.00051
19.0	16	.03	.01	8	.00049
22.0	19	.03	.01	11	.00055
57.0	49	.13	.11	100	.00194
87.0	74	.04	.03	23	.00029
117.0	100	.05	.03	25	.00024

Table 6 (cont.)

DATE 7/13/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	N	MAX	NORMALIZED A/L
2.0	2	.04	.03	49	.01307
5.0	4	.02	.01	16	.00174
7.0	6	.03	.01	28	.00211
10.0	9	.03	.01	28	.00147
17.0	14	.06	.04	78	.00244
19.0	16	.04	.02	42	.00116
22.0	19	.04	.03	56	.00134
57.0	49	.06	.04	80	.00074
87.0	74	.06	.05	90	.00055
117.0	100	.07	.05	100	.00045

DATE 7/15/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 28/77.9

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	13	.00200
5.0	4	.03	.01	37	.00227
7.0	6	.04	.03	96	.00419
10.0	8	.04	.02	78	.00240
17.0	14	.03	.02	63	.00114
19.0	16	.02	.01	24	.00039
22.0	19	.04	.03	85	.00118
57.0	49	.04	.03	87	.00047
87.0	74	.04	.03	100	.00035
117.0	100	.04	.03	91	.00024

DATE 7/15/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	12	.00302
5.0	4	.03	.01	26	.00255
7.0	6	.03	.02	34	.00239
10.0	8	.03	.01	27	.00134
17.0	14	.03	.02	30	.00103
19.0	16	.04	.02	45	.00116
22.0	19	.03	.02	42	.00094
57.0	49	.05	.04	75	.00065
87.0	74	.05	.04	82	.00046
117.0	100	.06	.05	100	.00042

Table 6 (cont.)

DATE 7/16/78 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	M	MAX	A/L
2.0	2	.02	.00	0	.00101
5.0	4	.04	.02	48	.00335
7.0	6	.03	.01	21	.00105
10.0	8	.02	.01	17	.00060
17.0	14	.03	.01	27	.00055
19.0	16	.03	.01	37	.00067
22.0	19	.03	.01	35	.00055
57.0	49	.05	.03	93	.00060
87.0	74	.04	.03	75	.00030
117.0	100	.05	.03	100	.00030

DATE 7/16/78 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	M	MAX	A/L
2.0	2	.02	.00	8	.00201
5.0	4	.03	.01	29	.00201
7.0	6	.02	.01	12	.00086
10.0	8	.03	.01	19	.00094
17.0	14	.05	.04	76	.00221
19.0	16	.05	.03	57	.00148
22.0	19	.03	.02	34	.00076
57.0	49	.05	.04	73	.00063
87.0	74	.07	.05	100	.00057
117.0	100	.07	.05	95	.00041

DATE 7/19/78 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	M	MAX	A/L
2.0	2	.02	.01	20	.00299
5.0	4	.02	.00	13	.00080
7.0	6	.03	.02	51	.00213
10.0	8	.02	.01	29	.00096
17.0	14	.02	.01	22	.00039
19.0	16	.04	.02	55	.00091
22.0	19	.02	.01	24	.00039
57.0	49	.03	.02	57	.00035
87.0	74	.05	.03	80	.00031
117.0	100	.06	.03	100	.00026

Table 6 (cont.)

DATE 7/18/7[illegible] STANDARD 7.50 MC/AMP TIME 6.0 HR EFF [illegible]/77.5

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	19	.00299
5.0	4	.02	.01	19	.00119
7.0	6	.03	.01	47	.00209
10.0	8	.02	.01	32	.00100
17.0	14	.03	.01	45	.00082
19.0	16	.02	.01	19	.00031
22.0	19	.03	.01	40	.00057
57.0	49	.04	.03	96	.00052
87.0	74	.04	.03	94	.00034
117.0	100	.05	.03	100	.00027

DATE 7/19/7[illegible] STANDARD 7.50 MC/AMP TIME 6.0 HR EFF [illegible]/77.5

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.03	.01	27	.00568
5.0	4	.03	.02	42	.00361
7.0	6	.03	.02	47	.00286
10.0	9	.04	.02	53	.00227
17.0	14	.03	.01	34	.00086
19.0	16	.04	.02	50	.00113
22.0	19	.04	.02	48	.00094
57.0	49	.05	.04	85	.00064
87.0	74	.05	.04	91	.00045
117.0	100	.06	.04	100	.00037

DATE 7/19/7[illegible] STANDARD 7.50 MC/AMP TIME 6.0 HR EFF [illegible]/77.0

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (UE/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	[illegible]	.00101
5.0	4	.02	.01	10	[illegible]
7.0	6	.03	.01	20	.00154
10.0	[illegible]	.03	.01	[illegible]	[illegible]
17.0	[illegible]	[illegible]	.02	[illegible]	.00123
19.0	[illegible]	.04	.02	35	[illegible]
22.0	[illegible]	[illegible]	.02	35	.00084
57.0	[illegible]	.05	.04	70	[illegible]
87.0	74	[illegible]	.04	78	.00048
[illegible]	[illegible]	[illegible]	.05	100	.00046

Table 6 (cont.)

DATE 7/21/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 30/77.0

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.02	.00	10	.00134
5.0	4	.02	.01	28	.00147
7.0	6	.02	.01	23	.00086
10.0	8	.02	.00	10	.00027
17.0	14	.02	.00	18	.00027
19.0	16	.02	.01	23	.00032
22.0	19	.03	.01	56	.00067
57.0	49	.04	.02	90	.00041
87.0	74	.04	.02	85	.00025
117.0	100	.04	.03	100	.00022

DATE 7/21/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 30/77.0

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.02	.00	19	.00200
5.0	4	.02	.01	34	.00147
7.0	6	.02	.01	25	.00076
10.0	8	.02	.01	26	.00060
17.0	14	.02	.01	28	.00035
19.0	16	.02	.00	19	.00021
22.0	19	.02	.00	22	.00021
57.0	49	.03	.01	66	.00025
87.0	74	.03	.02	75	.00018
117.0	100	.03	.02	100	.00018

DATE 7/22/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 30/77.0

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.02	.01	32	.00268
5.0	4	.02	.00	20	.00057
7.0	6	.03	.01	68	.00163
10.0	8	.02	.01	32	.00054
17.0	14	.02	.01	48	.00047
19.0	16	.02	.00	16	.00014
22.0	19	.02	.00	12	.00009
57.0	49	.03	.01	72	.00021
87.0	74	.03	.02	100	.00019
117.0	100	.02	.01	50	.00009

Table 6 (cont.)

DATE 7/22/75 STANDARD 7.50 MC/AMP TIME 6.0 HR FFF 33/76.6

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.02	.00	1	.00034
5.0	4	.02	.01	12	.00122
7.0	6	.03	.01	20	.00145
10.0	8	.02	.01	18	.00088
17.0	14	.03	.01	26	.00076
19.0	16	.04	.02	39	.00104
22.0	19	.03	.01	30	.00068
57.0	49	.06	.05	91	.00080
87.0	74	.07	.05	100	.00058
117.0	100	.06	.05	93	.00040

DATE 7/25/75 STANDARD 7.50 MC/AMP TIME 6.0 HR FFF 34/75.2

DEPTH 5 M DARK ASSIM .02 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.02	.00	19	.00204
5.0	4	.02	.01	25	.00109
7.0	6	.02	.01	31	.00097
10.0	8	.02	.01	31	.00068
17.0	14	.02	.01	34	.00044
19.0	16	.03	.01	44	.00050
22.0	19	.02	.01	28	.00028
57.0	49	.03	.02	75	.00029
87.0	74	.04	.02	100	.00025
117.0	100	.03	.02	81	.00015

DATE 7/25/75 STANDARD 7.50 MC/AMP TIME 6.0 HR FFF 35/74.8

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.02	.00	17	.00171
5.0	4	.02	.00	7	.00027
7.0	6	.02	.00	7	.00020
10.0	8	.02	.00	20	.00041
17.0	14	.03	.02	100	.00121
19.0	16	.02	.00	10	.00011
22.0	19	.02	.00	17	.00016
57.0	49	.02	.01	47	.00017
87.0	74	.03	.01	67	.00016
117.0	100	.03	.02	93	.00016

Table 6 (cont.)

DATE 7/24/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	10	.00138
5.0	4	.02	.00	12	.00069
7.0	6	.02	.01	26	.00108
10.0	8	.02	.01	19	.00055
17.0	14	.02	.00	17	.00028
19.0	16	.02	.01	29	.00044
22.0	19	.02	.01	26	.00034
57.0	49	.04	.02	74	.00038
87.0	74	.04	.03	98	.00033
117.0	100	.05	.03	100	.00025

DATE 7/24/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	8	.00138
5.0	4	.02	.00	0	.00000
7.0	6	.02	.00	8	.00040
10.0	8	.02	.01	17	.00055
17.0	14	.02	.00	10	.00020
19.0	16	.03	.01	33	.00058
22.0	19	.02	.01	17	.00025
57.0	49	.04	.02	71	.00041
87.0	74	.04	.03	77	.00029
117.0	100	.05	.03	100	.00028

DATE 7/27/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 30/77.0

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	42	.00497
5.0	4	.02	.01	31	.00146
7.0	6	.01	.00	3	.00009
10.0	8	.02	.01	42	.00099
17.0	14	.02	.01	36	.00051
19.0	16	.02	.01	39	.00049
22.0	19	.02	.01	39	.00042
57.0	49	.03	.02	69	.00029
87.0	74	.04	.02	100	.00027
117.0	100	.04	.02	100	.00020

Table 6 (cont.)

DATE 7/28/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 31/76.6

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.01	-.00	-5	-.00072
5.0	4	.02	.01	22	.00115
7.0	6	.02	.01	35	.00134
10.0	8	.04	.02	92	.00245
17.0	14	.03	.02	68	.00106
19.0	16	.02	.01	19	.00027
22.0	19	.02	.01	24	.00029
57.0	49	.03	.01	49	.00023
87.0	74	.04	.02	84	.00026
117.0	100	.04	.03	100	.00023

DATE 7/27/75 STANDARD 7.50 MC/AMP TIME 6.0 HR EFF 31/76.6

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.01	.00	0	.00000
5.0	4	.02	.00	12	.00061
7.0	6	.02	.00	6	.00029
10.0	8	.02	.01	24	.00081
17.0	14	.03	.01	41	.00079
19.0	16	.02	.01	24	.00043
22.0	19	.03	.01	37	.00055
57.0	49	.04	.02	65	.00038
87.0	74	.05	.03	100	.00038
117.0	100	.04	.03	82	.00023

DATE 7/27/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 31/76.6

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	7	.00146
5.0	4	.02	.00	7	.00058
7.0	6	.02	.00	9	.00052
10.0	8	.03	.01	24	.00095
17.0	14	.04	.02	54	.00124
19.0	16	.02	.01	20	.00042
22.0	19	.03	.02	41	.00073
57.0	49	.05	.03	87	.00069
87.0	74	.05	.04	91	.00041
117.0	100	.06	.04	100	.00034

Table 6 (cont.)

DATE 7/30/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	6	.00106
5.0	4	.02	.00	14	.00099
7.0	6	.02	.01	16	.00080
10.0	9	.02	.01	18	.00063
17.0	14	.02	.01	26	.00058
19.0	16	.03	.02	46	.00085
22.0	19	.02	.01	26	.00042
57.0	49	.04	.02	60	.00037
87.0	74	.05	.04	100	.00040
117.0	100	.04	.03	84	.00025

DATE 7/30/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 24/78.6

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.03	.01	23	.00491
5.0	4	.04	.02	53	.00463
7.0	6	.03	.01	23	.00140
10.0	8	.03	.02	35	.00154
17.0	14	.03	.01	27	.00070
19.0	16	.03	.01	34	.00078
22.0	19	.04	.02	56	.00112
57.0	49	.06	.04	100	.00076
87.0	74	.06	.04	97	.00048
117.0	100	.06	.04	94	.00035

DATE 7/31/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	5	.00180
5.0	4	.03	.01	22	.00288
7.0	6	.02	.01	10	.00093
10.0	8	.02	.01	14	.00094
17.0	14	.03	.01	15	.00064
19.0	16	.02	.01	13	.00046
22.0	19	.04	.03	38	.00115
57.0	49	.06	.05	75	.00087
87.0	74	.08	.07	100	.00076
117.0	100	.07	.06	83	.00050

Table 6 (cont.)

DATE 7/31/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 20/77.5

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	14	.00399
5.0	4	.03	.01	21	.00247
7.0	6	.02	.01	19	.00155
10.0	8	.03	.02	31	.00181
17.0	14	.03	.02	37	.00128
19.0	16	.03	.02	28	.00088
22.0	19	.05	.04	60	.00162
57.0	49	.06	.04	75	.00078
87.0	74	.07	.06	100	.00068
117.0	100	.06	.05	83	.00042

DATE 8/ 3/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 20/77.5

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	25	.00213
5.0	4	.01	.00	8	.00028
7.0	6	.01	.00	8	.00020
10.0	8	.02	.00	25	.00043
17.0	14	.02	.01	71	.00071
19.0	16	.02	.00	21	.00019
22.0	19	.02	.00	29	.00023
57.0	49	.03	.01	75	.00022
87.0	74	.03	.02	100	.00020
117.0	100	.03	.02	92	.00013

DATE 8/ 3/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 20/77.

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	21	.00284
5.0	4	.02	.00	16	.00085
7.0	6	.02	.00	8	.00030
10.0	8	.02	.01	26	.00071
17.0	14	.02	.01	26	.00042
19.0	16	.03	.01	42	.00060
22.0	19	.02	.01	37	.00045
57.0	49	.04	.02	87	.00041
87.0	74	.04	.02	87	.00027
117.0	100	.04	.03	100	.00023

Table 6 (cont.)

DATE 8/ 2/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	5	.00246
5.0	4	.03	.01	11	.00197
7.0	6	.02	.01	7	.00090
10.0	8	.03	.01	16	.00148
17.0	14	.05	.03	33	.00178
19.0	16	.03	.02	20	.00096
22.0	19	.05	.04	41	.00170
57.0	49	.09	.07	79	.00126
87.0	74	.10	.08	93	.00097
117.0	100	.11	.09	100	.00078

DATE 8/ 2/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 22/78.1

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.04	.03	48	.01472
5.0	4	.02	.00	7	.00086
7.0	6	.02	.00	0	.00000
10.0	8	.02	.00	5	.00029
17.0	14	.03	.01	19	.00068
19.0	16	.04	.02	38	.00125
22.0	19	.03	.02	31	.00088
57.0	49	.05	.04	62	.00067
87.0	74	.07	.06	95	.00068
117.0	100	.08	.06	100	.00053

DATE 8/ 6/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 26/74.3

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.01	.00	5	.00074
5.0	4	.02	.00	14	.00089
7.0	6	.03	.02	60	.00264
10.0	8	.03	.01	43	.00133
17.0	14	.02	.01	31	.00057
19.0	16	.02	.01	24	.00039
22.0	19	.03	.01	40	.00057
57.0	49	.04	.03	63	.00045
87.0	74	.04	.03	100	.00036
117.0	100	.03	.02	71	.00019

Table 6 (cont.)

DATE 8/ 6/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 21/77.6

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	I	M	MAX	A/L
2.0	2	.02	.01	11	.00283
5.0	4	.03	.02	32	.00326
7.0	6	.01	.00	5	.00040
10.0	8	.02	.01	15	.00078
17.0	14	.02	.01	23	.00071
19.0	16	.02	.01	21	.00056
22.0	19	.03	.02	32	.00074
57.0	49	.05	.03	60	.00060
87.0	74	.06	.05	100	.00059
117.0	100	.06	.05	100	.00044

DATE 8/ 5/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 20/77.5

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	I	M	MAX	A/L
2.0	2	.02	.00	2	.00072
5.0	4	.03	.01	18	.00229
7.0	6	.02	.01	8	.00072
10.0	8	.02	.01	15	.00093
17.0	14	.03	.02	27	.00101
19.0	16	.03	.02	24	.00079
22.0	19	.03	.02	31	.00088
57.0	49	.08	.06	98	.00108
87.0	74	.06	.06	100	.00072
117.0	100	.07	.06	94	.00051

DATE 8/ 5/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 20/77.5

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	I	M	MAX	A/L
2.0	2	.02	.01	6	.00255
5.0	4	.03	.01	22	.00247
7.0	6	.02	.01	13	.00104
10.0	[illegible]	.03	.01	26	.00166
17.0	14	.03	.02	29	.00090
19.0	16	.03	.01	22	.00065
22.0	19	.04	.02	40	.00103
57.0	49	.07	.06	100	.00100
87.0	74	.07	.06	94	.00061
117.0	100	.07	.06	97	.00047

Table 6 (cont.)

DATE 8/ 9/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	3	.00145
5.0	4	.02	.00	5	.00087
7.0	6	.02	.01	12	.00155
10.0	8	.03	.01	13	.00123
17.0	14	.03	.02	22	.00124
19.0	16	.04	.02	26	.00130
22.0	19	.05	.03	36	.00155
57.0	49	.06	.05	52	.00085
87.0	74	.11	.09	100	.00107
117.0	100	.11	.09	99	.00079

DATE 8/ 9/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.03	.02	14	.00796
5.0	4	.03	.02	17	.00376
7.0	6	.03	.01	12	.00197
10.0	8	.04	.03	25	.00282
17.0	14	.05	.04	32	.00213
19.0	16	.05	.03	29	.00168
22.0	19	.05	.04	35	.00178
57.0	49	.09	.08	69	.00136
87.0	74	.11	.10	88	.00112
117.0	100	.13	.11	100	.00095

DATE 8/ 8/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.03	.01	9	.00590
5.0	4	.03	.02	12	.00324
7.0	6	.04	.02	17	.00326
10.0	9	.03	.02	14	.00192
17.0	14	.04	.03	20	.00160
19.0	16	.04	.02	17	.00116
22.0	19	.07	.05	39	.00238
57.0	49	.14	.12	93	.00217
87.0	74	.13	.11	84	.00129
117.0	100	.15	.12	100	.00114

Table 6 (cont.)

DATE 8/ 4/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.03	.01	23	.00591
5.0	4	.02	.01	12	.00118
7.0	6	.02	.01	12	.00084
10.0	8	.04	.02	42	.00214
17.0	14	.04	.03	49	.00148
19.0	16	.04	.03	54	.00144
22.0	19	.04	.02	42	.00097
57.0	49	.07	.05	100	.00089
87.0	74	.06	.05	97	.00057
117.0	100	.05	.03	62	.00027

DATE 8/ 7/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH 60 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	1	.00154
5.0	4	.06	.05	9	.00969
7.0	6	.06	.05	9	.00681
10.0	8	.10	.09	16	.00877
17.0	14	.34	.32	58	.01892
19.0	16	.16	.15	26	.00765
22.0	19	.33	.32	57	.01437
57.0	49	.57	.55	100	.00966
87.0	74	.30	.28	52	.00327
117.0	100	.29	.27	49	.00233

DATE 8/12/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 58/77.9

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	10	.00284
5.0	4	.02	.01	14	.00170
7.0	6	.02	.01	11	.00091
10.0	8	.03	.01	24	.00142
17.0	14	.04	.02	35	.00121
19.0	16	.04	.03	48	.00149
22.0	19	.04	.02	35	.00094
57.0	49	.07	.06	100	.00105
87.0	74	.07	.06	96	.00065
117.0	100	.07	.06	99	.00050

Table 6 (cont.)

DATE 8/12/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 28/77.9

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.03	.01	9	.00355
5.0	4	.03	.01	12	.00185
7.0	6	.03	.01	14	.00162
10.0	8	.03	.01	17	.00135
17.0	14	.05	.03	43	.00205
19.0	16	.04	.02	29	.00123
22.0	19	.05	.03	32	.00116
57.0	49	.08	.06	77	.00108
87.0	74	.09	.07	91	.00084
117.0	100	.10	.08	100	.00069

DATE 8/11/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	7	.00393
5.0	4	.03	.01	13	.00286
7.0	6	.02	.01	7	.00112
10.0	8	.03	.01	12	.00136
17.0	14	.04	.02	22	.00147
19.0	16	.04	.02	17	.00101
22.0	19	.06	.04	36	.00188
57.0	49	.08	.06	56	.00113
87.0	74	.13	.11	100	.00131
117.0	100	.12	.11	93	.00091

DATE 8/11/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 29/77.5

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.03	.01	5	.00435
5.0	4	.03	.01	6	.00203
7.0	6	.03	.01	6	.00135
10.0	8	.04	.02	11	.00181
17.0	14	.04	.02	15	.00145
19.0	16	.05	.03	17	.00149
22.0	19	.06	.04	23	.00172
57.0	49	.09	.07	43	.00127
87.0	74	.12	.10	61	.00118
117.0	100	.19	.17	100	.00143

Table 6 (cont.)

DATE 8/15/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 28/77.9

DEPTH 5 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)		ASSIM (MGC/M3/HR)			NORMALIZED
	MAX	L	N	MAX	A/L
2.0	2	.04	.02	35	.01007
5.0	4	.06	.04	65	.00733
7.0	6	.05	.03	52	.00421
10.0	8	.06	.04	71	.00403
17.0	14	.06	.04	70	.00233
19.0	16	.04	.02	35	.00106
22.0	19	.06	.04	70	.00180
57.0	49	.07	.05	86	.00086
87.0	74	.06	.04	77	.00050
117.0	100	.08	.06	100	.00049

DATE 8/15/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 27/78.4

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)		ASSIM (MGC/M3/HR)			NORMALIZED
	MAX	L	N	MAX	A/L
2.0	2	.04	.02	25	.00751
5.0	4	.03	.01	20	.00243
7.0	6	.03	.01	13	.00112
10.0	8	.03	.01	23	.00136
17.0	14	.04	.02	35	.00122
19.0	16	.03	.01	12	.00038
22.0	19	.04	.02	27	.00075
57.0	49	.06	.04	69	.00073
87.0	74	.08	.06	92	.00063
117.0	100	.08	.06	100	.00051

DATE 8/14/75 STANDARD 6.95 MC/AMP TIME 6.2 HR EFF 27/78.4

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)		ASSIM (MGC/M3/HR)			NORMALIZED
	MAX	L	N	MAX	A/L
2.0	2	.03	.01	11	.00553
5.0	4	.04	.02	14	.00387
7.0	6	.03	.01	12	.00178
10.0	8	.04	.02	20	.00208
17.0	14	.05	.03	28	.00175
19.0	16	.04	.02	24	.00131
22.0	19	.05	.03	27	.00129
57.0	49	.11	.09	83	.00153
87.0	74	.13	.11	100	.00121
117.0	100	.12	.10	95	.00085

Table 6 (cont.)

DATE 8/14/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 23/77.9

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.03	.01	10	.00683
5.0	4	.03	.01	9	.00244
7.0	6	.04	.02	12	.00236
10.0	8	.06	.04	27	.00374
17.0	14	.06	.04	32	.00254
19.0	16	.06	.04	27	.00197
22.0	19	.07	.05	37	.00229
57.0	49	.13	.10	77	.00184
87.0	74	.14	.11	84	.00131
117.0	100	.16	.14	100	.00117

DATE 8/16/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH 60 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.09	.07	12	.03616
5.0	4	.26	.25	42	.04908
7.0	6	.20	.18	31	.02572
10.0	8	.61	.59	100	.05886
17.0	14	.32	.30	51	.01774
19.0	16	.31	.29	49	.01527
22.0	19	.35	.33	56	.01497
57.0	49	.44	.42	71	.00734
87.0	74	.48	.46	79	.00531
117.0	100	.42	.40	69	.00345

DATE 8/18/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) I	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	31	.00538
5.0	4	.02	.01	19	.00135
7.0	6	.02	.01	17	.00086
10.0	8	.03	.02	50	.00175
17.0	14	.04	.02	62	.00127
19.0	16	.03	.01	38	.00071
22.0	19	.03	.02	60	.00095
57.0	49	.05	.03	90	.00055
87.0	74	.05	.03	100	.00040
117.0	100	.05	.03	100	.00030

Table 6 (cont.)

DATE 8/18/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	D	MAX	NORMALIZED A/L
2.0	2	.03	.01	41	.00605
5.0	4	.03	.02	52	.00309
7.0	6	.02	.01	34	.00144
10.0	8	.03	.02	55	.00161
17.0	14	.03	.02	59	.00103
19.0	16	.03	.01	50	.00078
22.0	19	.04	.02	80	.00107
57.0	49	.04	.02	84	.00044
87.0	74	.04	.03	100	.00034
117.0	100	.04	.03	93	.00024

DATE 8/17/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	D	MAX	NORMALIZED A/L
2.0	2	.06	.05	65	.02315
5.0	4	.05	.03	49	.00694
7.0	6	.03	.01	17	.00175
10.0	8	.04	.02	28	.00197
17.0	14	.04	.03	36	.00148
19.0	16	.08	.07	94	.00351
22.0	19	.05	.03	47	.00152
57.0	49	.09	.07	100	.00124
87.0	74	.08	.05	84	.00068
117.0	100	.09	.07	98	.00059

DATE 8/17/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	D	MAX	NORMALIZED A/L
2.0	2	.04	.02	24	.00849
5.0	4	.04	.02	25	.00353
7.0	6	.03	.01	17	.00175
10.0	8	.05	.04	50	.00353
17.0	14	.06	.04	56	.00232
19.0	16	.04	.02	35	.00129
22.0	19	.04	.03	38	.00120
57.0	49	.07	.05	72	.00088
87.0	74	.08	.05	82	.00066
117.0	100	.09	.07	100	.00060

Table 6 (cont.)

DATE 8/20/75 STANDARD 6.95 MC/AMP TIME 6.0 HR EFF 34/75.2

DEPTH 60 M DARK ASSIM .02 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.03	.01	6	.00579
5.0	4	.07	.05	28	.01050
7.0	6	.08	.06	34	.00915
10.0	8	.11	.09	46	.00864
17.0	14	.14	.12	62	.00686
19.0	16	.13	.11	60	.00589
22.0	19	.15	.13	70	.00593
57.0	49	.18	.16	87	.00286
87.0	74	.20	.18	98	.00210
117.0	100	.21	.19	100	.00160

DATE 8/21/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 33/75.7

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.02	.01	13	.00436
5.0	4	.03	.02	32	.00429
7.0	6	.04	.03	42	.00402
10.0	8	.05	.03	51	.00349
17.0	14	.04	.03	40	.00158
19.0	16	.03	.01	21	.00074
22.0	19	.04	.03	38	.00116
57.0	49	.06	.05	71	.00085
87.0	74	.08	.07	100	.00078
117.0	100	.07	.06	84	.00049

DATE 8/23/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 32/76.1

DEPTH 60 M DARK ASSIM .02 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.03	.01	3	.00593
5.0	4	.06	.04	12	.00897
7.0	6	.08	.06	17	.00847
10.0	8	.11	.09	27	.00807
17.0	14	.16	.13	39	.00728
19.0	16	.16	.14	41	.00733
22.0	19	.21	.19	55	.00858
57.0	49	.34	.32	92	.00553
87.0	74	.37	.33	98	.00375
117.0	100	.36	.34	100	.00292

Table 6 (cont.)

DATE 8/24/75 STANDARD 7.55 MC/AMP TIME 7.1 HR EFF 21/76.6

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	32	.00506
5.0	4	.02	.00	11	.00067
7.0	6	.02	.01	18	.00080
10.0	8	.02	.01	26	.00084
17.0	14	.02	.01	33	.00063
19.0	16	.03	.02	60	.00101
22.0	19	.03	.01	42	.00061
57.0	49	.04	.02	75	.00042
87.0	74	.04	.03	86	.00032
117.0	100	.05	.03	100	.00027

DATE 8/27/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 55/74.8

DEPTH 5 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.04	.02	54	.01086
5.0	4	.03	.01	19	.00149
7.0	6	.02	.01	17	.00097
10.0	8	.03	.01	32	.00129
17.0	14	.04	.02	56	.00132
19.0	16	.03	.01	29	.00061
22.0	19	.03	.01	32	.00059
57.0	49	.06	.04	98	.00069
87.0	74	.06	.04	100	.00046
117.0	100	.05	.04	90	.00031

DATE 8/27/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 24/74.3

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.03	.01	10	.00512
5.0	4	.03	.01	13	.00259
7.0	6	.03	.01	9	.00127
10.0	8	.03	.01	14	.00163
17.0	14	.04	.03	27	.00157
19.0	16	.05	.03	29	.00151
22.0	19	.07	.05	52	.00239
57.0	49	.08	.05	63	.00110
87.0	74	.12	.10	100	.00115
117.0	100	.11	.10	97	.00092

Table 6 (cont.)

DATE 8/26/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 31/76.6

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.05	.03	27	.01524
5.0	4	.05	.03	27	.00610
7.0	6	.04	.02	18	.00293
10.0	8	.05	.03	24	.00272
17.0	14	.07	.05	42	.00277
19.0	16	.03	.01	12	.00073
22.0	19	.07	.05	43	.00223
57.0	49	.12	.10	89	.00177
87.0	74	.13	.11	100	.00130
117.0	100	.12	.10	89	.00087

DATE 8/26/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 31/76.6

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.00	0	.00000
7.0	6	.03	.00	11	.00068
10.0	8	.03	.01	19	.00081
17.0	14	.05	.03	66	.00163
19.0	16	.04	.02	37	.00082
22.0	19	.04	.02	50	.00095
57.0	49	.06	.04	97	.00071
87.0	74	.06	.04	94	.00045
117.0	100	.06	.04	100	.00036

DATE 8/30/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 35/74.8

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.03	.01	6	.00407
5.0	4	.03	.01	9	.00244
7.0	6	.02	.01	5	.00087
10.0	8	.03	.01	9	.00135
17.0	14	.04	.02	18	.00144
19.0	16	.04	.02	15	.00111
22.0	19	.05	.03	21	.00130
57.0	49	.11	.09	65	.00156
87.0	74	.12	.11	80	.00124
117.0	100	.15	.14	100	.00115

Table 6 (cont.)

DATE 9/ 2/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 21/77.8

DEPTH 10 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	6	.00261
5.0	4	.02	.01	10	.00170
7.0	6	.02	.01	10	.00121
10.0	8	.09	.08	86	.00750
17.0	14	.04	.03	29	.00150
19.0	16	.03	.02	17	.00079
22.0	19	.04	.02	23	.00092
57.0	49	.07	.05	61	.00093
87.0	74	.10	.09	100	.00100
117.0	100	.10	.09	99	.00074

DATE 9/ 5/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.01	.00	0	.00000
5.0	4	.02	.00	2	.00027
7.0	6	.02	.01	7	.00076
10.0	8	.03	.01	13	.00107
17.0	14	.04	.02	29	.00137
19.0	16	.04	.02	27	.00112
22.0	19	.04	.02	31	.00112
57.0	49	.09	.07	93	.00131
87.0	74	.09	.08	94	.00087
117.0	100	.09	.08	100	.00068

DATE 9/ 5/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 15/76.2

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.03	.01	13	.00666
5.0	4	.02	.01	11	.00226
7.0	6	.03	.02	15	.00228
10.0	8	.03	.01	14	.00147
17.0	14	.04	.02	24	.00145
19.0	16	.03	.02	21	.00112
22.0	19	.04	.03	28	.00133
57.0	49	.08	.06	61	.00110
87.0	74	.08	.07	63	.00075
117.0	100	.12	.10	100	.00088

Table 6 (cont.)

DATE 9/ 4/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 21/77.8

DEPTH 20 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.01	7	.00261
5.0	4	.02	.01	13	.00183
7.0	6	.02	.00	6	.00065
10.0	8	.03	.01	17	.00117
17.0	14	.04	.02	30	.00127
19.0	16	.04	.02	29	.00110
22.0	19	.05	.03	43	.00139
57.0	49	.07	.05	74	.00093
87.0	74	.07	.06	81	.00066
117.0	100	.09	.07	100	.00061

DATE 9/ 4/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 20/77.5

DEPTH 30 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	2	.00065
5.0	4	.02	.01	13	.00170
7.0	6	.02	.01	13	.00122
10.0	8	.03	.02	29	.00190
17.0	14	.05	.03	47	.00181
19.0	16	.05	.03	46	.00158
22.0	19	.05	.03	52	.00158
57.0	49	.08	.06	98	.00114
87.0	74	.08	.07	100	.00076
117.0	100	.07	.05	87	.00049

DATE 9/ 8/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 16/76.4

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	M	MAX	NORMALIZED A/L
2.0	2	.02	.00	4	.00199
5.0	4	.02	.01	5	.00106
7.0	6	.02	.01	6	.00095
10.0	8	.03	.01	12	.00126
17.0	14	.04	.02	20	.00129
19.0	16	.05	.03	30	.00171
22.0	19	.05	.03	31	.00151
57.0	49	.09	.08	75	.00142
87.0	74	.12	.11	100	.00124
117.0	100	.11	.10	90	.00083

Table 6 (cont.)

DATE 9/11/75 STANDARD 7.55 MC/AMP TIME 6.0 HR FFF 26/73.8

DEPTH 60 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	3	.00374
5.0	4	.05	.03	13	.00598
7.0	6	.05	.04	16	.00525
10.0	8	.09	.07	32	.00707
17.0	14	.09	.07	30	.00400
19.0	16	.09	.07	33	.00387
22.0	19	.24	.22	100	.01017
57.0	49	.17	.15	69	.00270
87.0	74	.16	.14	63	.00163
117.0	100	.19	.17	78	.00149

DATE 9/14/75 STANDARD 7.55 MC/AMP TIME 6.0 HR FFF 15/76.2

DEPTH 5 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	8	.00400
5.0	4	.02	.01	12	.00226
7.0	6	.03	.01	13	.00181
10.0	9	.03	.02	19	.00187
17.0	14	.05	.04	38	.00216
19.0	16	.04	.03	30	.00151
22.0	19	.05	.04	40	.00176
57.0	49	.09	.08	80	.00134
87.0	74	.09	.08	82	.00090
117.0	100	.11	.10	100	.00082

DATE 9/14/75 STANDARD 7.55 MC/AMP TIME 6.0 HR FFF 15/76.4

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	5	.00266
5.0	4	.03	.01	10	.00239
7.0	6	.03	.01	10	.00171
10.0	9	.03	.02	18	.00206
17.0	14	.04	.03	26	.00164
19.0	16	.04	.03	21	.00133
22.0	19	.05	.04	32	.00172
57.0	49	.10	.08	70	.00144
87.0	74	.09	.08	69	.00092
117.0	100	.13	.12	100	.00100

Table 6 (cont.)

DATE 9/13/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	6	.00268
5.0	4	.02	.01	11	.00215
7.0	6	.02	.01	11	.00144
10.0	8	.03	.02	17	.00161
17.0	14	.04	.02	25	.00142
19.0	16	.04	.03	27	.00134
22.0	19	.05	.04	39	.00168
57.0	49	.08	.07	75	.00125
87.0	74	.10	.08	89	.00097
117.0	100	.11	.10	100	.00081

DATE 9/13/75 STANDARD 7.55 MC/AMP TIME 6.0 HR EFF 13/75.6

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	7	.00369
5.0	4	.03	.01	14	.00282
7.0	6	.03	.01	15	.00211
10.0	8	.04	.03	27	.00262
17.0	14	.06	.04	44	.00253
19.0	16	.05	.03	33	.00173
22.0	19	.06	.05	48	.00213
57.0	49	.09	.08	76	.00132
87.0	74	.11	.10	99	.00112
117.0	100	.11	.10	100	.00084

DATE 9/20/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH 5 M DARK ASSIM .02 MG/M3/HR

LIGHT (ME/M2/S)	MAX	ASSIM (MGC/M3/HR) L	N	MAX	NORMALIZED A/L
2.0	2	.02	.01	6	.00462
5.0	4	.04	.02	14	.00447
7.0	6	.05	.03	21	.00473
10.0	8	.05	.04	24	.00370
17.0	14	.08	.07	45	.00403
19.0	16	.08	.06	40	.00328
22.0	19	.09	.07	46	.00322
57.0	49	.15	.13	85	.00231
87.0	74	.17	.15	100	.00178
117.0	100	.16	.14	93	.00122

Table 6 (cont.)

DATE 9/28/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 23/78.3

DEPTH 10 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.05	.04	31	.02118
5.0	4	.04	.03	22	.00585
7.0	6	.04	.03	22	.00429
10.0	8	.05	.04	31	.00416
17.0	14	.08	.07	51	.00408
19.0	16	.08	.07	49	.00353
22.0	19	.09	.08	61	.00378
57.0	49	.14	.13	98	.00234
87.0	74	.15	.14	100	.00156
117.0	100	.14	.13	99	.00115

DATE 9/28/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 19/76.

DEPTH 20 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.03	.02	12	.00766
5.0	4	.04	.02	20	.00500
7.0	6	.05	.03	28	.00495
10.0	8	.05	.03	26	.00322
17.0	14	.07	.05	44	.00322
19.0	16	.05	.04	30	.00195
22.0	19	.08	.06	52	.00293
57.0	49	.12	.11	90	.00194
87.0	74	.14	.12	100	.00142
117.0	100	.12	.10	83	.00088

DATE 9/28/75 STANDARD 6.35 MC/AMP TIME 6.0 HR EFF 11/

DEPTH 30 M DARK ASSIM .01 MG/M3/HR

LIGHT		ASSIM (MGC/M3/HR)			NORMALIZED
(ME/M2/S)	MAX	L	N	MAX	A/L
2.0	2	.02	.01	11	.00482
5.0	4	.04	.02	25	.00466
7.0	6	.03	.02	23	.00298
10.0	8	.04	.02	26	.00241
17.0	14	.06	.05	54	.00283
19.0	16	.06	.04	40	.00220
22.0	19	.07	.05	57	.00237
57.0	49	.11	.09	100	.00161
87.0	74	.10	.08	89	.00094
117.0	100	.10	.08	92	.00072

from 60 m, must be subjected to further analysis and the fitting of photosynthesis vs. light equations before further comparisons can be made.

D. Zooplankton: Three of the larger, more abundant copepod species *Calanus hyperboreus*, *C. glacialis*, and *Euchaeta glacialis* were counted and identified to developmental stage for 8 samples. Total numbers (Table 7 and Figs. 7-9) have not been adjusted to mouth opening or filtration efficiency of the net (100% filtration is assumed).

C. hyperboreus (Fig. 7) females and stage V's show maximum abundance in July. Stage II and IV show maximum abundance in September whereas Stages I and II peak in mid-August. Stage III's are the most abundant.

C. glacialis (Fig. 8) females and stage V's are most abundant in July and early August. Except for early June, Stage IV's are absent. Stages I, II, and III are abundant in July-August, August, and late-September, respectively. Stage I and females are the most abundant.

E. glacialis (Fig. 9) females and stage V's are abundant from mid-July on. Stage II, III, and IV are abundant in June, August, and September, respectively. Stage I's were not found. Stage III's show the dominant abundance, peaking in early August.

Maximum abundance in terms of total numbers of these three species (Fig. 10) occurred in early September. The peak is composed mainly of *C. hyperboreus*. stage III.

IV. Preliminary Interpretation of Results.

Interpretation of the primary productivity data will be postponed until further analysis has been done to determine the ambient light levels and the response of the phytoplankton *in situ*. At this point, the assimilation data only serve to confirm the time and depth patterns observed in the chlorophyll measurements, and shed light on the variability with which the investigator has to contend.

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Table 7. Numbers of adult females and juvenile stages I-V for *Calanus hyperboreus*, *C. glacialis*, and *Euchaeta glacialis* as sampled by 150-0 m net hauls 8 times during the summer 1975.

	June		July		August	September		
Stage \ Date	7	24	12	30	17	4	13	28
				Calanus hyperboreus				
Females	20	54	71	73	20	35	54	26
V	39	44	47	47	7	34	43	14
IV	22	16	3	14	23	42	48	57
III	0	0	0	0	43	319	371	138
II	0	0	0	0	115	32	8	0
I	0	0	0	0	5	0	0	0
				Calanus glacialis				
Females	7	16	63	40	24	7	17	17
V	1	7	10	13	6	6	9	8
IV	1	1	0	0	0	0	0	0
III	0	0	0	1	1	2	4	19
II	0	0	0	0	30	24	17	17
I	0	0	43	25	67	7	27	11
				Euchaeta glacialis				
Females	0	0	2	5	3	2	5	3
V	0	3	6	8	9	5	7	5
IV	2	1	0	0	2	3	6	3
III	0	3	15	65	39	8	8	2
II	21	13	12	2	1	2	2	1
I	0	0	0	0	0	0	0	0

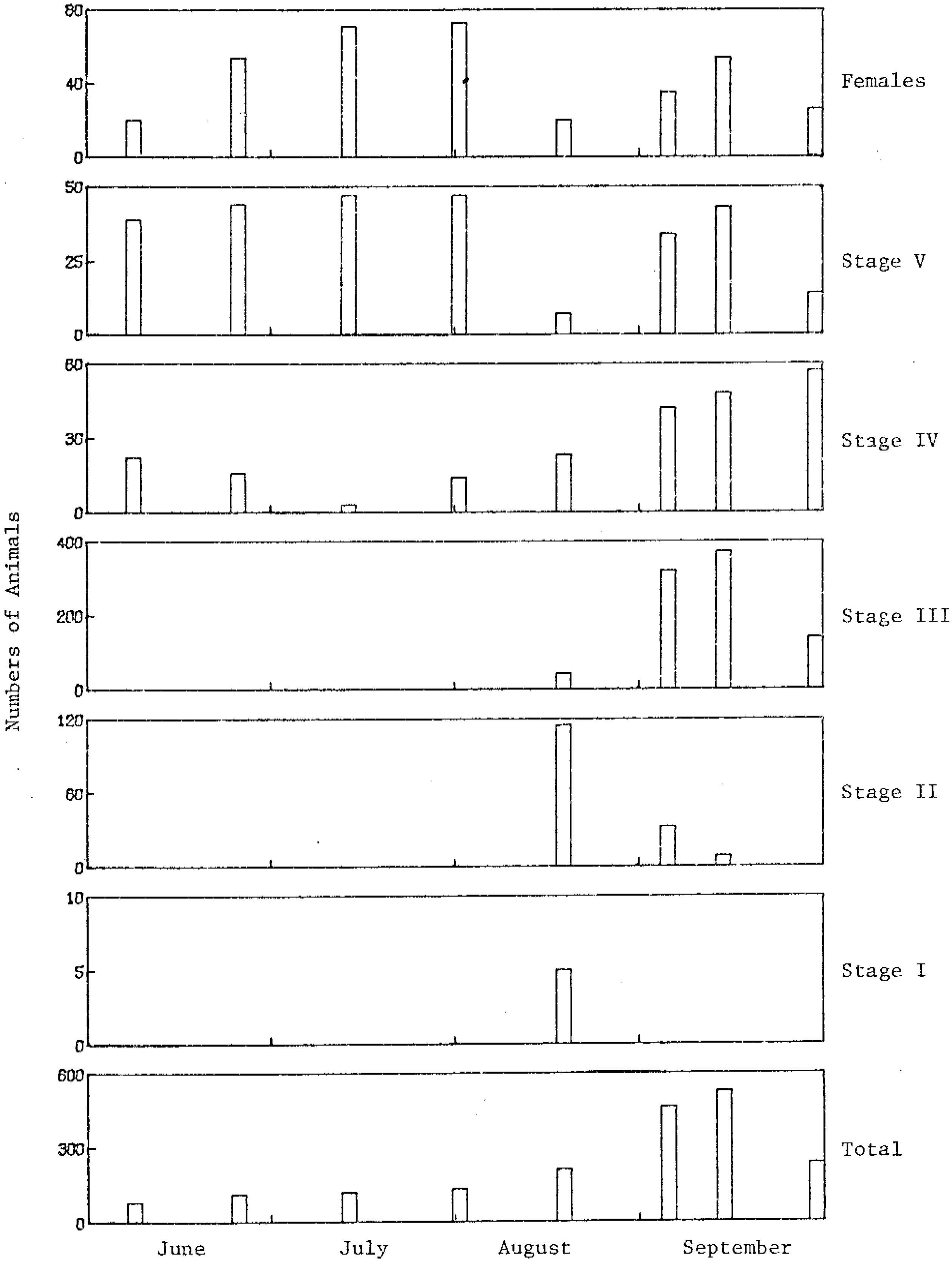


Fig. 7. Number of adult females, stages I-V, and total animals of *Calanus hyperboreus* sampled 8 times during the summer of 1975.

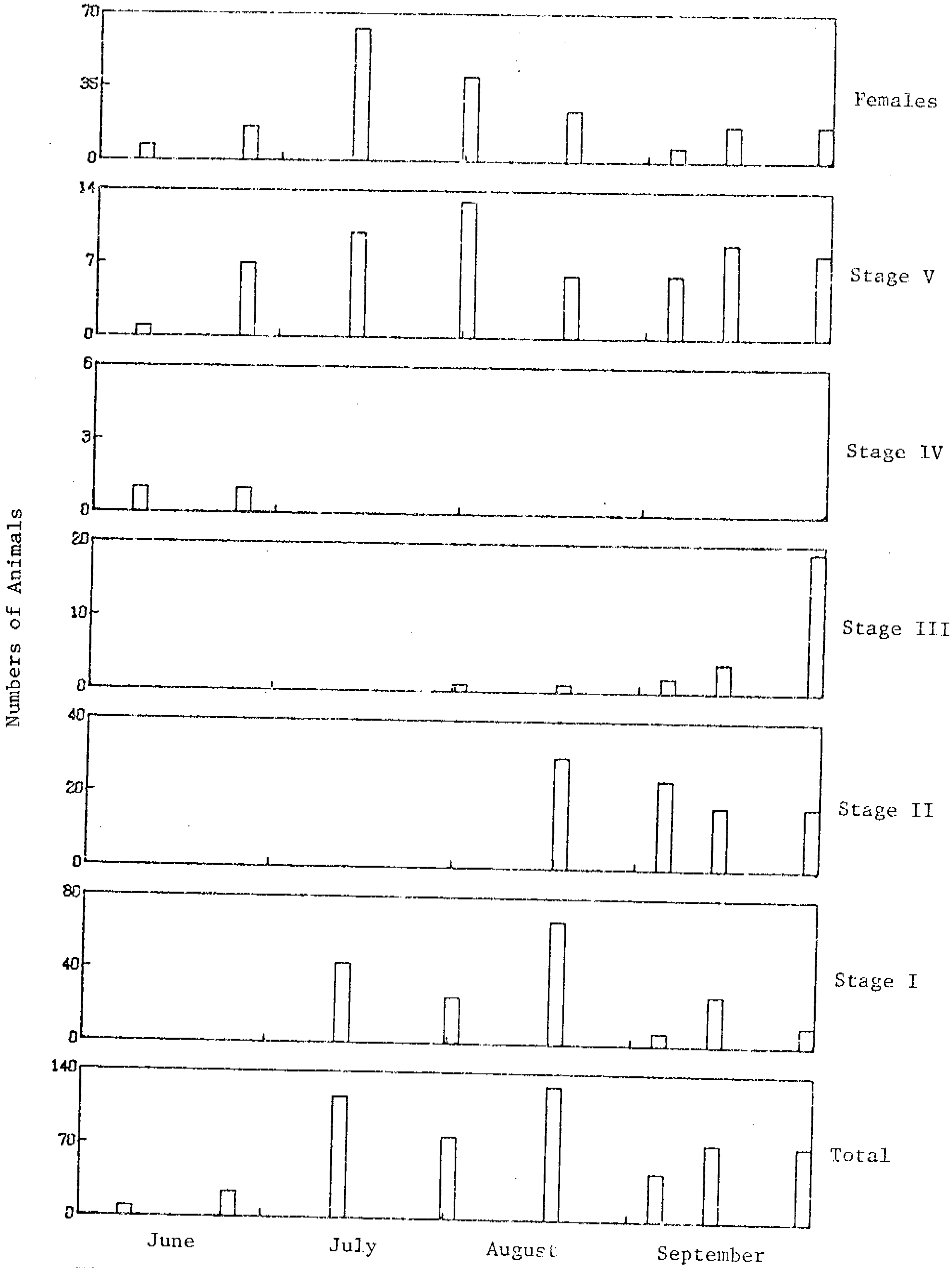


Fig. 8. Number of adult females, stages I-V, and total animals of *Calanus glacialis* sampled 8 times during the summer of 1975.

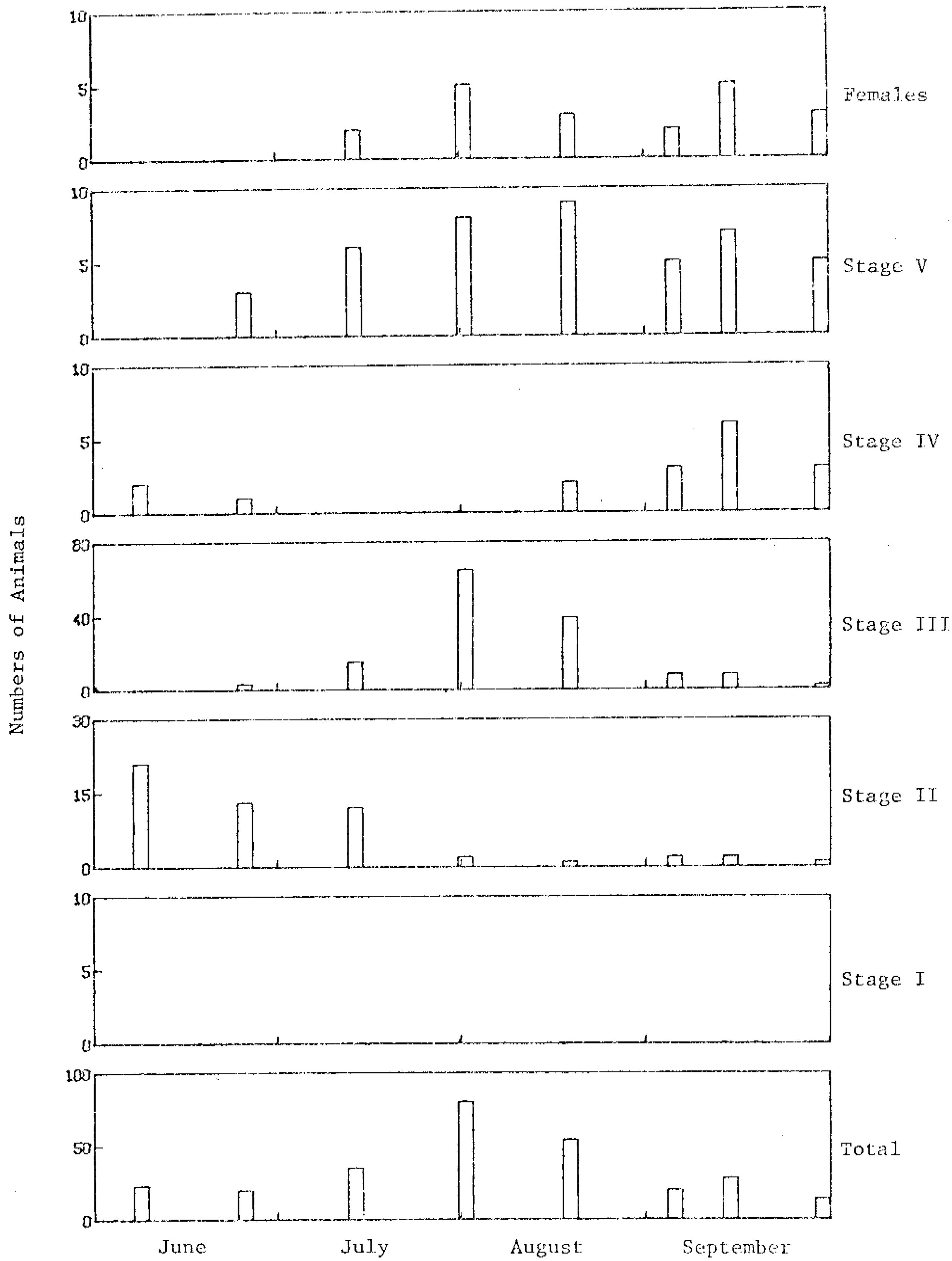


Fig. 9. Number of adult females, stages I–V, and total animals of *Euchaeta glacialis* sampled 8 times during the summer of 1975.

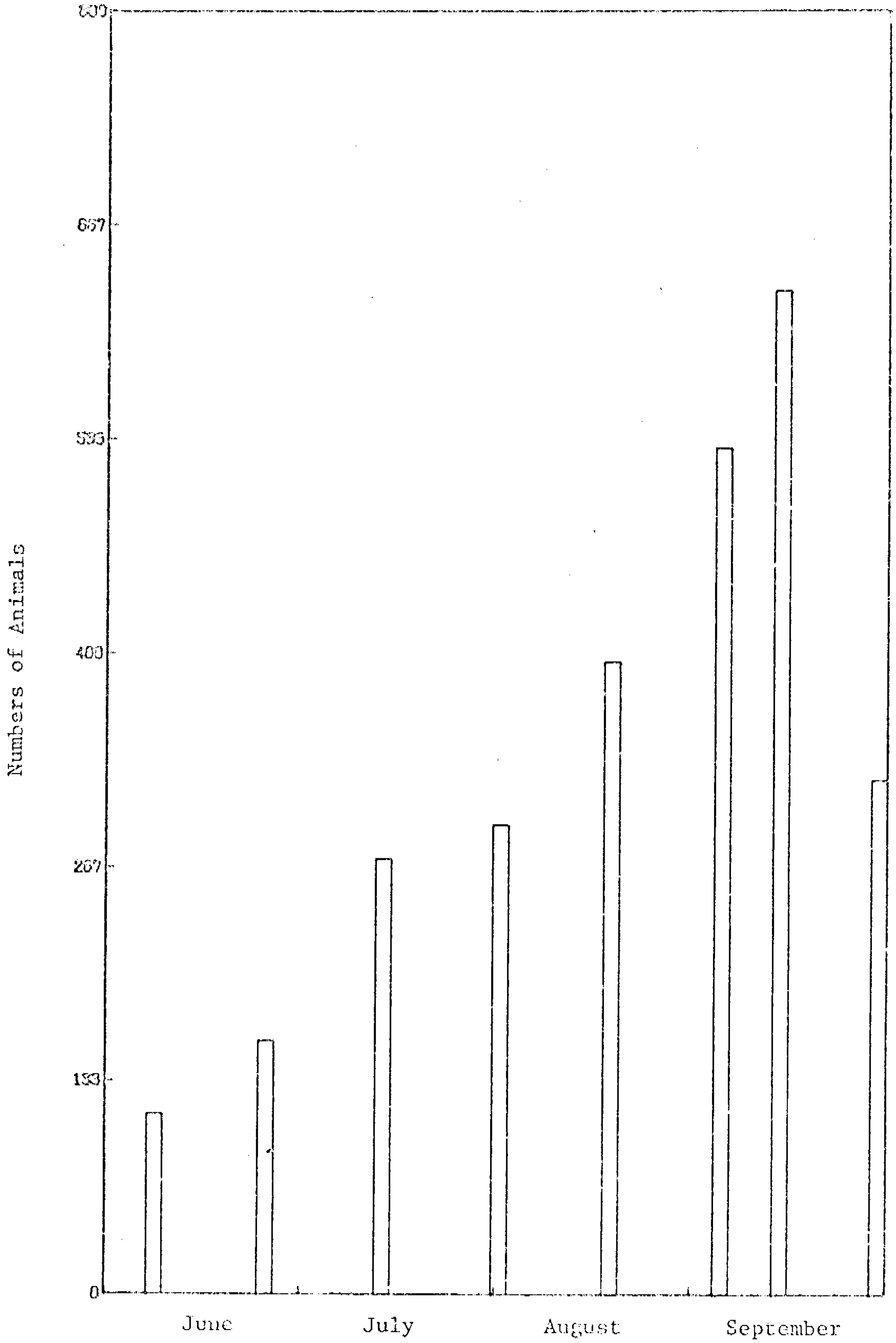


Fig. 10. Total numbers of *Calanus hyperboreus*, *Calanus glacialis* and *Euchaeta glacialis* sampled 8 times during the summer of 1975.

QUARTERLY REPORT

Contract No: None
Research Unit No: RU-380
Reporting Period: April 1-June 30, 1976
Number of Pages: 1

ICHTHYOPLANKTON OF THE EASTERN BERING SEA

Dr. Felix Favorite and Mr. Kenneth Waldron
National Marine Fisheries Service
Northwest Fisheries Center

28 June 1976

I. Task Objective: Collect and analyze ichthyoplankton samples from a portion of the eastern Bering Sea during the spring of 1976.

II. Field or Laboratory Activities:

A. Ship schedule:

1. April 24 - June 3, 1976 NOAA vessel <u>MILLER FREEMAN</u>

B. Scientific Party:

Kenneth D. Waldron, NMFS, NWFC, Chief Scientist (April 24-May 13) and Field Party Chief (May 17-June 3, 1976)

Donald Fisk, NMFS, NWFC, Field Party member

C. Methods:

1. Collected plankton samples with 60 cm bongo nets and neuston net following methods prescribed by MARMAP I Field Office.

D. Sample localities: See attached chart.

E. Data collected:

1. Number of Samples: At 56 stations collected 56 neuston samples and 112 bongo net samples.

2. Analyses: None

III. Results

Samples collected and returned to Seattle on 24 June 1976. Bids obtained for sorting samples and preparation made to send samples to successful bidder.

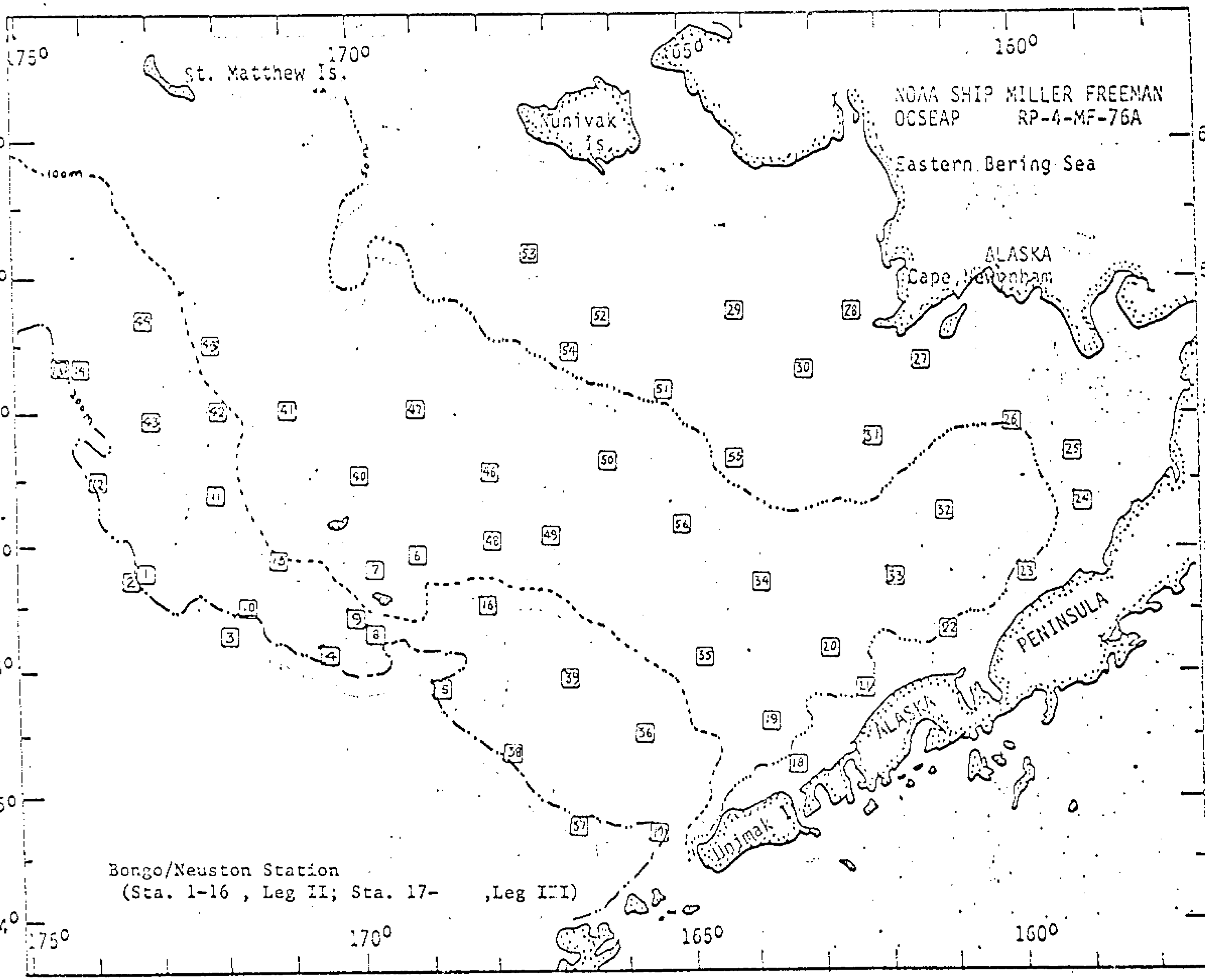
IV. Preliminary interpretation of results.

None

V. Problems encountered and recommended changes:

Ice prevented occupation of several stations, generally between latitudes 59 and 60°N. There were no problems in vessel operation which prevented collection of samples. Placement of winch, winch controls and arrangement of work area could be improved, and these matters have been called to the attention of the vessel staff (see cruise report for Leg III of Cruise RP-4-MF-76-A, Leg III, Ichthyoplankton Studies).

VI. Estimate of funds expended: $4,000


NOAA SHIP MILLER FREEMAN
OCSEAP RP-4-MF-76A
Eastern Bering Sea
St. Matthew Is.
Nunivak Is.
ALASKA
Cape Newenham
PENINSULA
ALASKA
Unimak I.
Bongo/Neuston Station
(Sta. 1-16 , Leg II; Sta. 17- ,Leg III)

Research Unit # U 486-76

Demersal Fish and Shellfish Assessment in Selected Estuary Systems of Kodiak Island

Principal Investigator
JAMES E. BLACKBURN
Alaska Department of Fish and Game
P.O. Box 686
Kodiak, Alaska 99615

July, 1976

Completion Report for Period, April 1 - June 30, 1976

Prepared for:

National Oceanic and Atmospheric Administration
Environmental Research Laboratories
Boulder, Colorado

INTRODUCTION

This report describes activities, decisions, progress, and some preliminary results on Demersal Fish and Shellfish Assessment in Selected Estuary Stytems of Kodiak Island, Research Unit U 486-76, from its initial funding in May, 1976 through June, 1976.

The study area for this project is inside of a line drawn between headlands and deeper than ten fathoms (18M) in Ugak and Alitak bays on Kodiak Island (Figure 1).

Task Objectives

Task objectives of this project are listed below.

A. Determine the spatial and temporal (June-September) distribution, relative abundance and inter-relationships of the various demersal finfish and shellfish species in the study area.

B. Determine the growth rate and food habits of selected demersal fish species.

C. Conduct literature survey to obtain and summarize an ordinal level documentation of commercial catch, stock assessment data, distribution as well as species and age group composition of various shellfish species in the study area.

D. Obtain basic oceanographic and atmospheric data to determine any correlations between these factors and migrations and/or relative abundance of various demersal fish and shellfish species encountered.

Field or Laboratory Activities

As final OCSEAP funding for this project was granted in May 1976, activities were necessarily directed toward expediting initiation of field studies: personnel were hired, equipment was ordered and assembled, a vessel was chartered, a data management plan was drafted and approved, operational plans were formalized, sampling sites were selected and actual field sampling was initiated.

Otter trawl stations were chosen in Ugak and Alitak bays by gridding the entire study area deeper than ten fathoms (18M) into one nautical mile squares. In Ugak Bay there were 30 potential sampling areas and in Alitak Bay there were 57. Based upon estimates of four days work in each bay and about eight stations per day, all areas in Ugak Bay were chosen and odd numbered areas in Alitak Bay were chosen as sampling stations.

The M/V BIG VALLEY was utilized from June 16 to 23, 1976, to otter trawl in Ugak and Alitak bays on Kodiak Island (Figure 1). Aboard during the cruise were Alaska Department of Fish and Game personnel Jim Blackburn, Principal Investigator; Dan Wieczorek, staff member; Al Carbary, staff member; and Steve Jewett, of the University of Alaska project entitled "Distribution, Abundance and Diversity of Epifaunal Benthic Organisms in Two (Alitak and Ugak) Bays of Kodiak Island, Alaska".

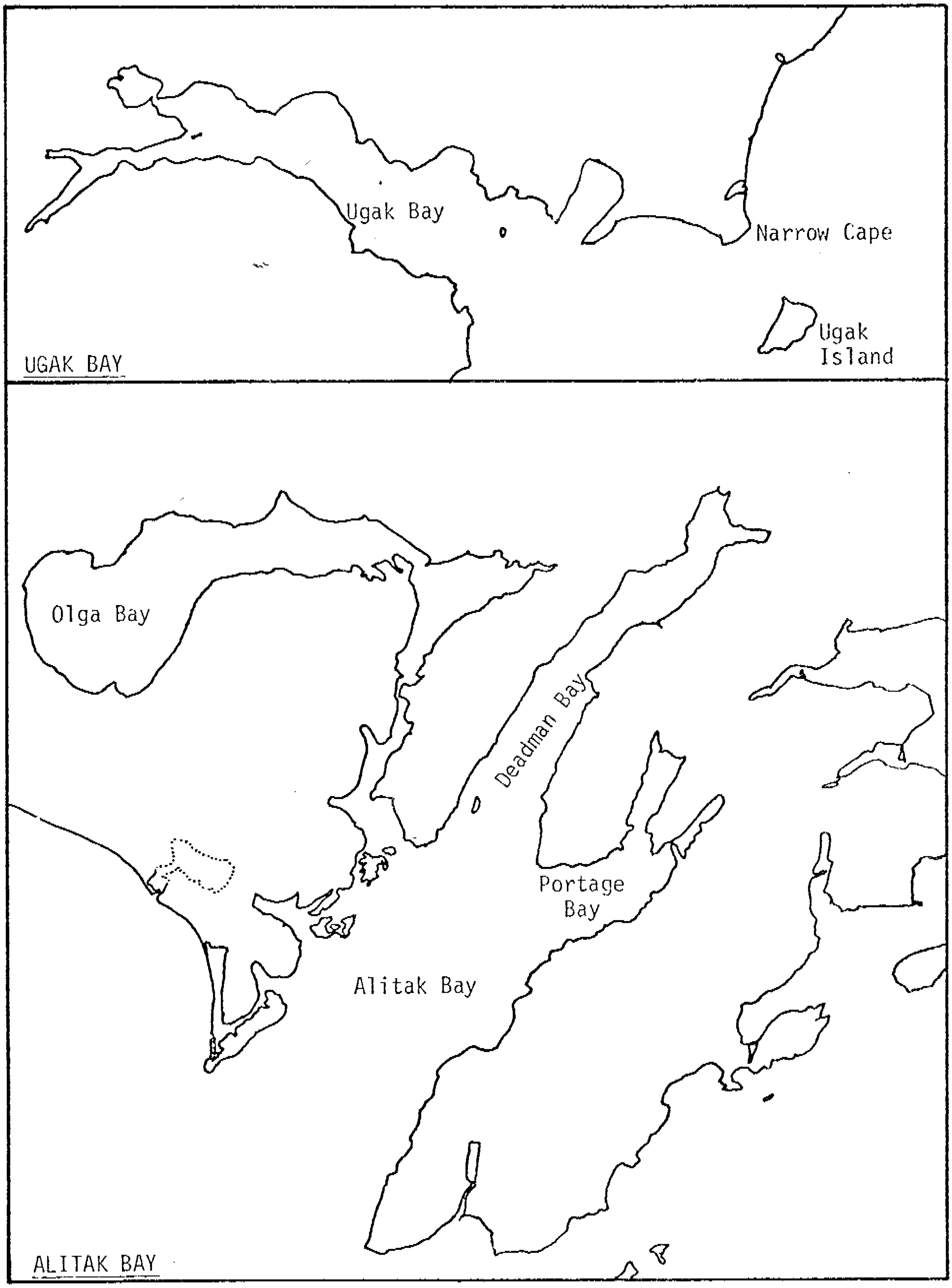


Figure 1. Diagram of the study areas, Ugak and Alitak bays on Kodiak Island.

A 400 mesh eastern ot⁺ᵊr trawl was used to make 20 minute hauls. A total of 25 samples were take ı Ugak Bay and 28 samples were taken in Alitak Bay. All taxa sampled werε lentified, enumerated, and weighed. Unknown species were preserved for la r identification. All invertebrates were handled by the University of Alaska representative.

III Results

A total of 54 otter trawl hauls were completed, 25 in Ugak Bay and 29 in Alitak Bay. Catches in both bays consisted almost entirely of flounders (Pleuronectidae), crustacea, sculpins (Cottidae), and cod (Gadidae) (Table 1). All data on crustaceans was kindly provided by the University of Alaska for the purpose of this report.

Predominant species in Ugak Bay, in order of weight captured, were tanner crab (*Chionoecetes bairdi*) brown Irish Lord (*Hemilepidotus spinosus*), yellowfin sole (*Limanda aspera*), flathead sole (*Hippoglossoides elassodon*), Pacific cod (*Gadus macrocephalus*), great sculpin (*Myoxocephalus polyacanthocephalus*), king crab (*Paralithodes camtschatica*), and Pacific halibut (*Hippoglossus stenolepis*). An unidentified sculpin (*Cymnocanthus sp.*) and the aggregate of shrimps occurred in nearly equal weight as Pacific halibut (Table 1).

Catches of fish in Ugak Bay were generally smaller near the head of the bay and greater near the mouth (Figure 2). There were fewer taxa near the head of the bay than through the rest of it. There was a tendancy for mean fish size to be smaller near the head of Ugak Bay for several species, including yellowfin sole, brown Irish Lord, and capelin (*Mallotus villosus*), while other taxa were of uniform size throughout.

Predominant taxa in Alitak Bay in order of weight captured were tanner crab, yellowfin sole, shrimp, great sculpin, king crab and Pacific halibut.

Catches of fish in Alitak Bay were generally smaller in Deadman Bay than in the other part of Alitak Bay. Catches of shrimp were greatest inside of Middle Reef and they declined considerably near the mouth of Alitak Bay. King crab distribution was nearly opposite that of shrimp with more occurring inside of Middle Reef and greater catches on the sill at the mouth of Alitak Bay. The catch of fish and number of fish taxa were generally smaller near the head of Alitak Bay and greater near the mouth. Flatfish were an obvious contributor to this trend but eelpouts (Zoarcidae) and snailfish (Cyclopteridae) tended to be more abundant near the head of the bay.

Alitak Bay yielded greater catches of crustaceans and less of fish than did Ugak Bay (Table 1). Tanner crab and shrimp were considerably more abundant in catches in Alitak Bay than in Ugak Bay. Brown Irish Lord, flathead sole, Pacific cod, rocksole and butter sole were markedly less abundant in catches in Alitak Bay. Large numbers of juvenile Alaska pollock occurred in Alitak Bay, while comparatively few were captured in Ugak Bay. Other subtler differences were noted, for example, capelin (*Mallotus villosus*) tended to be smaller in Alitak Bay.

Table 1. Otter trawl catch in kilograms per haul in Ugak and Alitak bays on Kodiak Island, June 17 to 23, 1976.

	Ugak Bay	Alitak Bay
Crustacea	45.3	85.7
Flounders	53.8	29.7
Sculpins	49.0	11.5
Cod	13.0	3.8
King crab	7.1	8.4
Tanner crab	31.8	65.8
Shrimp	6.4	11.6
Yellowfin sole	23.4	16.5
Brown Irish Lord	29.5	0.3
Flathead sole	18.0	2.1
Great sculpin	9.8	10.9
Halibut	5.9	7.1
Pacific cod	12.5	T[1]
Rock sole	2.5	0.8
Butter sole	2.1	0.1
Starry flounder	0.4	2.7
Alaska pollock	0.2	3.7
TOTAL	164.2	133.5

[1] Trace, less than 0.1 kg/haul

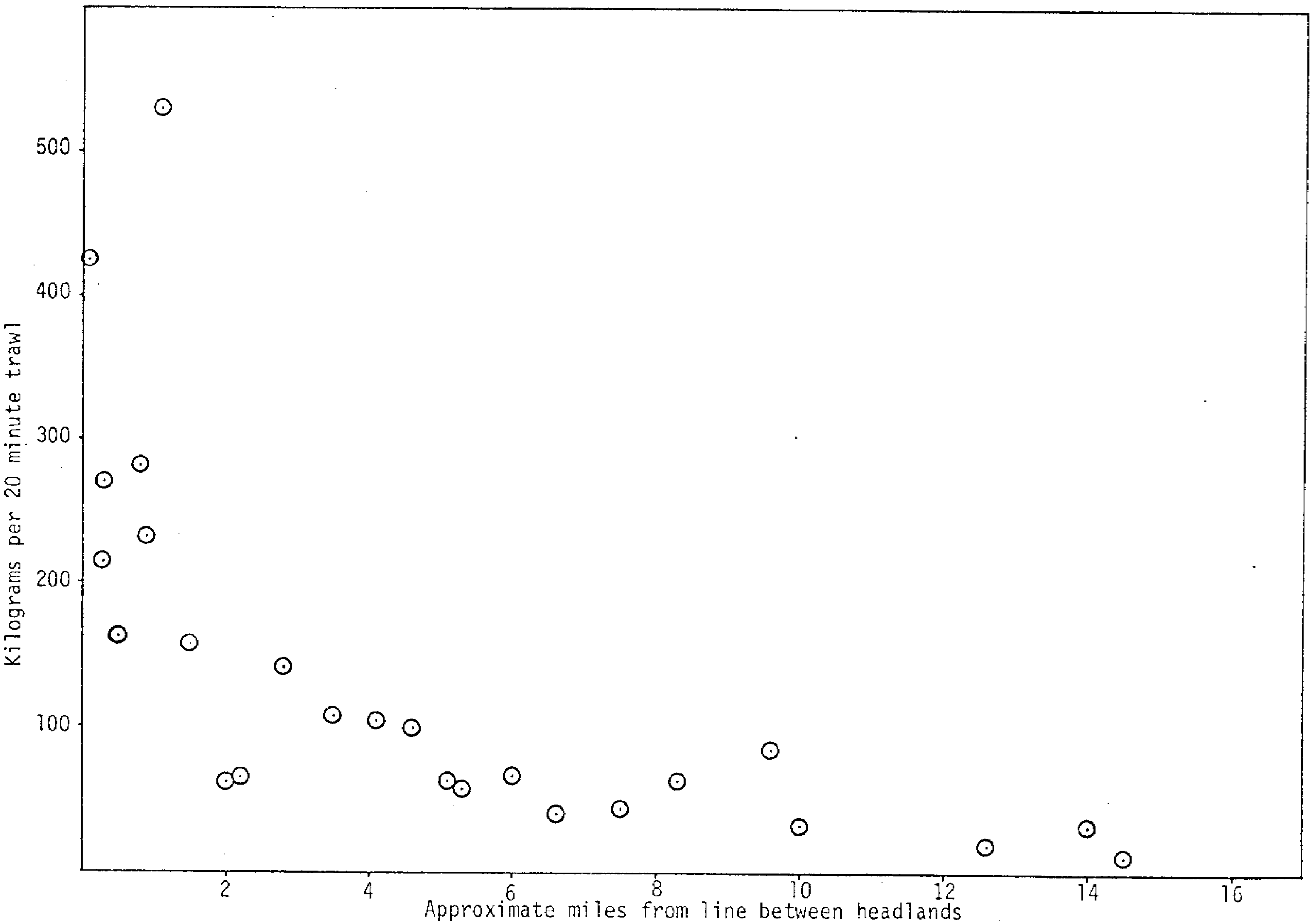


Figure 2. Otter trawl catch of fish in kilograms per 20 minute haul in Ugak Bay by approximate distance in miles between the area sampled and a line between the headlands of the bay.

IV Preliminary Interpretation of Results

Based on a preliminary analysis of the initial set of data collected it appears that both Ugak and Alitak bays provide a rearing grounds for young fish. These bays must then be directly associated with spawning areas for the species found there as young. Assessment of the relative importance of these bays in the production cycle requires a braoder scope of effort which other OCS programs may contribute.

The several trends seen between the head and mouth of the two bays probably represents real differences associated with differences in habitat parameters.

V Problems Encountered/Recommended Changes

The short time between project funding and field implementation resulted in some problems. By mid-June when the boat charter began we had the trawls but several ancillary pieces of equipment were not received. More time between funding and field implementation would allow more complete use of field time.

Problems caused by rocky bottom were largely avoided because personnel had a greater level of knowledge of the bottom than they did of Cook Inlet, there were fewer rocky areas than in Cook Inlet and because of caution resulting from problems encountered in Cook Inlet. In Ugak Bay an area about two miles wide from the mouth of Pasagshak Bay to Narrow Cape appeared on the depth recorder to be too rocky to sample and was not sampled. In Alitak Bay a rocky area near Tanner Head was accomodated by shortened tows and Portage and Sulua bays were occupied by crab pots in storage and these were unsamplable.

Preliminary Audit of Expenses to Date

A. Personnel		1.6[1]
Permanent	0	
Temporary	1.6	
B. Travel and Subsistence		0.4
C. Contractual Services		10.8
D. Commodities[2]		.7
E. Equipment		1.6
	TOTAL	15.1
	10% overhead	1.3
		16.4

[1]Includes
[2]Includes expendable fishing gear, i.e. trawls seines

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