Environmental Assessment of the Alaskan Continental Shelf

Quarterly Reports of Principal Investigators October - December 1977

Volume I

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Research Laboratories

VOLUME I

RECEPTORS (BIOTA)
MARINE MAMMALS
MARINE BIRDS
MARINE FISH
MICROBIOLOGY

CONTAMINANT BASELINES

EFFECTS

VOLUME II

TRANSPORT

HAZARDS

DATA MANAGEMENT

Environmental Assessment of the Alaskan Continental Shelf

QUARTERLY REPORTS OF PRINCIPAL INVESTIGATORS
FOR OCTOBER - DECEMBER 1977

VOLUME I

Outer Continental Shelf Environmental Assessment Program

Boulder, Colorado

March 1978

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Research Laboratory

U.S. DEPARTMENT OF INTERIOR
Bureau of Land Management

DISCLAIMER

VOLUME 1

CONTENTS

RECEPTORS (BIOTA)

MARINE MAMMALS

RECEPTORS (BIOTA)

MAMMALS

Quarterly Report

Contract #R7120804
Research Unit #67
1 October - 31 December 1977
4 pages

Baseline Characterization of Marine Mammals in the Bering Sea

Howard W. Braham

David J. Rugh

Marine Mammal Division
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
National Oceanic & Atmospheric Administration
7600 Sand Point Way, N.E.
Seattle, Washington 98115

December 1977

I. Abstract.

Data synthesis is well underway. Northern sea lion population estimates are summarized for the study area, and counts have been compared to those made by previous researchers. Data on other subject species are being prepared for finalization. OCSEAP marine mammal research efforts have been presented publicly, notably at the Second Conference on the Biology of Marine Mammals in San Diego in December.

II. Objectives.

The primary objectives for RU 67 this quarter were (1) summarization of Eumetopias jubatus population studies for the eastern Aleutian Islands; (2) continued distribution and abundance studies of marine mammals in the Bering and southern Chukchi Seas, especially with regard to data synthesis and analysis, and (3) public presentations of our research efforts when appropriate.

III. Field or Laboratory Activities.

A. Ship or field trip schedule. N/A

B. Scientific party.

Howard Braham	Marine Mammal Division NWAFC, NMFS, NOAA	P. I.
David Rugh	"	P. I.
Robert Everitt	"	Research Asst.
David Withrow	"	Research Asst.

C. Methods.

Computer processing of data is being done in conjunction with RU 69.

D. Sample collection localities. N/A

E. Data collected and/or analyzed.

1. Number and type of samples or observations. N/A

2. Number and type of analyses.

10+ Wilcoxon's Signed Rank Test (nonparametric) (Hollander and Wolfe, 1973)
8 Theil Test for Regression (nonparametric) (Hollander and Wolfe, 1973)
1+ Regression Analyses (parametric)
1 Least Squares Analysis (parametric)

IV. Results.

"Preliminary evidence of a northern sea lion (Eumetopias jubatus) population decline in the eastern Aleutian Islands" was finalized as a processed report (Braham et al., 1977a).

The 1976 annual report for research unit 67 was edited and finalized as a processed report entitled "Marine mammals of the Bering Sea: a preliminary report on distribution and abundance, 1975-76" (Braham et al., 1977b).

V. Preliminary Interpretation of Results.

Substantial and conclusive evidence indicates that populations of northern sea lions are declining in the eastern Aleutian Islands--and probably throughout the range of these animals. Oil extraction activities in sensitive areas (such as near major hauling sites and rookeries) may impose severe threats to this species.

Gray whales (and perhaps many other pelagic species) concentrate or funnel through Unimak Pass and follow the shores of the Alaska Peninsula closely. This makes them highly vulnerable to oil development activities in these areas.

VI. Auxiliary Material.

A. Bibliography of references.

Braham, H. W., R. D. Everitt, and D. J. Rugh.
1977a. Preliminary evidence of a northern sea lion (Eumetopias jubatus) population decline in the eastern Aleutian Islands. Processed Rep. U. S. Dep. Commer., NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, WA. 30 p.

Braham, H. W., R. D. Everitt, B. D. Krogman, D. J. Rugh, and D. E. Withrow.
1977b. Marine mammals of the Bering Sea: a preliminary report on distribution and abundance, 1975-76. Processed Rep. U. S. Dep. Commer., NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, WA. 90 p.

Hollander, M., and D. A. Wolfe.
1973. Nonparametric Statistical Methods. John Wiley & Sons, New York. 503 p.

B. Papers in preparation or in print.

Braham, H. W., R. D. Everitt, and D. J. Rugh.
1977. Preliminary evidence of a northern sea lion (Eumetopias jubatus) population decline in the eastern Aleutian Islands. Processed Rep. U. S. Dep. Commer., NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, WA. 30 p.

Braham, H. W., R. D. Everitt, B. D. Krogman, D. J. Rugh, and D. E. Withrow.
1977. Marine mammals of the Bering Sea: a preliminary report on distribution and abundance, 1975-76. Processed Rep. U. S. Dep. Commer., NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle, WA. 90 p.

Braham, H. W., R. D. Everitt, and D. J. Rugh. Northern sea lion population decline in the eastern Aleutian Islands. (in preparation for J. Wildl. Manage.)

Braham, H. W., and B. D. Krogman. Spring distribution and abundance of the Pacific walrus (*Odobenus rosmarus*) in the Bering Sea. (in preparation as a processed report)

Braham, H. W., G. A. Fedoseev, J. J. Burns, B. D. Krogman, and D. J. Rugh. Distribution and abundance of Phocine seals and walruses in the Bering Sea pack ice in the spring, 1976. (in preparation as a book chapter, US-USSR Conv. Env. Conserv. Marine Mammals)

Braham, H. W. Spring migration of the gray whale (*Eschrichtius robustus*) in Alaska. (in preparation as a processed report)

Everitt, R. D., H. W. Braham, and D. J. Rugh. Distribution and abundance of the land breeding harbor seal (*Phoca vitulina richardii*) in the Bering Sea. (in preparation as a processed report)

Rugh, D. J., and H. W. Braham. Fall migration of the gray whale (*Eschrichtius robustus*) through Unimak Pass. (in preparation for J. Mammal.)

Severinghaus, N. C. Annotated bibliography on marine mammals of Alaska--an update. (in preparation as a processed report)

C. Oral presentations.

17 October. OCSEAP marine mammal display in conjunction with the National Marine Fisheries Service, Marine Mammal Division at the Seattle Fisheries Exposition.

29 October. OCSEAP marine mammal display in conjunction with the Marine Mammal Division at Involvement Day, sponsored by the Cousteau Society, Seattle, WA.

13 December. "Northern sea lion (*Eumetopias jubatus*) population decline in the eastern Aleutian Islands, Alaska", presented at the Second Conference on the Biology of Marine Mammals, San Diego, CA.

14 December. Poster session on all aspects of OCSEAP-Marine Mammal Division research, presented at the Second Conference on the Biology of Marine Mammals, San Diego, CA.

VII. Problems Encountered and Recommended Changes.

Our research efforts have suffered frequent setbacks due to the intermittent nature of the employment situation. Having full-time permanent employees would streamline operations.

VIII. Estimate of Funds Expended.

Salaries/Benefits	$5,908.39
Travel/Per Diem	534.99
Equipment/Supplies	68.95
Computer	200.00
	$6,712.33

Quarterly Report

Contract #R7120806
Research Unit #68
1 October - 31 December 1977
3 pages

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

Howard W. Braham

Roger W. Mercer

Marine Mammal Division
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
National Oceanic & Atmospheric Administration
7600 Sand Point Way, N. E.
Seattle, Washington 98115

December 1977

I. Abstract.

Fifty cruises of data have been checked thoroughly by computer and all editing has been completed. Data is being translated into the OCS-027 format for transmittal to Juneau. Area and month crosstabulations are being produced for all POP data.

II. Objectives.

The objective of Research Unit 68 is to analyze Platforms of Opportunity data collected from 1 January 1971 to 30 August 1977, and to extract seasonal distribution and relative abundance information on marine mammals in the study area.

III. Field or Laboratory Activities.

A. Ship or field trip schedule.

No RU 68 personnel made cruises on OCSEAP vessels. Marine mammal sightings were coded on MOSAs by OCSEAP contract vessels according to OCSEAP instructions.

B. Scientific party.

Howard Braham	Marine Mammal Division NWAFC, NMFS, NOAA	P. I.
Roger Mercer	"	P. I.
Patrick McGuire	"	Data processing
Carl Peterson	"	Data processing

C. Methods.

Most data have been collected by non-Marine Mammal Division observers participating in our Marine Mammal Platforms of Opportunity Project. Logbooks from all sources are examined in the laboratory for general quality; acceptable sighting records are then coded for computer processing and archival. The computerized data are subjected to two manual quality checks and to one comprehensive computer check.

After the data have passed all three verification stages they will be translated into 027 format for submission through the Juneau Project Office. Analyses of the data will be made on the same "batches" that are submitted to Juneau.

D. Sample collection localities.

Nearly all data collected by our own observers have come from Kodiak, Bristol Bay, St. George and Norton Basins, as outlined for OCSEAP research activities. Platforms of Opportunity data have been acquired from the Bristol Bay area and the Gulf of Alaska.

E. Data collected and/or analyzed.

1. List number and type of samples or observations.

The following data has been checked, logged and submitted for keypunching:

No. records	Vessel	Cruise Dates	Area
45	Discoverer	18 Feb.- 8 Mar. 1977	WGOA
113	Miller Freeman	24 Jan.-16 Nov. 1976	GOA/Bering
748	Surveyor	22 Jun.-14 Jul. 1977	GOA/Bering
163	Surveyor	15 Mar.- 2 Apr. 1976	GOA/Bering
836	Discoverer	19 Aug.-23 Sep. 1976	Bering/Chukchi
176	Surveyor	7 Sep.-16 Sep. 1976	GOA

2. List number and type of analyses.

Data from 133 cruises have been blocked and prepared for breakdown by area and month for plotting.

IV. Results.

Efforts during this quarter have been directed primarily toward data reduction--not analysis. Results from analyses now being run will be presented in the annual report.

V. Preliminary Interpretation of Results.

N/A

VI. Auxiliary Material

A. Bibliography of references.

N/A

B. Papers in preparation or in print.

Braham, H. W., and R. W. Mercer. Seasonal distribution of Dall porpoise, Phocoenoides dallii, in the North Pacific Ocean. (in preparation for processed report)

OCSEAP RU 68 final report due 30 September 1978.

C. Oral presentations.

N/A

VII. Problems Encountered and Recommended Changes.

None.

VIII. Estimate of Funds Expended.

Salaries/Benefits	$2,081.14
Travel/Per Diem	0.
Computer	800.00
	$2,881.14

Quarterly Report

Contract #R7120807
Research Unit #69
1 October-31 December 1977
3 pages

Distribution and Abundance of Bowhead and Beluga Whales in the Bering, Chukchi and Beaufort Seas

Howard W. Braham

Bruce D. Krogman

Marine Mammal Division
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
National Oceanic & Atmospheric Administration
7600 Sand Point Way, N. E.
Seattle, Washington 98115

December 1977

I. Abstract.

Ice camp data collected during 1976 and 1977 is being analyzed with the objective of improving indices. Correction factors and confidence limits are being studied as possible means of improvement. Oral presentation summarizing 1976 and 1977 research was made at the Second Conference on the Biology of Marine Mammals held in San Diego, California, 12-15 December.

II. Objectives.

Objectives were limited to analysis of ice camp data collected during 1976 and 1977. While we are sure that the indices developed for estimating numbers of whales passing ice camps are valid, we are developing new techniques for generating indices which are better; taking into account visibility, sea state, lead width and, additionally, providing indices around which statistical confidence limits can be placed.

III. Field or Laboratory Activities.

A. Ship or field trip schedule. N/A

B. Scientific party.

Howard Braham	Marine Mammal Division NWAFC, NMFS, NOAA	P. I.
Bruce Krogman	"	P. I.
David Withrow	"	Research Asst.
Ron Sonntag	"	Research Asst.

C. Methods.

Contingency tests, Analysis of Variance, T-tests, and various manipulations of data are being performed to identify trends in data which may be attributable to sampling conditions and methods or to real biological phenomena. Correction factors and confidence limits applied to the indices are being studied for statistical validity. Histograms and rate graphs are being made.

D. Sample collection localities. N/A

E. Data collected and/or analyzed.

1. List number and type of samples or observations. N/A

2. List number and type of analyses.

Data is being extracted as subsets, i.e. trends in data are being examined according to specific environmental conditions. Rates of moving animals are being compared during open versus closed lead conditions, good versus poor visibility conditions, and correction factors are being developed. See also methods for number and type of analyses.

IV. Results. and V. Preliminary Interpretation.

The major result of our analysis has been the preliminary quantification of environmental and biological phenomena which occur during our sample effort and which may affect our survey results. Basically these phenomena can be categorized as (1) differential migrational patterns and rates by whales, (2) variable lead widths, and (3) variable visibility conditions. These factors are being studied so that any adjustments that may be required can be made, and the most reliable indices can be developed.

VI. Auxiliary Material.

A. Bibliography of references. N/A

B. Papers in preparation or in print.

No new papers planned since last quarterly report.

C. Oral presentations.

An oral presentation was made at the Second Conference for the Biology of Marine Mammals held in San Diego, California, 12-15 December 1977. Preliminary results of the first two years of research under RU 69 were presented. Abstract of presentation follows:

"Research on the bowhead and beluga whale (Delphinapterus leucas) was conducted under the Alaska Outer Continental Shelf Environmental Assessment Program to identify migratory routes and timing during the spring and fall, and to make estimates of population abundance.

Counts of bowhead whales were made from ice camps during the spring (April-June) of 1976 and 1977 from Pt. Barrow, and from Pt. Hope during 1977. Approximately 125 aerial survey hours were flown in 1976 to delineate nearshore and offshore distribution of whales in the Bering, Chukchi and Beaufort Seas. Results indicate that most bowheads pass close to shorefast ice counting stations and that a reliable index of population abundance can be made using ice camp data. Peaks in the northerly migration past Pt. Barrow occurred during the third week of May in 1976, and the first week of May in 1977. Based on new evidence, the migration east of Barrow to Canadian waters is believed to occur offshore in the Beaufort Sea. Fall migration is still poorly understood.

Mating was observed on 8 May 1976 indicating that reproduction occurs during the northward migration. Observations of young of the year calves suggest that parturition occurs in the southern range of the species or during the spring migration."

VII. Problems Encountered and Recommended Changes.

None.

VIII. Estimate of Funds Expended.

Salary/Benefits	$2,880.57
Travel and Per Diem	533.67
Purchases	87.06
Computer	200.00
	$3,701.30

QUARTERLY REPORT

Contract 03-5-022-56
Task Order No. 8
Quarter Ending: 12/31/77
R.U. #194

MORBIDITY AND MORTALITY OF MARINE MAMMALS (BERING SEA)

Principal Investigator

Dr. Francis H. Fay
Associate Professor of Marine Science
and Arctic Biology
Institutes of Marine Science and Arctic Biology
University of Alaska
Fairbanks, Alaska 99701

Assisted by:

Associate Investigator

Dr. Robert A. Dieterich
Professor of Veterinary Science and Wildlife Disease
Institute of Arctic Biology
University of Alaska
Fairbanks, Alaska 99701

and

Larry M. Shults
Biological Technician
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

31 December 1977

QUARTERLY REPORT

I. TASK OBJECTIVES THIS QUARTER

A. To continue processing of pathological and parasitological materials obtained in the previous two quarters.

B. To begin field work in the Gulf of Alaska and Lower Cook Inlet.

II. FIELD AND LABORATORY ACTIVITIES

A. Field Trip Schedule

25-28 October (Fay, Dieterich) OCSEAP Bird & Mammal Review, Fairbanks

25 October-2 November (Shults) *Surveyor* NEGOA

9-11 November (Fay) LCI Coordination Meeting, Seattle

12-19 November (Shults) *Resolution* Prince William Sound

15 November (Fay) Stranding necropsy at Homer, LCI

2 December (Dieterich) Naval Biosciences Laboratory, Oakland

B. Laboratory Activities

Tissues were prepared for sectioning, and selected samples were sent to the Department of Pathology, The Johns Hopkins School of Medicine, Baltimore for pathological diagnosis. Serum antibody analyses of samples sent earlier were obtained from the Naval Biosciences Laboratory, Oakland, and results from recent samples were obtained from the Virology-Rabies Unit, Division of Public Health, Fairbanks. All parasite and microbiological isolates were identified.

C. Methods

As described previously.

III. RESULTS

A. Pathology

Histological examination of the materials collected in FY77 and the first quarter of FY78 indicates that the principal agents involved in the development of the gross pathological lesions identified were helminthic parasites. Second in order of importance was trauma; microbiological agents were third.

B. Serology

Serum antibodies to *Leptospira pomona* and San Miguel Sea Lion Virus (SMSV) were present in significant amounts in the majority of Steller sea lions and a few of the harbor seals examined. However, there was no serological evidence of antibodies to either of these agents in any of the walruses or ice seals.

IV. PRELIMINARY INTERPRETATION OF RESULTS

As above.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES

None.

MILESTONE CHART

R.U. # 194 P.I. Francis H. Fay

Major Milestones: Reporting, data management and other significant contractual requirements; periods of field work; workshops; etc.

MAJOR MILESTONES	1977 O	1977 N	1977 D	1978 J	1978 F	1978 M	1978 A	1978 M	1978 J	1978 J	1978 A	1978 S	1978 O	1978 N	1978 D
NEGOA collection & necropsy (*Surveyor*)	▲														
NGOA/PWS collection & necropsy (Pitcher charter)		▲													
SE Bering collection & necropsy (CG Icebreaker)					Δ										
NEGOA collection & necropsy (Pitcher charter)						Δ									
Norton Sd. collection & necropsy (shore-based)							Δ								
SE Bering collection & necropsy (*Surveyor*)									Δ						
NGOA collection & necropsy (*Surveyor*)										Δ					
Kodiak/Tugidak strandings (UH1H helo)								Δ		Δ	Δ				
Alaska peninsula strandings (charter & UH1H?)										Δ					
Kodiak collection & necropsy (Pitcher charter)										Δ					
St. Lawrence/Norton strandings (charter)											Δ				
Kodiak collection & necropsy (*Surveyor*)												Δ			
LCI strandings (charter)												Δ			

Δ Planned completion date ▲ Actual completion date

QUARTERLY REPORT

Contract #03-5-002-69
Research Unit #229
Reporting Period 1 October
thru 31 December 1977

Number of Pages - 2

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

Investigations into the biology and ecology of the harbor seal in the Gulf of Alaska are continuing in order to minimize effects of oil and natural gas development. Continuing research, begun in 1975, is examining food habits, population productivity, growth rates and body condition. New work, to be conducted in FY 78, is centered around the important Tugidak Island "population". Major objectives of this work are to collect data on movements and population discreetness of harbor seals on Tugidak Island, to determine if there are differential use patterns by sex and age class of harbor seals, to find out the proportion of time seals spend hauled during the periods of pupping and molt, to examine activity patterns of harbor seals on Tugidak and to establish population trend count areas at strategically located haul-out areas. Peripheral objectives include collection of data concerning distribution, use of critical habitats, effects of disturbance, population composition and collection of specimen materials for disease and environmental pollutant analysis.

Methods used for collection of data have been detailed in the annual reports.

A single cruise aboard the NOAA ship "Surveyor" was conducted between 25 October and 2 November 1977. The fringes of tropical storm Harriett reduced our effectiveness during the early stages of the trip. Nine harbor seals were collected in Icy Bay (NEGOA).

Laboratory activities, included sorting and identification of stomach and intestinal contents and sectioning of teeth for age determination. Data management continued to absorb an inordinate amount of time.

Quarterly Report

Contract #02-5-022-53
Research Unit #230
Reporting Period: October-December 1977
Number of Pages: 4

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

Principal Investigators:

John J. Burns and Thomas J. Eley
Marine Mammals Biologists
Alaska Department of Fish and Game
1300 College Road
Fairbanks Alaska 99701

Assisted by: Kathryn Frost, Lloyd Lowry, Glenn Seaman, Richard Tremaine, Dan Strickland, Robin Lynn, Richard LaBonity, William Harrigan and John Wheeler

31 December 1977

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 productivity, growth rates and mortality in these two species.

3. Acquisition of baseline data on mortality (including parasitology, diseases, predation and human harvest) of ringed and bearded seal.

4. Determination of population structure of bearded and ringed seals as indicated by composition of harvest taken by Eskimo subsistence hunters.

5. 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.

6. Acquisition of additional information on seasonal migrations.

II. Field and Laboratory Activities

A. Schedule

Date	Location	Activity	Personnel
October-December	Fairbanks	Analyses of seal specimens and specimen data	Burns, Eley
October-December	Fairbanks	Data management	Eley, Frost
October-November	Shishmaref	Collection of seal specimens	Tremaine
October	Fairbanks	Attended OCSEAP seabird and marine mammal meeting	Burns, Eley
November	Prudhoe Bay	Collection of seal specimens	Eley, Lowry
November	Barrow	Collection of seal specimens	Eley, Burns
November	Nome	Collection of seal specimens	Frost
December	San Diego	Attended marine mammal biology conference	Burns, Eley
December	Seattle	Attended marine mammals-fisheries interactions conference	Eley, Burns
December	Fairbanks	Preparation of quarterly report	Eley, Burns

B. Scientific Party

Name	Affiliation	Role
John J. Burns	ADF&G	Principal Investigator
Thomas J. Eley	ADF&G	Principal Investigator
Kathryn Frost	ADF&G	Marine Mammals Biologist
Lloyd Lowry	ADF&G	Marine Mammals Biologist
Glenn Seaman	ADF&G	Marine Mammals Technician
Dan Strickland	ADF&G	Marine Mammals Technician
Richard Tremaine	ADF&G	Marine Mammals Technician
Robin Lynn	ADF&G	Marine Mammals Technician

C. Analytical Methods

For a discussion of methods refer to RU#230 Annual Report, 1 April 1977.

Whenever possible meat from seals collected for this research is given to residents of the appropriate coastal area.

D. Data Collected

A total of 29 male, 28 female and 4 ringed seals of undetermined sex were obtained this quarter (Table 1) yielding a 1:1 sex ratio. Seventeen bearded seals were collected and consisted of 9 males and 8 females. The sex ratio of bearded seals was 1 male to 1 female.

Table 1. Seal specimens obtained during October-December, 1977.

Location	Sex Male	 Female	 Unknown	 Total
Shishmaref				
Ringed Seal	10	7	0	17
Bearded Seal	7	7	0	14
Barrow				
Ringed Seal	8	13	1	22
Bearded Seal	1	0	0	1
Prudhoe Bay				
Ringed Seal	11	8	3	22
Bearded Seal	1	1	0	2
Total				
Ringed Seal	29	28	4	61
Bearded Seal	9	8	0	17

III and IV. Results and Preliminary Interpretation

During this quarter we continued our major field effort directed specifically at the Beaufort Sea. With the excellent OCSEAP provided helicopter support, we were quite successful in acquiring a sample of ringed and bearded seals in the Beaufort Sea (Table 1) during the early winter when our previous samples were inadequate. In addition, fall and early winter collections at Shishmaref during the seal harvest by Native hunters were productive.

Laboratory activities consisted mainly of processing male and female reproductive tracts and determining ages of seals by examination of claw and tooth annuli. In addition, parasitological determinations were made.

Data management was continued on an ongoing basis, as was the acquisition of information from other related studies, mainly those conducted by Soviet investigators.

A detailed presentation and discussion of results will be presented in our 1978 annual report.

V. Problems Encountered/Recommended Changes

None

VI. Estimates of Funds Expended

As of 30 November we have expended the following approximate amounts during FY78:

Salaries and benefits	$6,995.42
Travel and per diem	1,135.04
Contractual services	709.13
Commodities	654.61
Equipment	24.25
Total Expenditures	$9,518.45

Quarterly Report

Contract #03-5-022-53
Research Unit #232
Report Period: 1 October-31 December 1977
Number of Pages: 5

Trophic Relationships Among Ice Inhabiting Phocid Seals

Principal Investigators:

Lloyd F. Lowry
Marine Mammals Biologist
Alaska Department of Fish and Game
1300 College Road
Fairbanks, AK 99701

Kathryn J. Frost
Marine Mammals Biologist
Alaska Department of Fish and Game
1300 College Road
Fairbanks, AK 99701

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

Assisted by: Tom Eley, Glenn Seaman, Dan Strickland, Richard Tremaine, Robin Lynn

31 December 1977

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

During the past quarter considerable effort was directed to laboratory processing of specimen material. A portion of the large sample of seal stomachs collected at Shishmaref in the spring was analyzed. Analysis of fishes and invertebrates collected from the USCGC GLACIER was begun.

Only limited field collections were made. A UHIH and Bell 206 helicopter were used to collect seals from the Beaufort Sea. Collections were made from Deadhorse and Barrow. A small collection was obtained from hunters in the village of Shishmaref. A specimen collection attempt at Nome was unsuccessful due to inclement weather.

Data management continued on an intermittent basis. Specimen records and stomach contents data sheets were completed in the field and submitted for keypunching immediately upon return to Fairbanks.

Table 1 provides a complete listing of field and laboratory activities during the past quarter. Dates and personnel are included.

Table 1. Field and laboratory activities, 1 October-31 December 1977.

Activity	Dates	Personnel
Specimen collection at Shishmaref	15-31 October 5-11 November	R. Tremaine
Specimen collection from Deadhorse	5-11 November	L. Lowry, T. Eley
Specimen collection from Barrow	12-17 November	T. Eley, J. Burns
Specimen collection at Nome	16-19 November	K. Frost
Laboratory processing of specimen material	continuous	L. Lowry, K. Frost, R. Lynn, D. Strickland
Compilation and analyis of data	intermittent	L. Lowry, K. Frost
Data management	intermittent	K. Frost, R. Lynn
Preparation of quarterly report	1-7 December	L. Lowry
OCSEAP Bird and Mammal Project Review	25-28 October	L. Lowry, K. Frost, J. Burns, T. Eley
Conference on the Biology of Marine Mammals	12-16 December	L. Lowry, K. Frost, J. Burns, T. Eley

Methods

Field collection procedures at coastal hunting villages and methods for laboratory analysis are described in the 1977 annual report for RU#232. At Deadhorse a NOAA UHIH helicopter was used for four days of collecting and an ERA Bell 206 helicopter was used for two days. At Barrow the ERA 206 was used for the entire collection period of four days. Specimens were processed in the manner described in the 1977 annual report for RU#232.

Various biological parameters of fishes collected from the GLACIER are being examined. Each fish is identified to species and the length and weight measured. Where possible the age of each specimen is determined by reading annuli in otoliths. Sex, reproductive state and stomach contents are noted.

Whenever feasible usable meat from seals collected by ADF&G personnel was given to residents of coastal communities.

Data Collected or Analyzed

Table 2 summarizes the results of our collection efforts from 1 October to 31 December 1977. A total of 86 stomachs were collected, 50 from the southern Chukchi Sea and 36 from the Beaufort Sea.

Table 2. Seal stomachs collected during the period 1 October to 31 December 1977. Not all stomachs contained food.

Location	*Phoca* (*Pusa*) *hispida*	*Erignathus barbatus*	*Phoca vitulina largha*
Deadhorse	19	2	0
Barrow	14	1	0
Shishmaref	13	14	23
Total	46	17	23

III and IV. Results and Discussion

Results of our recent collections were presented in the previous section. The collections from Deadhorse and Barrow are very significant because no material was previously available from either location during November. The fall collection from Shishmaref will be valuable to compare with the spring collections made during the previous two years.

Presentation and discussion of the results of analyses will be done in the upcoming annual report of this research unit.

V. Problems Encountered/Recommended Changes

None

QUARTERLY REPORT

Contract # 03-5-022-69
Research Unit #243
Reporting Period-Oct. 1 thru Dec. 31
Number of Pages - 5

Population Assessment, Ecology and Trophic Relationships of Steller Sea Lions in the Gulf of Alaska

Principal Investigators:

Donald G. Calkins, Alaska Department of Fish and Game
Kenneth W. Pitcher, Alaska Department of Fish and Game

December 31, 1977

I. Task Objectives

To determine numbers and biomass of Steller sea lions in the Gulf of Alaska. To establish sex and age composition of groups of sea lions utilizing the various rookeries and hauling grounds. To determine patterns of animal movement, population identity and population discreteness of sea lions in the Gulf. To determine changes in seasonal distribution.

To investigate population productivity and growth rates of Steller sea lions in the Gulf of Alaska with emphasis on determining; age of sexual maturity, overall birth rates, duration of reproductive activity and survival rates for various sex and age classes.

To determine food habits of Steller sea lions in the Gulf of Alaska with emphasis on variation with season and habitat type. An effort will be made to relate food habits with prey abundance and distribution. Effects of sea lion predation on prey populations will be examined.

To incidentally collect information on pathology, environmental contaminant loads, critical habitat and fishery depredations.

II. Field or Laboratory Activities

A. Field Activities

1. Cruise aboard NOAA vessel "Surveyor"

   a. Oct. 25 through Nov. 2

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

   a. Nov. 12 through Nov. 19

B. Scientific Parties

1. Oct. 25 through Nov. 2

   a. Donald Calkins A.D.F.&G.

      Principal Investigator

   b. Kenneth Pitcher, A.D.F.&G.

      Principal Investigator

   c. Charles Irvine, A.D.F.&G.

      Observer and collecting crew

   d. Dennis McAllister, A.D.F.&G.

      Collecting crew

   e. Walt Cunningham, A.D.F.&G.

      Sea lion observations, Cape St. Elias

   f. Dave Johnson

      Sea lion observations, Cape St. Elias

   g. Rod Swope, OCS Proj. Office

      Collecting crew, OCS observer

   h. Marci Butcher, OCS Proj. Office

      Collecting crew, OCS observer

   i. Larry Schults, University of Alaska

      Parsitology and pathology

2. Nov. 12 through Nov. 19

   a. Donald Calkins, A.D.F.&G.

      Principal Investigator

   b. Kenneth Pitcher, A.D.F.&G.

      Principal Investigator

   c. Karl Schneider, A.D.F.&G.

      Collecting crew

d. Dennis McAllister

Collecting crew

e. Larry Shults

Parsitology and pathology

C. Methods

1. See annual report

D. Sample localities

1. Oct. 25 through Nov. 2

a. Prince William Sound

b. Cape St. Elias

c. Sitkagi Bluffs

d. Middleton Island

2. Nov. 12 through Nov. 19

a. Prince William Sound

E. Data Collected

1. Counts at hauling areas in the northern Gulf:

Hauling Area	Date	Count
Pleiades Islands	Nov. 14, 1977	125
Point Eleanor	Nov. 18, 1977	250
Glacier Island	Nov. 13, 1977	150
Perry Island	Nov. 14, 1977	200
Point Elrington	Nov. 16, 1977	560
Sitkagi Bluffs	Oct. 29, 1977	150
Middleton Island	Nov. 1, 1977	122

2. A total of 40 sealions have been collected this quarter.

III. Results

A. Analysis of specimen materials collected is in progress.

IV. Preliminary Interpretation of Results

A. None available until analysis of specimen materials is complete.

V. Problems Encountered

A. None

Quarterly Report

Contract #03-5-022-55
Research Unit Number: 248
Report Period: 1 Oct. - 31 Dec. 1977
Number of Pages: 2

The relationships of marine mammal distributions, densities and activities to sea ice conditions

Principal Investigators:

John J. Burns
Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701

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

Lewis H. Shapiro
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

Assisted by: Kathryn J. Frost and Larry M. Shults
Lloyd F. Lowry, and Thomas J. Eley

31 December 1977

I. Task Objectives

The specific project objectives are:

1) to determine the extent and distribution of regularly occurring, ice-dominated marine mammal habitats in the Bering, Chukchi and Beaufort Seas;
2) To describe and delineate those habitats;
3) To determine the physical environmental factors that produce those habitats;
4) To determine the distribution and densities of the various marine mammal species in the different ice habitats; and
5) To determine how the dynamic changes in quality, quantity and distribution of sea ice relates to major biological events in the lives of marine mammals (e.g. birth, nurture of young, mating, molt and migrations).

II. Field and Laboratory Activities

A. Field Trip Schedule

5-11 November (Lowry, Eley) Western Beaufort (Deadhorse)

12-16 November (Burns, Eley) Barrow

B. Laboratory Activities

Data compilation - satellite imagery (Burns, Shapiro)

III. Results

Data analysis incomplete, will be presented in annual report.

IV. Preliminary Interpretation of Results

The Beaufort Sea was exceptionally ice-free in the summer-autumn of 1977. By late November, the multi-year ice was still about 45 nm north of Barrow and 100 nm north of Prudhoe Bay. Extensive new ice had formed between the shore and the multi-year ice by mid-November, and this was unusually uniform in quality, rather than the usual mixture of new ice and old, rough floes. Field operations were conducted entirely within this new, seasonal ice.

Both ringed and bearded seals were common in the leads north of Deadhorse and Barrow, and a clear trend of movement of these animals from east to west was evident most of the time. Judging from the tracks of polar bears, they too were moving from east to west at that time, as was one bowhead whale sighted on 14 November.

V. Problems Encountered/Recommended Changes

None

VI. Estimate of Funds Expended This Quarter

$12,000

RECEPTORS (BIOTA)

MARINE BIRDS

RECEPTORS (BIOTA)

BIRDS

QUARTERLY REPORT

Contract #03-5-022-69

Research Unit #3

Reporting Period October 1, 1977

December 31, 1977

Pages 4

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

Paul D. Arneson

Alaska Department of Fish and Game

December 30, 1977

I. Task Objective for 1st Quarter, FY 1978

A. To determine winter distribution and abundance of marine birds in relation to ice conditions and other environmental parameters in Lower Cook Inlet.

II. Field Activities

A. Field Trip Schedule: On November 22, 1977 shoreline and pelagic bird surveys were conducted in Lower Cook Inlet with a Grumman Wigeon owned by Sea Air, Inc. and leased to Orin Seybert of Peninsula Airways.
B. Scientific Party: Observers for the surveys were Paul Arneson and Marilyn Allen, Alaska Department of Fish and Game, Anchorage, Alaska.
C. Methods: Shoreline survey techniques as described in previous reports were used from West Foreland to Oil Point and from Bluff Point to East Foreland. Line-of-sight pelagic transects were flown in Kamishak Bay, across the Inlet, and in Outer Kachemak Bay with observers looking 100 meters from each side of the aircraft.
D. Sample Locatities: See Figure 1.
E. Data Collected: During surveys, approximately 375 km of shoreline and 650 km of pelagic transects were flown. Over 400 records were entered into computer format.

III. Results

The first bird survey was scheduled for what was considered incipient winter conditions and after the arrival of many wintering birds. Cold weather prior to the survey caused ice to form at the head of some bays and in shallow water over mudflats. No ice floes formed in Upper Cook Inlet had drifted down into Lower Cook Inlet at survey time.

A total of 3111 birds (a minimum of 27 species) were enumerated: 2507 in shoreline stations and 604 along pelagic transects. Of the total, 60 percent were sea ducks. Scoters made up 66 percent and eiders 19 percent of the sea ducks observed. Ninety-five percent of the scoters and 41 percent of the eiders were recorded on shoreline stations. The remainder were on pelagic surveys. About 25 percent of the total birds were gulls and 9 percent were alcids.

Shoreline Surveys: Sixteen shoreline stations were censused: 7 in Northwest Lower Cook Inlet, 2 in Kamishak Bay, and 7 on the east side. Bird abundances were 2.9, 1.4 and 11.5 birds per kilometer of shoreline surveyed for the three regions, respectively. Most birds were observed in Station 12 (Figure 1) where 65.5 birds per kilometer were recorded. There was a steady decrease in abundance as we went north along the east side.

On the west side most birds were in Station 3 (9.9 birds/km). This was due to a large flock of small gulls just north of the mouth of Tuxedni Bay.

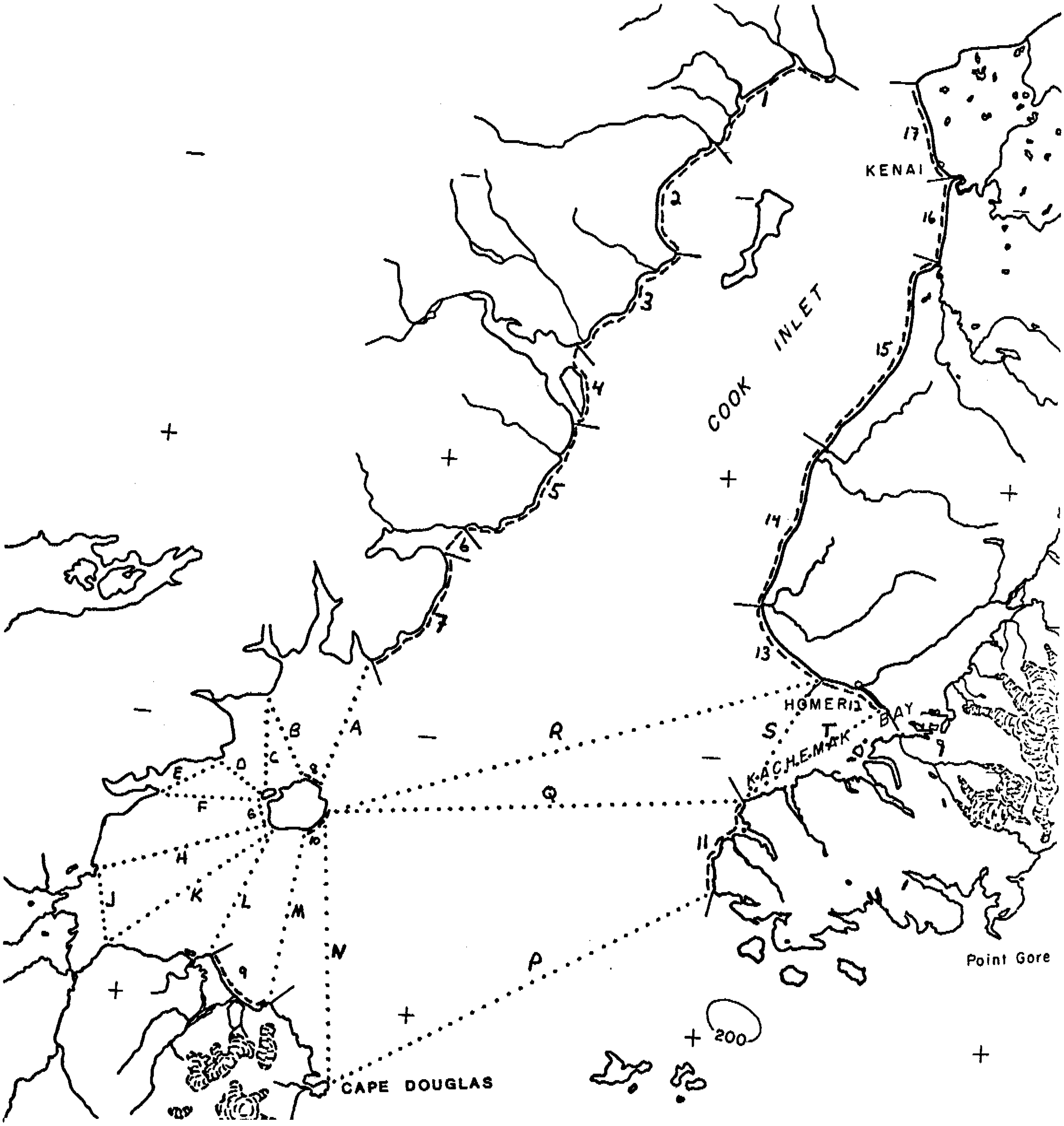


Figure 1. Trackline of shoreline stations and transects for winter bird surveys, 22 November 1977, Lower Cook Inlet.

Sixty-two percent of the birds observed along the shoreline were sea ducks. Of these, 75 percent were scoters and only 9 percent eiders. Gulls comprised 24 percent of the total birds along the shore and alcids 7 percent.

Pelagic Surveys: There were 50 percent sea ducks, 26 percent gulls and 18 percent alcids in pelagic transects. Eiders were by far the most abundant sea duck comprising 70 percent of the total while scoters were a distant 22 percent.

Densest concentrations of birds were recorded in outer Kachemak Bay where 19.1 birds (per sign) km^2 were observed in two transects. Only 4.3 birds per km^2 were found in the 12 transects of Kamishak Bay. Most of the birds observed in Kamishak were in two large flocks consisting of Steller's and unidentified large eiders (likely common). In three transects across the inlet 266 kilometers were covered and only 1.7 birds/km^2 were recorded. Most of these were sea ducks, gulls and alcids in descending order of abundance although four shearwaters were also observed.

IV. Preliminary Interpretation

Although survey conditions were excellent in Upper Cook Inlet, they became much worse the farther south we went into Lower Cook Inlet. Wind velocities reached 30 knots and swells were up to three meters at certain locations. This made observations difficult and numbers of observations were likely reduced. It was obvious nonetheless, that bird concentrations were low in Kamishak Bay and on transects across the Inlet.

Survey conditons were much better in Outer Kachemak Bay because it was in the lee of northeast winds. Large numbers of birds (primarily scoters) were within 300 meters of shore from Homer to Anchor River. Other scattered individuals were found throughout the outer portion of Kachemak Bay.

The remaining three winter surveys will give a much better picture of the degree of winter bird usage in Lower Cook Inlet, but based on this survey and past information, Outer (and Inner) Kachemak Bay are much more critical to wintering birds by the direct effects of oil and gas development.

V. Problems Encountered

The accidental erasure of flexible discs containing most of the data from FY77 surveys by an unthinking key punch operator caused considerable delays in submitting the information in a timely manner.

Also, the lack of code numbers for certain bird species groups under the new code system has caused delays in submission of the most recent survey. An expeditious solution to the missing codes would be most helpful.

11th Quarterly Report

Contract # 03-5-022-72
Research Unit 83
Reporting Period 1 October-
31 December 1977
4 pages

Reproductive Ecology of Pribilof Island Seabirds

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

1 January 1978

I. Abstract

During the 11th quarter, emphasis has been placed on the reduction of the 1977 field data to a form comparable with the results of the 1975 and 1976 field seasons. This work is progressing well. Coding and entry of the last of previous years' data and the 1977 data have been postponed pending final authorization to hire a coder/data manager as agreed in Juneau. Considerable progress has been made toward integrating at sea studies of foraging seabirds with the PROBES efforts to determine the reasons for and distribution of regions of high productivity in the southeastern Bering Sea, particularly in relation to the production of Polloch.

II. Task Objectives

The task objectives of the 11th quarter were:

1) To begin work up and reduction of the 1977 field data.
2) To check inventories of equipment and supplies and initiate planning and purchasing for the 1978 field season.
3) To code and punch all remaining data from the 1975, 1976 and 1977 field seasons.
4) To develop an integrated, cooperative program with the PROBES study in order to better relate seabird foraging distribution to productivity and the distribution of Polloch.

III. Laboratory Activities

A. Trips

The Prinicipal Investigator attended the OCSEAP marine bird and mammal P.I. meeting in Fairbanks in October.

B. Scientific Party

George L. Hunt, Jr.	Associate Professor, UCI, P.I.
Barbara Mayer	Assistant Specialist, UCI, in charge of logistics and work up of food samples. In charge of field operations on St. Paul Is.
Ron Squibb	Laboratory Assistant II, UCI, in charge of work up of colony data, in charge of field operations on St. George Is.
Bill Rodstrom	Laboratory Assistant II, UCI, in charge of work up of ship and aerial surveys of foraging birds.

C. Methods

We are using the same methods of analysis as used in previous years. Please see the 1976 Annual Report for details.

D. Sample Locations/Trackline - not applicable.

E. Data Analysed

1. Colony data:

	St. Paul			St. George		
	phenology	reproductive success	growth	phenology	reproductive success	growth
Fulmar	-	X	NA	-	X	NA
Red-faced Cormorant	-	-	-	X	X	-
Black-legged Kittiwake	P	P	X	X	X	X
Red-legged Kittiwake	X	X	-	X	X	X
Common Murre	X	X	-	X	X	-
Thick-billed Murre	X	X	-	X	X	-

X - completed
P - partially done
\- - to be done
NA - data not taken

2. Foods

To date 257 of 891 food samples collected have been analysed.

3. Survey Data

Data from virtually all of 700 ten minute transects taken in 1977 have been given a first level of analysis from which density/km^2 has been calculated.

Data from tapes made during helicopter transects have been transcribed and are in the process of being analysed.

IV, V. Results and Preliminary Interpretation

A. The work up of the 1977 field data is progressing well. At present, it appears that all colony work and at sea surveys will be analysed in time for the 1 April Annual Report. It is anticipated that a large, representative sample of the food samples taken will be worked up, but it is likely that, due to the large number obtained and the small staff available, that some samples will not be processed in time for inclusion in the annual report.

So far, the results of the colony work suggest an increase in reproductive success on both islands over that found in 1975 and 1976, but only a small change in timing of breeding, in spite of the mild weather in 1977.

The preliminary work on the at sea surveys generally confirms the picture found in 1975 and 1976 with the largest concentrations of birds near the islands. This year, we feel we located a heretofore unrecognized major foraging area for murres NE of St. George and E of St. Paul. Murres had been seen flying in that direction from St. George and to a lesser extent from St. Paul.

On the August cruise we were able to coordinate our efforts with Dr. Tom Kinder from Dr. L. Coachman's laboratory and we are hopeful of the possibility of relating satellite imagery of sea surface temperatures, C.T.D. costs and bird distributions as we obtained satellite imagery for the same day that we were making bird observations.

It is presently too early in the analysis of the food samples for anv preliminary report of results.

B. We have been going over the needs for motorcycle parts and gun repair and almost certain we will need to purchase at least one additional shotgun for use on the PROBES vessel.

C. All coding and punching of data has been held in abeyance pending final authorization to hire a coder/data manager per instructions from Juneau. We hope to have hiring completed early in January, at which point a large volume of coded data will be sent out for punching, and coding of the remaining 1977 data will commence.

D. The P.I. attended a planning session of PROBES for the 1978 field season. Our OCSEAP program has been invited to put a bird observer on their ships in order to correlate densities of foraging birds with the distribution of potential prey items. PROBES personnel are also interested in sampling beneath bird flocks and in collecting birds in the vicinity of their stations. One possibility of considerable interest is the following of birds under water with high resolution sonar, observing them enter a school of fish and then collecting the birds as they surface in order to "ground truth" the sonar echo and relate echo to type of target. This sort of work would also yield the first reliable data on the depth to which the various alcids dive in search of food.

In addition, Dr. Ted Cooney has expressed a willingness to put one of his staff on any OCSEAP cruises to aid us in obtaining data on prey species availability in areas not covered by PROBES.

VI. Auxiliary Material

A. Paper in print

1) Hunt, G.L. and M.C. Thompson. Black-legged Kittiwake nesting on snow bank (in press, Wilson Bull.).

B. Oral Presentations

1) Aspects of the reproductive biology of Red-legged and Black-legged Kittiwakes (<u>Rissa brevirostris</u> and <u>R. tridactyla</u>) on the Pribilof Islands. Ann. meeting Pacific Seabird Group with M. Hunt.

2) In the January 1978, Pacific Seabird Group meeting the P.I. will be leading a workshop on the Black-legged Kittiwakes studies in Alaska. We will present one paper on kittiwakes in that workshop and possibly an additional paper in the contributed papaers session.

VII. Problems encountered

At present, work is progressing well and there are no significant problems worthy of OCSEAP attention. Overall the project is running reasonably smooth and with the addition of the coder/data manager I foresee little problem in the future for prompt submission of data.

Data submission will be further enhanced if OCSEAP decides to provide us with the Direct Data Entry System demonstrated at the October 1977 Fairbanks meeting.

VIII. Estimate of Funds Expended

	Nov. 30, 1977 expenditures	Total
		$68,629.14
Direct costs		
Salaries	$35,264.81	
Fringe Benefits	9,482.27	
Equipment	-0-	
Travel	13,194.18	
Supplies and Expenses	4,992.54	
Other	5,694.34	

It is my expectation, barring changes in housing costs, that we have sufficient funds to carry out the agreed upon work.

QUARTERLY REPORT

Contract No. 03-5-022-84
Research Unit #172
Reporting Period: 1 Oct. - 31 Dec. 1977
Number of Pages: 3

Shorebird Dependence on Arctic Littoral Habitats

Research Coordinator: Peter G. Connors
Bodega Marine Laboratory
University of California
Bodega Bay, California 94923

Principal Investigator: R. W. Risebrough

Date of Report: December 20, 1977

I. Task Objectives

The ultimate objective of this study is the assessment of the degree and nature of dependence of each shorebird species on Arctic habitats which may be susceptible to perturbation from offshore oil development activities. The approach entails three major areas of investigation:

1. Seasonal occurrence of shorebirds by species, in a variety of arctic littoral and near-littoral habitats.

2. Diets of shorebirds in the arctic littoral zone, by species, as these change through the season.

3. Comparison of habitat use patterns, densities, and timing of shorebird littoral and tundra events at multiple sites along the Beaufort and Chukchi coasts.

II. Lab Activities

A. None

B. Scientific Party

Research Coordinator: Peter G. Connors, Univ. of California

Research Assistant: Douglas Woodby, UC-BMT.

C. Methods

Data from marked transects at each principal study site (Barrow, Wales, Cape Krusenstern) have been tabulated by species, age, sex, habitat, and census period. Preliminary treatment of these data has included seasonal habitat use plots of several of the most common species; comparison between sites for particular species; and comparison between years at Barrow site.

D. Sample Localities - not applicable.

E. Data Analyzed.

The results of approximately 900 littoral zone transect censuses and 300 tundra transect censuses have been tabulated. Preliminary computer plots of population changes throughout the season have been constructed for six species.

Approximately one-half the total data gathered have been entered on coding sheets (Format 034). These efforts were interrupted in late October when the possibility of a direct entry-microcomputer system arose. We have recently learned that this change will require several months, and have therefore resumed our coding efforts.

III. and IV. Results and Interpretation

Continued analysis does not suggest any changes in the preliminary interpretations included in the previous quarterly report.

A refinement of our classification of Barrow shorebirds' susceptibility to oil development disturbances in the littoral zone shifts two species (Western and Semipalmated Sandpipers) from high to medium susceptibility. The revised classification for Barrow is:

High	Medium	Low
Red Phalarope	Western Sandpiper	Golden Plover
Sanderling	Semipalmated Sandpiper	Pectoral Sandpiper
Ruddy Turnstone	Baird's Sandpiper Dunlin Long-billed Dowitcher	

Surprisingly, habitat use patterns for some species are sufficiently different in Kotzebue Sound and northern Seward Peninsula to shift this classification for that area. Analyses have not proceeded far enough to permit a full classification yet, but it seems likely that Golden Plover and Pectoral Sandpiper should receive a medium, rather than low, susceptibility rating.

V. Problems: None

VI. Estimate of Funds Expended.

Funds expended from April 15, 1975 through December 15, 1977 totaled approximately 97,000. This rate of expenditure is on schedule with work accomplished.

Quarterly Report

Contract # 03-7-022-35140
Research Unit: 196
Report Period: 1 October - 31 December 1977
Number of Pages: 3

The Distribution, Abundance and Feeding Ecology of Birds Associated with Pack Ice

George J. Divoky
Principal Investigator

Assisted by:

Deborah M. Ford

Point Reyes Bird Observatory
4990 State Route 1, Stinson Beach
California 94970

I. Abstract of Quarter's Accomplishments

Compliation and tabulation of 1977 summer field data was begun. Initial analysis of 1977 data was presented in late October at the OCSEAP bird and mammal meeting in Fairbanks. A data entry program for the shipboard entry of pelagic transect data was nearly completed. The hardware and software of the system was demonstrated at the Fairbanks meeting. The system will be given a field trial on a November cruise to the Antarctic. The principal investigator will participate in the 15 November to 15 January cruise.

II. Task Objectives

Determine the relationship of pelagic seabirds to the ice environment on a seasonal basis in the Bering, Chukchi and Beaufort seas.

III. Field Activities

A & B. Field Schedule and Personnel

Divoky participated in an NSF funded cruise to the Antarctic from 15 November to 15 January. Ford compiled data.

C. Methods

Not applicable

D. Sample localities

None

E. Data collected

None

IV. Results

None

V. Preliminary Interpretation of Results

None

VI. Auxillary Material

None

VII. Problems Encountered

None

QUARTERLY REPORT

Contract #: 03-6-022-35208
Research Unit #: 237
Reporting Period; October 1 - December 31, 1977

Birds of Coastal Habitats on the South Shore of the Seward Peninsula, Alaska

William H. Drury
Principal Investigator
College of the Atlantic

Quarterly Report

Research Unit #237

Contract #03-6-022-35208

Birds of Coastal Habitats on the South Shore of the Seward Peninsula, Alaska

I. Highlights of Quarter's Accomplishments

Drury attended the meetings of P.I.s responsible for studies of seabirds and sea mammals at Fairbanks in October.

The possibility of a very helpful change in processing field data onto floppy disks was suggested at that meeting and permission to use the equipment has been requested.

Field notebooks and journals have been reviewed and the information for our data reduction so far indexed. Data of interest to Professor Brina Kessel (U. of Alaska) for her book on the birds of the Seward Peninsula were sent to her.

Data on nine study locations of Kittiwakes (300 regularly attended nesting sites) were entered on graph paper and events in the reproductive cycle have been summarized.

II. Task Objectives

1. To determine the numbers and distribution of species of seabirds , shorebirds and waterfowl.
2. To determine the schedule of events during migration and the breeding season and, where possible, the effects of weather.
3. To clarify the trophic relations of certain species of seabirds by estimating reproductive success, by finding the distribution of birds feeding at sea, and by collecting the food brought to the cliffs.
4. To determine the effects of Ravens and Glaucous Gulls as predators on nesting seabirds.
5. To survey coastal lakes, estuaries and tundra by air and record the concentrations of waterfowl and shorebirds and the habitats in which concentrations occur.

III. Field or Laboratory Activities

A. No field work done in this quarter.

B. Scientific Party

William H. Drury	College of the Atlantic	Principle Investigator
John O. Biderman	Processing field data	
Sarah Hinckley	Processing field data, archiving data	

C. Field methods have been described previously.

In preparing field notes for reporting, the daily entries have been indexed, the notes on Glaucous Gulls and Ravens sent to J.B. French who is working on those data.

The notes taken at every-other-day visits to study sites have been entered on graph paper for each nest of Kittiwakes studied. In these displays we can see the synchrony of events readily and find the important happenings.

Data from mapped sites of eggs and chicks of Common and Thick-billed Murres have been tabulated.

D. Sample locations are the same as in previous studies.

E. Data analyzed.

Number of study sites, censuses, and transects have been reported before

IV. Results

No new results since September Quarterly Report.

V. Preliminary Interpretation of Results.

Our discussion in the Quarterly Report of 28 September 1977 still seems valid.

VI. Auxiliary Material

A. A paper "Bering Sea Birds" has been accepted for publication in the February 1978 issue of Natural History. The text is by W. Drury and the photographs (taken in 1975 at Sledge Island and Bluff) by Hope Alexander.

B. Three oral presentations of data and ideas coming from this NOAA work have been given in this quarter.

QUARTERLY REPORT

Contract: 01-5-022-2538
Research Unit: RU-337
Reporting Period: October 1 to December 31, 1977
Principal Investigators:
Calvin Lensink
Kenton Wohl

SEASONAL DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS

Study Leaders

Patrick J. Gould

Craig S. Harrison

U.S. Fish and Wildlife Service
Office of Biological Services - Coastal Ecosystems
800 A Street - Suite 110
Anchorage, Alaska 99501

January 1, 1978

Research Unit - 337
October - November, 1977

I. Title

Seasonal Distribution and Abundance of Marine Birds

II. Objectives

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 Arctic Ocean 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.

Field work on this research unit was completed in Fiscal Year 1977. The objectives for Fiscal Year 1978 are: 1) Final processing and transmittal of all data to the Juneau Project Office, 2) Data analysis, and 3) Preparation of a final report.

III. Present Status

A preliminary analysis of Black-legged Kittiwake and Tufted Puffin data from 1977 Kodiak Island surveys is in preparation for presentation at the January Pacific Seabird Group meetings and for upcoming Kodiak Island project workshops. Final analysis of all RU 337 data, however, will not be possible until we receive copies of all data tapes which have been submitted by us to the Juneau Project Office and processed by Dr. Hal Petersen's verification and translation programs. At the present time, we are developing software programs for the eventual computer analysis of all data.

IV. Next Quarter's Activities

During the next quarter we will continue to develop data analysis programs and hopefully be able to begin actual data analysis. These activities will center around our 1977 Kodiak Island work in preparation for the writing of the April 1, 1978 Annual Report.

V. Data Management

At the close of the first quarter of FY 78 all but one field operation has been key punched and submitted to the Juneau Project Office on magnetic tapes. Of the field operations submitted, all are in, or have been converted to, the NODC format and all but eight have gone through the final verification process.

Contract: 01-5-022-2538
Research Unit: 341
Period: October 1 to December 31, 1977
Principal Investigators: C. Lensink & K. Wohl

QUARTERLY REPORT

POPULATION DYNAMICS AND TROPHIC RELATIONSHIPS OF MARINE BIRDS IN THE GULF OF ALASKA

Study Leaders

P. J. Gould	R. E. Gill, Jr.	G. A. Sanger	R. D. Jones
Seabird and Seabird Habitat	Shorebird-Waterfowl and Estuarine Habitat	Feeding Ecology and Trophic Relationship	Effects & Special

U.S. Fish & Wildlife Service
Office of Biological Service - Coastal Ecosystem
800 A Street - Suite 110
Anchorage, Alaska 99501

I. Title: Population Dynamics and Trophic Relationships of Marine Birds in the Gulf of Alaska.

II. Objectives: Research Unit 341 is designed to obtain information necessary to satisfy OCSEAP tasks E-3 and E-4 which are to "determine the seasonal density distribution, critical habitats, migratory routes, and breeding locales of key marine bird species and to describe dynamics and trophic relationships of key marine bird species at offshore and coastal study sites" potentially subject to impact from petroleum exploration and development. (FY 78 OCSEAP TDP). More specifically, our objectives are to:

A. Determine the reproductive success and the chronology of major phases of the breeding season for key species of seabirds at selected colonies.

B. Determine the amount, kinds, and trophic levels of prey utilized by key species and, when possible, to determine the relationship of prey selected to prey availability, and to describe feeding cycles, areas, and behavior.

C. Determine the location, species composition, abundance, phenology, and habitat use of selected seabird colonies.

D. Establish an index to natural mortality from observations of dead birds on selected beaches.

III. Present Status: During the quarter, October - December major effort for this research unit has been spent preparing field reports, manuscripts, and presentations covering field activities of the past summer. Several papers covering aspects of this research unit were prepared for presentation at the bird and mammal review meeting, and Pacific Seabird Group Meeting. We have participated in OCSEAP-sponsored workshops and meetings such as the bird and mammal review meeting in Fairbanks, Lower Cook Inlet integrated study coordination meeting in Seattle, Oil Spill Contingency meeting in Anchorage, and an RPC meeting in Boulder. A continuing effort was directed towards processing birds collected for analyses of food habits and working with various aspects of data management including revising marine bird computer formats and instructions. These formats have been submitted to the Juneau Project Office for approval.

Field activities this quarter were restricted to the initiation of two new studies: a study of the feeding ecology of seaducks and seabirds in Kachemak Bay and a beached marine bird and mammal surveys in Lower Cook Inlet and northeast and northwest Gulf of Alaska.

Study of avian trophic relationships in Lower Cook Inlet requires collection of seaducks and murres in Kachemak Bay where these birds represent the largest avian biomass in the Inlet. To this end, collections were made Nov. 11 and Dec. 8 and 9. A total of 10 oldsquaw ducks, 3 white-winged scoters, 1 black scoter, 1 surf scoter, and 6 common murres has been collected and laboratory analysis is proceeding. Initial findings suggest use of molluscs by the sea ducks and small fish by the murres.

The goal of the beached bird and marine mammal task is to establish an index to bird and mammal mortality to be used as a basis for assessing the potential damage from offshore petroleum development activities.

Thirty survey sites have been selected in Lower Cook Inlet, northeastern Gulf of Alaska and Kodiak Island (Table 1). Beached marine bird and mammal surveys were initiated in November 1977. A total of 29 surveys has been conducted covering a total of 69.0 kilometers (Table 2). The remains of 46 birds of 6 species and 1 marine mammal was found. None of the corpses was oiled.

The only moribund marine mammal was found on Middleton Island. It was identified as a Risso's dolphin (Grampus griseus). Dr. Frances Fay, Institute of Arctic Biology, was contacted, and appropriate parts of the dolphin were salvaged for his research.

To date, the following NOAA funded logistics have been used.

Company	Trips	Total Cost
Pat's Flying Service	3	$ 3404.82
Sea Airmotive	1	?
Chitna Air Service	1	?

Table 1. Locations of Beached Bird & Marine Mammal Survey Transects Conducted by USFWS in the OCSEA Program, Alaska.

Place Name	Location				Length of Transect (Km)
	Begin		End		
	Lat. (N)	Long.(W)	Lat. (N)	Long.(W)	
Lower Cook Inlet					
Whiskey Gulch	59°49'30"	152°49'24"	59°50'30"	152°48'42"	2.0
Anchor River	59°46'40"	152°51'48"	59°45'24"	152°51'30"	2.3
Homer Spit	59°36'00"	151°25'06"	59°37'18"	151°27'54"	3.8
Coal Bay	59°36'42"	151°26'18"	59°38'06"	151°29'06"	4.2
Swamp Creek	60°23'36"	151°58'42"	60°21'30"	152°00'00"	6.0
Chisik Island					
Amakdedori River					
*Clam Gulch	60°15'15"	151°23'30"	60°18'45"	151°23'00"	8.0
*Cape Kasilof	60°22'15"	151°22'30"	60°18'45"	151°23'00"	6.5
NW Gulf of Alaska					
English Point	57°43'22"	152°28'19"	57°43'33"	152°27'47"	0.7
Happy Beach	57°41'06"	152°28'12"	57°41'18"	152°28'30"	0.6
Middle Bay	57°38'48"	152°29'06"	57°39'06"	152°30'18"	1.7
Bushy Point	57°39'06"	152°28'06"	57°39'24"	152°27'36"	1.2
Mayflower Creek	57°38'54"	152°26'06"	57°39'06"	152°26'18"	0.6
Kalsin Bay	57°35'06"	152°38'12"	57°35'36"	152°26'00"	1.8
Narrow Cape	57°27'06"	152°19'30"	57°28'06"	152°19'36"	2.1
NE Gulf of Alaska					
Patton Bay	59°56'24"	147°30'00"	59°54'54"	147°30'00"	3.0
*Jeanie Cove					
*Wooded Island					
*Fish Island					
Hook Point	60°20'54"	146°16'12"	60°20'54"	146°17'54"	3.0
*Egg Island	60°22'30"	145°43'36"	60°21'48"	145°46'30"	10.0
*Strawberry Island	60°13'00"	144°44'42"	60°13'24"	144°50' 0"	6.5
Nuchek Beach					3.0
Middleton Island #1	59°27'42"	146°18'36"	59°27'40"	146°17'55"	3.0
Middleton Island #2	59°27'40"	146°17'55"	59°26'55"	146°18'55"	4.0
Middleton Island #3	59°24'42"	146°20'18"	59°24'30"	146°22'12"	4.0
Middleton Island #4	59°24'24"	146°20'18"	59°24'20"	146°22'00"	2.0
Middleton Island #5	59°24'20"	146°22'00"	59°24'40"	146°21'48"	3.5
Middleton Island #6	59°24'40"	146°21'48"	59°27'42"	146°18'36"	4.0

*Not regular survey sites

Table 2. Summary of Beached Marine Bird & Mammal Surveys in Alaska, November and December, 1977.

	Lower Cook Inlet	Northeastern Gulf of Alaska	Kodiak Island	Total
Number of Beaches	9	14	7	30
Number of Surveys	8	7	14	29
Total Kilometers	24.5	28.1	17.4	69.0
Total Bird Corpses	2	43	1	46
Total M. Mammal Corpses	0	1	0	1
Total Bird Species	1	6	1	6
Total M. Mammal Species	0	1	0	1
Percent Bird Corpses Oiled	0	0	0	0

Work on the Seabird Colony Catalog has been directed toward preparing data for keypunching, soliciting comment and corrections for the preliminary catalog of the Beaufort, Chukchi and Northern Bering Sea (Quarterly Report October 1, 1977) and preparing preliminary catalogs for Southeastern Alaska (Appendix 1) and for the Aleutians (Appendix 2)

The annual report (April 1978) will be a revised catalog on the Gulf of Alaska, Bristol Bay and any other maps with enough new data to warrant updating. This will complete catalog revisions for the entire state and will in effect be a draft of the final report to be submitted in October 1978. It should be noted that our final product to OCSEAP is anticipated to be a published catalog rather than the submission of a camera-ready form. The number of published copies to be submitted will be determined in the near future.

IV. Next Quarter's Activities: The major effort next quarter will be spent in analyzing field data and completing the annual report due 1 April 1978, reduction of data for processing and archival by OCSEAP, and preparation of manuscripts for publication.

Field activities will include continuing efforts in our feeding ecology study of seabirds and sea ducks in Kachemak Bay and Beached bird and mammal surveys in the Gulf of Alaska and Lower Cook Inlet regions.

Our efforts for the Colony Catalog project next quarter will be on continued analysis of data for the Final Report, reviewing data for completeness and accuracy, coordination with all OCSEAP bird studies and other data sources to insure that as much data as possible from the 1978 field season will be included in the Final Report, and final preparation of the catalog in a camera ready form.

V. Data Management: This past quarter we have developed an in-house operating system for data control and tracking procedures. This new system will provide for the efficient and timely flow of digital data.

File type 035 data for 1975-1976 have been keypunched and await verification. These data, however, are coded and entered in the old format. Since it would take as long to identify and correct errors in the old format as it would to retranscribe and keyenter the data in the new format, a formal request for approval of reprocessing the data has been sent to OCSEAP, with data due 150 days after approval of the new format. OCSEAP has not responded to this request.

All data on specimens have been keypunched on existing USFWS formats. The data will be translated to new OCSEAP formats upon approval of these formats by the Program Office. Computer formats for data included in the Colony Catalog were completed and submitted to the OCSEAP Project Office for approval. All catalog data is being keypunched and incorporated in the FWS data base as computer processing and analysis is essential for completion of a final report. The preliminary processing will also permit more rapid transfer of data to OCSEAP upon approval of formats.

The FWS's "beached bird and marine mammal survey" computer format is presently being used to organize digital data. Data management efforts this quarter have been in transcribing this quarter's surveys and older surveys going back to 1974.

APPENDIX - I

"CATALOG OF SEABIRD COLONIES: SOUTHEASTERN ALASKA"

Southeastern Alaska is one of the least known regions for seabirds in the entire state. This catalog contains a summary of information on location, species composition and population size of known seabird colonies in the region. Additional colonies are likely to be present and this report is meant as a base to which information can be added, updated and corrected.

The outer coast has many small islands and offshore rocks that appear suitable for nesting, but few colonies have been reported. Nocturnal species (fork-tailed and leach's storm petrels, ancient murrelets, cassin's and rhinoceros auklets) could be particularly abundant and have gone unnoticed because of their nocturnal nature at the colony site.

The protected channels, fjords and straits of Southeastern Alaska are unlikely to have colonies of nocturnal species, but the area most certainly has numerous colonies of gulls, pigeon guillemots and cormorants. Information indicates these colonies, if they are present, do not exceed 2,000 birds at any particular site.

Conspicuous by its absence are data on Marbled and Kittlitz's murrelets. When considering that fewer than eight nests of Kittlitz's murrelets and possibly only two nests of Marbled murrelets have ever been recorded by ornithologists, it is understandable that they do not contribute importantly to the catalog even though qualitatively and quantitatively they represent important elements of the seabird population within the region treated in this report.

Southeastern Alaska has high populations of bald eagles. This catalog records eagles when they are associated with a seabird colony, but does not attempt to present data on the location of all known eyries. For that reason, the numbers for bald eagles and other species which are not colonial do not reflect the area's total population.

While FWS contract obligations to the Outer Continental Shelf Environmental Assessment Program (OCSEAP) require only the gathering of information for those regions being considered for oil and gas leasing, the U.S. Fish and Wildlife Service is cataloging all seabird colonies within Alaska as well as the Atlantic, Gulf and Pacific states. The catalog for Southeastern Alaska was completed with

U.S.F.W.S. funds and is submitted to OCSEAP because the data are relevant to the understanding of seabirds for the entire Gulf of Alaska, and because the Southeast region could be significantly affected by oil spills from tanker traffic which will occur with OCS development.

Methods of data collection and analysis are identical to those described in our annual report "Catalog of Seabird Colonies", March 1977. The following people deserve special thanks for contributing to this catalog: Tony DeGange, Earl Possardt and Jay Nelson (USFWS) and Sam and Renee Patten (John Hopkins University).

Data presented on Southeastern Alaska includes 25 colony areas with an estimated 1,170,000 birds. Colonies of major interest include those at Forrester Island, Hazy Islands and St. Lazaria all of which are Wilderness Areas in the National Wildlife Refuge system. No estimates of populations are available for the large colony at Hazy Islands and those for St. Lazaria were done in 1912. Glacier Bay National Monument contains 12 of the known seabird colonies in Southeastern Alaska. This may be due to unusual biological richness of the Bay or simply a better knowledge of the region.

The lack of information on location and status of seabird colonies in Southeastern Alaska or on primary seabird foraging areas precludes adequate evaluation of potential impacts from tanker traffic or from other development activities. The current limited effort in the region should be expanded to include an evaluation of all large colonies such as at St. Lazaria and the Hazy Islands as well as surveys of areas where other colonies are likely to occur. The small islands bordering the outer coast appear to have the most potential for colonies and may be severely impacted by an oil spill. They should thus be given primary consideration. Protected bays, fjords and channels are also of interest, but are considered of less immediate concern as it is unlikely that large colonies would have remained unknown in these well traveled areas.

Bibliography

Drent, R. H. and C. J. Gurgnet. 1961. A catalogue of British Columbia sea-bird colonies. Occasional papers of the British Columbia Provincial Museum. No. 12.

DeGange, A. R., Possardt E. E. and Frazer, D. C. 1977. The breeding biology of seabird on the Forrester Island Nat. Wildlife Refuge. 15 May to 1 September 1976. Unpubl. U.S.F.W.S. report, Anchorage, Alaska.

Gabrielson, I. N. and F. C. Lincoln. 1959. The birds of Alaska. The Stackpole Co., Harrisburg, Pennsylvania, and the Wildlife Manage. Instit., Washington, D. C.

Gibson, D. D. 1976. Bird species and habitat inventory, Alexander Archipelago, Alaska, summer 1975. unpubl. Univ. of Alaska Mus. Contract Report No. 01-283.

Gibson, D. D. and S. O. MacDonald. 1975. Bird species and habitat inventory mainland Southeast Alaska, summer 1975. unpubl. Univ. of Alaska Mus. Contract Report No. 01-283.

Patten, S. and R. Patten. 1975. A (Marine) Bird Survey of the Dixon Harbor Area Glacier Bay Nat. Monument, Gustavas, Alaska. Unpublished report, National Park Service, Glacier Bay Nat. Monument.

Streveler, G. P. and I. A. Worley. 1975. Final report of the summer phase of 1974 Research. National Park Service, Juneau, Alaska.

Wik, D. 1976. Birds of Glacier Bay National Monument. National Park Service, Juneau, Alaska.

Willett, G. 1912. Report of George Willett, agent and warden stationed on St. Lazaria Bird Reservation, Alaska. Bird Lore 14:419-426.

Table 1A. Area number, colony name, investigators and date of information for known seabird colonies in Southeast Alaska.

AREA NO.	COLONY NAME	INVESTIGATORS	DATE
001 001	Petrel Island	DeGange, Possardt	1976
002	Forrester Island		
003	Sea Lion Rock		
004	Cape Horn Rocks		
005	Lowrie Island		
002	NO KNOWN COLONIES		
003	NO KNOWN COLONIES		
004 001	St. Nicholas Point	A.D.F. & G.	
002	Noyes Island		
003	Timbered Island		
004	Hazy Islets	U.S.F.W.S.	
005 001	Guibert Islets	Johnson	
002	Baili Rock		
003	Necker Islands	A.D.F. & G.	
004	St. Lazaria	Willet	1912
005	Cornwallis Point		
006 001	Bluff Island	Montgomery	8-6-74
002	Protection Head		8-3-74
007	NO KNOWN COLONIES		
008	NO KNOWN COLONIES		
009 001	Urey Rocks		
010 001	Astrolabe Peninsula	Pattèn	1974
002	Boussole Head		
003	Cenotaph Island		1975
004	S. Marble Island		1973
005	N. Marble Island		
006	Lone Island	Wik	1967
007	Adams Inlet	Trautman Wik	 7-21-67
008	Reid Inlet	Wik	1967
009	Russel Islets		7-29-67
010	Triangle Island		
011	Sealer's Island	Trautman Wik	 1967
011	NO KNOWN COLONIES		
012	NO KNOWN COLONIES		
045 001	Margerie Glacier	Streveler, Gordon	7-1-67

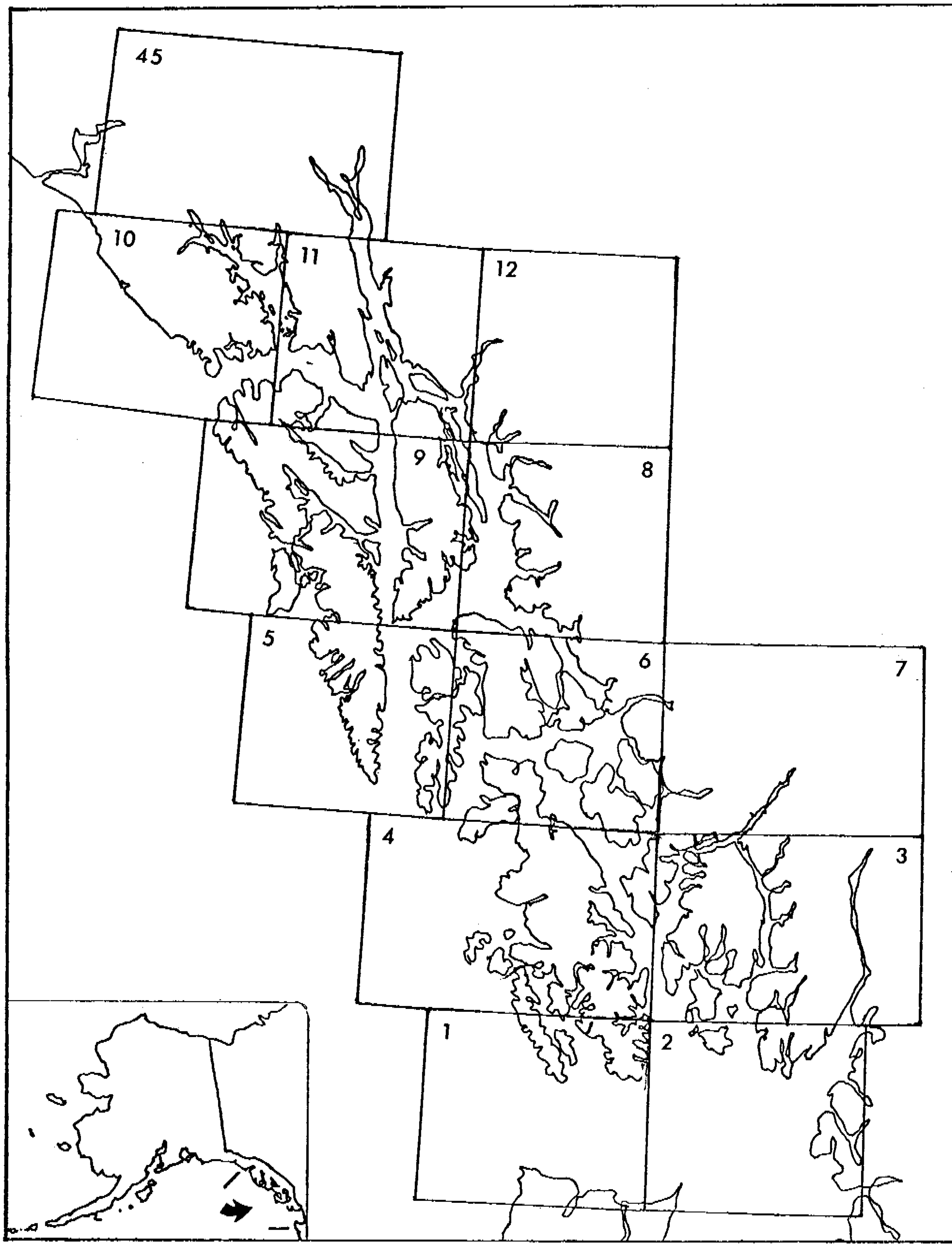


Figure 1. Location of maps used in this colony catalog of Southeastern Alaska.

Table 1. Summary of data on known seabird colonies of map 1, Dixon Entrance.

SPECIES	AREA NUMBER 001 001	001 002	001 003	001 004	001 005	Total
Northern Fulmar	150					150
Fork-tailed Storm Petrel	88,700				X	88,700
Leach's Storm Petrel	688,500				900	689,400
Cormorant						
Double-crested Cormorant						
Pelagic Cormorant	150	X	42	X		192
Red-faced Cormorant						
Harlequin Duck	P	20	P	P	P	20
Common Eider						
Bald Eagle	10	10			4	24
Black Oystercatcher	8	50			10	68
Glaucous Gull						
Glaucous-winged Gull	350	150	100	200		800
Mew Gull						
Black-legged Kittiwake						
Red-legged Kittiwake						
Arctic Tern						
Aleutian Tern						
Murre						
Common Murre	2,000	3,800		1,500		7,300
Thick-billed Murre						
Black Guillemot						
Pigeon Guillemot	32	300	P	6	32	370
Ancient Murrelet	X	60,000			X	60,000
Cassin's Auklet	23,340	4,400			40,000	67 740
Parakeet Auklet						
Crested Auklet						
Least Auklet						
Whiskered Auklet						
Rhinoceros Auklet		108,000			30	108,030
Horned Puffin	70	750		50		870
Tufted Puffin	13,400	70,000		300	X	83,700
other	4^k	$X^a, 4^k$			2^k	$10^k, X^a$
Total	816,714	247,484	142	2,056	40,978	1,107,374

X = Present P = Probably Present a = Marbled Murrelet, k = Peregrine Falcon,

Table 4. Summary of data on known seabird colonies of map 4, Craig.

SPECIES	AREA NUMBER															Total
	004 001	004 002	004 003	004 004												
Northern Fulmar																
Fork-tailed Storm Petrel																
Leach's Storm Petrel																
Cormorant																
Double-crested Cormorant																
Pelagic Cormorant		X														
Red-faced Cormorant																
Harlequin Duck																
Common Eider																
Bald Eagle																
Black Oystercatcher																
Glaucous Gull																
Glaucous-winged Gull	X	X	X	X												
Mew Gull																
Black-legged Kittiwake																
Red-legged Kittiwake																
Arctic Tern																
Aleutian Tern																
Murre																
Common Murre		X	X	X												
Thick-billed Murre																
Black Guillemot																
Pigeon Guillemot																
Ancient Murrelet																
Cassin's Auklet																
Parakeet Auklet																
Crested Auklet																
Least Auklet																
Whiskered Auklet																
Rhinoceros Auklet																
Horned Puffin																
Tufted Puffin																
other																
Total	X	X	X	X												

X = Present P = Probably Present

Table 5. Summary of data on known seabird colonies of map 5, Port Alexander.

SPECIES	AREA NUMBER															Total
	005 001	005 002	005 003	005 004	005 005											
Northern Fulmar																
Fork-tailed Storm Petrel				4,000												
Leach's Storm Petrel				40,000												
Cormorant					X											
Double-crested Cormorant																
Pelagic Cormorant				300												
Red-faced Cormorant																
Harlequin Duck																
Common Eider																
Bald Eagle				4												
Black Oystercatcher				8												
Glaucous Gull																
Glaucous-winged Gull	X	X	X	600												
Mew Gull			X													
Black-legged Kittiwake			P													
Red-legged Kittiwake																
Arctic Tern																
Aleutian Tern																
Murre																
Common Murre			X	600												
Thick-billed Murre																
Black Guillemot																
Pigeon Guillemot			X	300												
Ancient Murrelet																
Cassin's Auklet																
Parakeet Auklet																
Crested Auklet																
Least Auklet																
Whiskered Auklet																
Rhinoceros Auklet				150												
Horned Puffin				24												
Tufted Puffin				4,000												
other																
Total	X	X	X	50,986	X											

X = Present P = Probably Present

Table 6. Summary of data on known seabird colonies of map 6, Petersburg.

SPECIES	AREA NUMBER															Total
	006 001	006 002														
Northern Fulmar																
Fork-tailed Storm Petrel																
Leach's Storm Petrel																
Cormorant																
Double-crested Cormorant	100															
Pelagic Cormorant	100	12														
Red-faced Cormorant																
Harlequin Duck																
Common Eider																
Bald Eagle																
Black Oystercatcher																
Glaucous Gull																
Glaucous-winged Gull																
Mew Gull																
Black-legged Kittiwake																
Red-legged Kittiwake																
Arctic Tern																
Aleutian Tern																
Murre																
Common Murre																
Thick-billed Murre																
Black Guillemot																
Pigeon Guillemot		50														
Ancient Murrelet																
Cassin's Auklet																
Parakeet Auklet																
Crested Auklet																
Least Auklet																
Whiskered Auklet																
Rhinoceros Auklet																
Horned Puffin																
Tufted Puffin																
other																
Total	200	62														

X = Present P = Probably Present

Table 9. Summary of data on known seabird colonies of map 9, Sitka.

SPECIES	AREA NUMBER															Total
	009 001															
Northern Fulmar																
Fork-tailed Storm Petrel																
Leach's Storm Petrel																
Cormorant																
Double-crested Cormorant																
Pelagic Cormorant																
Red-faced Cormorant																
Harlequin Duck																
Common Eider																
Bald Eagle																
Black Oystercatcher																
Glaucous Gull																
Glaucous-winged Gull	X															
Mew Gull																
Black-legged Kittiwake																
Red-legged Kittiwake																
Arctic Tern																
Aleutian Tern																
Murre																
Common Murre																
Thick-billed Murre																
Black Guillemot																
Pigeon Guillemot																
Ancient Murrelet																
Cassin's Auklet																
Parakeet Auklet																
Crested Auklet																
Least Auklet																
Whiskered Auklet																
Rhinoceros Auklet																
Horned Puffin																
Tufted Puffin																
other																
Total	X															

X = Present P = Probably Present

Table 10. Summary of data on known seabird colonies of map 10, Mt. Fairweather.

SPECIES	AREA NUMBER 010 001	010 002	010 003	010 004	010 005	010 006	010 007	010 008	010 009	010 010	010 011					Total
Northern Fulmar																
Fork-tailed Storm Petrel																
Leach's Storm Petrel																
Cormorant																
Double-crested Cormorant																
Pelagic Cormorant		80	P	200	200				20		X					500
Red-faced Cormorant																
Harlequin Duck				10	10											
Common Eider					1											X
Bald Eagle				8	10											18
Black Oystercatcher				8	14											22
Glaucous Gull																
Glaucous-winged Gull	20	20		550	1,500		X			X						2,090
Mew Gull				40	20											60
Black-legged Kittiwake		800	800													1,600
Red-legged Kittiwake																
Arctic Tern				30	50		120	22			60					282
Aleutian Tern																
Murre																
Common Murre	X	46			30											76
Thick-billed Murre																
Black Guillemot																
Pigeon Guillemot	X	X		100	120											220
Ancient Murrelet																
Cassin's Auklet																
Parakeet Auklet																
Crested Auklet																
Least Auklet																
Whiskered Auklet																
Rhinoceros Auklet																
Horned Puffin		4		6	2											12
Tufted Puffin		80		40	60	X										180
other					15[d]		X[d]			X[d]	12[d]					27[d]
Total	20	1,030	800	992	2,032	X	120	22	20	X	72					5,087

X = Present P = Probably Present

Table 45. Summary of data on known seabird colonies of map 45, Skagway.

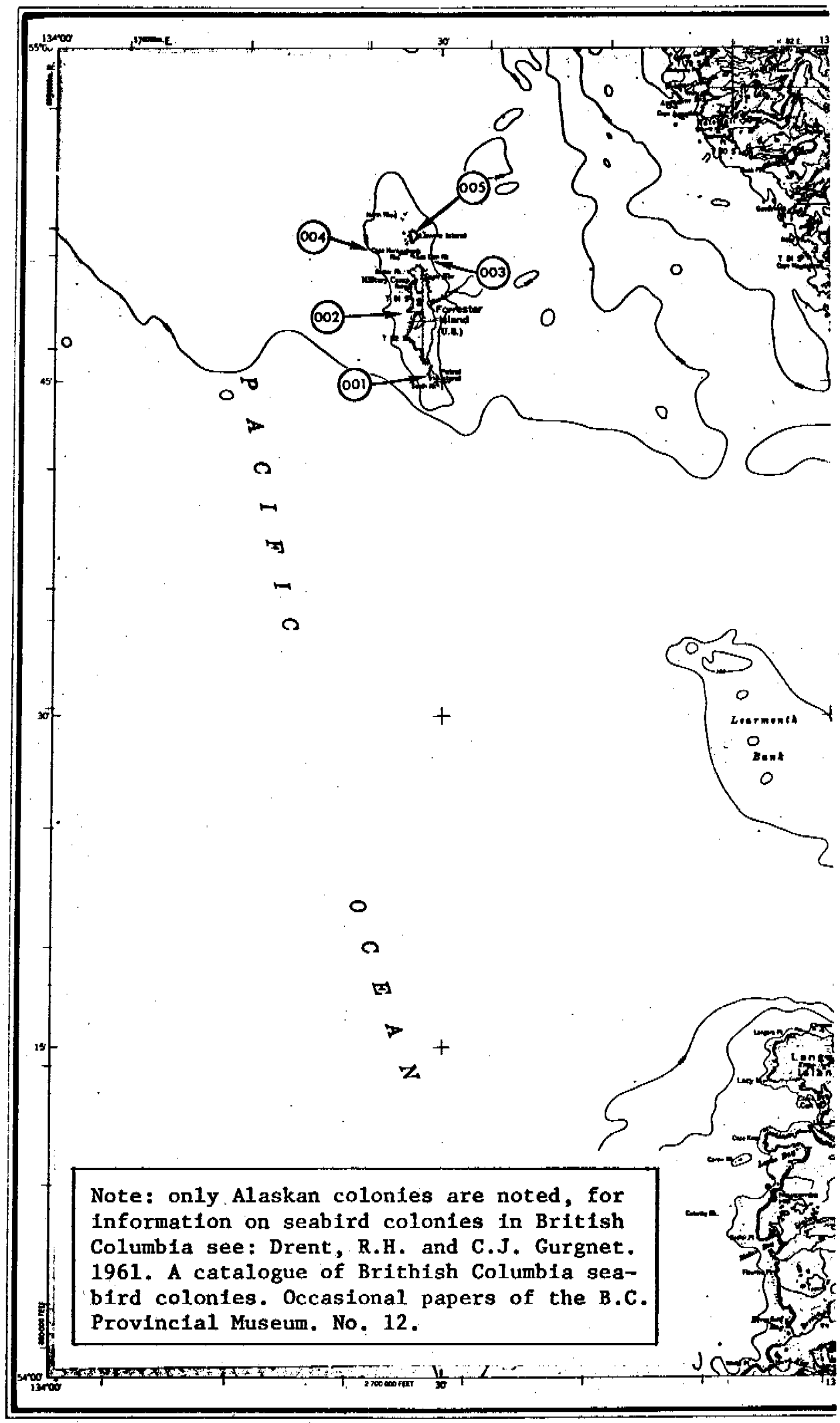
SPECIES	AREA NUMBER															Total
	045 001															
Northern Fulmar																
Fork-tailed Storm Petrel																
Leach's Storm Petrel																
Cormorant																
Double-crested Cormorant																
Pelagic Cormorant	X															
Red-faced Cormorant																
Harlequin Duck																
Common Eider																
Bald Eagle																
Black Oystercatcher																
Glaucous Gull																
Glaucous-winged Gull																
Mew Gull																
Black-legged Kittiwake	226															
Red-legged Kittiwake																
Arctic Tern																
Aleutian Tern																
Murre																
Common Murre																
Thick-billed Murre																
Black Guillemot																
Pigeon Guillemot																
Ancient Murrelet																
Cassin's Auklet																
Parakeet Auklet																
Crested Auklet																
Least Auklet																
Whiskered Auklet																
Rhinoceros Auklet																
Horned Puffin	P															
Tufted Puffin																
other																
Total	226															

X = Present P = Probably Present

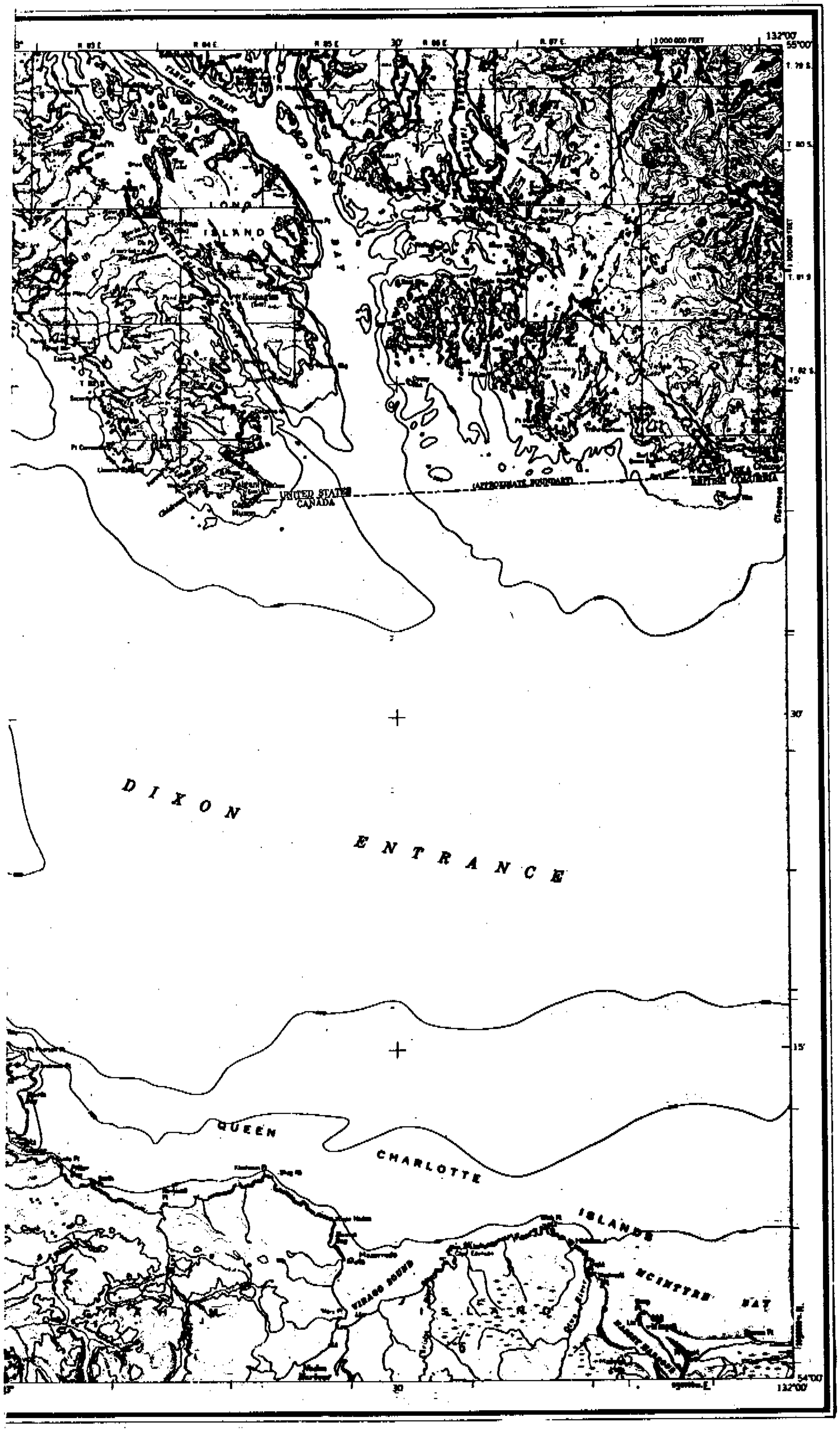
MAPS:

Colony Catalog Southeastern Alaska

Note: only maps of areas where colonies have been located have been included. Maps: 2 - Prince Rupert, 3 - Ketchikan, 7 - Bradfield Canal, 8 - Sumdum, 11 - Juneau, 12 - Taku River have no known colonies.



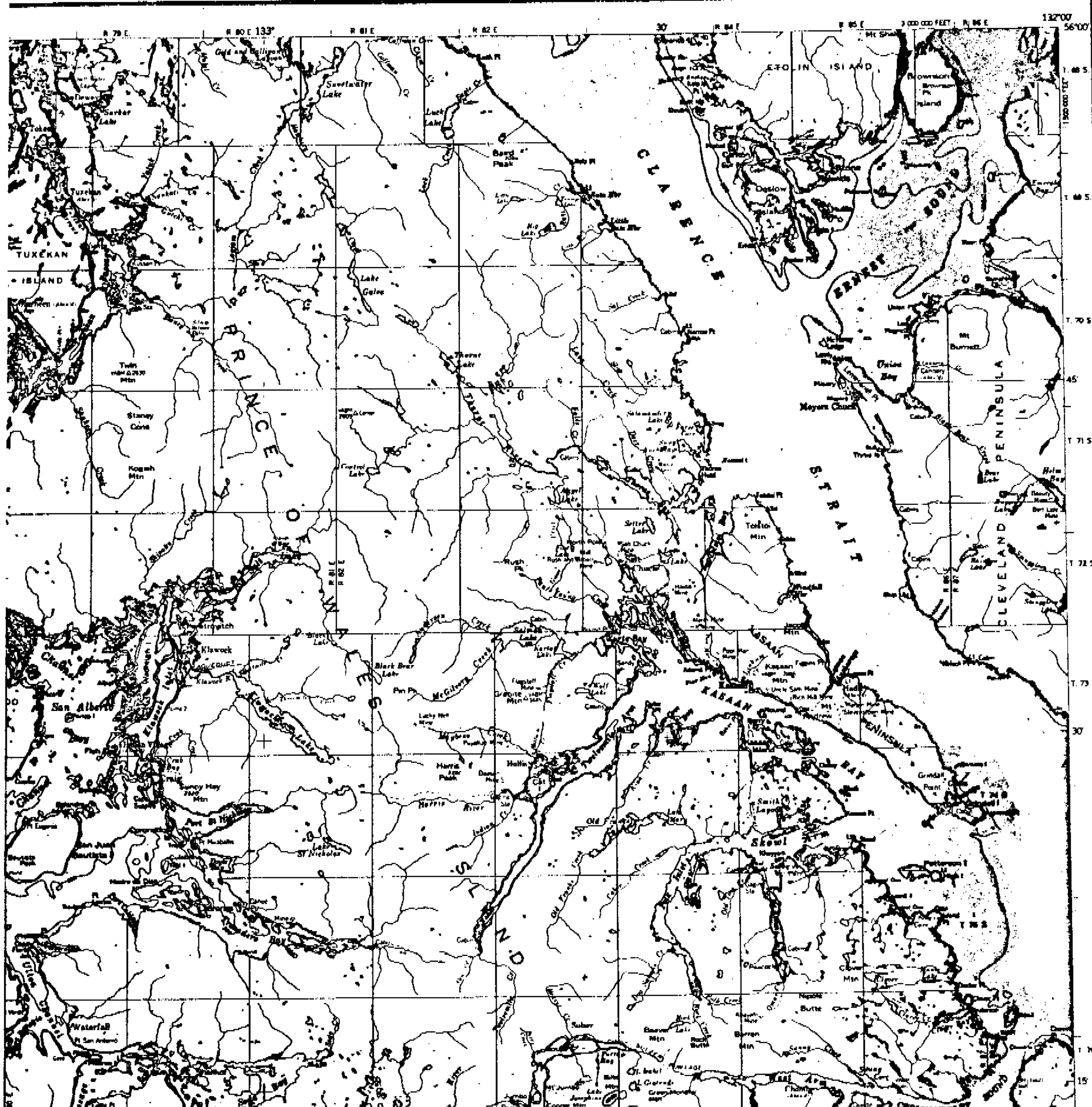
Map 1. Known seabird colonies in topographic area 001,

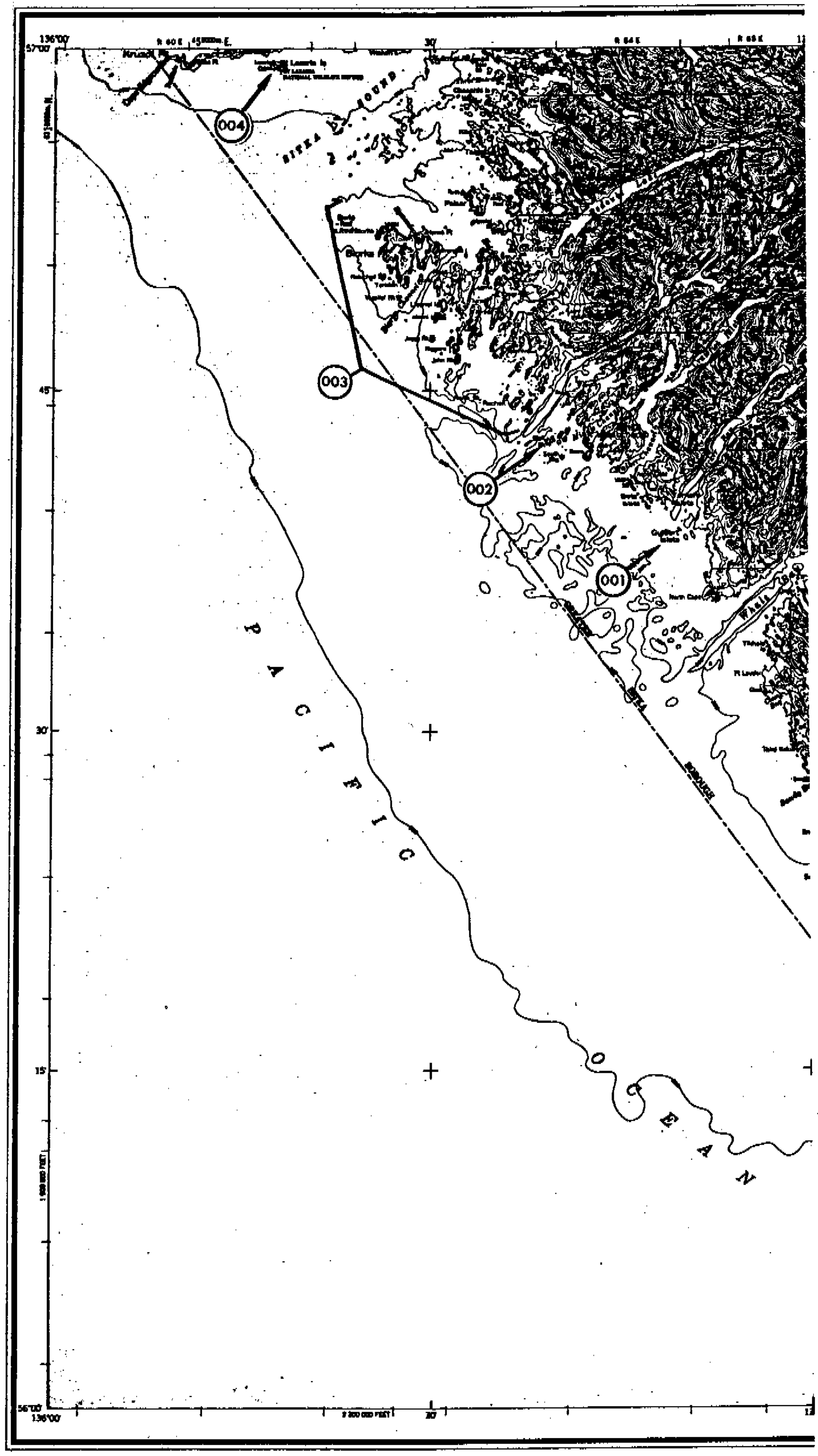


Dixon Entrance.

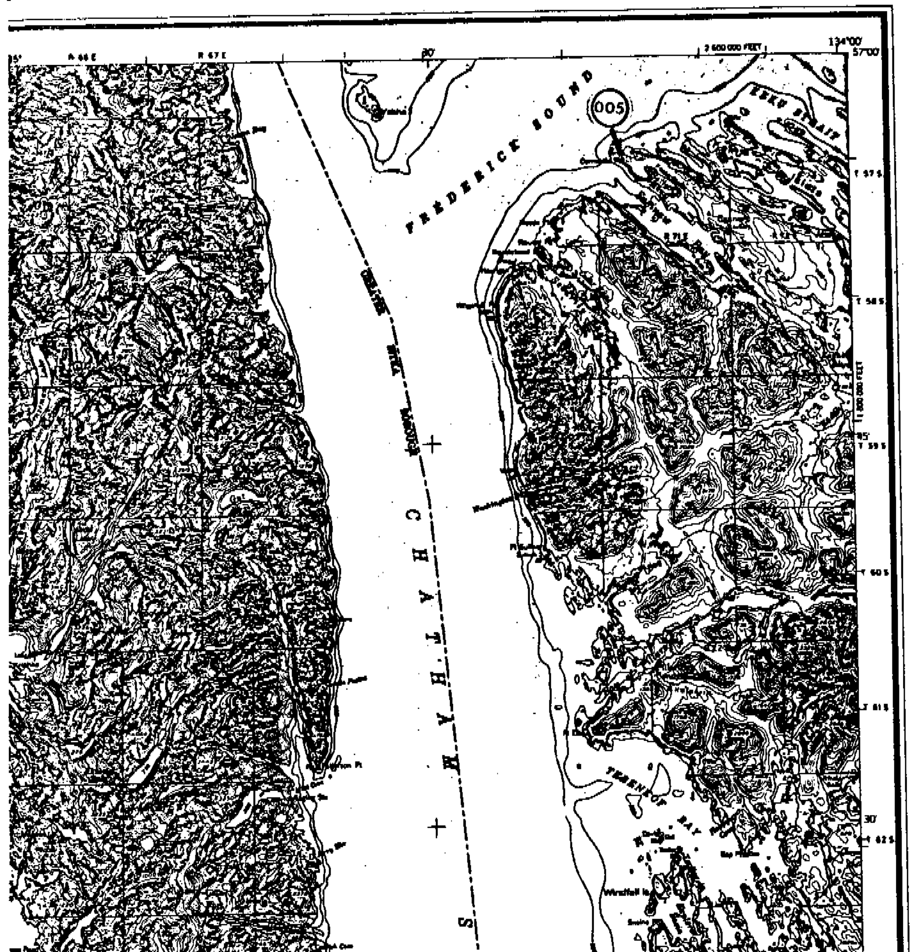
Map 4. Known seabird colonies in topographic area 004, Craig.

ıG

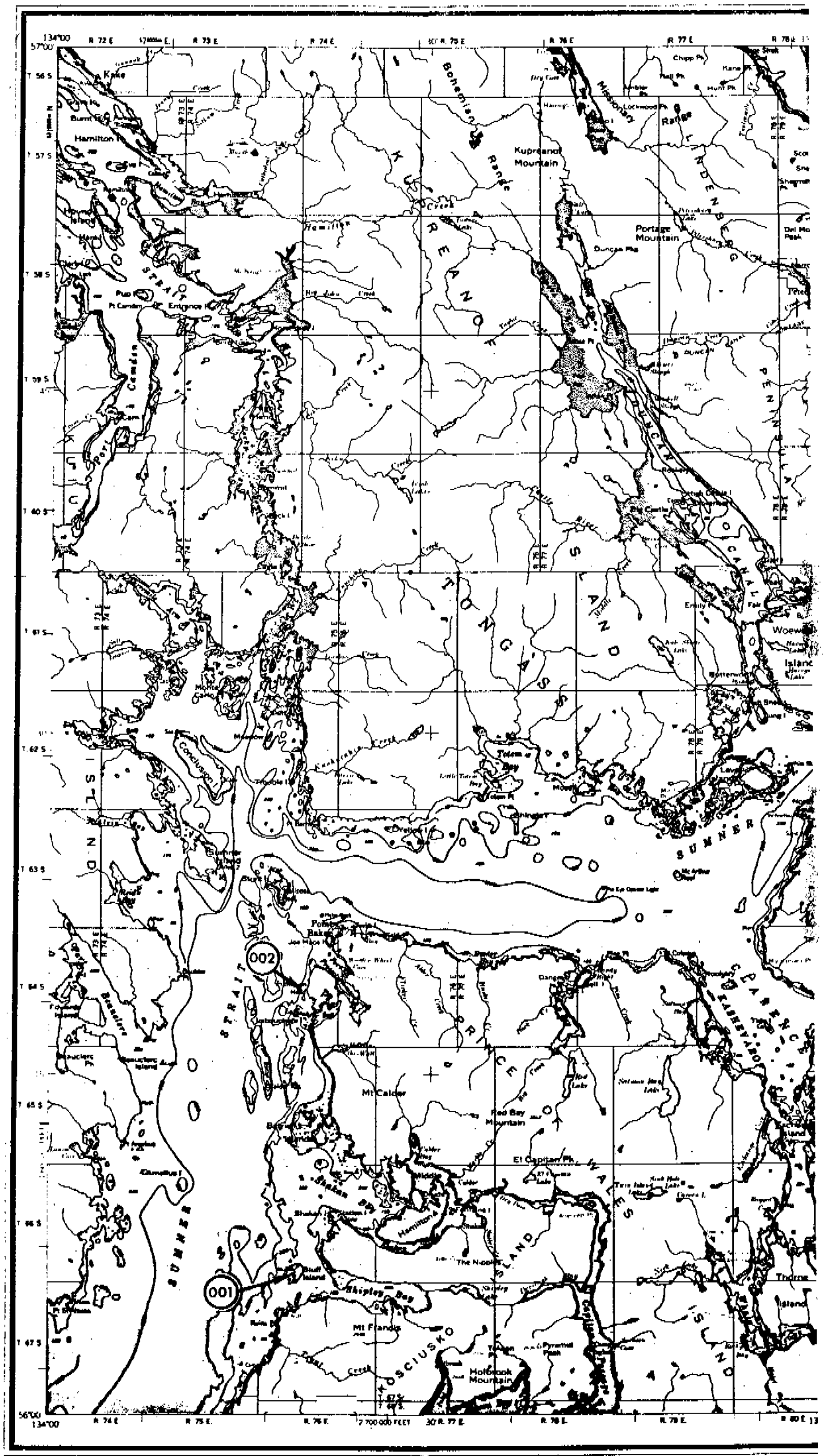

CLARENCE STRAIT
PRINCE OF WALES ISLAND
CLEVELAND PENINSULA
KASAAN BAY
Klawock
Hydaburg
Craig
Kasaan
Hollis



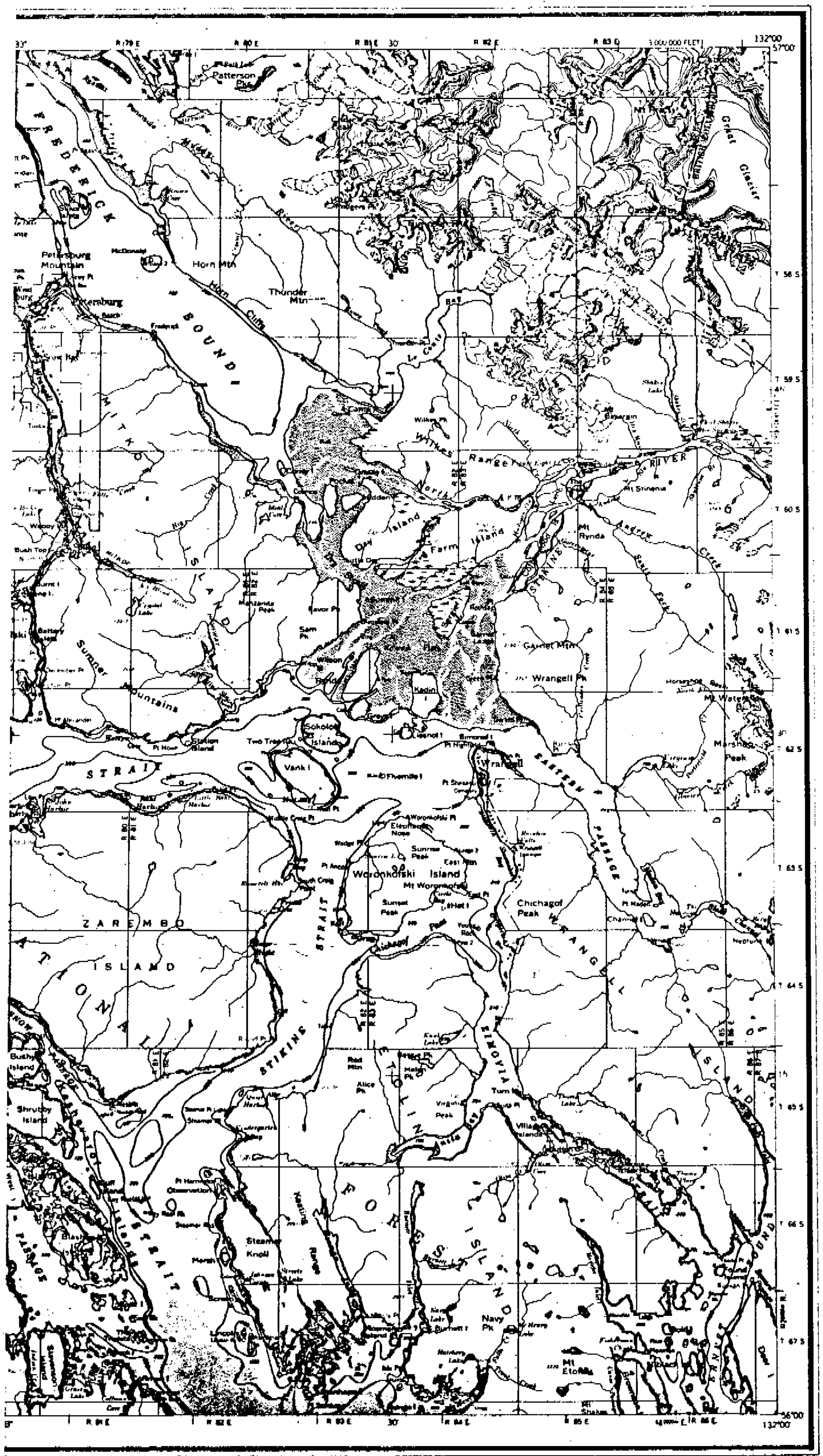
Map 5. Known seabird colonies in topographic area 005,



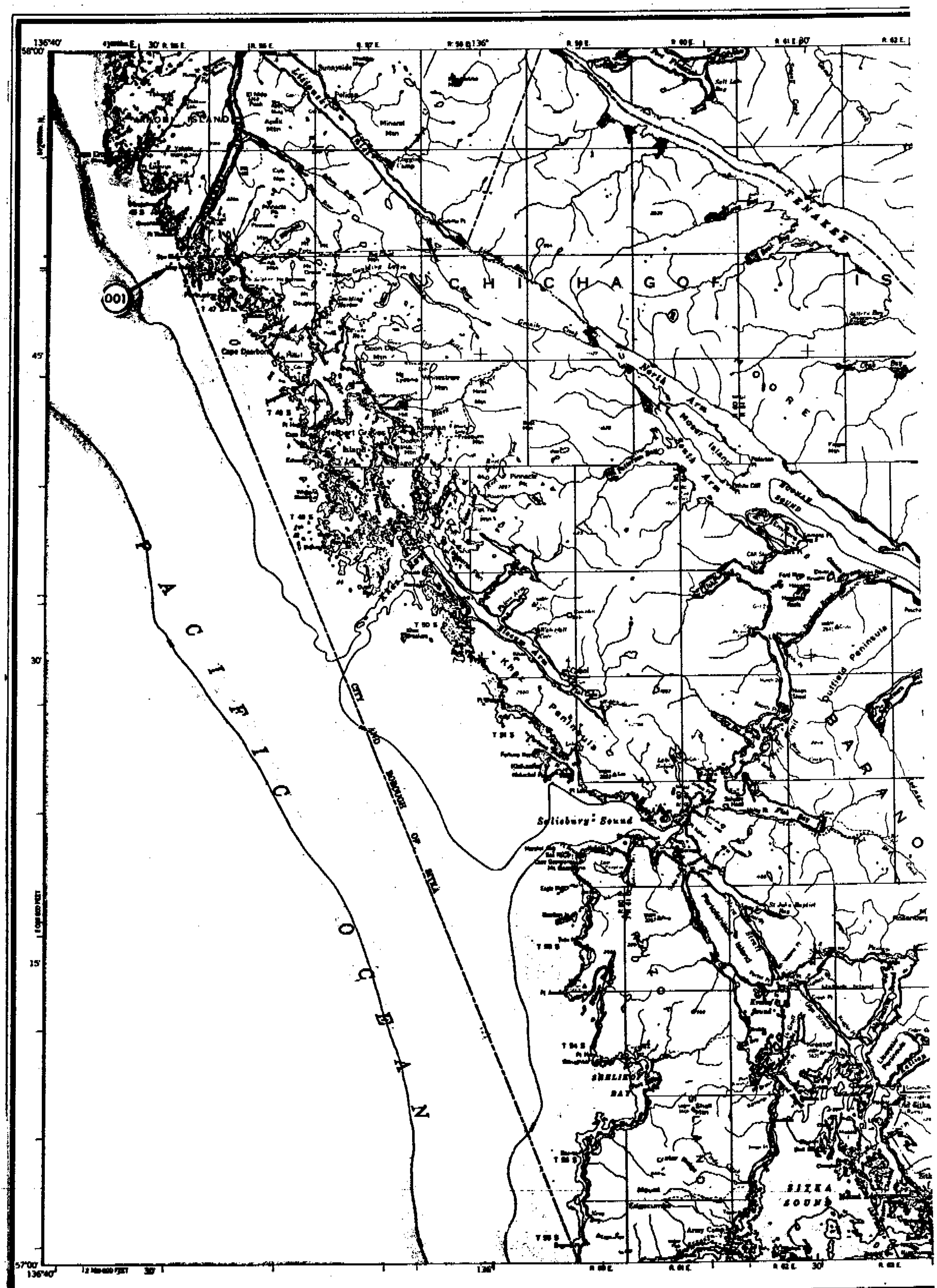
Port Alexander.



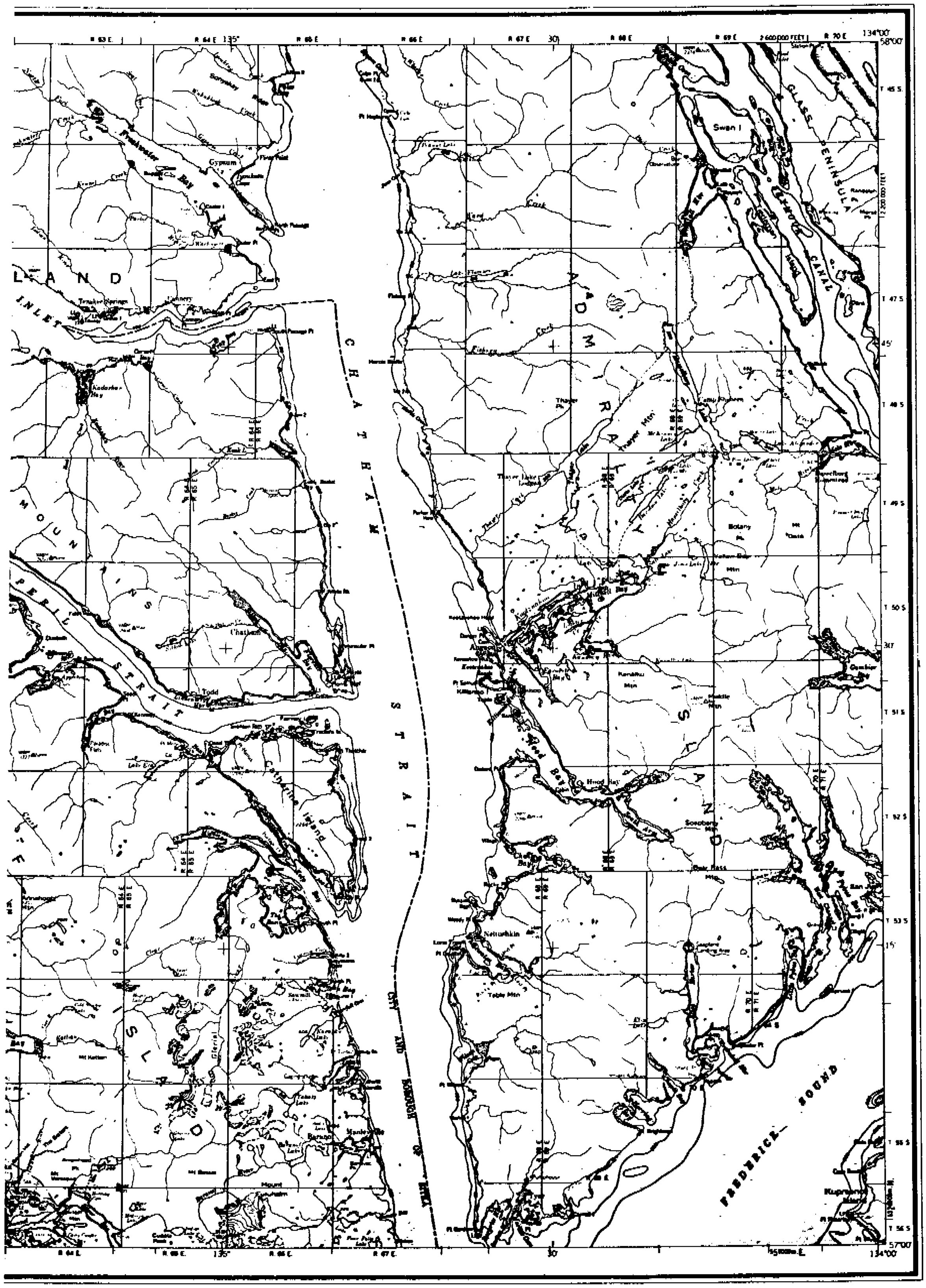
Map 6. Known seabird colonies in topographic area 006,

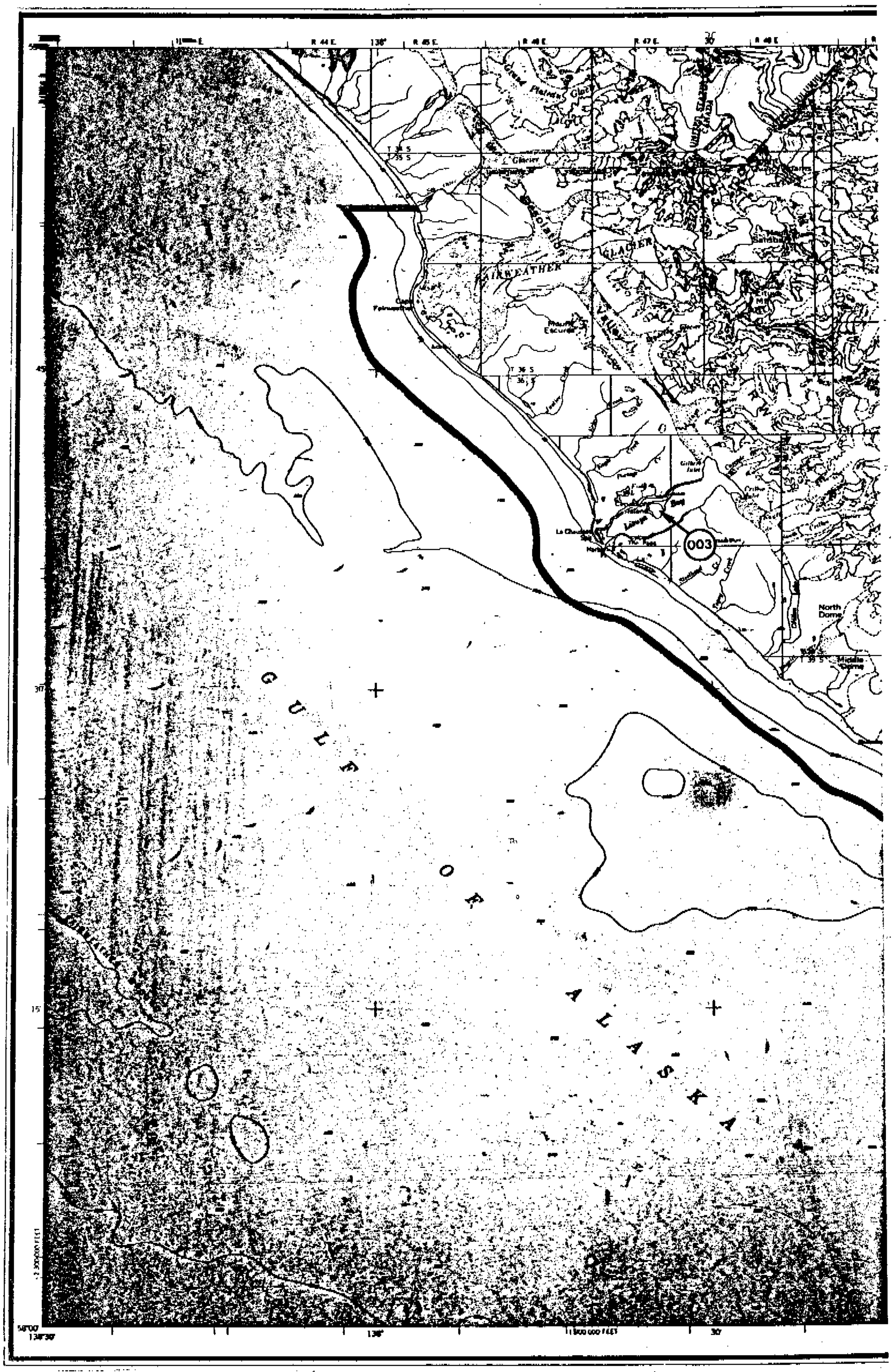

FREDERICK SOUND
Petersburg Mountain
Horn Mtn
Horn Cliffs
Thunder Mtn
Great Glacier
MITKOF ISLAND
Sumner Mountains
Wilkes Range
North Arm
Dry Island
Farm Island
STIKINE RIVER
Mt Rynda
Garnet Mtn
Wrangell Pk
Sokolof Island
Two Tree I
Vank I
Wrangell
EASTERN PASSAGE
STRAIT
ZAREMBO
ISLAND
Woronkofski Island
Mt Woronkofski
Sunrise Peak
Sunset Peak
Chichagof Peak
STIKINE STRAIT
WRANGELL ISLAND
ETOLIN
ZIMOVIA
Red Mtn
Alice Pk
Virginia Peak
Shrubby Island
Steamer Knoll
Navy Pk
Mt Etolin
132°00'
57°00'
56°00'

Petersburg.

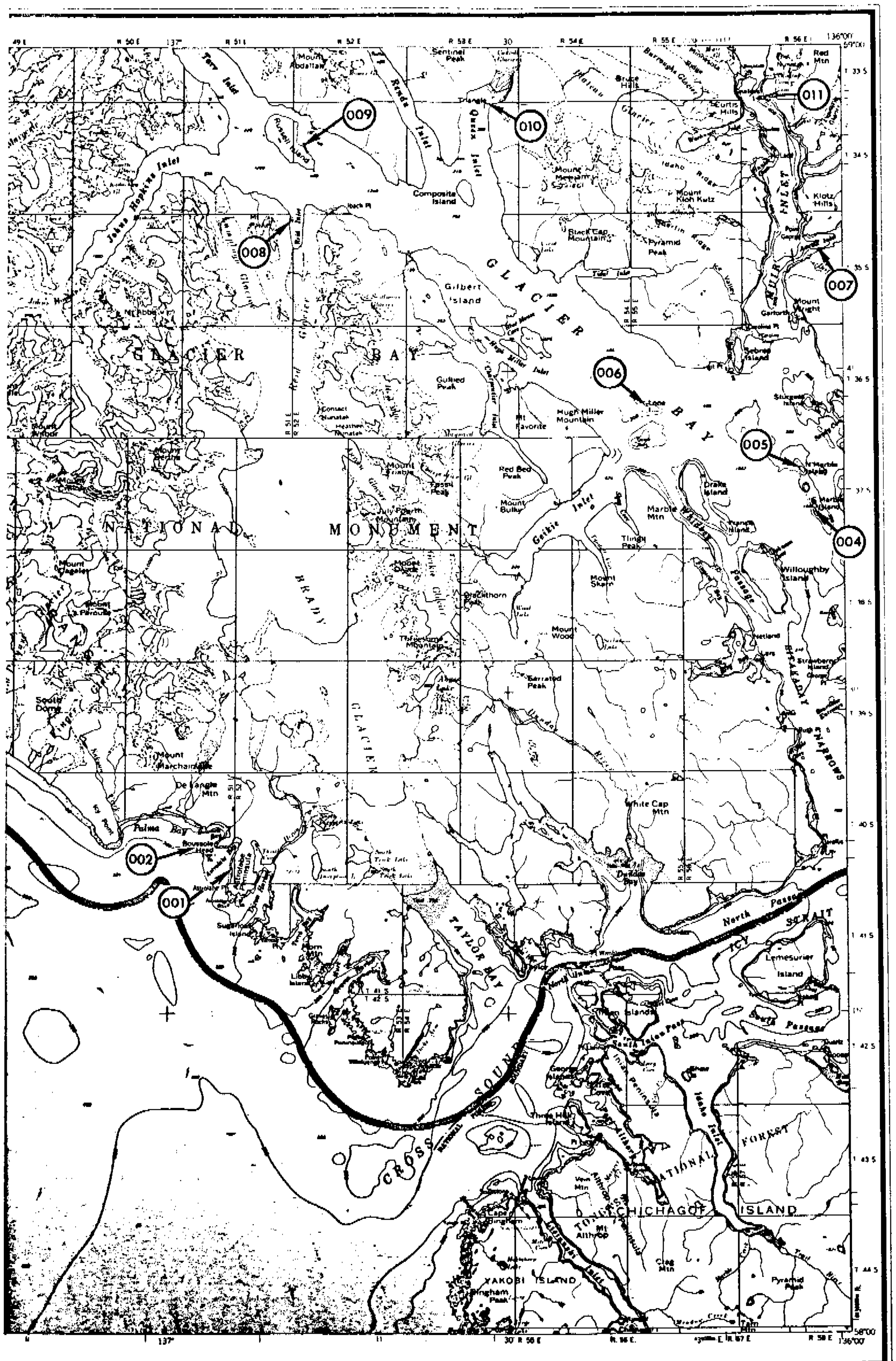


Map 9. Known seabird colonies in topographic area 009, Sitka.

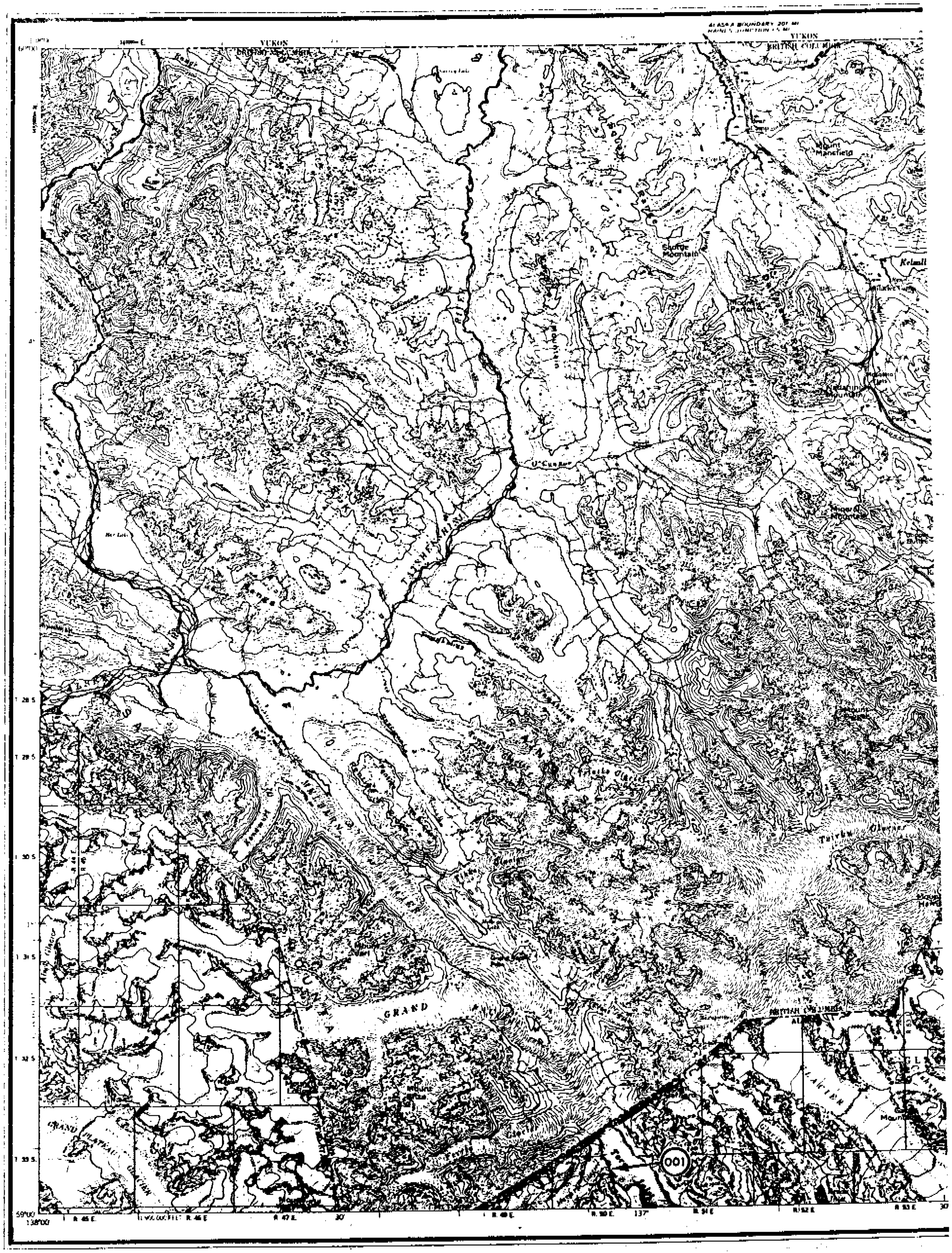

C H A T H A M
S T R A I T
A D M I R A L T Y
I S L A N D
FREDERICK SOUND
GLASS PENINSULA
SEYMOUR CANAL
Swan I
Gypsum
Chatham
Todd
Hood Bay
Neltushkin
Table Mtn
Baranof
Saltery
Mount
CITY AND BOROUGH OF SITKA
134°00'
58°00'
57°00'
135°



Map 10. Known seabird colonies in topographic area 010, Mt. Fairweather.


001
002
004
005
006
007
008
009
010
011
GLACIER BAY
NATIONAL MONUMENT
GLACIER BAY
Johns Hopkins Inlet
Gilbert Island
Composite Island
Hugh Miller Mountain
Geikie Inlet
Marble Mtn
Willoughby Island
Drake Island
Mount Wright
Sebree Island
White Cap Mtn
North Passage
ICY STRAIT
Lemesurier Island
TAYLOR BAY
CROSS SOUND
CHICHAGOF ISLAND
YAKOBI ISLAND
Bingham Peak
Pyramid Peak
Palma Bay
De Langle Mtn
Mount Marchainville
Red Bed Peak
Mount Bulky
Tlingit Peak
Mount Wood
Serrated Peak
Mount Merriam
Black Cap Mountain
Pyramid Peak
Mount Abdallah
Sentinel Peak
Red Mtn
Klotz Hills
Triangle
Mount Favorite
Gullied Peak
BRADY
GLACIER
Curtis Hills
Idaho Ridge
Mount Abbe
Strawberry Island
137°
136°00'
58°00'
59°00'

Part A



Map 45. Known seabird colonies in topographic area 045, Skagway.


YUKON
BRITISH COLUMBIA
Rothwell Peak
Mount Foster
Mount Van Wagenen
Haines

QUARTERLY REPORT

Contract #03-5-022-56

Research Unit #441

Task Order #27

1 October - 31 December 1977

Avian Community Ecology at Two Sites on Espenberg Peninsula in Kotzebue Sound, Alaska.

Principal Investigator: P. G. Mickelson
Institute of Arctic Biology

Report Prepared By: Douglas Schamel
Diane Tracy
Anne Ionson

31 December 1977

I. TASK OBJECTIVES

1. To determine phenology of events from spring arrival through departure of birds,

2. To determine the distribution and abundance of birds and their predators,

3. To describe habitat utilization of birds and their predators during migration, the nesting season, and the brood rearing season,

4. To estimate production of all avian species nesting on Cape Espenberg,

5. To determine the abundance of small mammals which are utilized by avian and mammalian predators,

6. To describe availability of food and utilization by shorebirds,

7. To determine distribution and abundance of sea mammals,

8. To provide recommendations to lessen the impact of developments on the avian community and avian habitat at Cape Espenberg,

9. To establish baseline study plots to evaluate the impact of developments on the avian community and avian habitat at Cape Espenberg,

   and

10. To assess bird use of coastal habitats in southern Kotzebue Sound by flying aerial surveys at regular intervals.

II. FIELD ACTIVITIES

None.

III. RESULTS

Our fall has been occupied with sample processing, data summarization, and data management coding. Approximately 2,000 gull regurgitation pellets have been analyzed. Sixty intertidal samples from 1977 were processed; 1976 intertidal samples are now completely processed and have been summarized. Aerial surveys have been summarized. Predator watches have been transcribed from tapes. Transect data and banded sandpiper data are currently under analysis.

IV. PRELIMINARY DISCUSSION OF RESULTS

No additional discussion at this time. (See September 1977 Quarterly Report).

QUARTERLY REPORT

Research Unit #: 447
Reporting Period: October 1 - December 31, 1977

Site Specific Studies of Seabirds at King Island and Little Diomede Island

William H. Drury
Principal Investigator
College of the Atlantic

QUARTERLY REPORT

RESEARCH UNIT #447

Reporting Period: October 1, 1977 to December 31, 1977

Title: Site Specific Studies of Seabirds at King Island and Little Diomede Island

I. Highlights of quarter's accomplishments - none.

II. Task Objectives

1. To determine the numbers and distribution of species of seabirds.
2. To describe the schedule and phenology of events during occupation of the cliffs, the breeding period, and the period when the birds leave.
3. To examine trophic relations by making estimates of reproductive success, by determining distribution and concentrations of birds breeding at sea, and by identifying the organisms used as food.
4. To compare these results with those from the Southern Chukchi Sea and the Northern Bering Sea.

III. Field or Laboratory Activities

A. No field work done in this quarter.

B. Scientific Party

William H. Drury	College of the Atlantic	Principal Investigator
John O. Biderman	Processing of field data	
Sarah Hinckley	Processing field data, archiving data	

C. Field methods have been described previously.

The biweekly summaries prepared by field workers during their stay on Little Diomede Island from mid May to early August were reviewed. Questions raised by the notes have been answered by the field workers.

D. Sample locations are the same as in previous studies.

E. Data analyzed.

Number of study sites, censuses, and transects have been reported before.

IV. Results

No new results since September Quarterly Report.

V. Preliminary Interpretation of Results.

Our discussion in the Quarterly Report of 28 September 1977 still seems valid.

VI. Auxiliary Material

A. A paper "Bering Sea Birds" has been accepted for publication in the February 1978 issue of Natural History. The text is by W. Drury and the photographs (taken in 1975 at Sledge Island and Bluff) by Hope Alexander.

B. Three oral presentations of data and ideas coming from this NOAA work have been given in this quarter.

Quarterly Report

Contract # 03-5-022-56
Research Unit #458
Task Order #28
Reporting Period 10/1-12/31/77
Number of Pages 4

Avian Community Ecology of the Akulik-Inglutalik River Delta, Norton Bay, Alaska

Dr. Gerald F. Shields
and
Mr. Leonard J. Peyton
Institute of Arctic Biology
University of Alaska
Fairbanks, Alaska 99701

December 21, 1977

I. Field Activities

No field activities were conducted during this quarter.

II. Data Analysis

A.) Research Party

Name	Affiliation	Role
Gerald F. Shields	Institute of Arctic Biology	Co-principal Investigator
Leonard J. Peyton	Institute of Arctic Biology	Co-principal Investigator
Declan Troy	Institute of Arctic Biology	Graduate Student

B.) Research Schedule

Laboratory activities for this quarter have involved analysis of data for the following parameters:

1.) Avifaunal descriptions of migratory and breeding birds

2.) Banding analysis

3.) Nonbreeding general analysis

4.) Descriptions of botanical communities

5.) Weather analysis

The duration of research activities of each investigator are listed below:

Investigator	Duration	Remuneration
Gerald F. Shields	80 hours	none
Leonard J. Peyton	160 hours	none
Declan Troy	240 hours	½ time R.A. (20 hrs./ week)

III. Results:

The following data sets have been generated from summer field activities:

Data Batch I-Avifaunal descriptions

A.) Migratory descriptions

1.) Numbers of migrants (spring) / species / day

2.) Numbers of migrants (fall) / species / day

B.) Nest records

1.) Numbers of breeding pairs/ species/ km^2

2.) Numbers of nests/ species/ km^2

3.) Numbers of eggs laid/ species / nest

4.) Numbers of eggs hatched / species / nest

5.) Numbers of eggs hatched / species / km^2

6.) Numbers of young fledged / species/ km^2

C.) Birds banded

1.) Numbers of nestlings banded/ species

2.) Numbers of breeding adults banded/ species

3.) Numbers of recoveries from 1976 field season

4.) Numbers of migrants banded

5.) Estimates of breeding - post breeding residence times have been completed for most birds based on both visual observations and capture - recapture of banded birds.

D.) Nonbreeding general

1.) Chronological determinations of abundance of nonresident birds

2.) Chronological determinations of nonbreeding birds

Data Batch 4-Descriptions of botanical communities

1.) Nest site-plant associations (km^2)

2.) Species/ location / ecotype

3.) Flowering times/ species

4.) Relative species density/ km^2

Data Batch 5 - Weather

1.) Temperature, max-min./day

2.) Wet bulb-dry bulb, relative humidity/ day

3.) Wind direction/ day

4.) Wind velocity/ day

5.) Cloud cover/ day

6.) Precipitation/ cm. / day

The following data sets will be completed during the next quarter and will be included in the final report.

Data Batch 3 Invertebrate Analyses

A.) Numbers and dry weight/ taxon/ km^2

1.) Sweep net samples

2.) Rectangular grib samples

3.) Pond dip net samples

Data Batch 2 Avian stomach content analysis

A.) Predator information

1.) Collection location/ specimen

2.) Size class/ specimen

3.) Dry weight/ specimen

4.) Number of food items/ taxon/ specimen

A COMPARATIVE SEA-CLIFF BIRD INVENTORY OF THE CAPE THOMPSON VICINITY, ALASKA
(R.U. No. 460)

A SEA-CLIFF BIRD SURVEY OF THE CAPE LISBURNE - PT. HOPE, ALASKA COASTLINE
(R.U. No.461)

(Contract 03-6-022-35210)

Quarterly Report
1 January 1978

RENEWABLE RESOURCES CONSULTING SERVICES, Ltd.

Principal Investigators

David G. Roseneau
Alan M. Springer

SUMMARY OF 3rd. QUARTER OPERATIONS

I. Field Activities

No field activities occurred during this quarter. The NOAA-OCSEAP Marine Mammal/Seabird workshop held at the University of Alaska 25-28 October 1977 was attended by D. G. Roseneau. D. G. Roseneau also participated as a member of the Bird/Mammal Panal at the EPA-NOAA Oil Spill Response workshop held in Anchorage 27-30 November 1977.

II. Laboratory/Office Activities

Field data collected a Cape Thompson and Cape Lisburne during FY 77 have been extracted from notebooks, organized and reduced to tabular or graphic form where appropriate. Currently, these data are being analysised and interpreted. Our primary efforts during late November and December have been directed towards the preparation of an annual report to be submitted 1 April 1978.

Stomach contents of Common Murres, Thick-Billed Murres, and Black-Legged Kittiwakes were sorted and shipped to Dr. Peter Craig's analyses are now complete and the stomach contents of 91 Thick-Billed Murres, 30 Common Murres, and 39 Black-Legged Kittiwakes collected at Cape Lisburne, and 109 Thick-Billed Murres, 19 Common Murres, and 54 Black-Legged Kittiwakes collected at Cape Thompson have been identified. These data will be cimpared to those of Swartz (1966) and Springer and Roseneau (1977); a preliminary general comparison has revealed a marked difference with regard to the occurance of some prey species in the diet of these seabirds between 1976 and 1977.

Several parasite specimens, including one flea obtained from the bird specimens collected during 1977 have been sent to Eric Hoberg and Dr. Robert Rausch, University of Saskatchewan for positive identification. All parasite specimens collected in 1976 have now been identified.

Data preparation is currently being undertaken in anticipation of the upcoming Beaufort Sea Synthesis Meeting to be held in Barrow, 23-27 January 1978.

III. Data Management

Preparations are being made to meet with Data Management personnel during February, 1978.

Literature Cited

Springer, A. M. and D. G. Roseneau 1977. A comparative sea-cliff bird inventory of the Cape Thompson vicinity, Alaska. Annual Report Research Unit 460/461. Outer Continental Shelf Environmental Assesment Program; Boulder, Colo. 54pp.

Swartz, L. G. 1966. Sea-cliff birds. Pages 611-678 in: N. J. Wilimovsky and J. N. Wolfe, eds. Enviroment of the Cape Thompson Region, Alaska. U.S. Atomic Energy Commission, Oak Ridge, Tennessee.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Boulder, Colorado 80302

ENVIRONMENTAL ASSESSMENT OF THE ALASKAN CONTINENTAL SHELF

Annual Reports of Principal Investigators

for the year ending March 1977

ERRATUM SHEET

Annual Report, Volume V, RU 470, page 376

Report entitled, "Some Aspects of the Ecology of Cliff-Nesting Seabirds at Kongkok Bay, St. Lawrence Island, Alaska, during 1976"

ERRATUM: Table 23. 446,000 Least Auklets were estimated to be present at the Ataakas-Kookoolik colony during 1966.

RECEPTORS (BIOTA)

FISH, LITTORAL, BENTHOS, ETC.

RECEPTORS (BIOTA)

FISH

QUARTERLY REPORT

Contract 03-5-022-56
Research Unit #5
Reporting Period: 10/1/77-12/31/77
Task Order Nos. 15, 20, 29, 30
Number of Pages: 8

THE DISTRIBUTION, ABUNDANCE, DIVERSITY AND PRODUCTIVITY OF BENTHIC ORGANISMS IN THE GULF OF ALASKA, KODIAK SHELF BERING SEA, CHUKCHI SEA, AND NORTON SOUND

Principal Investigator

Dr. Howard M. Feder

Assisted by: Associate Investigators

M. Hoberg, S. Jewett, G. Matheke, G. Mueller

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

December 1977

BERING SEA AND GULF OF ALASKA

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.

II. FIELD AND LABORATORY ACTIVITIES

A. Grab Program

1. No cruises were scheduled for this quarter.

2. Analysis of all samples collected in the last two years is still in progress at the Marine Sorting Center and the Data Processing Section of the Institute of Marine Science.

3. Organization of data for reports and publications are in progress.

B. Trawl and Pipe Dredge Program

1. Cruise on NOAA Ship *Surveyor* 4 November - 18 November, Lower Cook Inlet.

2. Cruise on R/V *Acona* in Resurrection Bay November 28 - December 2.

3. All trawl and pipe dredge material from Cook Inlet and the Bering Sea were examined and data submitted for key punching.

4. Dominant clam species from Cook Inlet and the Bering Sea were examined for age and growth determinations. Data has been key punched and printed. Age-growth history tables were organized.

C. Microbiological/Detrital Studies

1. Initial experimental studies with sediment bacteria were initiated.

III. RESULTS

A. Grab Programs

1. Additional programs to further the analysis of NEGOA are being developed.

2. The Final Report is in progress.

B. Trawl and Pipe Dredge Program

1. Trawl and pipe dredge data from cruises of past year in Cook Inlet and the Bering Sea have been key punched and printed out. Checking and analysis of this data is in progress.

2. Clam species from Cook Inlet and the Bering Sea have been aged, measured, data recorded on computer forms, and subjected to analysis. Species examined were: (1) Cook Inlet - *Spisula polynyma, Nuculana fossa, Tellina nuculoides, Glycymeris subobsoleta, Macoma calcarea, Nucula tenuis*, and (2) Bering Sea - *Spisula polynyma, Macoma calcarea, Tellina lutea, Nuculana fossa, Yoldia amygdalea.*

3. A manuscript on the feeding biology of the snow crab *Chionoecetes bairdi* in Cook Inlet is completed and will be available to the Final Report.

4. Large numbers of live snow crab, dungeness crab, hermit crabs, and shrimps were collected. Some were preserved for food studies; others were returned to Seward for experimental studies. Experimental feeding studies have been initiated in tanks at Seward.

5. The Final Report for Cook Inlet is in progress.

6. NEGOA and Bering Sea reports are in process of organization.

IV. PRELIMINARY INTERPRETATION OF RESULTS

General interpretations of grab and trawl data are included in the 1976 and 1977 Annual Reports and in Institute of Marine Science Technical

Report R76-8. Additional comments on this, pipe-dredge data, and food relationships will be included in the Final Report.

V. PROBLEMS ENCOUNTERED

No direct problems.

We have essentially no food data from the northeast Gulf of Alaska, and Bering Sea food data is spotty. I would strongly suggest that data on food habits of fishes in these regions be collected in the near future.

It is anticipated that problems will arise after each cruise into Cook Inlet. Live material will be obtained for use in the experimental studies at Seward, but no ship time is included in the schedule for a "touch and go" in Seward. Alternate arrangements should be made at Homer for transfer of 50-gallon drums of sea water and crabs from ship to shore.

KODIAK SHELF

I. TASK

Objectives

1. Assess spatial and temporal distribution and relative abundance of epifaunal invertebrates in selected bays and inshore areas.

2. Where possible, assess spatial and temporal distribution of selected, important inshore infaunal invertebrate species.

3. Determine, where possible, the feeding habits of the principal inshore epifaunal invertebrate species exclusive of king crab (see 4 below).

4. Determine the feeding habits of the king crab. The following listed objectives should eventually delineate (1) what the major geographic areas are that support (in terms of food) king crab of various sizes and life stages, and (2) which food item(s) or group(s) are most important to the enhancement of the size of a particular king crab stock.
    a. Examine the percent weight and/or volume composition of prey items of king crab of different sex, length and ecdysis stage by area (depth) and time of the year.
    b. Examine the feeding intensity of king crab following the same parameters as in objective (a) above.
    c. Examine the correlation between catch number of king crab and their feeding intensity as determined by objective (b).

5. If appropriate, determine food habits of selected bottom-feeding fishes (species predominantly or exclusively utilizing invertebrates for food) (see Feder *et al.*, 1977a, b, c for examples of a similar approach.

6. Develop food webs integrating invertebrate, fish and bird feeding data in collaboration with the Alaska Department of Fish and Game R.U. 486 (see references in 5 above for examples of this approach) and U.S. Fish and Wildlife Service (R.U. 341).

7. Compile seasonal reproductive data, and other biological data whenever possible, on dominant benthic epifaunal invertebrates.

8. Initiate recruitment, age and growth, and mortality studies on important clam species (specifically species important as food for dominant epifaunal species such as king crab, snow crab, selected species of bottom-feeding fishes) taken in the course of the proposed study.

9. Utilize data obtained in this proposed work in conjunction with data on inshore fishes (proposed study by A.D.F.&G. for R.U. 486)

and bottom-feeding birds (proposed study by U.S. Fish and Wildlife Service for R.U. 341) to suggest the potential sensitivity of the inshore marine communities to oil pollution.

II. FIELD AND LABORATORY ACTIVITY

A. No cruises scheduled

B. Kodiak Final Report (Alitak and Ugak Bay) completed.

III. RESULTS

A. No field or laboratory activities.

B. Some preliminary planning in progress.

IV. PRELIMINARY INTERPRETATION OF RESULTS

V. PROBLEMS ENCOUNTERED

The lack of communication between various scientific segments of this OCSEAP project are unfortunate. The objectives outlined above attest to the complexity of the program planned by our group. Thus, it is essential that coordination meetings and cruises be organized in the very near future.

CHUKCHI SEA AND NORTON SOUND

I. TASK OBJECTIVES

To conduct a survey of the benthic epifaunal invertebrates of the Chukchi Sea/Norton Sound areas.

II. SHIP OR LABORATORY ACTIVITIES

A. No ship activity this quarter.

B. No laboratory activities.

III. RESULTS

A. Data on distribution and abundance, predator-prey relationships and reproductive notes have been examined. An extensive report on the food of the starry flounder is in preparation. The report is based on 133 stomachs examined in the field using the frequency of occurrence method of analysis and 177 stomachs examined using volumetric and numerical methods of analysis.

B. Distribution and abundance data are presently being analyzed.

C. The final report is in the final stages of preparation, and should be completed this month.

IV. PROBLEMS ENCOUNTERED

No immediate problems. However, lack of infaunal data from the study area has hampered the interpretation of feeding data, and will limit distributional information on an important component of the benthos, the infauna. Infaunal samples should be collected when activities in this lease area intensify.

Milestones

It is intended to maintain a consistent schedule for report preparation in the next few months. Some of the report submission dates have been altered slightly from that included in the quarterly report of September 1977. Some of the reports will be subdivided into sections, each section to be submitted as it is completed. The latter procedure should increase the data flow and data interpretation available to OCSEAP. The schedule for report submissions are as follows:

1. Kodiak (Alitak and Ugak Bays) - Completed and submitted November.
2. Norton Sound-Chukchi Sea - Mid January.
3. Cook Inlet - Late February.
4. Bering Sea Trawl Report - Late March.
5. NEGOA grab and trawl report - April.
6. Bering Sea grab and pipe dredge report - May.

QUARTERLY REPORT

Contract No. 03-5-022-68, Task Order 5
Research Unit #6
Reporting Period: 1 October - 31 December 1977

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

December 23, 1977

Andrew G. Carey, Jr.
Principal Investigator

I. Task Objectives

A. General nature and scope of the problem

The distribution, abundance and natural variability of benthic macrofauna will be described on the southwestern Beaufort Sea continental shelf. Patterns of faunal distributions will be described and characterized using suitable bio-indices and multivariate techniques. Seasonal changes in the structure of benthic populations will be studied by sampling four times within a single year. Feeding interactions between organisms will be characterized by describing the benthic food web.

B. We propose to describe the benthic infauna of the western Beaufort Sea continental shelf including studies of both geographic and seasonal variability. Data are to be obtained on the faunal composition and abundance to form baselines to which potential future changes can be compared. The structure of the benthic food web will provide information on links in the food web that are important for the existence of the communities and by which pollutants may enter man's food web.

Specific objectives include the continuation of studies and analyses to:

1. Describe the distribution, species composition, numerical density, and biomass of the benthos in the area of interest.

2. Describe the spatial and seasonal variability of faunal distributions and abundances.

3. Describe the benthic communities present and delineate their geographical and environmental extent.

4. Describe the effect of seasons on population size and reproductivity activity of dominant species.

5. Determine the degree of correlation of species distributions and of various bio-indices with features of the benthic environment.

6. Determine the basic structure of the *in situ* benthic invertebrate food web from a literature review and gut content analyses of selected, abundant species.

II. Field or Laboratory Activities

A. Ship or field trip schedule

1. No field activities were undertaken during this quarter.

B. Scientific party

1. No field activities were undertaken during this quarter.

2. Laboratory personnel

Paul Scott was rehired on 15 November 1977 as the third biological Research Assistant Unclassified to aid with the routine sample processing, quantification of data, and the identification of the benthic fauna. He will work with the picking and sorting of fauna from the Smith-McIntyre bottom grab samples. Scott will identify the mollusca. With his assistance we will be able to process the large macro-infauna from the past coastal samples collected from depths of 5-25 meters during the 1976 R/V ALUMIAK cruise.

C. Methods

1. No field activities were undertaken during this quarter.

2. Laboratory analysis

No changes have been made in our laboratory methodology this quarter. Procedures on laboratory screening of organisms in the 0.5-1.0 mm and >1.0 mm size range have been examined and standardized. See previous reports for standard laboratory procedures.

D. Sample localities

No samples were collected during this quarter.

E. Data collected or analyzed

1. Number and types of samples/observations.

No samples were collected during this quarter.

2. Number and types of analyses

Twenty-six 0.1 m^2 Smith-McIntyre bottom grab samples have been picked and sorted into major taxa in the laboratory. The organisms in each category have been counted and weighed (wet-preserved weight). The 26 samples collect on OCS-7 during August 1977 from a total of 10 continental slope stations have been processed for macro-infauna (0.5-1.0 mm in size). See Section III - Results.

3. Miles of trackline

No fieldwork was undertaken during this quarter.

F. Milestone Chart and Data Submission Schedule (see page 3).

III. Laboratory Results

A. Biomass of macro-infauna

Wet-preserved weights for the 26 grabs from 10 continental slope stations collected on the August 1977 USCGC GLACIER cruise (OCS-7) are listed in Table 1.

B. Numerical density of macro-infauna

Annual densities for the 26 grabs from the 10 continental slope stations collected on OCS-7 are listed in Table 2.

F. MILESTONE CHART and DATA SUBMISSION SCHEDULE

1977-78 Laboratory Schedule - Contract No. 03-5-022-68, Task Order 5.

	1977			1978								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1. OCS-7 continental slope infauna (>1.0 mm) basic picking/sorting.	—	—	—									
2. OCS-5 coastal infauna (>1.0 mm) basic picking/sorting (BAB and DPB)				—	—	—						
3. OCS-5 coastal infauna (>1.0 mm) basic picking/sorting (BRB+PIB)							—	—	—			
4. OCS-, Pitt Point standard station (PPB) fauna (>1.0 mm) basic picking/sorting										—	—	—
5. Dominant species identifications (selected groups.	—	—	—	—	—	—	—	—	—	—	—	—
6. Sediment analyses (OCS 1-7)				—	—	—	—	—	—			
7. WEBSEC-OCS epifaunal photo survey summary								—	—	—	—	
8. WEBSEC-OCS infaunal survey summary										—	—	—
9. PPB seasonal community analysis - preliminary summary				—	—	—						
10. Benthic food web analysis and synthesis				—	—	—	—	—	—	—	—	—
11. Quarterly Reports			—			—			—			—
12. Data transmission (magnetic tape)												
a. OCS-7 station data			—									
b. Continental slope infauna						—						
c. Coastal infauna (BAB and DPB)									—			
d. Coastal infauna (BRB and PIB)												—
e. Pitt Point (PPB) standard stations												→
13. Yearly Report	—	—	—	—	—	—						

NOTE: OCS-5 = 1976 R/V ALUMIAK coastal cruise; OCS-7 = 1977 USCGC GLACIER summer cruise; WEBSEC = Western Beaufort Sea Ecological Cruise - USCG 1970-73; PPB = Pitt Point Benthos transect line; BAB = Barter Island Benthos transect line; DPB = Demarcation Point Benthos transect line; BRB = Barrow Benthos transect line; PIB = Pongok Island Benthos transect line.

Table 1 : Biomass, preserved wet weights in grams per 0.1 m^2, from OCS-7 deep water stations, collected in August 1977. *Trace found, included in total.

Station	Depth(m)	Grab	Anthozoa	Sipunculida	Annelida	Arthropoda	Mollusca	Echinodermata	Misc.Phyla	TOTAL
10	2470	1530	.03	.01	.23	.01	.04	---	.01	.33
12	2840	1539	---	---	.02	---	.01	.01	---	.04
	2650	1540	---	---	.05	.02	.02	.16	---	.25
28	3750	1599	---	---	*	---	.01	---	*	.03
	3841	1600	---	---	*	---	.01	---	*	.02
29	3511	1601	---	---	.01	---	---	---	---	.01
	3576	1602	---	---	.01	---	---	---	---	.01
	3843	1604	---	---	.02	---	.01	---	---	.03
31	3566	1605	---	---	*	---	.01	---	*	.02
	3570	1607	---	---	.01	---	---	---	---	.01
32	3386	1608	---	---	.01	---	.01	---	.06	.08
34	1958	1610	---	---	.09	.04	---	---	---	.13
	1976	1611	---	---	.01	.02	---	---	.04	.07
	2048	1612	---	---	.02	.01	---	---	.01	.04
	2086	1613	---	---	.32	.01	.01	---	.03	.37
35	1097	1614	---	.02	.21	.01	.13	---	---	.37
	997	1615	---	.04	.61	.02	.13	---	.15	.95
	686	1616	---	.06	1.31	.02	.01	---	.02	1.41
	640	1617	---	.07	.62	.01	.08	---	.01	.79
	644	1618	.03	.03	.69	.01	.36	---	.19	1.31
	659	1619	.03	.02	.62	.27	.03	---	.02	.99
	659	1620	---	.02	.85	.14	.10	---	.01	1.12
	1025	1622	.05	.06	.27	.01	.06	---	.01	.46
54	2104	1661	---	.01	.13	.02	.12	---	.03	.31
58	1144	1663	---	.01	.23	.03	.07	---	---	.34
	1144	1664	.01	.01	.38	.06	.07	---	.01	.54

Table 2: Numerical density per 0.1 m^2 from OCS-7 deep water stations, collected in August 1977.

	Station	10	12	12	28	28	29	29	29	29	31	31	31
	Grab	1530	1539	1540	1599	1600	1601	1602	1603	1604	1605	1606	1607
	Depth(m)	2470	2840	2650	3750	3841	3511	3576	3843	3843	3566	3569	3566
	Fraction(mm)	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5
Cnidaria:	Anthozoa	2/-	-/-	-/1	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Nematoda		5/271	-/3	-/-	3/-	1/1	1/-	-/-	-/-	-/-	1/-	-/-	-/-
Annelida:	Polychaeta	27/23	2/1	6/3	1/3	1/10	3/3	1/8	-/5	5/9	3/4	-/2	2/7
Sipunculida		1/-	-/1	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Arthropoda:	Crustacea												
	Harpacticoida	-/3	-/-	-/-	-/-	-/-	-/-	-/1	-/1	-/-	-/-	-/1	-/-
	Isopoda	1/3	-/-	1/4	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
	Ostracoda	-/1	2/-	1/-	-/2	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
	Tanaidacea	1/9	-/-	-/4	-/-	-/-	-/-	-/1	-/-	-/-	-/-	-/-	-/-
Mollusca:	Pelecypoda	2/4	2/2	4/23	1/-	1/4	-/3	-/2	-/-	1/3	1/-	-/1	-/3
	Gastropoda	-/-	-/-	-/-	1/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
	Scaphopoda	1/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Echinodermata:	Echinoidea	-/-	2/-	1/-	-/-	-/1	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Hemichordata		1/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Chordata:	Ascidiacea	-/1	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
TOTALS		41/315	8/7	13/35	6/5	3/16	4/6	1/13	-/6	6/12	5/4	-/4	2/10
Total in Grab		356	15	48	11	19	10	14	6	18	9	4	13

Numerical density table continued

	Station Grab Depth(m) Fraction(mm	32 1608 3386 1.0/.5	33 1609 1.0/.5	34 1610 1958 1.0/.5	34 1611 1976 1.0/.5	34 1612 2048 1.0/.5	34 1613 2086 1.0/.5	35 1614 1097 1.0/.5	35 1615 997 1.0/.5	35 1616 686 1.0/.5	35 1617 640 1.0/.5	35 1618 644 1.0/.5
Cnidaria:	Anthozoa	-/-	-/-	-/-	-/-	-/1	-/-	-/-	-/-	-/-	-/-	2/-
Nematoda		-/2	-/2	-/25	-/2	1/18	-/48	2/13	11/34	15/3	20/31	7/14
Nemertinea		-/-	-/-	-/-	2/-	1/-	-/-	-/2	2/2	1/-	1/7	1/-
Annelida:	Polychaeta	2/5	-/3	15/34	1/5	5/24	13/37	48/62	32/46	79/24	51/52	89/79
Sipunculida		-/-	-/-	-/-	-/-	-/1	-/2	4/4	24/3	18/1	17/5	10/4
Echiuroidea		-/-	-/-	-/-	-/-	-/-	-/-	-/-	1/-	-/-	-/-	-/-
Arthropoda:	Crustacea											
	Amphipoda	-/-	-/-	6/5	-/1	3/6	2/-	-/-	1/-	-/1	2/6	1/-
	Harpacticoida	-/1	-/-	-/1	-/-	-/-	-/5	2/15	-/18	8/16	-/25	-/32
	Isopoda	-/-	-/-	-/2	2/-	1/-	-/1	-/4	-/2	8/5	4/10	2/8
	Ostracoda	1/2	-/-	1/1	-/-	-/-	-/-	-/-	-/-	1/1	-/2	-/2
	Tanaidacea	-/-	-/-	3/2	1/3	-/4	1/14	8/12	4/6	6/2	4/10	1/5
	Cumacea	-/-	-/-	1/-	-/-	-/-	-/-	1/1	2/4	-/-	1/1	-/1
Mollusca:	Pelecypoda	1/1	1/2	-/3	-/2	-/3	1/2	6/25	4/26	4/8	7/24	8/35
	Gastropoda	-/-	-/-	-/-	1/-	-/-	-/-	-/-	-/-	-/-	-/1	-/3
	Aplacophora	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	1/-	-/1	2/-
	Scaphopoda	-/-	-/-	-/-	-/-	-/2	-/1	3/-	-/1	1/-	-/-	1/1
Echinodermata:	Ophiuroidea	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/1
	Holothuroidea	-/-	-/-	-/-	1/-	-/-	1/-	-/-	-/-	-/-	-/-	2/-
Hemichordata		-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/2
TOTAL		4/11	1/7	26/73	8/13	11/59	18/110	74/138	81/142	142/61	107/175	126/187
Total in Grab		15	8	99	21	70	128	212	223	203	282	313

Numerical density table continued

	Station	35	35	35	54	58	58
	Grab	1619	1620	1622	1661	1663	1664
	Depth(m)	659	659	1025	2104	1144	1144
	Fraction(mm)	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5	1.0/.5
Cnidaria:	Anthozoa	5/-	-/-	2/-	1/-	-/-	2/-
Nematoda		42/11	7/11	3/48	9/11	4/3	2/11
Nemertinea		-/-	-/-	-/2	-/-	-/2	-/-
Annelida:	Polychaeta	81/18	90/54	35/97	33/48	36/27	28/36
Sipunculida		8/7	8/7	22/2	1/1	2/-	2/-
Arthropoda:	Crustacea						
	Amphipoda	-/1	-/-	-/-	8/2	2/8	3/6
	Harpacticoida	8/11	2/37	-/15	-/2	-/26	-/-
	Isopoda	10/2	3/9	-/1	2/4	7/22	3/1
	Ostracoda	2/2	1/3	3/2	-/2	-/4	2/8
	Tanaidacea	3/1	4/13	2/12	1/3	1/1	-/3
	Cumacea	4/1	2/4	-/4	-/-	4/6	-/-
Mollusca:	Pelecypoda	13/21	9/47	16/40	11/15	19/58	9/32
	Gastropoda	-/3	2/-	-/1	-/-	-/-	-/-
	Aplacophora	-/-	2/-	-/-	-/-	-/-	-/-
	Scaphopoda	2/-	-/2	2/1	-/-	-/-	-/-
TOTAL		178/78	130/187	85/226	66/88	75/157	51/97
Total in Grab		256	317	311	154	232	148

IV. Preliminary Interpretation of Results

Interpretation will be undertaken when further samples have been processed and a more complete data set can be statistically analyzed. Statistical analyses on the data collected to date are in progress.

V. Problems Encountered/Recommended Changes

No problems or changes have been encountered during this quarterly report period.

VI. Estimate of Funds Expended

	Budget	Spent	Outstanding	Spent This Quarter
Salaries & Wages	166,965	111,400		15,528
Materials & Services	31,235	21,832		1,878
Travel	13,350	10,458		252
Equipment	47,617	47,224		--
Payroll Assessment	26,291	16,621		2,253
Overhead	85,367	53,866		7,863
TOTAL	370,825	261,401		27,774

Quarterly Report

R.U. 19
Oct. 1 - Dec. 31
Three Pages

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 Road
Anchorage

December 1977

I. Task Objectives

The objectives of this research unit 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 other forage fish within the study area.

4) Monitor egg density, distribution and development and document types of spawning substrates of herring and other forage fish species.

5) Monitor local resident subsistence utilization of the herring fishery resource.

II. Field Activities

Activities during this quarter (October-December) included completion of fall inshore sampling in Port Clarence and Golovin Bay. Aerial surveillance of the coastline for determining the presence of forage fish was also concluded due to inclimate weather conditions (turbid water and blowing snow). Aerial coverage ended on October 28. Field camps were closed down at Port Clarence and Golovin on October 19 and October 24, respectively.

All EDS forms were completed and three batches of data (large vessel studies, inshore studies at Unalakleet and aerial herring surveys) key punched, recorded on disketts and submitted to the Juneau Project office for archiving with NODC.

The largest task during this quarter has primarily dealt with summary and analysis of the extremely large volume of data collected, and include:

1) Analysis of herring scales for age determinations.
2) Tabulation of length frequencies.
3) Tabulation of pelagic fish catches by species, gear type, time and location.
4) Tabulation of aerial survey results.

Other activities included submission of remaining unknown and larval fish to the National Marine Fisheries Service in Seattle (NWFC) for identification.

III. Results and Preliminary Interpretation

Only four aerial surveys were attempted during this quarter due to inclimate weather conditions. These accounted for only two hours of air time and about 200 kilometers of coastal coverage. All surveys were ranked unacceptable and no fish were observed. However, preliminary figures reveal 25 surveys were flown on 24 days from June 9 through October 28 along the coast of Norton Sound and the Seward Peninsula. More than 8,000 kilometers of ground coverage occurred in 58 hours of air time. A total of 478 schools of fish were observed during this period. Species varification was not always possible.

Preliminary analysis of the relative maturity of herring captured in the fall in both Port Clarence and Golovin Bay indicates that these fall fish are not spawning populations. The reproductive organs were relatively undeveloped as compared to spring spawning populations. Preliminary results also indicate that size differences for herring of a similar age class existed between some areas in Norton Sound in 1977 (i.e., Golovin Bay versus Port Clarence).

Following is a tenative listing of catch by species of fish and shellfish captured in Norton Sound from May through October, 1977 (includes Yukon River samples):

Species	Catch	Species	Catch
pink salmon	4,776 (juveniles)	pricklebacks	73
	28 (adults)	rock greenling	26
chum salmon	2,061 (juveniles)	round whitefish	28
	75 (adults)	sculpins	118
king salmon	32 (juveniles)	saffron cod	1,844
coho salmon	18 (juveniles	starry flounder	736
	12 (adults)	sheefish	97
red salmon	2 (adults)	sand lance	49,490
Pacific herring	287 (juveniles)	stickleback (3/9)	132/664
	2,396 (adults)	tubenose poacher	101
arctic char	278	whitespotted greenling	37
arctic flounder	225	yellowfin sole	27
Alaska plaice	12	rock flounder	1
bering cisco	578	wolf fish	3
bering poacher	27	larval saffron cod	4,100
boreal smelt	1,010	larval whitefish sp.	1,590
broad whitefish	111	larval Osmerids and Clupeids	7,411
capelin	1	lamprey	41
pond smelt	11,963	red king crab	73 (M)
humpback whitefish	426	blue king crab	2 (F), 1 (M)
least cisco	1,127	tanner crab	1 (F)
northern pike	15	Korean horsehair crab	3 (M)
northern sucker	6		
burbot	461		

Of the total catch of 92,526 fish, approximately 95% were released unharmed.

IV. Problems and Changes

None.

V. Estimate of Funds Expended

Approximately $11,200 have been spent (for salaries) of the $60,000 FY 78 allocation. The remainder is primarily for salaries needed to finalize the project completion report due September 30, 1978. A limited amount will be used for printing, key punching, and computer time.

QUARTERLY REPORT

Contract No.
Research Unit #78
Reporting Period-October 1-December 31,1977
Number of Pages - 4

BASELINE/RECONNAISSANCE CHARACTERIZATION LITTORAL BIOTA, GULF OF ALASKA AND BERING SEA

by

Charles E. O'Clair
Theodore R. Merrell, Jr.

Northwest and Alaska Fisheries Center Auke Bay Laboratory
OUTER CONTINENTAL SHELF ENERGY ASSESSMENT PROGRAM
Sponsored by
U.S. Department of the Interior
Bureau of Land Management

January 1, 1978

I. Abstract

Our activities during this quarter centered around graphical and numerical analysis of data on the relative abundance and distribution of intertidal plants and animals along five segments of Alaskan coastline. A report on the results of these analyses for the Eastern Gulf of Alaska (EGOA) is partially written. The estimated date of completion of the report on EGOA has been delayed until March 1, 1978 because of delays in sample processing by the Institute of Marine Sciences, University of Alaska. All data from the Western Gulf of Alaska were submitted to the National Oceanographic Data Center. A schedule for submission of future reports and computer data is included.

II. Objectives

The objectives of this task are to describe the distribution and abundance patterns of biotic populations in intertidal communities at representative sites along the coast of Alaska and to compare communities within and between sites.

III. Field or Laboratory Activities

No field studies were conducted, as directed by the Juneau Project Office.

Laboratory activities consisted of graphical and numerical analyses of weights and abundances of plants and animals (termed "Basins"): the Western Gulf of Alaska, the Eastern Gulf of Alaska, St. George Basin, Bristol Bay, and Norton Sound. Qualitative observations from other sites in these Basins supplement the quantitative data.

IV. Results

We will report the results of field work that was conducted previously to this quarter in final summary reports on each of the five Basins listed in Section III. These reports will be appended to future quarterly reports. We will follow the reporting schedule shown in Fig. 1 unless otherwise directed by the Juneau Project Office. The report on the Western Gulf of Alaska is an exception, in that it will be released as a processed report in January, 1978. The changes in reporting and data management schedules are a result of delays in sample processing by the Institute of Marine Sciences, University of Alaska.

We have converted all of the data at hand to the new National Oceanographic Data Center (NODC) taxonomic codes. As shown in Fig. 1, all data from the Western Gulf of Alaska have been submitted to NODC.

V. Auxiliary Material

Papers in preparation or in print.

Zimmerman, S.T., N.I. Calvin, J.T. Fujioka, J.A. Gharrett, J. Gnagy, and J.S. MacKinnon 1978 Intertidal biota of the Kodiak Island area. Northwest and Alaska Fisheries Center Auke Bay Laboratory, Auke Bay, Alaska (in press).

Figure 1.

MILESTONE CHART

RU #: 78

PI: Charles E. O'Clair and Theodore R. Merrell, Jr.

△ Planned Completion Date

▲ Actual Completion Date

Major Milestones: Reporting, data management and other significant contractual requirements; periods of field work; workshops; etc.

MAJOR MILESTONES	1977			1978											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Submission of all the remaining data (1975 and 1976) from the Western Gulf of Alaska to NODC	▲														
Final report on the Western Gulf of Alaska (Kodiak Island area).				△											
Submission of all the remaining data for 1975 to NODC					△										
Annual Report with emphasis on EGOA						△									
Submission of data for St. George Basin to NODC									△						
Quarterly report with emphasis on St. George Basin									△						
Submission of data for Bristol Bay to NODC													△		
Quarterly report with emphasis on Bristol Bay													△		
Submission of data for Norton Sound to NODC		3 months after reception of data from the Institute of Marine Sciences (I.M.S.)													
Quarterly report with emphasis on Norton Sound		In that quarter which occurs 3 months after reception of data from I.M.S.													

PROJECT RU-380 Ichthyoplankton of the Eastern Bering Sea, NWAFC DATE 21 December 1977

PRINCIPAL INVESTIGATORS F. Favorite and K. Waldron, NWAFC

	MAJOR MILESTONES/ ACTIVITIES	QUARTERS FY76 Ap	Jl	O FY77	Jny	Ap	Jl	O	Jny FY78
1	MILLER FREEMAN Cruise 76A, Collect Plankton Samples								
2	Samples returned to Seattle aboard FREEMAN								
3	Award sorting contract								
4	Sort plankton for ichthyoplankton and major taxa								
5	Identification of ichthyoplankton								
6	Analysis of data								
7	Annual Report								
8	Quarterly Reports								
9	Transcription to OCSEAP format & submit mag tapes								
10	MILLER FREEMAN Cruise 77B, Collect plankton samples								
11	Samples returned to Seattle via commercial carrier								
12	Sort samples for ichthyoplankton by contract								
13	Identification of ichthyoplankton								
14	Analysis of data								
15	Final Report (a) Start								
16	(b) Submit for internal review								
17	(c) Final draft preparation								
18	(d) Submit to NOAA								

Contract 03-5-022-81
Research Unit 356
October 1 to December 31, 1977

QUARTERLY REPORT

Environmental Assessment of Selected Habitats in the Beaufort and Chukchi Sea Littoral System

December 28, 1977

I. TASK OBJECTIVES: The primary objective of this quarter was laboratory analysis of samples and data from the 1977 field season. Some taxonomic (identification) problems with 1976 samples remain.

II. FIELD OR LABORATORY ACTIVITIES:

A. Ship or field trip schedule: none.

B. Scientific party (all of Western Washington Univeristy)

1. A. C. Broad, Principal Investigator (half-time)
2. Helmut Koch, Laboratory Supervisor
3. Gregg M. Petrie, Computer Programmer (hourly wages)
4. Laboratory Assistants (hourly wages)
   a. Mark Childers
   b. James Hanes
   c. Scott Hansen
   d. Patricia Jackson
   e. Scott Morrison
   f. Wendy Pounds
5. Contract labor for preparation of plant specimens.
   a. Lynn Van Rooy
   b. S. Edwards
6. Work-study students (provided by University)
   a. Ron Adams
   b. Dawn Christman

C. Methods: as previously reported

C. Sample localities: not applicable

E. Data analyzed:

1. Number of samples taken: none

2. Number of analyses: 54 biological samples (all from 1977 ALUMIAK cruise) and 57 sediment samples have been sorted or otherwise analyzed. Taxonomic determinations are in progress.

3. Miles of trackline: none.

F. Milestone chart and data submission schedule:

1. The 1977 samples taken aboard R/V ALUMIAK have proved to be more difficult to sort than anticipated (due to volume of samples and number of organisms). Consequently, in spite of extra personnel in our laboratory, we have not made the progress we should have. In order to deal as rapidly as possible with the 1977 samples, most of which are from the Beaufort Sea lease zone, we have neglected some final processing of 1976 data with resultant slippage in deadlines shown in our milestone chart. The first tapes of 1976 data will be at least a month later in arriving at NODC than we had previously thought.

III. RESULTS:

A. Sample locations: RU356 now has established 249 stations in the littoral zone of the Beaufort and Chukchi coasts. These stations are described in Table 1 appended to this report.

Our stations are of two kinds: beach or shore stations; and deep stations ("deep" in the context of the zone of our concern) which are not associated with shorelines. Beach stations are based on transects that extend from below what is conventionally called the intertidal zone shoreward across the beach and to the lower limit of truly terrestrial vegetation. At these stations we have data on beach profiles, sediment composition, benthic infauna, epibenthos, other biological information, beach plant composition, cover by beach plant species, and routine hydrographic and meteoralogic data. The so-called deep stations are single point locations not associated with shorelines. At deep stations we have data on benthic infauna and epifauna (and epiflora), other biological data, and routine hydrographic and meteorologic data. Surface plankton samples have been taken at most stations but are largely unprocessed.

A breakdown of stations by type and area is given in Table 2.

Table 2: Number of sampling stations established by RU356.

	Beaufort Sea	Chukchi Sea
Beach Stations	45	57
Deep Stations	128	19

B. Marsh ecology: In the summer of 1977, our program began to focus on function of arctic littoral ecosystems. Salt marshes elsewhere are primary sources of detritus to shallow, marine waters and may also be in Arctic Alaska. Marshes of the Arctic Ocean are an important source of food for geese. They also are the sea-land interface most likely to be affected by floating oil. The vegetation of beaches and marshes is the initial colonizer of new land in river deltas. Mason[1] has shown marsh vegetation to be an important contributor to soil strength and presumably beach stability.

In an effort to develop a notion of functional "structure" of coastal salt marshes, several perturbing stresses were applied individually to four plant communities in each of two marshes. One was south of Kotzebue at Arctic Circle landing strip, and one was in Prudhoe Bay at the mouth of the Putuligayuk River. The stresses include: applications of Prudhoe Bay crude oil, sand, nitrogen, and phosphorus; reduction of light intensity; periodic clipping to simulate grazing; and vertical cutting of the turf. Typically, six stress levels, evenly spanning three orders of magnitude, were used. The total vegetational cover and the partial contribution of each species to that total, along with leaf-length or plant-height measurements of characteristic species, constituted the output of strain states resulting from the stresses. These dependent state variables were noted as the independent stress was begun early in the 1977 field season and three times thereafter.

Results are plotted in accord with a log-linear stress-strain model and appended to this report (Figures 1-7). In the case of inorganic nitrate-nitrogen fertilization (Figure 1) both cropped weight and the total cover showed stimulation by nitrogen. A highly significant ($p > .999$) correlation of weight to cover ($r = 0.964$) suggests that the measures are usefully comparable. Maximum stimulation apparently lies beyond 10 g NO_3-N/M^2. Along with increases of biomass and cover went an increase in plant community diversity (Shannon-Weaver, ln partial species cover basis) which was significantly ($p > .99$) correlated with the total cover ($r = 0.980$).

Local beach sand on the high marsh at Kotzebue produced a sharp decrease of cover as the sand depth increased (Figure 2), with a sand depth of 3.4 cm ($s = 0.5$) producing a 50% decrease in cover. [(This figure, the $STRESS_{50}$, derived from least squares fit of ln (sand depth) to per cent maximum cover, is analogous to the LD_{50} of standard bioassay techniques]. At Prudhoe this $STRESS_{50}$ value for the Carex ursina community (Figure 3) averaged 1.0 cm and increased as the season progressed (and the community recovered) from 0.5 cm on 23 July to 0.8 cm on 6 August and finally 1.6 cm on 24 August. Recovery is manifest in the shapes of the stress-strain curves as well: as the season progressed the log-linear slopes of the low-stress end of these curves decreased, reflecting the long-term growth stimulus that moderate sand cover produces. (The average Carex subspathacea leaf length above the sand was 60% longer in 3 cm deep sand than in 0.1 cm deep sand.)

This same community at Prudhoe (Figure 4) and the near-by but slightly lower Carex subspathacea community (Figure 5) showed a similar response to treatment with crude oil, both with slopes and $STRESS_{50}$ increasing as the season progressed: the oil application level which decreased the cover to half went from 830 to 1700 m./M^2 as the C. ursina community recovered 6-24 August, and from 130 to 150 m./M^2 in the C. subspathacea community over the same period.

Although total cover decreased with increasing oil, the growth responses of two plants in the Carex ursina community showed a stimulatory effect from higher oil applications (Figure 6). Albedo and consequent soil surface temperature differences were noted along this oil-application gradiant. This alone may have mediated the increased growth seen in these plants.

At Arctic Circle Beach south of Kotzebue, the oil had only a minimal effect on cover in the community dominated by a Carex *ramenskii/subspathacea* intermediate (Figure 7). However, the species diversity decreased, partly as the result of selective reduction of the *Puccinellia phryganodes* whose shoots were immediately killed by the oil. This southern ecosystem showed a major simplification of the community along with a minor (or insignificant) decrease in cover at the high oil application levels. The final, harvested biomass in this community at the highest oil application levels showed a decrease to 58% of the average of lower applications, but the simple, almost diagramatic quantitative responses to oil seen in the harsher Beaufort environment were complicated in the Chukchi by additional species.

Estimates of above-ground plant production were obtained in the course of the grazing experiment. To simulate the effects of grazing by geese and brant, birds which depend on the Alaskan coastal salt marshes for building up reserves for the over-ocean southward migration, a Black and Decker battery-operated grass trimmer ("electric goose") was used to cut the plants about 2 mm above the soil. Several clipping regimes gave an average value of 59% recovery at Prudhoe compared to only 15% recovery at the Arctic Circle site. The standing crop produced in the season, however, was 45 g dry weight/M^2 at Prudhoe and 124 g at Kotzebue. Values for production, corrected for ash content, showed an average of 0.88 g volatile weight/M^2/day at Prudhoe, and 0.52 g at Kotzebue. These values were derived from the clipped quadrats; somewhat higher values would be anticipated, especially earlier in the year at Kotzebue where the growing season is longer.

In summary, the larger more diverse southern community showed low growth and consequently low recovery rates from clipping and in response to innundation with sand. Higher rates of production along with lower standing crop at Prudhoe permitted good recovery from clipping and sand treatment. However, the Prudhoe community showed a clear decrease of cover in response to oil even though some plants comprising that cover showed growth stimulation by the oil. At Kotzebue, oil caused insignificant changes in cover but decreased the higher plant diversity, killing, especially, the leaves of *Puccinellia phryganodes*. A similar selective kill of this plant was noticed at Prudhoe. Since *Puccinellia* is the initial colonizer of the salt-marsh ecosystem, its sensitivity to oil pollution is noteworthy.

C. Food webs in the littoral zone: Our current research objectives include the identification of the main food of the principal species of amphipods and annelid worms and (subsequent) work on the feeding habits of other, littoral species. During the Summer of 1977 we began examination of gut contents and fecal pellets of 15 common, littoral species and experiments in which various foods or potential foods were offered to 8 species. Results of these experiments are summarized in tabular form in appended tables 3 and 4. The following overview is based on still too few experiments and must be considered both tentative and incomplete.

Gammarus setosa, one of the commoner amphipods of the Beaufort Sea littoral had ingested virtually everything offered it in the laboratory. The guts and fecal pellets of *G. setosa* individuals taken in traps include, among the identifiable components, diatoms (the principal component), crustacean fragments, peat fragments, wood fibers (vascular tissue from higher plants), algal filaments, both polychaete and oligochaete setae, and foraminifera. Onisimus glacialis, another very abundant amphipod species, seems to feed mainly on crustacea (fragments are the principal identifiable gut or fecal pellet component) but also includes in its diet diatoms, peat (and wood fibers) algae, and worms. In the laboratory, O. glacialis ingests peat and both oligochaete and polychaete worms. G. setosa, Acanthostepheia beringiensis, and Gammaracanthus loricata may feed largely on diatoms. O. glacialis (and O. littoralis) seem to us to be primarily carnivorous. All amphipod species so far tested, however, are omnivorous to a marked degree.

The isopod, Saduria entomon, feeds in captivity on virtually everything offered it (amphipods, polychaetes, oligochaetes, and even Laminaria). Fecal pellets of trapped S. entomon contain crustacean parts, peat fragments, wood fibers, algal filaments, and polychaete setae. Diatoms found in Saduria feces were undigested.

An abundant polychaete of the deeper part of the Beaufort littoral (+2M depth) is Terebellides stroemi. T. stroemi fecal pellets contain diatom values (the main identifiable component) but also crustacean fragments, peat fragments, wood fibers, and algal filaments.

The commonest fish in our collections from the Beaufort littoral is Myoxocephalus quadricornis. The principal identifiable component of the gut contents and feces of the four-horned sculpin is crustacean parts, and _M. quadricornis_ readily accepts amphipods and mysiids in captivity.

The amount of peat (remains of terrestrial, vascular plants) in the Beaufort littoral has suggested a potential energy or nutritive source. Investigations of possible avenues of entry of peat into aquatic food webs was begun in 1977. Experiments and observations mentioned above indicate that many of the commoner animals ingest peat. We attempted two categories of further experiments. If peat enters food webs, it is ground up in the process--that is, the individual pieces of peat are reduced to smaller particles. Can the activity of individual species account for this reduction? To test the hypothesis that species A will reduce the size of peat fragments, individual were placed in aquaria containing peat (both autoclaved and natural) for various periods of time. At the conclusion of the experiment, the peat was seived through a graded series of screens and that portion of the total that passed through the finest screen (0.432 mm) calculated. The results of experiments performed in 1977 are summarized graphically in appended figure 8. Clearly, _Gammarus setosa_ and _Saduria entomon_ grind up peat; _Onisimus glacialis_ and other species tested probably do not.

If animals ingest peat, is it digested? Do animals utilize epifaunal and epifloral organisms that grow on peat? Directly or indirectly through the agency of microorganisms, is peat utilized as an energy source? Experiments designed to test the hypothesis that peat is, in fact, utilized by species A, unfortunately, were inconclusive and must be repeated with better controls and an improved experimental design. Gammarus setosa, however, was maintained on a diet of peat for periods up to 27 days during which time several individuals molted.

Microscopic examination of peat reveals an abundant epiflora of diatoms and filamentous algae and an epifauna of protozoa. The presence of bacteria may be inferred. A final experiment reported here was designed to test the hypothesis that this peat-based community was an actively metabolizing potential food source. Respiration of fresh peat, peat with introduced antibiotics (to remove bacteria), and autoclaved or sterile peat was determined in a Gilson differential respirometer (darkened to inhibit photosynthesis). The results of these experiments are presented in Table 5.

Table 5: Respiration of peat and peat-based epiphytes and epizoans.

Treatment of Peat	Oxygen Consumed ($\mu\ O_2$/g/hr)	n
fresh in sea water	99.59	24
with 10 μ tetracycline per ml seawater	77.92	9
with 100 μ tetracycline per ml seawater	89.62	13
autoclaved	15.82	9

The peat community respiration is on the same order of magnitude of that of many invertebrate animals. Currently we do not know why autoclaved peat shows a small, residual respiration. The results obtained are compatible with the hypothesis that the peat supports an organic community that is itself a potential food source in Arctic littoral ecosystems.

IV. PRELIMINARY INTERPRETATION OF RESULTS: see item V above.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES: Not applicable to this report.

VI. ESTIMATE OF FUNDS EXPENDED:

	Amount Budgeted	Amount Spent	Amount Remaining
Salary, PI	41,506	32,032	9,474
Salaries, Associates	66, 623	53,820	12,803
Salaries, other	126,972	102,043	24,929
Fringe	30,579	21,742	8,837
Travel and Freight	39,025	31,594	7,431
Chukchi (PI) logistics	92,451	34,567	57,884
Supplies	7,500	8,112	- 612
Equipment	17,265	8,025	9,240
Computer costs	7,800	5,441	2,359
Overhead	102,103	54,790	47,313
	$531,824	$352,166	$179,658

Footnote:

1. Mason, David T., 1978. Effect of vegetation on salt marsh soil strength in arctic Alaska, U.S.A. Manuscript submitted to Canadian Geotechnical Journal.

APPENDICES

Table 1: Sampling stations, Beaufort and Chukchi Littoral; RU356, 1975, 1976, 1977.

Station No.	North Latitude ° ' "	West Longitude ° ' "	Location
BØ6	69 5Ø 54	142 Ø5 Ø4	Beaufort Lagoon, Aichilik River Delta
B16	67 54 25	142 16 5Ø	Barrier Island, sea beach
B17	69 53 2Ø	142 18 ØØ	Beaufort Lagoon, Nuvagapak Point
B18	69 53 ØØ	142 18 Ø7	Beaufort Lagoon, Nuvagapak Camp
B1A	69 53 Ø9	142 19 18	Nuvagapak Bight Transect
B1B	69 53 11	142 19 Ø6	Nuvagapak Bight Transect
B1C	69 53 12	142 19 ØØ	Nuvagapak Bight Transect
B1D	69 53 12	142 18 54	Nuvagapak Bight Transect
B1E	69 53 ØØ	142 18 54	Nuvagapak Bight Transect
B1F	69 53 21	142 18 ØØ	Beaufort Lagoon Transect, south
B1G	69 53 33	142 17 3Ø	Beaufort Lagoon Transect, mid
B1H	69 53 5Ø	142 15 5Ø	Beaufort Lagoon Transect, north
B21	69 55 35	142 21 Ø9	Angun Point/Nuvagapak Entrance
B22	69 55 3Ø	142 21 3Ø	Angun Point/Nuvagapak Lagoon
B2A	69 53 Ø8	142 19 36	Nuvagapak Bight Transect
B2B	69 53 13	142 19 24	Nuvagapak Bight Transect
C1A	7Ø Ø8 Ø6	143 11 24	Tapkaurak Entrance, 3.5M
C1B	7Ø Ø9 24	143 Ø8 24	Tapkaurak Entrance, 10M
C35	7Ø Ø7 52	143 35 32	Barter Island, Pipsuck Point
C36	7Ø Ø6 38	143 36 3Ø	Barter Island, Lagoon shore
C37	7Ø Ø8 ØØ	143 36 48	Barter Island, Pipsuck Bight shore
C38	7Ø Ø6 12	143 38 Ø6	Barter Island SE, Lagoon
C39	7Ø Ø8 Ø8	143 39 12	Barter Island, North Shore
C3A	7Ø Ø7 57	143 34 3Ø	North Kaktovik Lagoon
C3B	7Ø Ø8 Ø6	143 34 3Ø	Bernard Harbor Transect
C3C	7Ø Ø8 Ø8	143 34 3Ø	Bernard Harbor Transect
C3D	7Ø Ø7 ØØ	143 34 ØØ	Manning Pt.-Barter Isl. Transect
C3E	7Ø Ø7 54	143 35 24	Barter Island-Off Pipsuck Pt.
C3F	7Ø Ø7 54	143 36 24	In Pipsuck Bight
C3G	7Ø Ø7 ØØ	143 32 ØØ	Manning Pt.-Barter Isl. Transect
C3H	7Ø Ø7 ØØ	143 32 42	Manning Pt.-Barter Isl. Transect
C4Ø	7Ø Ø6 Ø1	143 39 3Ø	Barter Island South, Lagoon
C41	7Ø Ø5 Ø1	143 41 Ø6	Mainland South of Barter Island

Table 1, continued.

Station No.	North Latitude °	'	"	West Longitude °	'	"	Location
C4A	70	06	06	143	38	00	South Kaktovik Lagoon Transect
C4B	70	06	00	143	38	00	South Kaktovik Lagoon Transect
C4C	70	05	30	143	37	38	South Kaktovik Lagoon Transect
C4D	70	04	42	143	37	18	South Kaktovik Lagoon Transect
C4E	70	08	05	143	40	54	Barter Island North, 2M
C4F	70	08	18	143	41	00	Barter Island North, 5M
C4G	70	09	00	143	41	00	Barter Island North, 10M
D00	70	05	32	143	59	08	Arey Island SW, Lagoon
D0A	70	05	42	144	05	00	off Hulahula River, 5M
D0B	70	07	30	144	05	00	off Hulahula River, 10M
D5A	70	00	24	144	54	24	Collinson Point North, 5M
D5B	70	02	48	144	54	24	Collinson Point North, 10M
E59	70	10	55	145	59	00	Flaxman Island SE, lagoon beach
F0A	70	11	30	146	00	00	Flaxman Island North, 3M
F0B	70	11	42	146	00	00	Flaxman Island North, 5M
F0C	70	12	24	146	00	00	Flaxman Island North, 10M
G3A	70	23	57	147	30	30	Narwhal Island NW, 5M
G3B	70	13	36	147	36	48	Foggy Island Bay, 2M
G3C	70	16	00	147	38	00	Foggy Island Bay, 5M
G3D	70	24	48	147	35	36	Narwhal Island, NW, 10M
H08	70	20	17	148	08	12	Sagavanirktok River Delta
H0A	70	22	30	148	07	48	Heald Point NE, 2M
H0B	70	24	18	148	06	36	Heald Point NE, 5M
H0C	70	29	49	148	01	12	Cross Island NW, 10M
H12	70	20	42	148	12	18	Heald Point E side, river shore
H19	70	21	00	148	19	00	N. Prudhoe Bay Transect
H1A	70	20	48	148	15	00	Prudhoe Bay S, Niakuk Islands
H1B	70	19	00	148	19	12	S. Prudhoe Bay Transect
H20	70	20	01	148	19	42	Prudhoe Bay, mid
H22	70	20	06	148	22	30	Prudhoe Bay, mid
H28	70	18	32	148	28	48	Putuligayuk River mouth
H2A	70	19	06	148	20	24	S. Prudhoe Bay Transect
H2B	70	21	54	148	21	18	Prudhoe Bay off Gull Island

Table 1, continued.

Station No.	North Latitude			West Longitude			Location
	°	'	"	°	'	"	
H2C	70	19	24	148	23	30	South Prudhoe Bay Transect
H2D	70	20	54	148	23	36	North Prudhoe Bay Transect
H2E	70	21	06	148	20	18	North Prudhoe Bay Transect
H2F	70	19	42	148	25	48	South Prudhoe Bay Transect
H2G	70	18	50	148	27	20	Put. River/Prudhoe Bay Transect, Mid.
H2H	70	18	50	148	23	40	Put. Rover/Prudhoe Bay Transect
H32	70	22	48	148	32	48	Prudhoe Bay NW, ARCO Causeway
H39	70	24	19	148	40	12	Point McIntyre airport, mudflat
H3A	70	23	06	148	32	00	Prudhoe Bay NW, seaward transect
H3B	70	24	00	148	32	24	Prudhoe Bay NW, seaward transect
H3C	70	24	24	148	32	12	Prudhoe Bay NW, seaward transect
H3D	70	24	48	148	31	00	Prudhoe Bay NW, seaward transect
H3E	70	25	33	148	34	30	Stump Island N. 5M
H3F	70	24	57	148	34	34	Stump Island N, 2M
H3G	70	25	42	148	32	24	Prudhoe Bay NW, 5M
H3H	70	32	24	148	32	24	Prudhoe Bay NW, 12M
H40	70	24	19	148	40	12	Point McIntyre Airport, Gwydyr Bay
I30	70	33	24	149	30	36	Pingok Island S, lagoon beach
I31	70	33	32	149	30	36	Pingok Island N, sea beach
I3A	70	33	24	149	30	24	Simpson Lagoon, Pingok Island Transect
I3B	70	32	36	149	30	30	Simpson Lagoon, Pingok Island Transect
I3C	70	32	06	149	30	36	Simpson Lagoon, Pingok Island Transect
I3D	70	31	12	149	31	12	Simpson Lagoon, Pingok Island Transect
I3E	70	33	42	149	32	15	Pingok Island N, 2M
I3F	70	33	57	149	32	54	Pingok Island N, 5M
I3G	70	34	30	149	30	00	Pingok Island N., 10M
I3H	70	33	48	149	30	00	Pingok Island N., 5M
I50	70	30	01	149	50	18	SE Oliktok Point
I58	70	28	12	149	58	42	3.5 mi. SW Oliktok Point
I5A	70	30	42	149	50	12	Simpson Lagoon, Spy Island Transect
I5B	70	32	06	149	51	18	Simpson Lagoon, Spy Island Transect
I5C	70	30	06	149	50	00	Simpson Lagoon, Spy Island Transect
I5E	70	33	30	149	53	18	Simpson Lagoon, Spy Island Transect

Table 1, continued.

Station No.	North Latitude °	'	"	West Longitude °	'	"	Location
I5F	70	33	06	149	52	30	Simpson Lagoon, Spy Island Transect
I5G	70	29	18	149	56	18	Simpson Lagoon, Thetis Island Transect
I5H	70	29	54	149	56	54	Simpson Lagoon, Thetis Island Transect
J06	70	26	00	150	06	00	Kalubik Creek Mouth
J0A	70	30	24	150	00	00	Simpson Lagoon, Thetis Island Transect
J0B	70	30	54	150	01	54	Simpson Lagoon, Thetis Island Transect
J0C	70	30	00	150	09	20	Colville River Delta, 3.5M
J1A	70	33	03	150	14	00	Colville River Delta, 5M
J22	70	26	36	150	22	06	Colville River Delta, Anachlik Island
J23	70	24	00	150	34	00	Neil Allen's Island, Kupigruak Channel
J24	70	29	10	150	24	30	Colville River Delta, Kupigruak Channel
J25	70	23	20	150	40	50	Silt Dune Island, Kupigruak Channel
J2A	70	32	42	150	25	00	Colville River Delta, 2M
J2B	70	33	30	150	25	00	Colville River Delta, 5M
J2C	70	35	30	150	25	00	Colville River Delta, 10M
J2D	70	26	20	150	22	00	Colville River Transect, West
J2E	70	26	20	150	21	50	Colville River Transect, Mid
J2F	70	26	20	150	21	40	Colville River Transect, East
J2G	70	28	45	150	24	30	Kupigruak Channel Transect, East
J2H	70	29	00	150	25	30	Kupigruak Channel Transect, Mid
J2I	70	29	10	150	26	00	Kupigruak Channel Transect, West
K2A	70	39	10	151	27	12	Harrison Bay, 10M
K3A	70	36	42	151	33	30	Harrison Bay, 5M
K4A	70	34	00	151	40	06	Atigaru Point NE, 2M
L0A	70	53	30	152	08	42	Cape Halkett NE, 10M
L1A	70	50	48	152	15	30	Cape Halkett NE, 2M
L1B	70	51	18	152	14	00	Cape Halkett NE, 5M
M07	70	55	00	153	07	00	Pitt Point, sea beach
M08	70	55	00	153	08	00	Pitt Point, Smith River Mouth
M10	70	55	30	153	10	30	Pitt Point, sea beach
M11	70	55	18	153	10	36	Pitt Point, mud flat
M14	70	54	30	153	14	00	Lonely Lagoon
M1A	70	56	42	153	12	42	Pitt Point, 5M

Table 1, continued.

Station No.	North Latitude ° ' "	West Longitude ° ' "	Location
M1B	7Ø 55 42	153 14 12	Pitt Point, 2M
M1C	71 ØØ ØØ	153 14 18	Pitt Point N, 10M
M1D	7Ø 56 33	153 15 18	Pitt Point N, 5M
M1E	7Ø 55 18	153 15 18	Pitt Point N, 2M
N1A	7Ø 55 14	154 13 3Ø	Ikpikpuk River delta, 5M
N1B	7Ø 53 54	154 11 12	Ilpikpuk River delta, 3M
N1C	71 ØØ 36	154 1Ø 3Ø	Smith Bay, 10M
N42	71 Ø3 2Ø	154 42 3Ø	Cape Simpson DEWLine, mud flat
N43	71 Ø3 3Ø	154 42 3Ø	Cape Simpson DEWLine, sea beach
N44	71 Ø3 4Ø	154 44 ØØ	Cape Simpson DEWLine, lagoon
N4A	71 Ø4 ØØ	154 41 3Ø	Cape Simpson NE, 5M
N4B	71 Ø5 3Ø	154 35 42	Cape Simpson NE, 10M
O1A	71 Ø9 ØØ	155 1Ø ØØ	Dease Inlet N transect
O1B	71 Ø8 ØØ	166 16 ØØ	Dease Inlet N transect
O2A	71 Ø8 ØØ	155 22 ØØ	Dease Inlet N transect
O39	71 14 ØØ	155 39 ØØ	Cooper Island N, seabeach
O3A	71 Ø7 ØØ	155 3Ø ØØ	Dease Inlet N transect
O4Ø	71 14 ØØ	155 4Ø ØØ	Cooper Island S, lagoon beach
O42	71 14 ØØ	155 42 ØØ	Cooper Island S, harbor
O4A	71 15 ØØ	155 47 ØØ	Ross Bay-Ekilukruak Entrance transect
O4B	71 14 ØØ	155 46 ØØ	Ross Bay-Ekilukruak Entrance transect
O4C	71 14 18	155 4Ø 3Ø	Cooper Island N, 2M
O4D	71 14 42	155 4Ø 3Ø	Cooper Island N, 5M
O4E	71 17 12	155 4Ø 3Ø	Cooper Island N, 10M
O5A	71 13 ØØ	155 51 ØØ	Ross Bay-Ekilukruak Entrance transect
O5B	71 12 ØØ	155 53 ØØ	Ross Bay-Ekilukruak Entrance transect
PØA	71 15 ØØ	156 Ø4 ØØ	Deadman's Isl.-Scott Pt. transect
PØB	71 17 ØØ	156 Ø8 ØØ	Deadman's Isl.-Scott Pt. transect
P1A	71 21 ØØ	156 13 ØØ	Deadman's Isl.-Scott Pt. transect
P1B	71 2Ø ØØ	156 15 ØØ	Deadman's Isl.-Scott Pt. transect
P28	71 23 ØØ	156 28 ØØ	Point Barrow, sea beach
P2A	71 21 54	156 21 36	Eluitkak Pass transect
P2B	71 2Ø 54	156 25 36	Eluitkak Pass transect

Table 1, continued.

Station No.	North Latitude ° ' "	West Longitude ° ' "	Location
P2C	71 2Ø 18	156 27 42	Eluitkak Pass transect
P2D	71 23 18	156 27 Ø6	Point Barrow, 2M
P2E	71 23 24	156 27 ØØ	Point Barrow, 5M
P2F	71 25 48	156 27 12	Point Barrow, 10M
P3Ø	71 22 ØØ	156 3Ø ØØ	Barrow Spit, Elson Lagoon
P31	71 22 ØØ	156 31 ØØ	Barrow Spit, Chukchi beach
P33	71 18 3Ø	156 33 ØØ	Elson Lagoon, W. shore
P34	71 19 ØØ	156 33 2Ø	Elson Lagoon near Brant Point
P4A	71 19 48	156 4Ø 3Ø	NARL, Chukchi Sea, 3.5M
P52	71 15 Ø3	156 52 Ø3	Nunavak Bay
R19	7Ø 49 Ø9	158 19 Ø6	Tachinisok Inlet, sea beach
R20	7Ø 49 Ø6	158 19 ØØ	Tachinisok Inlet, lagoon beach
R23	7Ø 49 24	158 22 3Ø	Peard Bay, sea beach
R28	7Ø 48 Ø9	158 26 52	Peard Bay, Nalimiuts Point
R2A	7Ø 49 18	158 22 3Ø	Peard Bay E transect
R2B	7Ø 48 3Ø	158 22 3Ø	Peard Bay E transect
R2C	7Ø 48 2Ø	158 22 3Ø	Peard Bay E transect
R4Ø	7Ø 47 12	158 4Ø ØØ	Peard Bay, south shore
S51	7Ø 42 47	159 51 Ø1	2 miles NE Sinarurok River, sea shore
S56	7Ø 41 ØØ	159 56 Ø2	1 mile SW Sinarurok River, sea shore
S5A	7Ø 35 33	159 56 36	Wainwright Lagoon E
S5B	7Ø 34 1Ø	159 52 22	Kuk River
TØ2	7Ø 37 48	16Ø Ø1 42	Wainwright, lagoon beach
TØ3	7Ø 38 12	16Ø Ø2 3Ø	Wainwright, sea beach
TØA	7Ø 35 ØØ	16Ø Ø2 36	Wainwright Lagoon transect
TØB	7Ø 36 25	16Ø Ø1 11	Wainwright Lagoon transect
TØC	7Ø 37 12	16Ø ØØ 25	Wainwright Lagoon transect
TØD	7Ø 34 46	16Ø Ø5 22	Wainwright Lagoon transect
T11	7Ø 34 Ø3	16Ø 11 3Ø	3 miles SW Marsh Pt., lagoon beach
T12	7Ø 34 1Ø	16Ø 11 48	3 miles SW Marsh Pt., sea beach
U51	7Ø 17 Ø9	161 51 52	Icy Cape, slough
U55	7Ø 17 Ø3	161 55 54	Kasegaluk Lagoon, opp. Icy Cape Pass
U57	7Ø 16 12	161 57 Ø8	Kasegaluk Lagoon, 2 miles SW airstrip

Table 1, continued.

Station No.	North Latitude °	'	"	West Longitude °	'	"	Location
U59	7Ø	17	45	161	59	3Ø	Icy Cape Pass, sea beach
U5A	7Ø	19	37	161	53	15	Icy Cape Pass, 2M
U5B	7Ø	16	3Ø	161	59	ØØ	Kasegaluk Lagoon
ZØ9	68	52	42	166	Ø9	Ø6	Cape Lisburne
Z44	68	21	48	166	44	48	Maryat Inlet, West
Z45	68	21	42	166	45	18	N. Point Hope, sea beach
Z46	68	21	36	166	45	18	Ipiutak Lagoon
45Y	68	Ø6	ØØ	165	45	ØØ	Ogotoruck River Mouth
46Y	68	Ø6	ØØ	165	46	Ø8	Cape Thompson, sea beach
48Y	68	Ø6	ØØ	165	48	Ø7	Cape Thompson, Crowbill Point
33X	67	44	29	164	33	45	Kivalina
44W	67	Ø9	Ø7	163	44	Ø6	Cape Krusenstern, N of airstrip
45W	67	Ø8	Ø7	163	44	Ø6	Cape Krusenstern, S of airstrip
27V	66	56	27	162	27	23	N. Baldwin Peninsula, Lockhart Pt.
28V	66	57	2Ø	162	28	ØØ	Hotham Inlet transect, south
2AV	66	57	1Ø	162	28	ØØ	Hotham Inlet transect, south
2BV	66	58	2Ø	162	28	ØØ	Hotham Inlet transect, mid
2CV	66	58	4Ø	162	28	ØØ	Hotham Inlet transect, north
31T	66	34	49	16Ø	31	17	Selawick Lake, Singauruk Pt.
ØU3	66	Ø9	22	161	Ø3	3Ø	Buckland River mouth
2U1	66	15	33	161	21	15	Eschscholtz Bay, Elephant Pt.
5U1	66	13	41	161	51	21	Chamisso Refuge, Puffin Island
5U2	66	26	26	161	52	Ø8	Baldwin Pen. Arctic Circle
5U4	66	15	53	161	54	15	Choris Peninsula
UA5	66	16	58	161	5Ø	3Ø	Eschscholtz Bay West
IV7	66	43	Ø3	162	18	ØØ	Cape Blossom, Riley's wreck marsh
IV8	66	43	15	162	18	38	Cape Blossom, Riley's wreck march
3V2	66	48	27	162	32	2Ø	Baldwin Peninsula, Sadie Creek
4V3	66	Ø5	Ø8	162	44	22	Deering
4V4	66	Ø6	11	1[illegible]	44	49	Cape Deceit Bluffs
4V5	66	Ø5	46	162	45	31	Cape Deceit Bluffs
1WØ	66	Ø3	33	163	1Ø	Ø7	E. of Sullivan Bluffs
1W2	66	Ø3	53	163	12	16	Sullivan Bluffs

Table 1, continued.

Station No.	North Latitude ° ' "	West Longitude ° ' "	Location
2WØ	66 Ø5 15	163 2Ø Ø5	Rex Point
4W5	66 35 15	163 45 2Ø	Cape Espenberg, sea beach
4W6	66 34 1Ø	163 45 15	Cape Espenberg, sound beach
5W3	66 35 ØØ	163 53 ØØ	Cape Espenberg, marsh
4YØ	66 Ø2 ØØ	165 4Ø ØØ	Arctic River
4Y1	66 Ø6 14	165 41 3Ø	Shishmaref Inlet S, Arctic R. mouth
YA4	66 Ø9 2Ø	165 43 2Ø	Shishmaref Inlet SE
5Y2	66 Ø6 48	165 52 15	Shishmaref Inlet S, Oopik Cliff
ØZ4	66 15 3Ø	166 Ø5 2Ø	Sarichef Island, tundra burn
ØZ7	66 14 45	166 Ø6 ØØ	Sarichef Island, lagoon beach
ØZ8	66 14 53	166 Ø6 3Ø	Sarichef Island, sea beach
75Ø	65 45 3Ø	167 5Ø ØØ	Sin-I-Rock, sea beach
751	65 45 ØØ	167 51 ØØ	Sin-I-Rock, lagoon beach
8Ø1	65 37 36	168 Ø1 ØØ	Lopp Lagoon SW
8Ø2	65 37 3Ø	168 Ø2 ØØ	Lopp Lagoon SW
8Ø5	65 36 ØØ	168 Ø5 15	Wales, boulder beach
8Ø6	56 37 Ø3	168 Ø6 15	Wales, sand beach

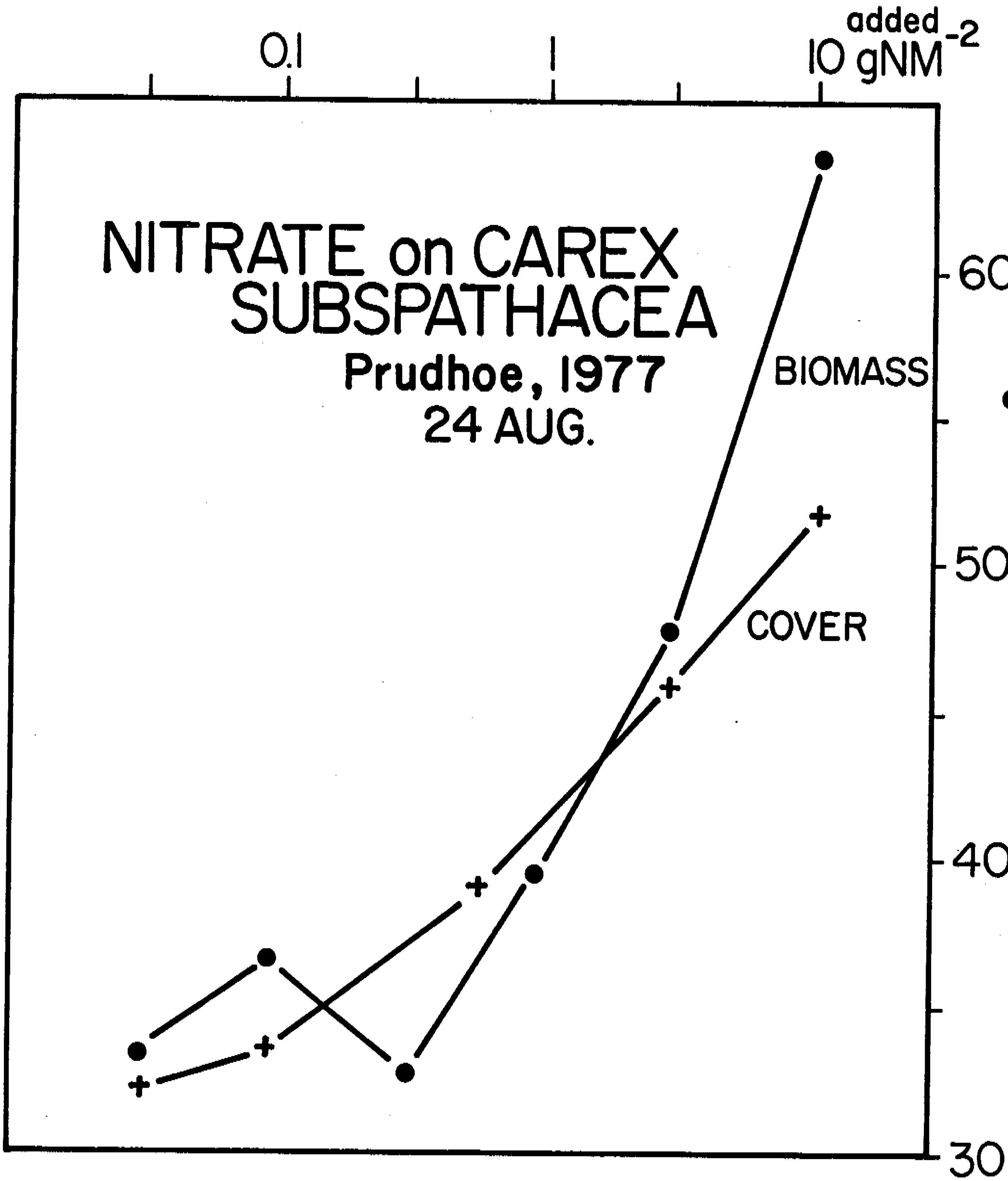


Figure 1. Biomass and cover, two related measures of strain on a plant community dominated by _Carex subspathacea_ at Prudhoe, as related to levels of fertilization stress from applied nitrate-nitrogen. The two measures have a correlation coefficient of 0.96; intercept cover was determined per mm on a 500mm line, and biomass in 0.1 m^2 by a standard electric clipping and vacuuming collection, washing, and drying at 70°C.

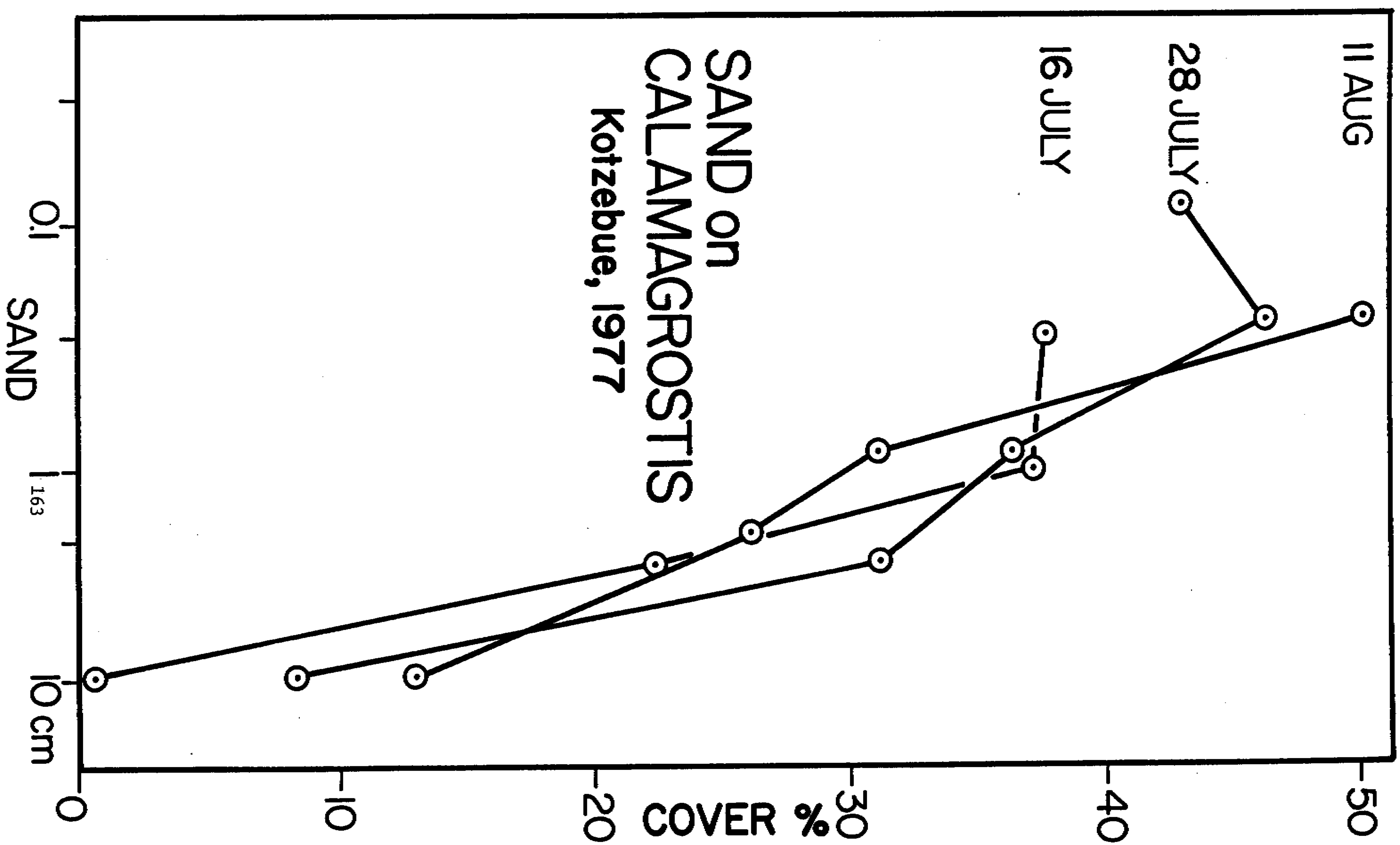


Figure 2. Development of total plant cover after early season (21 June) covering with local beach sand at Arctic Circle Beach south of Kotzebue. This community is characterized by *Calamagrostis deschampsioides* and dominated by *Carex aquatilis*. On 21 June the cover was 21% uniformly (s=1%); it successively rose to 37, 45, and 50% through the season on the unaffected community.

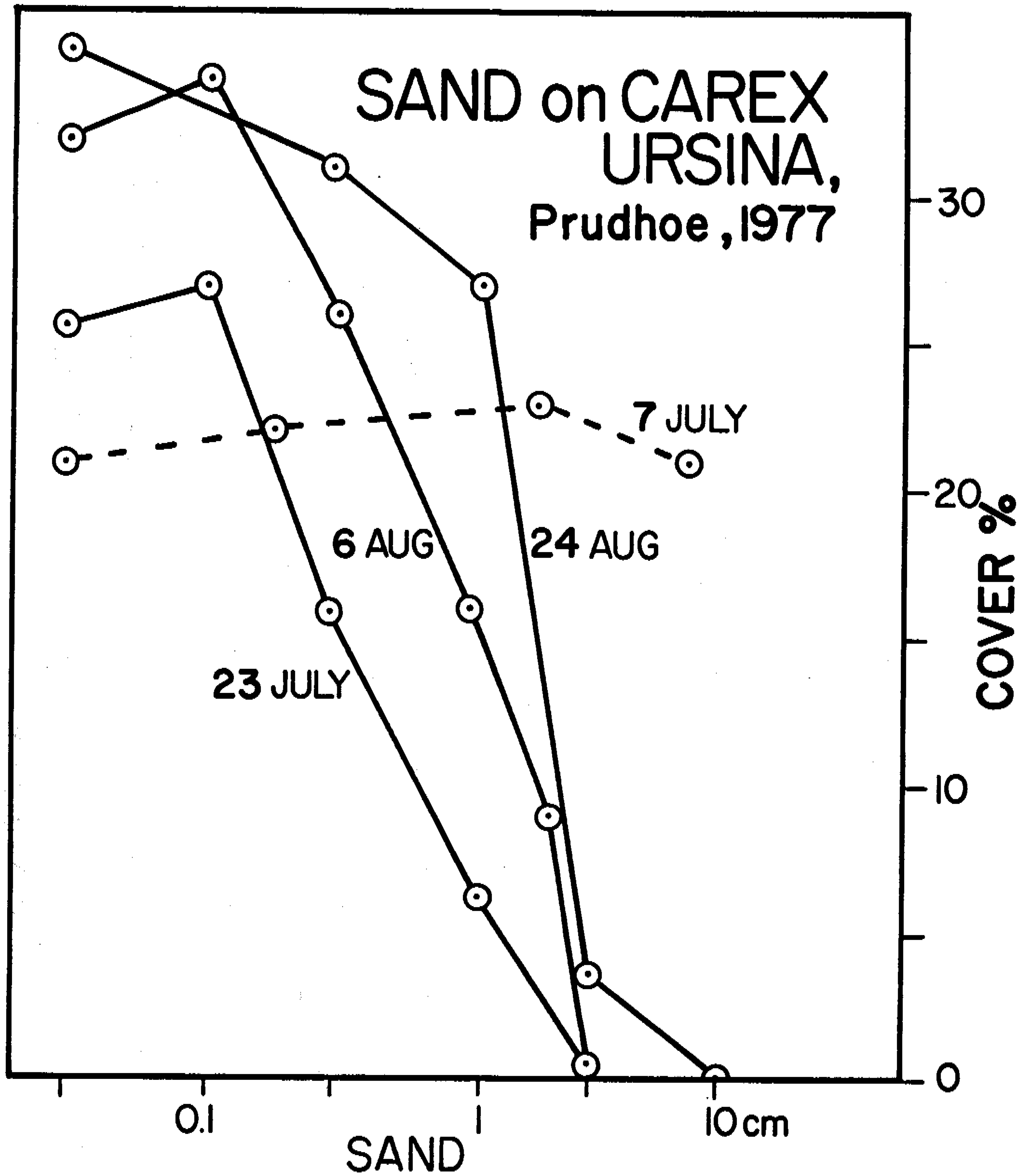


Figure 3. Development of total plant cover after early season (7 July) covering with local river sand, at Prudhoe. This community near the top of the salt marsh is characterized by Carex ursina in a mixture with C. subspathacea, Stellaria humifusa, and Puccinellia phryganodes. On 7 July the cover was 22% (s=1%); it successively rose to 26, 33, and 35% through the season on the unaffected community.

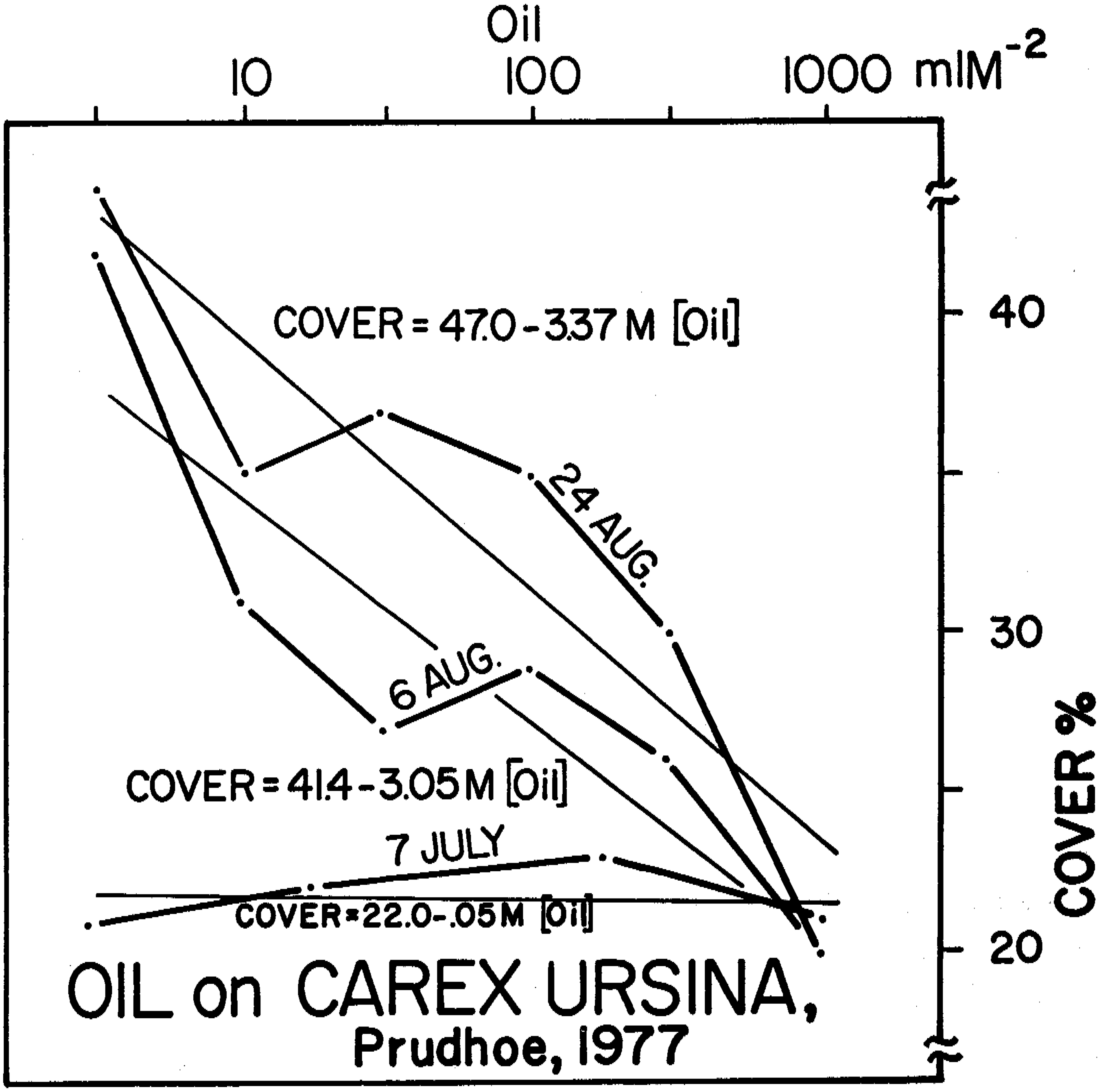


Figure 4. Development of total plant cover after early season (7 July) covering with Prudhoe crude oil, at Prudhoe. The straight lines are loeast square fits. Oil was applied on top of about 3 cm of local estuarine water which then seeped slowly into the saltmarsh, coating the vegetation and soil fairly uniformly with oil. The plant community is the same as in Figures 3 and 6.

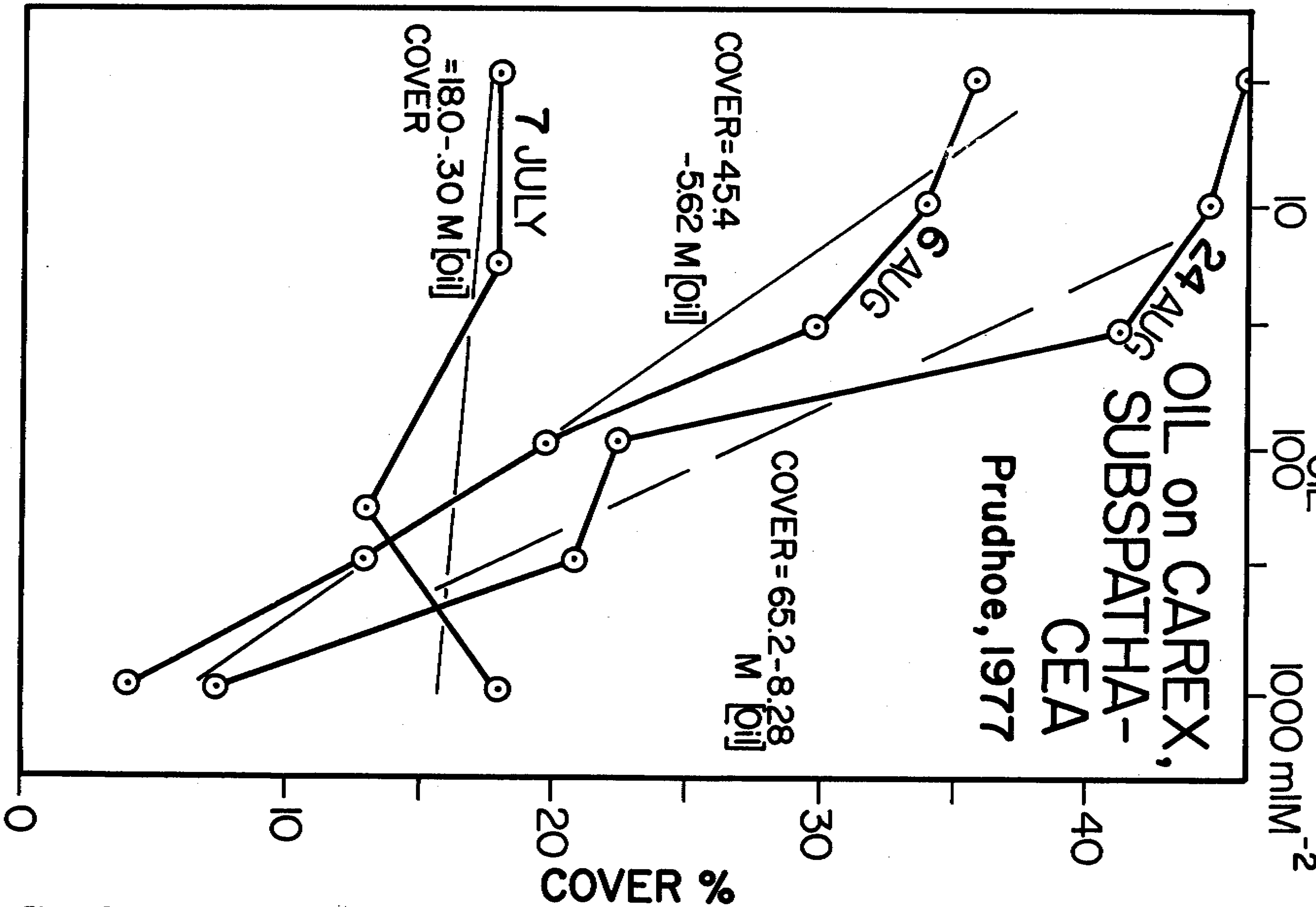


Figure 5. Development of total plant cover after early season (7 July) covering with Prudhoe crude oil, at Prudhoe. The straight lines are least squares fits. Oil was applied on top of about 3 cm of local estuarine water which then seeped slowly into the saltmarch, coating the vegetation and soil fairly uniformly with oil. The plant community is the same as that in Figure 1 and is dominated by <u>Carex subspathacea</u>.

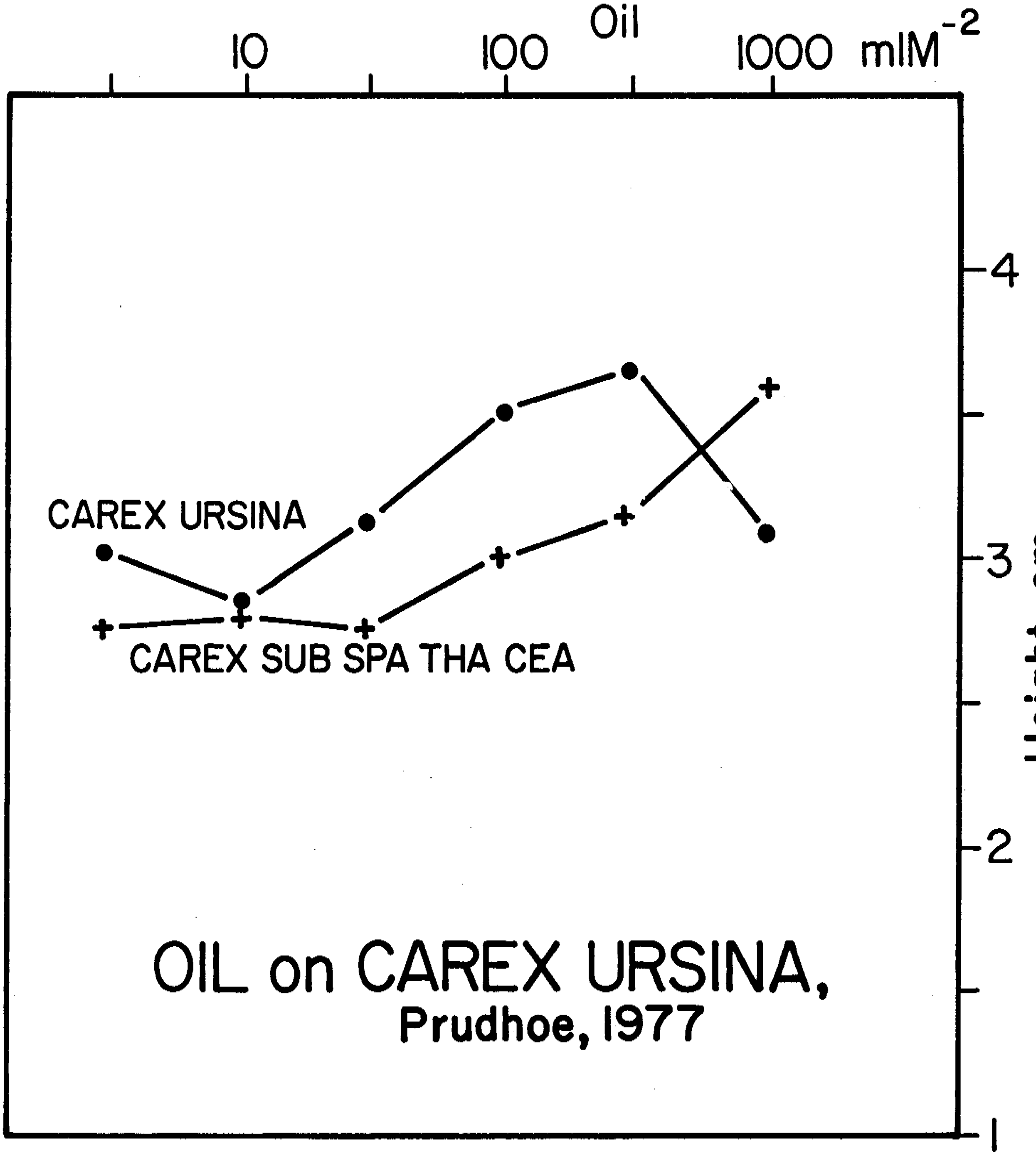
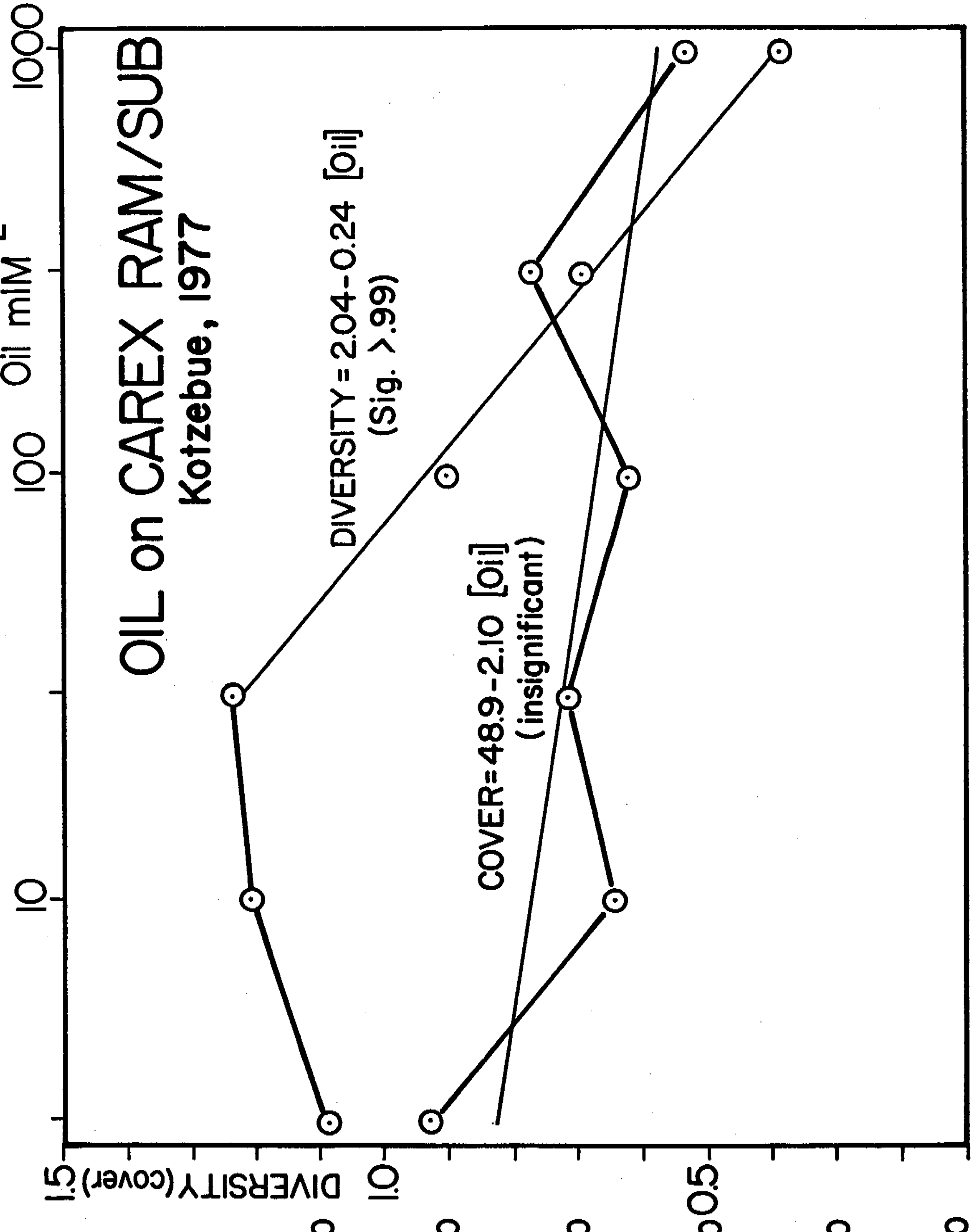


Figure 6. Growth response of two species in the Carex ursina community at Prudhoe to increasing oil application levels. The major increases of length are significant at >95% using a Students-t criterion. Each point is an average of about 20 individual measurements.

Figure 7. Response on 11 August of the Carex ramenskii/subspathacea plant community at Kotzebue to oil applied 16 July. Although the correlation of applied oil to cover is not significant, there is a significant decrease of diversity with increasing oil. The Shannon-Weaver diversity was calculated on a natural logarithmic basis from the partial relative percent cover values for each of the species at this site.



OIL on CAREX RAM/SUB
Kotzebue, 1977
Oil mlM-2
10
100
1000
DIVERSITY = 2.04-0.24 [oil]
(Sig. >.99)
COVER=48.9-2.10 [oil]
(insignificant)
1.5 DIVERSITY (cover)
1.0
0.5
COVER %
60
50
40
30
20
10

Table 3: Identifiable components of gut contents and fecal pellets of selected animals of the Beaufort Sea littoral zone. X = present; XX = major identifiable component; U = present but undigested.

Species	(n) gut contents	(n) fecal pellets	Diatoms (mostly Centrales)	Amphipleura rutilans (Pennales)	Crustacean parts	Peat fragments	Wood fibers	Algal filaments	Polychaete setae	Oligochaete setae	Foraminifera	Blue-Green algae
Gammarus setosa	20	26	xx	x	x	x	x	x	x	x	x	
Onisimus glacialis	6	11	x		xx	x	x	x	x	x		
Onisimus littoralis		4	x		x	x	x			x		
Acanthostepheia behringiensis	2	4	xx		x				x			
Gammaracanthus loricata	3	2	x	xx	x	x		U				
Apherusa glacialis		4	x		xx	x						
Saduria entomon		5	U	U	x	x	x	x	x			U
Pagurus trigonochirus		5	x		xx							
Terebellides stroemi		6	xx	x	x	x	x	x				
Cylichna oculate		2	x				x					
Myoxocephalus quadricornis	2	2	U		xx							

Table 4. Food ingested by selected Beaufort Sea littoral aminals in laboratory culture. + = food eaten; 0 = food not eaten.

prey (food offered) / predator	Peat	Laminaria	Nephtys (polychaete)	Oligochaete	Mysis	Mysis (dead)	Gammarus	Gammarus (dead)	Onisimus	Amphipod (dead)	Acanthostepheia
Gammarus setosa	+	+		+	0	+					
Onisimus sp.	+		+	+							
Gammaracanthus loricata	+		+	+							
Acanthostepheia behringiensis			+	+							
Saduria entomon		+	+	+			+		0	+	
Pagurus sp.		+					+				+
Harmothae sp. (polychaete)				0							
Myoxocephalus quadricornis	0		0	+	+		+	+			

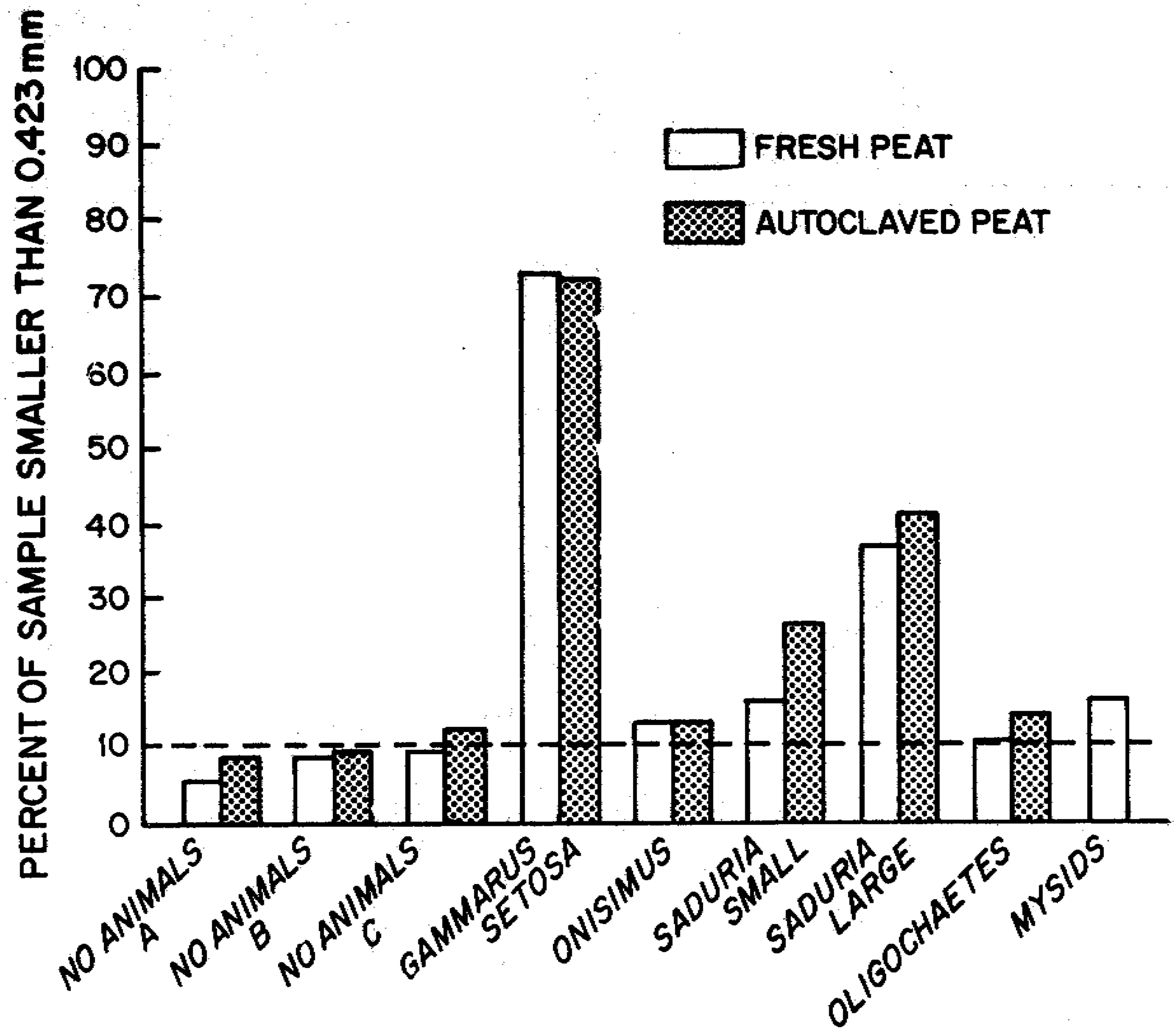


Figure 8. Percent of fresh and autoclaved peat that passes through a 0.423 mm screen after being subject to grazing by selected Beaufort Sea littoral animals. A designates millipore filtered, tetracycline treated sea water. B is Whatman No. 5 filtered sea water. C is sea water filtered through a 0.2 mm screen. All other treatments were in raw sea water containing designated animals.

QUARTERLY REPORT

Contract #: 03-78-B01-6
Research Unit #: 359
Reporting Period: 1 Oct - 31 Dec 1977
Number of Pages: 2

Beaufort Sea Plankton Studies

Rita A. Horner

1 January 1978

I. Abstract - Highlights

One hundred phytoplankton standing stock samples have been analyzed for species present and abundance. Small species of the diatom genus *Chaetoceros* are usually the most abundant organisms. Two species not common in the nearshore Beaufort Sea were found at station 14.

II. Task Objectives

The objectives of this study are to assess the density distribution and environmental requirements of zooplankton and ichthyoplankton and to make measurements of phytoplankton activity.

III. Field or Laboratory Activities

A. There were no field activities during this quarter.

B. Laboratory activities

Analysis of phytoplankton standing stock samples has begun. A typographical error in Table 2 of the quarterly report for 1 October 1977 indicated that all the phytoplankton standing stock samples had been analyzed; the number analyzed should have been zero (0). One hundred phytoplankton standing stock samples from stations 1 through 14 have been analyzed for species present and abundance as of 15 December 1977.

C. Methods

Phytoplankton standing stock samples are being analyzed using a Zeiss phase-contrast inverted microscope following the method of Utermöhl (1931). Five and 50 ml Zeiss settling chambers are set up for each sample. Rare organisms and cells larger than 75 μm are counted at 100 X magnification in the 50 ml chambers and small, abundant organisms are counted at 250 X magnification in the 5 ml chambers. One-fifth of the 50 ml chamber is counted and 1/8 of the 5 ml chamber is counted. References being used for species identification include Hustedt (1930, 1959) and Cupp (1943) for diatoms and Schiller (1933, 1937) for dinoflagellates. Meunier (1910) and Brandt and Apstein (1908) are used for diatoms, dinoflagellates, and other organisms including silicoflagellates.

IV. Results

In the phytoplankton samples that have been analyzed, small species of the diatom genus *Chaetoceros* are usually the most abundant cells. The small species of *Chaetoceros*, including *Ch. ceratosporum* Ostenfeld, *Ch. fragilis* Meunier, *Ch. furcellatus* Bailey, *Ch. gracilis* Schütt, *Ch. socialis* Lauder, and *Ch. wighami* Brightwell, have been grouped into one category "*Chaetoceros* small cells" because of the difficulty in identifying them in the settling chambers.

Two species not often seen in the nearshore area of the Beaufort Sea were found at station 14 (71° 10'N, 150° 04'W). *Dictyocha fibula* Ehrenberg, a silicoflagellate that is very common in central Arctic waters and in temperate coastal areas, was found at all depths, but was most abundant at 25 m. Also at 25 m, one 3-celled chain of the diatom *Skeletonema costatum* (Greville) Cleve was found. *Skeletonema* is a common spring bloom species in temperate areas, but rarely occurs in the Chukchi and Beaufort seas.

V. Preliminary Interpretation of Results

It is too early for any interpretation of results.

VI. Auxiliary Materials - Bibliography

Brandt, K., and C. Apstein. 1908. Nordisches Plankton. Botanischer Teil. Lipsius and Tischer, Kiel and Leipzig. 343 pp.

Cupp, E. E. 1943. Marine plankton diatoms of the West Coast of North America. Bull. Scripps Instn. Oceanogr. 5:1-238.

Hustedt, F. 1930. Die Kieselalgen. In L. Rabenhorst, Kryptogamen-Flora von Deutschland, Österreich und der Schweiz VII(1):1-920.

Hustedt, F. 1959-1962. Die Kieselalgen. In L. Rabenhorst, Kryptogamen-Flora von Deutschland, Österreich und der Schweiz VII(2):1-845.

Meunier, A. 1910. Microplancton des Mers de Barents et de Kara. Duc d'Orléans Campagne Arctique de 1907. Charles Bulens, Bruxelles. 355 pp.

Schiller, J. 1933-1937. Dinoflagellatae (Peridineae). In L. Rabenhorst, Kryptogamen-Flora von Deutschland, Osterreich und der Schweiz X(3), Teil 1, 609 pp.; Teil 2, 590 pp.

Utermöhl, H. 1931. Neue Wege in der Quantitativen Erfassung des Planktons. Verh. int. Verein. theor. angew. Limnol. 5:567-596.

VII. Problems

There have been no problems.

VIII. Estimate of Funds Expended

Salaries and Wages		$8524.00
Supplies and Materials		600.00
Analytical Services		1000.00
	Total	$10124.00

QUARTERLY REPORT

Contract No.	:R7120824
Research Unit No.	:RU-380
Reporting Period	:1 Oct. - 31 Dec. 1977
Number of Pages	:4

ICHTHYOPLANKTON OF THE EASTERN BERING SEA

Co-Principal Investigators

Kenneth D. Waldron and Felix Favorite
National Marine Fisheries Service
Northwest and Alaska Fisheries Center
Seattle, Washington
December 1977

PI QUARTERLY PROGRESS REPORT

Reporting Period: 1 October - 31 December 1977

Project Title: Ichthyoplankton of the eastern Bering Sea (RU-380)

I. Highlights of Quarter's Accomplishments

Identification of ichthyoplankton collected with neuston nets and .505 mm mesh bongo nets during Cruise RP-4-MF-77B, Legs V and VI were completed during the quarter, and preparation of distributional charts was begun.

II. Objectives

Collect and analyze ichthyoplankton samples from a portion of the eastern Bering Sea during the spring of 1976 (completed) and 1977 (in progress).

III. Field or Laboratory Activities

A. Ship or Field Trip Schedules
None

B. Scientific Party

Kenneth D. Waldron	NMFS	Co-Principal Investigator (part-time)
Beverly M. Vinter	NMFS	Ichthyoplankton specialist (part-time)
Donald M. Fisk	NMFS	Technician (part-time)

C. Methods
Fish larvae were identified by microscopic examination and standard procedures used in larval fish taxonomy. Fish larvae were measured by means of a calibrated ocular micrometer.

D. Sample Collection Localities
No samples were collected during the quarter.

E. Data Collected and/or Analyzed

1. Number of samples examined:
In addition to those examined last quarter, the remaining 80 neuston samples were examined. The total samples examined to date are:

Bongo Samples (.505 mm mesh only)	134
Neuston Samples	146

2. Number and type of analyses:
An additional 1,561 larval specimens from neuston samples were identified, bringing the total larvae identified to:

Bongo samples -- larvae identified	9,694
Neuston samples - larvae identified	4,520

Standard length of 3,367 pollock larvae (*Theragra chalcogramma*) was measured.

IV. Results

The 137 neuston net samples collected during 1977 contained 4,520 fish larvae and 93% of the samples contained at least one larva. By comparison, the 134 bongo net catches contained 9,694 larvae and 96% of the samples contained at least one larva.

Two types of neuston nets with different mouth openings were used for the 1976 and 1977 surveys, and in order to compare catches for the two years catches were standardized as numbers per 1,000 m^3 of water filtered. In 1976 neuston catches ranged from 0 - 1,905 larvae/1,000 m^3 and only 52% of the samples for 1976 contained fish larvae. In 1977, catches with neuston nets ranged from 0 - 12,805 larvae/1,000 m^3 and 93% of the samples contained fish larvae.

Species present in the neuston samples collected during 1977, shown in Table 1, were generally the same as those found in the 1977 bongo samples, but there was a marked difference in dominant taxa. In the bongo samples, pollock larvae ranked first in abundance and accounted for 83% of the catch, but in the neuston samples this species ranked eighth and accounted for only 6% of the neuston catch. The most abundant single species in the 1977 neuston samples was a cottid of the genus *Hemilepidotus* and accounted for 19.8% of the neuston catch, followed by *Pleurogrammus monopterygius* of the family Hexagrammidae. The two families Cottidae and Hexagrammidae contributed over 72% of the 1977 neuston catch.

The larvae of the two most abundant genera, *Hemilepidotus* and *Hexagrammos* were generally large larvae or post-larvae, and yet because of overlapping meristic characters it was not possible to assign specific designations with certainty. On the basis of a character index developed by Schultz and Welander (1934) it is likely that *Hemilepidotus* (A, C, and D - see Table 1) are, respectively, *H. hemilepidotus*, *H. jordani*, and *H. papilio* (=*Melletes papilio* of some authors). Of the Hexagrammidae we are certain only of the specific identity of *Pleurogrammus monopterygius*, the Atka mackerel.

V. Preliminary Interpretation of Results

None

VI. Auxiliary Material

A. Bibliography of References

Schultz, L.P. and A.W. Welander. 1934. The Cottoid genus *Hemilepidotus* of the North Pacific. J. Pan Pacific Research Institute 9(27):5-6.

B. Papers in Preparation or in Print

Waldron, Kenneth D. Ichthyoplankton of the eastern Bering Sea, April-May 1976. Journal: NMFS Special Report, Status of the Environment, 1976 (manuscript).

C. Oral Presentations
Informal presentation of the preliminary results of the 1977 survey was made at a meeting of the PROBES group at Lake Quinault on November 30, 1977.

VII. Problems Encountered and Recommended Changes

As stated in previous reports, lack of adequate published descriptions makes it difficult to make specific identifications of certain larvae, and this is especially true in the families Agonidae, Bathymasteridae, Cottidae, Cyclopteridae, Hexagrammidae, Pholidae, and Stichaeidae. Taxonomic status of the Bering Sea members of some of these groups is uncertain and adequate descriptions of adults are lacking in many instances. It is strongly suggested that specific systematic and taxonomic studies be funded, either by OCSEAP or NMFS.

VIII. Estimate of Funds Expended

This project was not funded for FY 1978.

Table 1.--Larval fish caught in the neuston net MF 77B-V & VI

Taxa	Observed Catch	Percent
Hexagrammidae	(1,804)	(39.9)
Hexagrammos (not typed)	475	10.5
Hexagrammos (A)	430	9.5
Hexagrammos (B)	218	4.8
Hexagrammos (C)	155	3.4
Pleurogrammus monopterygius	526	11.6
Cottidae		
Hemilepidotinae	(1,464)	(32.4)
Hemilepidotus (A)	384	8.5
Hemilepidotus (C)	897	19.8
Hemilepidotus (D)	183	4.0
Other Cottidae	21	0.5
Osmeridae		
Mallotus villosus	389	8.6
Stichaeidae	331	7.3
Gadidae		
Theragra chalcogramma	266	5.9
Bathymasteridae	96	2.1
Scorpaenidae		
Sebastes sp.	28	0.6
Agonidae	17	0.4
Ammodytidae	10	0.2
Anarrhichadidae	5	0.1
Zaproridae	5	0.1
Cyclopteridae	3	0.1
Pleuronectidae		
Hippoglossus stenolepis	3	0.1
Pleuronectidae (unidentified)	4	0.1
Unidentified Larvae	74	1.6
	4,520	100

Ecological Studies of Intertidal
and Shallow Subtidal Habitats in
Lower Cook Inlet

Research Unit #417
Number of Pages: 11

Prepared for

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

Prepared by

DAMES & MOORE

February 14, 1978

SA
AN
EO

Job No. 6797-007/0106

ANCHORAGE
ATLANTA
BILLINGS
BOCA RATON
BOSTON
CHICAGO
CINCINNATI
CRANFORD
DENVER
FAIRBANKS
HONOLULU
HOUSTON
LEXINGTON, KY
LOS ANGELES
NEW ORLEANS
NEWPORT BEAC
NEW YORK
PHOENIX
PORTLAND
SALT LAKE CITY
SAN FRANCISCO
SANTA BARBARA
SEATTLE
SYRACUSE
WASHINGTON, D.C.
WHITE PLAINS

DAMES & MOORE

CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

ATHENS
CALGARY
JAKARTA
KUWAIT
LONDON
MADRID
MELBOURNE
VANCOUVER, B.C.
PERTH
RIYADH
SINGAPORE
SYDNEY
TEHRAN
TOKYO
TORONTO

SUITE 310, 510 L STREET • ANCHORAGE, ALASKA 99501 • TELEPHONE: (907) 279-0673
CABLE: DAMEMORE TELEX: (090) 25227

14 February 1978

Dr. Herb Bruce, Director
National Oceanic & Atmospheric Administration
OCSEAP Office
P. O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

Quarterly Report
R. U. #417
Ecological Studies of Intertidal and Shallow Subtidal Habitats in Lower Cook Inlet

This administrative summary reports the status of this study after the fall field season. This was the fifth series of surveys conducted since February 1977. We collected information on fall conditions in the intertidal and subtidal rock habitats and intertidal mud and sand habitats. Persistently poor weather hampered field activities, particularly at Seldovia Point, where we were unable to conduct a fall intertidal survey, and Jakolof Bay. We were able to document fall conditions at Chinitna Bay, on the west side of the inlet, but climatic conditions were quite severe. Ice was forming on the exposed mud sediments at low tide and the upper 2 cm of substrate were frozen. Furthermore, icy conditions resulted in a non-injury accident to the charter plane that stranded my personnel, the pilot and the plane for a few days. Wind chill factor was probably at least -25° F while sampling.

Sample analysis is progressing normally. The backlog is limited to mid-summer and fall samples from Chinitna, and the recent fall samples from Deep Creek and Homer Spit. The latter will be processed very rapidly. Data reduction is complete through mid-summer and preparation of those data for keypunching is in the final stages. I am presently preparing the annual report, which will present and discuss all the data collected to this time. A summary is included in Section IV, Preliminary Interpretation of Results.

Except for surveys that could not be conducted during the scheduled season because of the problems of combining low tides and fair weather, the planned schedule is intact. If you have any questions, please contact me at the Homer office, (235-8494).

Very truly yours,

DAMES & MOORE

Dennis C. Lees

Dennis C. Lees
Project Manager

DCL:lw

QUARTERLY REPORT

I. Task Objectives

The main purpose of the study is to describe some of the important features of the principal intertidal and nearshore assemblages in lower Cook Inlet. Specific overall objectives are to obtain information on patterns of trophic dynamics and succession, and to develop preliminary estimates of primary and secondary production in the assemblages examined. Considerable effort is being placed in obtaining biomass and production estimates for the algal assemblages in the rocky intertidal and subtidal region on the south side of Kachemak Bay.

II. Field and Laboratory Activities

A. Ship of Field Trip Schedule--Fifth Sampling Period

1. 13 September--Seldovia Point--subtidal--via Dames & Moore skiff
2. 13 October--Gull Island--intertidal--via chartered vessel, M. V. Humdinger
3. 31 October, 3 November--Jakolof Bay--subtidal--via chartered vessel, M. V. Humdinger
4. 2, 5 November--Seldovia Point--subtidal--via chartered vessel, M. V. Humdinger
5. 10 November--Deep Creek--intertidal--via personal car
6. 11 November--Homer Spit--intertidal--via personal car
7. 14-16 November--Chinitna Bay mudflat--intertidal--via chartered plane and helicopter

B. Scientific Party

1. Deborah Boettcher, Dames & Moore, Assistant Biologist
2. William Driskell, Dames & Moore, Assistant Biologist
3. David Erikson, Dames & Moore, Assistant Biologist
4. Dr. Jonathan Houghton, Dames & Moore, Project Marine Biologist

C. Methods

1. Field Sampling

   a. Soft Substrates

      (1) A profile of beach elevations is established;
      (2) A stratified random sample design is being utilized.
      (3) Ten cores 10 cm in diameter and about 30 cm long are collected randomly at each of at least three levels of the beach below mean sea level.

(4) Samples are individually bagged and labelled.
(5) When weather permits, the fresh samples are screened in seawater through a 1 mm sieve to remove the sand. In winter, it was frequently necessary to knead a 10% formaldehyde-seawater solution into the sample and sieve at a later date in heated quarters. The sample remaining in the screen is rebagged with its label and fixed with a 10% formaldehyde-seawater solution.

b. Rock Substrates

(1) A stratified sampling design is being used.
(2) Levels being occupied at Seldovia Point are about +8 ft, +2 ft, MLLW, -1 ft, -20 ft, -40 ft and -60 ft elevations.
(3) Levels being occupied at Gull Island are about +12 ft, +5 ft, MLLW and -1 ft elevations.
(4) Ten-1/4 m^2 quadrats are placed randomly at each level; within each quadrat the number and/or relative cover of each plant taxon are recorded and all plants attached within the frame are removed and bagged. Additionally, the number and/or relative cover of conspicuous invertebrates and fish are recorded.
(5) Additional quadrats (from 1/16 m^2 to 25 m^2 are utilized at each level to obtain better estimates of density and cover for the plants and animals in the study area.
(6) Feeding observations are recorded.
(7) Samples of many invertebrates are collected to establish size distributions.
(8) At Jakolof Bay, individual plants of _Laminaria groenlandica_, _Agarum cribrosum_, _Alaria fistulosa_, and _Nereocystis luetkeana_ were tagged, measured and marked in such a manner as to allow the determination of growth rates.

2. Laboratory Procedures

a. Soft Substrates

(1) In the laboratory, the samples are sorted and the organisms identified to the lowest practical taxon and counted.
(2) Aggregate drained wet weights are measured for each species, where practical, or for major taxa.
(3) Representative specimens are sent to taxonomic specialists for identification for verification.

b. Rock Substrates

(1) Plant samples from each level are handled and recorded individually.
(2) Drained wet weight and length are measured for each laminarian; aggregate drained wet weights are measured for all other algae.
(3) Sizes are measured for various invertebrate species to establish size distributions.
(4) Fish and selected invertebrate species are dissected in order to examine stomach contents and develop food webs.

D. Sample Localities (Figure 1)

1. Soft Substrates

a. Deep Creek--1½ mi. south of beach access at beach park (Figure 1); transect based on very large triangular boulder at base of cliff; and
b. Homer Spit--2½ mi. south of Kachemak drive, off beach access ramp on west side of spit (Figure 1).
c. Chinitna Bay--the transect line extends normal to the shoreline from an intertidal boulder in front of Wayne Byer's home site.

2. Rock Substrates

a. Gull Island, in Kachemak Bay--Gorilla Rock at west end of Island (Figure 1);
b. Jakolof Bay, in Kachemak Bay--on the reef at the mouth of Jakolof Bay, under the overhead high tension wires (Figure 1);
c. Seldovia Point, in Kachemak Bay--directly at the point; transect based on a very large boulder, marked by a painted arrow, at the base of the cliff (Figure 1).

E. Data Collected or Analyzed

1. Soft Substrate

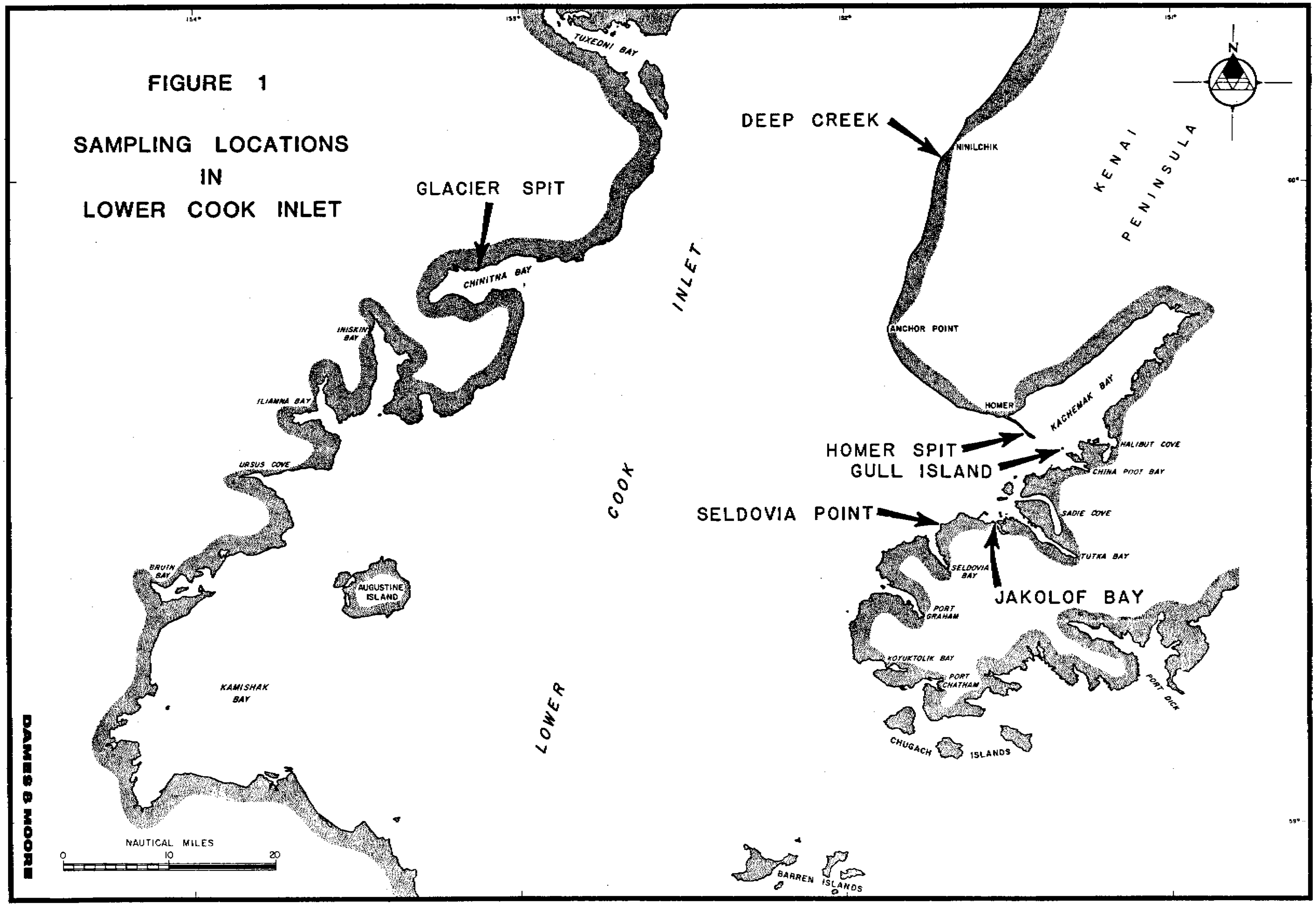
a. Deep Creek (10 November)

(1) Beach profile
(2) Forty core samples--sorted

b. Homer Spit (11 November 1977)

(1) Beach profile
(2) Forty core samples--sorted

c. Chinitna Bay (14 November 1977)--Forty samples--sorted



DAMES & MOORE

FIGURE 1

2. Rock Substrates

a. Gull Island

(1) 1/4 m^2 quadrats for plant cover, density and biomass--20
(2) 1/4 m^2 quadrats for cover and density of invertebrates--20

b. Seldovia Point Intertidal Survey--not conducted because of wave and ice conditions and inaccessibility by land.

c. Seldovia Point Subtidal Survey

(1) 1/4 m^2 quadrats for plant cover, density and biomass--30
(2) 1/4 m^2 quadrats for cover and density of dominant plants and animals--50
(3) Feeding observations--20

d. Jakolof Bay Subtidal Studies

(1) Large quadrats for plants and large invertebrates:

1 x 20 m - 2
0.5 x 25 m - 1
1 x 25 m - 4

(2) 1/4 m^2 quadrats for plant density, cover and biomass--17
(3) Plants tagged and measured:

Agarum cribrosum--10
Alaria fistulosa-- 5
Laminaria groenlandica--15
Nereocystis luetkeana--3

(4) Feeding observations--13
(5) Size distribution for five species

F. Milestone Chart and Data Submission Schedule

The scheduling projected in the milestone chart (Figure 2) is being met and no significant delays are anticipated. Field schedules are weather dependent, resulting in not being able to collect some intertidal and subtidal data.

III. Results

The results are presently being compiled and analyzed and will be submitted in the upcoming annual report.

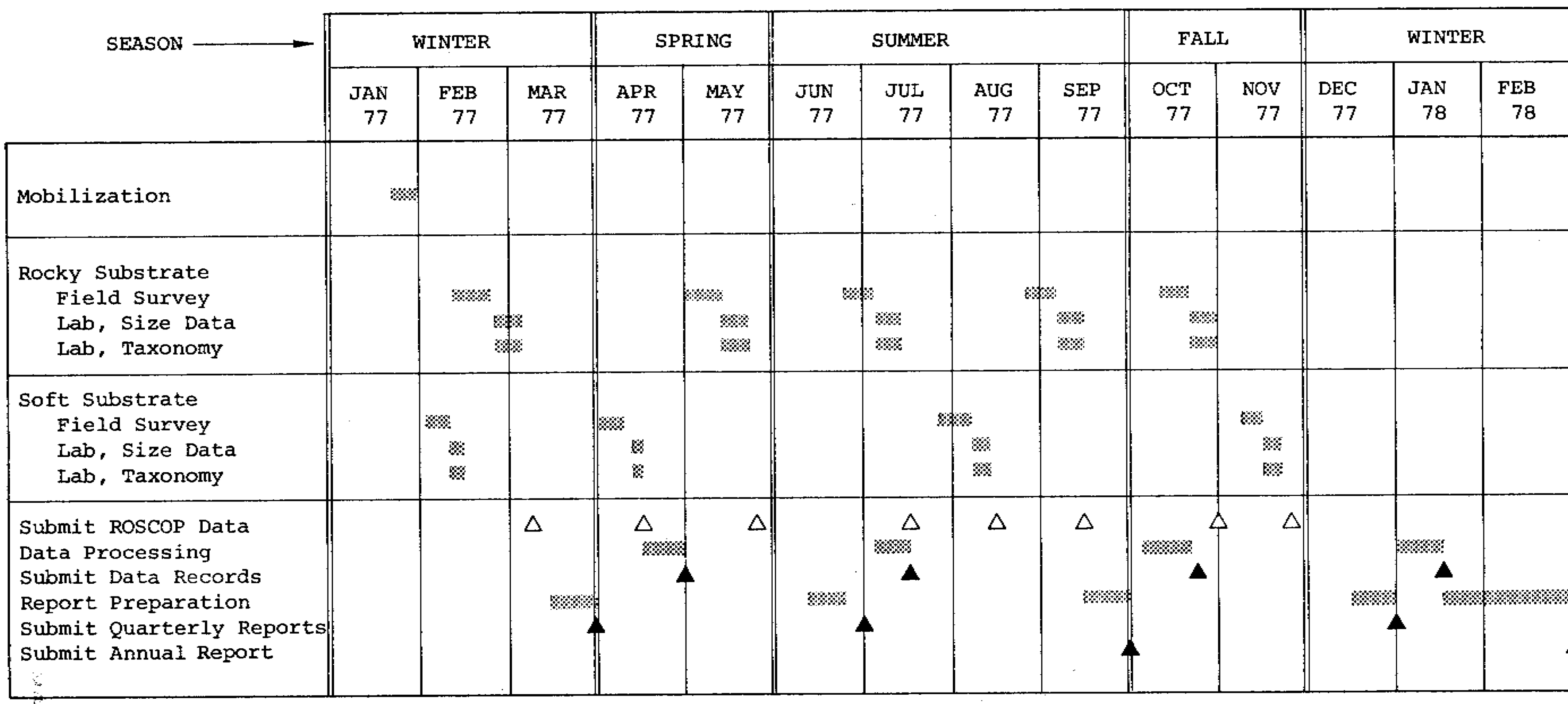


FIGURE 2. ACTIVITIES SCHEDULED FOR LOWER COOK INLET STUDIES (R. U. NO. 417) - MILESTONE CHART

IV. Preliminary Interpretation of Results

Plant assemblages on the rock substrates were strongly reduced by the storm induced wave action. Growth rates for the laminarians examined were quite low during the last period examined (Sept.-Nov.). Soft substrate samples from this period have not been examined.

The following is a brief summary of the results being compiled for the annual report. Some of this information was also presented at the Lower Cook Inlet Synthesis meeting (17-19 January 1978). This summary, augmented with draft figures and tables, has also been submitted to SAI to permit an update of the LCI synthesis report.

Rock Habitats

The flora of the rocky habitats examined in Kachemak Bay is dominated by Fucus distichus in the mid-intertidal zone; by Alaria spp., Hedophyllum sessile and Laminaria groenlandica in the lower intertidal zone; by Laminaria groenlandica and Agarum cribrosum out to a depth of 70' - 80'; and by Alaria fistulosa and Nereocystis luetkeana between 25' and 40' depths. These brown seaweeds probably comprise about 85% of the biomass observed in any season at nearly all levels examined.

There are large annual differences in cover, composition and biomass of the offshore surface canopy. It is not presently feasible to predict what proportion of the canopy will be A. fistulosa or Nereocystis from one year to the next. Turbidity of the water during early spring (especially the influence of runoff during break up) may be important to this variability, based on the literature and our observations.

Biomass varies tremendously seasonally and by elevation (or depth).

Season	Intertidal	Subtidal
Winter	400-850 g/sq m	230-720 g/sq m
Spring	600-2200 g/sq m	425-1150 g/sq m
Mid summer	2400-5600 g/sq m	250-6500 g/sq m
Late summer	950-2000 g/sq m	350-2020 g/sq m

The subtidal figures generally do not consider the contribution of the two large species that form surface canopies (Alaria fistulosa and Nereocystis), which occur most commonly in a depth range between the depth levels examined this year.

It is fairly apparent that standing stocks peak during mid summer. However, growth rates for three of these species appear to be greatest in late winter and early spring.

Species	Growth Maximum Observed	Growth Minimum Observed
Agarum cribrosum	about 0.3 cm/day in March-April	about 0.1 cm/day in Sept.-Oct.
Laminaria groenlandica	about 0.5 cm/day in March-April	only 0.003 cm/day in Sept.-Oct.
Alaria fistulosa	10-11 cm/day in March-April	about 3.0 cm/day in Sept.-Oct.

At Jakolof Bay, cumulative blade growth for these species between March and November is estimated as follows:

Agarum: 45 cm
Laminaria: 45 cm
Alaria: 12.5 meters

Minimal estimates of carbon production were computed very roughly, based on the increase in standing stock between March and July-August, and a ratio of C to wet weight of 3-4%. For the intertidal zone, this method predicts fixation of 150-200 g C/sq m, and, in subtidal zone, up to about 225 g C/sq m. However, because of the importance of the loss of fixed carbon as dissolved organics or by blade erosion, these estimates are very conservative. Sieburth and Jensen (1970) provide information indicating that some fucoid and laminarian algae lose up to 40% of fixed carbon by exudation during immersion. As blade erosion is also very important, it is probable that the actual amount of carbon fixed is at least 2 to 3 times that indicated by differences in standing crop.

Mud Habitat

The mud habitat examined (Glacier Spit, Chinitna Bay) is dominated by clams, primarily *Macoma balthica* and *Mya* spp (*M. arenaria*, *priapus*, and *truncata*). Other important species observed are the polychaete *Nephtys* and the echiurid *Echiurus*, both of which contribute considerably to overall biomass.

Sieburth, J. M., and Arne Jensen. 1970. Production and transformation of extracellular organic matter from littoral marine algae: a resume, pp. 203-223, IN: Organic Matter in Natural Waters (D. W. Hood, ed.) Inst. Marine Science, Univ. Alaska Occas. Publ. No. 1.

It appears that the animal assemblage on the mudflats fluctuates enormously seasonally and annually. Comparison of the size and density data for Macoma balthica exemplify this fact. Following the harsh winter of 1975-76, a 0-year class was lacking in the size structure of the population sampled at this location. After the mild winter of 1976-1977, the 0-year class was very conspicuous in April, but was strongly reduced by July. Density decreased dramatically (about 50%) between April and July 1977. Our observations suggest that predation by scoters and scaup, and possibly some fish and crabs, are responsible for this reduction. Although the data have not been tabulated, it is probable that other species exhibit similar patterns.

Sand Habitats

Sand beaches were examined quantitatively at Deep Creek and Homer Spit, both on the east side of the inlet. Although basically similar in composition, faunal structure differed significantly between these areas. The data were remarkably consistent between surveys, so the patterns reported seem reliable. Only ten of the 32 nominal taxa were found at both sites. Homer Spit supported more species, but density levels were surprisingly similar. Homer Spit was dominated by polychaetes in terms of abundance (about 85%) and biomass, whereas Deep Creek was dominated by gammarid amphipods (about 80% of the specimens). The dominant organisms at Homer Spit were the polychaetes Scolelepis sp A and Paraonella platybranchia and at Deep Creek, the gammarid amphipod Eohaustorius eous.

At both locations, densities increased about 60% from February to July. The decline in abundance at Homer Spit in March was probably a consequence of a heavy storm surf that occurred just prior to sampling.

Over half of the important species at both intertidal sites were common members of the infaunal assemblages observed in sand habitats in the middle of lower Cook Inlet, at a depth of 200 feet. This is an extraordinary condition and appears indicative of the high energy level of the physical environment in the offshore portions of the inlet.

The intensity of tidal currents and frequency of storm waves are probably the most important determinants in these faunal differences in the intertidal zone. Deep Creek is exposed to much more rigorous conditions than Homer Spit. Tidal currents and wave action are strong at Deep Creek, and this may account for the high densities of the gammarid amphipods,. which are mainly suspension feeders. Homer Spit is mild by comparison, and is dominated by deposit feeders. Furthermore, the faunal assemblage is apparently more highly developed, as indicated by the presence of a more diverse collection of polychaetes, the redneck clam (Spisula) and a fish (Ammodytes).

The data presently available do not permit assessment of the importance of the sandy habitats to predators, particularly commercial species. Secondary production appears to be low, at least based on standing crop, but this assumes that grazing and turnover rates are low. Clam production is low on both beaches, however.

V. Problems Encountered

Climatic conditions in November resulted in two non-injury accidents involving my sampling crew on the survey at Chinitna Bay. The aircraft coming to pick them up after the sampling effort misunderstood the weather report from a local family and tried to land on the frozen, icy beach. The plane slid into the water and the efforts to drive up out of the water showered salt water over the wings and tail. The water rapidly froze. After the plane was pulled from the water and parked high up on the beach, much of the ice was removed. The low temperatures, waning daylight and absence of proper winter aircraft heaters prompted a quick decision by the pilot to return to Homer without my crew. When he took off, it became apparent that the remaining ice on the left wing would not permit flight. To avoid flipping the plane, he banked sharply through the patchy trees to his left and crash landed at the edge of a slough. The plane was sufficiently damaged to preclude further flight.

The pilot and my crew remained with Wayne Byer at his home site and were returned to Homer the next day by charter helicopter. The plane was picked up by landing craft later in the week and returned to Homer.

VI. Estimate of Funds Expended

$120,000

QUARTERLY REPORT

Contract # 03-5-022-67-TA8 #4
Research Unit # 424
Reporting Period: 1 Oct 77 - 1 Jan 78
Number of Pages: 21

Lower Cook Inlet Meroplankton

T. Saunders English
Department of Oceanography
University of Washington
Seattle, Washington 98195

1 January 1978

Departmental Concurrence: [signature]
George C. Anderson
Associate Chairman for Research

REF: A77-20

LIST OF TABLES

I. Task Objective

Our main objective is to conduct a quantitative survey to determine the seasonal distribution of commercially or ecosystem important species of ichthyoplankton, crab and shrimp larvae in Lower Cook Inlet, Alaska.

II. Field or Laboratory Activities

A. Ship or Field Trip Schedule

None in this quarter.

B. Scientific Party

None in this quarter.

C. Methods

The methods of laboratory analysis are unchanged from earlier reports.

D. Sample Localities

See Figure 1 and Table 1.

E. Data Analyzed

Supplementary data were analyzed from 333 μm mesh bongo net tows not previously reported from four cruises during 1976.

F. Milestone Chart and Data Submission Schedules

The Milestone Chart (Table 2) covers the contract period from 1 October 1977 through 1 October 1978 and includes the first two quarters of 1979.

III. Results

The summaries of samples analyzed from the *Acona* cruise, Leg II, 08-15 July 1976, and not previously reported, include the taxonomic categories of crab larvae (Table 3). These data are correct and need no further additions or revisions.

The summaries of samples analyzed from the *Surveyor* cruise, Leg II, 24-31 August 1976, and not previously reported, include the taxonomic categories of crab larvae (Table 4). These data are correct and need no further additions or revisions.

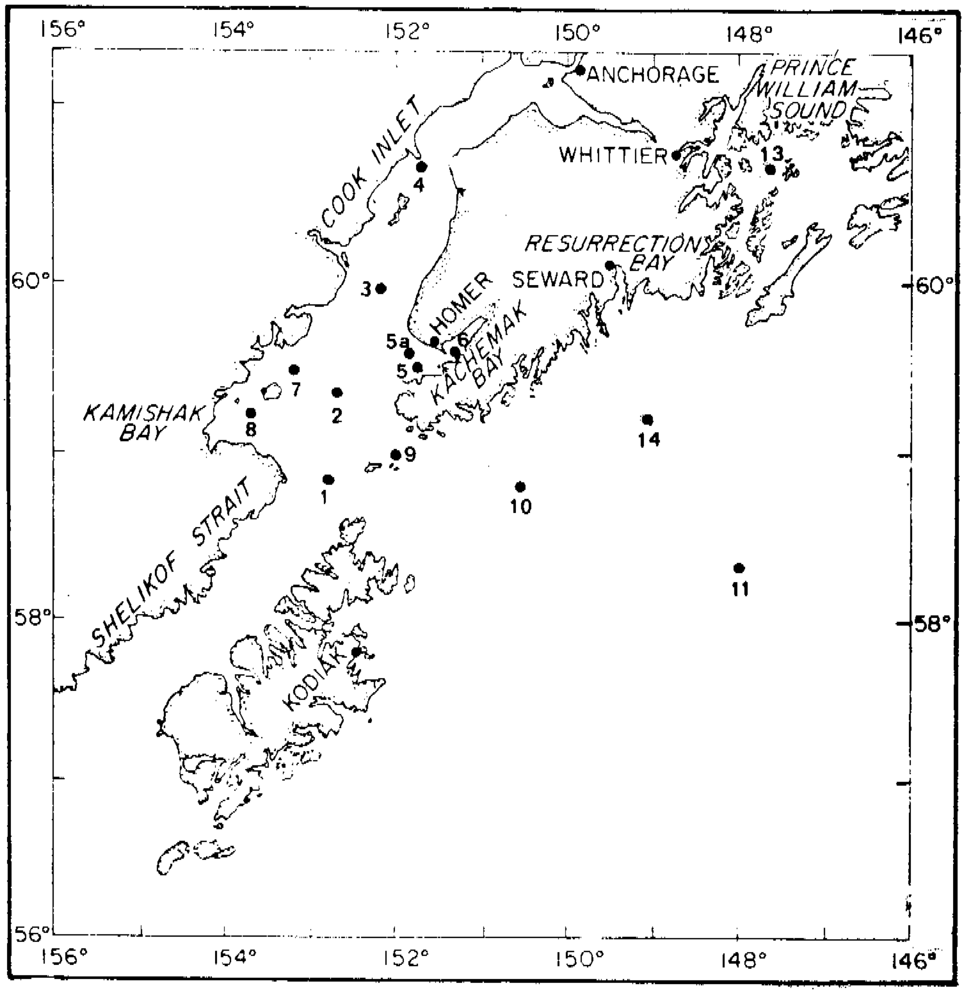


Figure 1. Station locations, Cook Inlet area.

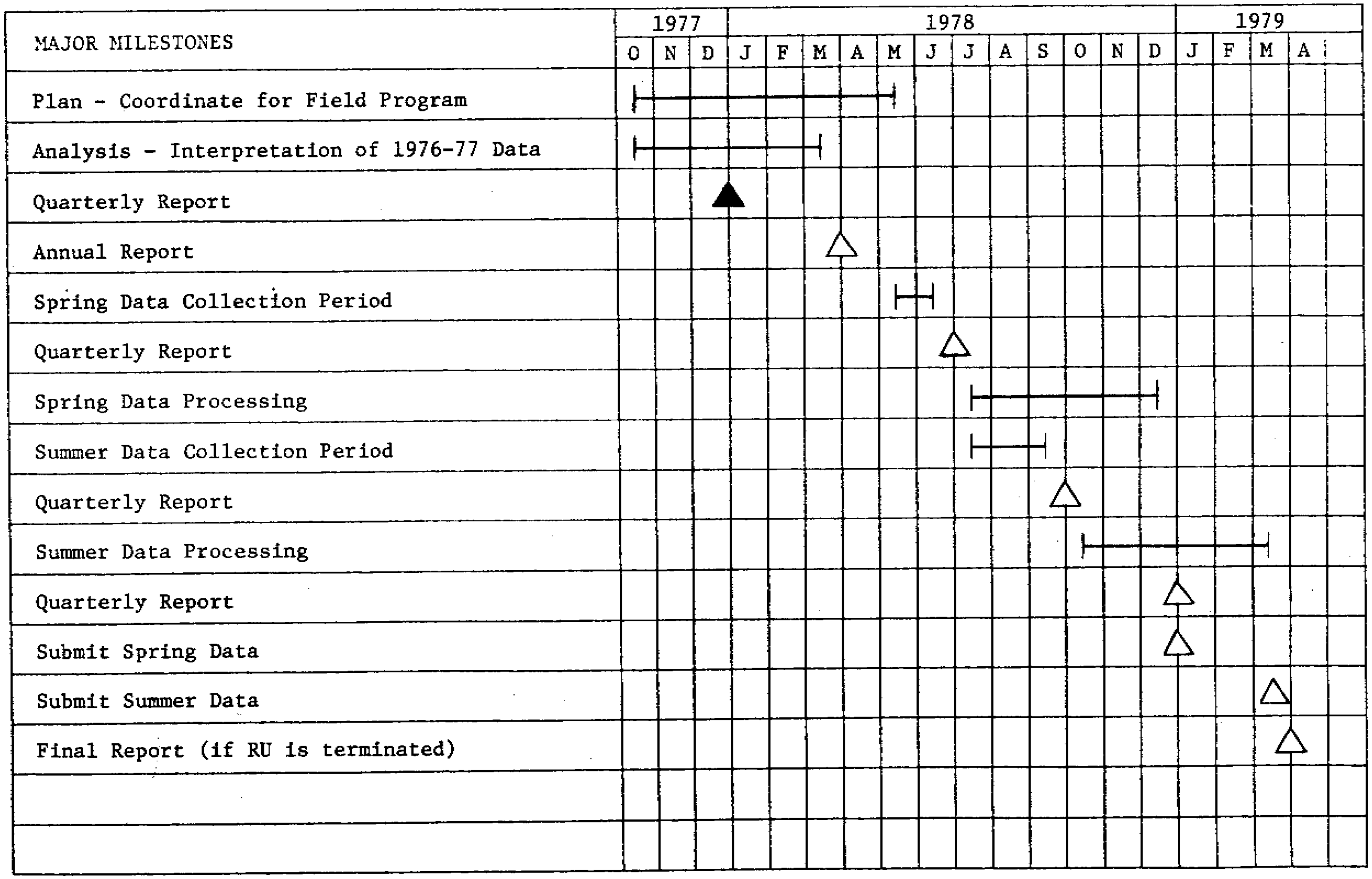
Table 1. Station Locations

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	58° 53.0'	152° 48.0'	174	Lower Cook Inlet
2	59° 22.0'	152° 40.0'	62	Lower Cook Inlet
3	60° 00.0'	152° 10.0'	58	Lower Cook Inlet
4	60° 40.0'	151° 40.0'	36	Cook Inlet
5	59° 31.0'	151° 45.0'	80	Outer Kachemak Bay
5a	59° 35.0'	151° 49.0'	36	Outer Kachemak Bay
6	59° 36.0'	151° 18.0'	77	Inner Kachemak Bay
7	59° 30.0'	153° 10.0'	35	Lower Cook Inlet
8	59° 14.0'	153° 40.0'	29	Kamishak Bay
9	59° 02.0'	151° 58.0'	196	Kennedy Entrance
10	58° 52.0'	150° 51.0'	210	Gulf of Alaska
11	58° 23.0'	148° 03.0'	1005	Gulf of Alaska
13	60° 42.0'	147° 41.0'	686	Prince William Sound
14	58° 24.0'	149° 05.0'	214	Gulf of Alaska

Table 2. MILESTONE CHART

RU #: 424 PI: T. Saunders English

Major Milestones: Reporting, data management and other significant contractual requirements; periods of field work; workshops; etc.



△ Planned Completion Date ▲ Actual Completion Date

Table 3. Identification of crab larvae by station

Lower Cook Inlet bongo net tows, *Acona*, Leg II, 08-15 July 1976

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
13 Jul	0119	1	1[a]	333	zoea	176	unidentified anomurans
					I	840	*Cancer oregonensis*
					II	328	*C. oregonensis*
					III	16	*C. oregonensis*
					II	80	*Chionoecetes bairdi*
					zoea	352	unidentified brachyurans
					megalopa	120	unidentified brachyurans
12 Jul	1133	2	1[b]	333	megalopa	3	*Paralithodes platypus*
					zoea	131	unidentified anomurans
					megalopa	9	unidentified anomurans
					I	186	*Cancer oregonensis*
					II	282	*C. oregonensis*
					III	32	*C. oregonensis*
					II	3	*Chionoecetes bairdi*
					zoea	279	unidentified brachyurans
					megalopa	87	unidentified brachyurans
10 Jul	0901	3	1[a]	333	zoea	136	unidentified anomurans
					I	1200	*Cancer oregonensis*
					II	192	*C. oregonensis*
					III	8	*C. oregonensis*
					I	8	*Chionoecetes bairdi*
					zoea	136	unidentified brachyurans
					megalopa	8	unidentified brachyurans

[a] The sample was split and 1/8 was sorted for crab larvae; totals given are for the entire sample.

[b] The sample was split and 11/32 was sorted for crab larvae; totals given are for the entire sample.

Table 3. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
10 Jul	1556	4	1	333	zoea	12	unidentified anomurans
					megalopa	1	unidentified anomuran
					I	44	*Cancer oregonensis*
					II	7	*C. oregonensis*
					I	2	*Chionoecetes bairdi*
					zoea	14	unidentified brachyurans
11 Jul	0018	5a	1[c]	333	zoea	560	unidentified anomurans
					I	2800	*Cancer oregonensis*
					II	192	*C. oregonensis*
					III	16	*C. oregonensis*
					zoea	832	unidentified brachyurans
					megalopa	48	unidentified brachyurans
11 Jul	1009	6	2	333	zoea	19	unidentified anomurans
					I	30	*Cancer oregonensis*
					II	1	*C. oregonensis*
					zoea	66	unidentified brachyurans
11 Jul	1031	6	3	333	zoea	46	unidentified anomurans
					megalopa	1	unidentified anomurans
					I	21	*Cancer oregonensis*
					II	1	*C. oregonensis*
					zoea	104	unidentified brachyurans

[c] The sample was split and 1/16 was sorted for crab larvae; totals are given for the entire sample.

Table 3. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
11 Jul	2051	6	4	333	zoea	22	unidentified anomurans
					I	50	*Cancer oregonensis*
					II	5	*C. oregonensis*
					zoea	30	unidentified brachyurans
11 Jul	2113	6	5	333	zoea	25	unidentified anomurans
					I	21	*Cancer oregonensis*
					II	1	*C. oregonensis*
					zoea	43	unidentified brachyurans
10 Jul	0405	7	1[d]	333	megalopa	16	*Paralithodes platypus*
					zoea	624	unidentified anomurans
					I	16	*Cancer oregonensis*
					II	16	*C. oregonensis*
					zoea	2352	unidentified brachyurans
					megalopa	64	unidentified brachyurans
10 Jul	0010	8	1	333	zoea	23	unidentified anomurans
					zoea	18	unidentified brachyurans
					megalopa	1	unidentified brachyurans
13 Jul	0548	9	1	333	zoea	80	unidentified anomurans
					megalopa	1	unidentified anomuran
					I	31	*Cancer oregonensis*
					II	15	*C. oregonensis*

[d] The sample was split and 1/16 was sorted for crab larvae; totals are given for the entire sample.

Table 3. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (µm)	Stage	Total	Identification of Larvae
13 Jul	0548	9	1	333	III	22	*C. oregonensis*
					zoea	168	unidentified brachyurans
					megalopa	215	unidentified brachyurans
13 Jul	1230	10	1	333	zoea	16	unidentified anomurans
					I	1	*Cancer oregonensis*
					II	60	*C. oregonensis*
					III	33	*C. oregonensis*
					IV	1	*C. oregonensis*
					zoea	45	unidentified brachyurans
					megalopa	84	unidentified brachyurans
13 Jul	2243	11	1	333	II	5	*Chionoecetes bairdi*
					megalopa	54	*C. bairdi*
					zoea	2	unidentified brachyurans
					megalopa	1	unidentified brachyuran
14 Jul	0835	11	2	333	IV	2	*Cancer magister*
					II	10	*Chionoecetes bairdi*
					megalopa	8	*C. bairdi*

Table 4. Identification of crab larvae by station

Lower Cook Inlet bongo net tows, *Surveyor*, Leg II, 24-31 August 1976

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
25 Aug	0840	1	1	333	zoea	182	unidentified anomurans
					megalopa	5	unidentified anomurans
					V	1	*Cancer magister*
					megalopa	1	*C. magister*
					III	6	*C. oregonensis*
					IV	13	*C. oregonensis*
					V	17	*C. oregonensis*
					megalopa	4	*C. oregonensis*
					megalopa	4	*Chionoecetes bairdi*
					zoea	12	unidentified brachyurans
					megalopa	2	unidentified brachyurans
25 Aug	1206	2	1[a]	333	zoea	62	unidentified anomurans
					megalopa	2	unidentified anomurans
					V	2	*Cancer magister*
					II	2	*C. oregonensis*
					III	28	*C. oregonensis*
					IV	204	*C. oregonensis*
					V	98	*C. oregonensis*
					megalopa	12	*C. oregonensis*
					megalopa	16	*Chionoecetes bairdi*
					zoea	100	unidentified brachyurans
					megalopa	6	unidentified brachyurans

[a] The sample was split and 1/2 was sorted for crab larvae; totals given are for the entire sample.

Table 4. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
25 Aug	1952	3	1	333	megalopa	2	unidentified anomurans
					III	3	*Cancer oregonensis*
					IV	6	*C. oregonensis*
					V	6	*C. oregonensis*
					megalopa	1	*Chionoecetes bairdi*
					zoea	17	unidentified brachyurans
					megalopa	1	unidentified brachyurans
26 Aug	0400	4	1	333	zoea	1	unidentified anomuran
					megalopa	1	unidentified anomuran
					IV	8	*Cancer oregonensis*
					V	1	*C. oregonensis*
					megalopa	1	*C. oregonensis*
					zoea	55	unidentified brachyurans
26 Aug	1040	5a	1[b]	333	zoea	1088	unidentified anomurans
					megalopa	32	unidentified anomurans
					megalopa	8	*Cancer magister*
					III	40	*C. oregonensis*
					IV	376	*C. oregonensis*
					V	144	*C. oregonensis*
					megalopa	48	*C. oregonensis*
					zoea	1280	unidentified brachyurans
					megalopa	8	unidentified brachyurans

[b] The sample was split and 1/8 was sorted for crab larvae; totals are given for entire sample.

Table 4. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
26 Aug	2203	6	1[c]	333	zoea	74	unidentified anomurans
					III	2	*Cancer magister*
					III	62	*C. oregonensis*
					IV	186	*C. oregonensis*
					V	160	*C. oregonensis*
					megalopa	10	*C. oregonensis*
					zoea	106	unidentified brachyurans
					megalopa	2	unidentified brachyurans
27 Aug	1000	6	2[d]	333	zoea	384	unidentified anomurans
					megalopa	4	unidentified anomurans
					II	4	*Cancer magister*
					I	24	*C. oregonensis*
					II	80	*C. oregonensis*
					III	164	*C. oregonensis*
					IV	240	*C. oregonensis*
					V	108	*C. oregonensis*
					megalopa	52	*C. oregonensis*
					megalopa	4	*Chionoecetes bairdi*
					zoea	424	unidentified brachyurans
					megalopa	24	unidentified brachyurans

[c] The sample was split and 1/2 was sorted for crab larvae; totals are given for the entire sample.

[d] The sample was split and 1/4 was sorted for crab larvae; totals are given for the entire sample.

Table 4. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
28 Aug	0650	7	1	333	zoea	38	unidentified anomurans
					megalopa	5	unidentified anomurans
					II	5	*Cancer oregonensis*
					III	21	*C. oregonensis*
					IV	36	*C. oregonensis*
					V	15	*C. oregonensis*
					zoea	27	unidentified brachyurans
					megalopa	4	unidentified brachyurans
28 Aug	0330	8	1	333	zoea	29	unidentified anomurans
					megalopa	1	unidentified anomuran
					III	2	*Cancer magister*
					megalopa	1	*C. magister*
					III	12	*C. oregonensis*
					IV	92	*C. oregonensis*
					V	56	*C. oregonensis*
					megalopa	2	*C. oregonensis*
					zoea	49	unidentified brachyurans (some damaged)
					megalopa	1	unidentified brachyuran
28 Aug	1832	9	1	333	zoea	13	unidentified anomurans
					megalopa	2	unidentified anomurans
					megalopa	1	*Cancer magister*
					III	2	*C. oregonensis*
					IV	12	*C. oregonensis*
					V	57	*C. oregonensis*

Table 4. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
28 Aug	1832	9	1	333	megalopa	25	*C. oregonensis*
					megalopa	2	*Chionoecetes bairdi*
					zoea	8	unidentified brachyurans (many damaged)
					megalopa	2	unidentified brachyurans
28 Aug	1919	9	2	333	zoea	38	unidentified anomurans
					megalopa	1	unidentified anomuran
					megalopa	1	*Cancer magister*
					III	12	*C. oregonensis*
					IV	62	*C. oregonensis*
					V	248	*C. oregonensis*
					megalopa	88	*C. oregonensis*
					V	12	*Cancer* sp.
					megalopa	4	*Cancer* sp.
					megalopa	4	*Chionoecetes bairdi*
					zoea	23	unidentified brachyurans (many damaged)
					megalopa	3	unidentified brachyurans
29 Aug	0459	10	1	333	III	1	*Cancer oregonensis*
					IV	3	*C. oregonensis*
					V	18	*C. oregonensis*
					megalopa	8	*C. oregonensis*
					megalopa	2	*Chionoecetes bairdi*
					zoea	3	unidentified brachyurans
					megalopa	1	unidentified brachyuran

Table 4. (continued,

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
29 Aug	1922	11	1	333	IV	1	*Cancer magister*
					V	2	*C. magister*
					IV	1	*C. oregonensis*
					V	3	*C. oregonensis*
					megalopa	13	*C. oregonensis*
					megalopa	1	unidentified brachyuran
31 Aug	0641	13	1[e]	333	zoea	48	unidentified anomurans
					III	4	*Cancer magister*
					megalopa	8	*C. magister*
					IV	24	*C. oregonensis*
					V	104	*C. oregonensis*
					megalopa	536	*C. oregonensis*
					megalopa	80	*Cancer* spp.
					megalopa	4	*Chionoecetes bairdi*
					zoea	160	unidentified brachyurans
					megalopa	28	unidentified brachyurans
30 Aug	0459	14	1	333	zoea	1	unidentified anomuran
					megalopa	1	unidentified anomuran
					V	1	*Cancer magister*
					V	16	*C. oregonensis*
					megalopa	9	*C. oregonensis*
					megalopa	2	*Cancer* sp.
					megalopa	5	*Chionoecetes bairdi*

[e] The sample was split and 1/4 was sorted for crab larvae; totals are given for the entire sample.

The summaries of samples analyzed from the *Miller Freeman* cruise, Leg III, 17-29 October 1976, and not previously reported, include the taxonomic categories of crab larvae (Table 5). These data are correct and need no further additions and revisions.

The summaries of samples analyzed from the *Discoverer* cruise, Leg I, 21-26 February 1976, and not previously reported, include the taxonomic categories of crab larvae (Table 6). These data are correct and need no further additions and revisions.

IV. Discussion

This discussion will take the form of a summary status report. Our next major activity is the Lower Cook Inlet Synthesis Meeting in January. We expect to receive soon, from the Project Office, a letter of comment on our quarterly report submitted on 1 October 1977. That letter is expected to contain guidance useful for the synthesis meeting and for our annual report.

We are in receipt of a letter dated 7 December 1977 from our tracker, Susan J. Anderson. We have noted each comment and made what seem to be the appropriate corrections. We have passed the letter to our local data management specialist, Dean Dale, who will prepare a letter for Suzy, copy to us. We await the results of the NODC check program from the Project Office before making final corrections. It seems appropriate to note that none of the comments in the letter of 7 December was related to an inadvertent omission or proofreading error; rather each incidence was a situation where our interpretation differed from the correct procedure as determined by data management experts. We appreciate continuing guidance on these details and hope never to make the same misinterpretation twice.

We have reworked our digital data parameters according to the letter of guidance of 15 September 1977 from Herbert E. Bruce (Table 7). Our original attempt to define ranges of digital data parameters was based on the File Type 024 - Zooplankton table in the Instructions for Preparing and Submitting Proposals to OCSEAP/NOAA (Table 8). We have tried to give the range of values we expect. We have used the terms Haul Distance and Duration of Tow to avoid the time-space ambiguity of the word length.

We have followed the Record Format Descriptions dated 17 May 1977, as reflected in the Zooplankton PUNCH CARD TRANSCRIPT of 18 May 1977. We have taken the Size of Subsample, Ship Speed, Surface Water Temperature, and Record Type 6 Concentrations to be similar, in that no decimal is punched. Therefore, we punch 0.1 as 1, and 100.0 as 1000, if we are asked to report to 1/10; we punch 0.001 as 1, and 100.000 as 100000, if we are asked to report to 1/1000.

We believe that ship speed should be reported as meters/second rather than knots.

Table 5. Identification of crab larvae by station

Lower Cook Inlet bongo net tows, *Miller Freeman*, Leg III, 17-29 October 1976

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
29 Oct	0845	2	2	333			no sample
23 Oct	1935	3	1	333	megalopa	1	unidentified anomuran
24 Oct	1004	4	1	333		0	
23 Oct	1006	5a	1	333	zoea	1	unidentified anomuran
					megalopa	2	unidentified anomurans
					megalopa	3	*Cancer oregonensis*
					zoea	1	unidentified brachyuran
22 Oct	1758	6	1	333		0	
21 Oct	0907	7	1	333	megalopa	2	*Cancer oregonensis*
					zoea	1	unidentified brachyuran (damaged)
22 Oct	0403	8	1	333	zoea	1	unidentified anomuran
					megalopa	1	unidentified anomuran
					megalopa	1	*Cancer oregonensis*
28 Oct	1244	9	1	333		0	

Table 6. Identification of crab larvae by station

Lower Cook Inlet bongo net tows, *Discoverer*, Leg I, 21-26 February 1977

Date (1977) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
24 Feb	1331	1	1	333		0	
22 Feb	0736	2	1	333		0	
25 Feb	2340	2	3	333	zoea	1	unidentified anomuran
22 Feb	2108	3	1	333	zoea	3	unidentified anomurans
22 Feb	1723	4	1	333		0	
22 Feb	0447	5a	1	333	I	3	*Paralithodes camtschatica*
23 Feb	0415	5a	2	333	I	1	*Paralithodes camtschatica*
					zoea	7	unidentified anomurans
					I	14	*Cancer oregonensis*
					zoea	1	unidentified brachyuran
25 Feb	0031	5a	3	333	I	2	*Paralithodes camtschatica*
					zoea	2	unidentified anomurans
25 Feb	0745	5a	4	333	zoea	3	unidentified anomurans
					I	1	*Cancer oregonensis*
					zoea	1	unidentified brachyuran

Table 6. (continued)

Date (1977) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Stage	Total	Identification of Larvae
22 Feb	0050	6	1	333	I	2	*Paralithodes camtschatica*
					zoea	23	unidentified anomurans
					I	16	*Cancer oregonensis*
					zoea	130	unidentified brachyurans (few damaged)
23 Feb	0645	6	2	333	I	1	*Paralithodes camtschatica*
					zoea	3	unidentified anomurans
					zoea	95	unidentified brachyurans (few damaged)
25 Feb	0235	6	3	333	I	1	*Paralithodes camtschatica*
					zoea	6	unidentified anomurans
					I	1	*Cancer oregonensis*
					zoea	75	unidentified brachyurans (few damaged)
25 Feb	1039	6	4	333	zoea	2	unidentified brachyurans
24 Feb	1604	7	1	333		0	
26 Feb	0429	8	3	333		0	
23 Feb	1055	9	1	333		0	
23 Feb	1501	10	1	333		0	
23 Feb	2137	11	1	333		0	

Table 7. Digital Data

Parameters	Limits of Values Min	Max
Common to all records		
File Type	024	024
File Identifier	alphanumeric	
Record Type	1	6
Station Number (Record Types 2-6 only)	alphanumeric	
Record Type '1' - Header		
Vessel Name	alphabetic	
Cruise Number	alphanumeric	
Cruise Dates	750101	991231
Area/Project	alphabetic	
Investigator/Institution	alphabetic	
Record Type '2' - Location		
Latitude	580000	620000
Longitude	1380000	1540000
Date	750101	991231
Time	0001	2400
Depth to Bottom (m)	0	1500
Sample Interval		
Upper	0	1500
Lower	0	1500
Ship Speed (knots to 1/10)	0	150
Surface Water Temperature (to 1/10)	-10	200
Record Type '3' - Total Haul		
Gear Characteristics (codes)	1	10
Mesh Size	333	2000
Haul Distance (m)	1	9999
Volume of Water Filtered (m^3)	1	999999
Duration of Tow (hr/min/sec)	1	20000
Haul Type (code)	alphabetic	
Record Type '4' - Subsample Data 1		
Sample Number	1	9999
NODC Taxonomic Code	6175	8857041902
Life History (code)	alphanumeric	
Size of Subsample (% to 1/10)	1	1000
Number in Subsample	1	99999
Concentration of Subsample ($/m^3$)	1	999999
Record Type '5' - Text		
Sequence Number	1	9999
Text	alphanumeric	
Record Type '6' - Subsample Data 2		
Same as Record Type '4'		
Concentration of Subsample ($/m^3$ to 1/1000)	1	999999

Table 8. File Type 024 - Zooplankton

Common to all records
- File Type
- File Identifier
- Record Type
- Station Number (Record Types 2-5 only)

Record Type '1' - Header
- Vessel Name
- Cruise Number
- Cruise Dates
- Area/Project
- Investigator/Institution

Record Type '2' - Location
- Geographic Position
- Date/Time
- Water Depth
- Sample Interval

Record Type '3' - Total Haul
- Gear Characteristics (codes)
- Duration/Length of Haul
- Volume of Water (Filtered/Settled/Displaced)
- Total Wet and Dry Weights

Record Type '4' - Subsample Data 1
- Sample Number
- NODC Taxonomic Code
- Life History (code)
- Size/Number of Subsample
- Concentration of Subsample
- Wet and Dry Weights
- Number of Adults/Juveniles/Eggs/Larvae

Record Type '5' - Text
- Text
- Sequence Number

Record Type '6' - Subsample Data 2
- Same as Record Type '4' -
- (Concentrations reported to different precision)

Our detailed description of quality control of data processing has been discussed with our Project Office and will be submitted after further guidance is available.

V. Problems Encountered/Recommended Changes

The funding for this research unit did not reach the university until December. In another year, that could have caused a severe problem. We recommend that funding arrangements be completed by the first day of a contract year.

We are awaiting the letter of comment on our last quarterly report. We recommend that such letters be available in time to be assimilated into the next quarterly report, as we are anxious to make as many new drafts as possible in our approach to an optimal final product.

VI. Estimate of Funds Expended

We estimate that $33,500 will have been expended by 31 December 1977.

QUARTERLY REPORT

Research Unit #: 425
Reporting Period: October 1 -
December 31, 1977

Composition and Source Identification of Organic Detritus in Lower Cook Inlet

David Tennant
Principal Investigator
Pacific Marine Environmental Laboratory
Seattle, Washington

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Pacific Marine Environmental Laboratory
NOAA Building Number 32
7600 Sand Point Way NE
Seattle, WA 98115

DATE: December 30, 1977

TO: Dr. Herb Bruce, Juneau Project Manager, OCSEAP/NOAA

FROM: David Tennant, Oceanographer, Biology & Chemistry Group, PMEL

SUBJECT: January Quarterly Report: Composition and Source Identification of Organic Detritus in Lower Cook Inlet; R.U. #425

To date our efforts have been in preparing for the 1978 field season and in meeting concomitant responsibilities. These activities include personnel and equipment logistics problems, reviewing and coordinating schedules with other research units, designing and procuring special equipment (acoustic releases, sediment traps, etc.), and calibrating instrumentation.

In November Jerry Larrance participated in a two-day Cook Inlet workshop, assembled by the OCSEAP Project Office in Juneau, for the purpose of reviewing and planning the FY 1978 field activities.

We have drafted a work statement for the OCSEAP Project Office defining and delimiting the research responsibilities and objectives of R.U. #425. The original draft of this work statement has undergone two revisions per instructions from the OCSEAP Project Office.

We have employed Engineering, PMEL, Seattle to design sediment trap mooring arrays, sediment trap orientation gimbles and vanes, and pressure housings for timed releases. Our electronics section has designed and is in the process of assembling the timers which will close the sediment traps prior to recovery. We have made arrangements with the OCSEAP Project Office to supply us with five acoustic releases and accessory components (tension rods).

Pacific Marine Center, Operations, Seattle is cooperating with us to secure space and handling for the transport of moorings aboard Alaska-bound NOAA vessels. Tentative arrangements have been made for about 11 mooring anchors.

cc: Curl
Larrance
Chester

QUARTERLY REPORT

Contract 03-5-022-56
Research Units #426/427
Task Orders #1 and #13
Reporting Period 10/1 - 12/31/77

ZOOPLANKTON, MICRONEKTON STUDIES
(BERING SEA ICE EDGE ECOSYSTEM STUDY)

Dr. Vera Alexander
Dr. R. Ted Cooney

January 6, 1978

I. Task Objectives

A. R.U. #427

To study the dynamics of 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 southease Bering Sea during ice free conditions in order to compare seasonal activity, and also to look at the role of the shelfbreak and the Aleutian upwelling in Bering Sea production dynamics. The seasonal role of algae growing on the underside of the ice is also included in the study.

B. R.U. #426

This study addresses the survey of zooplankton and micronekton communities in the inshore region from Norton Sound to Point Hope. Standing stocks and occurrance of cominant species in the diets of fish collected by other investigators will be used to evaluate the importance of animal plankters in the nearshore zone during the mid-summer period.

II. Field and Laboratory Activities

The field work for both of these projects, as currently conceived by NOAA, was completed in the summer of 1977.

All laboratory analysis, for which funding has been received, have been completed. Analysis of these data and preparation of final reports is proceeding.

IV. Problems:

As of this date we have not received approval of FY '78 proposal including the remainder of the funds covered by that proposal. This delay in funding may jeopardize the analysis of the one remaing batch of zooplankton data.

RECEPTORS (BIOTA)

MICROBIOLOGY

RECEPTORS (BIOTA)

MICROBIOLOGY

Quarterly Report

Contract # 03-5-022-85
Research Unit 29
Period 10/1 - 12/31

Assessment of Potential Interactions of Microorganisms and Pollutants Resulting from Petroleum Development

Submitted by: Ronald M. Atlas
Principal Investigator
Department of Biology
University of Louisville
Louisville, Kentucky 40208

January 1, 1978

levels may be lower than in previous samples. Final results of enumerations are not yet available.

No new cluster analyses were performed during this period.

IV. Interpretation of Results

Cluster analyses from Beaufort Sea summer 1975 samples were interpreted. The numerical taxonomic analyses indicate that the Beaufort Sea bacteria are different than bacteria previously described. The dominant taxa in the Beaufort Sea during summer 1975 have tentatively been identified as *Flavobacterium* spp., *Microcyclus* spp. and *Vibrio* spp. Dominant hydrocarbon utilizing heterotrophs appear to be *Acinetobacter* spp. *Pseudomonas* spp. notably were not among the dominant microflora. A manuscript describing the distribution of these bacteria is presently being prepared and will be submitted to the project office during the next month. Also, a manuscript describing hydrocarbon biodegradation potential and distribution of hydrocarbon utilizing bacteria is being prepared and will be submitted shortly.

V. Problems Encountered

As noted in the last quarterly report we have had to replace several key personnel working on this project. Two new postdoctoral associates will begin work on the project January 1. We are also upgrading the analytical capability of the laboratory. We are awaiting installation of new equipment. We anticipate that chemical analyses of residual oils recovered from *in situ* incubation in the Beaufort Sea will resume in mid-January.

We are also still awaiting modifications to the cluster analyses programs at NIH needed to reduce costs and increase readability of the output. As soon as these changes are made cluster analyses on Cook Inlet isolates will be run. Modifications to feature frequency analysis programs have been completed.

VI. Estimate of Funds

It is estimated that 40% of this year's funds were expended as of December 31, 1977.

TABLE 1

DATE	ST.#	LATITUDE N	LONGITUDE W	DEPTH	SALINITY	TEMP	ANALYSES 1	2	3	4	5	6	7
11/3	429	57 47.2	151 58.8	0.5	31.6680	7.11	+	+	+		+	+	+
11/3	429	57 47.2	151 48.8	75.9	32.2184	7.14	+	+	+		+	+	
11/3	418	58 04.8	151 42.0	0.5	32,0203	6,43	+						+
11/3	418	58 04.8	151 42.0	166.	32,3717	5,96	+						
11/4	417	58 17.5	151 25.8	0.5	32.2293	6.43	+						+
11/4	398	58 48.9	152 11.6	0.5	31.9958	6.96	+	+	+		+		+
11/4	K	59 36,5	151 25.5	0.5	29.	3.5	+	+	+	+	+	+	+
11/4	K	59 36.5	151 25.5	1.5	29.	3.5	+	+	+	+	+	+	
11/4	J	59 35.5	151 10,5	0.5	29.	7.5	+	+	+		+		+
11/5	370	58 17,2	154 02.3	128.5	32.2722	7.27	+						
11/5	360	57 57.0	154 41.3	0.5	30.6575	6,99	+						
11/5	350	57 31.4	155 32.8	0.5	30.5376	6.68	+				+	+	+
11/5	350	57 31.4	155 32.8	185,7	32.9088	5.85	+				+	+	
11/5	354	57 27.5	155 14.5	0.5	31,8362	6,09	+	+	+	+	+	+	+
11/5	354	57 27.5	155 14.5	234.9	33.5018	4.96	+	+	+	+	+	+	
11/5	358	57 18,4	154 57.0	0.5	31.7498	6.25	+	+	+		+	+	+
11/5	358	57 18.4	154 57.0	175.8	33.0676	5.38	+	+	+		+	+	
11/6	364	57 50.1	154 25.0	0.5	31.9004	6.06	+	+	+		+	+	+
11/6	364	57 50.1	154 25.0	211.3	33.4228	5.04	+	+	+		+	+	
11/6	378	58 01.6	153 29.0	0.5	31.2415	6.38	+	+	+		+	+	+
11/6	378	58 01.6	153 29.0	85.1	32.2776	6.91	+	+	+		+	+	
11/6	374	58 10.8	153 45.0	0.5	31.3421	6.98	+	+	+		+	+	+
11/6	374	58 10.8	153 45.0	189.7	33.0967	5.46	+	+	+		+	+	
11/6	388	58 27.0	152 57.5	0.5	31.2487	7.34							+
11/6	394	58 42.4	152 59.7	0.5	31.0354	7.43	+	+	+	+	+	+	+
11/6	394	58 42.4	152 59.7	99.4	32,4860	6,62	+	+	+	+	+	+	+
11/6	390	58 53.3	153 11.5	0.5	30.2018	5.08							+

TABLE 1 (continued)

DATE	ST.#	LATITUDE N	LONGITUDE W	DEPTH	SALINITY	TEMP	ANALYSES 1	2	3	4	5	6	7
11/6	395	58 53.3	152 54.0	0.5	31.9030	7.11	+	+	+		+	+	+
11/6	395	58 53.3	152 54.0	159.7	32.7836	6.11	+	+	+		+	+	
11/7	205	59 06.2	152 41.3	0.5	31.0396	7.82	+	+	+		+	+	+
11/7	206	59 09.4	153 07.1	0.5	30.3092	6.61	+	+	+		+	+	+
11/7	212	59 32.5	153 21.2	0.5	30.0964	5.71	+	+	+		+	+	+
11/7	212	59 32.5	153 21.2	17.5	30.0993	5.71	+	+	+		+	+	
11/7	211	59 26.1	153 37.3	0.5	30.2516	5.60	+	+	+		+	+	+
11/7	211	59 26.1	153 37.3	16.8	30.2645	5.63	+	+	+		+	+	
11/7	213	59 29.4	153 12.7	0.5	29.8951	5.97							+
11/8	214	59 17.8	153 14.0	0.5	29.9772	6.24							+
11/8	203	59 06.2	153 29.1	0.5	30.3021	5.05							+
11/8	201	59 12.8	153 52.4	0.5	–	–	+	+	+		+	+	+
11/8	204	59 14.3	153 38.5	0.5	–	6.7	+	+	+		+	+	+
11/8	204	59 14.3	153 38.5	33.0	–	–	+	+	+		+	+	
11/9	215	59 21.1	153 48.8	0.5	30.6315	6.47	+	+	+		+	+	+
11/9	208	59 15.0	152 44.9	0.5	31.0320	7.00	+	+	+		+	+	+
11/10	207	58 59.8	152 52.9	0.5	31.4022	7.03	+	+	+		+	+	+
11/10	216	59 18.0	152 15.0	0.5	31.4129	7.81	+	+	+		+	+	+
11/11	217	59 27.7	152 22.9	0.5	31.4943	7.56	+	+	+		+	+	+
11/11	225	59 31.5	152 41.9	0.5	31.3060	7.13	+	+	+		+	+	+
11/11	226	59 33.3	152 18.6	0.5	31.3357	7.18	+	+	+		+	+	+
11/11	227	59 33.5	151 36.1	0.5	30.9908	7.23	+	+	+		+	+	+
11/11	227	59 33.5	151 36.1	75.6	31.1435	7.38	+		+		+	+	
11/12	249	59 51.3	152 02.1	0.5	30.8016	6.29	+	+	+		+	+	+
11/12	246	60 02.5	151 47.5	0.5	30.7139	2.2	+		+		+	+	+
11/12	266	60 41.2	151 25.6	0.5	23.0305	4.4	+		+		+	+	+
11/12	265	60 33.6	151 51.6	0.5	–	–	+	+	+	+	+	+	+
11/12	255	60 19.9	151 45.9	0.5	28.8097	5.35	+		+		+	+	+

TABLE 1
(continued)

DATE	ST.#	LATITUDE N	LONGITUDE W	DEPTH	SALINITY	TEMP	ANALYSES 1	2	3	4	5	6	7
11/12	235	59 42.1	152 38.1	0.5	30.0459	6.08	+	+	+	+	+	+	+
11/12	235	59 42.1	152 38.1	20.2	30.0649	6.08	+	+	+	+	+	+	+
11/12	235	59 42.1	152 38.1	30.3	30.0672	6.09	+	+	+	+	+	+	
11/13	234	59 37.6	152 55.8	0.5	30.3563	6.33							+
11/13	245	60 06.7	152 14.5	0.5	29.3584	5.29	+	+	+		+	+	+
11/13	U	60 12.8	152 36.1	0.5	27.	2.0	+	+	+		+	+	+
11/13	U	60 12.8	152 36.1	3.0	27.	2.0	+	+	+		+	+	
11/13	V	60 13.7	152 45.7	0.5	28.	2.0	+		+		+	+	+
11/13	V	60 13.7	152 45.7	1.5	28.	2.0	+		+		+	+	
11/14	242	60 09.0	152 25.5	0.5	29.3427	5.05	+		+		+	+	+
11/14	242	60 09.0	152 25.5	31.0	29.4418	5.39	+		+		+	+	
11/15	236	59 41.3	152 14.1	0.5	31.3903	6.95	+		+		+	+	+
11/15	229A	59 40.4	151 14.3	0.5	30.7286	5.48	+	+	+		+	+	+
11/15	229A	59 40.4	151 14.3	16.2	30.8106	5.58	+	+	+		+	+	
11/15	229	59 37.5	151 17.8	0.5	30.9019	6.15	+	+	+		+	+	+
11/15	229	59 37.5	151 17.8	72.0	31.1113	6.98	+	+	+		+	+	
11/16	106	59 00.6	152 01.4	0.5	31.5408	6.90	+	+	+		+	+	+
11/16	105	58 49.8	151 17.8	0.5	31.1630	6.45	+	+	+		+	+	+

1. Direct Count - epifluorescent total counts.

2. Viable heterotrophs - counts on marine agar 2216 - incubation at 5 C for psychrophiles and psychrotrophs incubation at 20 C for mesophiles.

3. Viable plate count of hydrocarbon utilizers - Bushnell Haas agar control and for low nutrient bacteria; Cook Inlet crude agar for hydrocarbon utilizers. Incubation at 5 C.

4. Oil tolerant plate count. Marine agar and Cook Inlet crude, incubated at 5 C.

5. Most Probable Number of hydrocarbon utilizers - ^{14}C hexadecane spiked Cook Inlet crude, incubated at 5 C.

6. Hydrocarbon biodegradation potential using ^{14}C hydrocarbon spiked Cook Inlet crude oil incubated at 5 C. Hexadecane, pristane, naphthalene and benzanthracene = hydrocarbons.

7. Nutrient analyses.

I. Task Objectives

A. To characterize marine microbiological communities in sufficient detail to establish a baseline description of microbiological community characteristics on a seasonal basis.

B. To determine the role of microorganisms in the biodegradation of petroleum hydrocarbons.

II. Field and Laboratory Activities

A. Field Schedule

Samples were collected for microbiological studies in Lower Cook Inlet during November. The sampling vessel was the Surveyor. The sampling party was Mr. Amikam Horowitz and Mr. George Roubal. Table 1 shows a list of samples collected and which tests each was processed for. One test not previously employed was used for these samples. Plate counts on marine agar with 1% Cook Inlet crude oil were used to determine the number of heterotrophs that could grow in the presence of petroleum hydrocarbons. This is an estimate of the petroleum tolerant microbial population. Methods for other tests have been described in previous reports.

B. Samples from the November cruise are being analysed in the laboratory. Results of the tests will be transmitted to NIH during January. No taxonomic tests were performed during this period.

III. Results

Initial results of microbial enumerations indicate that population

Quarterly Report

Task Numbers A-27; B-9
Contract # 03-5-022-68
Research Unit # 190
Report Period 1 September to
30 December, 1977

Number of pages: 24

Study of Microbial Activity and Crude Oil-Microbial Interactions in the Waters and Sediments of Cook Inlet and the Beaufort Sea

SUBMITTED BY:

Robert P. Griffiths
Co-Principal Investigator
Assistant Professor
Department of Microbiology
Oregon State University
Corvallis, OR 97331

Richard Y. Morita
Co-Principal Investigator
Professor of Microbiology and
Oceanography
Department of Microbiology
Oregon State University
Corvallis, OR 97331

I. Task Objectives

A. Cook Inlet

1. To continue studies of relative microbial activity and respiration (mineralization) ratios of natural microbial populations found in water and sediment samples. The samples will be taken in such a way as to characterize these measurements both geographically and temporally. These studies will fill some of the data gaps which still exist from past studies in this region. Areas which are shown to have particularly high activity should be those in which crude oil will be degraded at higher rates. These areas probably support the highest overall biological activity and as such may be the areas which will be most affected by the presence of crude oil. These data may also be used in the future to estimate the degree of perturbation caused by chronic crude oil input.

Characterization of water masses using microbial measurements might also be useful in following movement of water masses within the Inlet.

2. To evaluate the extent of nitrogen fixation in the sediments and gut contents of animals found in this region and to determine what, if any, effect crude oil might have on this process. Significant impact on function of any process in the nitrogen cycle could have a profound effect on all trophic levels in the Cook Inlet.

3. To evaluate techniques which might be used to determine crude oil degradation in sediments.

4. To provide nutrient data on all water and sediment samples taken by both microbiological groups. These data are important in evaluating other data collected by us, especially data on N_2 fixation and denitrification.

B. Beaufort Sea

1. To obtain information concerning the effects of added crude oil on the natural microflora of the sediments. These studies will include crude oil affects on microbial function as measured by uptake and respiration characteristics using several labeled compounds. They will also include the study of nitrogen fixation and the effects of crude oil on this process. These studies are designed to simulate the introduction of crude oil into the sediments by buried pipeline breaks similar to those discussed during the February, 1977 synthesis meeting held in Barrow, AK.

2. To continue collecting data on relative microbial activity and respiration percentages in this region during the August-September, 1978 Glacier cruise in this region. Nitrogen fixation rates will also be estimated on sediment samples collected at the same time.

3. To provide nutrient data on all water and sediment samples collected by both Dr. Atlas and ourselves.

4. To estimate the effects of crude oil on natural microbial populations which undergo osmotic stress during freezing and thawing.

C. General

1. To coordinate our sampling efforts and experimentation with that of Dr. Atlas and his associates at the University of Louisville. This will minimize duplication of effort and maximize the usefulness of the resulting data.

2. To continue our laboratory studies at Oregon State University on the effects of crude oil on nitrogen fixation in marine sediments. We also plan to study crude oil degradation by bacteria isolated from the Beaufort Sea and the Cook Inlet.

II. Field and Laboratory Activities.

A. Field trip schedule

We participated in a cruise in the Cook Inlet on the NOAA ship Surveyor from 3 November to 17 November, 1977.

B. Scientific party

All of the personnel involved in this project are in the Department of Microbiology, Oregon State University.

C. Personnel

Dr. Robert Griffiths, Co-Principal Investigator
Dr. Richard Y. Morita, "
Mr. Thomas McNamara, Technician (Research Assistant, Unclassified
Ms. Sue Steven, " " " "

D. Methods

The methods used in our field work are essentially the same as those reported in our last quarterly and annual reports. We are still in the process of evaluating various techniques used to assay biodegradation. Within the next few weeks, we will acquire the capability of interfacing our gas chromatograph with our minicomputer. This capability will greatly increase our ability to assay biodegradation of crude oil by bacterial cultures that have been isolated from the Arctic and Subarctic marine environment.

III. Results

A. Field studies

1. During the course of the November, 1977 Cook Inlet cruise, we collected water and/or sediment samples at 3 beach and 56 offshore locations. Relative microbial activity was measured using ^{14}C labeled glucose and glutamic acid in all samples collected. The effects of crude oil on the uptake and respiration of these substrates was observed in 24 water samples. Similar studies are being conducted on the sediment samples that we brought back to the laboratory after the cruise.

Nitrogen fixation rates were measured in all sediment samples in the field. Of these, 12 were tested for the affects of crude oil on nitrogen fixation rates. Studies are also being conducted on the affects of crude oil on nitrogen fixation in sediment samples that have been supplemented with high levels of sucrose. Nitrogen fixation rates were also measured in homogenates of 6 species of benthic organisms.

Subsamples of all water and sediment samples were flash frozen with dry ice in the field and returned to Oregon State University for inorganic nutrient analysis.

Surface and bottom water temperature and salinity measurements were made with the CTD by the ship's personnel. In addition to these measurements, the tidal condition at the time of sampling was also noted. These and all other data collected as the result of this cruise will be reported in the annual report due 1 April, 1978.

2. As was mentioned in our previous quarterly report, we received 20 fresh sediment samples from the September, 1977 Glacier cruise in the Beaufort Sea. We have completed the analysis of these samples and the results are given in detail below. The observations of sample position (Fig. 1), sample date, and water column depth are given in Table 1.

B. Laboratory studies

1. The observed relative microbial activity as measured by glucose and glutamic acid uptake and the respiration procentages are given in Table 2. The average glutamic acid uptake was 0.42 μg/gram dry

wt and the average glucose uptake was 10.2 ng/g. dry weight/h. The average percent respiration with glutamic acid was 38 and with glucose was 25. In general, the uptake rates for glutamic acid was highest in the stations to the west of # 74A. Samples collected at stations 74a, 80a, 99 and 110 showed low rates of microbial activity when either glucose or glutamic acid was used (Fig. 2 and 3).

2. In addition to these measurements, the concentration of various types of bacteria were measured using plate counts on several types of agar media (Table 3). The average "total count" or cell concentration was 8.4×10^6 cells/g dry wt as measured using "Lib-X" medium and it was 3.7×10^6 cells/g dry wt as measured using Marine Agar "2216". The average cell concentration as measured on Tween-80 medium was 3.9×10^6 cells/g dry wt. The composition of the last two media are very similar and thus it is not surprising that the average observed values were essentially the same. Of the total organisms present that showed pigmentation, the average values were 1.9×10^6, 5.3×10^5 and 2.0×10^5 cells/g on Lib-X, 2216 and Tween-80 respectively. The total "Vibrio" count was also observed in all samples using TCBS medium. The average value observed was 4.6×10^5 cells/g or roughly 5% of the total counts as measured by Lib-X medium. Of the organisms that were capable of growth on Tween-80 medium, roughly 25% were capable of producing lipase and were thus potential hydrocarbon degrading bacterial strains. The average value for total anaerobic bacteria was calculated at 2.1×10^6 cells/g dry wt.

The values for all of the above observations were compared in all sediment samples studied and correlation coefficients were calculated (Table 4). The correlation coefficient between glucose and glutamic acid uptake was 0.68. The correlation between relative microbial activity as measured using both glucose and glutamic acid was higher when compared with cell counts on Lib-X medium than when compared with counts on Marine Agar. Relative microbial activity as measured using glucose had a higher correlation with plate counts on all media tested than did relative microbial activity when measured using glutamic acid.

3. Nitrogen fixation rates were also calculated for all sediment samples analyzed (Table 5). The rates of nitrogen fixation were about 20% lower in these samples than that observed in Cook Inlet sediments. As can be seen in Fig. 4, the rates of nitrogen fixation were highest in the stations closest to Pt. Barrow.

4. The effects of crude oil on the uptake and respiration of both glucose and glutamic acid were also measured in all sediment samples. Two series of tests were conducted, the

first set was conducted within two weeks after the sedeiments were received. The results of this study are shown in Table 2. Glucose uptake was decreased by an average of 55% and the uptake of glutamic acid was depressed by an average of 55% and the uptake of glutamic acid was depressed by an average of 43% under the same conditions. In the same samples, the percent respiration was increased from 25 to 36% and from 38 to 46% respectively. The change in the percent respiration was caused by a depression in the radioactivity associated with the cells rather than a change in the radioactivity associated with the $^{14}CO_2$. These observations lead us to our second series of experiments which were made approximately four weeks after we received the fresh sediment samples. In this series, we studied the effects of crude oil, "weathered" crude oil and crude oil aquous extract on the uptake and respiration of glucose and glutamic acid (Tables 6 and 7). In all cases, the effects of "weathered" crude oil and raw crude oil were the same. As was observed before, the effects of crude oil on the uptake of glucose was more pronounced than on the uptake of glutamic acid. The aqueous extract of crude oil did not apparently affect the uptake of glutamic acid uptake but it did have an effect on glucose uptake (the average percent reduction in counts was 36%). The patterns observed in this series of experiments lead us to suspect that the apparent reduction that we were observing in the crude oil exposed cells was due in part to a quenching effect of the oil on the assay used to determine radioactivity in the cells (an effect which was not reflected in a change in the apparent counting efficiency). In the procedure that we were using, the cells were coated with crude oil during filtration. Even though the cells were placed into a scintillation fluor that should have removed this crude oil coating, there was a possibility that the beta radiation emitted from the cells was not able to pass through the crude oil coating and thus would not be counted, giving lower counts than the control. We have initiated a series of experiments to determine if the reduction that we have observed in the cell counts were caused by this effect. Preliminary results to date indicate that this might well be the case. The effects that we saw on the aqueous extract on the uptak of glucose could not have been caused by this effect and thus is not an artifact of counting efficiency. Further work will have to be done to determine exactly what is happening in the cells exposed to crude oil.

5. The effect of crude oil on nitrogen fixation was also measured in 9 of the most active sediments from the Beaufort Sea (Table 8). No significant difference was seen between the nitrogen fixation rates in unsupplemented sediments treated with crude oil and those that had not been treated. A somewhat different picture was seen in the sediments that had been supplemented with sucrose. In six of the nine samples studied, there was a depression in nitrogen fixation rates in the presence of crude oil. These results are

similar to observations made in previous studies which we conducted on the effects of crude oil on nitrogen fixation rates in marine sediments.

6. Measurements were also made on the effects of crude oil on the growth of marine heterotrophic bacteria on Lib-X agar plates (Table 9). Four crude oil enrichment cultures isolated from Beaufort Sea sediments were used in one study. In all cases, there was a reduction in plate counts in the presence of crude oil. Comparative counts were also made using the same system and with sediment samples taken during the April Cook Inlet cruise. Five out of ten samples studied showed a reduction in plate counts in the presence of crude oil.

6. Crude oil degradation by Beaufort Sea sediments, was measured by using ^{14}C spiked crude oil. Results of these data are shown in Fig. 5.

7. All of the data that we collected during the April Cook Inlet cruise onboard the Miller Freemen have been entered into the NIH computer system under the file number 100254.

VI. Preliminary interpretation of results

A. Beaufort Sea sediment study

1. The relative microbial activity as measured using glutamic acid, was close to what we have observed in Beaufort Sea summer sediments in the past even though the sampling locations were different. The average value observed during the current study was 0.42 μg/g dry wt./h as compared to 0.52 and 0.69 during the summers of 1975 and 1976 respectively.

2. The average percent respiration was also comparable to that observed in past seasons. In the current study, the average percent respiration for glutamic acid was 38 as compared with 43 and 28 for the summers of 1975 and 1976 respectively.

3. The rates of nitrogen fixation which we observed in the Beaufort Sea were lower than those observed in the Cook Inlet during the April, 1977 cruise. The average value observed in the Cook Inlet study was 0.28 and the average observed in the Beaufort Sea sediments was 0.06 ng nitrogen fixed per g dry wt. per h.

4. In general, the highest rates of microbial activity were found in sediment samples taken to the west of station 74A. The highest rates of nitrogen fixation were found in the stations closest to Point Barrow. The highest crude oil degradation potentials were found in the nearshore stations sampled to the east of Prudhoe

Bay (Figure 5). This pattern could reflect either the natural seepage of crude oil, or its accidental release as a result of recent oil production activity in this area.

B. Crude oil effects studies

1. As we have seen before, there was little effect of crude oil on nitrogen fixation rates in sediments that had not been supplemented with sucrose. When sucrose was added to sediments, the level of nitrogen fixation was normally increased significantly and the effect of crude oil was more pronounced. In most cases, the nitrogen fixation rates were suppressed in the presence of crude oil but occasionally, the rate was increased. Continued observations in sediment samples and basic studies using pure strains of nitrogen fixing bacteria must be made to determine what these observations mean in terms of the potential impact of crude oil on nitrogen fixation *in situ*.

2. We are starting to accumulate data which suggests that crude oil might have a direct effect on the growth of heterotrophic bacteria. From the mixed results that we obtained on our plate count data (Table 9), it is obvious that more work needs to be done on this problem before decisive conclusions can be made. Further studies will be conducted to determine if specific strains of organisms are affected or if the physiological state of the cells is the most important factor in determining whether or not they will grow in the presence of crude oil.

3. The data presented in Tables 2, 6 and 7 suggest that crude oil might have a profound effect on the uptake and respiration of glucose and glutamic acid. A series of experiments currently underway suggest that at least part of the effect is an artifact of the assay system used to measure radioactivity in the cell fraction. Further studies will have to be made to determine how much of this effect has caused the alteration in function that we have observed. The data we have collected on the effects of crude oil aqueous extract on glucose uptake and respiration would not be subject to this counting efficiency problem. These observations should then reflect what is actually occurring in the sediments.

V. Problems encountered, recommended changes, acknowledgements

A. Problems encountered

The VanVeen sediment samplers which have been made available to us in the past cruises on board NOAA ships are no longer adequate for our purposes. The samples that we obtain in this manner are not quantitative enough for our sediment work. We are currently investigating what type of sampler would best be suited for our studies. From what we have discovered thus far, a small box corer would appear to be the best alternative.

B. See our FY 78 OCSEAP research proposal for recommended changes in our research goal for FY 78 and beyond.

C. We would like to thank the crew of the NOAA ship Surveyor for their excellent assistance during our last Cook Inlet cruise. We would also like to thank Dr. John Baross of our laboratory (not funded by NOAA) for his analyses of total viable bacterial counts, total viable fermentative bacteria, total vibrio viable counts, lipase positive strain concentrations, dry weight determinations, and sucrose positive vibrio counts in the Beaufort Sea sediment samples.

Table 1. Description of sample position, water column depth, grab numbers (OSU), sample numbers, station numbers and sampling date for all sediment samples collected during the summer, 1977 Glacier Cruise.

Sample number	Grab number	Station number	Sample depth (meters)	Date	Position Lat.	Position Long.
BB301	1523	14b	123	8/7	71° 46'	155° 35'
" 302	1529	18	384	8/9	71 57.5	154 34
" 303	1536	19	51	8/10	71 34.2	153 39.5
" 304	1544	24b	55	8/11	71 19.2	152 54
" 305	1555	25a	40	8/11	71 13.8	152 57.9
" 306	1568	25	24	8/11	71 0.6	153 01
" 307	1569	24	79	9/12	71 21.2	152 35
" 308	1580	24a	102	8/12	71 23.0	152 41
" 309	1586	31a	42	8/15	71 07.2	149 56.7
" 310	1588	74a	21	9/16	70 39.0	148 28.5
" 311	1595	80a	30	8/18	70 31.4	147 30.5
" 312	1598	91	31	8/18	70 23.2	146 33.3
" 313	1600	99	3841	8/20	72 53.8	146 27
" 314	1621	115	659	8/25	70 42.8	141 39.5
" 315	1628	110	26	8/26	69 49.5	141 28.5
" 316	1642	113	50	8/26	70 10.0	141 17.7
" 317	1648	114	106	8/27	70 33	142 27.5
" 318	1654	103	146	8/27	70 37.5	143 57
" 319	1660	95	521	8/29	71 01.5	145 26
" 320	1662	93	42	8/30	70 40.5	146 31

Table 2. Relative rates of microbial activity in sediment samples as measured by uptake of glutamic acid.

A. Glutamic acid

Sample number	μg/g dry wt/h No oil	μg/g dry wt/h Oil	Percent reduction	Percent respiration No oil	Percent respiration Oil
BB301	0.95	0.59	45	53	56
" 302	0.27	0.19	30	49	59
" 303	0.62	0.33	48	28	34
" 304	0.49	0.19	62	38	54
" 305	0.46	0.23	51	35	32
" 306	1.06	0.44	59	40	61
" 307	0.34	0.18	47	37	56
" 308	0.43	0.26	41	38	68
" 309	0.49	0.27	43	38	42
" 310	0.03	0.02	36	50	38
" 311	0.04	0.04	17	39	36
" 312	0.50	0.27	46	37	47
" 313	0.06	0.05	29	38	40
" 314	0.41	0.24	43	40	36
" 315	0.04	0.03	21	35	35
" 316	0.43	0.16	63	38	53
" 317	0.38	0.15	61	33	43
" 318	0.49	0.30	40	27	42
" 319	0.42	0.32	23	32	45
" 320	0.42	0.21	50	44	44
Average	0.42	0.22	43	38	46

B. Glucose

	ng/g dry wt. /h				
BB301	56.5	22.8	60	22	38
" 302	25.6	7.2	72	24	42
" 303	15.3	3.9	75	15	34
" 304	4.8	1.8	64	22	46
" 305	6.0	2.3	61	18	26
" 306	26.4	5.4	79	34	48
" 307	7.3	2.8	61	16	24
" 308	20.3	4.4	78	17	47
" 309	7.2	3.9	45	24	23
" 310	0.8	0.6	31	28	41
" 311	1.1	0.7	33	25	31
" 312	6.3	3.7	42	23	24
" 313	0.9	0.8	13	42	37
" 314	2.0	1.1	45	38	47
" 315	1.1	0.7	42	20	32

Table 2. (Con).

B. Glucose

Sample number	ng/g dry wt./h No oil	Oil	Percent reduction	Percent respiration No oil	Oil
BB316	5.5	1.3	76	28	40
" 317	6.6	1.4	79	18	39
" 318	4.1	1.8	60	24	34
" 319	2.3	1.6	30	29	37
" 320	3.8	2.1	46	24	37
Average	10.2	3.5	55	25	36

Table 3. Concentrations of various types of bacteria found in the Beaufort Sea sediment samples. All numbers are in number of cells per g dry wt. sediment.

Sample number	Total Counts Lib-X	2216	Anaerobic count	Total vibrios	Percent fermentative	Percent lipase+
301	3.0E7		7.7E6	7.7E5	26	6
302	1.2E7	5.4E6	3.5E6	7.9E4	29	5
303	1.0E7	7.0E6	1.4E6	8.7E5	14	10
304	8.8E6		1.3E6	9.5E5	15	12
305	4.5E6	2.4E6	7.5E5	4.0E5	17	2
306	1.6E7	4.3E6	2.6E6	7.4E5	16	9
307	1.9E7	1.0E7	4.5E6	2.0E6	24	10
308	1.9E7	8.6E6	4.8E6	1.1E6	25	10
309	7.1E6		2.0E6	8.0E6	29	20
310	1.5E6	4.5E5	3.1E5	1.3E5	20	9
311	8.4E5	5.1E5	4.5E4	2.6E4	5	23
312	5.8E6		4.3E5	2.3E5	7	11
313	1.5E6	5.0E5	2.3E4	1.1E4	1.6	18
314	9.4E5		2.1E4	2.2E4	2	19
315	9.4E5		9.8E4	3.2E4	10	12
316	9.3E6	3.6E6	8.1E5	4.3E5	9	15
317	2.7E7	3.8E6	9.8E6	1.5E5	36	8
318	3.9E6	1.1E6	2.7E5	1.8E5	7	5
319	3.5E6	6.9E5	3.0E5	7.9E4	8.5	17
320	6.8E6		8.2E5	1.4E5	12	12
Average	9.4E6	3.7E6	2.1E6	4.6E5	16	12

Percent fermentative and percent lipase positive based on Lib-X total counts as 100%. All count data based on plates that had been incubated at 0.5C for 14 days.

Table 4. Correlation coefficients calculated from various measurements made on Beaufort Sea sediments.

	Glutamic acid	Glucose uptake	Lib "X" plate counts	2216 plate counts	Tween 80 plate counts	Anaerobes	Total vibrios	Total sucrose utilizers	% fermentative bacteria
Glucose uptake	0.68								
Lib "X" plate counts	0.57	0.73							
2216 plate counts	0.35	0.60	0.73						
Tween 80 plate counts	0.49	0.79	0.90	0.92					
Anaerobes	0.37	0.61	0.95	0.55	0.84				
Total vibrios	0.39	0.32	0.53	0.87	0.60	0.38			
Total sucrose utilizers	0.52	0.67	0.62	0.60	0.70	0.47	0.49		
% fermentative bacteria	0.12	0.12	0.25	-0.01	0.22	0.30	0.07	0.03	
% lipase producers	-0.35	-0.44	-0.45	-0.31	-0.43	-0.40	-0.19	-0.29	-0.03

Table 5. Nitrogen fixation rates observed in Beaufort Sea sediment samples as calculated using the acetylene reduction method. Values reported as ng nitrogen fixed per gram dry weight of sediment per h.

Sample number	nitrogen fixation rate
301	0.21
302	0.20
303	0.18
304	0
305	0
306	0.12
307	0
308	0.09
309	0.03
311	0.05
312	0
313	0
314	0.02
315	0.01
316	0.07
317	0.003
318	0
319	0.09
320	0
Average	0.06

Table 6. Effects of aqueous crude oil extract and fresh and weathered crude oil on the uptake and respiration of glutamic acid in Beaufort Sea sediment samples.

	PERCENT REDUCTION			PERCENT RESPIRATION			
Sample #	Fresh crude	Aqueous extract	Weathered crude	No oil	Fresh crude	Aqueous extract	Weathered crude
301	30	0	17	53	71	49	71
302	36	0	35	64	83	66	86
303	57	0	45	41	86	37	69
304	48	17	50	40	64	42	70
305	32	0	27	44	62	39	66
306	43	0	43	41	72	42	80
307	43	0	40	48	78	48	77
308	6	6	30	49	52	51	75
309	30	0	17	39	65	40	73
310	28	0	12	31	53	34	50
311	8	0	8	61	73	63	81
312	32	0	35	46	59	38	64
313	0	0	32	52	47	53	64
314	36	0	51	44	48	44	50
315	29	0	26	60	73	60	76
316	48	5	54	49	86	45	84
317	19	0	36	56	74	55	88
318	60	0	60	40	71	38	76
319	26	0	30	54	66	44	78
320	41	10	43	50	78	41	80
Average values	33	2	35	48	68	46	73

Table 7. Effects of aqueous crude oil extract and fresh and weathered crude oil on the uptake and respiration of glucose in Beaufort Sea sediment samples.

	PERCENT REDUCTION			PERCENT RESPIRATION			
Sample #	Fresh crude	Aqueous extract	Weathered crude	No oil	Fresh crude	Aqueous extract	Weathered crude
301	60	36	62	21	44	20	43
302	59	2	49	37	67	34	65
303	64	24	64	17	45	18	52
304	73	57	64	20	52	22	42
305	57	61	34	24	41	25	40
306	66	68	68	21	51	26	57
307	65	20	63	23	57	28	54
308	38	45	64	26	39	28	62
309	59	21	66	21	47	24	57
310	28	0	12	31	53	34	50
311	0	0	0	28	37	39	52
312	61	53	60	21	42	25	38
313	0	0	18	42	32	42	50
314	48	9	42	29	38	31	42
315	41	9	50	36	60	34	65
316	72	60	70	26	74	28	61
317	68	75	75	23	38	32	57
318	65	43	63	20	53	30	55
319	61	46	52	37	57	43	72
320	56	90	56	27	53	17	47
Average values	52	36	52	27	50	29	53

Table 8. Effects of crude oil on nitrogen fixation in both raw sediments and in sediments that had been supplemented with sucrose. Values given below are pmoles ethylene produced per 0.3 ml of gas phase after 7 days incubation.

Sample #	No treatment	Crude oil	Sucrose added	Sucrose + crude oil
301	60	63	91	65
302	95	95	146	146
303	47	40	62	53
306	12	15	362	142
308	48	45	57	63
314	6	6	202	245
315	10	12	42	26
317	3	3	179	79
319	29	30	480	381

Table 9. Effects of crude oil on growth of bacteria on agar plates

a. Comparision of counts obtained in enrichment samples taken from Beaufort Sea sediment samples.

Cultures designator	Percent reduction in counts
A.	19
B.	46
F.	35
D.	49

B. Comparision of counts obtained in sediment samples taken from the Cook Inlet

Sample number	Percent reduction in counts
431	30
424	3
436	41
440	49
444	20
432	0
425	0
412	0
421	0
430	0

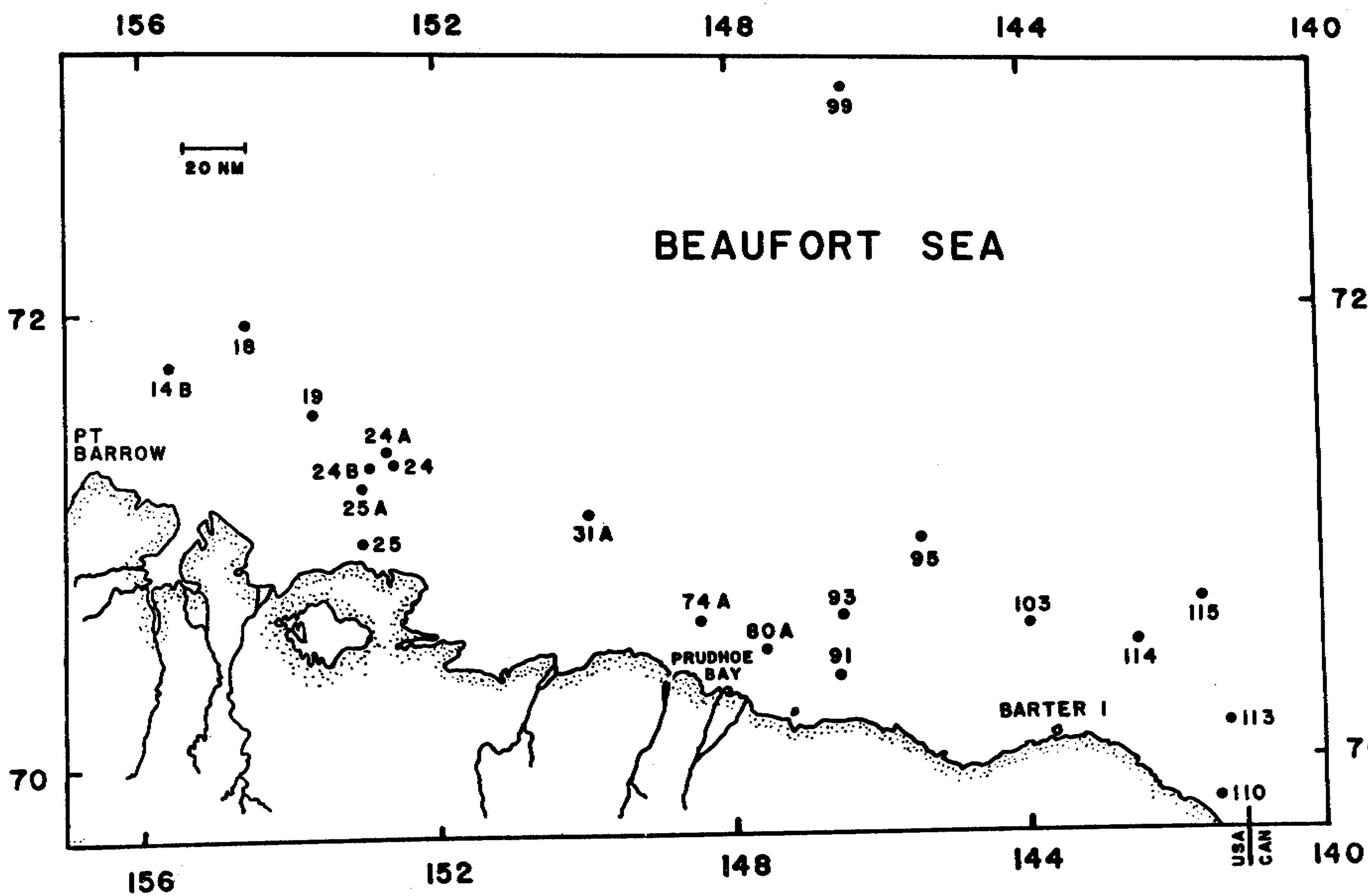


Figure 1. Position and identification of stations sampled in the Beaufort Sea during the summer, 1977 Glacier cruise.

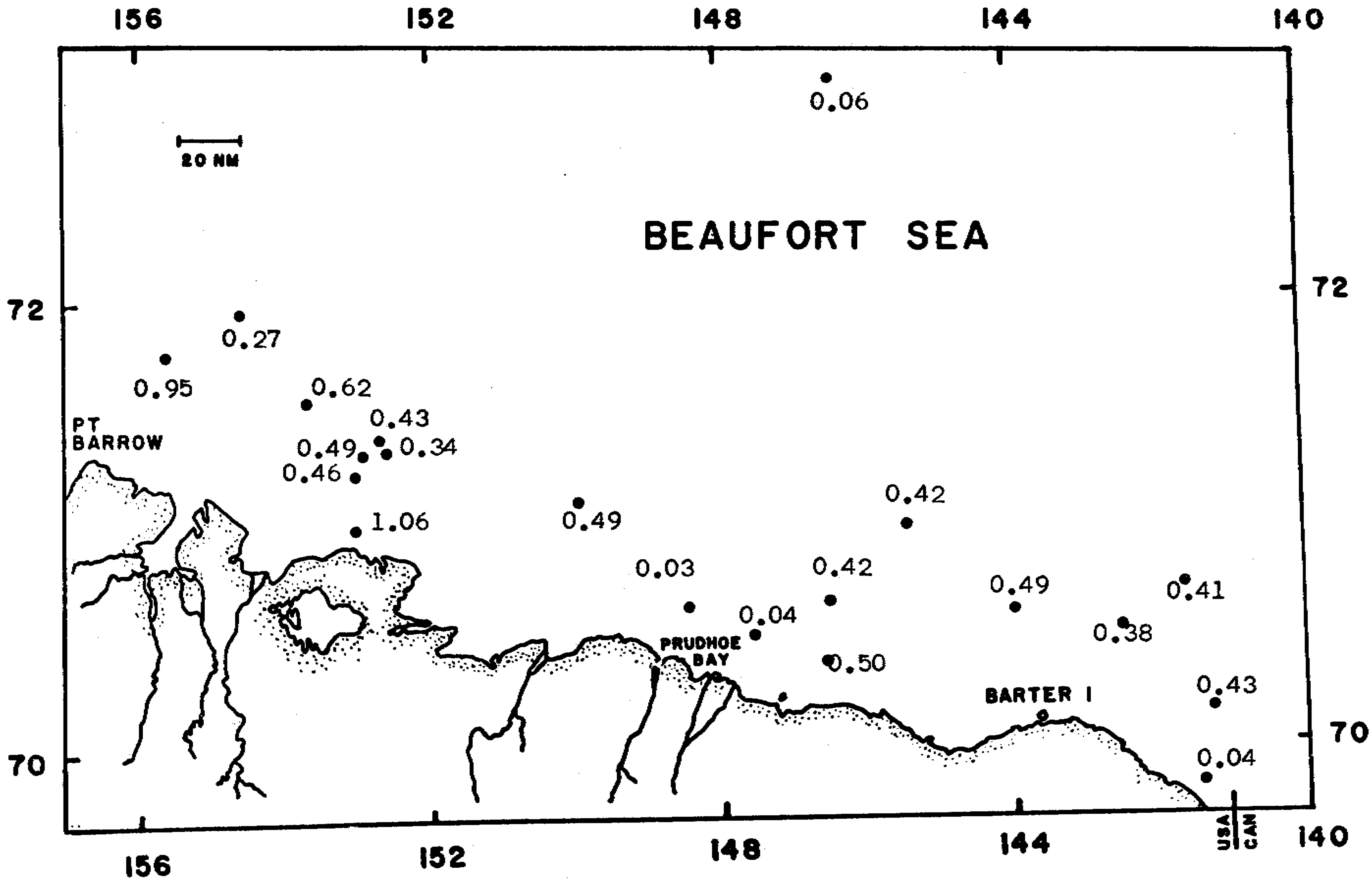


Figure 2. Uptake rates for glutamic acid in µg/g dry wt./h.

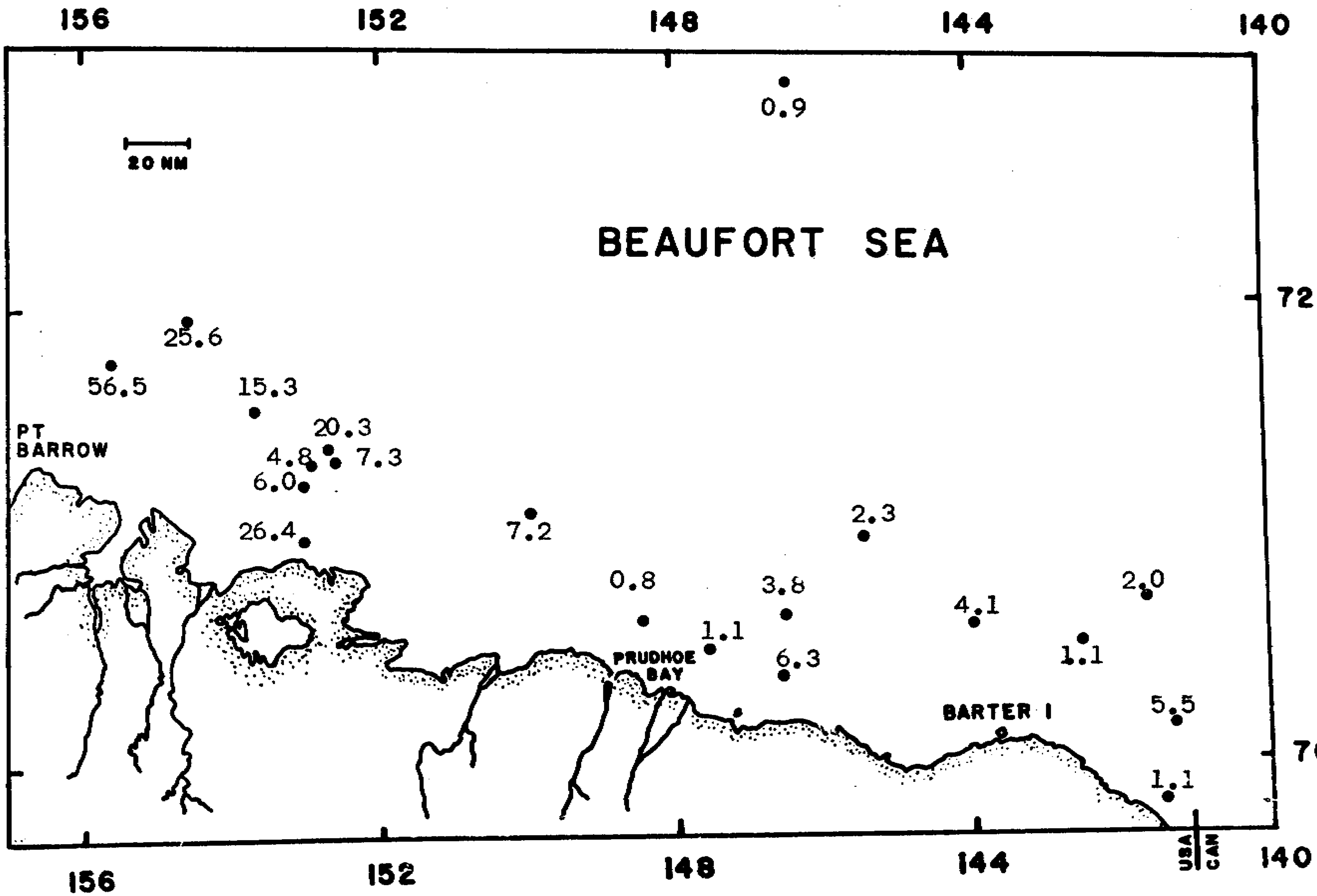


Figure 3. Uptake rates for glucose in ng/ g dry wt./h.

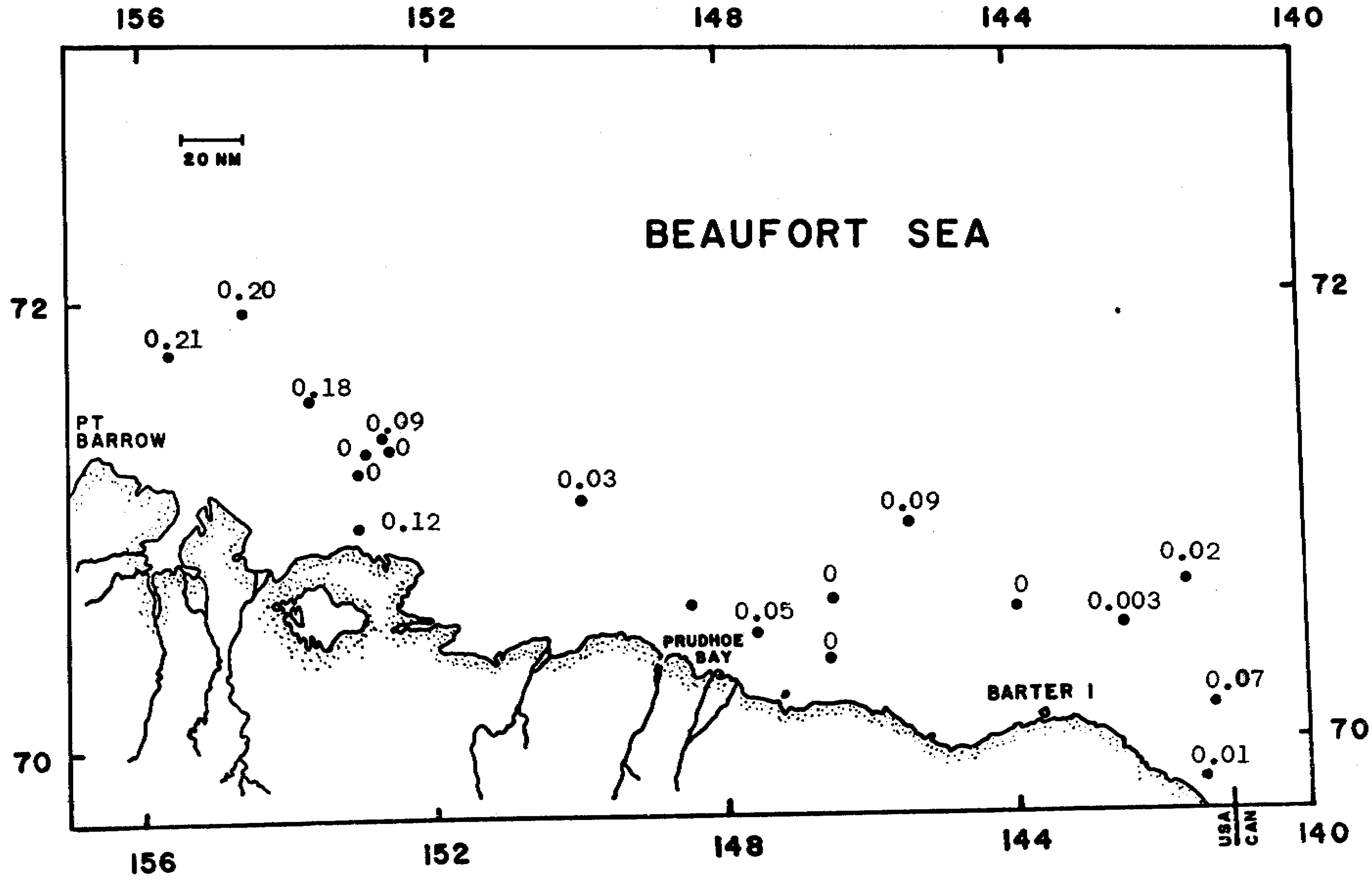


Figure 4. Nitrogen fixation rates in sediments expressed in units of nmoles nitrogen fixed per gram dry weight per h.

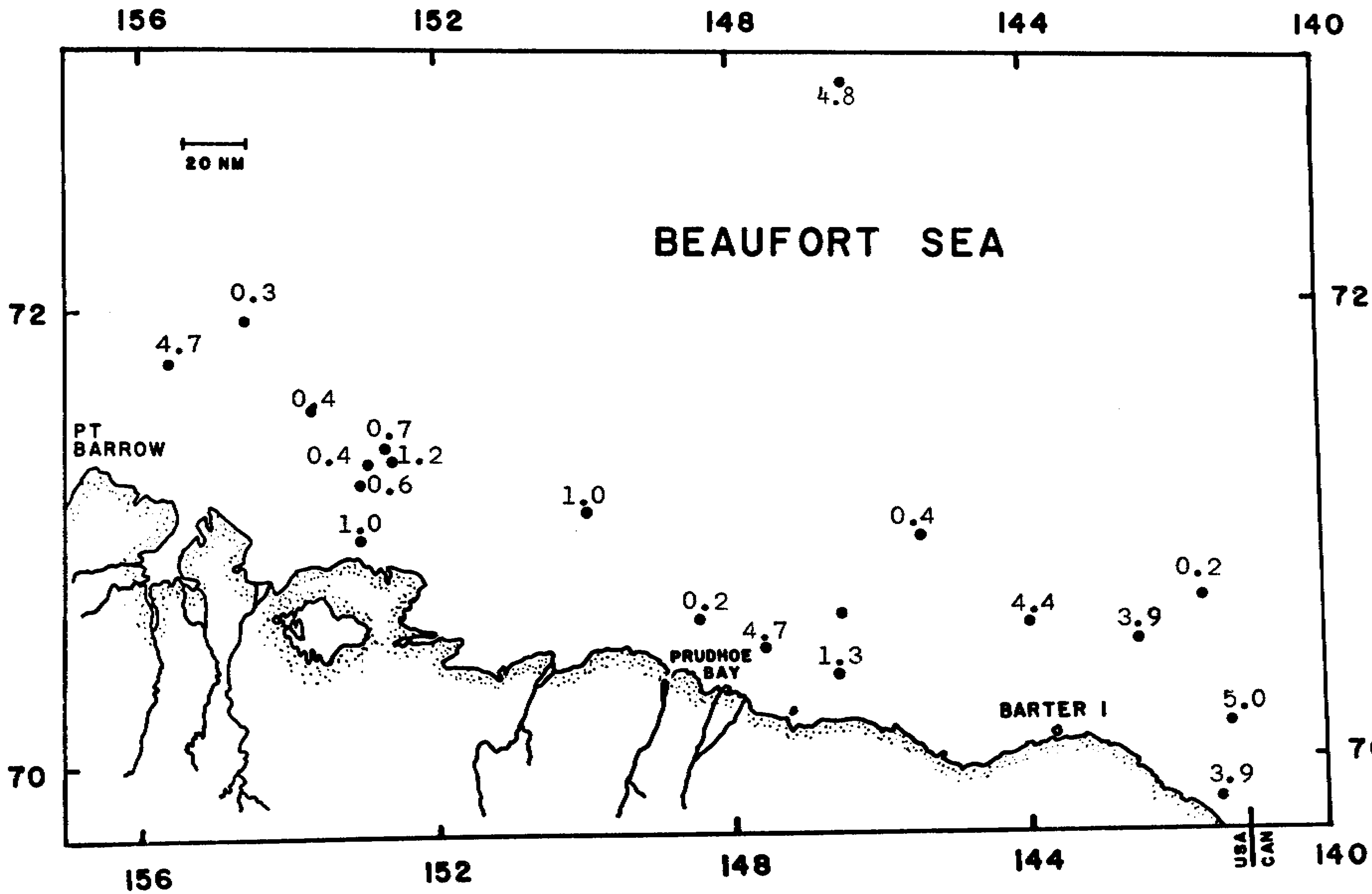


Figure 5. Crude oil biodegradation potentials as measured using ^{14}C spiked crude oil. Values given in thousands of DPM found in the CO_2 released during the total incubation time.

DETERMINE THE FREQUENCY AND PATHOLOGY OF MARINE FISH DISEASES IN THE BERING SEA, GULF OF ALASKA, AND BEAUFORT SEA

by

Bruce B. McCain*
Harold O. Hodgins*
Albert K. Sparks*
William D. Gronlund*

Submitted as a Quarterly Report
for Contract #R7120817
Research Unit #332
OUTER CONTINENTAL SHELF ENERGY ASSESSMENT PROGRAM
Sponsored by
U.S. Department of the Interior
Bureau of Land Management

October 1 to December 30, 1977

* Principal Investigators, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, Washington 98112

ABSTRACT

Two general areas of effort were emphasized. One involved planning for field studies to be conducted in the nearshore waters of the northern Gulf of Alaska (NGOA) during the spring and summer of FY 1979; and the other area of effort consisted of further analyses of field data collected during 1976 in the Bering Sea. Periodic contact has been made with Dr. Murray Hayes, RACE Division Director, NMFS, NWAFC, who is the coordinator for nearshore studies in the NGOA. A planning meeting of the investigators for the nearshore NGOA study was held in Seattle on December 14 and 15 in which we participated. Further data analyses were performed in response to the availability of additional data on the biological properties of the fish species in the same hauls as diseased fish were found. The length frequencies for total fish and abnormal fish of the same species from the same hauls were compared. Also, for certain pathological conditions, analyses such as disease frequency vs. fish density and disease frequency vs. year class were performed.

OBJECTIVES

Determine the frequency, geographical distribution, and biological and pathological characteristics of demersal marine animals and macro-invertebrates in the Bering and Beaufort Seas, and the Gulf of Alaska. Also, characterize the microorganisms isolated from diseased animals using standard microbiological procedures.

FIELD OR LABORATORY ACTIVITIES

SHIP OR FIELD TRIP SCHEDULE

No field activities were performed.

SCIENTIFIC PARTY

Name	Role
Bruce B. McCain, PhD	P.I., coordinates field and laboratory activities; participates in field activities, histopathological and microbiological analyses; and writes progress reports and manuscripts.
Harold O. Hodgins, PhD	P.I., supervises NMFS investigations and reviews all reports and manuscripts.
Albert K. Sparks, PhD	P.I., supervises the collection and histopathological analyses of invertebrates.
William D. Gronlund, MS	P.I., participates in field activities, data processing, and analyses of biological data.

Mark S. Myers	Performs histopathological analyses of tissue specimens and participates in field activities and data processing.
Kenneth V. Pierce, MS	Histopathologist.
Rod Ramos	Histology technician.

METHODS

Planning for the FY 1979 sampling in the nearshore waters of the NGOA has involved communicating our needs with the individuals who will be collecting demersal fish. Our principal need is to be able to have at least one person aboard the sampling vessels.

Analyses of field data involved separating out data for those catches from the Bering Sea 1976 cruise containing pollock with pseudobranchial tumors primarily 2-5 years of age.

The following relationships were analyzed: (1) The depth of fishing and tumor frequencies, (2) fish density and tumor frequencies, and (3) year class of fish and tumor frequencies. In addition, population estimates supplied by the RACE Division of the NWAFC allowed estimates to be made of the total numbers of pollock of various year classes with tumors in the Bering Sea in 1976.

SAMPLE COLLECTION LOCALITIES - None were obtained.

DATA COLLECTED AND/OR ANALYZED

Type of observation

New data concerning age composition and population estimates by area (7 areas) for the Bering Sea was received from the RACE Division of the NWAFC.

Types of analyses

Comparisons between depth and tumor frequency and population density and tumor frequency were made.

RESULTS

The results of logistics planning for nearshore sampling in the NGOA indicate that demersal fishes will be collected by a charter vessel with space for five scientists. Although there were no firm commitments from the RACE Division, it is anticipated that at least one of our unit will be aboard for several of the cruises. The sampling will be performed in four bays on Kodiak Island; these include Izhut, Kalsen, Ailiuda, and Kayugnak Bays.

More in-depth analyses of data on pollock with pseudobranchial tumors from the 1976 Bering Sea cruise were performed. The tumor frequency for individual year classes ranged up to 3.8% for males of the 1973 year class. It was estimated from population estimates for pollock, that, at the time of our sampling, 23 million pollock between the ages of 2 and 5 had tumors. This amount includes 10 million of the 1973 year class alone. Also, a clear relationship between depth of fishing and the frequency of pollock tumors was found. No tumor-bearing pollock were captured in any of the 12 hauls made deeper than 92 fathoms (168 m). Approximately 15% of the pollock in samples from more shallow waters (50-69 fathoms) had tumors. A relationship was also found between population density and tumor frequency; the largest catches of pollock had the lowest tumor frequencies. The small to intermediate level catches had higher frequencies of animals with tumors.

PRELIMINARY INTERPRETATION OF RESULTS

The logistics planning phase of sampling in the nearshore waters of the NGOA is progressing satisfactorily. The principal concern of our research unit is that we will be able to examine fish aboard the sampling vessel.

Recent analyses of the field data concerning pollock from the Bering Sea reemphasizes that the pollock pseudobranchial tumors affect mainly young pollock. The fate of tumor-bearing pollock over 5 years of age is not known. Two types of data suggest that the effects of the tumors are detrimental: (1) previous data has demonstrated that pollock with tumors were 15% shorter than normal-appearing pollock of the same age and sex, and (2) the observation that tumor-bearing pollock are more often caught in areas of lower pollock numbers suggests that affected pollock are unable to compete for survival with larger populations of fish and must move to niches where the populations are smaller and competition is reduced. In addition, the estimation that over 23 million pollock had tumors in the Bering Sea in 1976 reemphasizes the severity of this problem.

The observation that pollock in shallower waters tend to have higher tumor frequencies strengthens the need for the nearshore studies which are planned for FY 1979.

AUXILIARY MATERIAL

Bibliography of references - None

Papers in preparation or in print

McARN, G.E., B.B. McCAIN, and S.R. WELLINGS. 1978. Skin lesions and associated virus in Pacific cod (*Gadus macrocephalus*) in the Bering Sea. Fed. Am. Soc. Exp. Biol. (Abstr., In press).

McCAIN, B.B., S.R. WELLINGS, C.E. ALPERS, M.S. MYERS, and W.D. GRONLUND. 1978. The frequency, distribution, and pathology of three diseases of demersal fishes in the Bering Sea. J. Fish. Biol. 11 (In press).

McCAIN, B.B. 1978. The effects of Alaskan crude oil on flatfish, and the prevalence of fish pathology in Alaskan marine waters. In: Sublethal Effects of Petroleum Hydrocarbons and Trace Metals Including Biotransformations, as Reflected by Morphological, Physiological, Pathological, and Behavioral Indices. NOAA Tech. Memo. (In press).

McCAIN, B.B., W.D. GRONLUND, M.S. MYERS, and S.R. WELLINGS. 1978. Tumors and microbial diseases of marine fishes in Alaskan waters. J. Fish Diseases (Submitted).

Oral Presentations

McCAIN, B.B. The Effects of Alaskan Crude Oil on Flatfish, and the Prevalence of Fish Pathology in Alaskan Marine Waters. OCSEAP Program Review, Nov. 29-Dec. 2, 1977, Seattle, Washington.

PROBLEMS ENCOUNTERED -- None

ESTIMATE OF FUNDS EXPENDED

Total spent: $11.7K

QUARTERLY REPORT

Contract 03-5-022-56
Research Units #427/426
Task Orders #1 and #13
Reporting Period 10/1 - 12/31/77

BERING SEA ICE EDGE ECOSYSTEM STUDY
(ZOOPLANKTON, MICRONEKTON STUDIES)

Dr. Vera Alexander
Dr. R. Ted Cooney

January 6, 1978

I. Task Objectives

A. R.U. #427

To study the dynamics of 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 southease Bering Sea during ice free conditions in order to compare seasonal activity, and also to look at the role of the shelfbreak and the Aleutian upwelling in Bering Sea production dynamics. The seasonal role of algae growing on the underside of the ice is also included in the study.

B. R.U. #426

This study addresses the survey of zooplankton and micronekton communities in the inshore region from Norton Sound to Point Hope. Standing stocks and occurrance of cominant species in the diets of fish collected by other investigators will be used to evaluate the importance of animal plankters in the nearshore zone during the mid-summer period.

II. Field and Laboratory Activities

The field work for both of these projects, as currently conceived by NOAA, was completed in the summer of 1977.

All laboratory analysis, for which funding has been received, have been completed. Analysis of these data and preparation of final reports is proceeding.

IV. Problems:

As of this date we have not received approval of FY '78 proposal including the remainder of the funds covered by that proposal. This delay in funding may jeopardize the analysis of the one remaing batch of zooplankton data.

QUARTERLY REPORT

Contract #3-5-022-56
Research Unit 537
Task Order 32
Reporting period 10/1/77-12/31/77
Number of pages: 4

NUTRIENT DYNAMICS IN NEARSHORE UNDER-ICE WATERS

Dr. Donald M. Schell

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

I. TASK OBJECTIVES

The continuing evolution of this project to meet the data requirements of the integrated biological assessment being undertaken by the LGL Barrier Island - Lagoon System study group has resulted in the considerable expansion of the objectives of this project over the last few months. The initial task objectives remain valid and are as follows:

1. Establish mass balance relationships for particulate and dissolved nitrogenous nutrients beneath the winter ice cover in the nearshore Beaufort Sea.

2. Compare standing stocks of epontic algae in relation to under-ice circulation.

3. Collect data delineating temporal and spatial variability in ice algae blooms in the nearshore Beaufort Sea.

Since commencing work on the above objectives, research has shown that additional secondary trophic production may result from the utilization of detritus derived from terrestrial materials eroded or transported into the lagoon waters. Large quantities of benthic fauna have been found intimately associated with a matrix of loose detrital material composed primarily of peat residues eroded from the shorelines of Simpson Lagoon. Calculations of the eroded quantities indicate that this material contains a sizable fraction of the total annual input of fixed carbon and nitrogen to the lagoon ecosystem and modelling efforts require that the significance of this eroded carbon to the system be known. The objectives of this project are therefore being expanded to include the following:

4. Determine the approximate fraction of benthic biomass derived from carbon sources arising from eroded or transported material into the lagoon system.

The complexities of detrital food webs and the difficulties involved in sampling and interpretation have presented severe problems in most studies of this type and considerable effort has been expended in devising a study plan that fits the constraints imposed by time and money. Fortunately, the nature of the eroded and transported material into the lagoon is such that the movement of the detrital carbon into the epibenthic biomass can be measured through a combination of isotopic techniques. The bulk of the detrital carbon is presumably derived from eroded peat which has a mean radiocarbon age of approximately 5000 years B.P. Thus, incorporation of appreciable amounts of peat derived carbon into the epibenthic organisms should cause a depression in their apparent radiocarbon age proportional to the fraction of peat carbon comprising their biomass. The logical extension of ^{14}C-dating to include higher trophic levels of the lagoon ecosystem, i.e. fish and birds, will show if the detrital carbon is carried up the food chain in significant amounts. Furthermore, by coupling radiocarbon dating to $^{12}C/^{13}C$ isotopic ratio determination, the relative amounts of total marine and total terrestrial carbon inputs might be measured. A schematic summary of these techniques is included as Figures 1 and 2.

II. WORKSHOPS ATTENDED

The LGL - Barrier Island study group met at Vancouver on 6-8 December 1977 and during this session the modelling effort emphasized the need to determine the activity of detrital carbon to the ecosystem. It was at this time that the proposed radiocarbon tracer technique was put forward and agreed to be undertaken. In conjunction with the ^{14}C-technique, determination of $^{12}C/^{13}C$ isotope ratios was also envisioned as a possible means of further separating modern terrestrial carbon inputs to the lagoon from modern marine carbon input. Although the likelihood of isotopic overlap of marine photosynthetic carbon over terrestrial photosynthetic carbon is high due to the cold water temperatures of that environment, isotopic ratios will be determined for representative members of the biota and the detrital matter.

III. LABORATORY ACTIVITIES

Routine chemical analyses of dissolved organic nitrogen and particulate nitrogen continues on samples obtained in Spring 1977 field trips. Completion of the analyses is anticipated by March 1, 1978.

IV. PROBLEMS ENCOUNTERED

None.

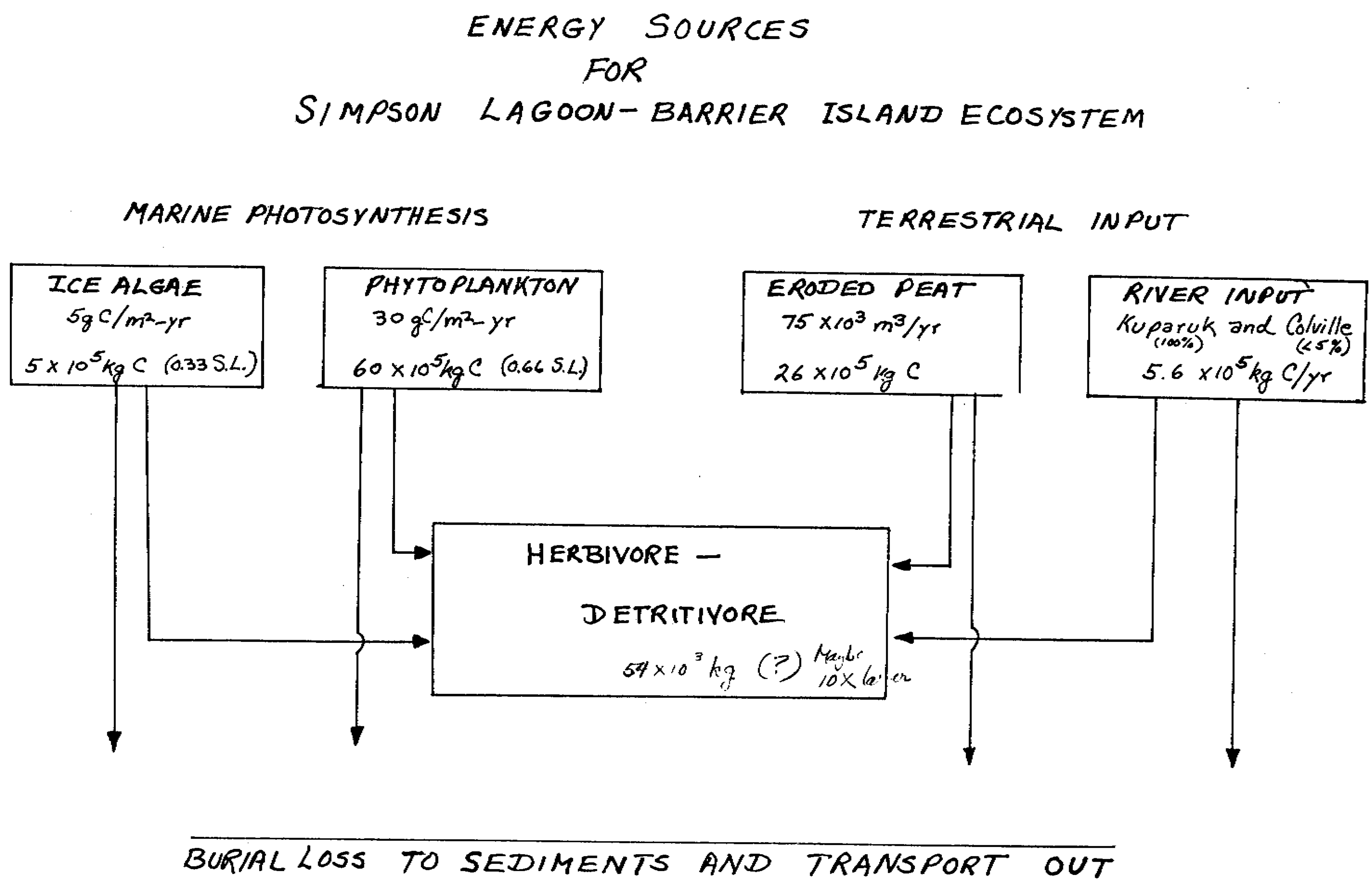


Figure 1. Energy flow and secondary production in Simpson Lagoon.

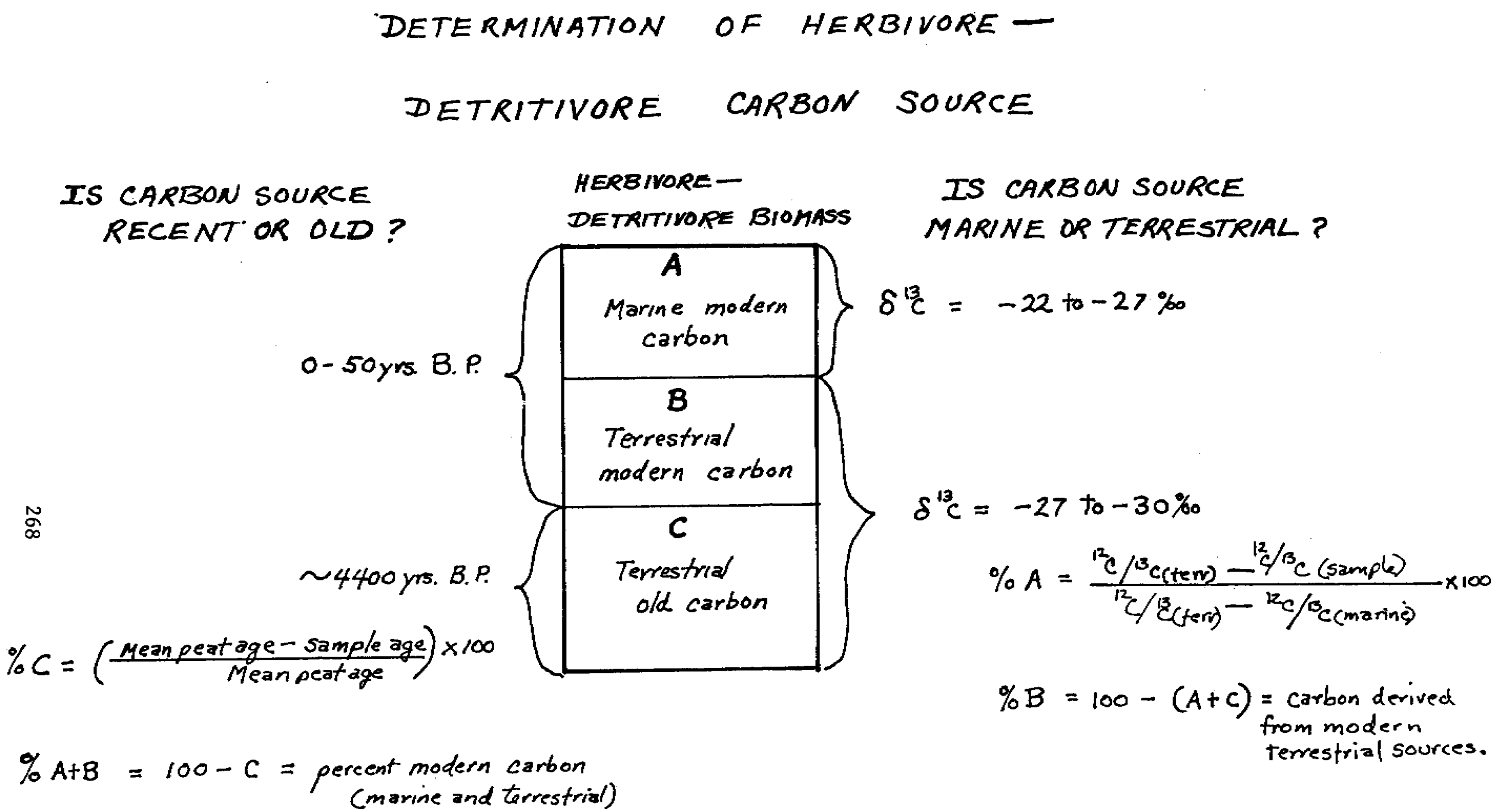


Figure 2. Carbon isotope techniques for allocation of energy sources in secondary production in Simpson Lagoon

CONTAMINANT BASELINES

CONTAMINANT BASELINES

QUARTERLY REPORT
Contract #01-6-022-11469

RESEARCH UNIT #43

Reporting Period
October 1, 1977 - December 31, 1977

Stephen N. Chesler, Harry S. Hertz, Willie E. May
and Stephen A. Wise

Trace Organic Analysis Group
Bioorganic Standards Section
Analytical Chemistry Division
National Bureau of Standards
Washington, D. C. 20234

January 3, 1978

I. Quarterly Accomplishments

Mytilus tissue samples being used for intercomparison study are being analyzed. Homogeneity and hydrocarbon content are being determined.

II. Task Objectives

The task reported herein relates to serving as a quality assurance laboratory for hydrocarbon analyses of marine waters, sediments and tissues. This objective is being met by: (1) conducting and interlaboratory comparison study on tissue samples of *Mytilus* homogenized by NBS; (2) acting as a consultant laboratory to other NOAA P.I.'s involved in hydrocarbon analysis.

III. Laboratory Activities

The two separates tissue homogenates which were prepared for the intercomparison study (one from *Mytilus* collected at Simpson Bay, Alaska and the other from *Mytilus* collected off Coal Oil Point, Santa Barbara, California) are being analyzed for homogeneity and hydrocarbon content. The primary analysis procedure consists of headspace sampling, LC clean up, and GC analysis. This procedure is being used to determine sample homogeniety and hydrocarbons in the GC range. GCMS is being used for qualitative identifications of compounds present in the cleaned headspace sample. Polynuclear aromatic hydrocarbons are being determined by a HPCL-Fluorescence procedure. Water content, and total extractable hydrocarbons are being done by gravimetric procedures.

IV. Recommendations

Laboratories should put all data on a comparable basis by determining the absolute recoveries of compounds added as internal standards. A procedure such as that recommended by John Farrington should be instituted on the next intercomparison study.

V. Funds Expended: $24,081.00

VI. Auxiliary Materials

Recent work in this laboratory on LC aminosilane columns will find application in NOAA contract laboratories. A paper describing this work is attached.

The following was submitted as part of this report:

Wise, S. A., S. N. Chesler, H.S. Hertz, L. R. Hilpert, and W. E. May (1977) "Chemically-Bonded Aminosilane Stationary Phase for the High-Performance Liquid Chromatographic Separation of Polynuclear Aromatic Compounds", Journal of the American Chemical Society, Vol. 49, No. 14, pp. 2306-2310.

Quarterly Report

Contract #01-6-022-11469

RESEARCH UNIT #43

Reporting Period

July 1, 1977 - September 30, 1977

Stephen N. Chesler, Harry S. Hertz, Willie E. May and

Stephen A. Wise

Trace Organic Analysis Group
Bioorganic Standards Section
Analytical Chemistry Division
National Bureau of Standards
Washington, DC 20234

October 1, 1977

I Quarter Accomplishments

During the last quarter the results of the second sediment intercomparison study were tabulated and analyzed. Also a *Mytilus* tissue intercomparison material was prepared and distributed.

II Task Objectives

The task reported herein relates to serving as a quality assurance laboratory for hydrocarbon analyses of marine waters, sediments and tissues. This objective is being met by: (1) conducting a second series of interlaboratory comparisons on sediment; (2) conducting an interlaboratory comparison study on tissue samples of *Mytilus* homogenized by NBS; (3) acting as a sample-split coordinating-laboratory [10% of all samples collected by NOAA Principal Investigators (P.I.'s) will be sent for NBS analysis and/or redistribution]; (4) acting as a consultant laboratory to other NOAA P.I.'s involved in hydrocarbon analysis.

III Laboratory Activities

A. Preparation of *Mytilus* Tissue Intercomparison Material

Two separate tissue homogenates were prepared: One from *Mytilus* collected at Simpson Bay, Alaska and the other from *Mytilus* collected off Coal Oil Point, Santa Barbara, California. The *Mytilus* were frozen in dry ice immediately after collection and remained frozen until the time of homogenization. At that time the bivalves were partially thawed to facilitate removal of the tissue from the shell. Approximately 2 kg of each tissue were shucked and placed in a 3L tall-form beaker. The tissue was then homogenized for 1.5 h using a Brinkman ultrasonic homogenizer. Aliquots of the homogenate were transferred to 50 mL acid-cleaned glass bottles and sealed with aluminum foil-lined caps. The homogenate samples were refrozen and stored in a freezer at -10 °C. They were subsequently packed in dry ice and sent to the participating laboratories.

B. Mytilus Tissue Intercomparison Study

Laboratories participating in the intercomparison study received four bottles containing ∿50 g each of tissue homogenate; two of the bottles contained Alaskan Mytilus and two contained Santa Barbara Mytilus. For the purposes of intercalibration the following data were requested: (1) total hydrocarbons in the GC elution range (roughly C_{10}-C_{30}); (2) total extractable hydrocarbons; (3) pristane/phytane ratio and the amount of these present; (4) percent water; (5) identities and amounts of the three most abundant aliphatic and the three most abundant aromatic hydrocarbons in the GC range; (6) total polynuclear aromatic hydrocarbon (PAH) concentration (4 rings and larger); (7) identity and amount of the most abundant PAH (4 rings or larger); (8) the level of the analytical blank; the frequency of obtaining and the precision of the blank value; (9) all additional single compound identifications and concentrations which are made in the laboratory.

Participants in the study are: John Laseter, University of New Orleans; Roy Carpenter, University of Washington; Andy Benson, University of California at La Jolla; Rudi Bieri, Virginia Institute of Marine Sciences; Scott Warner, Battelle/ Columbus; David Shaw, University of Alaska; Patrick Parker, University of Texas; George Gould, Analytical Research Laboratories, Inc.; Warren Steele, ERCO; John Farrington, Woods Hole Oceanographic; Roger Bean, Battelle/Northwest; William MacLeod, NOAA/Seattle.

IV Results of the Second Sediment Intercomparison

The second sediment intercomparison exercise has been completed. The intercomparison material was supplied by Ian Kaplan and consisted of a marine, benthic sediment (collected near Santa Barbara, California), spiked with 1000 ppm (wet weight) of Southern Louisiana crude oil.

The participants in the exercise were: Roger Bean, Battelle/Northwest; Rudi Bieri, Virginia Institute of Marine Sciences; John Calder, Florida State University; John Farrington, Woods Hole Oceanographic; Ian Kaplan, UCLA; John Laseter, University of New Orleans; William MacLeod, NOAA/Seattle; Patrick Parker, University of Texas; David Shaw, University of Alaska; Warren Steele, ERCO; Scott Warner, Battelle/Columbus.

The experimental results of the study are summarized in Tables I and II. The methods used by each laboratory are summarized in Table III.

V. Interpretation of Results of the Second Sediment Intercomparison Study

Statistical analysis of the second intercomparison sample, gave the same results as the first intercomparison sample: the values do not belong to the same population. The ranges reported for various parameters indicate that values differing by as much as a factor of 10 (1000%) did occur in this intercomparison study. This observation is alarming since the sediment sample used in this study has a hydrocarbon burden many times higher than samples normally analyzed by the laboratories participating in Outer Continental Shelf baseline studies. In the analysis of samples at this level of contamination, errors due to lack of sensitivity will be minimized and analytical blanks will appear small.

There are probably several causes for the wide variance observed in the analytical data reported in this intercomparison study. The most consistent source of error is probably the lack of compensation for component losses during the analytical procedure (i.e., method calibration). The majority of the laboratories in this study utilize solvent extraction, silica gel fractionation and capillary column GC. Therefore, method dependent systematic errors are probably not the main source of inter-laboratory variance. The lack of method calibration is illustrated by the most abundant aliphatic hydrocarbon data listed in Table II. The most abundant aliphatic hydrocarbon ranged from n-C_{13} to n-C_{20} and reported concentrations varied from 6 to 46 μg/g. Large deviations in these easily measured (chromatographically) compounds must be due to a lack of proper system response factors. Proper use of internal standards will greatly reduce this type of error by correcting for extraction efficiences, and losses during fractionation, concentration, and gas chromatography. When analyzing a mixture containing analytes of widely differing volatilities (e.g., n-C_{12} and n-C_{33}) more than one or two internal standards are needed to assign reasonable response factors.

External standard calibration with a mixture of known composition serves as a less statisfactory alternative to the use of internal standards.

VII Recommendations

All laboratories should be required to calibrate their methods through the use of internal/external standards. System response factors for a number of "marker" compounds should be reported.

VIII Estimate of Funds Expended

All FY 77 funds expended.

Table I. Results of Santa Barbara Sediment Intercomparison Study

Laboratory Code	Hydrocarbons in GC Range (μg/g) Aliphatic	Aromatic	Total	Total Extractables (μg/g)	Pristane/Phytane ratio	Water Content (% H_2O)
NBS	-	-	630±60	2124	1.13±.07	58.55±.04
1	98.8	216.5	315.3	4160	1.6	85.5
2	290	29	319	1329	1.33	-
3	-	-	2280±500	2100±100	.99±.10	53.8±2.5
4	-	-	-	-	4.0	-
5	488±154	51±32	539±186	-	1.95	60.08
6	-	-	-	1700	1.76	60
7:Method 1	305	138	443	4500	1.7	59
7:Method 2	262±25	60±9	322±36	4000	1.8±0.1	58
8	1200	1100	2300	-	1.38	-
9	74	34	108	2200	1.84	60
10	-	-	-	3253	1.74	-
11	905	700	1605	3365	2.0	55.8
Range	74-1200	29-1100	108-2300	1329-4500	.99-4.0	55.8-85.5
Ave	453±400	291±400	866±844	2831±1180	1.79±.73	61±9

Table II. Compound Specific Intercomparison Results*

Laboratory Code	Most Abundant Hydrocarbons (µg/g) Alphatic	Aromatic	PAHs >4 Rings	DDE Content (µg/g)
NBS	C_{13}-25±5 C_{10}-24±5 C_{14}-20±4	C_1-Naph-9±1 C_2-Naph-9±1 C_2-Naph-9±1	23±10	3.9±.2
1	C_{15}-8.6 C_{14}-8.4 C_{13}-7.5	C_2-Naph-27 C_2-Naph-16 2-Me-Naph-15	no PAHs	37
2	C_{20}-11.5 C_{21}-10.7 C_{22}-10.3	C_2-Naph-0.62 C_3-Naph-0.33 C_2-Phen-0.32	---	1.75
3	C_{16}-10.8±5.2 C_{19}- 9.4±2.9 C_{17}- 7.2±2.7	--- --- ---	---	---
4	C_{17}-8.3 C_{18}-7.2 C_{15}-6.8	--- --- ---	---	Most Abundant
5	C_{20}-16.8 C_{19}-16.7 C_{16}-15.9	--- --- ---	---	---
6	C_{15}-17.4 C_{14}-16.8 C_{17}-15.6	2-me-Naph-1.69 1-me-Naph-1.10 C_2-Naph-1.10	1.3	---

Table II (cont.)

Laboratory Code	Most Abundant Hydrocarbons (µg/g) Aliphatic	Aromatic	PAHs >4 Rings	DDE Content (µg/g)
7:Method 1	C_{16}-20.1 C_{15}-19.9 C_{17}-18.9	C_2-Naph-17 2-me-Naph-5.2 1-me-Naph-3.3	--	--
7:Method 2	C_{16}-17.5±1.9 C_{17}-17.0±1.6 C_{15}-16.4±1.8	C_2-Naph-11±1.5 2-me-Naph-2.8±.6 1-me-Naph-1.3±.2	--	--
8	C_{15}-46 C_{16}-43 C_{14}-37	--- --- ---	--	--
9	C_{16}-6.23 C_{15}-6.20 C_{14}-5.53	C_2-Naph-11.53 2-me-Naph-3.35 1-me-Naph-2.35	--	--
10	C_{15}-20.0 C_{16}-16.3 Pristane-15.2	---	--	--
11	C_{15}-27.7 C_{16}-26.3 C_{14}-24.9	C_2-Naph-2.25 C_2-Naph-0.91 C_2-Naph-0.81	--	2.0

* Abbreviations used: me = methyl, Naph = naphthalene, Phen = phenanthrene

Table III. Methods Used by Participating Laboratories

Laboratory Code	Method	Method Calibration
NBS	Dynamic headspace sampling for volatiles, hexane extraction for non-volatiles; capillary column GC.	Aliphatic and aromatic internal standard added prior to sample work-up at start of analysis. Southern Louisiana crude was used as external standard for total extractable hydrocarbons.
1	Freeze dry sediment; reflux with hexane and then benzene; silica gel fractionation and capillary column GC.	n-C_{14} used as an external standard for GC analysis.
2	Freeze dry sediment; reflux with toluene:methanol; saponify with 15N KOH; silica gel fractionation; capillary column GC.	Pyrene internal standard
3	Essentially same as Laboratory 2.	Cholestane and phenanthrene internal standard added prior to GC analysis.
4	Reflux wet sample with methanol; saponify; silica gel fractionation; GC.	No correction based on internal or external standard recoveries.
5	Four methods employed; results calculated from results of all methods.	Quantitation relative to an external standard.
6	Dry sediment with methanol; roll overnight with methanol: methylene chloride; rinse sediment; silica gel fractionation; capillary column GC.	Hexamethylbenzene used as GC internal standard; triphenylmethane internal standard added prior to extraction.

Table III. (cont.)

Laboratory Code	Method	Method Calibration
7 Method 1	Soxhlet wet sediment with benzene:methanol; silica gel fractionation; GC	C_{19}-cyclohexane internal standard added prior to GC analysis
Method 2	Essentially same as Laboratory 2.	
8	Soxhlet wet sediment with benzene:methanol; silica gel fractionation; capillary column GC.	Quantitation relative to an external standard composed of n-C_{14}, n-C_{18}, n-C_{22}, n-C_{32} and anthracene.
9	Shake wet sediment with anhydrous Na_2SO_4 and hexane overnight; silica gel fractionation; GC.	Internal standard added prior to GC analysis.
10	Freeze dry sediment, Soxhlet with methanol:toluene; TLC fractionation; capillary column GC.	Series of n-alkanes used as external standard for GC analysis.
11	Saponify and reflux sediment in methanolic KOH:toluene; Extract methanolic layer with toluene:petroleum ether; Cu-alumina clean-up; TLC fractionation; GC.	Androstane, n-C_{20}, and hexamethylbenzene added at time of extraction.

Quarterly Report

Research Unit: #152
Reporting Period: 10/1/77 - 12/31/77
Number of Pages: 28
Principal Investigators: Richard A. Feely
Joel D. Cline

Transport Mechanisms and Hydrocarbon Adsorption Properties of Suspended Matter in Lower Cook Inlet

Prepared by:

Richard A. Feely, Joel D. Cline, Gary J. Massoth,
Jane Hannuksela, and William M. Landing

Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration
3711 15th Avenue N.E.
Seattle, Washington 98105

December 31, 1977

I. Task Objectives

The major objectives of the Lower Cook Inlet suspended matter program include: (1) determination of the seasonal variability of the vertical fluxes, the distribution, and the composition of suspended particulate matter in areas of contrasting sedimentation and productivity; (2) participation in a cooperative study of the partitioning of certain trace element species among their major reservoirs; and (3) investigation of the physical processes and mechanisms controlling the accommodation of petroleum hydrocarbons with respect to Lower Cook Inlet suspended matter.

II. Field or Laboratory Activities

A. Field Activities

1. Ship Schedule

    a. DISCOVERER Cruise RP-4-Di-77C-II (3-12 October 1977)

    b. Previous cruises from which data will be discussed in this report:

    DISCOVERER Cruise RP-4-Di-77A-III (14-31 March 1977); and

    MILLER FREEMAN Cruise RP-4-MF-77B-III, 6-11 June 1977)

2. Participants from PMEL

    a. Dr. Richard Feely, Oceanographer

    b. Ms. Jane Hannuksela, Oceanographer

    c. Ms. Marilyn Pizzello, Physical Science Technician

3. Methods

    a. Particulate Matter - Water samples were collected in General Oceanics 1070 10-L PVC Top-Drop Niskin® bottles from preselected depths. Nominally these depths included: surface, 10 m, 20 m, 40 m, 60 m, 80 m, 100 m, 150 m, and 5 meters above the bottom. Aliquots were drawn within one-half hour after collection from each sample and vacuum filtered through preweighed 0.4 μm pore diameter Nuclepore® polycarbonate filters for total suspended matter concentration determinations and multielement particulate composition analyses. Samples were also filtered through 0.45 μm pore diameter Selas® silver filters for particulate carbon and nitrogen analyses. All samples were rinsed with three 10 mL aliquots of deionized and membrane filtered water, placed in individual polystyrene petri dishes with lids slightly ajar for a 24-hour desiccation period over sodium hydroxide and then sealed and stored (silver filters frozen) for subsequent laboratory analysis.

b. Sediment Trap Design, Deployment and Recovery - An exploded isometric view of the sediment trap design utilized for Lower Cook Inlet and northeastern Gulf of Alaska vertical flux studies is shown in figure 1. The sediment trap consists of a PVC cylinder (diameter = 152 mm; length = 475 mm) equipped with the following components: a grid (mesh size = 12 mm) mounted at the mouth to prevent large organisms from entering the trap and for reducing turbulence within the trap; a guillotine-type closing lid to maintain sample integrity during retrieval operations; a self-contained presettable timer to actuate lid closure; and a PVC side chamber containing reagent grade sodium azide to reduce bacterial activity. In addition, polyethylene screens having a mesh size of 54 μm were placed inside the traps to size fractionate the particulate matter as it was collected. Material collected from below the screen was then operationally defined as the fine fraction and that collected from above the screen was defined as the coarse fraction.

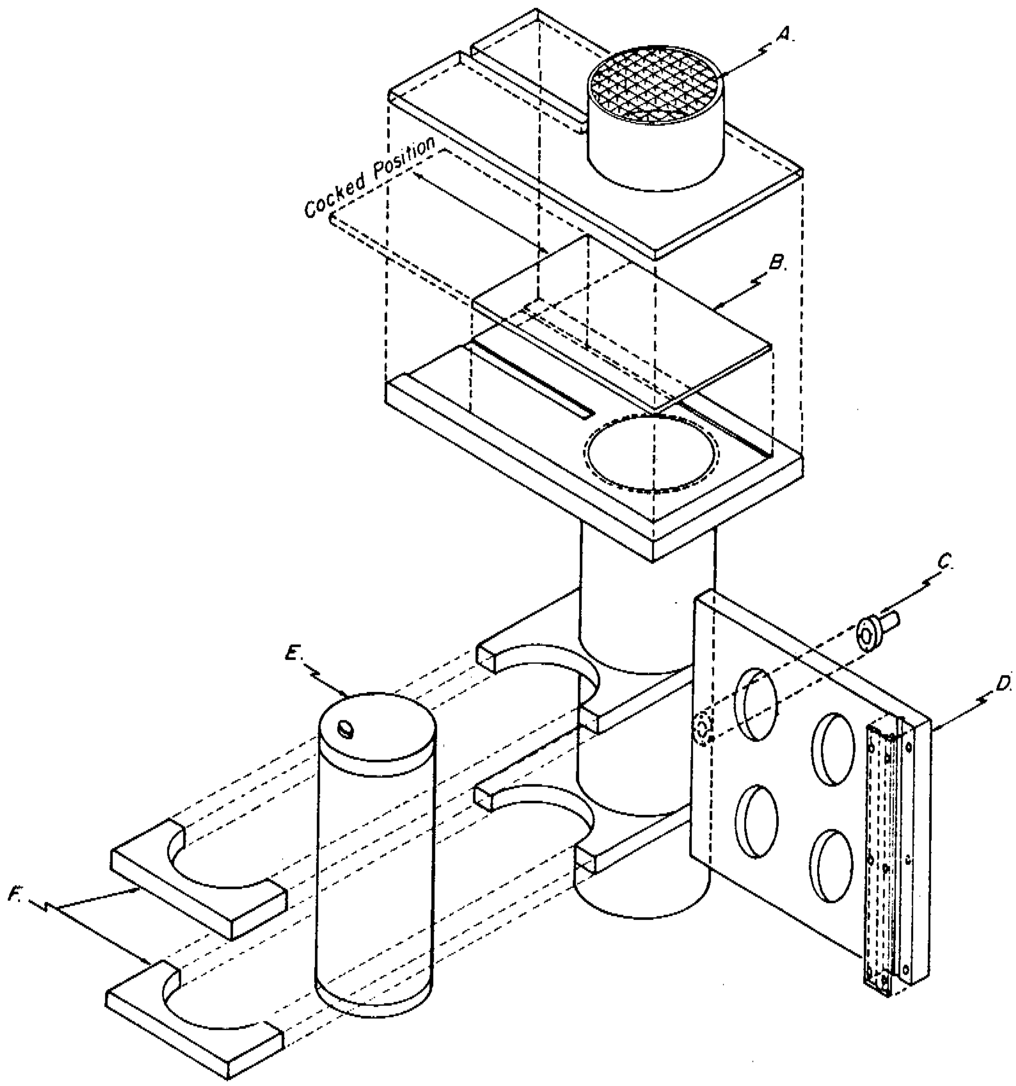


Figure 1. Exploded isometric design of the PMEL sediment trap. The major components of the sediment trap consists of the following: a. plastic grid for preventing large organisms from entering the trap; b. guillotine-type closing lid; c. sodium azide diffusion chamber; d. clamping brackets; e. presettable timer; and f. timer brackets.

Prior to deployment the sediment traps were sequentially washed with a mild laboratory soap solution, rinsed with reagent grade denatured alcohol, acid cleaned with 1N nitric acid, and finally, rinsed with deionized and membrane filtered water. Deployment of the traps entailed their attachment to the mooring cables of current meter arrays at preselected depths. The designs of the three arrays (designated C-1, C-4 and C-11) deployed in Lower Cook Inlet are shown in figures 2, 3, and 4. These arrays were deployed during Cruise RP-4-Di-77C-II (3-12 October 1977) and are scheduled for recovery in March 1978. Two arrays (SLS-22 and SLS-23, designs given in figures 5 and 6, respectively) were deployed south of Icy Bay in the northeastern Gulf of Alaska during Cruise RP-4-Di-77A-III (14-31 March 1977), and recovered during Cruise RP-4-MF-77B-III (6-11 June 1977). Sediment trap data from the latter two arrays only will be discussed in this report.

Lid closure for the sediment traps on the two northeastern Gulf of Alaska arrays was preset to occur 14 days after deployment and trap recovery was effected after a total of 84 days. The fine fraction material from the traps was collected on precleaned 142 mm, 0.4 μm Nuclepore® polycarbonate filters and rinsed with deionized, membrane filtered water adjusted to pH 8 with aqueous ammonia. The coarse fraction material and the supporting 64 μm screens were removed intact from the traps after rinsing with the pH adjusted water described above and stored in precleaned polyethylene bottles capped with pH 8 water for transport to the laboratory.

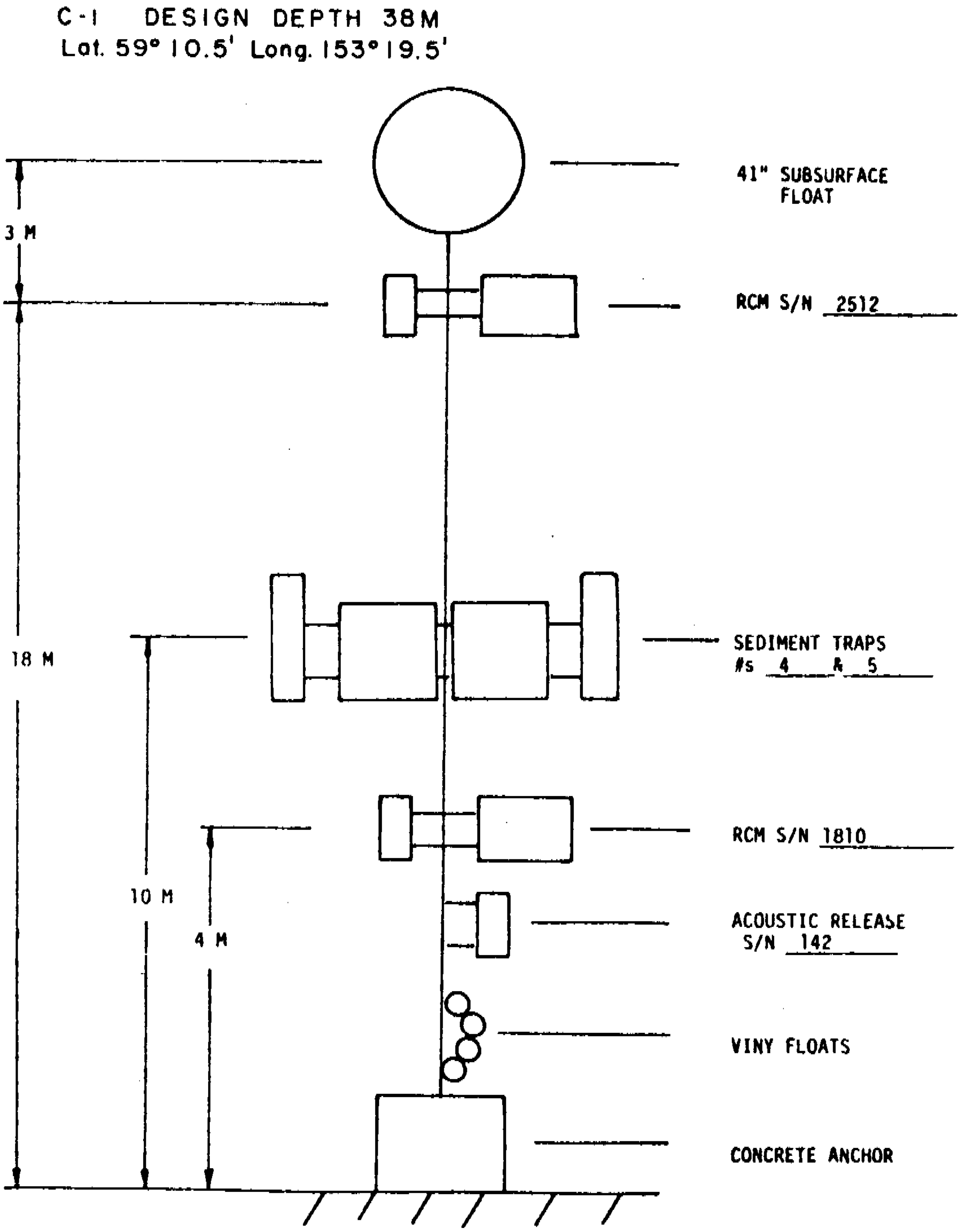


Figure 2. Mooring design for array C-1 deployed in Lower Cook Inlet (Cruise RP-4-Di-77C-II, 3-12 October 1977).

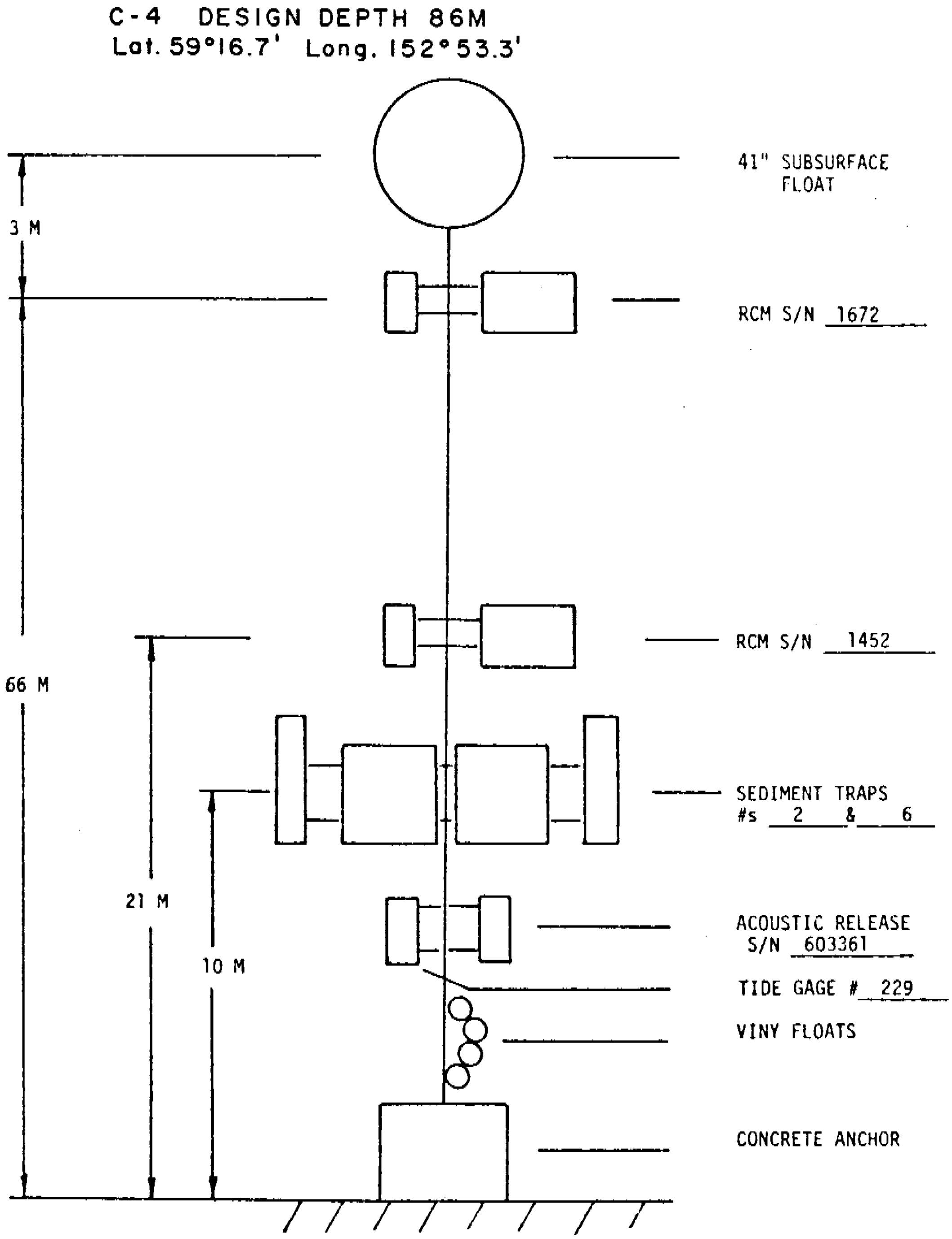


Figure 3. Mooring design for array C-4 deployed in Lower Cook Inlet (Cruise RP-4-Di-77C-II, 3-12 October 1977).

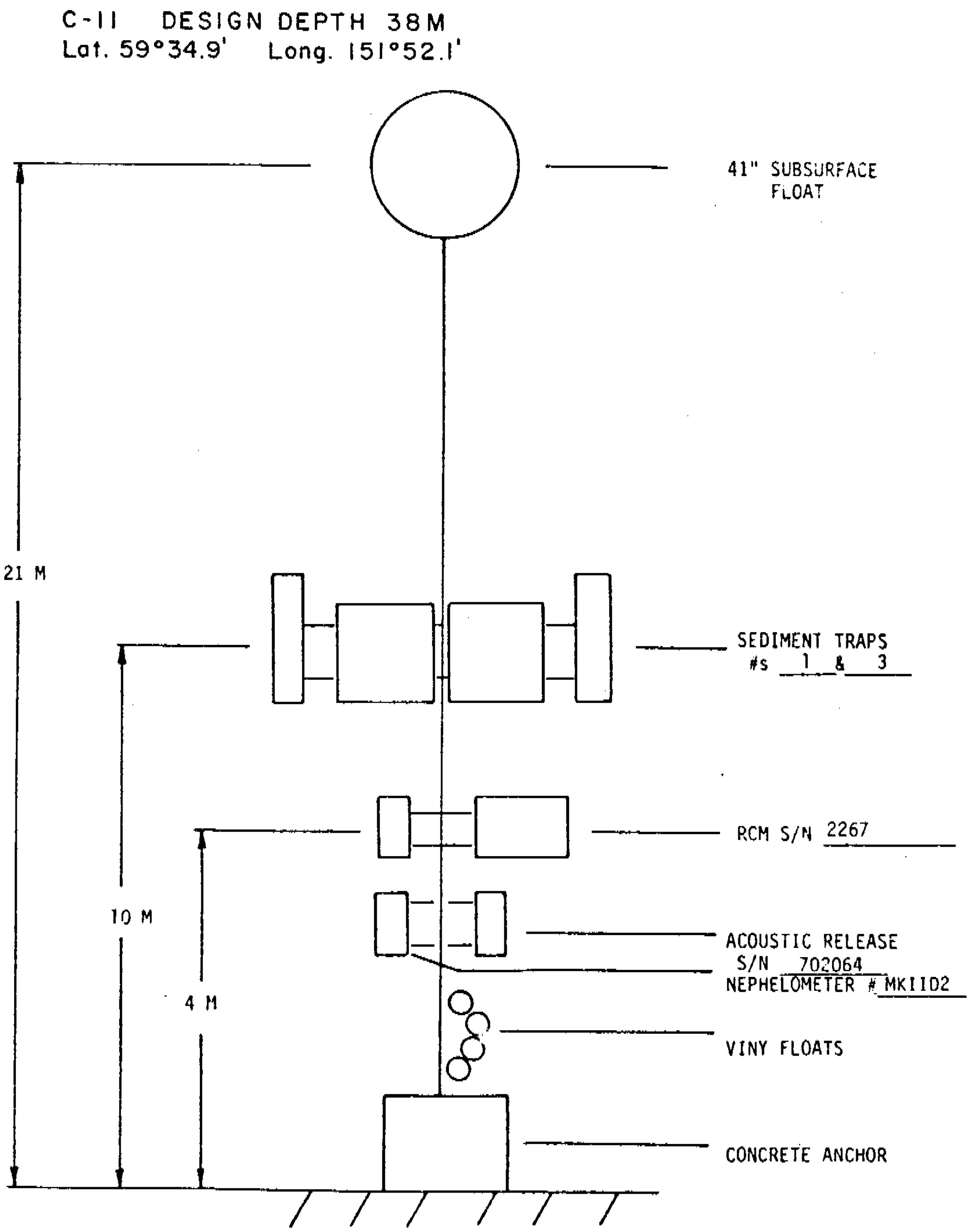


Figure 4. Mooring design for array C-11 deployed in Lower Cook Inlet (Cruise RP-4-Di-77C-II, 3-12 October 1977).

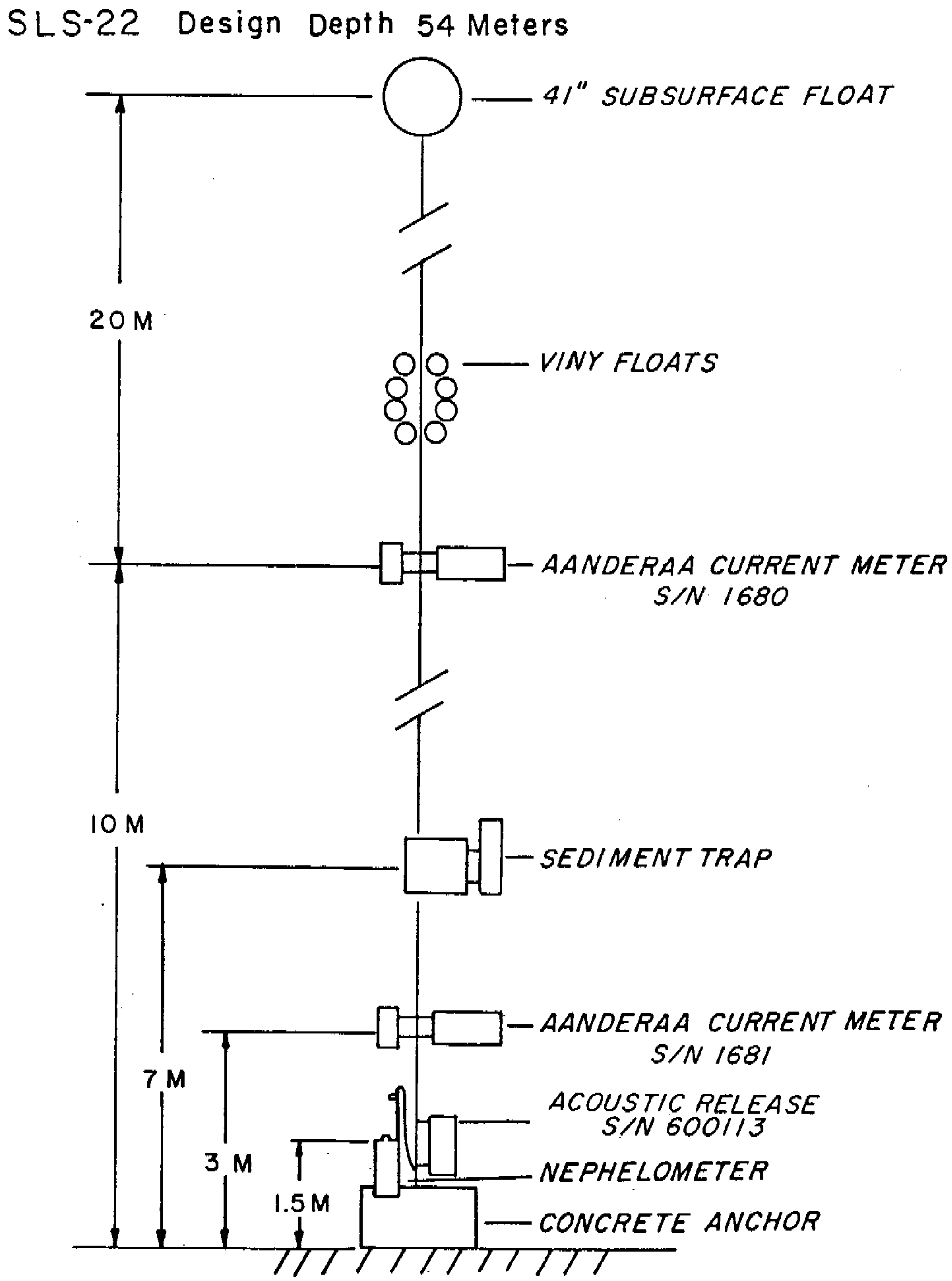


Figure 5. Mooring design for array SLS-22 deployed in the northeastern Gulf of Alaska. The mooring was deployed 17 March 1977 and recovered 8 June 1977.

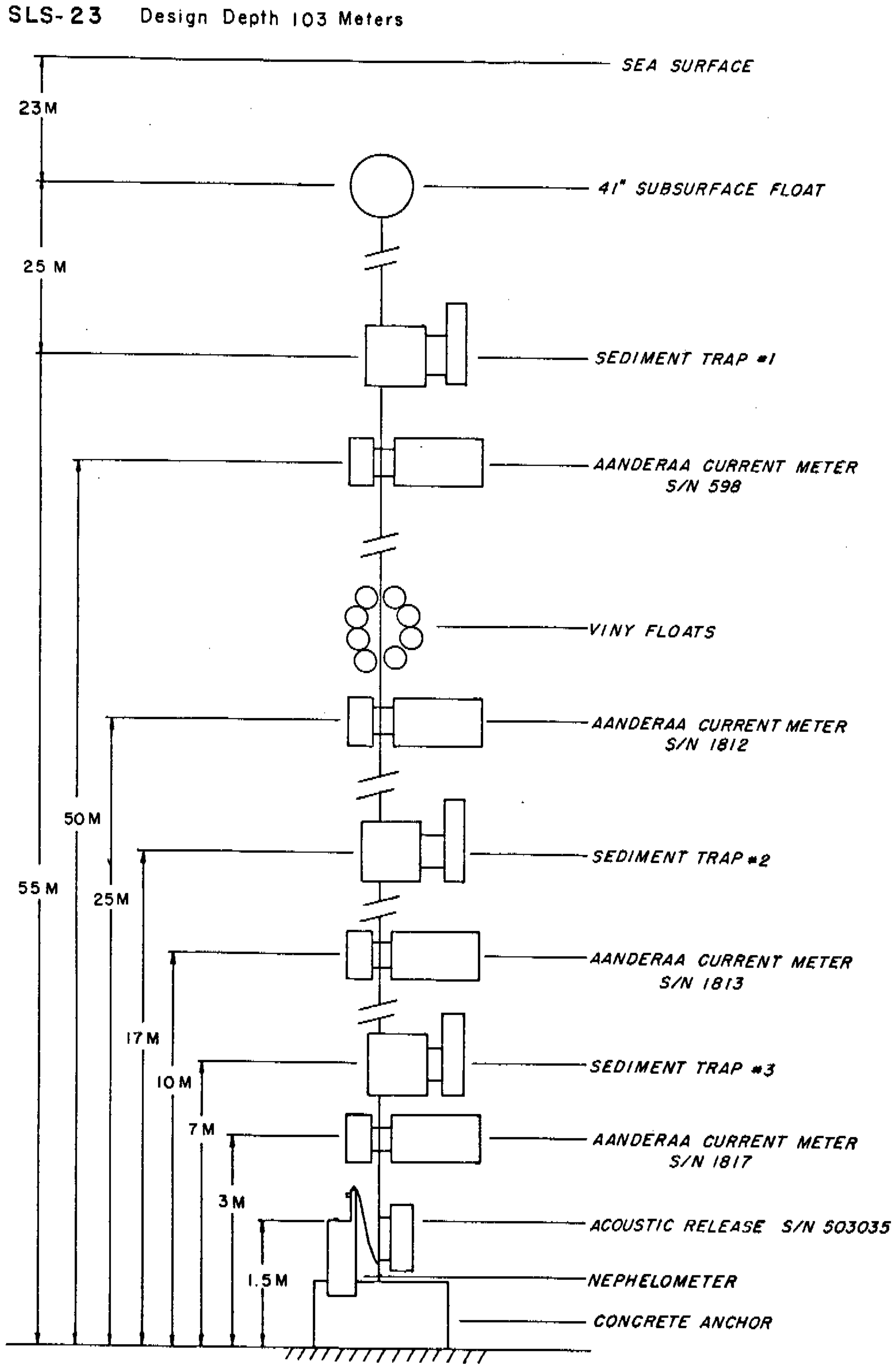


Figure 6. Mooring design for array SLS-23 deployed in the northeastern Gulf of Alaska. The mooring was deployed 17 March 1977 and recovered 8 June 1977.

c. Bottom Sediment - Bottom sediment samples were collected with a standard three-inch gravity corer equipped with plastic core liners and a standard Shipek grab sampler. All samples were immediately frozen and returned to the laboratory intact.

d. Nephelometry - The vertical distribution of suspended matter was determined with a continuously recording integrating nephelometer. The instrument was interfaced into the ship's CTD system using the sound velocity channel (14-16 KHz). Continuous vertical profiles of forward light scattering were obtained in analog form on a Hewlett Packard 7044 X-Y recorder.

In addition, digital recording nephelometers were used in conjunction with current meter arrays in both Lower Cook Inlet and in the northeastern Gulf of Alaska in order to obtain information relative to the processes that control resuspension and redistribution of bottom sediments. Semicontinuous digital information was recorded on magnetic tape over preset intervals during array deployment periods for subsequent interpretation with the aid of computer analysis at the laboratory.

e. Conductivity (Salinity), Temperature, and Depth - These standard hydrographic data were acquired with a Plessy Model 9040 Environmental Profiling System (CTD probe) and a Model 8400 digital data logger using 7-track, 200 B.P.I. magnetic tape. Temperature and salinity calibration data were provided by NOAA ship personnel from discrete water samples utilizing reversing thermometers and a bench salinometer, respectively. Signals from the CTD system and the nephelometer were also simultaneously interfaced into the ship's data acquisition system. This resulted in computer listings of continuous data for conductivity, temperature, depth, salinity, sigma-t and light scattering for all vertical profiles. A minimum of one vertical profile was obtained at each sampling location. The reduction and analysis of CTD data was performed by physical oceanographers at PMEL (RU #138).

4. Station Locations

   a. Figure 7 shows the locations of the suspended matter stations in Lower Cook Inlet (Cruise RP-4-Di-77C-II, 3-12 October 1977). Stations C-1, C-4, and C-11 are the locations of the arrays which contain current meters and sediment traps. A digital nephelometer was mounted on the array at station C-11 only.

   b. Figure 8 shows the locations of the suspended matter stations in the northeastern Gulf of Alaska (Cruise RP-4-Di-77A-III, 14-31 March 1977). Stations B (SLS-22) and D (SLS-23) are the locations of the arrays which contained current meters, sediment traps, and nephelometers.

5. Samples and Data Collected

   a. We have completed the first of six Lower Cook Inlet cruises scheduled for the present fiscal year. During this cruise (RP-4-Di-77C-II, 3-12 October 1977) we collected 175 particulate matter samples, two bottom grab samples, one gravity core sample, and 20 CTD and nephelometer profiles. A total of nine stations were occupied including one 24-hour time series study at station C-11 (figure 7).

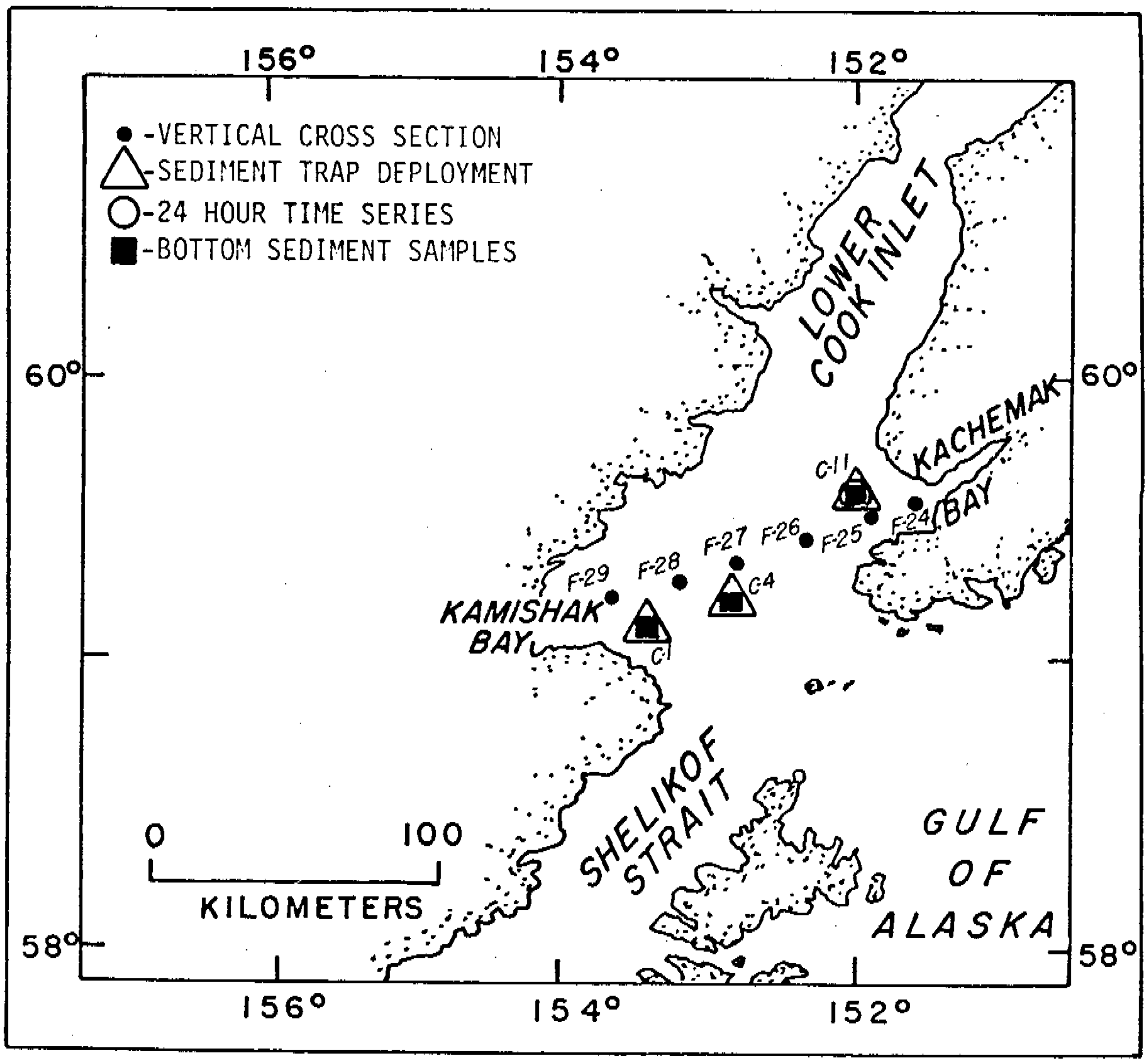


Figure 7. Locations of suspended matter stations in Lower Cook Inlet (Cruise RP-4-Di-77C-II, 3-12 October 1977).

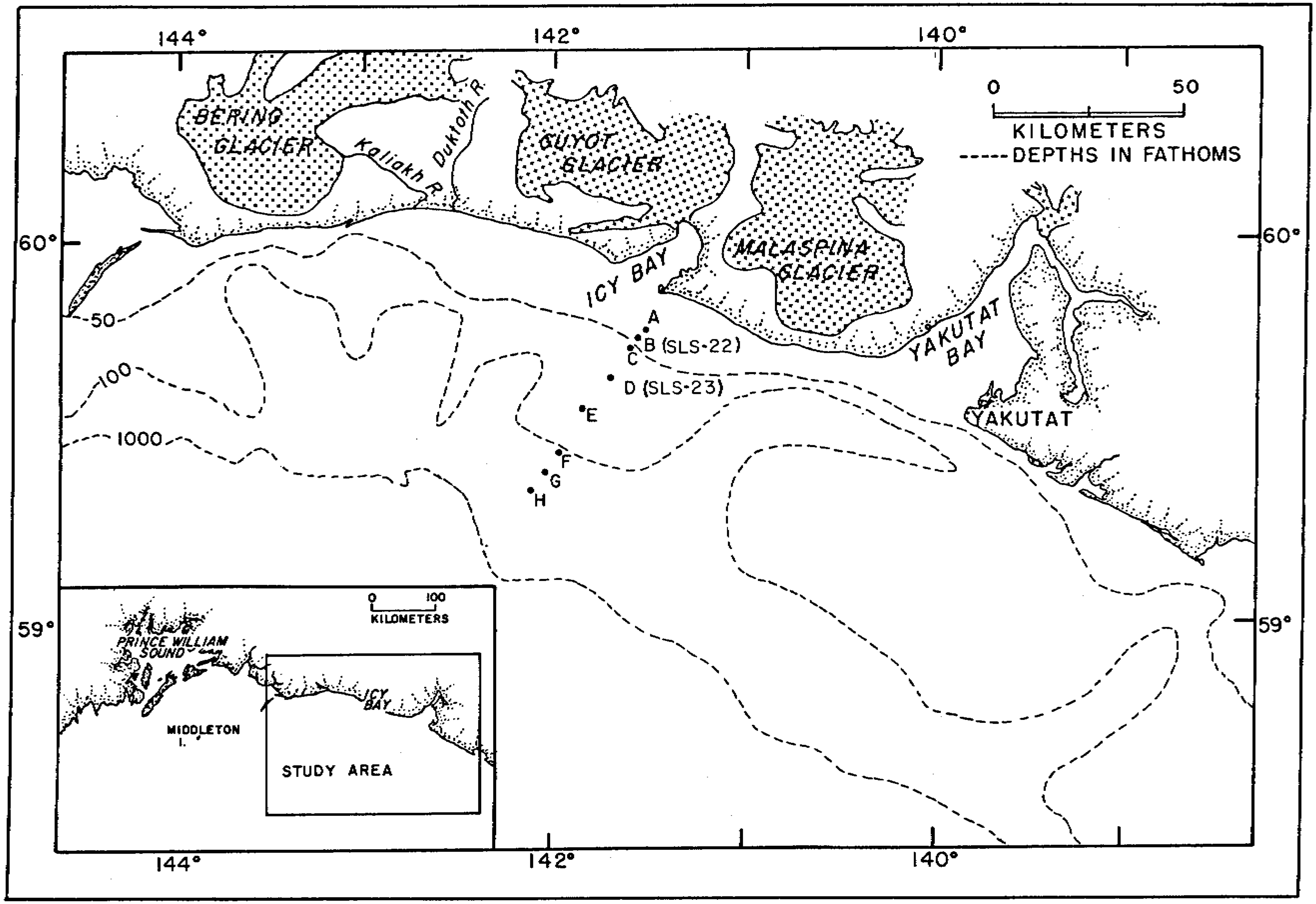


Figure 8. Locations of suspended matter stations in the northeastern Gulf of Alaska (Cruise RP-4-Di-77A-III, 14-31 March 1977).

b. Four sediment trap samples, one gravity core sample, one bottom grab sample, 175 particulate matter samples, and 40 CTD and nephelometer profiles obtained on cruises RP-4-Di-77A-III (14-31 March 1977) and RP-4-MF-77B-III (6-11 June 1977) in the northeastern Gulf of Alaska (figure 8) conducted prior to this reporting period will be discussed herein.

B. Laboratory Activities

1. Methods

a. Gravimetry - Total suspended matter concentrations and particulate fluxes were determined gravimetrically. Volumetric total suspended matter samples were collected on 47 mm, 0.4 μm pore diameter Nuclepore® filters which were weighed on a Cahn® Model 4700 Electrobalance before and after filtration. The suspended matter loadings were then determined by difference. The weighing precision ($2\sigma = \pm .011$ mg) and volume reading error (± 10 mL) yield a combined coefficient of variation in suspended matter concentration (mg/L) at mean sample loading and volume (2.057 mg and 2 L, respectively) of approximately 1%. However, preliminary investigations of sampling precision (coef. of var.: 25%) suggest that the actual variability in the particulate matter concentrations of these waters is much greater than the above analytical precision.

Particulate fluxes were calculated on a weight per unit time basis using the material collected in the various sediment traps. Trap material was quantitatively transferred to 142 mm, 0.4 μm Nuclepore® filters, dried in a vacuum desiccator over sodium hydroxide and weighed to .01 mg on a standard analytical balance.

b. Gas Chromatography - Analysis of total particulate carbon and nitrogen in suspended matter, sediment trap and bottom sediment samples was performed with a Hewlett Packard Model 185B C-H-N analyzer. In this procedure, particulate carbon and nitrogen compounds are combusted to CO_2 and N_2 (micro Dumas method), chromatographed on Poropak® Q, and detected sequentially with a thermal conductivity detector. NBS acetanilide is used for standardization. Analyses of replicate surface samples yield coefficients of variation ranging from 2 to 10% for carbon and 7 to 14% for nitrogen.

c. X-Ray Secondary Emission Spectrometry - The major (Mg, Al, Si, K, Ca, Ti, and Fe) and trace (Cr, Mn, Ni, Cu, Zn, and Pb) element chemistry of the suspended particulate matter, sediment trap and bottom sediment samples was determined by x-ray secondary emission (fluorescence) spectrometry utilizing a Kevex® Model 0810A-5100 x-ray energy spectrometer and the thin-film technique (Baker and Piper, 1976). The inherent broad band of radiation from a Ag x-ray tube was used to obtain a series of characteristic emission lines from a single element secondary target which then more efficiently excited the thin-film sample. Se and Zr secondary targets were used to analyze the samples for both major and trace elements. Standards were prepared by passing suspensions of finely ground USGS standard rocks (W-1, G-2, GSP-1, AGV-1, BCR-1, PCC-1) and NBS trace element standards through a 37 μm mesh polyethylene screen followed by collection of the size fractionated suspensates on Nuclepore® filters identical to those used for sample acquisition. The coefficient of variation for

10 replicate analyses of a largely inorganic sample of approximately mean mass was less than 3% for the major constituents and as high as 5% for the trace elements. However, when sampling precision is considered, the coefficients of variation increase, averaging 12 and 24% for major and trace elements, respectively.

d. Flameless Atomic Absorption Spectrophotometry - Sediment trap and bottom sediment sample elemental analysis was also performed by flameless atomic absorption spectrophotometry for Al, Cr, Mn, Fe, Ni, Cu, Zn, and Pb following a strong-acid total dissolution. Teflon digestion bombs (Bombco® Inc.) were utilized for dissolution, coupled with the reagent proportions outlined in Eggiman and Betzer (1976). Small quantities of each sample (1 to 3 mg) were placed in a bomb cup and 1500 μL of redistilled 6N HCl were added. The bomb was sealed, inserted in a hot-water bath, and boiled (90 to 100°C) for 30 minutes and then removed and allowed to cool. The bomb was then carefully opened and 250 μL of concentrated redistilled HNO_3 were added. The boiling and cooling process was then repeated. Finally, 50 μL of Ultrex® HF was added and the bomb was boiled for 60 minutes. Following cooling, the dissolute was transferred to a precleaned, CPE 30 mL bottle and diluted to 20 g total weight using deionized, filtered, redistilled water. Calibration standards were prepared by dilution of 1000 ppm stock solutions, and contained the acid reagents to duplicate the sample matrix. Samples were analyzed using a Perkin-Elmer 603 atomic absorption spectrophotometer equipped with an HGA-2200 flameless atomizer, D_2 background corrector, and an AS-1 automatic sampler. Data were collected on a model 56 chart recorder and tabulated by peak height. The precision of all analyses was generally well below the replicate sample variability reported as $\bar{x} \pm 1$ standard deviation. The accuracy of analysis and percent recovery of the digestion technique was checked by identical treatment of USGS Standard Reference Materials (SRM's: W-1, AGV-1, BCR-1, G-2). For all SRM's and all elements the percent recovery was essentially 100% within the statistical limits.

e. Visible Spectrophotometry - The analysis of Si in sediment trap and bottom sediment samples was accomplished following the spectrophotometric procedure of Strickland and Parsons (1960). Aliquots from samples prepared for flameless atomic absorption spectrophotometry (d above) were used and the analyses performed on a Beckman® Model 2400 spectrophotometer.

f. ^{210}Pb Radiometric Dating - Sediment accumulation rates were determined by the ^{210}Pb dating technique for core samples taken from the northeastern Gulf of Alaska and Lower Cook Inlet. Core subsections, one centimeter in thickness, were sent to the USGS laboratories in Corpus Christi, Texas where the analyses were conducted by Chuck Holmes and Ann Martin using the method described by Flynn (1968).

2. Sample and Data Status

a. Analysis of samples and data collected on Cruise RP-4-Di-77C-II (3-12 October 1977) and a laboratory investigation of crude oil-suspended matter interactions are currently under way and will be discussed in a future report.

b. The samples and data collected on Cruises RP-4-Di-77A-III (14-31 March 1977) and RP-4-MF-77B-III (6-11 June 1977) have been analyzed and will be discussed in the following sections.

III. Results

A. Vertical Particulate Flux Studies: Northeastern Gulf of Alaska

Hydrographic data and suspended matter distributions observed for a line of eight stations occupied during the March 1977 deployment of sediment traps in the northeastern Gulf of Alaska are shown in figure 9. The hydrographic parameters exhibit the expected seasonal distribution patterns with temperature increasing with depth in the nearshore region due to the introduction of relatively cold fresh water surface discharge and then decreasing with depth further seaward while salinity and sigma-t generally increase with depth throughout the study area. The suspended matter concentrations at station D (SLS-23) are relatively uniform with depth from the surface to about 90 meters where a steady increase is observed suggesting the presence of a bottom nepheloid layer which probably is due to the resuspension of sediments by bottom currents. The sediment trap positioned at 96 meters on the SLS-23 array was within the bottom nepheloid layer; and, consequently, the material captured within the trap might be expected to contain a significant quantity of resuspended sediments. The other two traps on this array were located above the bottom nepheloid layer and their contents should, therefore, more accurately reflect true sedimentation rates. The suspended matter concentrations at station B (SLS-22) are relatively high and uniform throughout the water column. The material captured in the single trap located at 47 meters on the SLS-22 array should, therefore, also accurately reflect the vertical particulate flux over the collection period at that site.

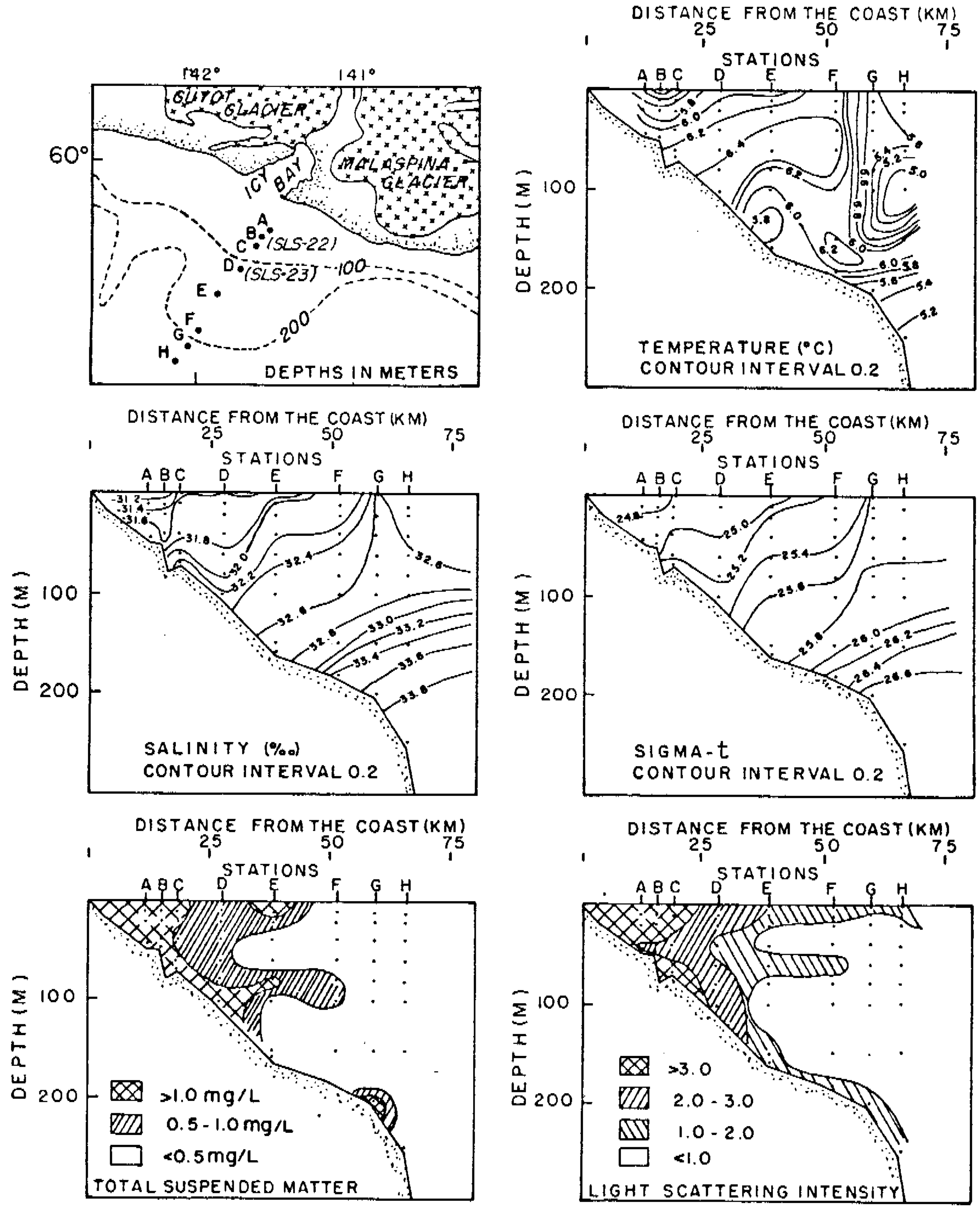


Figure 9. Hydrographic data and suspended matter distributions for suspended matter stations in the northeastern Gulf of Alaska (Cruise RP-4-Di-77A-III, 14-31 March 1977).

Table I shows a comparison of the sediment accumulation rate at SLS-23, which is based upon ^{210}Pb dating of a sediment core from the same location, with sedimentation rates from two size fractions in each of the three sediment traps. The data from the trap which was deployed at 48 meters is incomplete because the lid did not close and an undetermined amount of the coarse fraction was lost during the recovery operation. However, the sediment traps at 86 and 96 meters were recovered intact and the data show reasonably good agreement between the fluxes determined from the sediment traps and the sediment accumulation rate observed from the ^{210}Pb dating of the core. The middle trap, which was located at 86 meters, showed the best agreement with the accumulation rate. The total flux for the middle trap agrees within 13% of the accumulation determined from the core sample. The bottom trap is high by a factor of 2.7, and probably reflects its ability to capture resuspended sediments in addition to vertically settling particles. SLS-22 is not from the same area, so the accumulation rate will not agree with the ^{210}Pb number, but it does show the same percentages of fluxes in the coarse and fine fractions.

The next two columns in Table I show the absolute fluxes in the coarse and fine fractions of the bottom two traps, with the relative importance of these fractions indicated in the last two columns. The data shows that the major flux is associated with what we are defining as the coarse fraction. This relationship is consistent from one trap to another.

B. Composition of Particulate Flux Materials and Bottom Sediments: Northeastern Gulf of Alaska

The analytical techniques and the results of their application to the materials collected from the sediment traps and the underlying sediments at SLS-23 are shown in Table II. The data are reported as the mean ± 1 standard deviation, determined from replicate analyses. There are

TABLE I

Comparison of the sediment accumulation rate at SLS-23 (based upon ^{210}Pb dating of a sediment core sample) with sedimentation rates from two size fractions in each of three self-closing sediment traps which were deployed at 48, 86 and 96 meters on a current meter array from the same location and one sediment trap deployed at 47 meters on an array at SLS-22. The sediment traps were deployed open on March 17, 1977.

Sample Description	Time Open	Total Flux ($mg/cm^2/day$)	Particulate Flux ($mg/cm^2/day$)		Percentage of Total Flux	
			Coarse Fraction	Fine Fraction	Coarse Fraction	Fine Fraction
Sediment Trap #1 (SLS-23, 48 m)	84 days	-*	-*	0.26	-	-
Sediment Trap #2 (SLS-23, 86 m)	14 days	2.80	2.00	0.79	71.4	28.2
Sediment Trap #3 (SLS-23, 96 m)	14 days	8.80	6.60	2.20	75.0	25.0
Sediment Trap #4 (SLS-22, 47 m)	84 days	7.00	4.90	2.10	70.0	30.0
Sediment Core	-	3.20	-	-	-	-

*The sediment trap from 48 m did not close and a portion of the coarse fraction was lost.

Table II

Elemental composition of sediment trap samples and underlying sediments.

Sample Description	C[1] Wt. %	N[1] Wt. %	Si[2] Wt. %	Al[3] Wt. %	Cr[3] ppm	Mn[3] ppm	Fe[3] Wt. %	Ni[3] ppm	Cu[3] ppm	Pb[3] ppm	Zn[3,4] ppm
Sediment Trap #1 (SLS-23, 48m)											
Coarse Fraction...........	2.1 ±0.2	0.23 ±0.02	28 ± 1	6.1 ±0.2	94 ± 1	971 ± 12	4.6 ±0.05	43 ± 1	34 ± 2	18 ± 3	---
Fine Fraction	1.2 ±0.03	0.13 ±0.01	27 ± 1	6.6 ±0.4	99 ± 5	1055 ± 4	4.5 ±0.2	49 ± 1	41 ± 1	27 ± 2	161(140) ± 6 ±10
Sediment Trap #2 (SLS-23, 86m)											
Coarse Fraction...........	1.4 ±0.1	0.13 ±0.01	27 ± 2	7.2 ±0.2	93 ± 9	963 ± 16	5.3 ±0.6	49 ± 5	38 ± 1	27 ± 7	(104) ± 22
Fine Fraction	1.4	0.11	24 ± 0.5	7.7 ±0.2	100 ± 2	1034 ± 55	5.7 ±0.1	59 ± 4	51 ± 4	37 ± 1	194(173) ± 13 ± 4
Sediment Trap #3 (SLS-23, 96m)											
Coarse Fraction...........	1.2 ±0.1	0.12 ±0.02	33 ± 2	7.3 ±0.9	91 ± 3	933 ± 13	4.9 ±0.3	48 ± 4	39 ± 1	10 ± 1	(112) ± 2
Fine Fraction	1.7 ±0.06	0.14 ±0.01	24 ± 0.2	8.5 ±0.2	105 ± 2	1058 ± 5	6.2 ±0.1	60 ± 2	52 ± 3	16 ± 1	176(150) ± 9 ±12
SLS-23 Sediment Core.......	0.87 ±0.08	0.05 ±0.01	28 ± 1	8.1 ±0.4	100 ± 4	990 ± 16	5.2 ±0.3	51 ± 1	40 ± 2	10 ± 1	116 ± 7

[1]Carbon and nitrogen determined by dry-combustion gas-chromatography (micro Dumas technique).
[2]Silicon determined by standard colorimetric procedure following total dissolution ($HCl/HNO_3/HF$).
[3]Elements determined by flameless atomic absorption spectroscopy.
[4]Numbers in ( ) determined by secondary emission EDXRF spectrometry.

several interesting features illustrated in this table. First, total carbon and nitrogen appear to decrease slightly as one moves from the sediment trap at 48 meters to the sediments. Furthermore, within this depth sequence, nitrogen values decrease at a relatively faster rate than that observed for carbon and, thus, the carbon/nitrogen ratio progressively increases as one might expect. Second, Mn, Ni, Cu, Zn, and Pb appear to be enriched in the fine fractions of the sediment trap samples. However, element/Al ratios show significant enrichments for Cu and Pb only. This is an illustration of the dilution effect of excess Si, present either as biogenic opal or fine-grained quartz. The results for Zn also appear to indicate that analyses performed on subsamples of the sediment trap material by x-ray fluorescence tend to yield lower values than those performed by atomic absorption spectrophotometry. We are currently continuing this intercalibration study to determine the correspondence between both techniques for all elements studied.

While the gross elemental composition of the material collected at SLS-23 does not appear to change significantly, except for the elements already noted, there are some other interesting features that one may surmise from these data. First, the elemental composition of material collected in Trap #3 (96 meters) closely resembles the sedimentary material, supporting the contention that Trap #3 contains large quantities of resuspended material, while the carbon and nitrogen content more closely resembles the material from Trap #2 (86 meters). We suggest that this illustrates the importance of recycling of particulate organic matter, since the carbon and nitrogen content of the underlying sediments is significantly lower. If Trap #3 is to contain large quantities of resuspended sediments, then the recycling must occur in the sediments below the zone influenced by resuspension. Because the excess ^{210}Pb record shows no evidence of bioturbation (fig. 10), this recycling presumably occurs bacterially. Second, the depletion of particulate Pb between Trap #2 and Trap #3 is significant, but not completely understood at this time. We postulate that this depletion may represent the resuspension and subsequent loss of a Pb-containing and extremely fine-grained phase from the sediments. The input of either a continentally or atmospherically derived fine phase may be influencing the Pb content of the upper two traps, while the loss of this phase has resulted in a depleted Pb content for the sediments and Trap #3.

By combining the results of these elemental analyses with the flux determinations made for Trap #2 and the sediment accumulation rate determined for the gravity core, one may generate the elemental fluxes associated with both the sediment trap material and the sediment core. These data are shown in Table III. Because the total particulate flux as determined for Trap #2 accounts for only 87% of the sediment accumulation rate, one would expect the elemental fluxes to likewise account for only 87% of their accumulation rates if these particles settled unaffected by processes which may alter their composition. Significant excesses are seen for carbon, nitrogen, and Pb, a result consistent with the previous discussion regarding the total elemental analyses. Cu also exhibited a significant enrichment in the fine fraction for all three sediment traps, but the gross elemental composition, and hence the total Cu flux does not appear to reflect upon any processes which may have caused that enrichment. Finally, we see that while the trace metal content of the coarse fraction is depleted relative to the fine fraction on a ppm basis, the much greater coarse fraction flux leads to a greater total metal flux

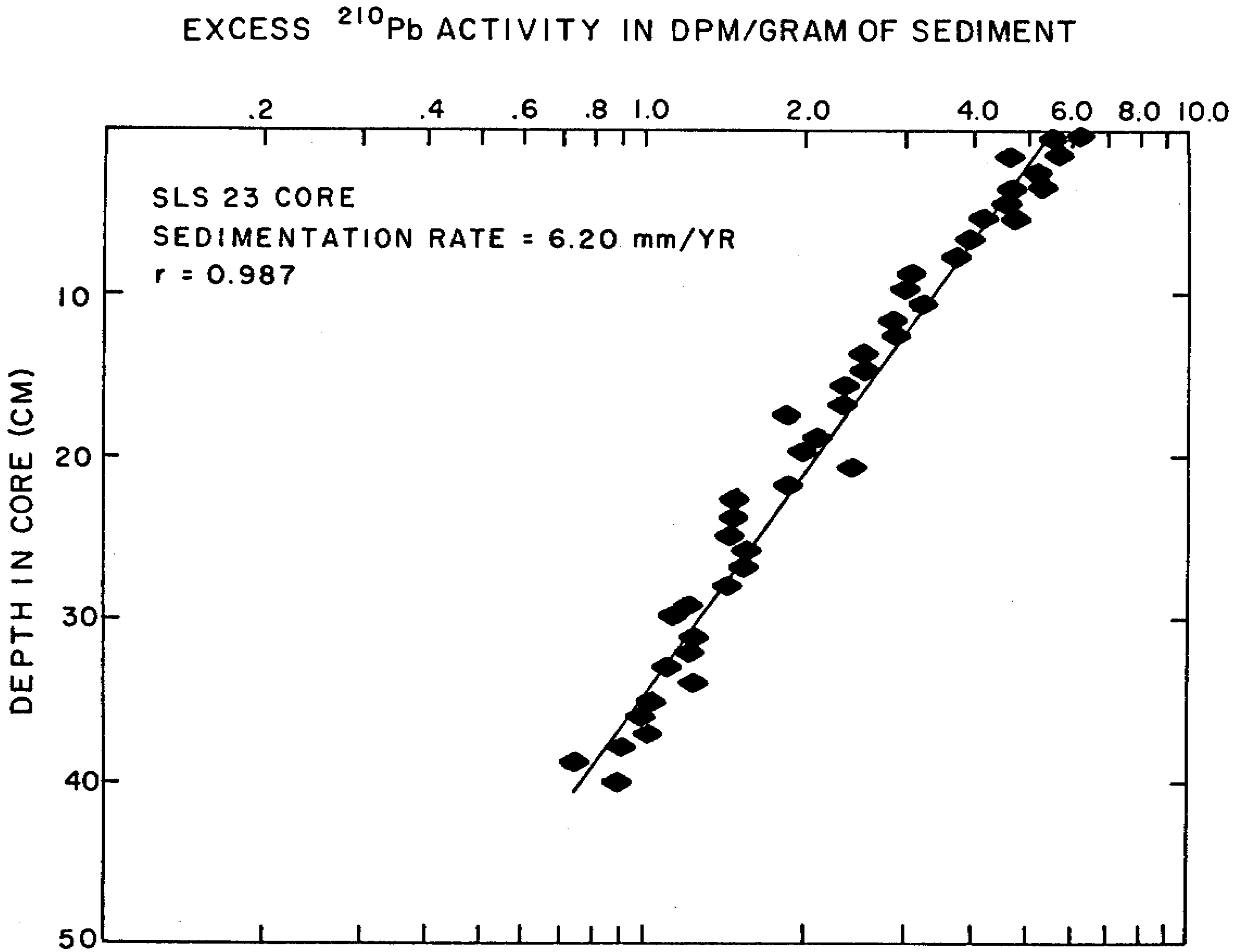


Figure 10. Excess ^{210}Pb activity profile for core sample obtained at SLS-23 (Cruise RP-4-Di-77C-IV, 14-31 March 1977). Data provided by C. Holmes and A. Martin, USGS, Corpus Christi, Texas.

TABLE III

COMPARISON OF MATERIAL FLUXES DETERMINED WITH THE MID-DEPTH SEDIMENT TRAP VS. MATERIAL ACCUMULATION RATES DETERMINED BY Pb-210 DATING OF THE UNDERLYING SEDIMENT CORE.

MATERIAL		SLS-23 SEDIMENT TRAP #2 COARSE FRACTION FLUX	FINE FRACTION FLUX	TOTAL FLUX	SLS-23 CORE ACCUMULATION RATE	PERCENT OF ACCUM. ACCOUNTED FOR BY FLUX
TOTAL PARTICULATE	mg/cm^2/day	2.0	0.79	2.79	3.20	87
CARBON	µg/cm^2/day	28 ± 2	11 ± 2	39 ± 4	28 ± 3	139 ± 21
NITROGEN	ng/cm^2/day	2600 ± 280	870 ± 100	3470 ± 300	1600 ± 320	220 ± 50
SILICON	µg/cm^2/day	540 ± 40	190 ± 4	732 ± 38	901 ± 25	81 ± 5
ALUMINUM	µg/cm^2/day	144 ± 11	61 ± 2	205 ± 11	260 ± 1	79 ± 5
CHROMIUM	ng/cm^2/day	186 ± 20	79 ± 2	265 ± 20	321 ± 11	83 ± 7
MANGANESE	ng/cm^2/day	1926 ± 31	817 ± 44	2743 ± 54	3168 ± 51	87 ± 2
IRON	µg/cm^2/day	106 ± 11	45 ± 1	151 ± 11	166 ± 9	91 ± 8
NICKEL	ng/cm^2/day	98 ± 10	47 ± 3	145 ± 11	163 ± 4	89 ± 7
COPPER	ng/cm^2/day	77 ± 1	41 ± 3	118 ± 3	128 ± 7	92 ± 5
LEAD	ng/cm^2/day	53 ± 13	29 ± 1	82 ± 13	33 ± 1	248 ± 10
ZINC	ng/cm^2/day	210 ± 44	153 ± 10	363 ± 45	371 ± 3	98 ± 12

within the coarse fraction. In fact, this greater coarse fraction flux leads to the conclusion that between 65 and 75% of the vertical flux of all elements is associated with this coarse fraction flux.

IV. Preliminary Interpretation of Results

The elemental composition and vertical flux of particulate material collected using sediment traps can accurately predict the composition and accumulation rate of the underlying sediments in the northeastern Gulf of Alaska study region, at least for this instance of trap deployment. Recycling of carbon, nitrogen, and copper possibly associated with particulate organic matter, appears to occur following deposition in the sediments below the zone of resuspension. A significant portion of the particulate flux to the sediments in the study area is in the form of large particles.

The significance of these results in relation to the effects of oil in the nearshore environment is obvious when the preliminary findings of a hydrocarbon-suspended matter interaction study are considered. These findings indicated that sediments may accommodate (and remove from solution) as much as 30% of their weight in oil (Feely and Cline, 1977). Therefore, if the particulate flux for a given area is known, then the amount of oil carried to the sediments by particles may be estimated. Furthermore, if elemental recycling associated with the sedimentary cycles is understood, then the effect of oil on the recycling process(es) may be investigated.

V. Problems Encountered

We have no significant problems to report at this time.

VI. Estimate of Funds Expended

	Allocated	Expended	Balance
Salaries and Overhead	$108.7K	$27.2K	$ 81.5K
Travel and Shipping	8.3K	1.4K	6.9K
Equipment	12.0K	4.5K	7.5K
Publications, Reports, Data Processing	1.7K	0.7K	1.0K
Other Direct Costs	6.7K	1.6K	5.1K
	$137.4K	$35.4K	$102.0K

References

Baker, E. T., and D. F. Piper. Suspended particulate matter: collection by pressure filtration and elemental analysis by thin-film x-ray fluorescence, Deep Sea Research, 23: 181-186, 1976.

Eggimann, D. W., and P. R. Betzer. Decomposition and analysis of refractory oceanic suspended materials, Analytical Chemistry, 48(6): 886-890, 1976.

Feely, R. A., and J. D. Cline. The distribution, composition, transport, and hydrocarbon adsorption characteristics of suspended matter in the Gulf of Alaska, Lower Cook Inlet and Shelikof Strait, Quarterly Report to OCSEAP, p. 36, 1977.

Flynn, W. W. The determination of low levels of polonium^{-210} in environmental materials, Analytica Chimica Acta., 43: 221-227, 1968.

Strickland, J.D.H., and T. R. Parsons. A Manual for Sea Water Analysis. Fisheries Research Board of Canada, Bulletin #125, p. 184, 1960.

QUARTERLY REPORT

Contract: #03-5-022-56
Research Unit: #12
R.U.: #162
Reporting Periods: 10/1/77-
12/31/77
Number of Pages: 66

DISTRIBUTION AND DYNAMICS OF HEAVY METALS IN ALASKAN SHELF ENVIRONMENTS SUBJECT TO OIL DEVELOPMENT

Dr. David C. Burrell
Principal Investigator
Professor of Marine Science

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

31 December 1977

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. TASK OBJECTIVES

The primary objective of this program is to research natural pathways of potentially toxic heavy metals to and through Alaskan Shelf and coastal marine biota (with emphasis on commercially important benthic species) and hence to determine and predict changes likely to result from oil industry activity in this marine zone. Ancillary components of this work include: (1) characterizing the heavy metal inventories of the water, sediment and indigenious biota in those geographical areas for which no background data exists; (2) determining non-biological pathways (rates and routes under both natural and stressed conditions) of the heavy metals as these affect the availability of metals to the organisms; (3) toxicity effects of selected heavy metals to animals which are of major commercial importance under Alaskan environmental conditions.

II. FIELD AND LABORATORY ACTIVITIES

A. Field Work

1. Lower Cook Inlet. O.S.S. *Surveyor* 3 - 17 November 1977.
   Personnel: T. Manson

Winter collection of sub-tidal benthic species: *Macoma calcarea* and crab. These samples were collected *via* trawl in cooperation with the benthic biology program. Sediment samples were collected also when possible using the Haps contamination-free corer. Samples collected are listed in Table I. Additional live samples of the sub-tidal *Macoma* were collected for laboratory experiments.

TABLE I

Lower Cook Inlet

Surveyor 3-17 November 1977

Sub-tidal species collected

Station	Surficial Sediment Sample	Sole	Crab[a]	Macoma	Neptunia
B		x			x
5			2		
27	x		1	x	
35			2		x
37	x	x	2	x[b]	
40	x	x	8		x
41			8		
53			4		x
62	x	x	6		x

a - Number of individual samples

b - Live subtidal *Macoma calcarea* to be used for aquaria experiments

2. Resurrection Bay (Lower Cook Inlet project). R/V *Acona* no. 254
28 November - 2 December 1977.
Personnel: D. C. Burrell
T. Owens
M. Robb
D. Weiss

Winter survey of hydrography, nutrient distributions at other chemical parameters in this estuary as shown in Table II. The primary objective of this cruise was to continue to obtain seasonal data for heavy metal distributions at the benthic boundary and within the water column. This inlet is a proxy for Lower Cook Inlet. Intertidal *Macoma* samples were also collected for aquaria experiments.

B. Scientific Parties

As noted above.

C. Field Collection Methods

1. Benthic biota. Sub-tidal samples trawled as noted above; intertidal samples hand-collected. Samples retained for tissue analysis were placed in clear sea water for 24 hours to allow depuration.

2. Sediment samples. Sediment samples on the *Surveyor* cruise (op cit) collected using the Haps corer. Splits were retained in duplicate wide mouthed bottles for sediment size analysis and extraction for heavy metal analysis.

3. Water samples. We have now standardized on a system for collecting water samples at sea for soluble heavy metal analysis. Since we have experimented with a number of procedures (and have had others forced on us because of the limitations of various sampling platforms) it would seem useful at this point to summarize our experience and make recommendations for future collection.

TABLE II

Resurrection Bay

R/V *Acona* Cruise 254 - December 1977

Operations

Physical and Chemical Observations

11.28	0856	001	Res 1	38 m	STD
11.29	0041	009	Res 2	168 m	STD, Hydro, Nuts
	0316	010	Res 3.5 A	278 m	STD, Hydro, Nuts
	0600	011	Res 2.5 B	275 m	STD, Hydro, Nuts
	1352	014	Res 3.5	193 m	STD, Hydro, Nuts
	1518	015	Res 4	255 m	STD, Hydro, Nuts
11.30	2125	0.7	Res 2.5	289 m	STD, Hydro, Nuts SS, Doc, Poc. TM
12.1	1511	020	A 1		STD, Hydro, Nuts
12.2	0730	024	A 2		STD

Early OCS work was carried out (and is still being performed to some extent) on NOAA vessels. None of these are specifically equipped to recover good contamination-free samples and therefore all collection procedures employed have and will be a compromise to some extent. For example, it is now an anathema in the chemical oceanographic community to collect water samples for this purpose from wire-hung bottles. All the samples collected to date from the *Surveyor*, *Discoverer* and *Oceanographer* have been so obtained and these data must be suspect to some extent because of this. Similarly, trace metal chemists, where they must use discrete samplers for deep waters, have virtually standardized on the go-flo type which contains no contaminating inner parts and which is isolated from the sea surface. The latter is inevitably contaminated because of discharges from the vessel. This type of bottle is still not ideal and further modifications are to be expected but it is a major advance on the samplers which were standard NOAA vessel equipment in the early days of the OCSEAP project. We have also samplers which are dedicated solely to this purpose and are specially cleaned and carefully stored. Use of ships rosette sampling bottles is less than ideal because these are general purpose samplers.

On *Acona* sampling trips the following trace metal sampling techniques are employed:

1. Use of Niskin go-flo bottles which are used only for this purpose. Each bottle is acid cleaned and carefully stored and all samples taken are identified with the individual bottle.

2. These samplers are hung on kevlar non-metallic line wound on a drum coated with non-metallic material and the bottles are tripped with coated messengers. The line is run out over a wooden block.

3. Water is directly pressure filtered from the bottle through an in-line filter and into a storage container. The nitrogen used to pressurize the bottle is filtered and the water filter holder and collection is done within a glove bag.

4. Filters used are washed, stored in acid and changed in a hood.

5. Sample collection bottles are all from a single batch which was carefully cleaned according to a standardized sequence and these bottles have been subsequently re-cleaned and re-cycled.

A different sampling procedure was attempted on the recent *Volna* cruise where only shallow water samples were required. In this case, water was pumped to and through the in-line filter directly using acid washed 3/4" I. D. polyethylane tubing and a high capacity Masterflex tube pump. Concurrently water samples were taken via a submersible pump installed on a CSTD system. A comparison of these data - which clearly demonstrates contamination from the bottles - will be given in the next report.

In view of the problems with contamination of samples intended for heavy metal analysis which have been documented in the last few years, it would seem that this is a very specialized procedure requiring time and equipment not readily compatible with NOAA Class I vessel operations.

D. Sample localities

1. Lower Cook Inlet. Sample localities for benthos and sediment collection on the November *Surveyor* cruise are shown in Table III and Figure 1.

2. Resurrection Bay. Station localities for R/V *Acona* cruise no. 254 are listed in Table IV.

TABLE III

Lower Cook Inlet

Surveyor 3-17 November 1977

Operations & Sample Locations

Station	Sample	Lat N	Lat W	Distance (nm)
B	Trawl	59°39.2'	151°45.7'	
		59°39.5'	151°46.9'	1.0
5	Trawl	59°01.6'	153°01.4'	
		59°03.4'	152°59.3'	2.2
27	Trawl	59°16.0'	153°33.2'	
		59°16.7'	153°36.6'	1.8
	Haps	59°15.0'	153°29.0'	
35	Trawl	59°27.2'	153°17.9'	
		59°27.3'	153°19.3'	1.5
37	Trawl	59°40.8'	151°13.6'	
		59°40.2'	151°14.8'	1.0
	Haps	59°41.2'	151°17.8'	
40	Trawl	59°35.7'	151°47.7'	
		59°36.4'	151°49.0'	1.1
	Haps	59°33.6"	151°44.6'	
41	Trawl	59°33.3'	151°53.9'	
		59°33.2'	151°56.0'	1.1
53	Trawl	59°32.2'	153°08.0	
		59°31.8'	153°10.6'	1.6
62	Trawl	59°40.8'	152°56.4'	
		59°46.0'	152°56.5'	0.8
	Haps	59°46.0'	152°56.2'	

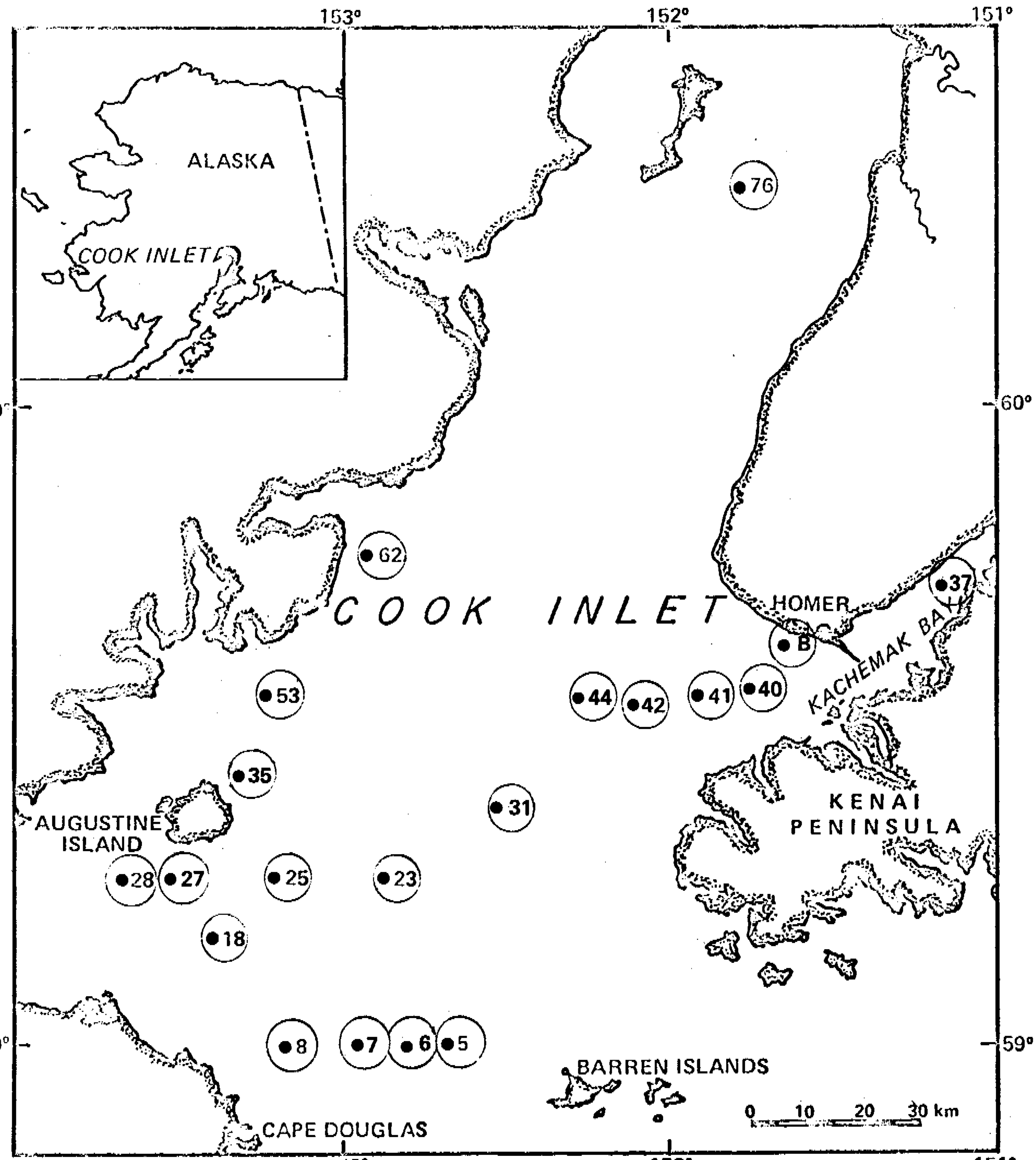


Figure 1. Lower Cook Inlet. Heavy metal chemistry program station localities occupied by O.S.S. *Surveyor* 3 - 17 November 1977.

TABLE IV

Resurrection Bay

R/V *Acona* No. 254 December 1977

Station Locations

Resurrection Bay

Res 1	60°06.5'	149°23.8'
Res 2	60°03.5'	149°23.4'
Res 2.5	60°01.2'	149°21.5'
Res 2.5 A	60°01.2'	149°23.0'
Res 2.5 B	60°01.2'	149°20.6'
Res 3		
Res 3.5	59°57.9'	149°20.7'
Res 4	59°54.7'	149°24.5'

Aialik Inlet

A1	59°53.7'	149°41.4
A3	59°45.7'	149°41.3'

3. Bering Sea. A corrected tabulation of station localities for the U.S.S.R. hydromet vessel *Volna* cruise of July - August (noted in previous quarterly reports) is given in Table V. These stations are plotted in Figure 2.

E. Laboratory Analysis Program

1. Marine mammal tissue samples. We have received and installed the low temperature plasma asher, and this is being currently used to complete the analysis phase of the marine mammal sub-project. A complete description of this new methodology now being developed for biota tissue samples will be given in the next quarterly report.

2. Benthic biota. The new ash/dissolution method noted above is now being applied to the benthic biota samples; both for samples sacrificed at sea and for those resulting from laboratory aquaria experiments.

3. Dissolved organic carbon. Difficulties with the procedure reported in the last quarterly report have now been resolved and all the back-logged samples have been run.

4. Analysis of suspended particulates. Suspended particulate samples from the standard stations in the FY '77 NEGOA specific study site (Yakutat Bay) and from the later Resurrection Bay study site have been analyzed for (1) total load, (2) particulate organic carbon, (3) Al content. Details of the procedures used for the latter will be given in a subsequent report.

5. Nutrient analysis. Samples from the Resurrection Bay study site are now being run. The Yakutat Bay data are complete and processed values from *Acona* cruise no. 240 are given in this report.

TABLE V

Bering Sea
U.S.S.R. Hydromet Vessel *Volna*, July-August 1977

Locations of heavy metal samples

Station no.	Sample type	Depth (m)	Latitude (n)	Longitude (w)
01	VP	125	57°30	173°20
03	VP	2700	57°59	175°00
05	VP	1140	58°30	176°40
07	VP	225	59°35	178°10
09	VP	115	59°55	174°57
11	VP	70	61°20	173°12
13	VP	70	63°00	173°40
15	VP	50	62°30	171°40
16	SF		62°15	170°50
17	VP	44	62°00	170°00
19	VP	29	61°30	168°10
21	VP	62	60°49	171°32
23	VP	100	59°58	173°20
26	VP	110	57°45	174°10
28	VP	2700	58°15	175°50
30	VP	140	59°01	177°18
32	VP	137	59°12	175°48
34	VP	85	60°37	174°05
36	VP	58	62°02	172°17
38	VP	57	62°45	172°40
40	VP	41	62°15	170°50
42	VP	38	61°45	169°05
44	VP	48	61°32	170°36
45	SF		60°50	171°32
46	VP	58	60°07	172°28
48	VP	139	58°41	174°10

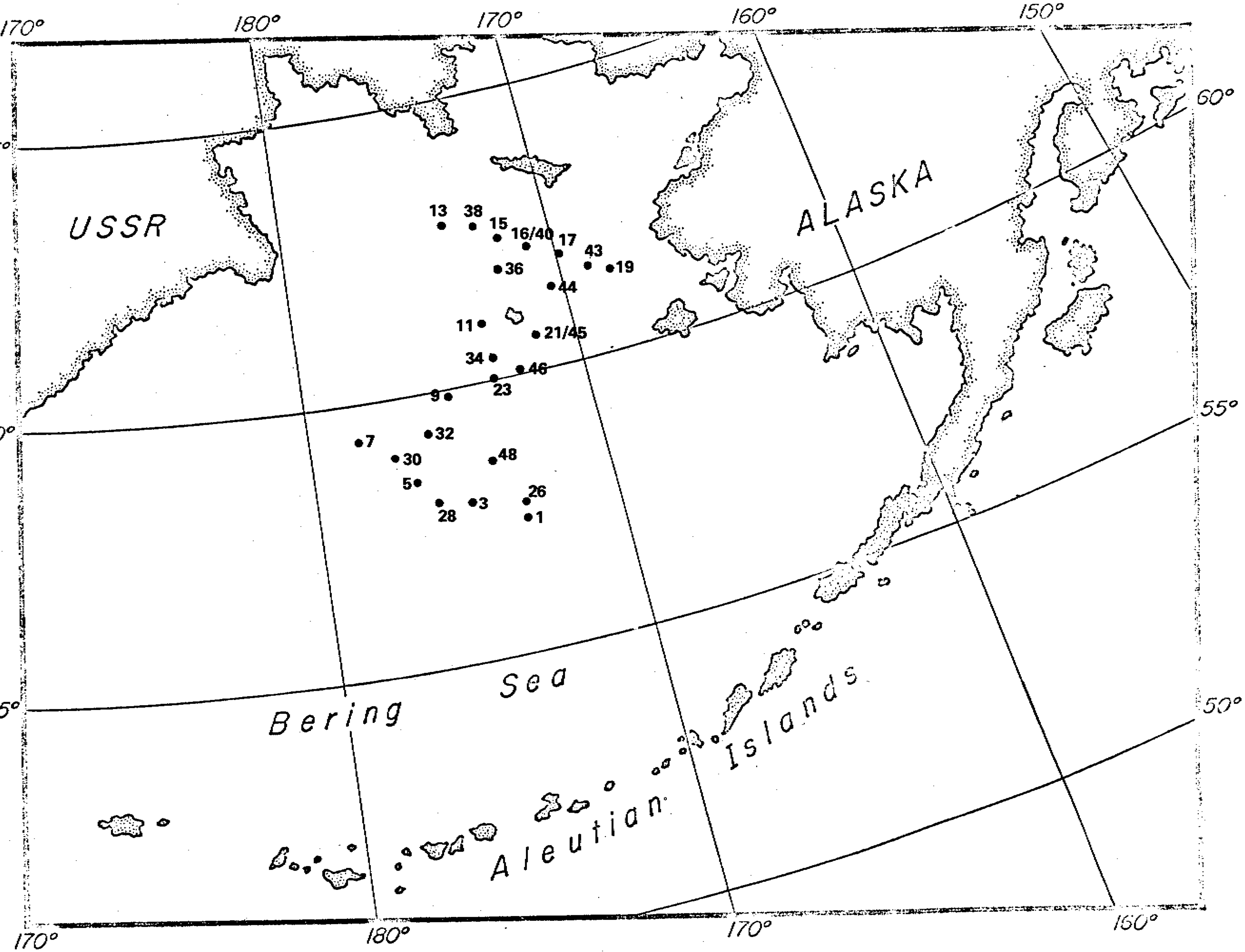


Figure 2. Heavy metal chemistry program, station occupied by U.S.S.R. hydromet vessel *Volna* July-August 1977.

6. Heavy metal contents of sediment extracts. No sediment has been processed in the current contract period. We are still waiting for a response from PMEL regarding the standardized extraction procedure to be followed as required by OCSEAP.

7. Soluble Cu and Mn by NAA (Dr. H. V. Weiss). This method is based upon the simultaneous isolation of copper and manganese from seawater by cocrystallization with 8-hydroxyquinoline (oxine). The crystals are irradiated with neutrons, and following simple radiochemical purification steps radio-induced ^{64}Cu and ^{56}Mn are quantified by gamma-ray spectrometry.

Chemicals. A solution was prepared to contain 10% (w/v) oxine in ethyl alcohol. Manganese and copper carrier solutions contained 10 mg ml^{-1} of cation in distilled water. Comparators were 1 and 4 μg ml^{-1} of manganese and copper, respectively. Hydrogen sulfide gas was of CP quality, while other chemicals were of AR grade.

Isolation of Copper and Manganese from Seawater. Seawater was acidified with concentrated hydrochloric or nitric acid to a final concentration of 1% (v/v). Aliquots (250 ml) were transferred to containers and received 10^{-2} μCi of a high specific activity ^{64}Cu (10^2 mCi g^{-1}Cu) or 0.1 ml of a carrier-free ^{54}Mn. The solution was warmed for 1 hr. on a hot-plate to approximately 80°C to equilibrate the radioelement with its counterpart in the sample. After cooling, an oxine solution (2.5 ml) was stirred into the sample and ammonium was encouraged by agitation with a rod. After the solution stood for 1 to 2 hrs, the crystals were collected on sintered glass of medium porosity. The isolated crystals, together with those adhering to the container walls, were dissolved in dilute nitric acid (1.6 N). The gamma-ray activity of the solution was measured in a well-type NaI(Tl) detector and compared with a tracer standard.

Treatment of Seawater Samples. Seawater was collected on two occasions 20-ft. below the surface off the end of the pier at the Scripps Institution of Oceanography, La Jolla, California. One collection took place on 2 July 1976, while the other was not dated. At the time of collection the samples were acidified - the undated with nitric acid and the dated with hydrochloric acid (10 ml l^{-1} of seawater) - and then filtered through a millipore membrane (0.45 μm). Aliquots (250 g) were transferred to plastic beakers; Mn (0.2 μg) and Cu (2.0 μg) were added to some aliquots. ^{54}Mn tracer was then added, and the elements were cocrystallized. The solution was next passed through a small filter membrane (1 cm diam) that was supported in a 7-ml polyethylene, snap-top, irradiation vial whose bottom was perforated with approximately 10 holes (0.05 cm diam). The ^{54}Mn gamma-ray activity of the separated crystals was measured and compared with a standard to correct for the fraction of oxine that adhered to the walls of the sample container.

Blanks. The copper and manganese content was determined, at least in duplicate, for oxine (250 mg), ethyl alcohol (2.5 ml), and ammonium hydroxide (2.5 ml). These reagents were used in these amounts in the preirradiation processing and were not common to the other procedure used in the comparative study. For future reference, these elements were also quantified in 2.5-ml aliquots of high-purity nitric acid (Ultrex, J. T. Baker).

Comparators. Each comparator solution (1 ml) was irradiated separately.

Irradiation. Samples, comparators, and blanks were irradiated for 2 hrs. at full-power in the TRIGA Reactor, University of California, Irvine, California. The flux was 1×10^{12} neutrons $cm^{-2} sec^{-1}$, and the specimens were rotated about the reactor core at 1 rev/min^{-1}.

Radiochemical Purification and Measurement. After irradiation the sample or blank was quantitatively transferred with 50 ml of 3 N HCl to a vessel that contained 1 and 2 ml of copper and manganese carriers, respectively. All blanks received a standard quantity of ^{54}Mn and, except for the oxine blank, they also received 250 mg of oxine. H_2S gas was bubbled for 30 sec through the solution, and the resultant CuS precipitate was collected by filtration. The filtrate was made ammoniacal, and the precipitated oxinate was collected and then dissolved in 50-ml concentrated HNO_3. The solution was heated over a flame for several minutes to degrade the oxine and, while hot solid $KBrO_3$ was added to precipitate MnO_2. After cooling in an ice-bath, the precipitate was separated by filtration.

The corresponding carrier was added to the comparator, and the Mn comparator was spiked with a standard quantity of ^{54}Mn. Copper was precipitated as described above; the Mn comparator was brought to 50 ml with concentrated HNO_3, heated, and then treated with $KBrO_3$.

All precipitates to be measured were collected on membrane filters, covered with a complementary paper disc, and bagged in polyethylene.

The induced radioactivities were measured flat against the surface of a 38-cm Ge(Li) detector coupled to a 4096 pulse-height analyzer. The gamma-ray pulses were accumulated for 10 to 20 min under live-time counting conditions. The pulse-height data were fed into a computer which provided the net counting rate for the 511 and 847 KeV photopeaks of ^{64}Cu and ^{56}Mn. The count rate was normalized for the ^{54}Mn yield determined prior to irradiation and for the lapse of time from the end of the irradiation.

Carrier Yield Determinations. The ^{54}Mn photopeak (834.8 KeV) of MnO_2 precipitates was measured at least 3 days after irradiation with a flat NaI(Tl) detector that was coupled to a 400-channel analyzer. The net count rate was corrected for the ^{54}Mn yield that was determined after the cocrystallization step. To permit comparison of these data with the ^{54}Mn standard solution, which was gross counted with a well detector, a factor was derived to normalize the different counting modes. A sample, determined to be radiochemically pure by gamma-ray spectrometry, was dissolved in concentrated HCl and counted in the same manner as the standard. With the factor derived from these two sample counts, the ^{54}Mn standard was adjusted to permit comparison of pulse-height analyzed samples with the solution standard, a process which provided the Mn carrier yield.

The filter membrane containing the precipitated copper was folded and inserted into a 1.3-ml, snap-top, polyethylene vial to which 0.6 ml of distilled water was added. Standards (0.6 ml of carrier solution) placed in similar vials also received a blank filter membrane to reproduce volume and geometric conditions. Samples and standards were irradiated for precisely 60 sec in a pneumatic tube facility with the reactor at full power. The 511-KeV photopeak of ^{64}Cu was measured in the manner described for the sample. After correction for decay from the end of the irradiation, comparison of the reirradiated samples with standards allowed calculation of the copper carrier yield.

The normalized ^{56}Mn and ^{64}Cu of the original irradiation were corrected for these yields. Upon comparison of fully normalized samples and comparator photopeaks, the weight of element in the sample was computed.

Results. In at least four assays during the cocrystallization step, the recovery of Mn and Cu was 99.8 ± 1.3 and 100.4 ± 1.4%.

Data show that following the initial acidification 0.003 ± 0.001 and 0.022 ± 0.004 μg of Mn and Cu were added to the sample by way of oxine, ethyl alcohol, and ammonium hydroxide. If nitric acid of the quality analyzed had been used in the acidification process, an additional 0.003 ± 0.001 and 0.005 ± 0.001 of the respective elements would have been introduced.

Discussion. In the crystallization step, copper and manganese were carried quantitatively with the solid phase. However, in subsequent processing the 5 to 10% of the oxine that adhered to the container walls was not transferred to the irradiation vial. A quantitative transfer was effected expeditiously by dissolution with acid. However, this treatment was precluded, since dissolved oxinate underwent degradation during the neutron bombardment which complicated the subsequent precipitation of the oxinate in the radiochemical purification of manganese.

The loss of metal-carrying oxine was corrected by measurement of the ^{54}Mn yield after transfer to the irradiation vial. Since Mn and Cu were completely cocrystallized, this yield also applied to Cu. Further, by not adding additional reagents before the irradiation, the blank was also minimized.

At the end of a 2-hr irradiation period, 1.2×10^3 and 3.5×10^4 photopeak counts min^{-1} were accumulated per microgram of Cu and Mn. Thus submicrogram amounts of these elements quantifiable with acceptable counting statistical error. Since the usual concentrations of Mn and Cu in seawater center around tenths of a part per billion (ppb) for Mn and ppb for Cu, even the modest irradiation schedule adopted provides for adequate sensitivity.

8. Soluble Vanadium by NAA (Dr. H. V. Weiss)

Chemicals and tracer. Iron carrier solution was prepared by dissolving 99.999% pure iron powder in *aqua regia* and diluting with distilled water to a final concentration of 10 mg ml. Vanadium-48 solution in the carrier-free form was prepared as vanadium(lV) in 0.1 M hydrochloric acid. Vanadium standard (2 μg ml) was made from a commercial 100-ppm standard prepared from ammonium metavanadate. Other reagents used were of analytical reagent grade.

Instruments. The ^{48}V tracer was gamma-counted with an NaI(Tl) well-type detector coupled to a scaler. The neutron-induced ^{52}V was measured with a 38-cm^3 Ge(Li) detector associated with a 4096-channel pulse-height analyser. The pulse-height data were transferred onto magnetic tape and thence into a computer, which provided the net counting rate for the 1434-keV photopeak of neutron-activated vanadium.

Isolation of vanadium from seawater. Iron carrier (1 mg/100 g of sample) was added to a weighed amount ($\leqslant$ 100 g) of acidified seawater. A known ^{48}V activity, usually about 10^4 cpm, was also added. Some samples were also treated with 0.1 ml of the vanadium standard at this stage. The solution was kept at 70-80° for 1 hr. to facilitate exchange between the various oxidation states of vanadium in solution. After cooling, the pH was adjusted to about 7 with 8 M ammonia and the precipitate was coagulated by warming and collected on a sintered-glass disc of medium porosity, washed with water to remove residual salts and dissolved in a small volume of 8 M nitric acid. The solution was transferred to a 7-ml polyethylene irradiation vial and brought to a final weight of 5.00 ± 0.05 g with 8 M nitric acid (4.13 ml). The recovery of ^{48}V in this solution was determined by comparison of its gamma-ray activity with that of a tracer standard (to provide information on the amount of sample solution transferred to the vial).

Blanks and standards. Three blanks were prepared namely 100 µl of the iron carrier solution in 8 M nitric acid, 8 M nitric acid, and 8 M ammonia. The standards were also made up in 8 M nitric acid and contained 0.2 µg of vanadium. Blanks, standards and samples all had the same volume, obtained by weighing the solution, the specific gravity of which was known.

Irradiation and measurement. Samples, blanks and standards were irradiated sequentially, each for 180 sec, in the pneumatic tube assembly of the TRIGA nuclear reactor at the University of California, Irvine, California. The thermal-neutron flux at the terminal end of this assembly is $3 \times 10^{12} n.cm^{-2} sec^{-1}$. After irradiation the sample was transferred to a 14-ml polyethylene vial, and the original vial was rinsed once with 1.5 ml of distilled water, the rinse being added to the irradiated solution. The sample was positioned in the centre of the Ge(Li) detector and separated from it by a plastic beta-particle absorber, 2 cm thick. The gamma-ray pulses were accumulated for 180 sec, commencing 90 sec after the end of the irradiation. The instrumental dead-time at the beginning and end of the counting interval was recorded. The 1434-keV photopeak of ^{52}V was corrected for the mean dead-time value and the isotopic yield in the initial isolation step. The corresponding quantity of vanadium was calculated by simple proportion from standards corrected for dead-time.

9. Soluble Cu and Pb by DPASV. Technique used here were as previously reported. The value of data such as these is limited by the collection procedure used; this has been discussed above.

10. Aquaria experiments on uptake and transfer of heavy metals by benthic biota.

A good start has been made on this most important aspect of the FY '78 program. It was intended that the sub-tidal *Macoma* would be used right from the beginning since the intention is to look at the clam-crab chain. To this end a few individual *Macoma calcarea* specimens were obtained on the November *Surveyor* cruise in Lower Cook Inlet. Surprisingly, this clam was not as easily obtained as had been expected (see concurred benthic biology report). Unfortunately, due to transportation difficulties, this initial batch survived only a few days under aquaria conditions in Fairbanks and a second collection, of the intertidal *Macoma balthica*, had to be made at the beginning of December from the mud flats of Resurrection Bay. This latter batch has been maintained without loss for nearly one month.

The thesis underlying this phase of the work required research on the pathways from the deposited sediment through the benthic food chain i.e., we wished to look primarily at deposit rather than filter feeding clams. Hence, an initial difficulty concerned the best means of labelling the deposited food source with metals. Recent work on detritivore ecology has flagged the particular importance of bacteria as food. This is of considerable importance to the heavy metal program since evidence is also accumulating regarding the importance of microbial mediation of benthic boundary reactions (including remobilization) of these potentially toxic elements. With this background we have proceeded to culture and label bacteria and to initiate metal transfer experiments by using the latter as the sole food source for batches of aquaria *Macoma*. These experiments have only just begun, and further details will be given in subsequent quarterly reports.

An ancillary project to that described above will be to analyze for heavy metals clam samples used in the organic chemistry aquaria oiling experiments. This will give us a first look at whether direct oil contamination affects the natural uptake of metals by these organisms.

III. RESULTS

A. Soluble V and Mn in the NEGOA specific study site. (Dr. H. V. Weiss)

Vertical profile data for V and Mn obtained at plations YAK-7 and 9 within Yakutat Bay on R/V *Acona* cruise no. 246 (July, 1977) are listed in Table VI and plotted in Figures 3 and 4.

B. Size distribution of surficial sediment from the S. Bering Sea (Dr. C. M. Hoskin)

These data are listed in Table VII and the distribution of surface fine grained sediment within this area is shown in Figures 5 and 6 (as % clay and mud - i.e., clay plus silt - respectively). Table VIII reproduces the heavy metal extract data given in previous reports with the corresponding fine grained sediment content.

C. Environmental data for NEGOA specific study site. This series of data are essential auxiliary information required to interpret the heavy

TABLE VI

N. E. Gulf of Alaska (Yakutat Bay)
R/V *Acona* Cruise No. 246 July 1977

Soluble heavy metal contents (μg/kg)
H. V. Weiss, Analyst

Depth (m)	Vanadium Station 7	Vanadium Station 9	Manganese Station 7	Manganese Station 9
10	1.40	1.30	0.56	0.77
20	1.48	1.40	0.89	0.63
40	1.44	1.50	0.56	0.46
60	1.50	1.43	0.57	1.03
80	1.40	1.53	0.77	1.30
100	1.54	1.40	0.93	1.44
120	1.42	1.42	1.26	2.75
130		1.42		3.04
160	1.43	1.44	1.49	4.32
150		1.53		6.75
160	1.39		2.66	
170	1.43		6.43	

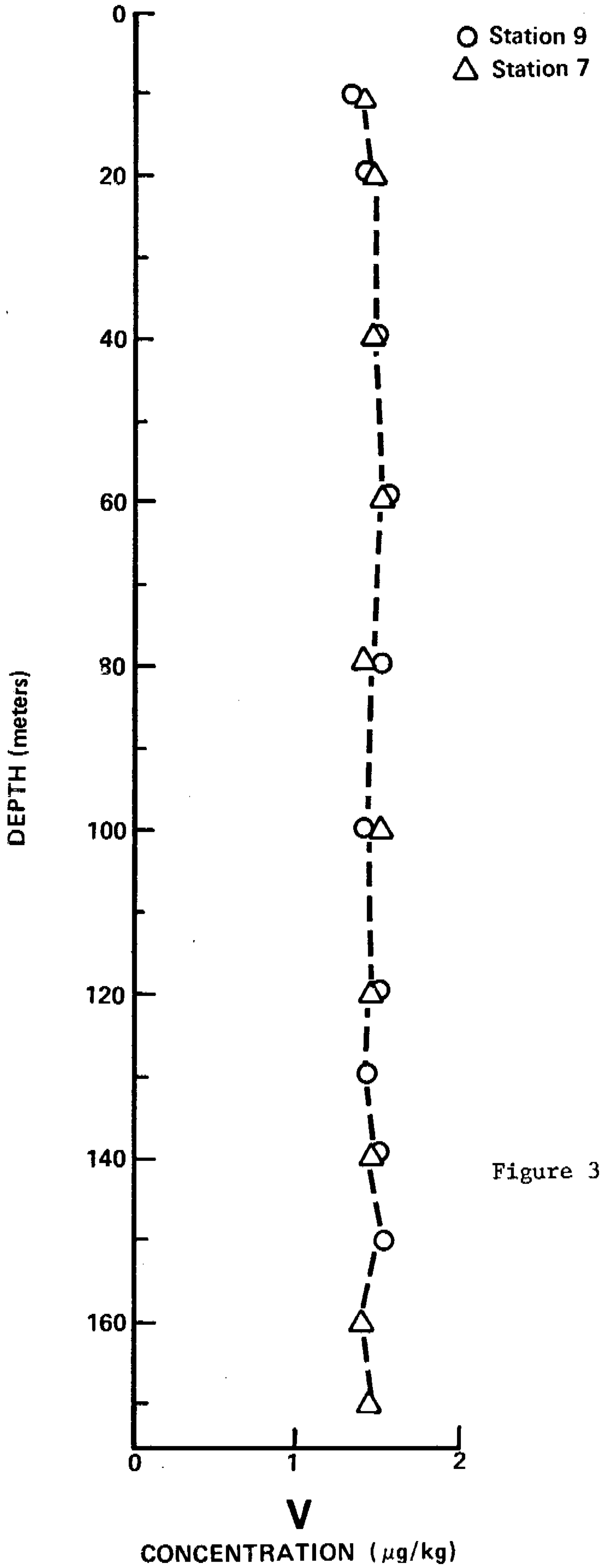


Figure 3. Yakutat Bay. Soluble (0.4 μm) V profiles at YAK-7 and YAK-9. *Acona* Cruise no. 246.

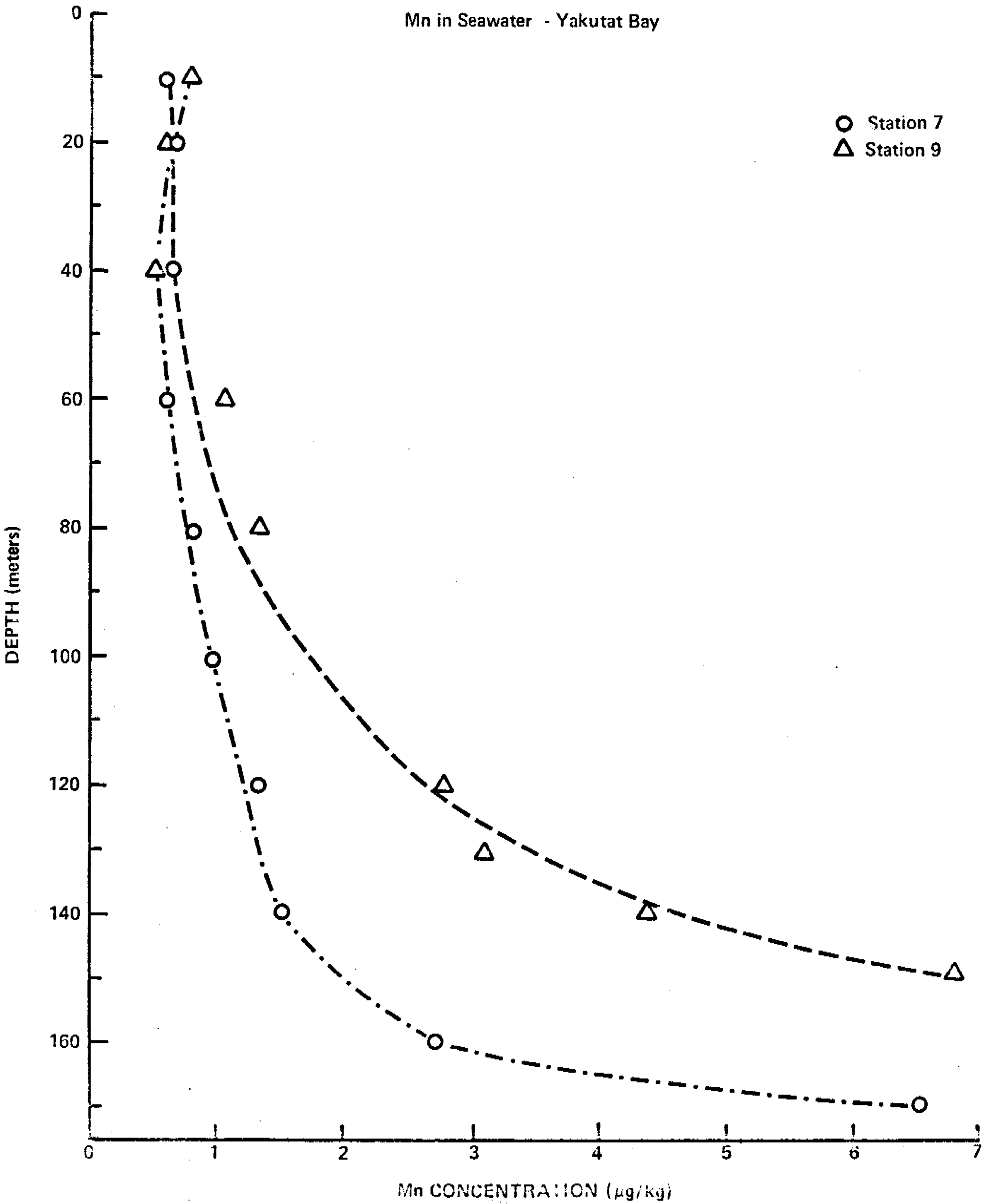


Figure 4. Yakutat Bay Soluble (0.4 µm) Mn profiles at YAK-7 and YAK-9. *Acona* Cruise no. 246, July 1977.

TABLE VII

S. Bering Sea
O.S.S. *Discoverer* - June 1975

Sediment Size Fractionation Data (%)

Station #	Clay	Silt	Sand	Gravel
01	7.82	19.57	72.61	0
03	0.02	0.30	82.81	16.86
05	0.04	0.10	22.44	76.92
06	1.78	0.61	97.61	0
07	0	0.11	81.42	18.48
08	0	0.15	99.85	0
09	0	0.02	93.01	6.96
10	10.42	8.68	80.90	0
11	9.67	5.66	84.67	0
13	8.23	30.73	61.04	0
14	5.30	6.46	46.97	41.26
16	9.65	28.01	62.34	0
17	13.64	49.92	36.44	0
19	7.45	33.28	59.27	0
20	7.80	6.41	88.79	0
21	6.82	3.75	89.43	0
22	6.50	2.80	90.70	0
23	1.69	0.23	98.08	0
24	0.06	0.11	46.83	53.00
25	0.30	0.26	99.44	0
26	7.21	7.02	85.77	0
27	6.98	8.25	84.77	0
28	9.74	36.85	47.21	6.21
29	6.96	30.99	62.05	0
31	7.83	15.27	76.90	0
34	7.97	17.45	74.58	0
37	8.66	25.70	65.63	0
38	8.65	44.28	47.07	0
39	7.90	15.37	76.73	0
40	8.30	7.65	84.04	0
41	2.46	0.63	96.91	0
42	1.22	1.26	97.51	0
43	7.26	7.47	85.00	0
44	6.23	8.67	85.10	0
45	6.31	34.29	59.40	0
46	8.15	31.22	60.63	0
47	7.15	21.35	71.51	0
48	7.81	6.80	60.52	24.87
49	15.20	53.66	31.14	0
50	7.76	10.38	81.86	0

TABLE VII (Continued)

Station #	Clay	Silt	Sand	Gravel
54	9.76	30.48	57.12	2.64
55	7.14	11.16	81.70	0
56	6.72	30.87	67.41	0
57	6.72	12.47	80.81	0
58	0.58	0.73	98.69	0
59	7.64	9.18	83.18	0
60	2.28	3.52	74.99	19.22
61	20.26	2.66	77.08	0
62	6.84	18.45	74.72	0
63	10.01	39.50	50.49	0
64	12.46	31.05	56.49	0
65	8.28	32.13	59.59	0
66	7.10	24.18	68.72	0
68	7.05	29.59	63.37	0
69	8.09	33.85	58.06	0
70	16.82	43.22	39.23	0.73
71	8.04	22.95	69.01	0
72	8.89	45.06	46.05	0
73	9.54	19.84	70.62	0
82	6.63	5.20	88.17	0
83	9.97	39.43	50.82	0
92	23.80	46.16	24.84	5.20

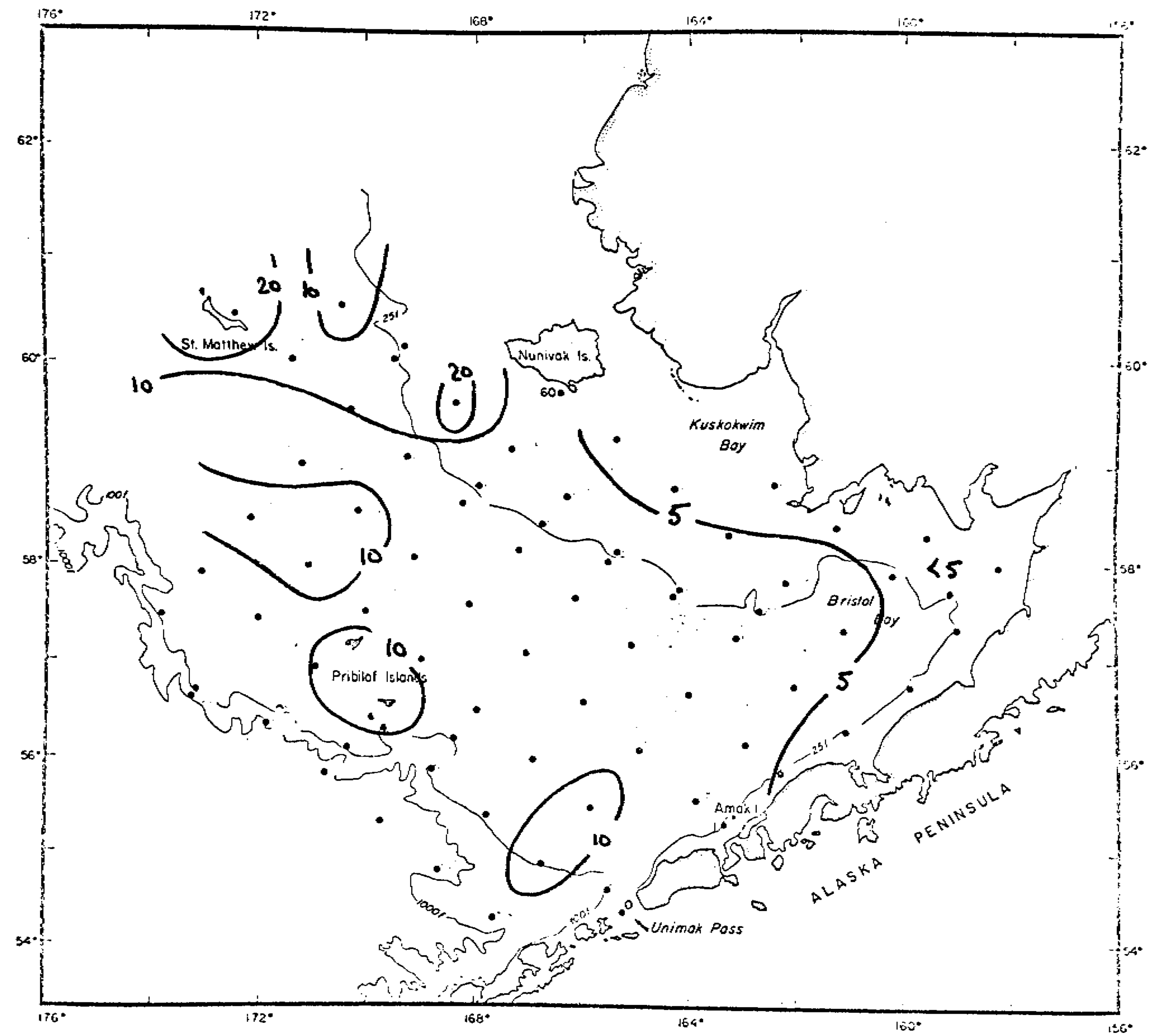


Figure 5. S. Bering Sea. Weight % of clay sized surficial sediment.

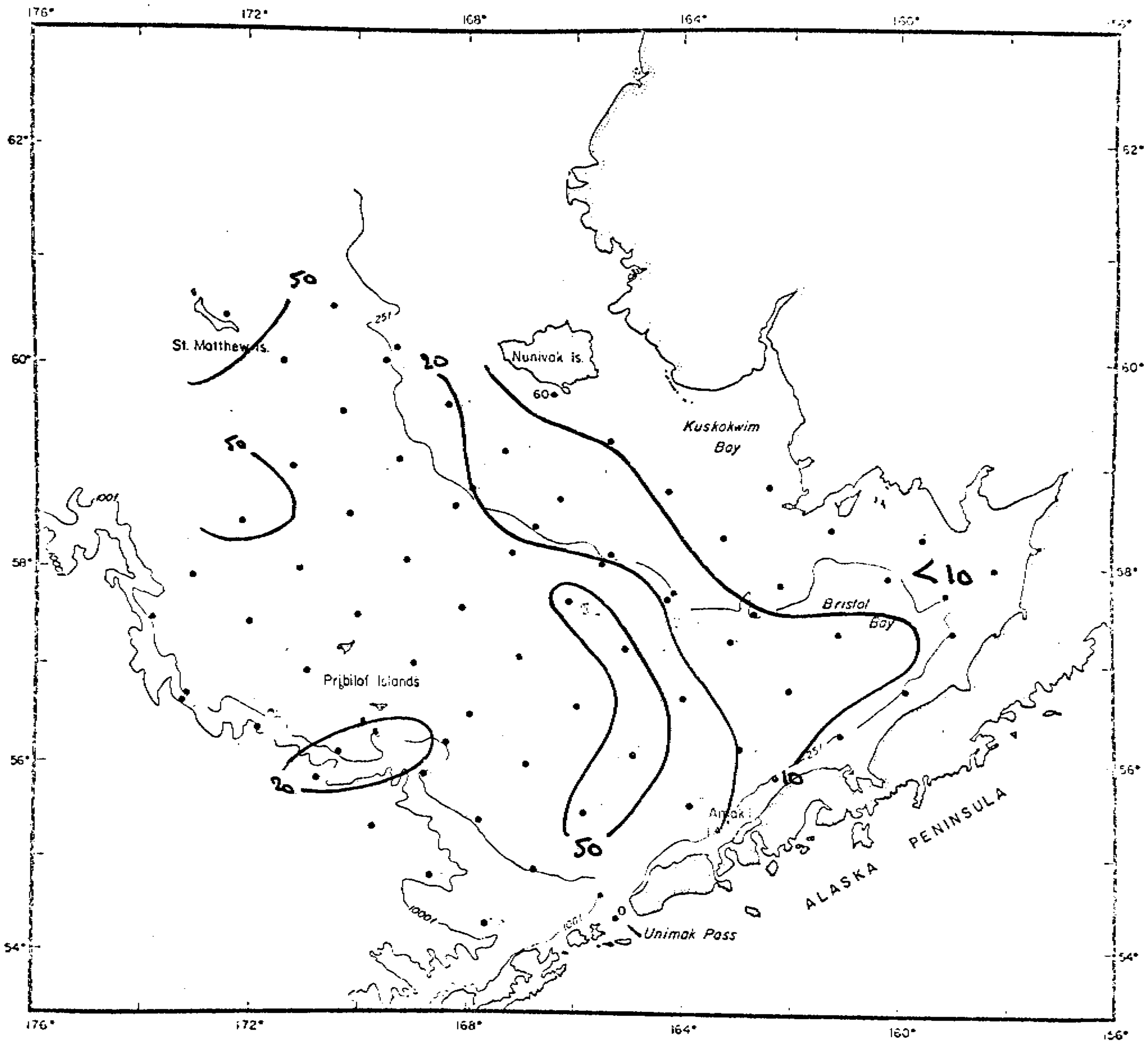


Figure 6. S. Bering Sea. Weight % of mud sized surficial sediment.

TABLE VIII

S. Bering Sea

O.S.S. *Discoverer* - June 1975

Summary of heavy metal contents of sediment extracts (μg/g) and % mud (silt & clay)

Station	Mud (%)	Ni	Zn	Fe	Mn
6	2.4	<2.5	6.4		
8	0.2	6.4	21.3		
10	19.1	<2.5	7.2		
12		<2.5	12.2		
13	40.0	3.0	9.3		
14	11.8	2.5	9.5		
17	63.6	<2.5	12.2	1920	26.0
19	40.7	<2.5	6.1	1900	26.0
21	10.6	<2.5	17.0		
26	14.2	<2.5	6.8		
28	46.6	3.0	9.9	1850	22.7
30		7.3	23.9		
31	23.1	<2.5	7.1	637	9.0
41	3.1	<2.5	6.4	1466	22.7
43	14.7	2.5	6.3		
44	14.9	<2.5	5.9	1040	16.2
56	37.6	8.2	19.3		
57	19.2	<2.5	6.8		
59	16.8	<2.5	4.8	1555	18.2
60	5.8	<2.5	12.0		

TABLE VIII (Continued)

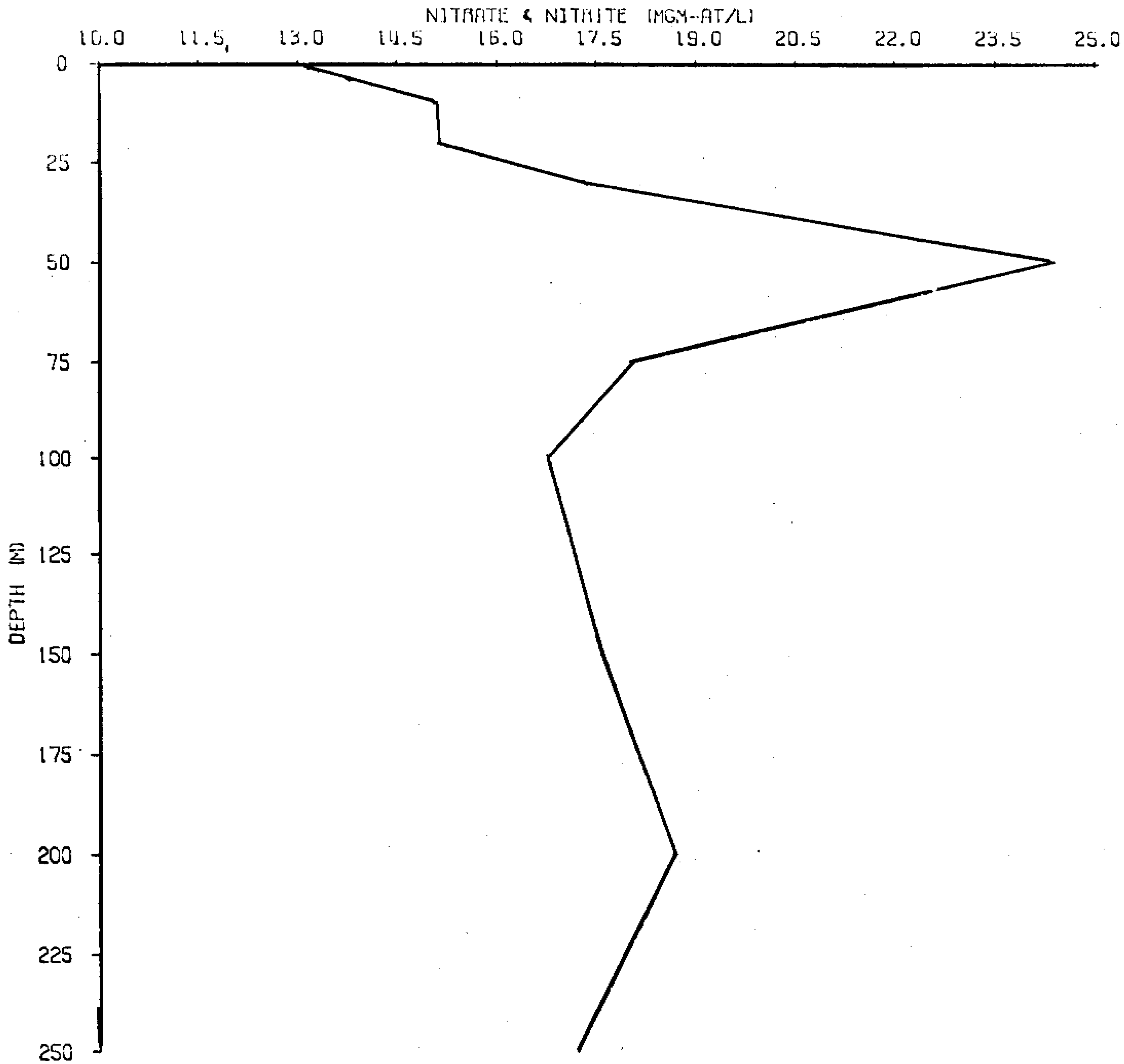
Station	Mud (%)	Ni	Zn	Fe	Mn
62	25.3	<2.5	9.7		
63	49.5	<2.5	13.3	1756	27.3
64	43.5	<2.5	12.0	1350	20.9
65	40.4	<2.5	10.5	915	18.8
69	41.9	<2.5	12.5	985	21.3

metal distribution work, some of which is included in this report. Initial hydrographic data for R/V *Acona* cruises nos. 234 and 240 (September and April, respectively) was given in the last report. Plots of the nutrient distributions for the latter cruise are included here as Figures 7 through 29.

D. Soluble Cu and Pb for summer surface water of the Bering Sea.

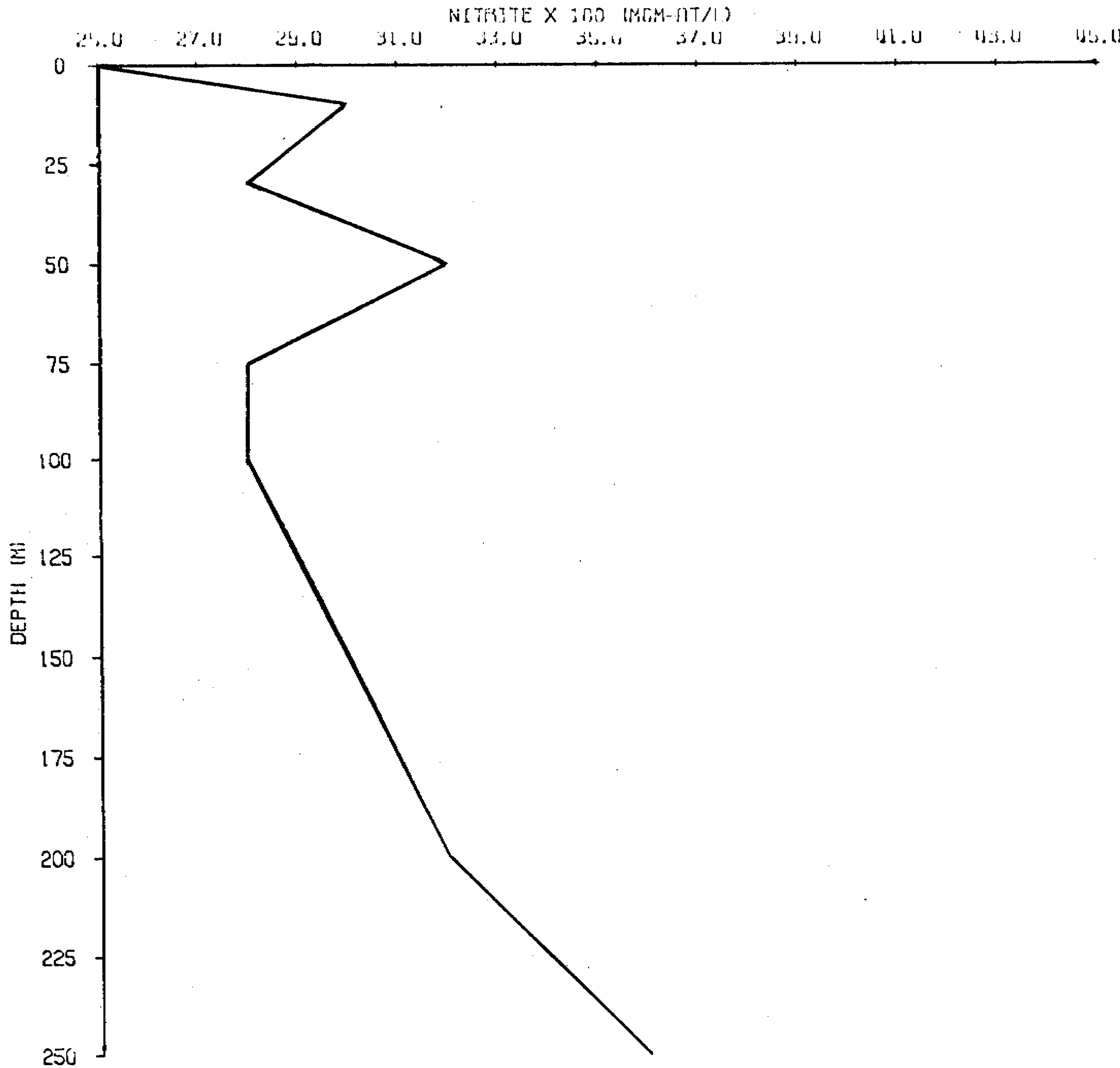
Data for Niskin bottle casts through the surface layer to (where appropriate) 75 m are given in Table IX. Soluble concentrations of these two metals in the surface "film" (unfiltered) and within the top meter (filtered at 0.4 μm) are given in Table X.

E. Heavy metal contents of seal tissue from the Bering Sea. Data for the Cd, Cu, Ni and Pb contents of liver, kidney and muscle tissue of various species of seals taken in the Bering Sea are given in Tables XI and XII. Table XI is for samples collected on the *Surveyor* March - April 1977 cruise and Table XII for *Discoverer* May - June 1977 samples. Stations locations and preliminary sample information has been given previously (Tables I and II and Figure 1 of the September 1977 quarterly report). Accuracy and precision data relating to this batch of numbers are given in Table XIII. The data of Tables XI and XII are means of duplicate determinations and hence the spread listed gives these individual values.



CRUISE 240, TAK 003

Figure 7.



CRUISE 248, TAN 003.

Figure 8.

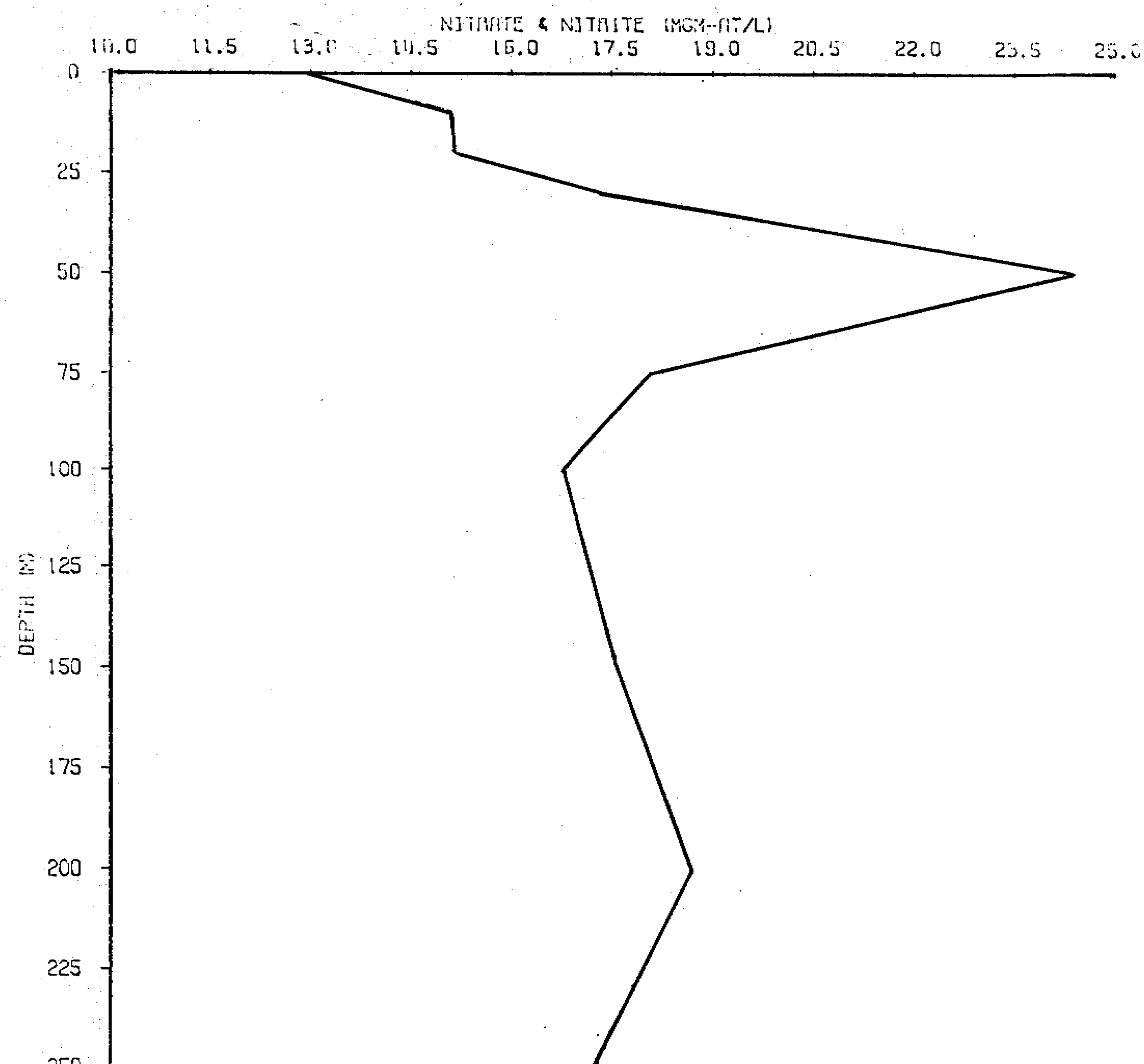
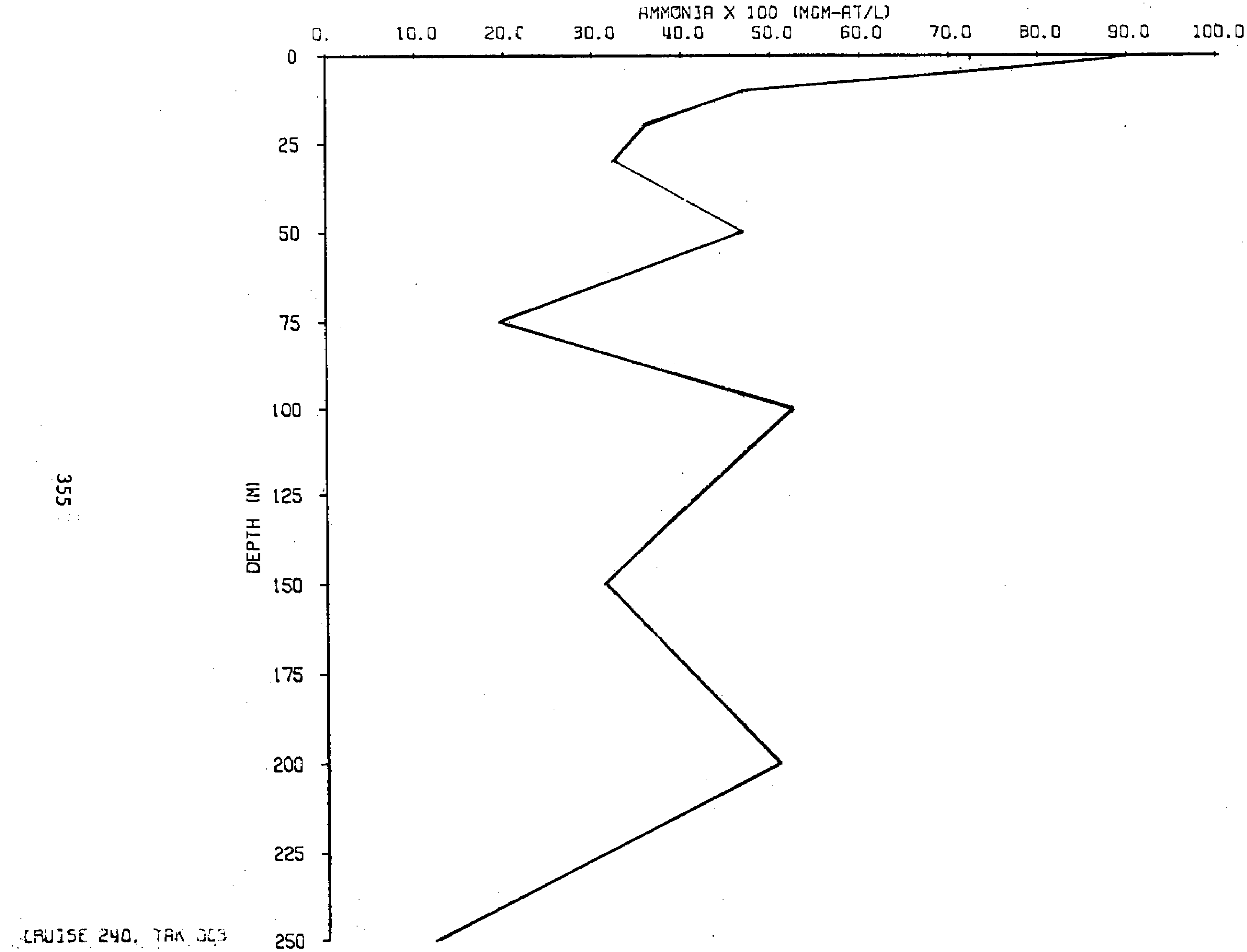
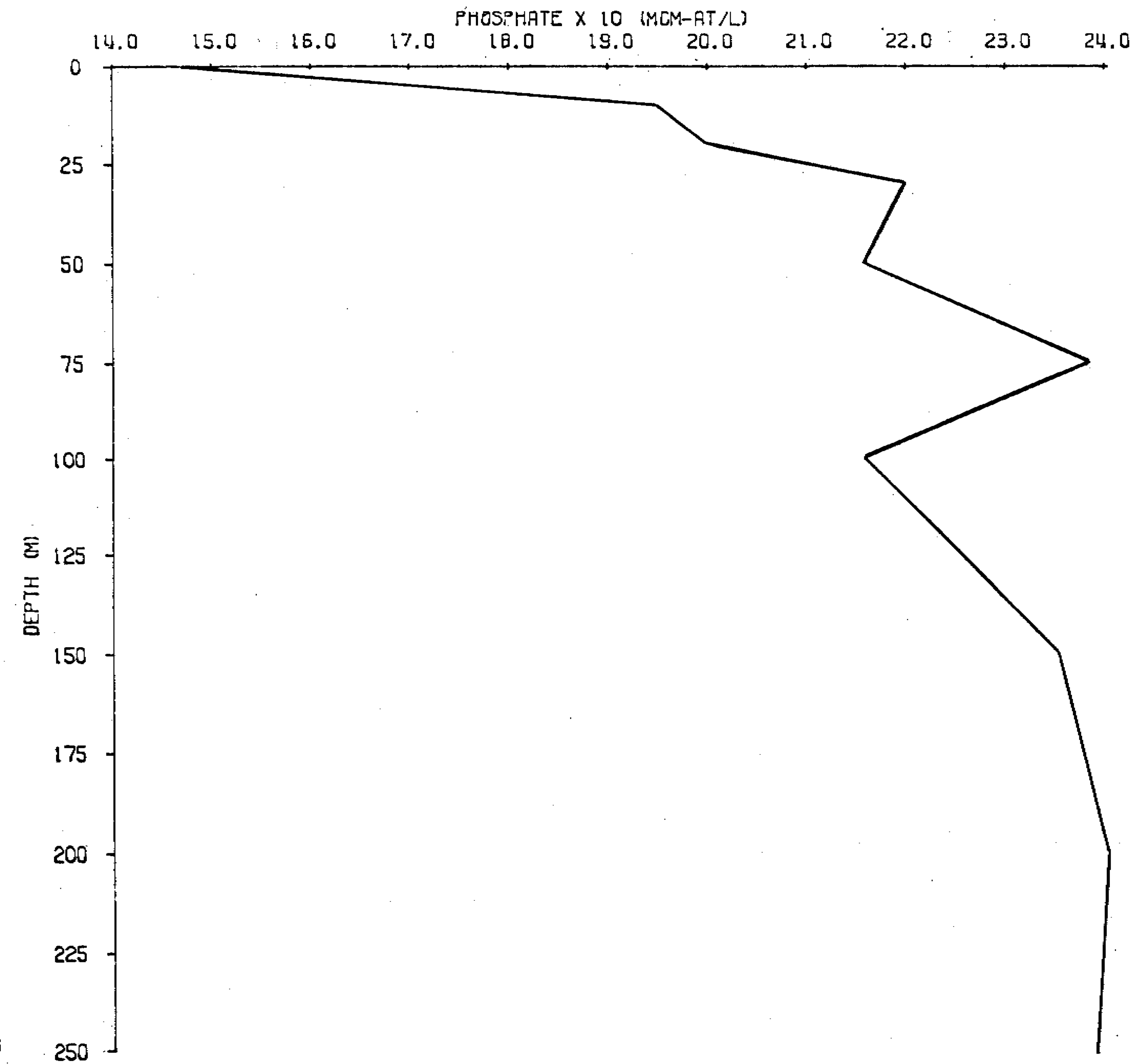

NITRATE & NITRITE (MGM-AT/L)
10.0
11.5
13.0
14.5
16.0
17.5
19.0
20.5
22.0
23.5
25.0
DEPTH (M)
0
25
50
75
100
125
150
175
200
225
250

Figure 9.



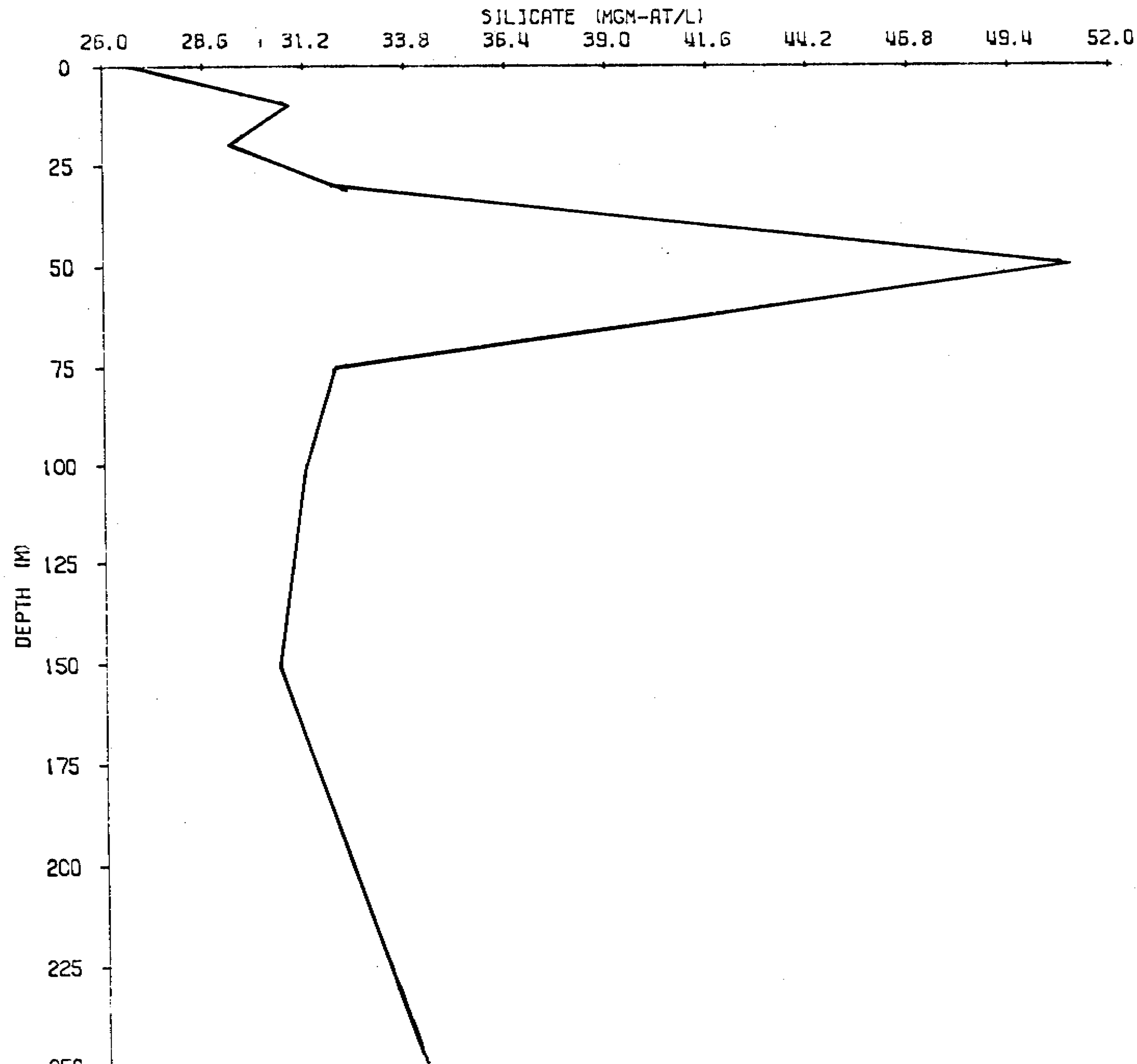
AMMONIA X 100 (MGM-AT/L)
0. 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 90.0 100.0
DEPTH (M)
0 25 50 75 100 125 150 175 200 225 250
CRUISE 240, TAK 003

Figure 10.



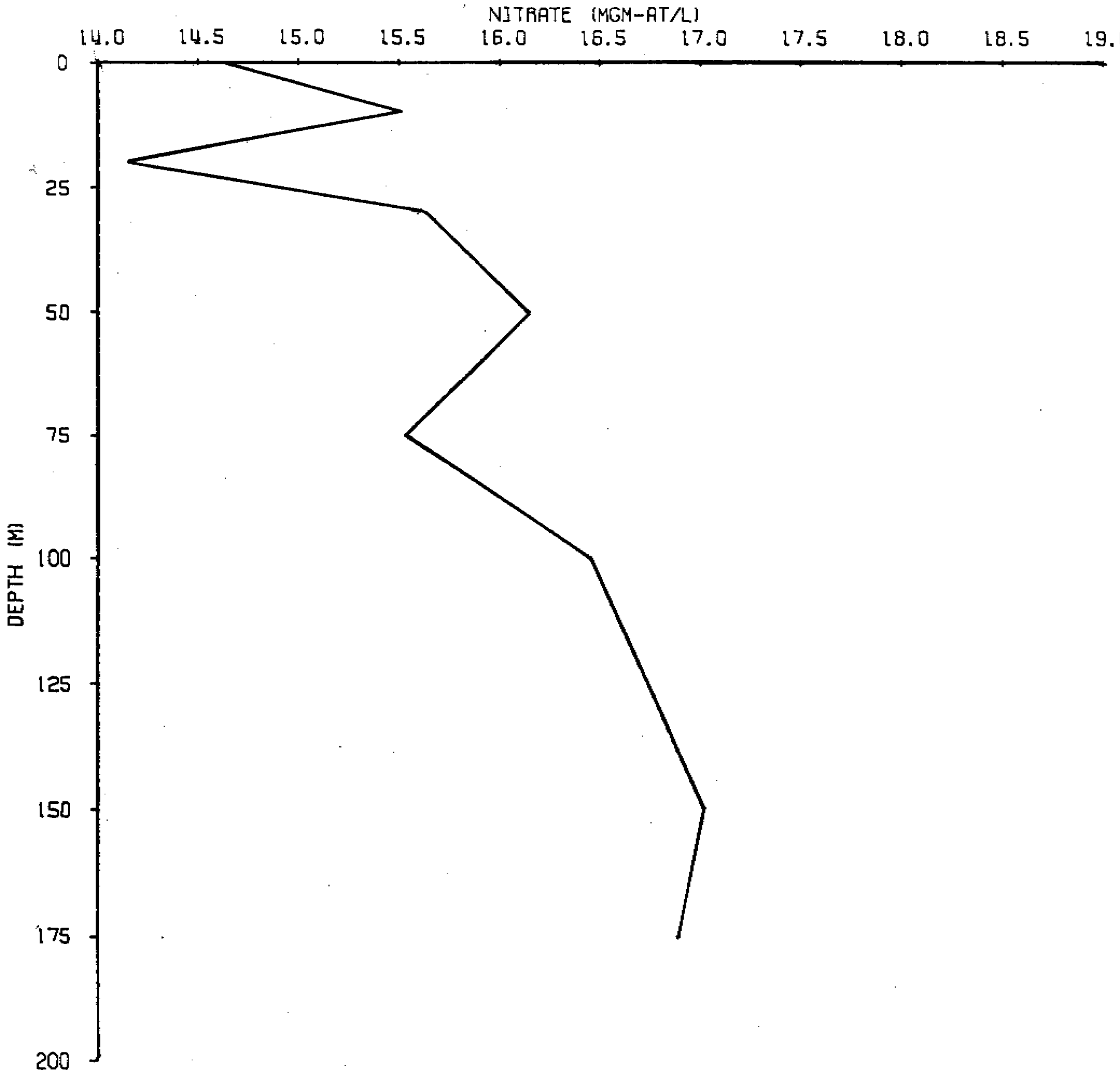
CRUISE 240, [illegible]K 003

Figure 11.



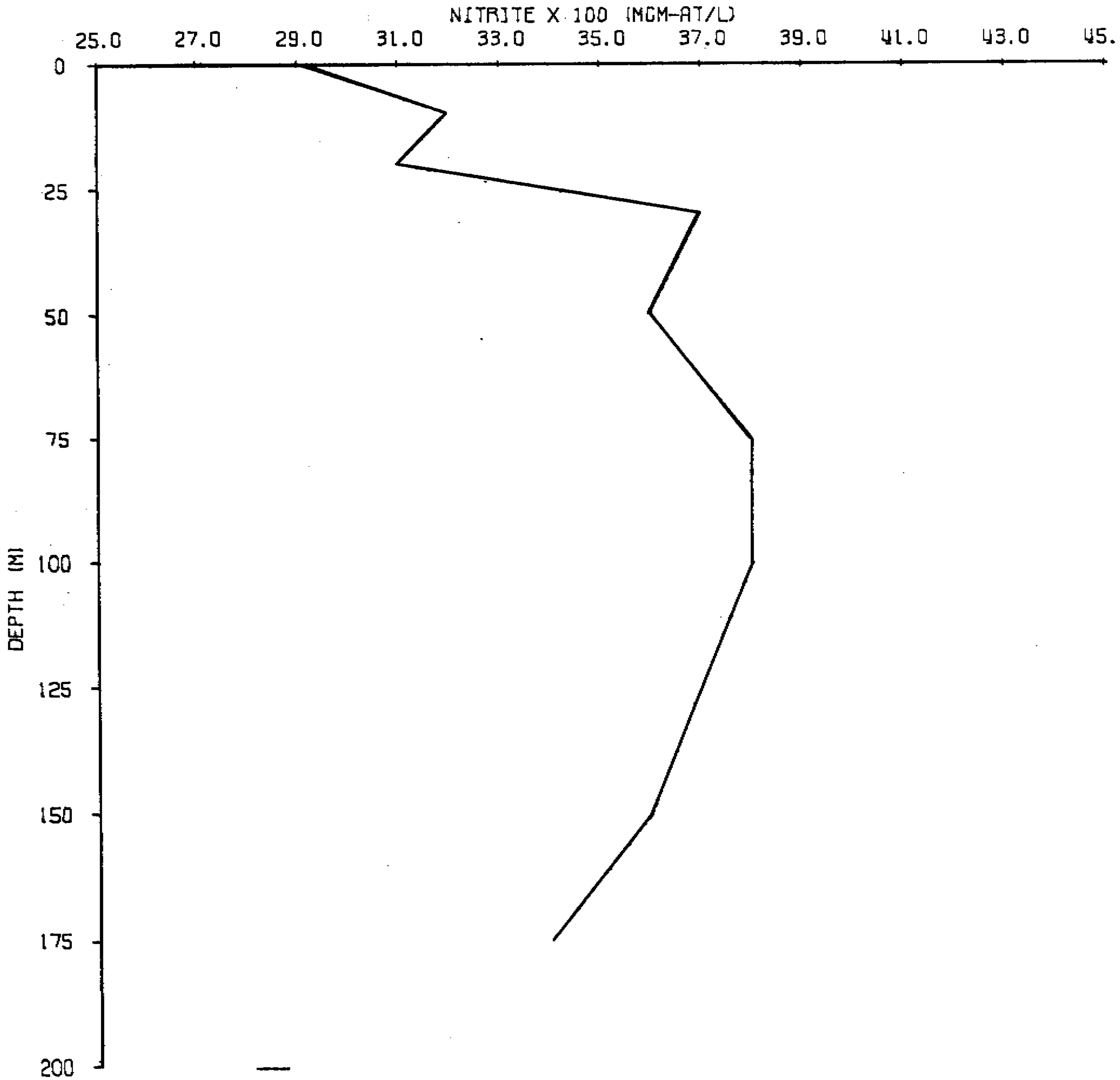
CRUISE 240, YAK CC3

Figure 12.



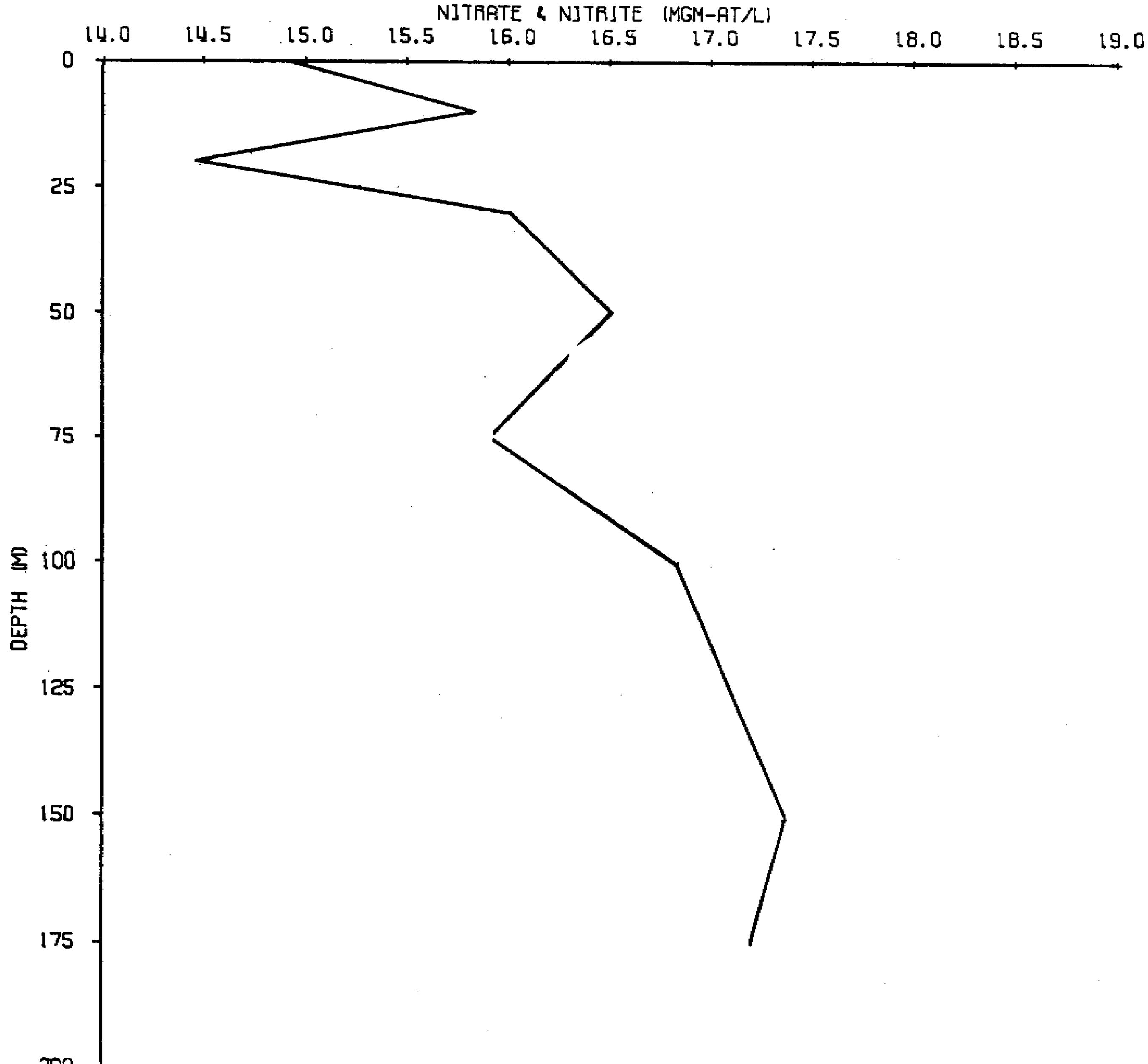
CRUISE 240. YAK 005.

Figure 13.



CRUISE 240. YAK 005.

Figure 14.



CRUISE 240, YAK 005

Figure 15.

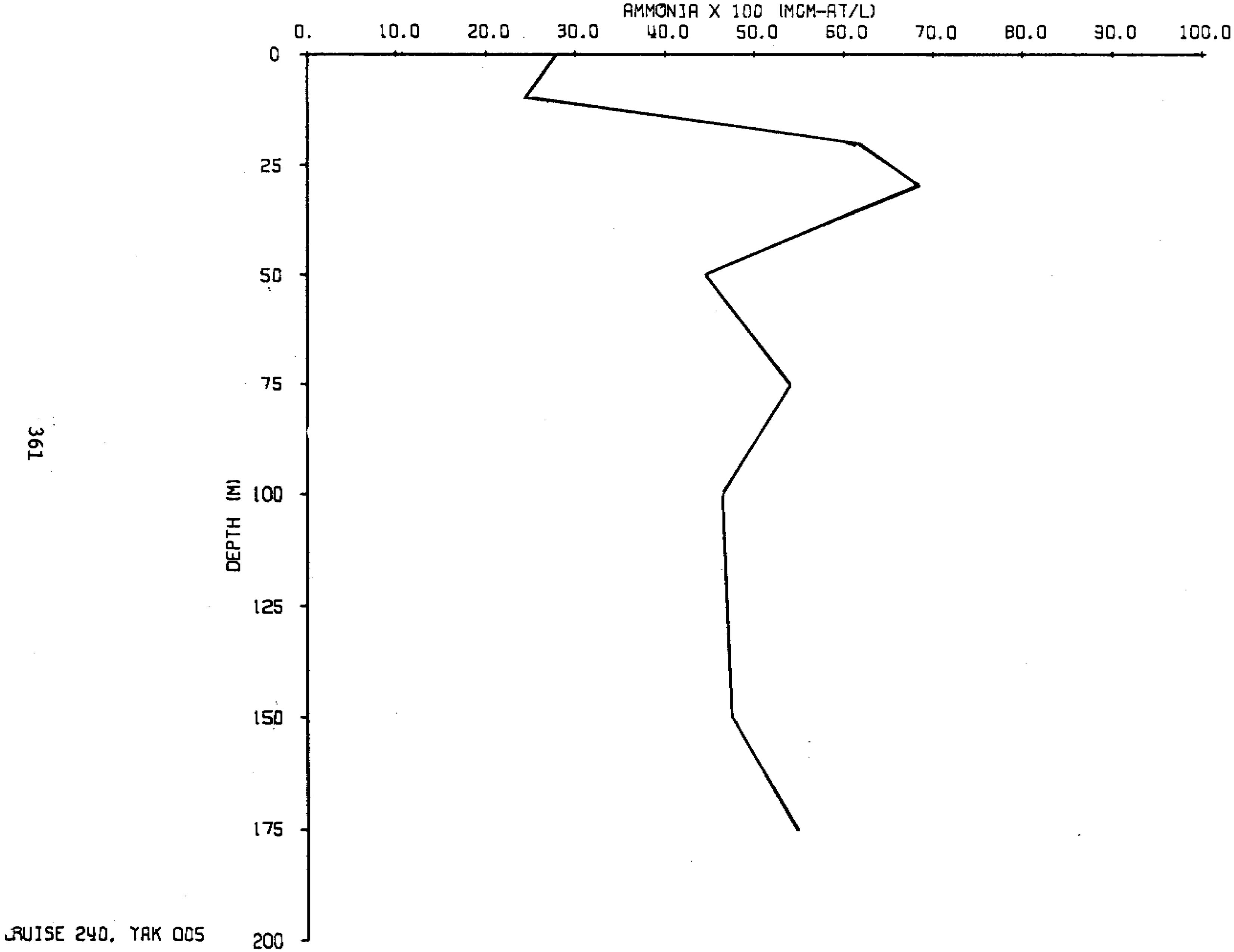

AMMONIA X 100 (MGM-AT/L)
0. 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 90.0 100.0
0
25
50
75
100
125
150
175
200
DEPTH (M)
CRUISE 240, YAK 005

Figure 16.

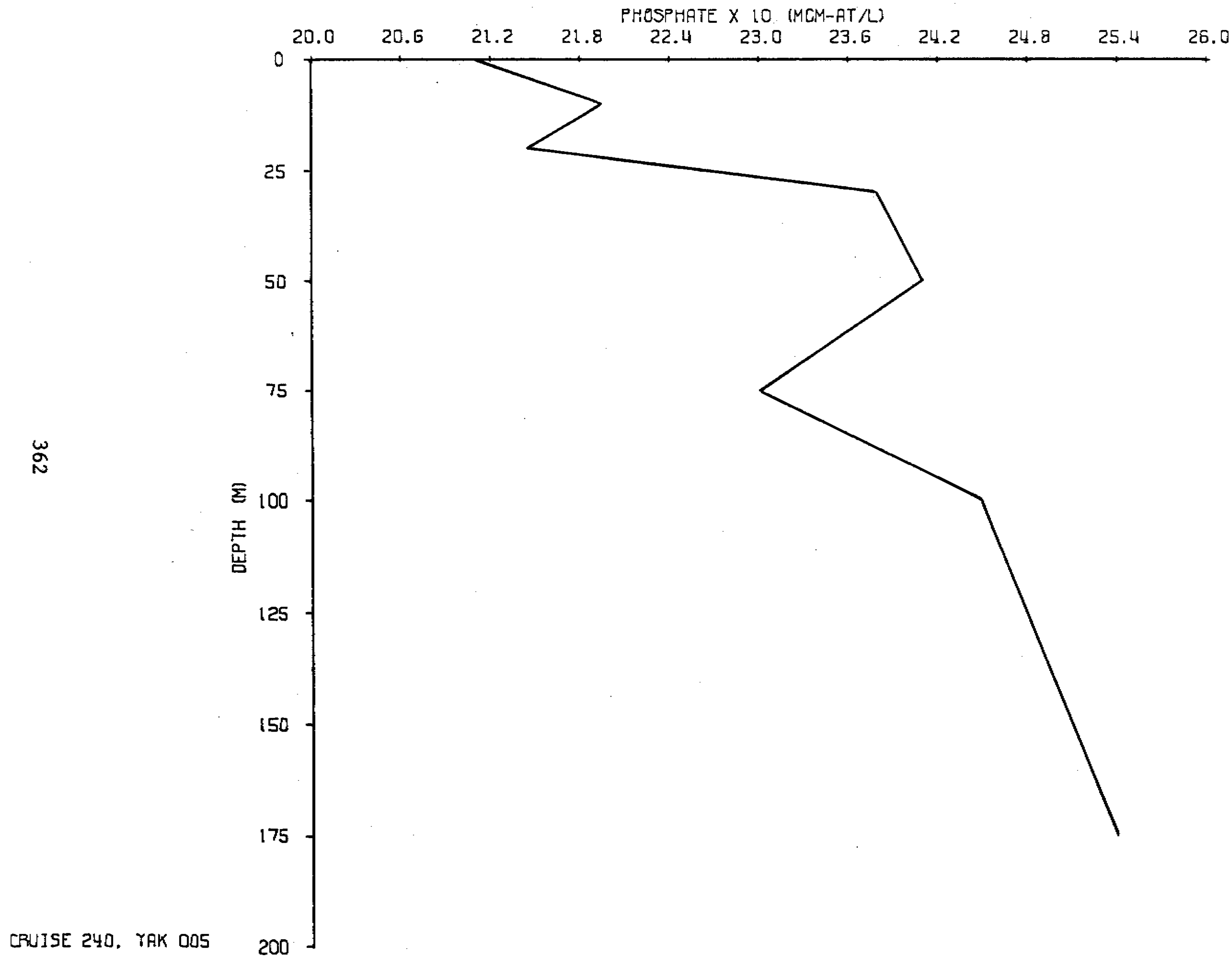
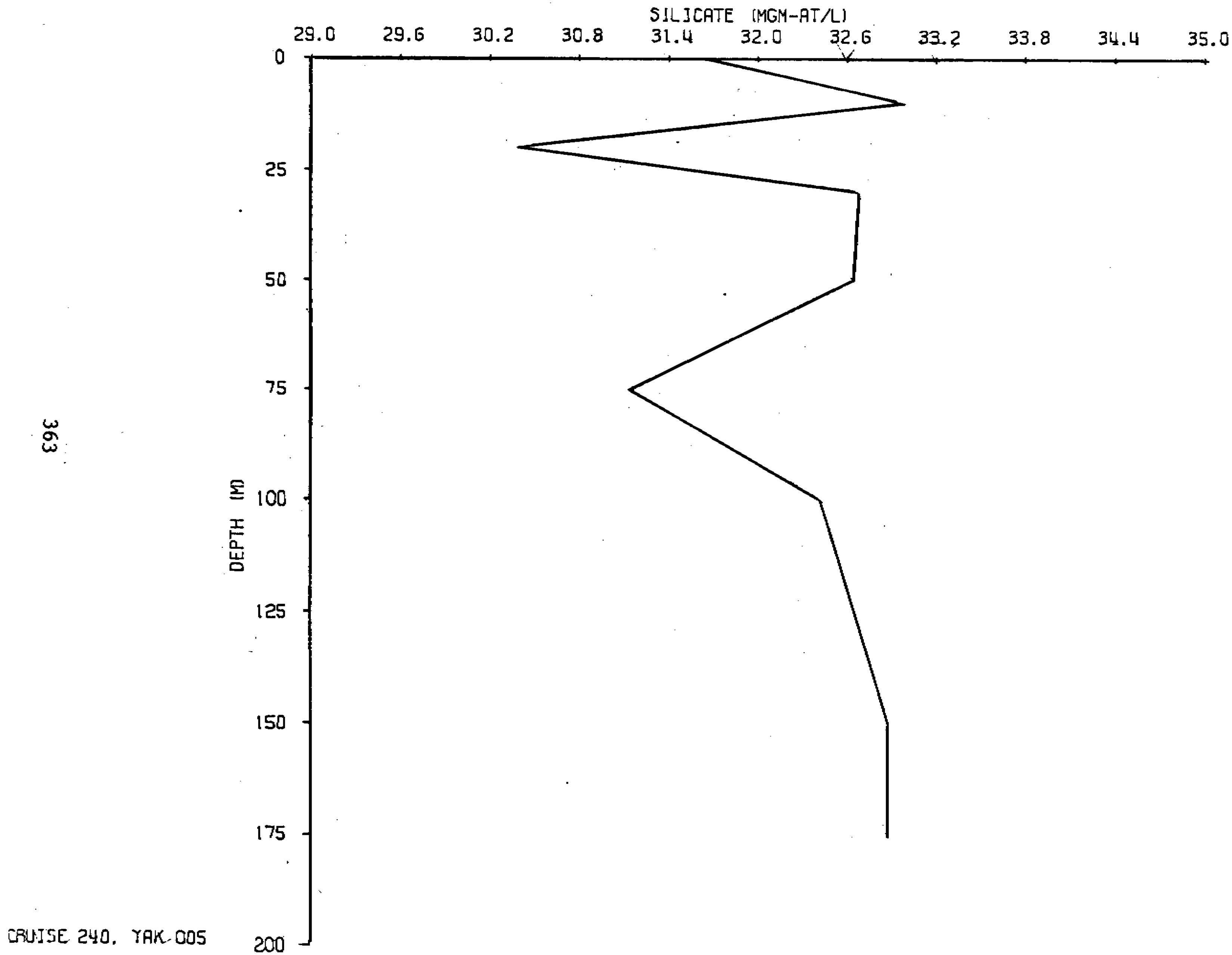
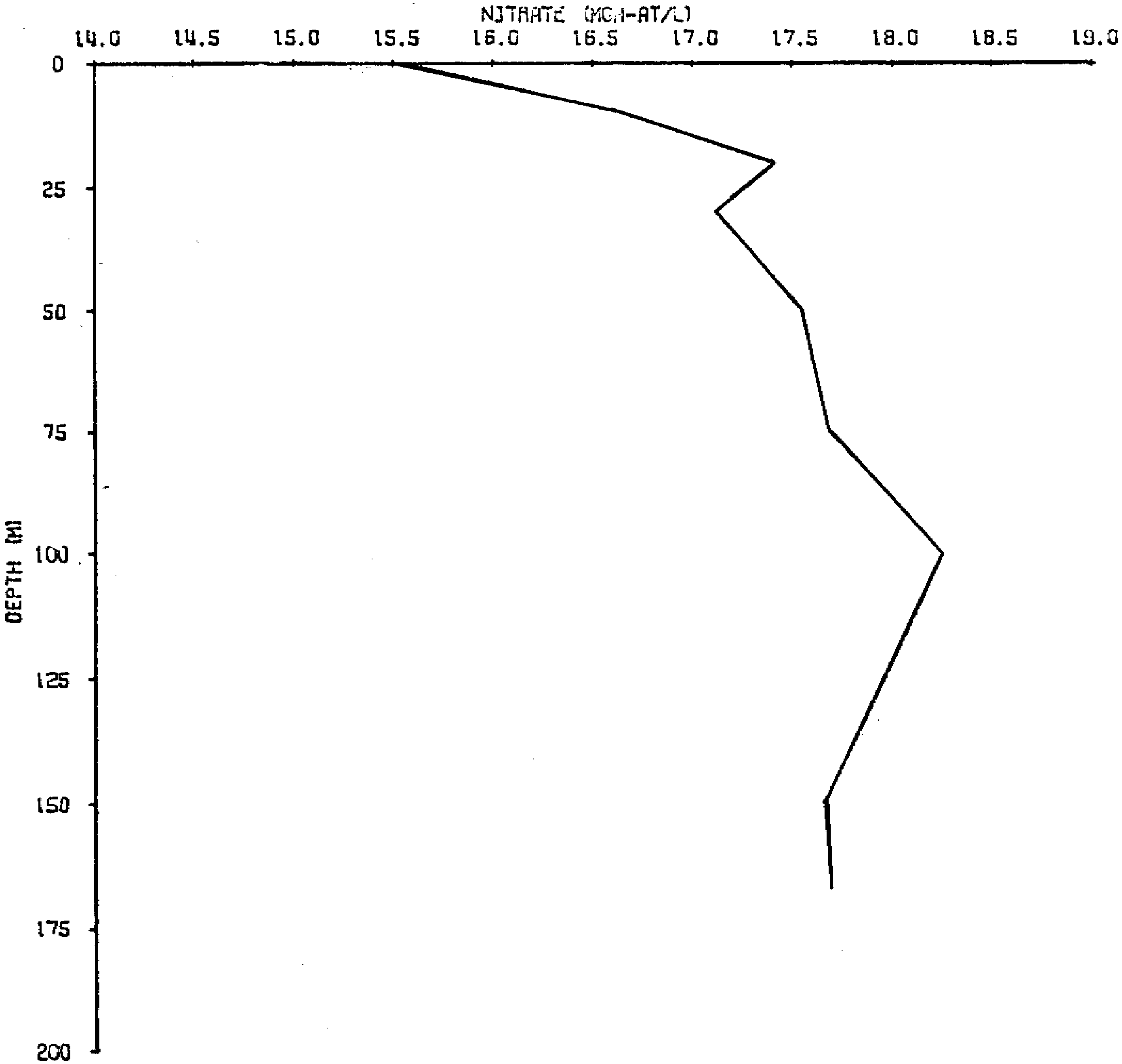

PHOSPHATE X 10 (MCM-AT/L)
20.0
20.6
21.2
21.8
22.4
23.0
23.6
24.2
24.8
25.4
26.0
DEPTH (M)
0
25
50
75
100
125
150
175
200
CRUISE 240, YAK 005

Figure 17.



SILICATE (MGM-AT/L)
29.0
29.6
30.2
30.8
31.4
32.0
32.6
33.2
33.8
34.4
35.0
0
25
50
75
100
125
150
175
200
DEPTH (M)
CRUISE 240, YAK-005

Figure 18.



ISE 240, TAK 007.

Figure 19.

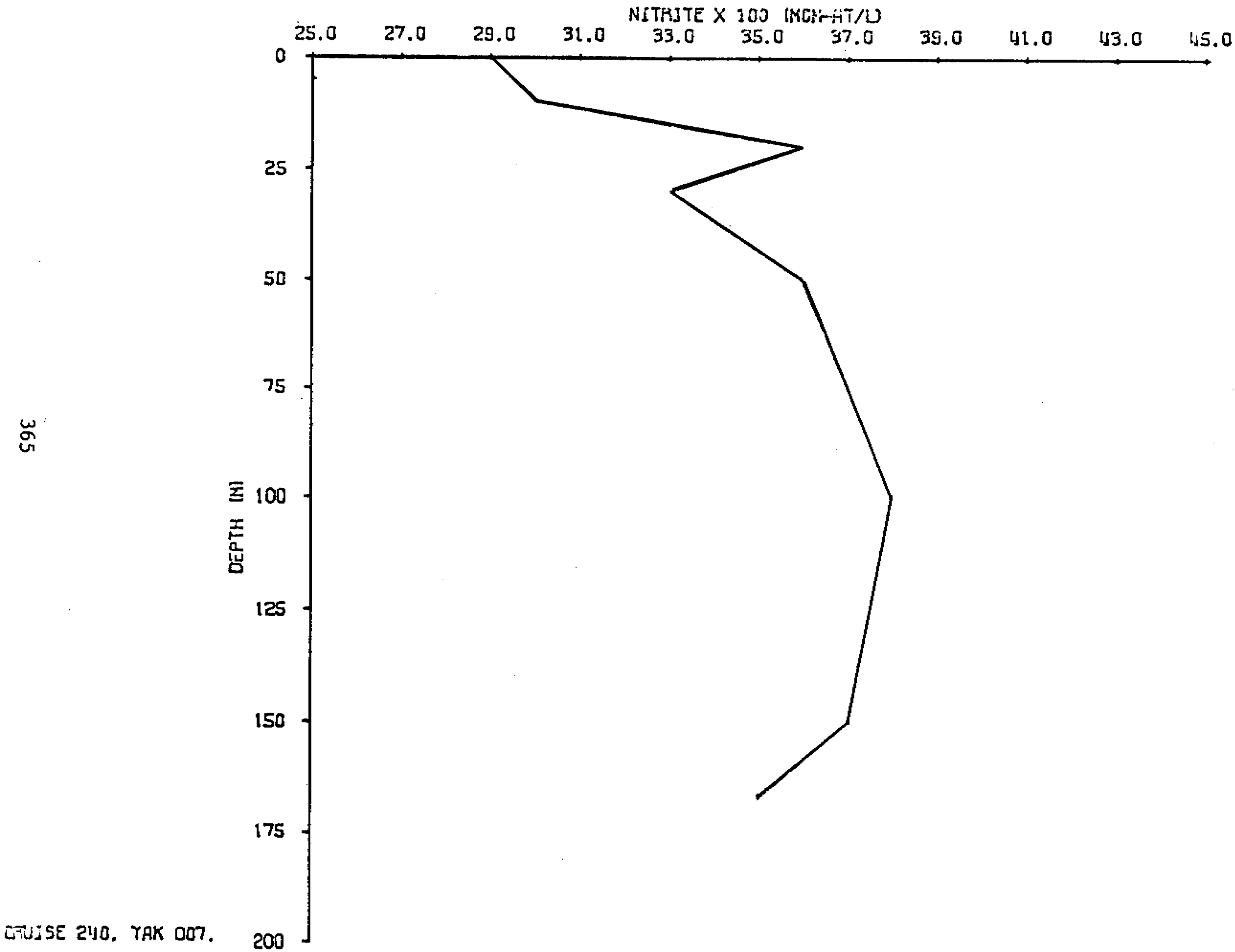
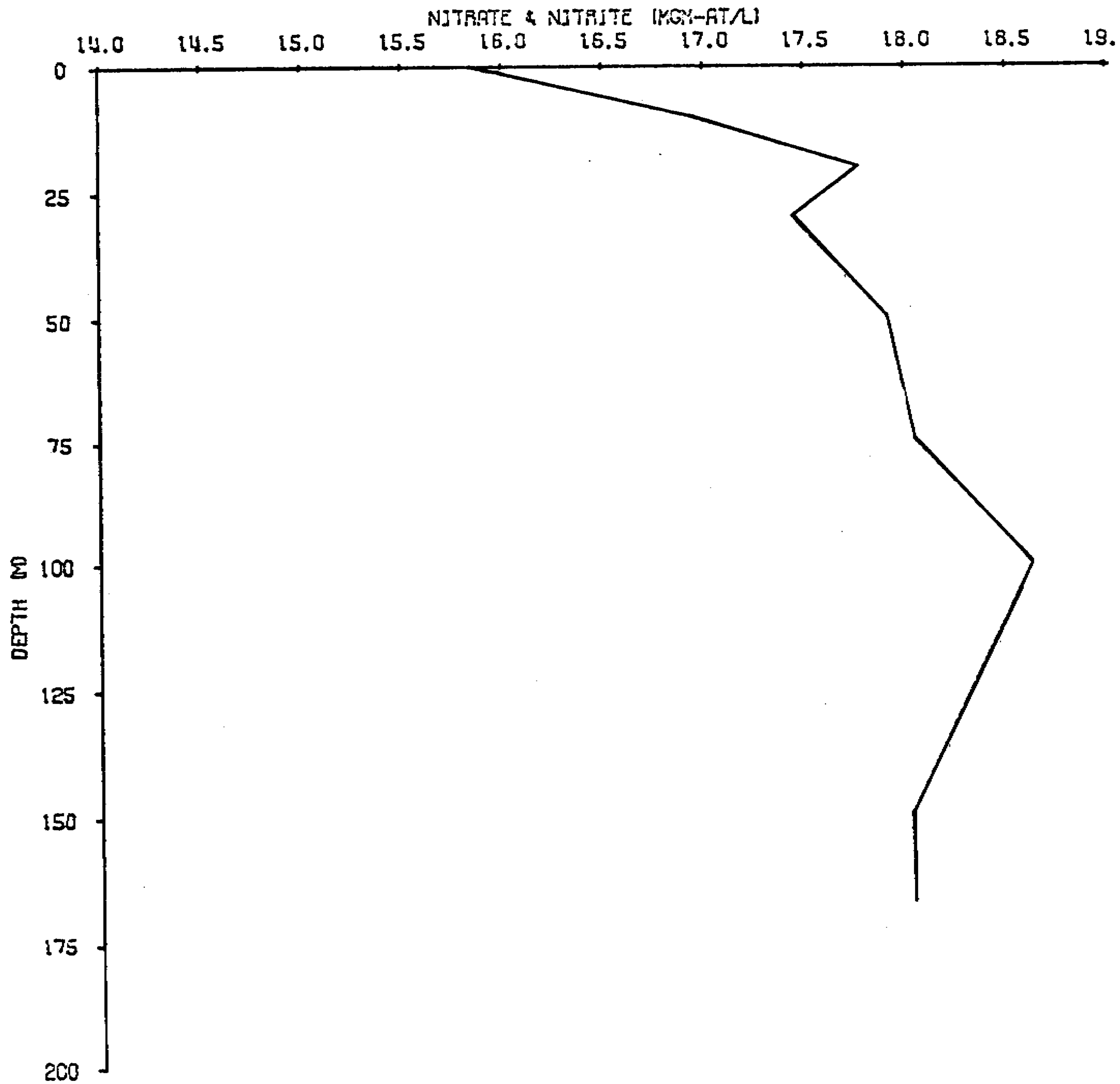

NITRITE X 100 (MGM-AT/L)
25.0
27.0
29.0
31.0
33.0
35.0
37.0
39.0
41.0
43.0
45.0
0
25
50
75
100
125
150
175
200
DEPTH (M)
CRUISE 240, TAK 007.

Figure 20.



CRUISE 240. TAK 007.

Figure 21.

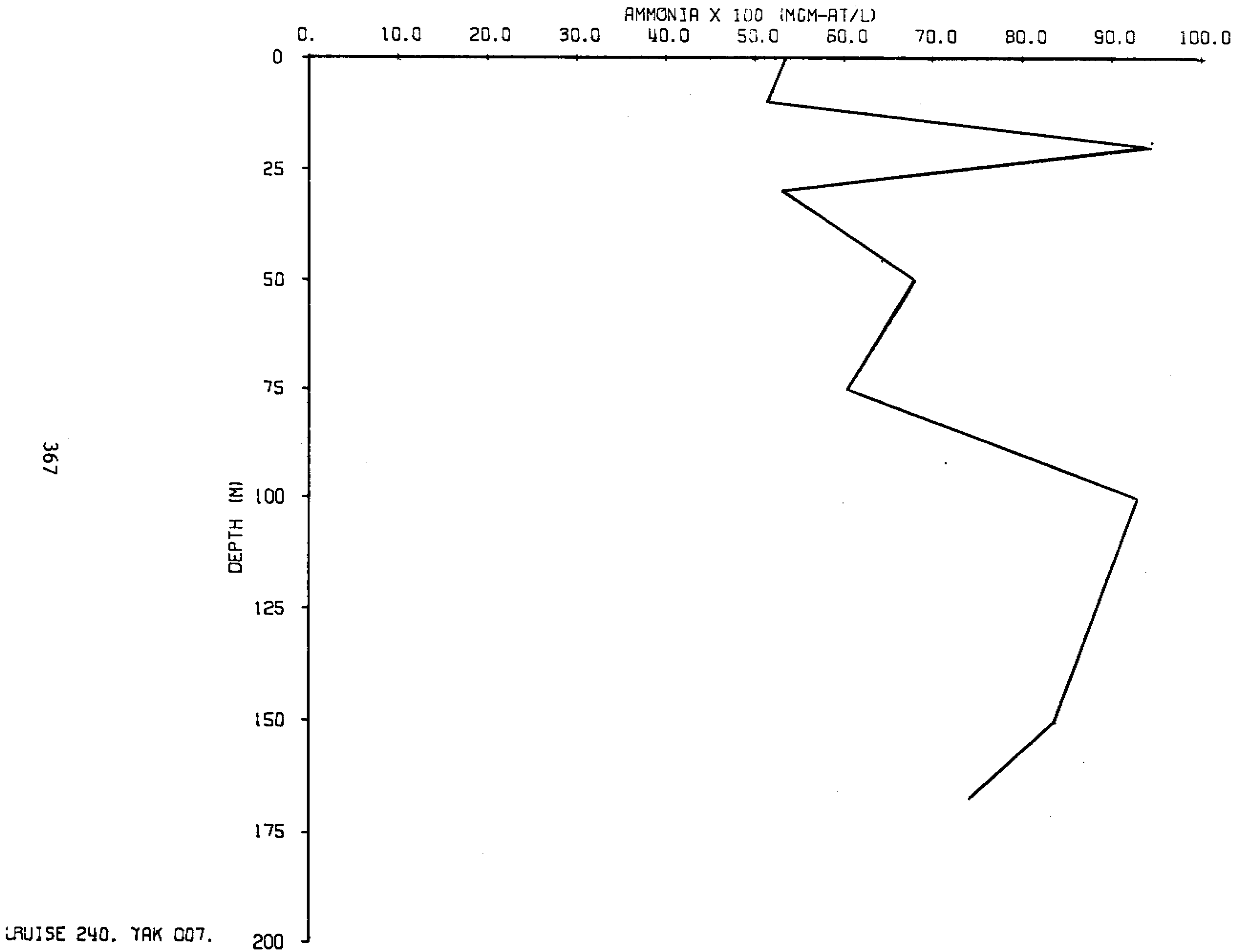

AMMONIA X 100 (MGM-AT/L)
0. 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 90.0 100.0
DEPTH (M)
0 25 50 75 100 125 150 175 200
CRUISE 240. YAK 007.

Figure 22.

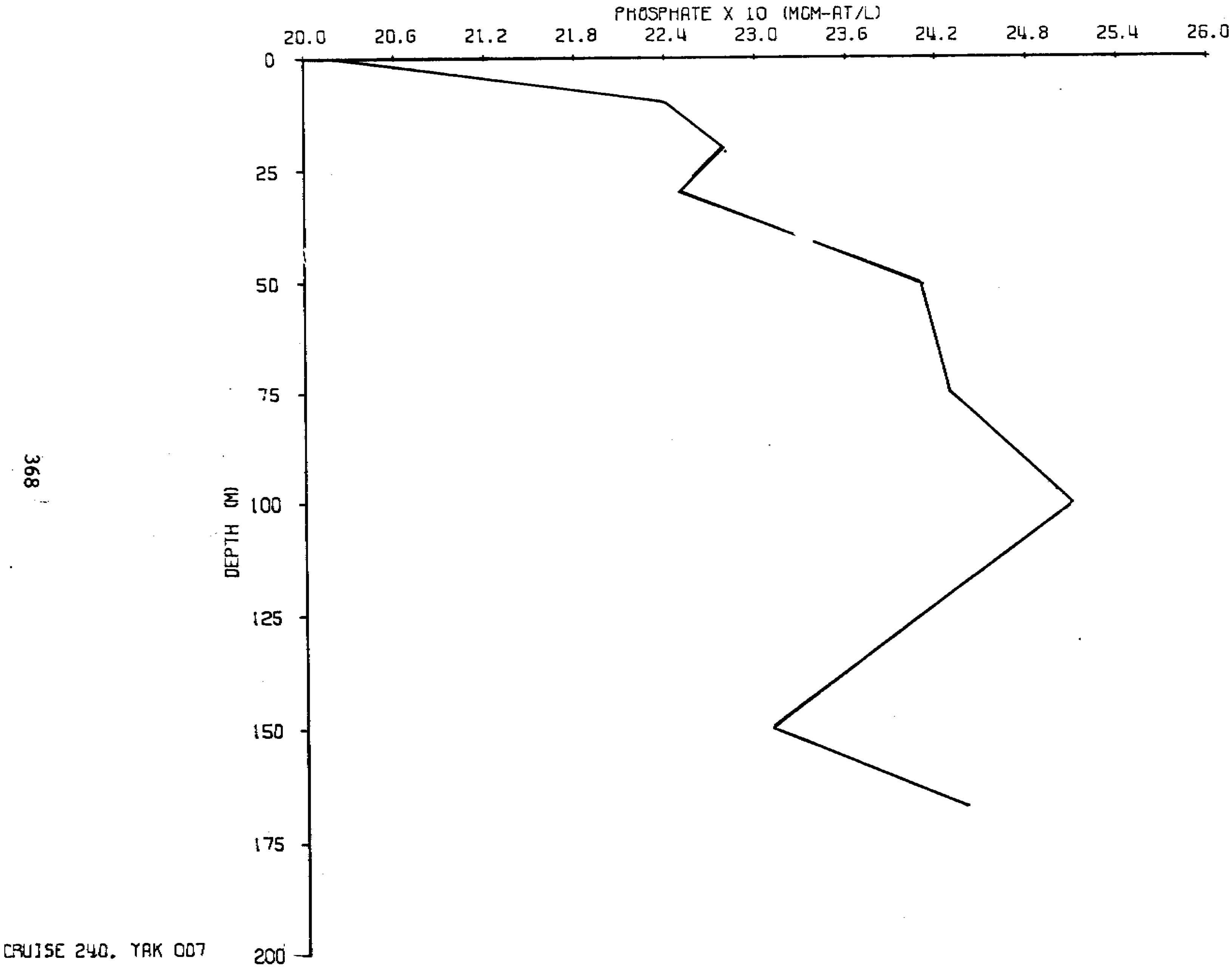
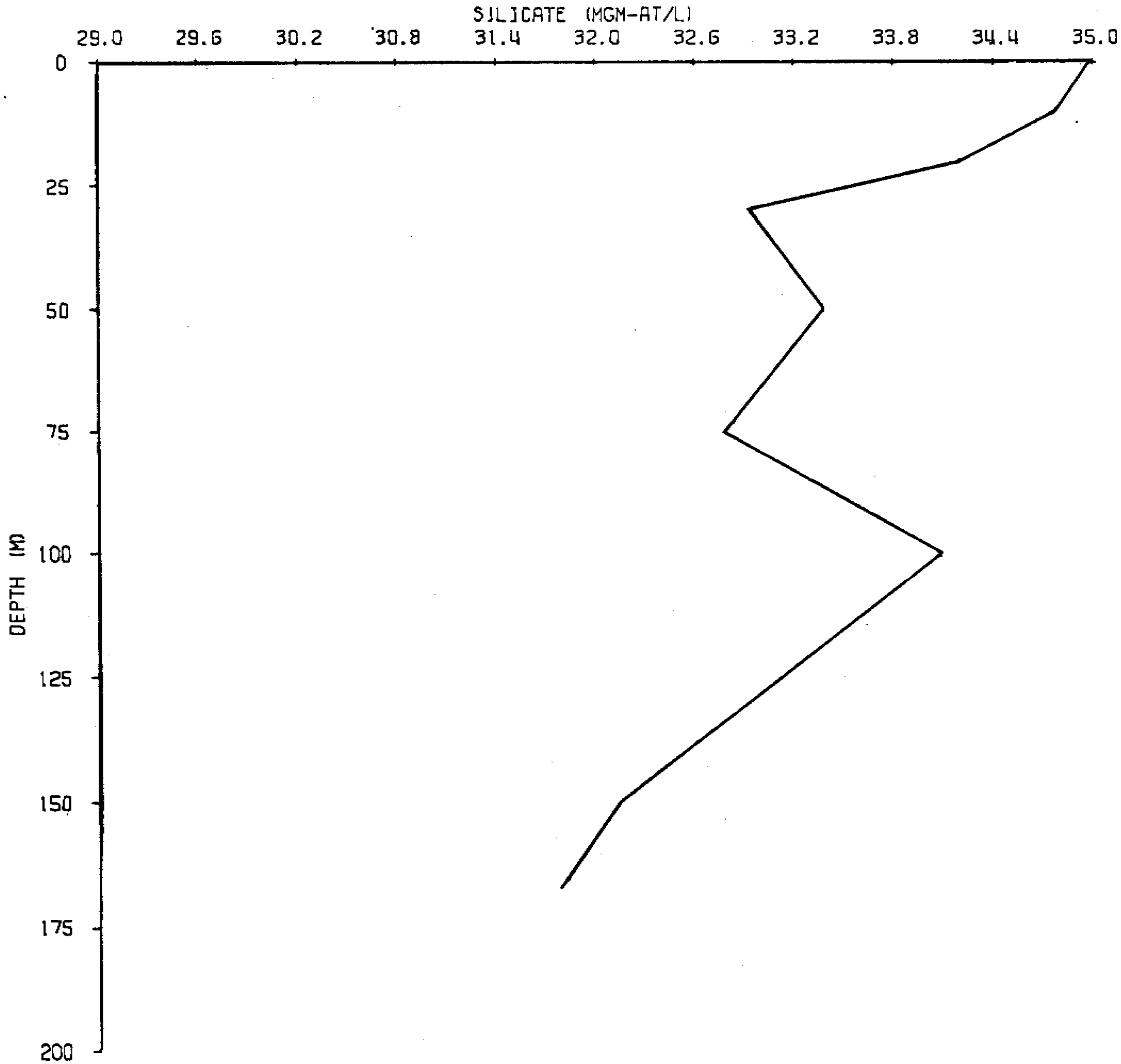
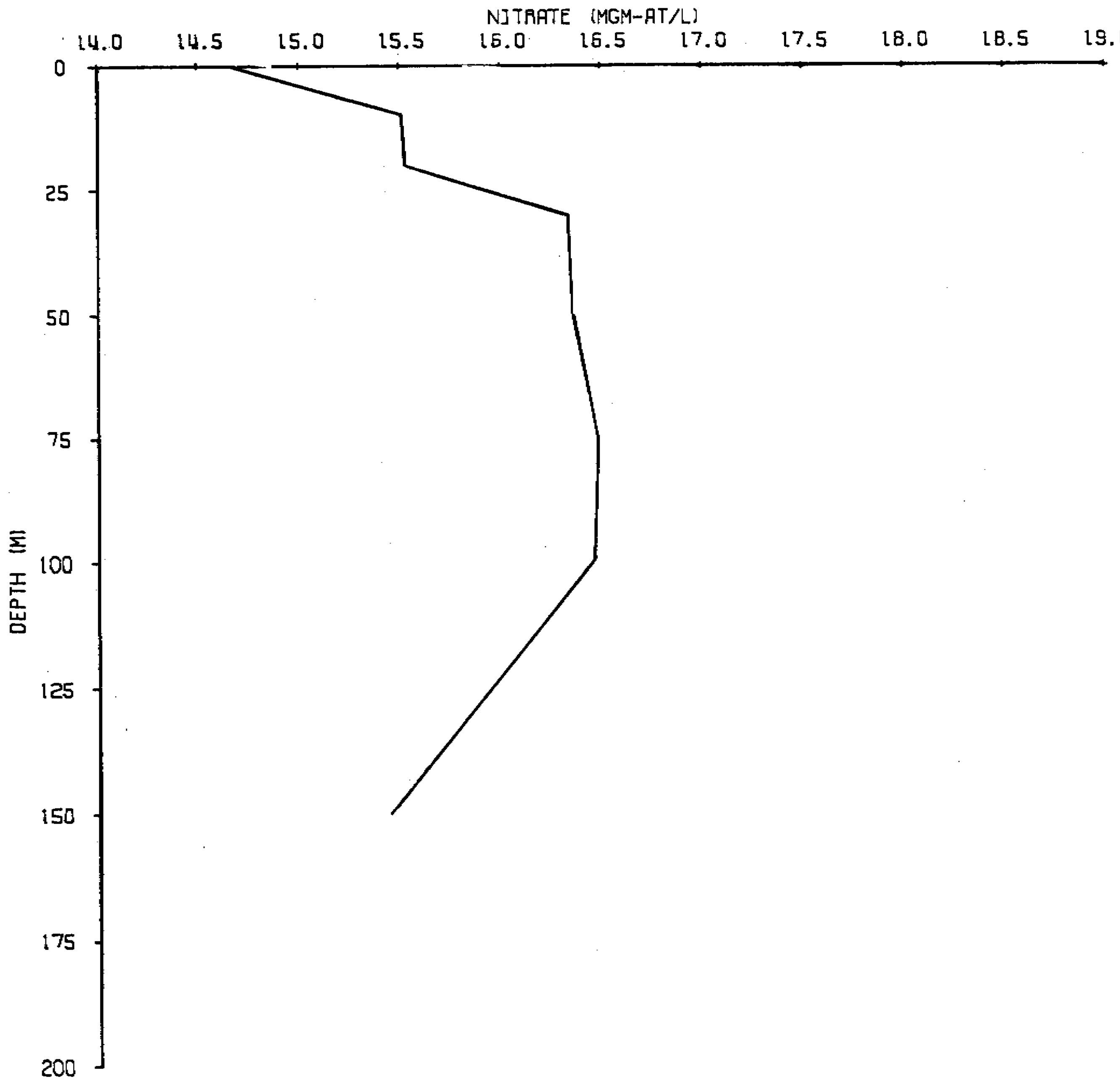

PHOSPHATE X 10 (MGM-AT/L)
20.0 20.6 21.2 21.8 22.4 23.0 23.6 24.2 24.8 25.4 26.0
DEPTH (M)
0 25 50 75 100 125 150 175 200
CRUISE 240, YAK 007

Figure 23.



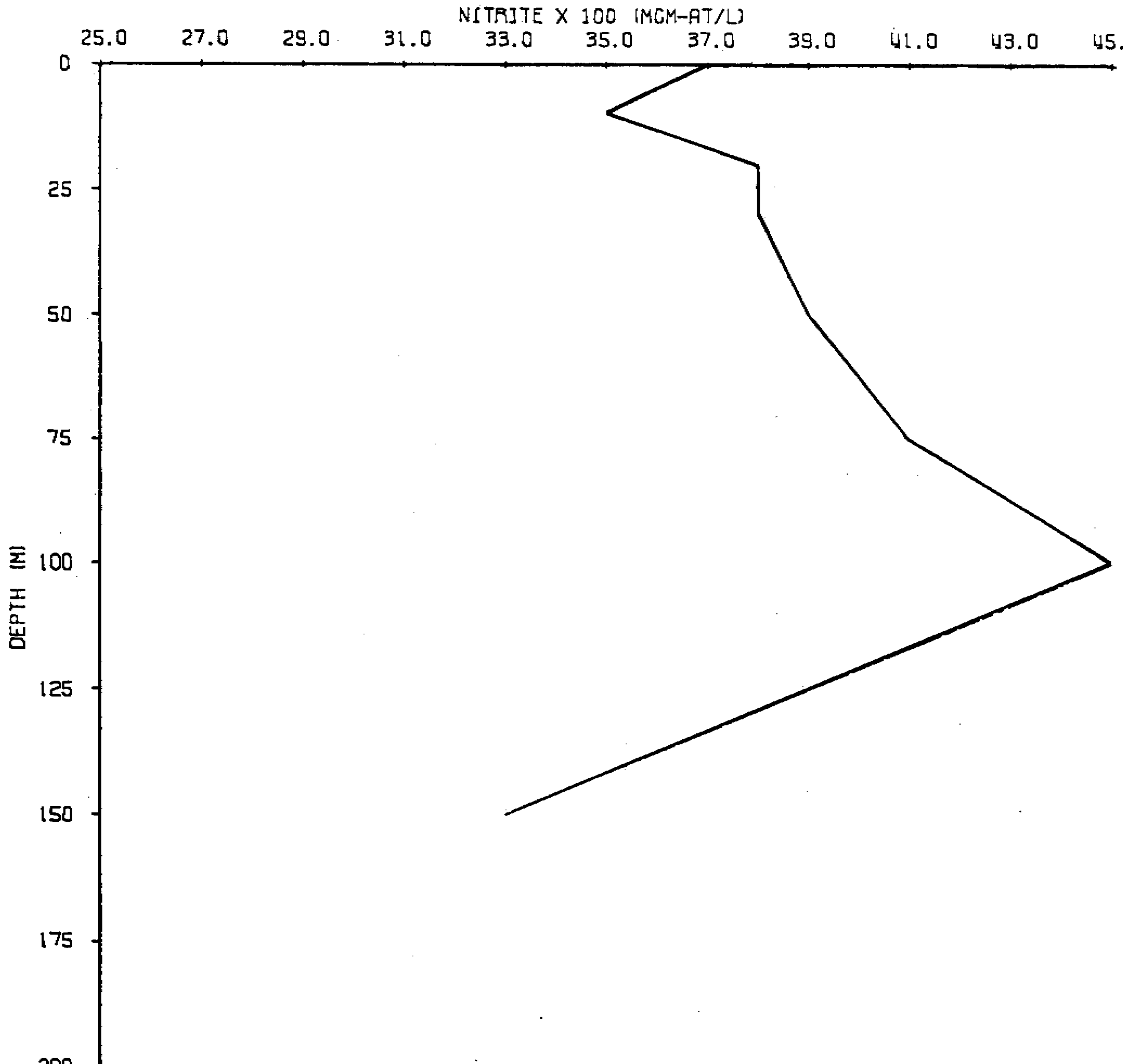
CRUISE 240, YAK 007

Figure 24.



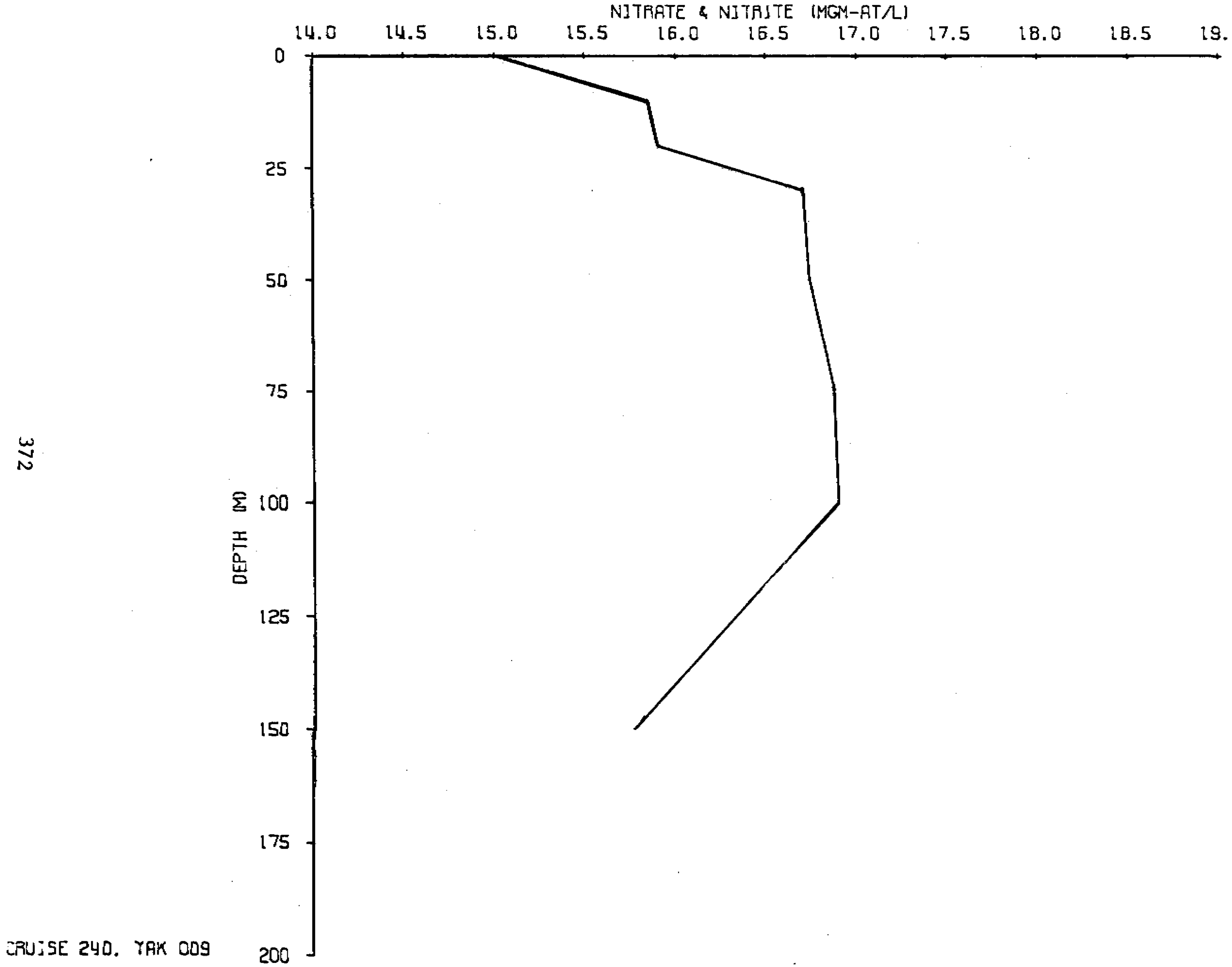
CRUISE 240, YAK 009.

Figure 25.



CRUISE 240, TAK 009.

Figure 26.



NITRATE & NITRITE (MGM-AT/L)
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5
19.0
0
25
50
75
100
125
150
175
200
DEPTH (M)
CRUISE 240. YAK 009

Figure 27.

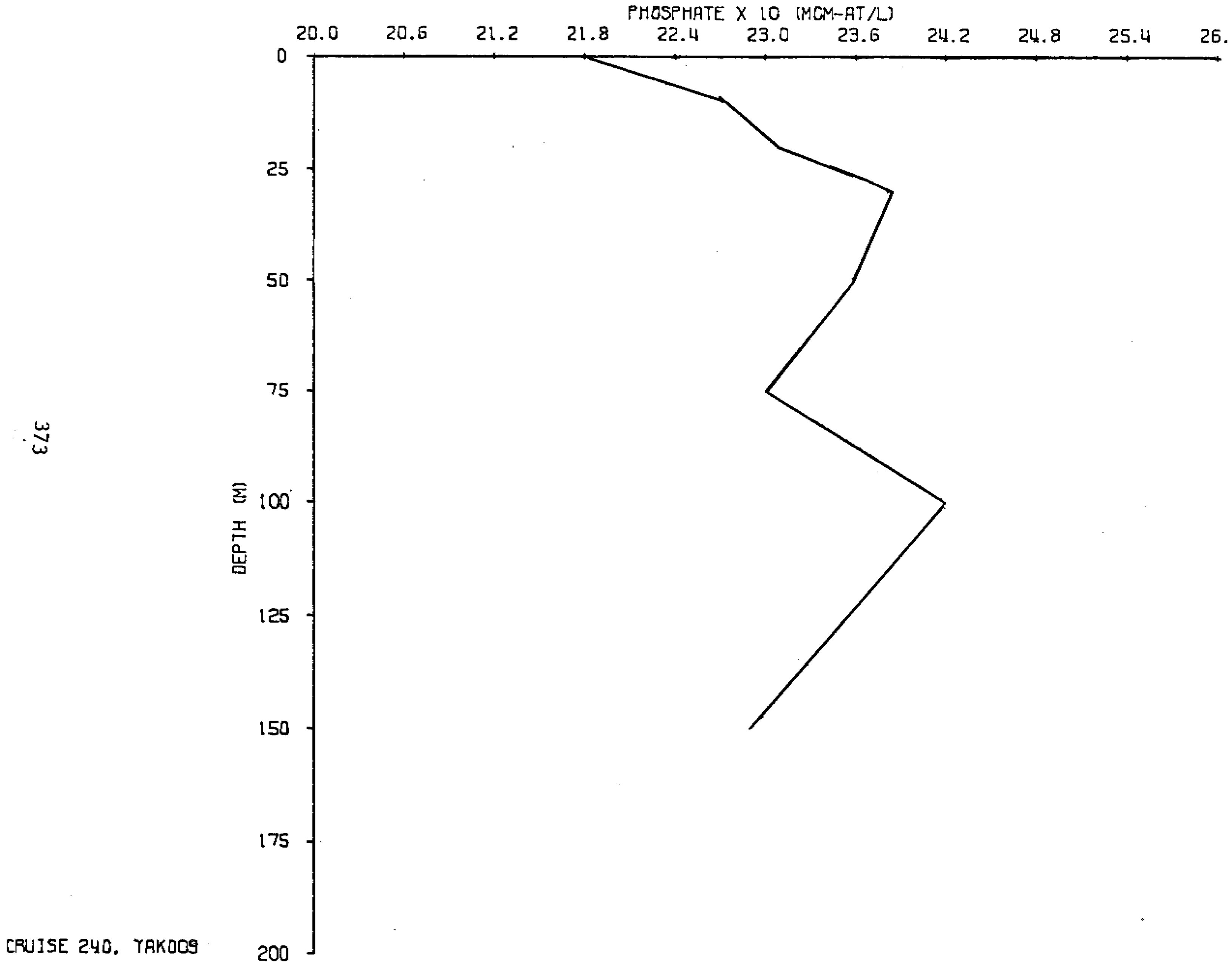

PHOSPHATE X 10 (MGM-AT/L)
20.0
20.6
21.2
21.8
22.4
23.0
23.6
24.2
24.8
25.4
26.0
DEPTH (M)
0
25
50
75
100
125
150
175
200
CRUISE 240, TAKOO9

Figure 28.

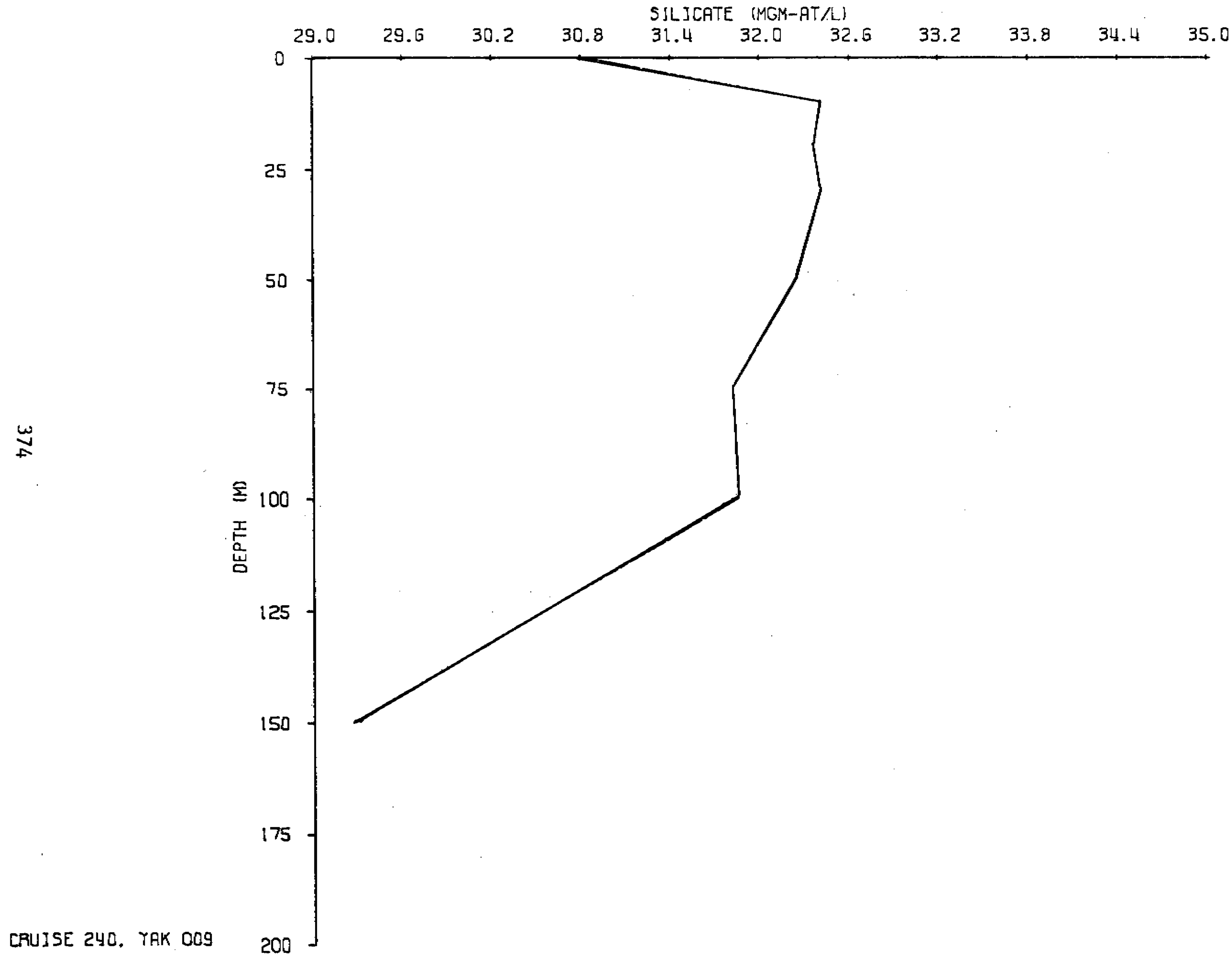

SILICATE (MGM-AT/L)
29.0 29.6 30.2 30.8 31.4 32.0 32.6 33.2 33.8 34.4 35.0
DEPTH (M)
0 25 50 75 100 125 150 175 200
CRUISE 240, YAK 009

Figure 29.

TABLE IX

Bering Sea

U.S.S.R. Hydromet vessel *Volna* July-August 1977
Soluble heavy metal contents (μg/l ; filtered at 0.4 μm)

Station No.	Depth (m)	Cu	Pb
1	0	0.21	(0.41)[a]
	10	0.14	
	25	0.28	(0.48)
	50	0.33	(0.21)
	75	0.22	
3	0	0.08	0.09
	10	0.16	0.16
	25	0.12	0.17
	50	0.14	0.10
	75	0.19	0.09
5	0	0.16	0.10
	10	0.15	0.16
	25	0.14	0.13
	50	0.19	0.22
	75	0.24	0.25
7	0	0.10	0.08
	10	0.16	0.14
	25	0.22	0.15
	50	0.37	0.19
	75	0.38	0.14
9	0	0.25	0.31
	10	0.38	0.20
	25	0.32	0.10
	50	0.22	0.05
	75	0.34	0.18
11	0	0.25	0.31
	10	0.27	0.21
	25	0.27	0.14
	50	0.26	0.03
	55	0.77	0.66
13	0	0.38	0.15
	10	0.19	0.03
	25	0.15	0.06
	50	0.20	0.17
	65	0.25	0.21

TABLE IX (Continued)

Station No.	Depth (m)	Cu	Pb
15	0	0.21	0.20
	10	0.17	0.21
	25	0.22	0.49
	45	0.34	0.26
17	0	0.67	0.42
	10	0.39	0.24
	25	0.22	0.16
	40	0.49	0.33
19	0	0.41	0.14
	10	0.65	0.33
	25	0.75	0.34
21	0	0.36	0.21
	10	0.38	0.16
	25	0.22	0.13
	50	0.30	0.21
	58	0.64	0.14
23	0	0.16	0.10
	10	0.25	0.21
	25	0.32	0.24
	50	0.28	0.20
	75	0.44	0.17
26	0	0.28	0.21
	10	0.35	0.44
	25	0.56	0.54
	50	0.23	0.09
	75	0.24	0.38
28	0	0.27	0.21
	10	0.35	0.27
	25	0.21	0.09
	50	0.41	0.31
	75	0.33	0.24
30	0	0.24	0.24
	10	0.37	0.18
	25	0.42	0.13
	50	0.25	0.18
	75	0.29	0.20

TABLE IX (Continued)

Station No.	Depth (m)	Cu	Pb
32	0	0.49	0.23
	10	0.74	0.68
	25	0.40	0.30
	50	0.43	0.40
	75	0.31	0.12
34	0	0.50	0.20
	10	0.35	0.10
	25	0.22	0.07
	50	0.25	0.10
	75	0.65	0.22
36	0	0.89	0.36
	10	0.55	0.38
	25	0.64	0.36
	50	0.62	0.42
38	0		
	10		
	25	0.84	0.18
	50	0.55	0.55
40	0	0.62	0.26
	10	0.74	0.32
	25	1.02	0.53
	40	0.65	0.39
42	0	0.60	0.10
	10	0.63	0.20
	25	0.87	0.26
	35	0.92	0.60
44	0	0.62	0.10
	10	0.41	0.07
	25	0.45	0.11
	45	0.47	0.11
46	0	0.54	0.26
	10	0.60	0.57
	25	0.59	0.11
	50	1.53	0.37
48	0	0.59	0.32
	10	0.20	0.21
	25	0.65	0.28
	50	0.31	0.38
	75	0.33	0.27

[a] - Contamination suspected

TABLE X

Bering Sea

U.S.S.R. Hydromet vessel *Volna* July-August 1977
Soluble (0.4 μm) heavy metal contents at sea surface (μg/ℓ)

Station No.	Depth (cm)	Cu	Pb
16	0[a]	0.73[b]	2.48[b]
	10	0.30	0.13
	20	0.17	0.08
	30	0.35	0.15
	45	0.33	0.19
	60	0.60	0.14
45	0[a]	0.25[b]	0.46[b]
	10	0.26	0.15
	20	0.24	0.17
	30	0.28	0.08
	45	0.16	0.06
	60	0.30	0.12
	85	0.19	0.19

[a] - collected on 1 mm pore size polyethlene screen.

[b] - data for unfiltered samples

TABLE XI

Bering Sea

O.S.S. *Surveyor* 31 March - 27 April 1977

Heavy metal contents of seal tissue (μg/g dry weight)

Sample	Species	Tissue	Cd[a]	Ni[a]	Cu[a]	Zn[a]
01	Rib	muscle	0.13 ± 0.01	2.5 ± 0.4	6.7 ± 0.5	37 ± 12
		liver	6.4 ± 0.1	2.6 ± 0.9	16.5 ± 0.2	169 ± 7
		kidney	53.0 ± 0.3	2.8 ± 0.2	19.4 ± 0.1	149 ± 1
02	Rib	muscle	0.3 (c)	1.3 (c)	4.4 ± 0.6	50 ± 0
		liver	8.7 ± 1.2	1.3 (c)	16.5 ± 3.5	8 ± 2
		kidney	20.1 ± 4.5	0.5 ± 0	16.5 ± 3.5	102 ± 22
03	Rib	muscle	0.25 ± 0	8.3 ± 1.0	5.5 ± 0	54 ± 2
		liver	6.4 ± 0.1	2.2 ± 0.4	26.9 ± 1.3	140 ± 15
		kidney	34.5 (c)	3.0 (c)	16.0 (c)	98 (c)
04	S	muscle	0.14 ± 0.01	3.0 ± 0.2	6.7 ± 1.3	51 ± 9
		liver	0.4 ± 0.1	2.5 ± 0.2	25.0 ± 2.5	116 ± 51
		kidney	16.7 ± 0.2	2.4 ± 0.4	44 ±13	113 ± 23
05	B	muscle	0.8 ± 0.1	2.8 ± 0.3	7 ± 2	175 ± 25
		liver	21.0 ± 0.5	1.3 ± 0.1	36.5 (c)	182 ± 2
		kidney	16.0 ± 2.0	2.0 ± 0.1	28.5 ± 0	163 ± 3
06	Rib	muscle	0.47 ± 0.01	5.8 ± 0	6.8 ± 0.8	18 ± 6
		liver	11.4 ± 0.1	0.9 ± 0.2	29.0 ± 2.5	100 ± 10
		kidney	33.4 ± 0	1.2 ± 0.2	17.5 ± 0.3	48 ± 0
07	B	muscle	0.57 ± 0.04	2.8 ± 0.2	<5 (b)	147 ± 20
		liver	22.2 ± 1.3	0.8 ±	22.8 ± 0.2	170 ± 17
		kidney	22.5 ± 2.0	1.3 ± 0.3	40 ± 6	160 ± 15
08	B	muscle	1.26 ± 0	1.2 ± 0.1	7.6 ± 0	40 ± 1
		liver	41.1 ± 0.9	0.5 ± 0	44.1 ± 2.4	87 ± 3
		kidney	17.4 ± 0.1	1.5 ± 0.1	28.1 ± 0.6	110 ± 1
10	S	muscle	1.5 ± 1.0	2.4 ± 0.2	11 ± 3	52.5± 0
		liver	0.6 ± 0.1	8.1 ± 1.6	18 ± 4	213 ± 7
		kidney	44.3 ± 0.7	<1.0 (b)	24.5 (c)	183 (c)
11	Rib	muscle	0.24 ± 0.02	<0.5 (b)	16.5 ± 3.5	140 ± 5
		liver	35 ±15	<0.5 (b)	13.8 ± 1.2	15 ± 10
		kidney	16 (c)	<0.5 (b)	19 ± 6	8 ± 3

TABLE XI (Continued)

Sample	Species	Tissue	Cd[a]	Ni[a]	Cu[a]	Zn[a]
16	B	muscle	1.13 ± 0.07	4.8 ± 0.2	6.9 ± 0.6	60 ± 10
		liver	5.3 ± 0.6	5.4 ± 1.1	37.6 ± 1.6	228 ± 3
		kidney	108.7 ± 0.5	6.2 ± 0.2	34.7 ± 0.2	110 ± 20
17	Walrus	muscle	1.50 ± 0.25	2.4 ± 0.5	6.3 ± 1.3	43 ± 8
		liver	26.0 ± 1.0	1.6 ± 0.3	41.6 ± 0.4	99 ± 1
		kidney	26.5 ± 1.0	<1.0 (b)	27.7 ± 0	96 ± 1
28	S	muscle	0.11 ± 0.01	<0.5 (b)	6.4 ± 0.05	68 ± 1
		liver	4.5 ± 0.05	<0.5 (b)	16.4 ± 0.1	136 ± 1
		kidney	– –	– –	– –	– –
29	Rib	muscle	0.70 ± 0.03	<0.5 (b)	1.7 ± 0	74 ± 2
		liver	17.0 ± 0.3	<0.5 (b)	5.2 ± 1.4	130 ± 3
		kidney	37 ± 5	<0.5 (b)	5.2 ± 1.3	92 ± 14
30	S	muscle	0.16 ± 0.04	<0.5 (b)	4.0 ± 0.1	133 ± 0
		liver	7.3 ± 0.2	<0.5 (b)	18.5 ± 0.2	160 ± 0
		kidney	34 ± 5	<0.5 (b)	15 ± 2.5	120 ± 17
32	S	muscle	0.17 ± 0.01	<0.5 (b)	1.1 ± 0.1	62 ± 9
		liver	15.9 ± 0.8	<0.5 (b)	17.1 ± 0.9	125 ± 23
		kidney	49 ± 7	<0.5 (b)	4 ± 2.5	110 ± 32

a = mean of duplicate determinations
b = duplicate determinations
c = single determinations

TABLE XII

Bering Sea

O.S.S. *Discoverer* 25 May - 5 June 1977

Heavy metal contents of seal tissue (μg/g dry weight)

Sample	Species	Tissue	Cd[a]	Ni[a]	Cu[a]	Zn[a]
01	Rib	muscle	0.29 ± 0.04	0.5 ± 0.1	4.6 ± 0.1	96 ± 5
		liver	3.2 ± 0.9	<0.5 (b)	6 ± 3	185 ± 15
		kidney	<0.3 (b)	1.3 ± 0.5	10 ± 1	197 ± 6
02	S	muscle	1.3 (c)	<0.5 (b)	3.9 ± 0.5	18.2 ± 1.1
		liver	2.48 ± 0.02	<0.5 (b)	11 ± 3	23.3 ± 0.2
		kidney	<0.5 (c)	<0.5 (b)	25.5 ± 0	22 ± 2
03	S	muscle	0.29 ± 0.07	2 ± 1	7.6 ± 0.8	87 ± 7
		liver	1.85 ± 0.15	2.5 ± 0	16.5 ± 0.1	114 ± 1
		kidney	11.0 (c)	1.4 (c)	24.0 (c)	93 ± 25
05	S	muscle	0.6 (c)	<0.5 (b)	2.2 ± 0.7	7.5 ± 1
		liver	0.99 ± 0.01	<0.5 (b)	2.3 ± 0.1	10 ± 1
		kidney	<0.5 (c)	<0.5 (b)	23 ± 3	13 ± 1
08	S	muscle	0.08 ± 0	<0.5 (b)	6.5 ± 0.5	62 ± 3
		liver	1.9 ± 0.4	<0.5 (b)	44.3 ± 0.3	101 ± 15
		kidney	1.52 ± 0.02	<0.5 (b)	29 ± 3	83 ± 3
10	S	muscle	0.24 ± 0	2.4 ± 0	7.1 ± 0.9	123 ± 2
		liver	2.6 ± 0.4	1.8 ± 0.2	20.3 ± 0	109 ± 5
		kidney	11 ± 4	0.9 ± 0.1	12 ± 3	103 ± 9
11	Ring	muscle	0.19 ± 0.01	0.6 ± 0.1	9.5 ± 0	135 ± 0
		liver	5.0 (c)	<0.5 (b)	25 (c)	72 ± 2
		kidney	2.52 ± 0.04	0.7 ± 0.1	10 (c)	227 ± 13
15	S	muscle	0.17 ± 0.05	1.4 ± 0.8	6.9 ± 0.1	80 ± 1
		liver	3.1 ± 0.4	2.1 ± 0.2	18.5 ± 1.5	134 ± 9
		kidney	13.1 ± 0.1	3.8 ± 0.3	16.1 ± 0.1	123 ± 1
07	Rib	muscle	0.27 ± 0.01	<0.5 (b)	3.3 ± 0.7	116 ± 7
		liver	3.0 ± 0.2	17.5 ± 0	2.5 (c)	115 ± 5
		kidney	5.5 ± 0	<0.5 (b)	10 ± 1	138 ± 3

a = mean of duplicate determinations
b = duplicate determinations
c = single determinations

TABLE XIII

Bering Sea

Marine mammal analysis program - precision and accuracy
(μg/g dry weight ± one standard deviation)

a. NBS Standard # 1571 orchard leaves.

Element	n	This Study	NBS Certified
Cd	3	0.15 ± 0.06	0.11 ± 0.02
Ni	4	1.4 ± 0.03	1.3 ± 0.2
Cu	7	10.5 ± 3	12 ± 1
Zn	7	25 ± 5	25 ± 3

b. NBS Standard # 1577 bovine liver.

Element	n	This Study	NBS Certified
Cd	3	0.31 ± 0.07	0.27 ± 0.04
Ni	4	0.9 ± 0.08	--
Cu	3	150 ± 30	193 ± 10
Zn	8	120 ± 20	130 ± 10

IV. PRELIMINARY INTERPRETATION

A. Distribution of heavy metals above the benthic boundary layer in fjord estuaries.

Vertical profiles of the type illustrated in Figure 4 further illustrate the process of an important flux of heavy metals from the deposited sediments back into the water column. We have previously documented this in detail for copper and have calculated flux rates for this metal. Similar work is in progress for cadmium. The data given in this report are the first such indication that similar effects apply to manganese in these waters although considerable research on this metal is in progress in more temperate areas. It would be expected that, given the redox environment of the bottom waters, the manganese contents shows, although passing a 0.4 μm filter and hence operationally "soluble", would be not in true solution but colloidal or very fine particulate.

These data cumulatively emphasize the importance of the sediment reservoir as a source of heavy metals to the water column. These are, of course, natural processes. However, the major emphasis of this program is to research ways in which industrial pollution could substantially affect the natural remobilization mechanisms and flux rates. We emphasize again that, although such transport of metals across the sediment interface must occur in all shelf and coastal environments it can only be studied easily in especially favorable locations. We have chosen to work with the deep basins of fjord estuaries because the gradients are not obscured by advective motion at the bottom boundary. It should be clear however, that the results are applicable in all other respects to adjacent areas such as Cook Inlet. This latter is itself a fjord but with a particularly complex circulation.

B. Extractable heavy metal contents of S. Bering Sea sediments.

The final summary of data for this area is given in Tables VII and VIII. This includes both extractable heavy metal contents and size fractionation data. In the last quarterly report we discussed similar sets of data for Norton Sound and the southern portion of the Chukchi Sea. Here, close correlations of the extractable Fe, Ni, Zi and Cu with grain size fineness could be statistically demonstrated. A similar rigorous treatment of the S. Bering Sea data is not possible since a large number of the values fall close to or beyond the detection limit of the analytical method used at that time. It should also be noted that, at the request of BLM, the extraction scheme used was different for each of these lease areas (future work e.g. in Lower Cook Inlet, will also not be comparable since yet another extraction scheme is currently being proposed) However, similar metal - clay content correlations appear to hold for the Bering Sea region, as might be expected. Except in geographically very limited areas of special scientific or industrial interest, there would seem little point in continuing this type of baseline summary.

C. Soluble Cu and Pb for summer surface waters of the Bering Sea.

Several interesting features are apparent from this extensive set of data given in Tables IX and X including a clear increase adjacent to the sea floor. This expedition, however, included a mass of ancillary environmental chemical data and it is hoped that we shall be able to have access to this material in the near future. In anticipation of this; we will postpone a discussion until a later report.

D. Heavy metal contents of Bering Sea seal tissue.

This sub-project was not renewed for FY '78 and is now essentially complete. All the analysis numbers are given in this report. Some very interesting characteristics are apparent and also surprisingly high values for, for example, cadmium. This is a highly toxic metal and it would seem inadvisable for liver and kidney of these mammals to form a regular part of any human diet. We are still awaiting further age, sex etc. data from the biologists which will be required in determining potential patterns of metal retention associated with, for example, feeding habits, age etc. It should be noted, however, that too few individuals of any one species or age group have been collected to permit anything approaching a rigorious statistical analysis. At this time, the following preliminary characteristics are apparent, but with numerous exceptions:

1. Cadmium

   a) Concentrations in the kidneys of ribbon seals greater than in spotted or bearded.

   b) Higher cadmium contents in the muscle tissue of bearded seals than in ribbon or spotted seals.

   c) Liver contents of spotted seals relatively low.

   d) Liver cadmium contents of bearded seals relatively high.

2. Nickel - muscle contents of this metal generally higher than liver or kidneys.

3. Copper - contents of spotted seal kidneys generally higher than liver but the reverse for ribbon and bearded seals.

4. Zinc

   a) Muscle contents of bearded (and possibly spotted) seals higher than ribbon seals.

   b) Concentration of zinc in all liver generally higher than in kidneys.

V. PROBLEMS ENCOUNTERED

A. By the end of this first quarter of FY '78, the proposed program has still not been approved. This is causing problems in two directions. In the first place, the interim funding received has not permitted us to purchase needed equipment nor replace badly needed items such as recorders. More importantly, however, is the fact that we are, of necessity, having to progress in a direction which may not eventually receive official blessing. The chief casually have, as in similar circumstances in previous years, in the absence of an orderly, long term (i.e., something in excess of one year) program. This consequences of this are noted in the following paragraph.

B. We have stressed repeatedly that a scientifically defensible program geared to OCSEAP needs must necessitate committment to a particular problem with supporting field collections and laboratory work over several years; i.e., spanning a number of seasons and multiple natural cycles. The direction of the chemistry program has been changed every year since its exception and appears likely to do so again in FY '79 although we have been encouraged to gear up for long term fate-and-effects projects. With this mode of operation we can continue to collect baseline data, but cannot hope to contribute to an understanding of the pathways and processes governing the transport and distribution of these pollutants in Alaskan coastal environments.

QUARTERLY REPORT

Contract #03-5-022-56
Research Unit #275
Task Order #5
Reporting Period 9/30/77 - 12/31/77

HYDROCARBONS NATURAL DISTRIBUTION AND DYNAMICS ON THE ALASKAN OUTER CONTINENTAL SHELF

D. G. Shaw
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

December 31, 1977

I. Project Name:

Hydrocarbons: Natural Distribution and Dynamics on the Alaskan Outer Continental Shelf.

II. Field Activities

During a cruise of the USNOSS Survey on 3-17 November, a variety of biological materials including crab, fish, shrimp, snails, algae, sea stars, urchins and bivalves were collected for hydrocarbon analysis. These collections were not totally successful in that all of the desired species of known trophic relation were not obtained. Sediment samples for analysis by I. R. Kaplan were also obtained.

III. Laboratory Activities

Analytical work in this quarter has had three primary areas of emphasis.

1. Analysis of nearshore Beaufort Sea sediments: this has progressed well with special attention to aromatics.

2. Analysis of the environmental variability of sediments from Kachemak Bay: this work, which was begun in FY 77, is nearing completion and is producing useful data.

3. Comparison of methods for analysis of biota: considerable effort has been required in this area because it has been found that recovery of added spikes is more variable than was previously believed. This problem is not yet fully resolved.

QUARTERLY REPORT

Research Unit #: 500
Reporting Period: October 1 - December 31, 1977

Activity-Directed Fractionation of Petroleum Samples

J.S. Warner
Principal Investigator
Battelle
Columbus, Ohio

Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 424-6424
Telex 24-5454

January 30, 1978

Dr. Herbert E. Bruce
ERL/OCSEAP
National Oceanic and Atmospheric Administration
P. O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

Reference: Research Unit 500

This letter will serve as our Third Quarterly Report on "Activity-Directed Fractionation of Petroleum Samples" covering the period of October 1, 1977, to December 31, 1977.

Work is continuing on the fractionation of oil using the modifications described in the last report. Gas chromatographic analysis of both the volatiles and the residual material obtained from a preliminary distillation at reduced pressure indicated that most components boiling below 190 C had been removed as the volatile fraction. The preliminary distillation step should therefore significantly reduce evaporative losses during the determination of residue weights of aliquots from subsequent subfractions of the residual material. Consequently it will be possible to obtain a much better material balance.

In an effort to obtain large enough amounts of fractions for bioassay without sacrificing column efficiency the silica gel fractionation step has been scaled up to permit fractionation of 5 g of oil using 1000 g of silica gel. A process blank, also involving 1000 g of silica gel, has been run to make sure that no activity found is attributed to the oil in error. The silica gel fractionation and subsequent concentration steps are being carried out under yellow lights to avoid degradation of photosensitive compounds such as polynuclear aromatic hydrocarbons, many of which are known mutagens and known to be present in most crude oils.

As mentioned in the last report a brine shrimp assay is being considered in place of a mammalian cell toxicity assay because the latter cannot tolerate the THF-dispersant mixture planned for use in the Ames mutagenicity assay. THF was tried in the mammalian cell toxicity assay to find out how much can be tolerated in the absence of a dispersant. Only 0.2 μl of THF ml of media could be tolerated. Therefore it does not appear practical to use this assay except for those fractions that can be dissolved in DMSO instead of THF.

Admittedly the work has progressed rather slowly this far. We expect much greater progress during the next quarter including completion of the fractionation of fresh oil and the in vitro bioassay of the fractions using the Ames mutagenicity assay.

If you have any questions concerning this work please do not hesitate to contact me.

Sincerely yours,

J. S. Warner
Senior Research Scientist
Organic, Analytical, and
Environmental Chemistry

JSW:jeb

xc: Dr. Rudolf J. Engelman

QUARTERLY REPORT

Research Unit # 506
Reporting Period 9/30/77 - 12/31/77
Number of Pages: 5

NATIONAL DISTRIBUTION OF TRACE METALS AND ENVIRONMENTAL BACKGROUND IN THREE ALASKA SHELF AREAS

PRINCIPAL INVESTIGATORS: David E. Robertson
Keith H. Abel
Senior Research Scients
Battelle, Pacific Northwest Labs.
Richland, Washington 99352

QUARTERLY REPORT FOR PERIOD ENDING DECEMBER 31, 1977

Project Title: National Distribution of Trace Metals and Environmental Background in Three Alaska Shelf Areas

Principal Investigators: David E. Robertson and Keith H. Abel
Senior Research Scientist
Battelle, Pacific Northwest Laboratories
Richland, Washington 99352

I. Task Objectives

The primary objective of this study is to determine environmental baseline concentrations of selected heavy metals in seawater (both dissolved and suspended fractions), in selected marine "indicator" organisms and in the sediments of the Alaskan Outer Continental Shelf (OCS) study area.

The research plan that we have formulated is coordinated in conjunction with the studies being conducted by other Alaskan OCS investigators and in particular with the University of Alaska group. We have complemented their work by measuring those heavy metals most amenable to neutron activation analyses. Of the total suite of elements considered of prime importance to this study (As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Zn, V, Ag, Ba, Co. Fe and Mn), we have concentrated our efforts on the analyses of As, Ag, Sb, V, Se, Fe, Mn and Co in seawater, biota and sediments. We are, however, able to measure additional elements which are automatically detected by the instrumental neutron activation method we employ, and which we feel are important in understanding the biogeochemistry of trace metals in Alaskan OCS areas.

II. Field or Laboratory Activities

No field work was conducted during this quarter of the program. Our main effort has been the completion of analyses of biological samples and suspended particulates. Analyses of seawater for dissolved trace metals by instrumental neutron activation analyses is nearly complete.

We have now completed analyses of all of the biological, suspended particulates, and sediments obtained during the previous two years and are presently completing data tabulation and review. All of these data, with appropriate narrative and summary, will be included in the April, 1978 Annual Report. Included in this Progress Report are data for the remaining 12 Mytilus samples, and the remainder of the suspended particulate analyses.

III. Results and Discussion

The results of the final Mytilus analyses are shown in the accompanying table. The elemental concentrations in the soft tissues are very similar to those reported in the September 30, 1977 Progress Report for the OCS areas. Trace metal distributions in Mytilus from the wide geographical range samples were only moderately variable. For the essential trace metals Zn and Se, and the toxic elements Hg and As, the distributions were remarkably homogeneous. The multielement measurement approach that we use identifies the presence of mineral matter (probably suspended sediments) in several of the Mytilus samples, notably those from Boswell Bay, Cape Pasashak and Port Dick. Mytilus from these areas are characterized by unusually high Fe, Cr and Sc concentrations which are indicative of the presence of mineral matter. The Mytilus may be good indicators of the suspended load of coastal waters.

The results of the final analyses of suspended particulates are presented in the accompanying tables. The concentrations, in nanograms/liter, (except Fe in micrograms/liter) are normally very low, and one to two orders of magnitude below the dissolved fraction of each element except for Fe, Co and Sc. All trace metal concentrations were significantly above the filtering procedural blank except Hg. The Hg data appear to merely represent fluctuations in the filter blank, and apparently the particulate Hg concentrations are below the procedural blank.

IV. Problems Encountered

No major problems were encountered during the period.

V. Estimate of Funds Expended

As of 12/31/77, $3617 have been spent or 13.6% of the $26,500 allocated for FY '78.

ELEMENTAL COMPOSITION OF BIOLOGICAL MATERIAL FROM ALASKA OCS STUDY AREAS ppm DRY WEIGHT (EXCEPT WHERE NOTED)

	SPECIMEN	LOCATION	As	Br	Co	Cr	Cs	Fe	Hg	Na (%)	K (%)	Rb	Sb	Sc	Se	Sr	Zn
73	MYTILUS	SUNDSTROM ISL.	11 ± 1	340 ± 10	0.97 ± 0.04	4.7 ± 0.3	0.046 ± 0.009	1840 ± 130	0.32 ± 0.08	3.38 ± 0.15	2.10 ± 0.68	13 ± 3	0.034 ± 0.029	0.69 ± 0.01	2.7 ± 0.1	200 ± 10	110
74		SUNDSTROM ISL.	13 ± 1	420 ± 10	0.65 ± 0.01	2.0 ± 0.1	0.031 ± 0.04	490 ± 50	0.46 ± 0.03	4.08 ± 0.23	1.73 ± 0.68	4.6 ± 1.3	0.045 ± 0.007	0.17 ± 0.01	2.9 ± 0.1	140 ± 10	100
75		CAPE NUKSHAK	8.4 ± 0.8	310 ± 10	2.1 ± 0.1	3.6 ± 0.2	0.21 ± 0.01	2280 ± 50	0.22 ± 0.06	2.40 ± 0.11	<1.22	22 ± 2	0.10 ± 0.02	0.97 ± 0.01	2.9 ± 0.1	150 ± 10	72
76		DAY HARBOR	7.1 ± 0.4	160 ± 10	1.1 ± 0.1	1.2 ± 0.1	0.028 ± 0.002	240 ± 10	0.13 ± 0.02	1.66 ± 0.09	0.74 ± 0.33	2.8 ± 0.9	0.016 ± 0.004	0.070 ± 0.001	2.1 ± 0.1	100 ± 10	50
77		BOSWELL BAY	8.0 ± 0.5	140 ± 10	3.0 ± 0.1	11.6 ± 0.2	0.26 ± 0.01	6000 ± 140	0.12 ± 0.06	1.22 ± 0.05	0.90 ± 0.31	12 ± 2	0.12 ± 0.02	2.5 ± 0.1	1.9 ± 0.1	160 ± 10	72
78		CAPE PASASHAK	8.7 ± 0.5	190 ± 10	1.2 ± 0.1	8.5 ± 0.2	0.095 ± 0.006	3960 ± 110	0.19 ± 0.05	2.42 ± 0.14	1.53 ± 0.50	8.7 ± 2.1	0.044 ± 0.015	1.4 ± 0.1	2.2 ± 0.1	51 ± 3	80
79		SENNETT POINT	10 ± 1	330 ± 10	0.55 ± 0.01	0.90 ± 0.13	0.027 ± 0.004	920 ± 40	0.37 ± 0.004	3.05 ± 0.15	<1.43	2.9 ± 1.4	<0.013	0.37 ± 0.01	2.4 ± 0.1	61 ± 3	110
80		CAPE HUPIT	7.0 ± 0.6	230 ± 10	0.37 ± 0.01	1.5 ± 0.1	0.015 ± 0.003	540 ± 20	0.16 ± 0.03	2.98 ± 0.17	1.88 ± 0.59	5.2 ± 1.1	0.018 ± 0.006	0.18 ± 0.01	1.9 ± 0.1	49 ± 2	97
81		EIDER POINT	1.0 ± 1	290 ± 10	0.30 ± 0.01	1.2 ± 0.1	0.015 ± 0.004	150 ± 10	0.19 ± 0.04	2.64 ± 0.12	<1.43	5.3 ± 1.1	<0.009	0.051 ± 0.002	2.5 ± 0.1	47 ± 2	170
82		LaTOUCHE POINT	8.6 ± 0.6	290 ± 10	1.3 ± 0.1	1.1 ± 0.1	0.016 ± 0.003	280 ± 10	0.12 ± 0.03	2.31 ± 0.13	<1.09	<1.5	0.021 ± 0.007	0.067 ± 0.001	2.6 ± 0.1	62 ± 2	63
83		PORT DICK	9.4 ± 0.7	290 ± 10	2.6 ± 0.1	12 ± 1	0.39 ± 0.01	5740 ± 160	0.31 ± 0.04	2.91 ± 0.13	<1.15	14 ± 2	0.22 ± 0.02	2.1 ± 0.1	3.2 ± 0.1	210 ± 10	130
84		LaCOON POINT	8.9 ± 0.5	220 ± 10	0.54 ± 0.01	1.2 ± 0.1	0.029 ± 0.003	380 ± 10	0.28 ± 0.03	2.73 ± 0.15	1.28 ± 0.56	4.8 ± 1.1	0.013 ± 0.005	0.13 ± 0.01	2.7 ± 0.1	62 ± 2	93

ELEMENTAL COMPOSITION OF SUSPENDED PARTICULATE MATERIAL (>0.4 µ) IN ALASKAN SHELF WATERS (ng/l EXCEPT WHERE NOTED)

STATION IDENTIFICATION			As	Ba (µg/l)	Co	Cs	Fe (µg/l)	Hg	Rb	Sb	Sc	Se	Sr
WESTERN GULF OF ALASKA	101	SURFACE	0.51 ± 0.11	<0.76	3.16 ± 0.08	0.42 ± 0.06	5.31 ± 0.14	2.8 ± 0.6	50 ± 30	0.26 ± 0.10	1.74 ± 0.01	<0.38	60 ± 40
		BOTTOM	3.4 ± 0.5	<0.67	5.30 ± 0.06	0.73 ± 0.05	8.71 ± 0.09	2.6 ± 0.3	<20	0.49 ± 0.11	3.20 ± 0.01	0.5 ± 0.2	860 ± 40
	104	SURFACE	4.7 ± 0.5	<0.64	1.74 ± 0.03	0.12 ± 0.03	1.58 ± 0.05	5.5 ± 0.2	<10	<0.73	0.59 ± 0.002	1.0 ± 0.1	400 ± 20
		BOTTOM	2.3 ± 0.4	<0.56	7.85 ± 0.09	1.1 ± 0.1	16.2 ± 0.1	7.4 ± 0.8	<40	0.48 ± 0.12	5.17 ± 0.01	1.5 ± 0.5	140 ± 50
	108	SURFACE	<1.8	<0.84	1.66 ± 0.13	0.23 ± 0.03	3.16 ± 0.04	1.9 ± 0.2	<20	0.19 ± 0.05	1.20 ± 0.01	0.46 ± 0.12	540 ± 10
		BOTTOM	<1.5	<0.69	7.18 ± 0.06	1.3 ± 0.1	16.8 ± 0.1	8.3 ± 0.7	70 ± 40	0.29 ± 0.11	6.30 ± 0.01	1.2 ± 0.4	560 ± 50
	119	SURFACE	7.5 ± 1.3	2.4 ± 1.0	10.3 ± 0.1	2.2 ± 0.1	22.0 ± 0.1	18 ± 1	50 ± 10	1.2 ± 0.1	8.77 ± 0.01	0.91 ± 0.28	300 ± 30
		BOTTOM	13 ± 1	<1.0	18.8 ± 0.1	2.6 ± 0.1	26.5 ± 0.2	16 ± 1	70 ± 40	0.94 ± 0.15	8.07 ± 0.02	1.4 ± 0.5	310 ± 60
	121	SURFACE	8.3 ± 1.3	<1.1	5.27 ± 0.01	1.0 ± 0.1	9.76 ± 0.06	14 ± 1	30 ± 10	4.7 ± 0.1	3.94 ± 0.01	1.4 ± 0.2	250 ± 20
	122	BOTTOM	<0.53	<0.69	6.31 ± 0.08	1.5 ± 0.1	16.8 ± 0.2	9.2 ± 0.8	80 ± 40	0.81 ± 0.13	6.18 ± 0.02	1.0 ± 0.5	210 ± 50
	124	SURFACE	5.0 ± 1.4	<1.2	6.14 ± 0.04	0.91 ± 0.05	9.17 ± 0.06	16 ± 1	30 ± 10	1.0 ± 0.1	3.91 ± 0.01	1.0 ± 0.2	200 ± 20
		BOTTOM	<0.52	<0.86	5.73 ± 0.07	1.2 ± 0.1	1.33 ± 0.01	9.4 ± 0.7	<40	0.37 ± 0.12	4.82 ± 0.01	0.99 ± 41	280 ± 40
	133	SURFACE	<3.3	<1.3	1.64 ± 0.03	0.21 ± 0.03	2.53 ± 0.08	20 ± 1	<30	0.42 ± 0.09	0.82 ± 0.06	1.2 ± 0.2	150 ± 20
		BOTTOM	<1.5	<1.0	4.63 ± 0.05	1.1 ± 0.1	10.0 ± 0.1	11 ± 1	60 ± 20	1.0 ± 0.1	3.64 ± 0.01	<0.58	140 ± 30
	135	SURFACE	5.6 ± 3.3	<1.3	2.07 ± 0.03	<0.05	0.85 ± 0.07	17 ± 1	<20	0.56 ± 0.08	0.30 ± 0.05	1.7 ± 0.2	200 ± 20
		BOTTOM	<2.5	<1.1	6.03 ± 0.06	1.3 ± 0.1	15.1 ± 0.1	10 ± 1	50 ± 20	1.7 ± 0.2	5.34 ± 0.01	<0.52	360 ± 30
	137	SURFACE	<3.6	<1.4	1.55 ± 0.03	0.14 ± 0.03	1.89 ± 0.07	15 ± 1	<20	0.57 ± 0.08	0.66 ± 0.05	<0.30	200 ± 20
		BOTTOM	<2.5	<1.1	6.13 ± 0.06	1.0 ± 0.1	11.7 ± 0.1	9.2 ± 0.5	50 ± 20	2.7 ± 0.2	4.13 ± 0.01	0.85 ± 0.33	270 ± 30
	145	SURFACE	<4.5	<1.8	2.57 ± 0.04	0.21 ± 0.04	3.65 ± 0.09	21 ± 1	<30	0.58 ± 0.10	1.27 ± 0.01	0.73 ± 0.23	780 ± 20
		BOTTOM	<2.2	<0.95	3.44 ± 0.04	0.18 ± 0.04	2.90 ± 0.13	12 ± 1	<20	1.5 ± 0.1	1.05 ± 0.01	0.77 ± 0.21	230 ± 20
	148	SURFACE	<3.4	<1.5	1.20 ± 0.03	0.12 ± 0.02	1.40 ± 0.07	17 ± 1	<20	2.2 ± 0.1	0.48 ± 0.05	0.64 ± 0.10	170 ± 20
		BOTTOM	3.0 ± 1.5	<1.2	5.33 ± 0.05	0.71 ± 0.05	8.00 ± 0.10	13 ± 1	<30	0.77 ± 0.14	2.86 ± 0.01	0.92 ± 0.28	180 ± 30
	157	SURFACE	<1.2	<0.51	3.60 ± 0.04	0.18 ± 0.03	3.66 ± 0.09	14 ± 1	<30	0.98 ± 0.11	1.19 ± 0.01	<0.46	100 ± 20
		BOTTOM	<1.2	<1.1	4.27 ± 0.05	0.24 ± 0.05	6.59 ± 0.09	14 ± 1	<30	1.3 ± 0.01	2.40 ± 0.01	0.59 ± 0.20	210 ± 20
	160	SURFACE	<8.0	<3.4	1.79 ± 0.06	0.089 ± 0.049	1.49 ± 0.17	34 ± 1	<10	1.2 ± 0.1	---	1.2 ± 0.3	350 ± 30
		BOTTOM	<2.8	<2.3	3.66 ± 0.04	0.44 ± 0.04	5.82 ± 0.12	14 ± 1	50 ± 40	0.52 ± 0.16	2.03 ± 0.01	0.73 ± 0.09	120 ± 30
BERING SEA	MB-2	SURFACE	7.4 ± 2.3	<1.1	2.63 ± 0.06	0.13 ± 0.06	6.06 ± 0.17	2.6 ± 0.7	---	0.53 ± 0.16	1.82 ± 0.01	0.82 ± 0.35	<100
		BOTTOM	6.3 ± 1.6	<1.2	3.27 ± 0.06	1.30 ± 0.07	10.1 ± 0.2	2.4 ± 0.9	90 ± 50	1.3 ± 0.2	3.81 ± 0.01	0.93 ± 0.45	180 ± 50
	MB-8	SURFACE	23 ± 2	1.9 ± 0.9	8.57 ± 0.09	1.29 ± 0.10	2.52 ± 0.08	<1.3	---	0.61 ± 0.26	8.46 ± 0.02	2.5 ± 0.6	340 ± 70
		BOTTOM	16 ± 2	<1.2	9.49 ± 0.09	1.33 ± 0.11	27.3 ± 0.2	3.8 ± 1.4	<10	0.89 ± 0.35	10.2 ± 0.1	0.81 ± 0.68	330 ± 70
	MB-14	SURFACE	<7.5	<2.9	2.43 ± 0.10	0.40 ± 0.08	3.65 ± 0.27	6.9 ± 1.1	---	2.0 ± 0.2	1.22 ± 0.02	1.4 ± 0.6	230 ± 60
		BOTTOM	2.7 ± 0.6	<1.4	1.06 ± 0.04	0.27 ± 0.04	2.35 ± 0.12	1.4 ± 0.6	---	0.78 ± 0.17	1.06 ± 0.01	0.58 ± 0.30	---
	MB-17	BOTTOM	13 ± 2	<1.4	9.53 ± 0.10	1.6 ± 0.1	32.21 ± 0.33	2.3 ± 1.5	---	0.87 ± 0.29	12.3 ± 0.1	2.1 ± 0.7	350 ± 80
	MB-24	BOTTOM	24 ± 2	<1.2	14.6 ± 0.1	1.8 ± 0.1	38.1 ± 0.3	<1.8	---	1.4 ± 0.4	13.2 ± 0.1	2.2 ± 0.8	250 ± 90
	MB-37	BOTTOM	13 ± 2	<0.77	3.78 ± 0.07	0.95 ± 0.08	12.9 ± 2	2.8 ± 1.0	---	0.64 ± 0.19	4.30 ± 0.01	1.7 ± 0.5	160 ± 50
	MB-41	BOTTOM	8.7 ± 1.2	<0.80	3.52 ± 0.07	1.9 ± 0.1	9.86 ± 0.17	2.8 ± 0.9	70 ± 50	0.84 ± 0.26	3.17 ± 0.01	1.2 ± 0.4	90 ± 50
	MB-43	BOTTOM	11 ± 2	<1.1	3.3 ± 0.1	0.49 ± 0.06	8.1 ± 0.2	3.5 ± 0.9	<79	0.96 ± 0.31	2.9 ± 0.1	1.0 ± 0.3	<480
	MB-53	SURFACE	6.4 ± 1.2	<1.1	1.2 ± 0.1	0.21 ± 0.05	4.3 ± 0.2	3.4 ± 0.7	<57	1.6 ± 0.2	0.73 ± 0.08	1.9 ± 0.3	670 ± 350
		BOTTOM	11 ± 2	<1.8	2.2 ± 0.1	0.40 ± 0.07	12 ± 1	3.9 ± 0.8	<52	0.80 ± 0.24	2.3 ± 0.1	1.1 ± 0.4	<420
	MB-59	BOTTOM	13 ± 2	<1.1	3.0 ± 0.1	0.58 ± 0.07	9.0 ± 0.2	2.5 ± 0.8	<58	0.42 ± 0.28	2.9 ± 0.1	2.1 ± 0.4	150 ± 50

ELEMENTAL COMPOSITION OF SUSPENDED PARTICULATES (>0.4 μ) IN ALASKAN SHELF WATERS
(ng/l EXCEPT WHERE NOTED) (CONTINUED)

EASTERN GULF OF ALASKA		Co	Cs	Fe (μg/l)	Hg	Rb	Sb	Sc	Se	Sr	Zn
EGA-2	SURFACE	8.1 ± 0.1	0.98 ± 0.09	13 ± 1	10 ± 1	<170	4.2 ± 0.4	4.2 ± 0.1	<0.6	430 ± 70	0.09 ± 0.01
	BOTTOM	10 ± 1	1.6 ± 0.1	24 ± 1	5.2 ± 1.0	<120	0.74 ± 0.28	6.0 ± 0.1	0.71 ± 0.42	270 ± 50	0.11 ± 0.01
EGA-5	SURFACE	8.8 ± 0.1	1.3 ± 0.1	20 ± 1	9.6 ± 0.9	<200	0.96 ± 0.25	6.2 ± 0.1	0.64 ± 0.39	610 ± 50	0.19 ± 0.01
	BOTTOM	13 ± 1	1.8 ± 0.1	12 ± 1	4.3 ± 1.0	620 ± 120	0.82 ± 0.28	7.4 ± 0.1	0.63 ± 0.45	630 ± 60	0.19 ± 0.01
EGA-8	SURFACE	5.0 ± 0.1	0.71 ± 0.08	11 ± 1	<1.3	<160	0.54 ± 0.35	3.6 ± 0.1	1.0 ± 0.5	390 ± 60	0.08 ± 0.01
	BOTTOM	22 ± 1	2.8 ± 0.1	54 ± 1	32 ± 1	280 ± 140	0.73 ± 0.36	15 ± 1	<2.3	460 ± 80	0.17 ± 0.01
EGA-15	SURFACE	7.4 ± 0.1	0.33 ± 0.09	6.2 ± 0.2	3.1 ± 1.1	<120	3.6 ± 0.2	2.0 ± 0.1	0.93 ± 0.44	650 ± 50	4.74 ± 0.01
	BOTTOM	1.7 ± 0.1	0.25 ± 0.03	3.8 ± 0.1	7.9 ± 0.5	<100	0.43 ± 0.13	0.93 ± 0.01	0.34 ± 0.21	460 ± 20	0.14 ± 0.01
EGA-26	SURFACE	3.8 ± 0.1	0.12 ± 0.03	3.4 ± 0.1	2.0 ± 0.5	<64	0.49 ± 0.12	0.95 ± 0.01	0.94 ± 0.20	340 ± 20	0.10 ± 0.01
	BOTTOM	7.1 ± 0.1	5.4 ± 0.5	15 ± 1	<0.91	<100	0.30 ± 0.25	4.9 ± 0.1	0.68 ± 0.40	230 ± 50	0.22 ± 0.01
EGA-29	BOTTOM	15 ± 1	1.5 ± 0.1	33 ± 1	8.5 ± 1.2	<150	0.83 ± 0.32	11 ± 1	1.3 ± 0.5	570 ± 60	0.61 ± 0.01
EGA-30	BOTTOM	93 ± 1	14 ± 1	220 ± 10	<3.0	<350	1.8 ± 0.8	57 ± 1	2.1 ± 1.2	1380 ± 150	0.91 ± 0.01
EGA-33	SURFACE	1.1 ± 0.1	0.12 ± 0.04	0.9 ± 0.1	2.3 ± 0.2	<97	0.50 ± 0.18	0.30 ± 0.01	<0.3	300 ± 30	0.09 ± 0.01
	BOTTOM	3.2 ± 0.1	0.26 ± 0.03	6.9 ± 0.1	<0.66	<80	0.26 ± 0.16	2.3 ± 0.1	0.63 ± 0.22	400 ± 30	0.12 ± 0.01
EGA-44	SURFACE	36 ± 1	5.4 ± 0.1	86 ± 1	4.1 ± 1.9	<300	1.6 ± 0.5	29 ± 1	<0.98	680 ± 100	0.34 ± 0.01
	BOTTOM	13 ± 1	1.2 ± 0.1	33 ± 1	<1.8	<260	<0.49	11 ± 1	1.6 ± 0.7	510 ± 100	0.20 ± 0.01
EGA-48	SURFACE	1.6 ± 0.1	0.16 ± 0.03	2.4 ± 0.1	2.4 ± 0.5	<72	0.60 ± 0.14	0.79 ± 0.01	0.86 ± 0.18	330 ± 20	0.12 ± 0.01
	BOTTOM	9.1 ± 0.1	0.83 ± 0.03	21 ± 1	3.6 ± 0.5	<210	<0.44	7.5 ± 0.1	<0.62	440 ± 30	0.15 ± 0.01
EGA-52	BOTTOM	11 ± 1	1.1 ± 0.1	25 ± 1	1.3 ± 0.9	<130	<0.25	8.5 ± 0.1	0.44 ± 0.37	200 ± 30	0.12 ± 0.01
EGA-53	SURFACE	13 ± 1	2.1 ± 0.1	24 ± 1	<1.1	<180	<0.29	7.8 ± 0.1	1.0 ± 0.4	320 ± 50	0.12 ± 0.01
	BOTTOM	51 ± 1	5.3 ± 0.1	120 ± 10	<2.8	<450	1.4 ± 0.4	39 ± 1	2.9 ± 0.5	920 ± 70	0.44 ± 0.01
EGA-55	SURFACE	32 ± 1	4.7 ± 0.1	69 ± 1	8.7 ± 1.6	<260	2.0 ± 0.4	23 ± 1	1.1 ± 0.6	750 ± 80	0.37 ± 0.01
	BOTTOM	27 ± 1	2.5 ± 0.1	63 ± 1	6.7 ± 1.4	<300	1.1 ± 0.4	21 ± 1	0.78 ± 0.57	540 ± 80	0.24 ± 0.01
EGA-58	BOTTOM	27 ± 1	2.6 ± 0.1	59 ± 1	4.5 ± 1.5	<250	1.2 ± 0.4	20 ± 1	0.83 ± 0.59	490 ± 80	0.23 ± 0.01
10 ℓ BLANK (144 mm)		0.19	<0.013	0.24	0.90	<2	0.20	0.04	<0.13	15	0.03
10 ℓ BLANK (144 mm)		0.23	<0.012	0.29	6.9	<2	0.53	0.02	<0.09	<10	0.007
10 ℓ BLANK (144 mm)		0.19	<0.017	0.21	1.4	<2	0.29	0.03	<0.13	14	0.054
10 ℓ BLANK (144 mm)		0.14	<0.013	0.12	0.40	<2	0.13	0.005	<0.12	<10	0.037
10 ℓ BLANK (144 mm)		0.17	<0.012	0.23		<2	0.39	0.008	---	24	0.03

EFFECTS

EFFECTS

Quarterly Progress Report
Research Unit #71
October - December, 1977

The Effects of Oil on Temperature Regulation in Sea Otters

Gerald Kooyman
Daniel Costa
Physiological Research Lab
Scripps Institution of Oceanography
La Jolla, California 92093

Date: 12/28/77

I. Highlights of the October-December Quarter 1977.

During this quarter otter B was oiled a second time. Complications arose during recovery and the otter is currently under veterinary supervision at Sea World. All control runs have been completed for otter D and she will be oiled soon.

II. Task Objectives:

1. Energy requirements of normal sea otters at various water temperatures.
2. Energy requirements of sea otters after oiling.
3. Appropriate procedures for rehabilitating oiled sea otters.
4. At sea behavior and energetics of sea otters.

These objectives will provide a data base from which the assessment of any kind of oil contamination, or other activity which may alter the nature of the otter's food sources can be derived. In addition, relative to oil contamination the difficulties and costs of rehabilitating the oiled otters can be estimated.

III. Laboratory Activities:

A. Scientific Party

1. Dr. Gerald Kooyman-Principal Investigator
2. Daniel Costa-Project Coordinator
3. John Caggiano-Student Inter-Southampton College-New York-Assist. in Data analysis and experimental runs
4. Randall Davis-Assist. in data analysis and experimental runs
5. Michael Bergey-Animal Caretaker
6. James Herpolsheimer-Animal Caretaker

B. Methods:

The sampling procedures will be the same as those recently used for fur seals and used previously in metabolic rates in penguins (Kooyman, G. L., R. L. Gentry, W. P. Bergman and H. T. Hammel, 1976, Comp. Biochem. Physiol. 54A: 75-80).

The thermal neutral zone will be determined in four sea otters conditioned to "rest" in the metabolic test chamber. The principle variable measured in these tests is oxygen consumed, and body and skin temperature. The control thermal neutral zone will be compared to otters after oiling and after cleaning. Furthermore, the continous sampling ability of our method will permit us to determine the average whole body heat conductance for a 5 to 6 hr. run. This will include the important activity (mainly grooming) periods. The changes in whole body conductance during exposure to various water temperatures before and after oiling will indicate the metabolic costs of oil on the fur. These same sampling procedures will be repeated after the oiled animals have been anesthetized and cleaned.

IV. Results:

To date 38 six hour metabolic runs at six different water temperatures between 5 and 30° have been made. The thermal neutral zone for the otters has been preliminarily established and appears to have a lower critical temperature between 5 and 10° (figure 1). The metabolic rates recorded are in agreement with other published estimates (Morrison, Rosenmann, and Estes 1975, Iverson and Krog, 1973). Prudhoe crude oil has been applied to one otter on two different occasions and the changes in metabolic rate after oiling, and washing have been made.

The application of 38 mls and 60 mls of crude oil upon the dorsal surface of the sea otter increased the otters average metabolic rate 24%, and 60% respectively.

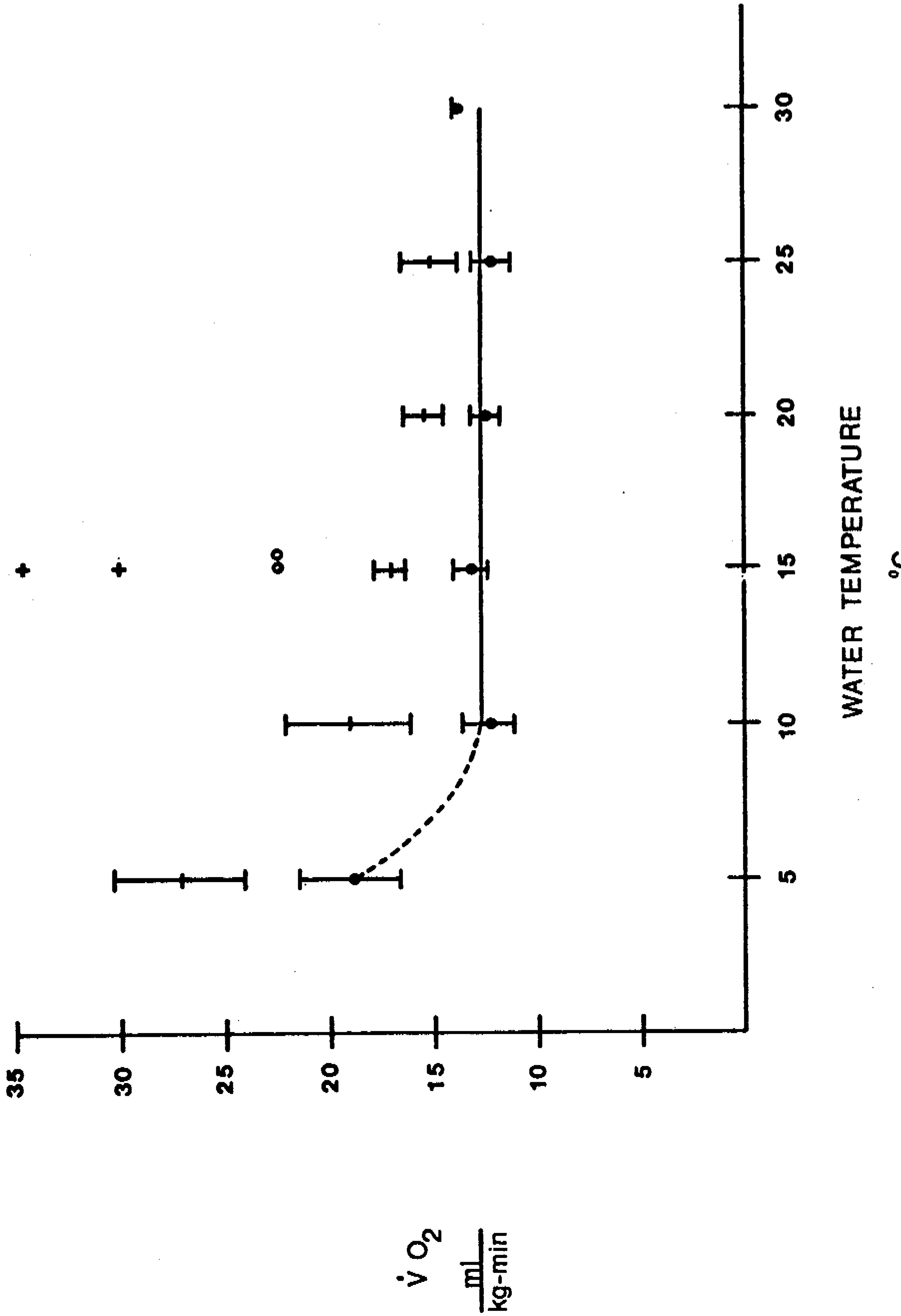
Upon washing the metabolic rate increased 115% and 53% above normal for the two oilings respectively(figure 2). The otters metabolic rate had returned to normal by the eighth day for the first oiling and was still slightly elevated by the 14th day for the second oiling. Upon washing, the fur of the entire animal appeared wet and the otter was observed shivering. This was a response to the increased heat loss due to the loss of insulating quality of the fur after washing. After the first oiling the washed otter recovered in our normal holding facility. However, after the second oiling, the washed otter was not capable of completely grooming her fur into condition. Forty-eight hours after washing she had only groomed her upper torso and the fur on her lower abdomen was totally wetted. During this time the otter shivered constantly. The lack of ability to groom and the shivering was probably a result of the cooler sea water temperature in the holding tank between the two oiling experiments. During the first oiling, the first oiling, the holding tank water temperature was 5°C higher than dring the second oiling. Due to the inability of the otter to groom itself properly and its constant shivering the otter was removed from the holding tank and placed in a small water tub filled with 25-30°C water. The tank was left filled for three hours and then drained and left empty for 1-2 hours and then filled again. This procedure was carried out for 24 hours. After the 24 hour period the otter had managed to successfully groom her entire body and was returned to our regular holding tank where she continued to groom normally and was not observed to shiver again.

FIGURE 1.

This figure shows the relationship between water temperature and metabolic rate for the three otters studied. The closed dots are the mean resting metabolic rate, the lined bars, the average metabolic rate. The open dots are the resting rates for the two oilings and the + are the resting washed rates. The error bars represent one standard error for 1,6,6,10,2,4 six hour runs at 30, 25, 20, 15, 10 and 5°C respectively.

Figure 2.

This figure displays the change in metabolic rate after oiling and washing in one otter. The diagonal lined bars represent the first oiling with 38 mls of crude oil and the cross hatched bars are from the second oiling with 60 mls of crude oil. C is the control value for the otter prior to each oiling. The lines above the bars represent one standard error. The number of measurements per 6 hour run was 5 for the first oiling and 6 for the second.



V̇ O2
ml/kg-min
35
30
25
20
15
10
5
5
10
15
20
25
30
WATER TEMPERATURE
°C

However, two weeks after the oiling experiment, routine blood samples were taken from both otters for routine examination and the otter which had been oiled exhibited an unusually high white blood cell count. The otter was then transferred to Sea World for veterinary care and is currently still at Sea World suffering from what they believe to be a deep seated pneumonia. The pneumonia is probably a result of the stress encountered by the otter during the post-washing period. It appears that the otter has sustain chronic lung damage and plans to permanently transfer her to Sea World are being made.

V. Auxillary Material:

A. Enclosed is a copy of the oral presentation given at the OCSEAP meeting in Seattle, WA, Nov. 29, 1977.

VI. Problems Encountered:

Due to the problems encountered with low holding tank temperatures, a small holding tank has been constructed. The tank will be used to hold the otter in warm water for 24 hrs. immediately following the washing. This change in experimental protocol has been made to reduce the stress to the animal and will hopefully reduce the chances of the otter contracting pneumonia

VII. Funds Expended:

Categories	Spent	Liened	Allocated
Supplies + Expense	5,295	1,687	19,240
Equipment	3,772		5,180
Travel	141		5,703
Salaries	18,998		31,762

MILESTONE CHART

▵ Planned Completion Date

▲ Actual Completion Date

RU #: 71 PI: Dr. Gerald Kooyman

Major Milestones: Reporting, data management and other significant contractual requirements; periods of field work; workshops; etc.

MAJOR MILESTONES	1977			1978											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Capture otter # 4			▲												
Complete Control Metabolic Runs Otter # 3			▲												
Oil otter # 3				▵											
Complete Control Metabolic Runs Otter # 4						▵									
Oil Otter # 4							▵								
Capture Otter # 5							▵								
Complete Control Metabolic Runs Otter # 5									▵						
Preliminary Field Research, Prince William Sound										▵					
Oil Otter # 5											▵				

5/20/77

QUARTERLY REPORT

Contract No.
Research Unit #72
Report Period - Oct. 1, 1977 to Jan. 1, 1978
Number of Pages - 7

ACUTE AND CHRONIC TOXICITY, UPTAKE AND DEPURATION, AND SUBLETHAL METABOLIC RESPONSE OF ALASKAN MARINE ORGANISMS TO PETROLEUM HYDROCARBONS

by

Stanley D. Rice
John F. Karinen
Sid Korn

Northwest and Alaska Fisheries Center Auke Bay Laboratory
National Marine Fisheries Service, NOAA
P.O. Box 155, Auke Bay, Alaska 99821

December 15, 1977

INTRODUCTION

In the October-December quarter, emphasis has been on final data collection for projects that required shrimp (which were not available in summer) data evaluation and manuscript synthesis. Several studies with shrimp were completed this quarter after shrimp became obtainable. Planning future OCSEAP studies also required significant time. Next quarter will emphasize manuscript synthesis, with some new data collection, and R&D for flow-through and larvae tests in spring 1978. We are on or ahead of schedule for all approved FY 78 research activities. We have not made rapid progress on manuscript synthesis of FY 77 research because data were still being collected as of December 15.

TASK OBJECTIVES AND PROGRESS[1/]

A. Toxic components and synergism of toxic components: We will continue investigating the contribution of toxic components with the objective of determining which compounds are primarily responsible for most of the observed toxicity. We have completed studies evaluating (probably eliminating) phenol, naphthol, and heterocycles as major contributers to toxicity, and the analysis and manuscript preparation will continue into FY 78.

1. Compare the toxicity of water-soluble fractions (WSF's) of crude oil with synthetically produced WSF's. Exposures are flow-through, analyses by GC, and test animals are pink salmon fry and shrimp (*Eualus*).

Progress: Experimental design is complete. The apparatus is being constructed, parts have been tested, and tests on shrimp are scheduled to begin in January 1978. GC analytical equipment has been upgraded and is being tested.

2. Synergistic effects of toluene and naphthalene: Several studies with fish and shrimp larvae strongly suggest that toluene and naphthalene have different mechanisms of toxicity, indicating that the toxicants probably have synergistic effects. If the toxicities are synergistic, this would help explain why simplistic experiments with single compounds have underestimated the toxicities of WSF's. Specifically:

a. Determine if toluene and naphthalene have synergistic toxicities to pink salmon fry and *Eualus* shrimp under flow-through conditions.

Progress: The assay using toluene and naphthalene and *Eualus* shrimp was completed in December 1977 and data analyses are in progress. A similar test with pink salmon fry is scheduled for spring 1978.

1/ Objectives and sub-objectives are underlined.

b. Determine if toluene and naphthalene have synergistic effects on uptake and/or depuration in pink salmon fry and *Eualus* shrimp.

Progress: Synergistic uptake studies will begin next quarter with shrimp, followed by tests in May with pink salmon fry.

B. Larvae: We have conducted tests with crustacean larvae before and during molting, including uptake-depuration. We will continue to examine the overall sensitivity of eggs and larvae.

1. Determine the sensitivity of eggs and larvae from several non-commercial species, e.g. barnacles, mussels, snails, and sea urchins. Static exposures will be used for these microscopic larvae, and will include tests with WSF's, toluene, and naphthalene.

Progress: Larval bioassays are scheduled for spring and summer 1978 when wild test organisms will be available.

2. Determine what concentrations impair swimming ability of larvae. Several species will be tested with WSF's, toluene, and naphthalene. Inability to swim will be interpreted as equivalent to death in the natural environment.

Progress: This study is scheduled for spring and summer 1978 when larvae become available.

3. Determine the uptake and retention of hydrocarbons into new and old eggs carried by *Eualus* shrimp. Exposures will be WSF's and isotopes, and analyses by GC and liquid scintillation.

Progress: The uptake of toluene and naphthalene in shrimp gonad, muscle, and hepatopancreas has been determined using radiolabelled compounds. This study will be repeated in mid-December on shrimp with newly extruded eggs, and again in March 1978 with shrimp carrying old eggs, just before their release.

An additional uptake study, to start in December 1977, will expose shrimp with new eggs to Cook Inlet WSF's continuously for 10 days. Samples of eggs and muscle will be sent to the National Analytical Laboratory, Seattle, for GC analyses. This study will be repeated with shrimp carrying old eggs in March 1978. The isotope studies will determine the rate of uptake, and the WSF-GC analysis studies will determine the concentrations at equilibrium for many compounds.

C. Sensitivity increase of smolts in seawater. Through bioassays, we have found that the sensitivity of seawater-adapted pink and sockeye salmon, and Dolly Varden, was greater than sensitivity in fresh water when exposed to WSF's, toluene, and naphthalene. First attempts at explaining this phenomenon through uptake and excretion experiments did not answer the question completely.

1. Determine the uptake of isotopes into tissues of fresh water and seawater-adapted salmonid smolts. Although whole body uptake was essentially the same, the uptake into different tissues may be different. Dr. Robert Thomas, Chico State University, will be co-investigator for this experiment.

Progress: This study is scheduled for summer 1978.

2. Determine the osmotic and ionic composition of blood in fresh water and seawater-adapted smolts exposed to toluene and naphthalene. This should give data relevant to osmotic and ionic regulating interference by the toxicants. Dr. W. Stickle, Louisiana State University, will be co-investigator for this experiment.

Progress: Osmotic studies are scheduled for May-June 1978 when wild smolts normally migrate from fresh water to salt water.

D. Long-term exposures: Long-term exposures have recently been possible because of improvements in flow-through exposure techniques. Most flow-through tests have been crude attempts, without verification of stable concentrations during exposure. We will conduct long-term exposures and compare the results with species we have previously tested in short-term exposures.

1. Determine the effects of flow-through toluene and naphthalene exposures on growth and survival of pink salmon fry exposed at different temperatures. Tests will be 40 days long, with samples of fish taken at 10-day intervals to measure effects on growth. Tests will be replicated at three temperatures to determine the influence of temperature on toxicity in long-term exposures.

Progress: Design of the apparatus has started with experiments scheduled for spring and summer 1978.

2. Determine the survival of two tolerant and two sensitive species to flow-through exposures of toluene and naphthalene.

Progress: The final tests with shrimp were completed this quarter. Shrimp (*Eualus suckleyi*), shore crab *Hemigrapsus nudis*, black sea cucumbers (*Cucumaria vegae*) and pink salmon fry were exposed to toluene and naphthalene using both static and continuous flow methodology. The two sensitive species (shrimp and pink salmon fry) had flow-through 96 h TLm's that were about 70% of the static 96 h TLm's. The two tolerant species had flow-through 96 h TLm's that were about 35% of the static TLm's. A manuscript comparing static versus continuous flow results for sensitive and resistant animals will be prepared.

E. Test the effect of intermittent air exposures on the sensitivity of intertidal species to toluene, naphthalene, and WSF. Exposure to air during and after exposure to toxicants may cause an additional stress on intertidal animals and result in decreased survival.

1. Determine the sensitivity of several intertidal species to toluene and naphthalene exposures, with and without intermittent exposure to air.

Progress: Bioassay with *Hemigrapsus nudis* to toluene and naphthalene are scheduled for spring 1978.

2. Determine the uptake, and especially the depuration pattern, of intertidal animals exposed to labelled toluene and naphthalene, with and without exposure to air.

Progress: All radiometric samples from last quarter's uptake study with *Hemigrapsus* have been completed. Data analyses is almost complete with manuscript preparation scheduled for winter 1978.

F. Dispersant testing: Literature review and R&D on methods of analysis and exposure will be probed. This will be a trial exercise in preparation for expanded testing in FY 79. We will conduct a literature survey and identify the dispersants of interests, and conduct some preliminary tests with dispersants on fish and shrimp in the summer of FY 78.

Progress: Literature review has started. New information was learned at the recent ASTM Conference on dispersants. At least four dispersants are now approved by EPA for uses that include "minimizing environmental damage". New dispersants are relatively non-toxic, effective- even at ratios of 1/50.

G. Writing-up of previous results: Manuscripts describing FY 77 research projects will be completed.

Progress: Robert Thomas and Stan Rice presented a paper "The significance of exposure temperatures on the sensitivity and respiration of pink salmon fry exposed to toluene and naphthalene" at the symposium on *Pollution and Physiology of Marine Organisms*, at Georgetown, South Carolina in November 1977. The manuscript is being reviewed for publication.

The manuscript "Effects of temperature on median tolerance limits of pink salmon fry and shrimp exposed to toluene, naphthalene, and Cook Inlet crude oil" was revised and resubmitted for publication.

H. Completion of previous objectives:

1. Continuous-flow bioassays with toluene and naphthalene at 4°, 8°, and 12° C were completed with *Eualus* shrimp.

2. A continous-flow uptake study with toluene and naphthalene at 4°, 8°, 12° C was completed with *Eualus* shrimp. A manuscript is in preparation describing effects of temperature on the toxicity, uptake, and depuration of toluene and naphthalene with pink salmon fry and shrimp.

INTERPRETATION OF RESULTS

Interpretations of results will be supplied in reviewed manuscripts.

PART IV. PROBLEMS ENCOUNTERED

We continue to have problems hiring and keeping experienced personnel. We are attempting to stabilize our staff through permanent appointments but position ceiling limitations thwart this approach. We had to terminate and rehire two temporary technicians at the beginning of FY 78, and may be forced to do the same on April 1, 1978.

SUBLETHAL EFFECTS OF PETROLEUM HYDROCARBONS AND TRACE METALS, INCLUDING BIOTRANSFORMATIONS, AS RELFECTED BY MORPHOLOGICAL, CHEMICAL, PHYSIOLOGICAL, PATHOLOGICAL, AND BEHAVIORAL INDICES

by

Donald C. Malins*

Edward H. Gruger, Jr.*

Harold O. Hodgins*

Neva L. Karrick*

Douglas D. Weber*

Submitted as a Quarterly Report
for Contract #R7120819
Research Unit #73
OUTER CONTINENTAL SHELF ENERGY ASSESSMENT PROGRAM
Sponsored by
U.S. Department of the Interior
Bureau of Land Management

October 1 to December 31, 1977

* Principal Investigators, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, Washington 98112

TABLE OF CONTENTS

ABSTRACT

The responses of marine organisms to environmental contaminants are reflected in a number of changes detectable at population and organismic levels, as well as at cellular, subcellular, and molecular levels. The general scope of this study is to evaluate effects on the various levels by multidisciplinary investigations of behavioral, morphological, chemical, physiological, and pathological changes in subarctic and arctic marine animals exposed to petroleum hydrocarbons and trace metals.

Behavior

A field study was conducted to determine the concentration of petroleum hydrocarbons in water which could cause migrating adult Pacific salmon (Oncorhynchus spp.) to avoid their home stream. A model mixture of monoaromatic hydrocarbons was introduced into water at 0.3 to 7.0 ppm. Threshold hydrocarbon concentrations that induced avoidance appeared to be of the order of 1 to 2 ppm; at higher hydrocarbon concentrations avoidance increased proportionately.

Chemistry

Biotransformation of Petroleum Hydrocarbons

The role of environmental temperature on the retention of 2,6-dimethylnaphthalene (2,6-DMN) and its total aromatic metabolites in coho salmon (O. kisutch) was investigated. Moreover, isolation procedures and quantitation of individual metabolites of 2,6-DMN in liver and gall bladder of coho dosed with the tritium-labeled hydrocarbon is under investigation.

Metabolism and Disposition of Naphthalene in Starry Flounder

Starry flounder (Platichthys stellatus), each fed tritiated naphthalene, accumulated maximum concentrations of naphthalene in liver at 8 hr and in blood and dorsal skin at 24 hr. The metabolite concentrations, expressed as naphthol, reached maxima at 24 hr in liver, blood, and skin. Subsequently, concentrations of both naphthalene and metabolites declined; however, the hydrocarbon concentrations decreased more rapidly. At 168 hr, liver, blood, and skin contained as much as 81, 87, and 75%, respectively, of the metabolites. The findings show that starry flounder, and perhaps other demersal fishes, accumulate considerable amounts of naphthalene in various tissues and are able to readily metabolize aromatic hydrocarbons.

Effects of Cadmium and Lead on Naphthalene Metabolism

Cadmium and lead at 200 ppb in seawater were found to inhibit the formation of a dihydrodiol metabolite of naphthalene in starry flounder.

Physiology

Mussel gametes exposed to naphthalene at concentrations of 100, 10, and 1 ppb form larvae that have decreased survival 24 hr after exposure of the gametes. There is an increase in abnormalities at the highest concentration

and a large percentage of the eggs are unfertilized when compared to controls. Exposure of oyster (Crassostrea gigas) gametes at 10 and 1 ppb indicates that the reduction in fertilization is related to the sperm rather than the egg suggesting a reduction in viability of the sperm or an inhibition of chemotaxis.

The high-pressure liquid chromatographic (HPLC) analysis of shrimp (Pandalus platyceros) and fish (O. kisutch) exposed to carbon-14 and tritium-labeled naphthalene in purified and unpurified forms indicates that there is no biological exchange of the tritium from the labeled compound. However, the purity of the compound can affect the interpretation of metabolic profiles and the comparability between carbon-14 and tritium exposures. Lower concentrations of naphthalene can be tested when tritium is used than when carbon-14 is used.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

Three species of flatfish, English sole (Parophrys vetulus), rock sole (Lepidopsetta bilineata), and starry flounder, were exposed to Alaskan-crude-oil-contaminated sediments for 2 weeks. The experiment had two main purposes: (1) to compare the ability of these species to take up petroleum hydrocarbons in certain tissues (liver, skin, gills, muscle), and (2) to determine if rock sole and starry flounder develop early signs of oil-related pathology similar to that previously found with English sole. Preliminary hematological data indicates that, after 14 days of exposure, oil-exposed starry flounder had significantly higher (95% confidence level) hematocrits than did the corresponding controls; hematocrits for control and oil-exposed English and rock sole were not significantly different. Histological and hydrocarbon analyses of fish tissues are presently being performed.

Effects of Petroleum on Fish Disease Resistance

Bacteria isolated from diseased Pacific cod (Gadus macrocephalus) captured in the Gulf of Alaska, and previously characterized marine vibrios pathogenic to Pacific salmon were screened for pathogenicity in two flatfish species. Only certain Vibrio anguillarum strains were found to be pathogenic for these species under laboratory conditions and these strains will be employed in disease resistance tests on flatfish maintained on oil-soaked sediment.

Morphology

Studies on the structure of normal lenses from selected Alaskan fish were completed. In addition, radioactivity resulting from the uptake of tritium-labeled naphthalene in the lens and vitreous humor of the eye as well as in blood, liver, and kidney was followed from 16 to 204 hr after feeding this labeled compound to rainbow trout. The highest levels of resultant radioactivity in all tissues, including the tissues of the eye, occurred between about 24 and 48 hr after introduction of the label.

OBJECTIVES

In this multidisciplinary approach to evaluate the effects of petroleum on marine organisms, there are a series of objectives. The specific objectives performed during the current quarterly reporting period of October 1 to December 31, 1977 are as follows:

Behavior

To determine if adult Pacific salmon avoid their home stream when petroleum hydrocarbons are present in the water.

Chemistry

Biotransformation of Petroleum Hydrocarbons

To determine if environmental temperature affects the accumulation of 2,6-DMN and its total metabolites in tissues and organs of coho salmon. Another ongoing objective is to determine structural identities of metabolites of this compound in coho salmon and to quantitate their levels in the gall bladder and liver.

Metabolism and Disposition of Naphthalene in Starry Flounder

To determine the extent of disposition and metabolism of petroleum aromatic hydrocarbons in flatfish.

Effects of Cadmium and Lead on Naphthalene Metabolism

To identify the possible influences of lead and cadmium on the metabolism of petroleum aromatic hydrocarbons in coho salmon and starry flounder.

Physiology

(1) To complete the work on the effects of naphthalene on gamete viability and early embryology of mussels which was started last quarter. (2) To study the effects of naphthalene on the gametes and early embryology of the oyster (Crassostrea gigas). (3) To determine if differences noted in the metabolic profiles of vertebrates and invertebrates, when carbon-14 and tritium labels of the same compound are used, are due to exchange of the tritium label or are caused by impurities in the labeled compound.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

To characterize the long-term pathological effects of exposing flatfish to petroleum hydrocarbons in sediment.

Effects of Petroleum on Fish Disease Resistance

To screen isolates of bacteria from diseased fish for subsequent pathogenicity challenge experiments on flatfish.

Morphology

To expand our understanding of the action of petroleum or the metabolic products of petroleum hydrocarbons on the eyes and lenses of fish and to enlarge a reference collection of lens micrographs from native Alaskan fish.

FIELD OR LABORATORY ACTIVITIES

SHIP OR FIELD TRIP SCHEDULE

Mostly laboratory activities, except for numerous 1-day field trips to sites of salmon homing studies listed under "Sample Collection Localities."

SCIENTIFIC PARTY

The following persons are affiliated with the Environmental Conservation Division of the Northwest and Alaska Fisheries Center.

Name	Role
D. Malins, PhD, DSc	Principal investigator; hydrocarbon metabolism
W. Roubal, PhD	Research chemist; hydrocarbon metabolism
D. Lazuran	Chemist; sample preparation; assistant to Dr. Roubal
J. Parker	Pathobiology; fish handling
H. Sanborn	Oceanographer; invertebrate zoology
C. Short	Graduate student; assistant to Mr. Sanborn
U. Varanasi, PhD	Research chemist; metal/hydrocarbon studies on skin/mucus
D. Gmur	Chemist; assistant to Dr. Varanasi
W. Reichert, PhD	Chemist; studies on metals/hydrocarbons
D. Federighi	Chemist; assistant to Dr. Reichert
E. Gruger, Jr., PhD	Principal investigator; coordinator of chemical analyses
D. Weber	Principal investigator; behavioral studies

D. Maynard	Fishery biologist; part-time, assistant to Mr. Weber, behavioral studies
V. Konchin, PhD	Ichthyologist; exchange program with Moscow State Univ., USSR; behavior studies with Mr. Weber
T. Schermann	Physical science technician; part-time; assistant to Mr. Weber
N. Karrick	Principal investigator; chemical investigations
H. Hodgins, PhD	Principal investigator; physiological and pathological studies
W. Gronlund	Fishery research biologist; assistant to Dr. Hodgins
B. McCain, PhD	Microbiologist; effects of petroleum in sediments on flatfish, coinvestigator with Dr. Hodgins
M. Myers	Fishery biologist; part-time; assistant to Dr. McCain
L. Rhodes	Biological aide; part-time; assistant to Dr. McCain
M. Schiewe	Fishery research biologist; disease resistance studies
E. Warinsky	Biological aide; part-time assistant to Mr. Schiewe
J. Hawkes, PhD	Fishery research biologist; electron microscopy
S. Gazarek	Technician; assistant to Dr. Hawkes
C. Stehr	Technician; assistant to Dr. Hawkes
L. Thomas, PhD	Research chemist; analyses of hydrocarbon metabolites

METHODS

Behavior

A mixture of hydrocarbons representative of the water-soluble fraction (WSF) of Prudhoe Bay crude oil (PBCO) (8% benzene, 57% toluene, 35% xylene-ethylbenzenes) was introduced into a salmon spawning stream. The study site consisted of a tidewater dam and identical fish ladders on each side of a central spillway--one ladder served for testing salmon avoidance, the other ladder as a control. A trap at the head of each ladder afforded a count of all salmon migrating past the dam.

The model hydrocarbon mixture was solubilized with a water jet eductor and diffuser pipe at the head of either ladder. At the end of each test salmon in each trap were counted.

Chemistry

Biotransformation of Petroleum Hydrocarbons

Fish studies: Coho salmon were force-fed radiochemically labeled and unlabeled 2,6-DMN in a salmon oil carrier. Tissues were removed and extracted via methods of Roubal et al. (1977). Metabolites were resolved via HPLC and thin-layer chromatography (TLC). HPLC fractions were assayed for radioactivity by scintillation counting, while separated TLC bands of metabolites were indicated by a variety of spray reagents.

A preparative HPLC system is under construction for the purification of commercial radiochemically-labeled aromatic hydrocarbons prior to their use in metabolism studies.

Rat study: One rat was dosed repeatedly via intraperitoneal injection with labeled plus unlabeled 2,6-DMN in order to extract usable quantities of individual metabolites for comparison with those recovered from fish. This portion of the study has just begun.

Metabolism and Disposition of Naphthalene in Starry Flounder

Starry flounder (100 ± 20 g) were each fed a gelatin capsule containing 87 μCi of tritium-labeled naphthalene (sp. act., 198 mCi/mMole) in salmon oil and were maintained in flowing seawater at 10° ± 1°C. Samples of epidermal mucus, dorsal skin, liver, and blood were taken from four fish at 8, 24, 48, and 168 hr after the initial treatment. Concentrations of naphthalene and its metabolites (expressed as naphthol) in each tissue were determined by previously described methods (Varanasi et al. 1977).

Effects of Cadmium and Lead on Naphthalene Metabolism

Exposure conditions for studies concerning the influence of heavy metals on hydrocarbon metabolism were described in OCSEAP Quarterly Report, RU 73/74, April 1 to June 30, 1977.

Physiology

The sperm only and eggs only of oysters were exposed to a seawater solution of tritium-labeled naphthalene at two concentrations for 15 min and the complementing gametes were added. Solutions at three naphthalene concentrations and one control were also injected with fresh gametes. Samples were taken at varying intervals for 48 hr and were preserved in 5% buffered formalin for future analysis. Water samples were taken at each time period to determine the concentration of naphthalene.

Adult shrimp (P. platyceros) and coho salmon fingerlings were exposed to a seawater solution of either purified carbon-14- and tritium-labeled naphthalene or unpurified carbon-14- and tritium-labeled naphthalene. After 12 hr the animals were washed in clean seawater and prepared for each specific analysis. The cephalothorax from three shrimp were combined giving duplicate samples from each test condition. The viscera were removed from three coho salmon and combined to give duplicates from each test condition.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

Flatfish were exposed to oil-contaminated sediment in 10 gal glass aquaria supplied with flowing seawater. Three aquaria contained 4 liters of contaminated sediment (a 0.2% v/v Alaskan crude oil and sediment mixture) and three aquaria had 4 liters of untreated sediment. Three flatfish species were used in these tests--English sole, starry flounder, and rock sole. For each species, two aquaria were used; one containing oiled sediment (test) and one containing untreated sediment (control). Twelve fish of the appropriate species were placed in each aquarium. The fish of each species were of similar length and weight.

Fish were sacrified at 0 time (fish used at this time were in addition to the 12 used per aquarium) and at 7 and 14 days. Tissue specimens were collected for histology (light and electron microscopic examination) and hydrocarbon analyses. Blood was drawn for hematological tests. Also, the livers from three to four fish from each of the six groups were excised and used in AHH activity assays. Sediment samples were collected for hydrocarbon analyses (total extractable hydrocarbons and gas-liquid chromatography) at 0 times, and at 1, 8, and 15 days after oiled-sediment was added to the aquaria.

Effects of Petroleum on Disease Resistance

Studies were begun on the selection of bacterial strains to be used in disease resistance tests. Twenty-nine bacterial isolates cultured from epidermal ulcers and pseudobranchial tumors of Pacific cod (Gadus macrocephalus) captured in the Gulf of Alaska were characterized and divided into seven groups on the basis of Gram stain, microscopic morphology, motility, cytochrome oxidase reaction, and oxidative or fermentative metabolism. Representative strains from each of these groups, in addition to several previously characterized marine vibrios pathogenic to salmon, were assayed for pathogenicity in either English sole or starry flounder. Test fish were held in 37-liter aquaria containing aerated seawater at 10°C and injected with varying bacterial concentrations.

Morphology

Light and electron microscopical studies following methods previously reported (Hawkes 1974) were performed on lenses from rainbow trout and 17 species of Alaskan flatfish and rockfish (See OCSEAP Quarterly Report, October 1977).

In addition, 73 ± 5 µCi of tritiated naphthalene in gelatin capsules were fed to 100 g rainbow trout and samples of blood, liver, kidney, vitreous humor, and lens were taken at 16, 24, 40, 48, 70, 168, and 204 hr after exposure.

SAMPLE COLLECTION LOCALITIES

Behavior

The field study involving salmon avoidance of petroleum hydrocarbons was conducted at the mouth of Chambers Creek. This creek enters southern Puget Sound at Steilacoom, Washington and supports a sizable salmon run. Of the 6,600 salmon migrating up the two fish ladders during the experimental period (29 September to 5 December 1977) 95% were coho, and the remainder were pink (3.7% O. gorbuscha), chum (0.8% O. keta), and chinook (0.5% O. tshawytscha).

Chemistry

All exposures of fish in seawater were conducted in the laboratory at the Northwest and Alaska Fisheries Center (NWAFC) Mukilteo Facility.

Starry flounder were obtained from near the mouth of the Columbia River.

Physiology

The adult shrimp were trapped and held in the laboratory until used. The oysters were collected in ripe condition and held in the laboratory until the induction of spawning.

Pathology

Exposures of flatfish to oiled sediment were performed at the Mukilteo Facility.

Sites for sample collections in the disease resistance study are presented in Table 1.

Morphology

Rainbow trout were obtained locally from NMFS hatchery stock. Alaskan flatfish and rockfish were caught in the Gulf of Alaska (See OSCEAP Quarterly Report, October 1977).

DATA COLLECTED AND/OR ANALYZED

Behavior

Over 120 water samples from the fish ladders at Chambers Creek were taken for analysis of hydrocarbons by gas chromatography. A total of 62 on-site test and observation sequences were conducted.

Chemistry

Biotransformation of Petroleum Hydrocarbons

In the study of coho salmon, four fish were used per test (4°C, in duplicate experiments). Likewise, four fish were used (duplicate experiments) at ambient Puget Sound water temperature (13°C) for a total of 16 fish used.

Individual gall bladders, livers, light muscle samples, dark muscle samples, kidneys, blood, brains, and digestive tracts from four fish held at 4° and 13°C were used for analyses in duplicate experiments for a total of 128 analyses. Samples were analyzed for 2,6-DMN and for total metabolites of that hydrocarbon.

Metabolism and Disposition of Naphthalene in Starry Flounder

A total of 16 test and 4 control fish were analyzed and a total of 80 tissue samples were processed.

Sixty-four test and 16 control samples were analyzed by a solvent partition technique (Varanasi et al. 1977). More than 200 samples were processed in a liquid scintillation spectrometer.

Physiology

The following were collected/analyzed: twelve shrimp samples; 275 water samples; 12 fish samples; 7 HPLC extractions; and 1,500 scintillation samples.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

Numbers and types of samples

Blood for hematology: 44
Tissue for light microscope histology (gills, skin, liver, kidney, gonad, intestine, heart, spleen, olfactory organ, fins): 624
Tissue for electron microscopy (eye lens, liver, olfactory organ): 120
Tissue for hydrocarbon analyses (gill, liver, skin, muscle): 104

Numbers and types of analyses

Hematology
- hematocrits: 84
- total RBC and WBC counts: 57
- hemoglobin: 84
- differential leucocyte: 88

Histology slides (light microscopy): 50

Effects of Petroleum on Disease Resistance

Numbers and types of samples

Bacterial isolates for pathogenicity tests in flatfish: 29

Numbers and types of analyses

Gram stains: 29; phase contrast microscopic examinations for determination of bacterial morphology and motility: 29; cytochrome oxidase tests: 29; determination of oxidative or fermentative glucose metabolites: 29; bacterial pathogenicity assays: 21.

Morphology

Numbers and types of samples

84 tissue samples were taken from tritiated-naphthalene-treated fish, initially frozen and later prepared for scintillation counting.

Numbers and types of analyses

Scintillation counting was completed on 168 samples.

RESULTS

Behavior

Increasing concentrations of a model mixture of monoaromatic hydrocarbons in home stream water caused progressively greater avoidance of the water by migrating adult salmon (Fig. 1). Under control conditions, 57% of the salmon chose the fish ladder on the right-hand side of the stream (facing downstream). When water flowing down this ladder contained hydrocarbon concentrations of between 1 and 2 ppm, an average of only 43% migrated via this ladder. Less than 10% of the salmon chose the right-hand side ladder when concentrations exceeded 6 ppm.

The data presented (65% of the tests conducted) have not been thoroughly analyzed in relation to natural environmental parameters which influence salmonid migration.

Chemistry

Biotransformation of Petroleum Hydrocarbons

Results of the study on the accumulation of 2,6-DMN and its total metabolites in key organs in fish held at 4° and 13°C show wide variations in values for the accumulations at both temperatures. Because of the widespread variations among individual fish with respect to the accumulations, there is no statistically significant difference in levels of accumulation at 4° and 13°C. The study on the characterization of individual metabolites in gall bladder and liver is still in progress; however, preliminary indications show that a number of metabolites of 2,6-DMN are present, with conjugates of hydroxylated 2,6-DMN predominating over hydroxylated metabolites.

Metabolism and Disposition of Naphthalene in Starry Flounder

Starry flounder, each fed tritiated naphthalene (56 μg), were maintained in flowing seawater at 10° ± 1°C. Maximum concentrations of naphthalene (2,100 ppb, dry wt) were reached in liver at 8 hr and in blood (100 ppb) and dorsal skin (67 ppb) at 24 hr after the feeding. The metabolite concentrations, expressed as naphthol, reached maxima at 24 hr in liver (190 ppb), blood (80 ppb) and skin (25 ppb). Subsequently, concentrations of both naphthalene and metabolites declined; however, the hydrocarbon concentrations declined more rapidly. Accordingly, at 24 hr, liver, blood, and skin contained 16, 44, and 27%, respectively, of the metabolites; whereas, at 168 hr, the values were 81, 87, and 75%, respectively (Varanasi and Gmur 1977).

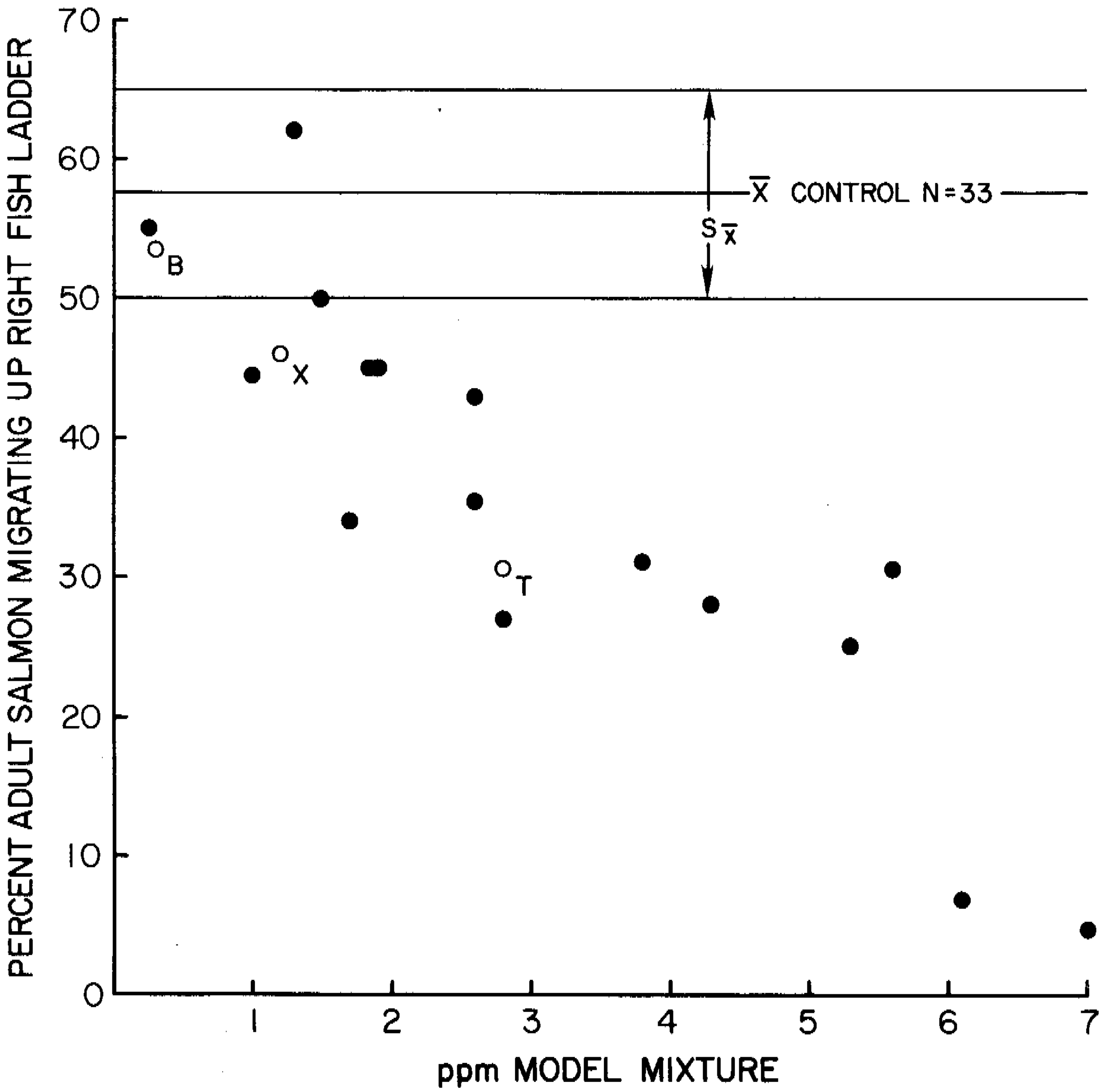


FIGURE 1. Percent adult salmon migrating up the right-hand side fish ladder at Chambers Creek in relation to concentrations of aromatic hydrocarbons present in the water. Closed circles represent tests with total model hydrocarbon mixture. Open circles are tests with components of model mixture relative to proportion in mixture at 4.5 ppm (B=benzene, T=toluene, X=xylenes-ethylbenzene). Concentration of model mixture is based on water flow in fish ladder and amount of mixture used during test.

Epidermal mucus contained 14 ppb (dry wt) of naphthalene and 31 ppb of the metabolites at 24 hr. During the entire exposure period, the mucus contained higher concentrations of the metabolites compared to naphthalene.

Effects of Cadmium and Lead on Naphthalene Metabolism

Preliminary results indicate that cadmium or lead at 200 ppb in seawater inhibited naphthalene metabolism in starry flounder. In both cadmium- and lead-exposed flatfish, the amount of the naphthalene metabolite, 1,2-dihydrodiol, in the liver was significantly lower (95% confidence level) than in the control livers.

Physiology

Mussel gametes were combined in solutions containing 1, 10, and 100 ppb naphthalene. The resulting larvae had reductions in percent survival after 24 hr of 52, 70, and 94%, respectively, compared to a 100% survival for controls. The 100 ppb solution interfered with fertilization; 24% of the exposed eggs were unfertilized compared to 3% in controls. The highest concentration produced abnormal embryological development in 25% of the animals after 1.5 hr of exposure, compared to 2% in controls. There appears to be an increase in the rate of embryological formation in the first 1.5 hr in the 10 ppb exposure group, but this is no longer apparent at 7 hr. The data from the oyster exposure indicate that sperm is affected more than the eggs by concentrations of 10 and 1 ppb naphthalene.

Preliminary results of the HPLC data indicate that there is no evidence of tritium exchange in the shrimp or coho salmon. However, the purity of the compound has an affect on the interpretation of HPLC metabolic profiles as well as on the comparability of the metabolic profiles of tritium- and carbon-14-labeled naphthalene.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

The experiment was only recently completed and only a limited amount of preliminary data is available. Both control and oil-exposed rock and English sole tolerated the 14-day experiment with no visible abnormalities. Three oil-exposed and two control starry flounder died during the experiment, presumably from causes not related to the experimental conditions. Analyses for hydrocarbons in sediment and fish tissues are presently being performed, as are histological examinations of tissues.

Preliminary hematological data demonstrate that oil-exposed starry flounder had significantly higher (95% confidence level) hematocrits (22.25%) than did controls (16.42%) after 14 days. Similar values for rock sole and English sole were not significantly different.

Effects of Petroleum on Disease Resistance

Results of the bacterial pathogenicity tests are shown in Table 1. Injection of representative bacterial types isolated from diseased Pacific cod failed to identify a strain which was more than marginally pathogenic to

TABLE 1. Results of bacterial pathogenicity tests

Bacterial strain	Bacterial source	Test species	Challenge dose[a] and injection route[b]	Number of mortalities[c]/ Number of fish injected
Vibrio anguillarum 775	*Oncorhynchus kisutch*; Puget Sound	*Parophrys vetulus*	10^{-1}, IP	2/2
			10^{-4}, IP	0/2
			10^{-1}, IM	2/2
			10^{-4}, IM	0/2
V. anguillarum R675-834	*O. kisutch*; Alaska	*P. vetulus*	10^{-1}, IP	2/2
			10^{-4}, IP	0/2
			10^{-1}, IM	2/2
			10^{-4}, IM	0/2
Vibrio sp. DC2	*Platichthys stellatus*; Puget Sound	*P. vetulus*	10^{-1}, IP	0/2
			10^{-3}, IP	0/2
Vibrio sp. DC1	*P. stellatus*; Puget Sound	*P. vetulus*	10^{-1}, IP	1/2
Vibrio sp. biotype 1669 stain DomF$_3$ kid	*O. kisutch*; Puget Sound	*P. vetulus*	10^{-1}, IP	0/2
V. anguillarum 5635 man	*Pleuronectes platessa*; Scotland	*P. vetulus*	10^{-1}, IP	1/2
			10^{-3}, IP	0/2
Alaskan isolates				
10-1	*Gadus macrocephalus*; Gulf of Alaska	*Platichthys stellatus*	10^{-1}, IP	0/2
10-2	"	"	10^{-1}, IP	0/2
26-3	"	"	10^{-1}, IP	0/2
32-3	"	"	10^{-1}, IP	0/2
32-2	"	"	10^{-1}, IP	0/2
32-5b	"	"	10^{-1}, IP	0/2

[a] Challenge dose expressed as the bacterial dilution based on an initial concentration of ca. 10^9 bacteria/ml.
[b] IP = intraperitoneal and IM = intramuscular.
[c] All mortalities were examined by bacteriological culture techniques and mortality was attributed to the test bacterium only when it was reisolated in pure culture.

flatfish under laboratory conditions. Several previously characterized strains of Vibrio anguillarum, however, were found to be pathogenic to English sole when relatively high numbers of bacteria were injected.

Morphology

Comparative studies of normal lenses of Alaskan flatfish and rockfish have been completed and a manuscript is in preparation. Laboratory studies on lenses this quarter focused on the uptake of radioactivity by several key tissues from fish fed tritiated naphthalene. Maximum radioactivity levels were reached between about 24 and 48 hr in all tissues (Fig. 2), including the eye, the organ of particular interest in the present studies.

PRELIMINARY INTERPRETATION OF RESULTS

Behavior

Results of the studies conducted on effects of petroleum hydrocarbons in water on salmon homing suggest that levels of the WSF of PBCO up to about 1 ppm do not markedly deter adult salmon from migrating up their home streams. If, however, levels of the dissolved hydrocarbons which were tested are present in excess of about 1 ppm, increasing concentration-dependent disruptions of upstream homing migrations are likely to occur.

Whether or not similar relationships hold for estuaries and further offshore areas is not known. However, movement of salmon into the fish ladders at Chambers Creek occurs predominantly at high tide, and at high tide only the top 1/4 to 1/2 of the fish ladders are exposed. Thus, the 1977 tests represent avoidance of hydrocarbons under estuarial rather than strictly freshwater conditions.

Chemistry

Biotransformation of Petroleum Hydrocarbons

No statistical difference in accumulation of 2,6-DMN was observed for coho salmon maintained at 4° and 13°C (duplicate experiments using eight fish per experiment). Collier et al. (1978), on the other hand, observed that significantly more naphthalene was retained in organs of coho salmon at 4° than at 10°C, 16 hr after feeding. Together, these findings suggest a possible different response by fish to alkylated aromatic hydrocarbons compared to nonalkylated analogs. An important conclusion from the present work is that coho salmon have a significant capacity to metabolize alkylated aromatic hydrocarbons presented in the diet. A variety of metabolites were found in all tissues examined.

Metabolism and Disposition of Naphthalene in Starry Flounder

The results show that demersal fish such as starry flounder exposed to dietary naphthalene accumulate considerable concentrations of naphthalene in various tissues and are able to extensively metabolize aromatic hydrocarbons. One week after the feeding, all tissues examined contained higher concentrations of metabolites compared to the naphthalene concentrations. It appears

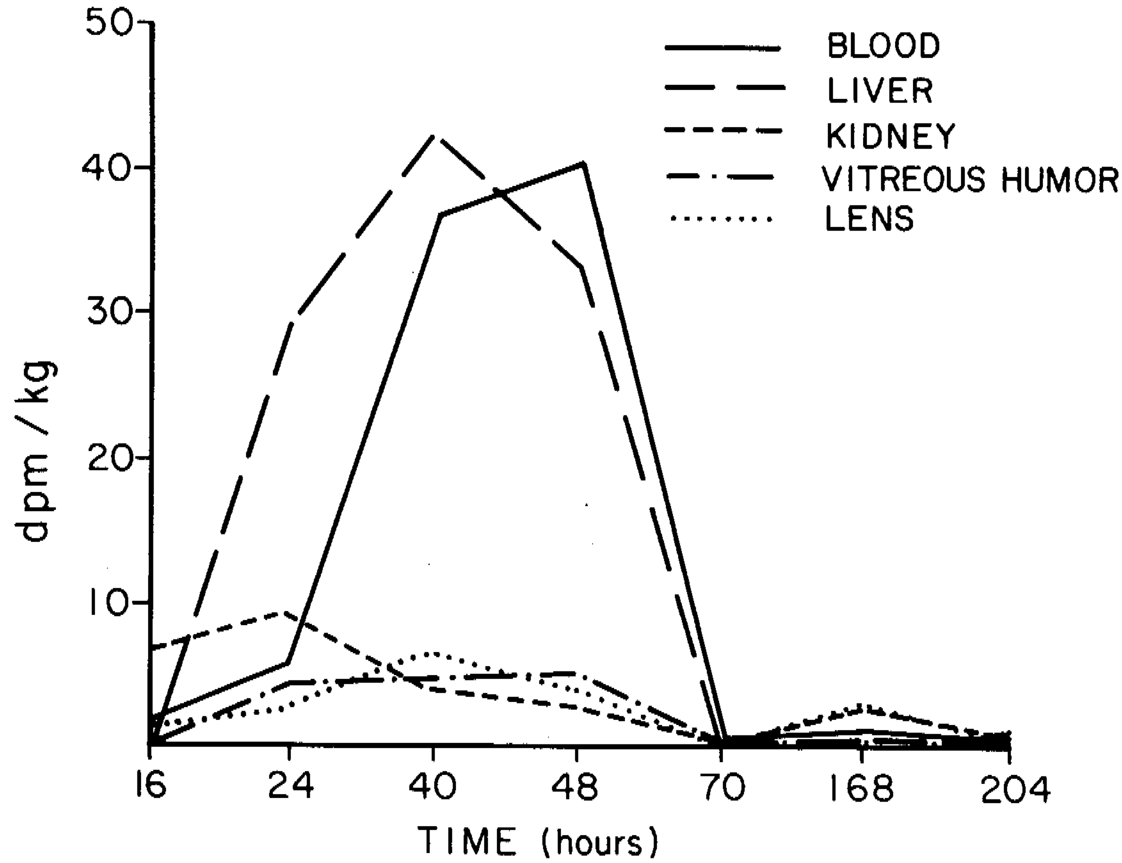


Figure 2. Uptake of ^{3}H-naphthalene in rainbow trout.

that a tendency exists in starry flounder to retain metabolic products in preference to the parent hydrocarbon.

During the entire experiment, epidermal mucus of the test fish contained considerably larger concentrations of metabolites compared to naphthalene, indicating that, similar to mucus of salmonids (Varanasi et al. 1977), mucus of starry flounder is involved in excretion of hydrocarbons and their metabolites.

Effects of Cadmium and Lead on Napnthalene Metabolism

The studies on the effects of lead and cadmium in naphthalene metabolism in starry flounder showed lower levels of the dihydrodiol in cadmium- and lead-exposed fish. This suggests that lead and cadmium are interfering with the disposition of naphthalene. The observed differences in dihydrodiol levels present in liver could be due to partial inhibition of the metabolism of naphthalene or to increased rates of excretion of the dihydrodiol from the liver. The findings indicate that starry flounder, under lead or cadmium stress, may have an altered capacity to metabolically respond to a petroleum challenge.

Physiology

Mussel and oyster gametes and the resultant larvae are sensitive to naphthalene in concentrations as low as 1 ppb. The major effect at low concentrations is a reduction in survival of the larvae. At higher concentrations, sperm is affected and results in a decrease in fertilization of eggs. Abnormalities also are more prevalent at concentrations greater than 1 ppb. All of these factors indicate a reduction in the ecological fitness of contaminated mollusc gametes and resulting larvae in relation to aromatic hydrocarbon exposure.

The lack of evidence of biological exchange of the tritium-label in naphthalene allows the use of compounds with higher specific radioactivity than is possible with carbon-14 and the subsequent use of lower concentrations of naphthalene for chronic exposure experiments. The higher radioactivity will allow the detection and quantitation of metabolic products in planktonic invertebrates. However, it is apparent that the compound must be radiochemically pure for the results to be meaningful.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

Rock sole, English sole, and starry flounder are flatfish species which are found in the Gulf of Alaska. Rock sole are also abundant in the Bering Sea. Therefore, these species are very appropriate candidates for experimental animals in tests designed to evaluate the effects of oil-contaminated bottom sediments on flatfish. As a result of the experiment involving exposure of these species to such sediment, two species will be chosen for subsequent experiments involving long-term exposure to oiled sediments. Selection will be based on the ability of a species to take up petroleum hydrocarbons and their potential for developing pathological changes from exposure to petroleum. The species cannot be selected, however, until data analyses are completed.

The preliminary results of the hematological tests suggest that the starry flounder, after 14 days of exposure, may have developed a stress response, as was suggested by elevated hematocrit values. A similar response was observed by us in English sole during a previous experiment.

Effects of Petroleum on Disease Resistance

Several strains of Vibrio anguillarum were clearly pathogenic to flatfish. These strains will be suitable for use in future studies of effects on disease resistance of flatfish exposed to petroleum-containing sediments.

Morphology

Naphthalene, one of the more deleterious components of crude oils, has long been known to be capable of inducing cataracts in rabbits (Van Heyingen and Pirid 1967) and other animals (Grant 1963). Results of the present radioactive tracer studies clearly indicate that naphthalene and/or its metabolites enter the eye and could, therefore, act directly to induce lens damage in fish.

The additions to our reference collection of micrographs of normal lens fibers from fish indigenous to Alaskan water improves our capability for evaluating damage to fish lenses from an oil spill or other environmental perturbation.

AUXILIARY MATERIAL

Bibliography of References

COLLIER, T.K., L.C. THOMAS, and D.C. MALINS. 1978. Influence of environmental temperature on disposition of dietary naphthalene in coho salmon (Oncorhynchus kisutch): Isolation and identification of individual metabolites. Comp. Biochem. Physiol. (In press).

GRANT, W.M. 1962. Toxicology of the Eye. Charles C. Thomas, Springfield, Illinois, 381 p.

HAWKES, J.W. 1974. The structure of fish skin. Cell Tissue Res. 149: 147-58.

ROUBAL, W.T., T.K. COLLIER, and D.C. MALINS. 1977. Accumulation and metabolism of carbon-14 labeled benzene, naphthalene and anthracene by young coho salmon. Arch. Environ. Contam. Toxicol. 5:513-29.

VAN HEYNINGEN, R., and A. PIRID. 1967. The metabolism of naphthalene and its toxic effect on the eye. Biochem. J. 102:42-52.

VARANASI, U. and D.J. GMUR. 1977. Metabolism and disposition of naphthalene in starry flounder (Platichthys stellatus). Fed. Am. Soc. Exp. Biol. (Abstr., In press).

VARANASI, U., M. UHLER, and S.I. STRANAHAN. 1978. Uptake and release of naphthalene and its metabolites in skin and epidermal mucus of salmonids. Toxicol. Appl. Pharmacol. (In press).

Papers in Preparation or in Print Relevant to this Quarter

COLLIER, T.K., L.C. THOMAS, and D.C. MALINS. 1978. Influence of environmental temperature on disposition of dietary naphthalene in coho salmon (Oncorhynchus kisutch): Isolation and identification of individual metabolites. Comp. Biochem. Physiol. (In press).

HAWKES, J.W. 1978. Morphology. In: Sublethal Effects of Petroleum Hydrocarbons and Trace Metals Including Biotransformations, as Reflected by Morphological, Physiological, Pathological, and Behavioral Indices. NOAA Tech. Memo. (In press).

HODGINS, H.O. 1978. Physiological and behavioral effects. In: Sublethal Effects of Petroleum Hydrocarbons and Trace Metals Including Biotransformations, as Reflected by Morphological, Physiological, Pathological, and Behavioral Indices. NOAA Tech. Memo. (In press).

MALINS, D.C. 1978. Disposition and metabolism of petroleum hydrocarbons. In: Sublethal Effects of Petroleum Hydrocarbons and Trace Metals Including Biotransformations, as Reflected by Morphological, Physiological, Pathological, and Behavioral Indices. NOAA Tech. Memo. (In press).

McCAIN, B.B. 1978. The effects of Alaskan crude oil on flatfish, and the prevalence of fish pathology in Alaskan marine waters. In: Sublethal Effects of Petroleum Hydrocarbons and Trace Metals Including Biotransformations, as Reflected by Morphological, Physiological, Pathological, and Behavioral Indices. NOAA Tech. Memo. (In press).

McCAIN, B.B., H.O. HODGINS, W.D. GRONLUND, J.W. HAWKES, D.W. BROWN, and M.S. MYERS. 1978. Effects of long-term exposure of flatfish to sediment contaminated with Alaskan crude oil. J. Fish. Res. Board Can. (In press).

ROUBAL, W.T., S.I. STRANAHAN, and D.C. MALINS. 1978. The accumulation of low molecular weight aromatic hydrocarbons of crude oil by coho salmon and starry flounder. Arch. Environ. Contam. Toxicol. (In press).

VARANASI, U. 1978. Biological fate of metals in fish. In: Sublethal Effects of Petroleum Hydrocarbons and Trace Metals Including Biotransformations, as Reflected by Morphological, Physiological, Pathological, and Behavioral Indices. NOAA Tech. Memo. (In press).

VARANASI, U. and D. MARKEY. 1978. Uptake and release of lead and cadmium in skin and mucus of coho salmon (Oncorhynchus kisutch). Comp. Biochem. Physiol. (In press).

VARANASI, U. and D.J. GMUR. 1978. Influence of environmental and dietary calcium on uptake and retention of water-borne lead in coho salmon (Oncorhynchus kisutch). Toxicol. Appl. Pharmacol. (Submitted).

VARANASI, U. and D.J. GMUR. 1977. Metabolism and disposition of naphthalene in starry flounder (Platichthys stellatus). Fed. Am. Soc. Exp. Biol. (Abstr., In press).

VARANASI, U., M. UHLER, and S.I. STRANAHAN. 1978. Uptake and release of naphthalene and its metabolites in skin and epidermal mucus of salmonids. Toxicol. Appl. Pharmacol. (In press).

Oral Presentations

HAWKES, J.W. Morphology. OCSEAP Program Review, Nov. 29-Dec. 2, 1977, Seattle, Washington.

HODGINS, H.O. Physiological and Behavioral Effects. OCSEAP Program Review, Nov. 29-Dec. 2, 1977, Seattle, Washington.

MALINS, D.C. Disposition and Metabolism of Petroleum Hydrocarbons. OCSEAP Program Review, Nov. 29-Dec. 2, 1977, Seattle, Washington.

McCAIN, B.B. The Effects of Alaskan Crude Oil on Flatfisn, and the Prevalence of Fish Pathology in Alaskan Marine Waters. OCSEAP Program Review, Nov. 29-Dec. 2, 1977, Seattle, Washington.

McCAIN, B.B. (H.O. Hodgins, W.D. Gronlund, J.W. Hawkes, D.W. Brown, and M.S. Myers). Effects of Long-term Exposure of Flatfish to Sediment Contaminated with Alaskan Crude Oil. Symposium on Recovery Potential of Oiled Marine Northern Environments, October 10-14, 1977, Halifax, Nova Scotia, Canada.

VARANASI, U. Biological Fate of Metals in Fish. OCSEAP Program Review, Nov. 29-Dec. 2, 1977, Seattle, Washington.

PROBLEMS ENCOUNTERED -- No major problems encountered.

ESTIMATE OF FUNDS EXPENDED

Total spent: $70.0K

QUARTERLY REPORT

Contract No: R7120810
Research Unit No: RU 77
Reporting Period: Oct. 1 - Dec. 30, 1977
Number of Pages: 3

NUMERICAL ECOSYSTEM MODEL FOR THE EASTERN BERING SEA

Co-Principal Investigators: T. Laevastu and F. Favorite
Northwest and Alaska Fisheries Center
2725 Montlake Blvd. E.
Seattle, Washington 98112
December 1977

PI QUARTERLY PROGRESS REPORT
Reporting Period: 1 October - 31 December 1977

I. Highlights of Quarter's Accomplishments

The DYNUMES II model was updated to DYNUMES III. This update includes the effects of environment (temperature and its anomalies) on the biological components of the ecosystem, space-time variable food composition, and effects of starvation.

The DYNUMES III model was used during the past quarter for the study of the effects of environment, man and trophic interspecies interactions on the pelagic resources in the eastern Bering Sea. A draft report has been prepared.

II. Task Objectives

To prepare a relatively complete ecosystem model for the eastern Bering Sea for evaluation of the possible effects of offshore oil development on the marine ecosystem.

III. Field and Laboratory Activities

A. Ship or Field Trip Schedules
None

B. Scientific Party

Dr. Taivo Laevastu	Co-Principal Investigator (part-time)
Pat Livingston	Fisheries Biologist (part-time)

C. Methods
Modeling techniques previously reported.

IV. Results

Preliminary analyses of biological data indicate that the rate of increase of biomass of a given species is a function of the distribution of biomass with age and temperature distributions, particularly during winter. These and other factors affecting the fluctuations of pelagic fishing resources in the eastern Bering Sea are being investigated.

V. Preliminary Interpretation of Results

It is apparent that the DYNUMES III model is adequate for studying cause and effect relations of major biomass fluctuations in the eastern Bering Sea and work in this area is progressing on schedule.

VI. Auxiliary Material

N/A

VII. Problems Encountered/Recommended Changes

No quarterly and/or annual reports have been received by PI's during the past year. The lack of these reports has prevented the update of the input data base in the model (see Revised Milestone/Activities Chart). It is extremely important that a meeting be held with PI's responsible for compiling time-space distributions of various biological components in the eastern Bering Sea so that present model inputs can be evaluated and augmented. Further, it would be useful to review past, current, and future OCSEAP field sampling procedures and individual component data analyses with respect to model outputs.

VIII. Estimate of Fund Expended

$12,500

MILESTONE CHART
(Revised Milestone/Activities Chart)

PROJECT Numerical Ecosystem Model for the Eastern Bering Sea DATE December 1977

PRINCIPAL INVESTIGATORS T. Laevastu and F. Favorite

	MAJOR MILESTONES/ ACTIVITIES	QUARTERS 1977 O N D	1978 J F M	A M J	J A S	O N D			
1	Update the input data base with all available new data								
2	Program in space & time variable food composition								
3	Investigate the effects of starvation								
4	Program subroutine for separation of dominant fish groups into juveniles and adults								
5	Program size-dependent feeding								
6	Program zooming subroutines for detailed investigation of small-scale effects of oil development								
7	in Bristol Bay and in St. George Basin.								
8	Model optimization and documentation								
9	Commencement of production runs:								
10	1. Determination of the effects of environment and man on the trophodynamics & interspecies								
11	competition 2. Determination of the drastic environment changes-								
12	effects versus increase of mortality and/or avoidance behavior as might be caused by oil spill								
13	3. Answering (with model use) other questions pertaining to offshore oil/gas development								
14									
15									
16									
17									
18									

Milestone: Start ├── **Estimated Completion** △ Actual Completion ▲

QUARTERLY REPORT

EFFECTS OF PETROLEUM EXPOSURE ON THE BREEDING ECOLOGY

of the

GULF OF ALASKA HERRING GULL GROUP

(*Larus argentatus* x *Larus glaucescens*)

with Appendix

of Recent Results

by

Samuel M. Patten, Jr.
Associate Investigator
Department of Pathobiology
The Johns Hopkins University
615 North Wolfe Street
Baltimore, MD 21205

Linda Renee Patten
Research Technician
Department of Pathobiology
The Johns Hopkins University
615 North Wolfe Street
Baltimore, MD 21205

Research Unit #96

National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Environmental Research Laboratories
Boulder, Colorado

December 30, 1977

Reporting Period: Oct. 77 - Dec. 77

I. Objectives and Rationale

This research is addressed to the following task: an analysis of the effects of petroleum exposure on the breeding ecology, including incubation behavior and hatching success, of the Gulf of Alaska Herring Gull group (Larus argentatus x Larus glaucescens).

The devastating effects of massive oil spills on seabird survival are widely reported, but little is known of the effects of low-level oil pollution on avian reproduction (Grau et al, 1977). Previous studies of petroleum effects on seabird eggs suggest hatchability is markedly reduced (Gross; Birkhead et al, 1973; Patten & Patten, 1977). Rittinghaus (1956) and Hartung (1963, 1964, 1965) reported that marine birds contaminate eggs with oil from the environment and hatching success of eggs thus exposed to petroleum was markedly reduced even after extended periods of incubation. Abbott, Craig and Keith (1964) suggested that oil interferred with normal respiratory exchange through the eggshell, while Szaro and Albers (1976) found hatching success of eider (Somateria mollissima) eggs was significantly reduced by microliters of petroleum exposure, that is, very small quantities. Patten and Patten (1977) have recently found unweathered North Slope Crude Oil 22 times more toxic than equivalent amounts of mineral oil under field conditions. Grau et al (1977) have confirmed in laboratory experiments that small amounts of bunker C oil significantly depress bird reproduction. Indeed, oil exposure has been used in the past to control gull populations along the Eastern Seaboard of the United States and in several western U.S. wildfowl refuges (Gross, 1950; R. King, USF&WS, pers. comm.)

In summary, literature on the effects of oil exposure on the reproduction of marine birds is limited. Studies that do exist suggest high toxicity of petroleum to eggs, and marked effects upon the reproductive productivity of females. Complete knowledge of the effects of petroleum exposure in various forms is needed to evaluate and predict the full impact of oil pollution on the annual productivity of marine bird populations.

This current research is to provide information on the effects of North Slope Crude Oil on the hatching success and incubation behavior of key seabird species nesting on Alaskan barrier islands in proximity to Valdez tanker lanes and offshore oil lease areas.

Species examined are Herring Gulls (Larus argentatus) and Glaucous-winged Gulls (Larus glaucescens), which are common inshore and marine scavengers nesting in colonies. The study sites are the largest gull colony in the northeast Gulf of Alaska, Egg Island, located 10 km SE of Point Whitshed and 20 km south of Cordova (60° 23' N, 145° 46' W), and Dry Bay, 75 km SE of Yakutat (59° 10' N, 138° 35' W).

Our research objectives are thus defined as:

1) to determine threshold levels of petroleum effects to gull reproduction under field conditions, and

2) to test alteration of incubation behavior and ability to produce second (replacement) clutches following experimental mortality due to petroleum exposure.

II. Materials and Methods

Our methods include analysis of reproductive productivity at a series of nests sites marked with survey flags. Petroleum exposure to eggs is by drops from microliter syringes with repeating dispensers, with equivalent amounts of non-toxic mineral oil applied to a control sample. Reproductive success/mortality is compared to further controls of 'normal' (unexposed) colonies adjacent to the experimental areas. The use of microliter syringes allows for precise manipulation of tiny amounts of petroleum exposure, which is in 20, 50, and 100 microliter doses at three (3) stages of incubation. Petroleum used is North Slope Crude Oil provided by NMFS Auke Bay Laboratory, with commercially available mineral oil as the control.

Experimental results are compared to the standards previously established for 'normal' Alaskan gull reproduction (Patten, 1974; Patten & Patten, 1975, 1976, 1977). Egg loss through conspecific predation has been the principal factor influencing hatching success and fledging rate in previous studies.

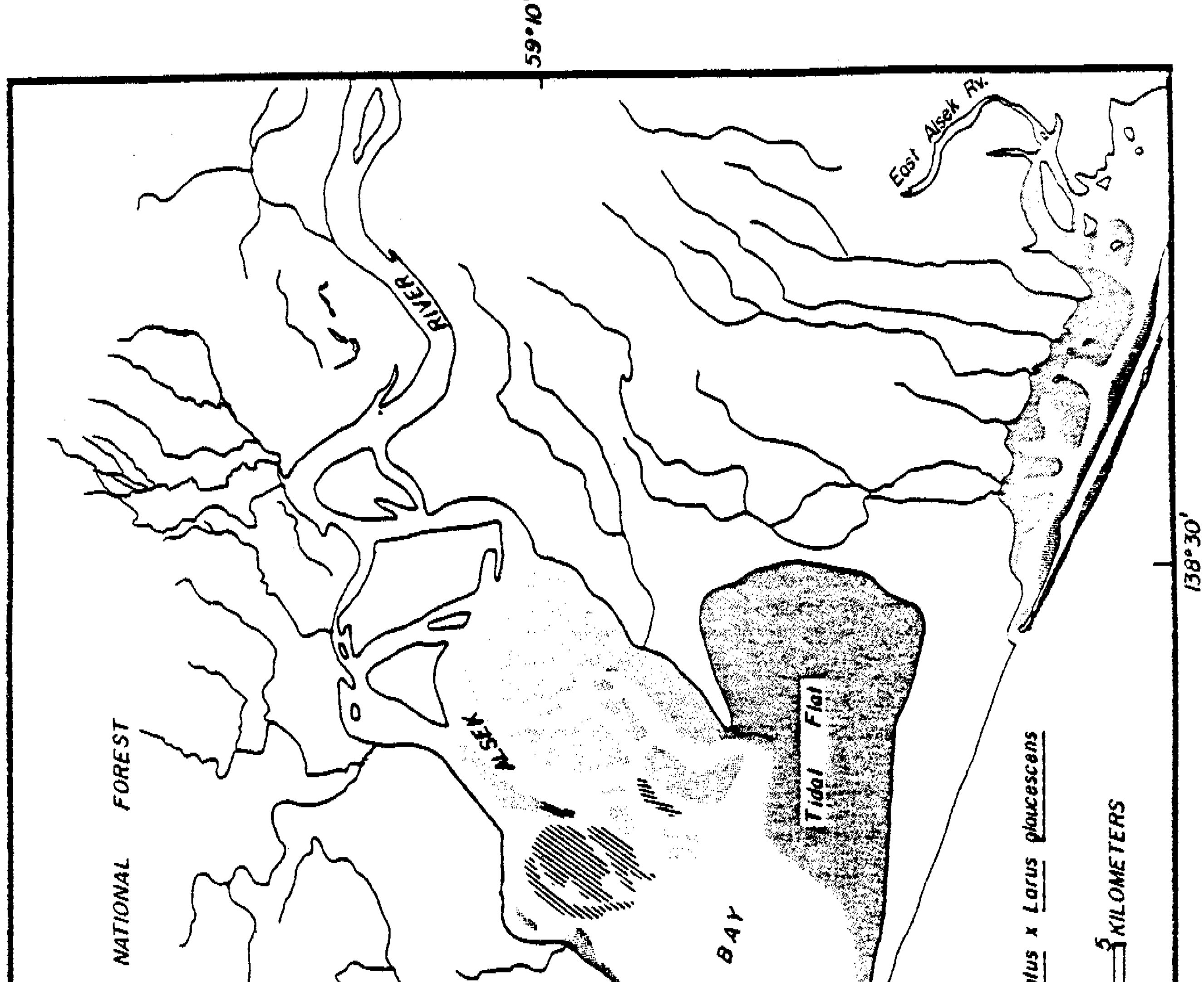
III. Results

1) To determine threshold levels of petroleum exposure to gull reproduction, we conducted an oiling experiment in a colony at Dry Bay, mouth of the Alsek River, 75 km SE of Yakutat, Alaska. The oil experiment was carried out in an experimental area adjacent to controls known as 'A' and 'B' colonies. Receptors were a mixed group of Glaucous-winged x Herring Gulls (Table 1).

Table 1

Petroleum Exposure Parameters

Sample size		Dose	Date	Approx. Day of Incubation
10 nests	30 eggs	20µl	24 May	1
20 nests	60 eggs	50µl	1 June	8
20 nests	60 eggs	100µl	4 June	11



59°10'
TONGASS NATIONAL FOREST
ALSEK
RIVER
East Alsek Rv.
Tidal Flat
DRY BAY
LEGEND
MIXED COLONY OF Larus argentatus x Larus glaucescens at Dry Bay
1 2 3 4 5 KILOMETERS
N
138°30'
138°45'

Petroleum Exposure Results

Table 2

Nests 1 - 10 Time: Onset of Incubation

Dose: 20µl		30 eggs	Date: 24 May
9/30	hatch	=	30%
6/30	"lost" (predated)	=	20%
15/30	failed to hatch	=	50%

Table 3

Nests 11 - 30 8th day of Incubation

Dose: 50µl		60 eggs	Date: 1 June
16/60	hatch	=	27%
14/60	"lost"	=	23%
30/60	failed to hatch	=	50%
early (1-2 days) chick mortality 3/60 eggs		=	5%

Table 4

Nests 31 - 50 11th day of Incubation

Dose: 100µl		60 eggs	Date: 4 June
41/60	hatch	=	68.3%
11/60	"lost"	=	18.3%
8/60	failed to hatch	=	13.3%
early (1-2 days) chick mortality 2/60 eggs		=	3%

Table 5

Mineral Oil Experiment

7th day of incubation

Nest #	# Eggs	Dose in µl	Failed to Hatch (Eggs Remaining)	Chick Mortality (Known)
51	3	20	0	
52	3	20	0	
53	3	20	0	
54	2	20	0	
55	3	20	0	
56	3	50	0	
57	3	50	0	
58	3	50	0	
59	2	50	0	
60	2	50	0	
61	3	100	0	
62	3	100	0	
63	2	100	0	
64	2	100	0	
65	3	100	1 died pipping	1 dead chick (5 days)
15 nests	40 eggs	3 different doses	mortality not significant	

Our conclusions from the above experiments are: very small amounts of North Slope Crude Oil exposure to gull eggs in the field, at early stages of incubation, lead to high embryonic mortality (Tables 2, 3). Embryonic resistance to petroleum exposure increases with the duration of incubation (Table 4). Mineral oil in equivalent microliter doses causes no significant mortality (Table 5).

Results

2) To test alteration of incubation behavior and ability to produce second (replacement) clutches following experimental egg mortality due to petroleum exposure, we conducted the following experiment: at Egg Island, the largest gull colony in the northeast Gulf of Alaska, located 20 km south of Cordova, we chose our experimental and control areas to coincide with our established study site (RU #96 - 76). There were 75 nests in the experimental area, compared to 186 in the adjacent 'normal' control colony. The experimental and control areas are located on the ocean slope of stabilized meadow-covered dunes at the east end of Egg Island in proximity to the U.S. Coast Guard Light Tower (Figures 1, 2, 3).

Oil was delivered to completed clutches of three eggs at the tenth day of incubation. Fifty clutches (150 eggs) received 1cc/egg surface application of North Slope Crude Oil, and 25 clutches (75 eggs) received the identical dose of mineral oil. Both treatments were delivered by drops from calibrated syringes. The initial dose was selected to be well below the lethal level of oiling for adult waterfowl (7.0 - 3.5 gms) reported by Hartung (1963), but is nearly completely lethal for eggs. Most evidence of petroleum exposure disappeared the next day except for slight petroleum odor (Figure 4).

Observed clutch size in the oiling experimental area initially declined at a rate compatible with normal predation from other gulls (Figure 5), but in July egg loss accelerated due to adult gulls abandoning unhatched clutches after incubation prolonged 100% longer than normal. At this time we terminated the experiment. A month after hatching began in the adjacent control colony, 33% of eggs oiled with North Slope Crude and 24.4% of eggs to which mineral oil had been applied remained in the nests on 15 July. These figures can be compared to 2% of eggs in the adjacent control area remaining in nests at the end of incubation, a 'normal' infertility rate (Figures 6, 7).

Hatching success in eggs exposed to this nearly completely lethal dose of North Slope Crude was 0.67% (Figure 8). Mineral oil applied in equivalent amounts to gull eggs led to a hatching rate of 14.6%. North Slope Crude Oil is thus calculated to be 22 times more toxic than equivalent amounts of mineral oil. Hatching success in the adjacent 'normal' control colony was 77%; the normal range for these gulls in Alaska is 67% - 77%. Adults continued to incubate almost all unhatched clutches at least 20 days longer than normal. Eggs opened at the close of the experiment were highly decomposed and no living embryos were found. Adult gulls nesting in the oiling area produced nore more replacement clutches than the neighboring control colony (4.0% vs. 4.8%) (Figures 9, 10, 11).

Gull behavior is thus altered by the continued incubation of dead eggs. Adults fail to respond with the normal production of replacement clutches, which normally follow clutch loss to natural causes. The combination of high egg mortality and alteration of adult behavior virtually eliminated gull reproduction in the experimentally oiled area.

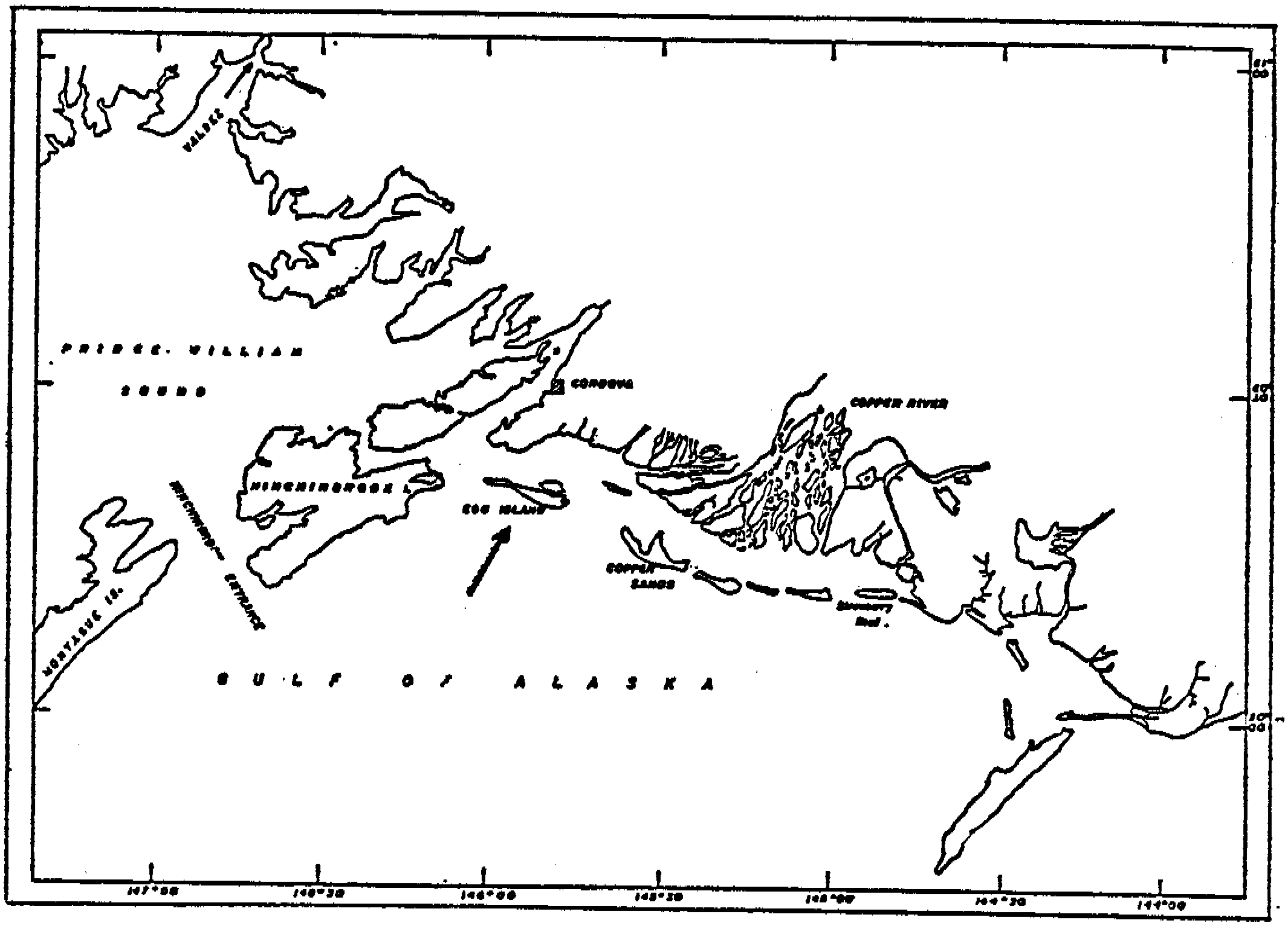


Figure 1. Map of the Copper River Delta region and Prince William Sound, showing location of Cordova, the Copper River, Egg Island (arrow), Copper Sands, and Strawberry Reef.

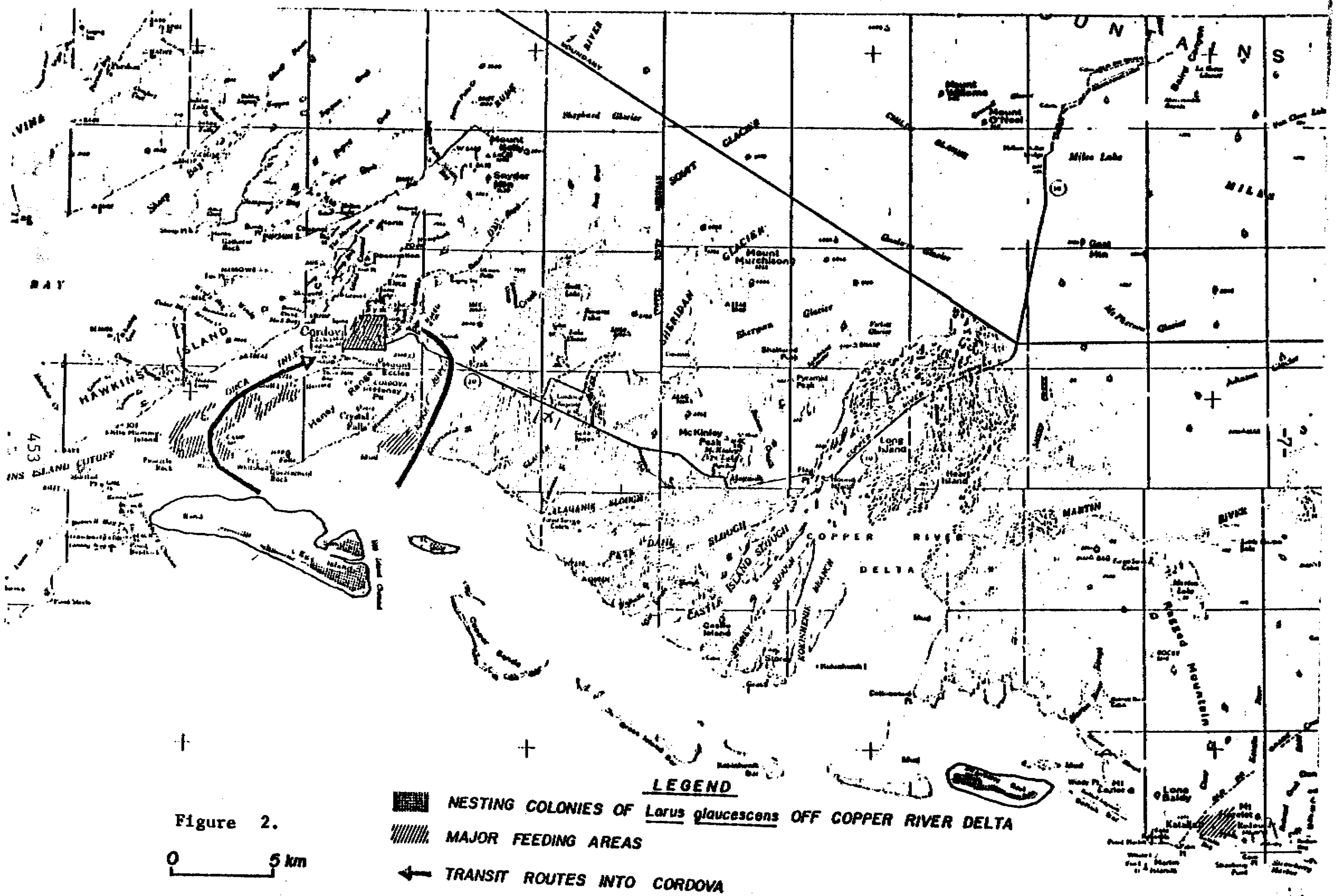

Cordova
HAWKINS ISLAND
ORCA INLET
COPPER RIVER
DELTA
Mount Murchison
SHERIDAN GLACIER
SCOTT GLACIER
Miles Lake
Long Island
Mount Eccles
Heney Range
McKinley Peak
EYAK RIVER
ALAGANIK SLOUGH
PETE DAHL SLOUGH
EASTIF ISLAND SLOUGH
Long Baldy
LEGEND
NESTING COLONIES OF Larus glaucescens OFF COPPER RIVER DELTA
MAJOR FEEDING AREAS
TRANSIT ROUTES INTO CORDOVA
0 5 km

Figure 2.

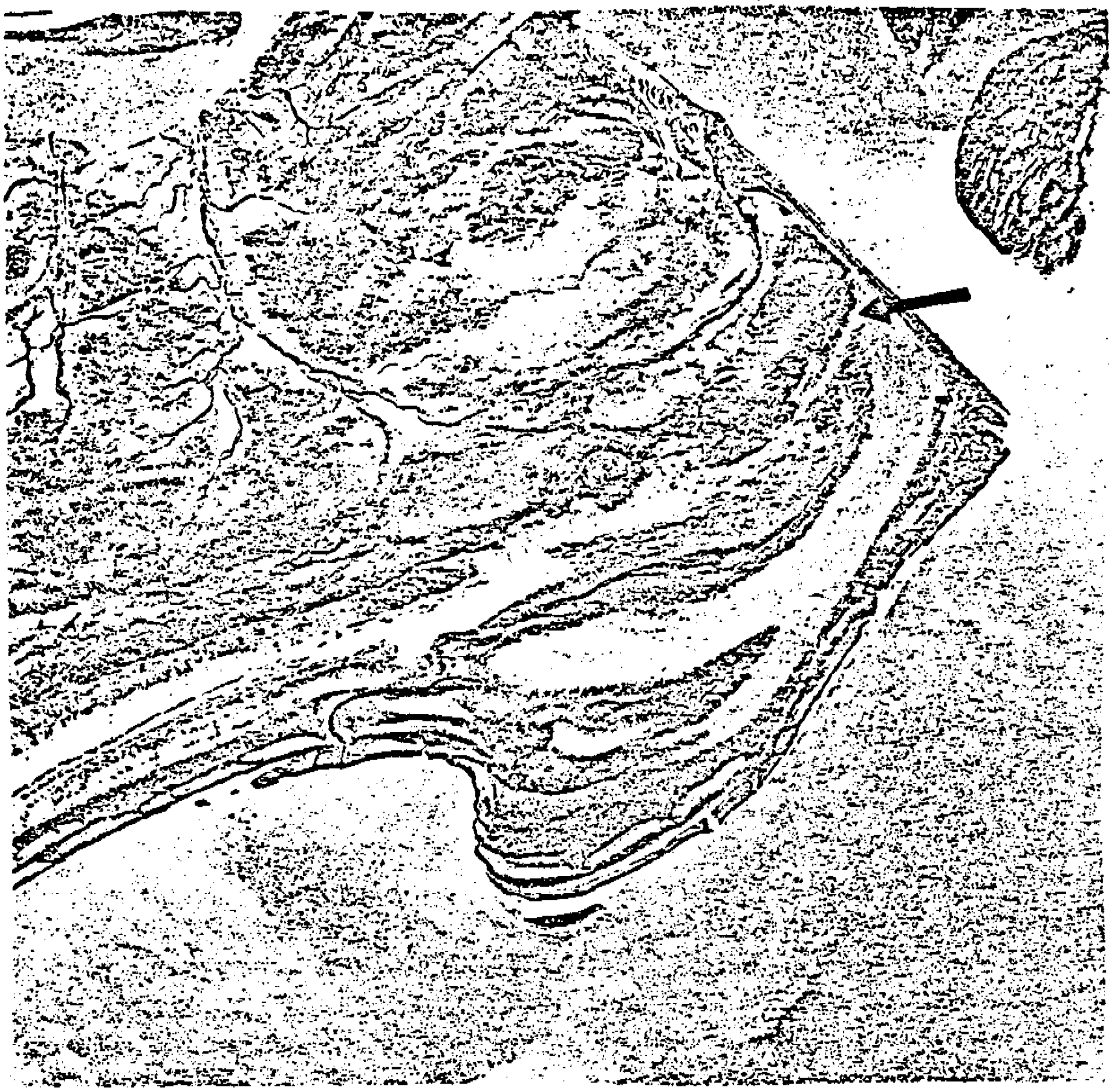


Figure 3. National Ocean Survey aerial photograph of E end of Egg Island, Off Copper River Delta, 9 July 1971, at low tide. Study Area (arrow) is located near the Light Tower. New ridges of sand dunes have formed after the 1964 earthquake, joining the series of islets together. Scale 1:30,000.

OBSERVED CLUTCH SIZE

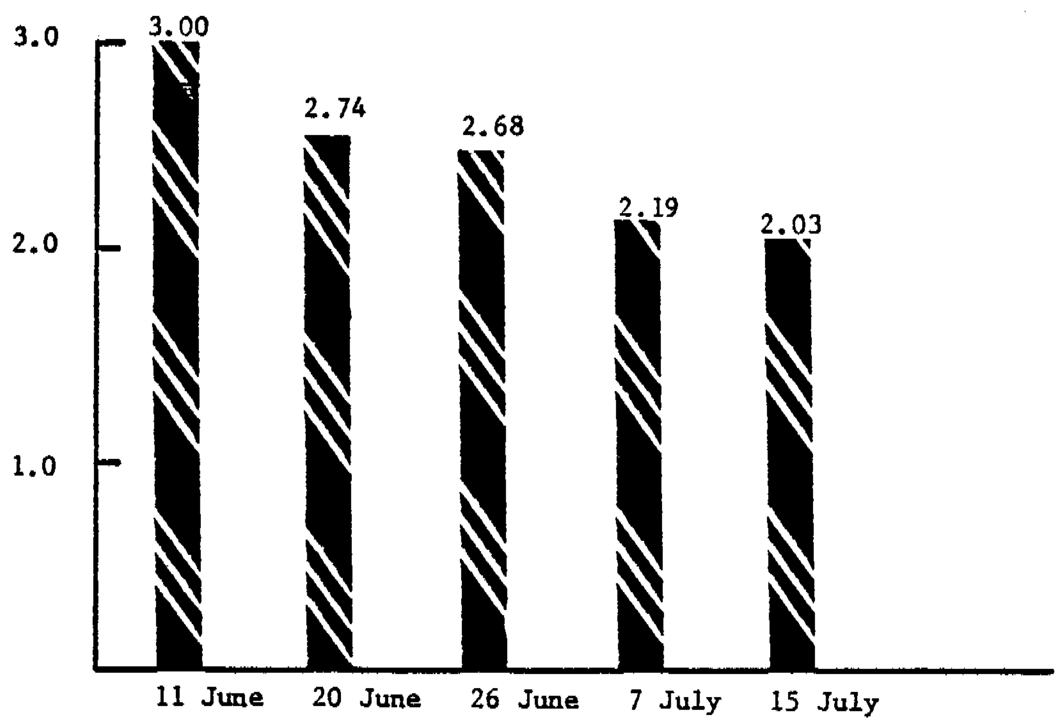


Figure 4. Observed clutch size in the oiling experimental area initially declined at a rate compatible with normal predation from other gulls.

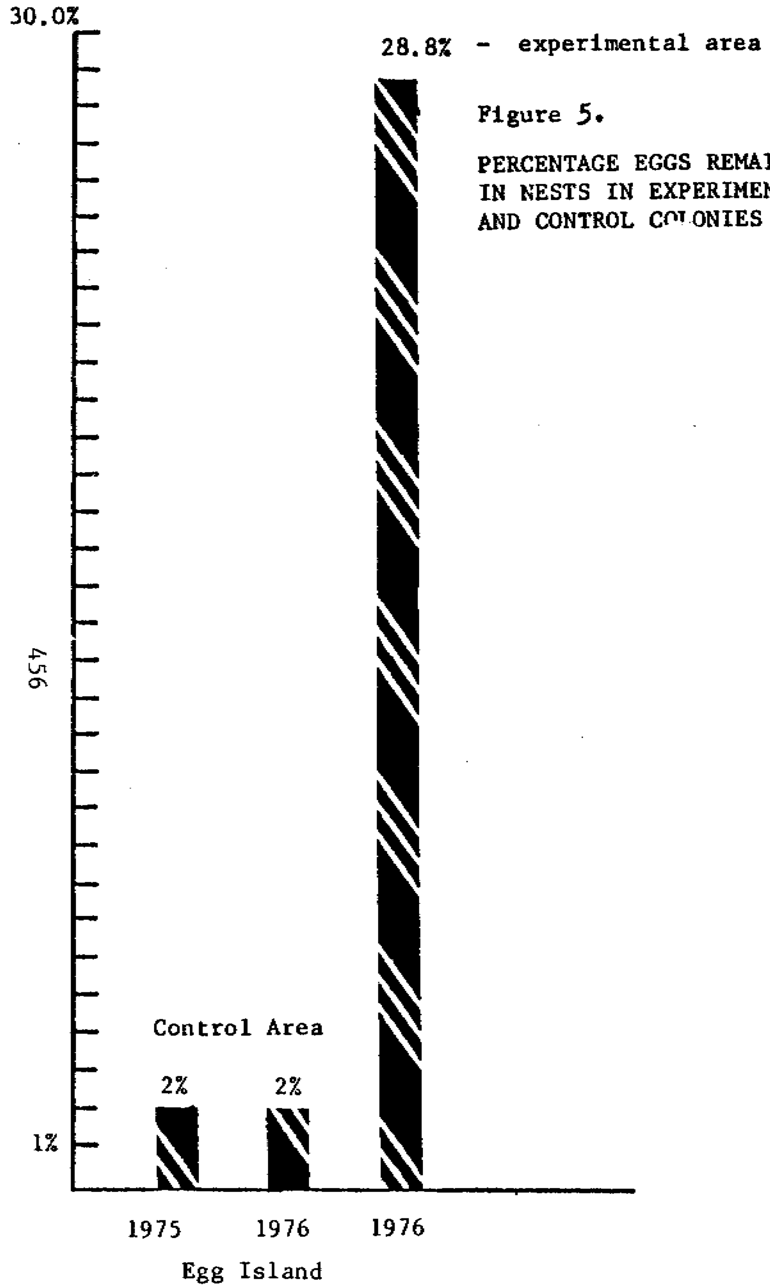


Figure 5.

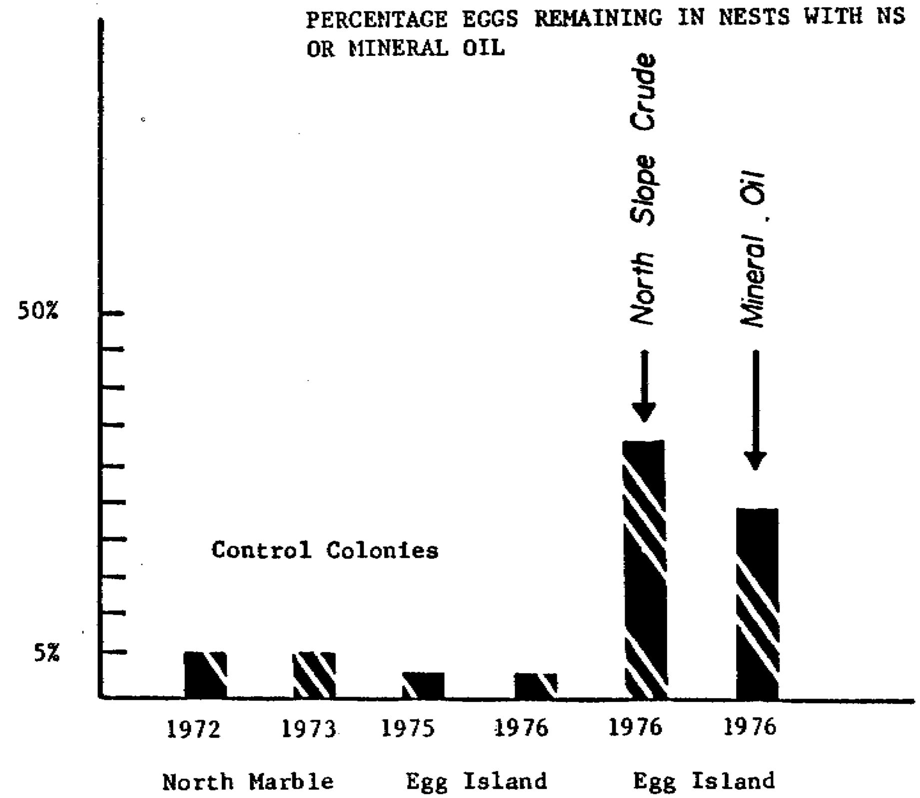
PERCENTAGE EGGS REMAINING IN NESTS IN EXPERIMENTAL AND CONTROL COLONIES

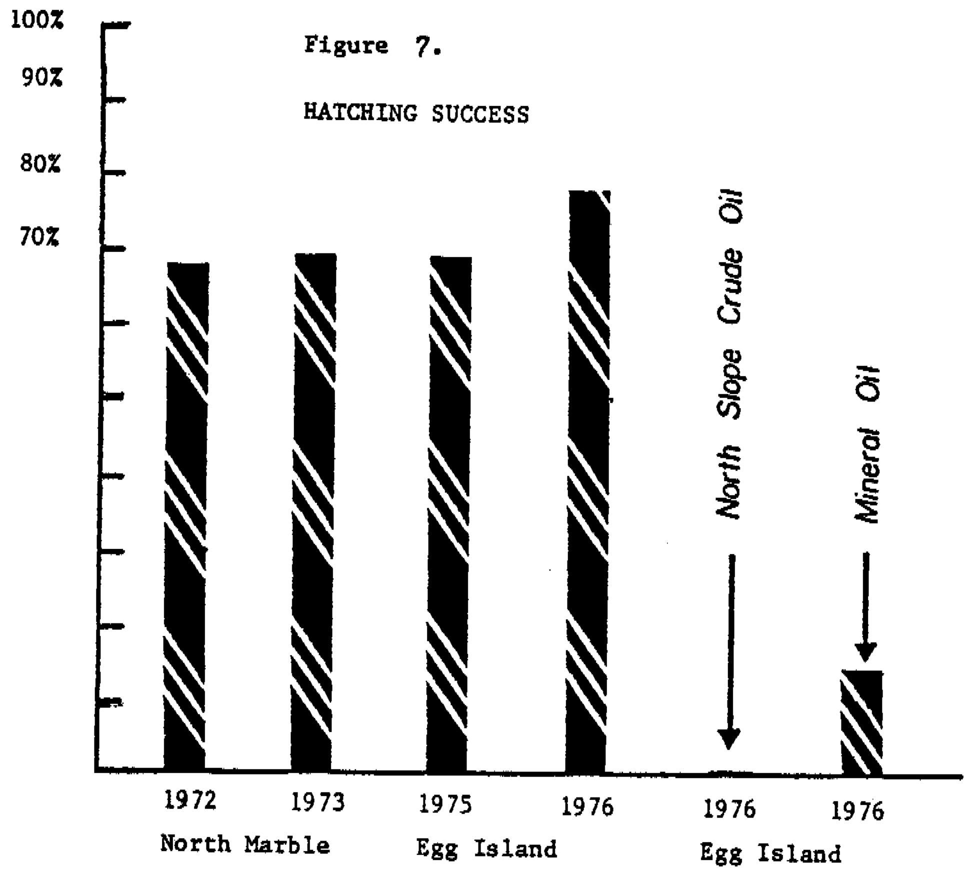
Figure 5. Percentage eggs remaining in nests at close of incubation or experimental period, experimental and control colonies, Egg Island, 1975-76.

Figure 6. A month after hatching began in the adjacent control colony, 33% of eggs oiled with North Slope Crude and 24.4% of eggs to which mineral oil had been applied remained in the nests.

Figure 6.

PERCENTAGE EGGS REMAINING IN NESTS WITH NS CRUDE OR MINERAL OIL




100%
90%
80%
70%
Figure 7.
HATCHING SUCCESS
North Slope Crude Oil
Mineral Oil
1972
1973
1975
1976
1976
1976
North Marble
Egg Island
Egg Island

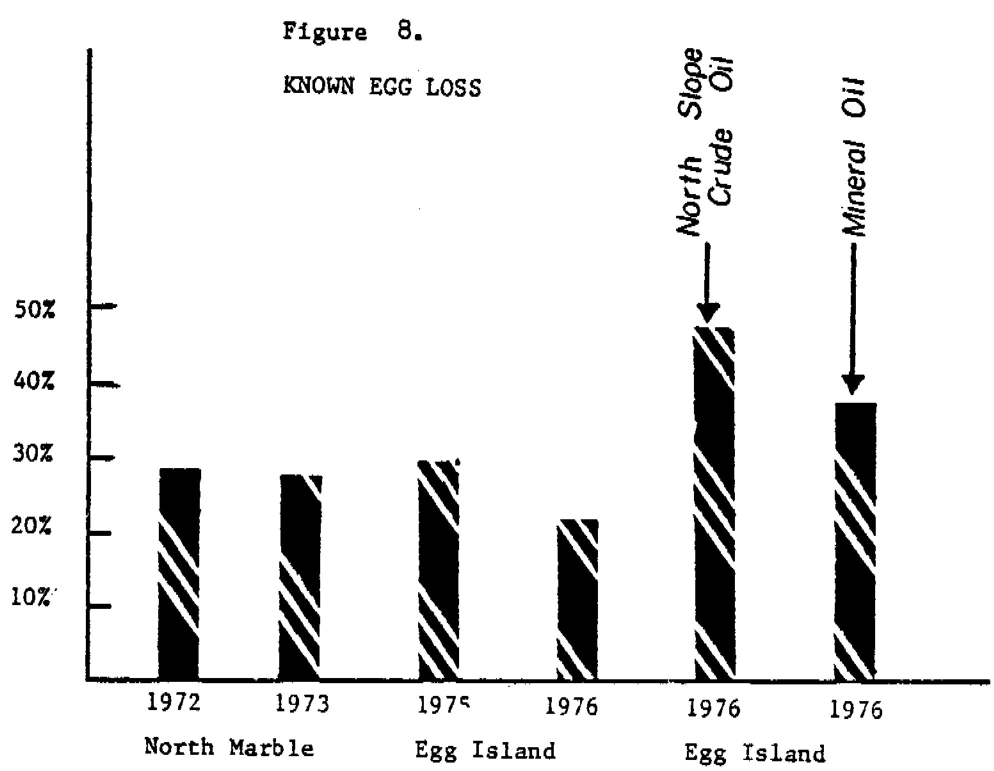


Figure 8.
KNOWN EGG LOSS
North Slope Crude Oil
Mineral Oil
50%
40%
30%
20%
10%
1972
1973
1975
1976
1976
1976
North Marble
Egg Island
Egg Island

Figure 9.

MEDIAN INCUBATION PERIODS,
EXPERIMENTAL AND CONTROL COLONIES

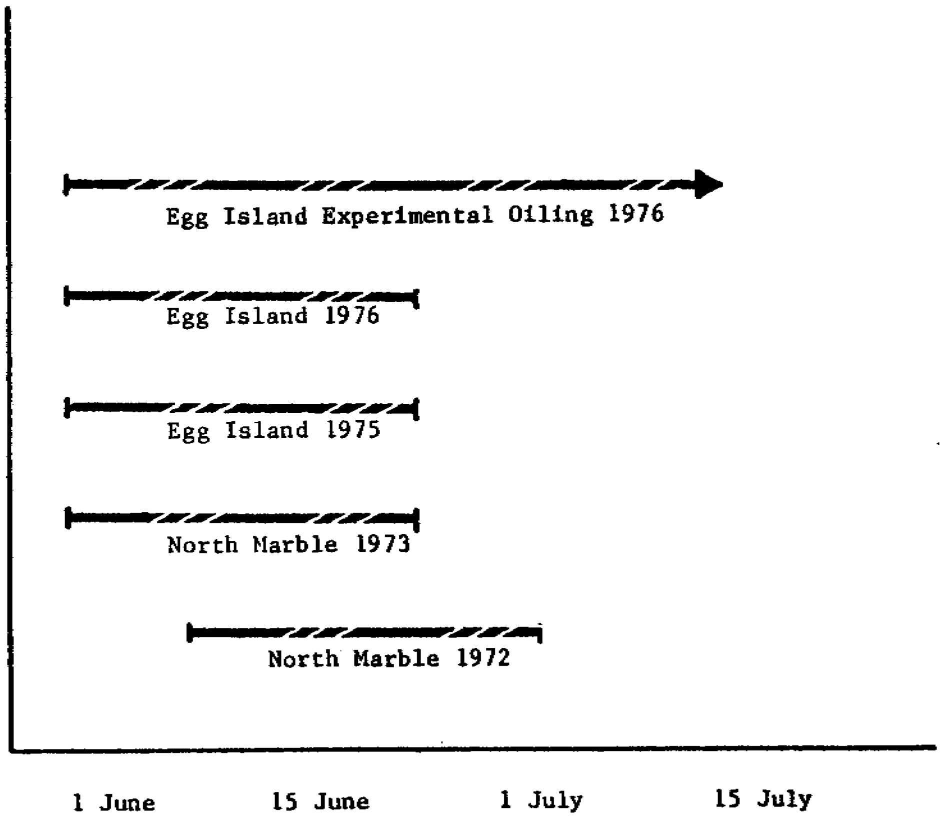
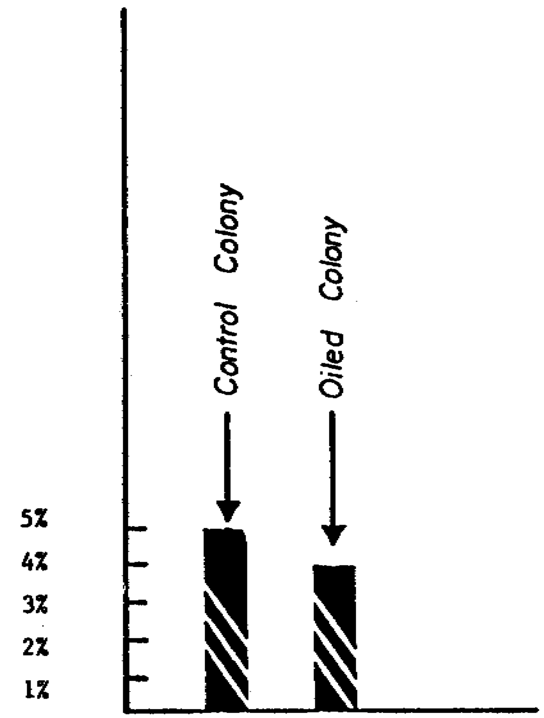


Figure 10.

PERCENTAGE REPLACEMENT CLUTCHES,
EXPERIMENTAL AND CONTROL COLONIES



IV. Problems Encountered

No major problems encountered.

V. Recommendations for Future Research

The literature on effects of petroleum exposure to marine bird reproduction is highly limited, and the field is completely open for continued experimentation. Existing studies demonstrate marine bird eggs are highly vulnerable to minute amounts of petroleum, several orders of magnitude less than necessary to cause adult mortality. Egg mortality is a subtile variable, and not easily observed as is adult seabird mortality. Potential effects on marine bird reproduction would not be observed until the adult population 'crashed' after some years of failure to reproduce.

Potential effects of petroleum exposure to seabird eggs hinge on transfer of petroleum during egg-laying or incubation. We are devising a protocol for capture of breeding adults, with subsequent artificial oiling, to test transfer to eggs. Necessary levels of contaminates needed to be established first, which we have now provided.

We are currently compiling information on petroleum effects on gull chick fledging success. We will carry out an expanded study of petroleum effects on gull chick viability during the 1978 field season.

Demonstrated effects to date have involved the use of unweathered North Slope Crude Oil. Petroleum encountered in the environment may or may not be weathered. The effects of weathered petroleum on marine bird reproduction are completely unexplored. Experiments should be designed and conducted in the field, first recapitulating experiments using 'raw' petroleum, and then expanding upon that body of knowledge. The comparison should be enlightening, since most toxic components are apparently volatile, and the concentration should expect to decrease with duration of atmospheric exposure.

VI. Recommendation to Regulatory Agencies:

Our information to date indicates that because eggs of marine birds are so vulnerable to tiny amounts of petroleum, even low-level oil pollution near marine bird colonies would be highly undesirable.

Literature Cited

Abbott, U.K., R.M. Craig, and J.O. Keith. 1964. Poult. Sci. 43: 1297. Carrier oil sprayed on to nests damaged eggs.

Birkhead, T.R., C. Lloyd, and P. Corkhill. 1973. Oiled seabirds successfully cleaning their plumage. Brit. Birds 66: 535.

Grau, C.R., T. Roudybush, J. Dobbs, and J. Wathen. 1977. Altered yolk structure and reduced hatchability of eggs from birds fed single doses of petroleum oils. Science 195: 779-781.

Gross, A.O. 1950. The herring gull-cormorant control project. Proc. Int. Orni. Congr. 10: 533.

Hartung, R. 1963. Ingestion of oil by waterfowl. Pap. Mich, Acad. Sci., Arts and Letters. 48: 49-55.

__________. 1964. Some effects of oil on waterfowl. Ph.D. thesis. U. Mich. Ann Arbor. Unpublished. 190pp.

__________. 1965. Some effects of oiling on reproduction of ducks. J. Wildl. Man, 29: 872.

Patten, S.M. Jr. 1974. Breeding ecology of the Glaucous-winged Gull in Glacier Bay, Alaska. M. Sc. thesis. University of Washington, Seattle. 90pp. Unpublished

Patten, S.M. Jr. and L.R. Patten. 1975. Breeding ecology of the Gulf of Alaska Herring Gull Group (Larus argentatus x Larus glaucescens). NOAA ERL PI Reports, Boulder Colo. 66pp.

______________________________. 1976. Evolution, pathobiology and breeding ecology of the Gulf of Alaska Herring Gull Group (Larus argentatus x Larus glaucescens). NOAA ERL PI Reports, Boulder, Colo. 128 pp.

______________________________. 1977. Effects of Petroleum Exposure on hatching success and incubation behavior of the Gulf of Alaska Herring Gull Group (Larus argentatus x Larus glaucescens). NOAA ERL PI Reports, Boulder, Colo. 22pp.

Rittinghaus, H. 1956. Etwas über die „indirekte" Verbreitung der Ölpest in einem Seevogelschutzgebiete. Orni. Mitt.8: 43-46.

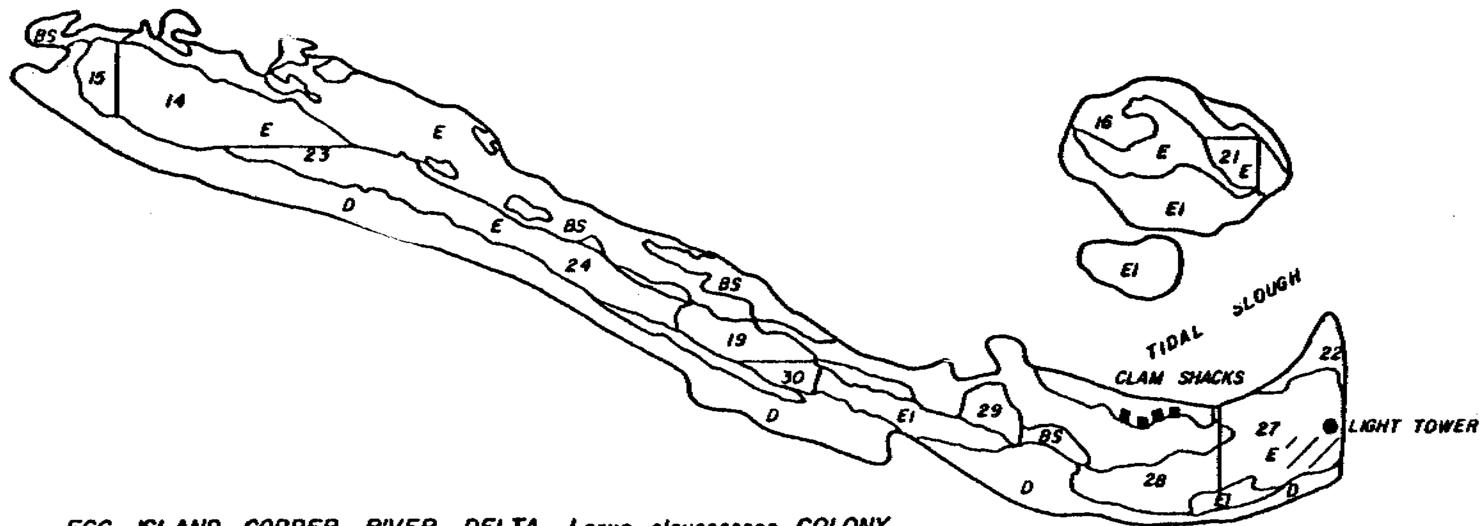
Szaro, R.C., and P.H. Albers. 1976. Effects of external applications of oil on common eider eggs. Fate & effects of petr. hydrocarb. in marine ecosys. and organisms. A symposium. NOAA-BLM. Seattle.

Appendix of Recent Research Results

We have recently had a number of notably successful computer 'runs' using the Johns Hopkins University DEC-system 10 Computer and the QD Cal-Comp Plotting System on *Larus glaucescens* - *Larus argentatus* gull data collected under NOAA and NPS contracts. The comparison between these two data sets is enlightening and we provide here our preliminary analysis of the graphics of a number of parameters.

We are also providing color photographs using the Xerox 6500 Color Copier as specified in our contract, an analysis of the gull productivity at Dry Bay south of Yakutat in 1977, and a series of median incubation periods by colonies from 1972 - 1977.

National Ocean Survey color aerial photograph of the east end of Egg Island, 9 July 1971, at low tide. New ridges of sand dunes have formed, joining the series of islets together. Scale 1:30,000. Xerox 6500 color copy of original color photograph has been submitted.



EGG ISLAND, COPPER RIVER DELTA, *Larus glaucescens* COLONY
WITH 1976 VEGETATION ANALYSIS

LEGEND
E - DUNEGRASS
EI - INVADING DUNEGRASS
D - DRIFTING SAND
BS - BARE GROUND
//. - STUDY AREA
SECTION NUMBERS - SEE TEXT

0 ___ 1 KILOMETER

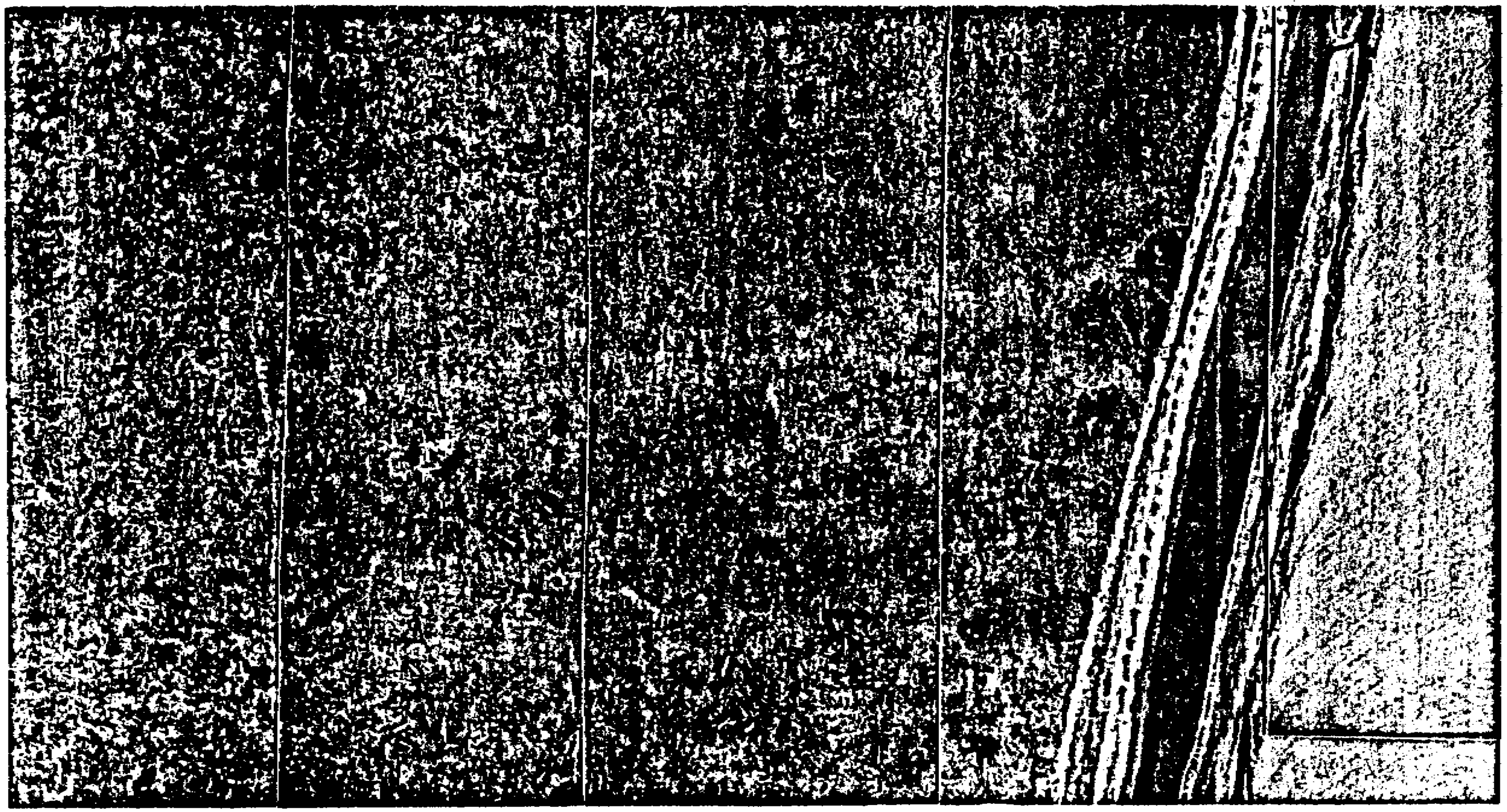


Figure 1. Composite color aerial photograph of Egg Island study area, 60° 23' N, 145° 46' W, SW of USCG Beacon Light Tower, July 1976 from 335 m elevation. The vegetative cover (<u>Elymus arenarius mollis</u>) is most dense around old drift logs marking the pre-'64 storm tide line. The entire lower portion of the photograph is a former wave-washed area. Nesting density of gulls is now highest in areas of most vegetative cover. Drift logs buried under several meters of sand, exposed by the cutbank of Egg Island channel, testify to the dynamic nature of the island. Photo courtesy of Mr. Robert Scheierl.

National Ocean Survey color aerial photograph of the southeast end of Copper Sands (S), 9 July 1971, at low tide. Gull colonies are located on the only three dunes covered with Elymus at the SE end of Copper Sands. Scale 1:30,000. Xerox 6500 color copy.

Figure 2. Composite color aerial photograph of two centrally located *Elymus*-covered dunes colonized by gulls at the SE end of Copper Sands (S), 60^{o} 18' N, 145^{o} 31' W. Copper Sands has much less vegetative cover than Egg Island and is inhabited by far fewer gulls. Photo courtesy of Mr. Robert Scheierl.

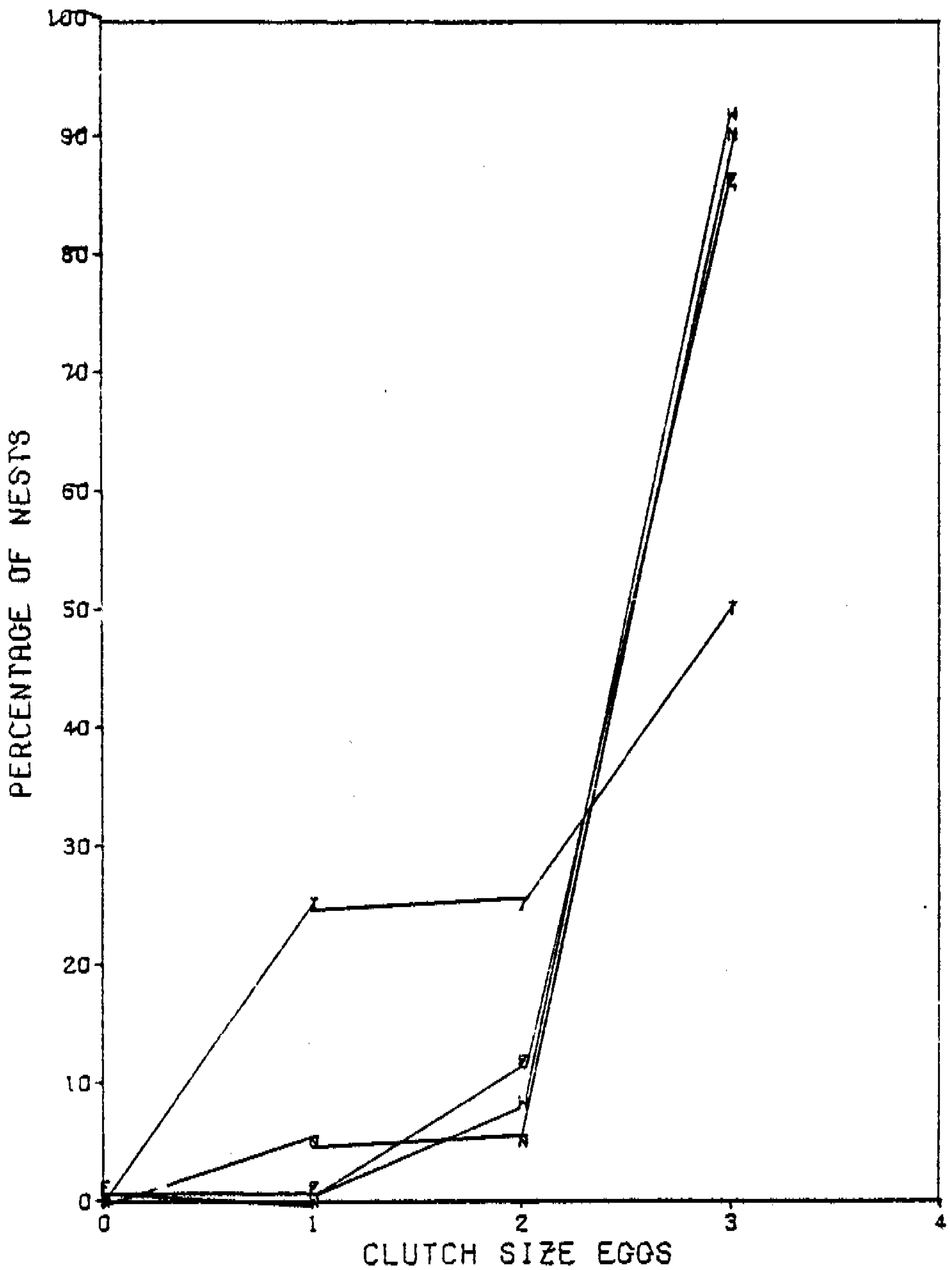


Figure 3. Clutch size plotted against percentage of nests, North Marble Island, 1972.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.
The Top Colony is different in clutch size; East, West, and North are similar.

The most likely explanation for the difference is young females laying for the first time produce smaller clutches.

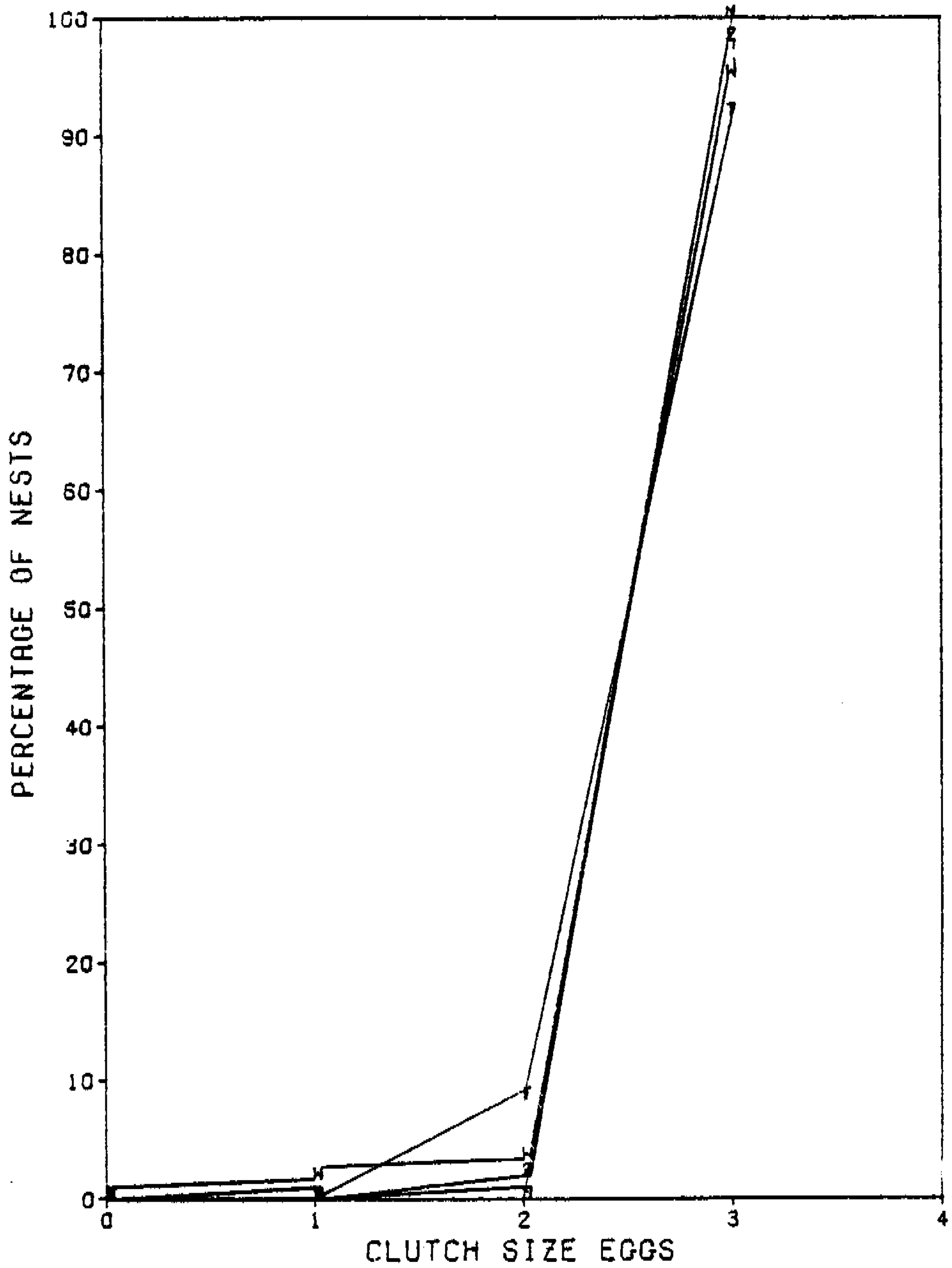


Figure 4. Clutch size plotted against percentage of nests, North Marble Island, 1973.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

All colonies show similar tendencies.

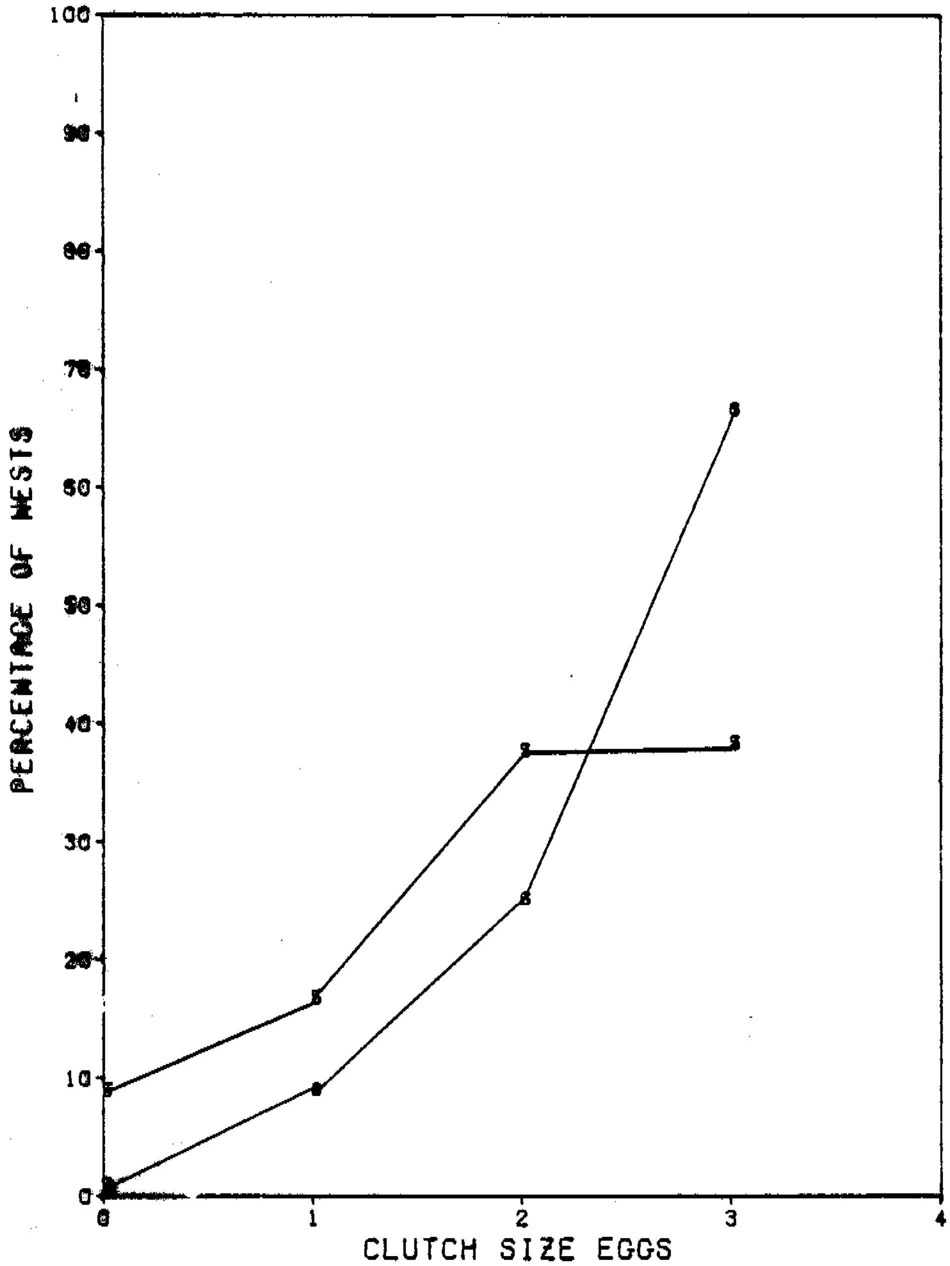


Figure 5. Clutch size plotted against percentage of nests, Egg Island 1975 - 1976.
5 = 1975 survey, 6 = 1976 survey.

Clutch size is smaller on Egg Island than on North Marble, probably due to the expanding population on Egg Island, with a higher percentage of young females producing smaller clutches. Egg Island most resembles the Top Colony on North Marble in 1972.

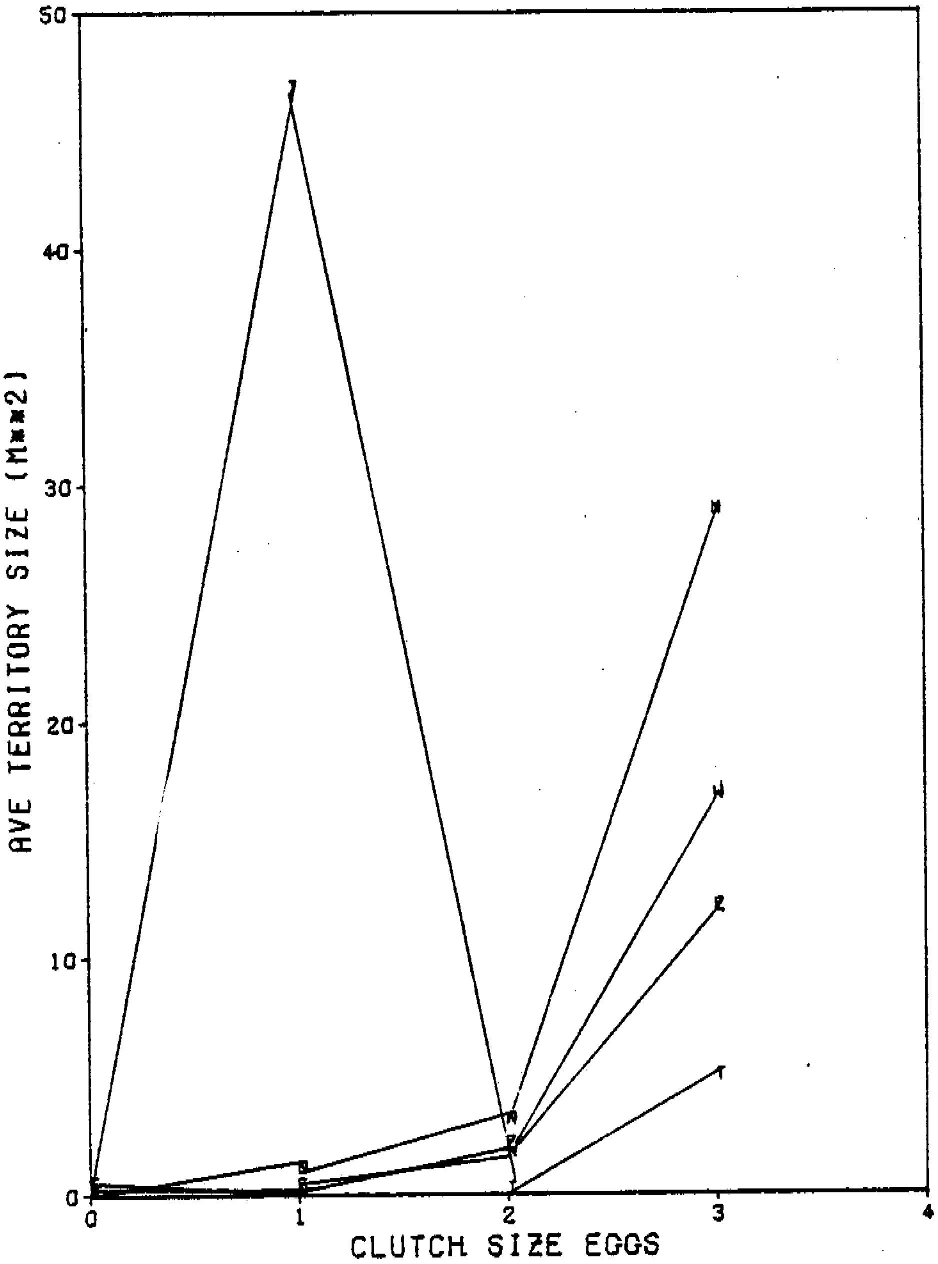


Figure 6. Clutch size plotted against average territory size, North Marble, 1972.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

East, West, and North Colonies show rather similar tendencies. Top Colony is strikingly different, with a large mean territory size and concurrent 1-egg clutches.

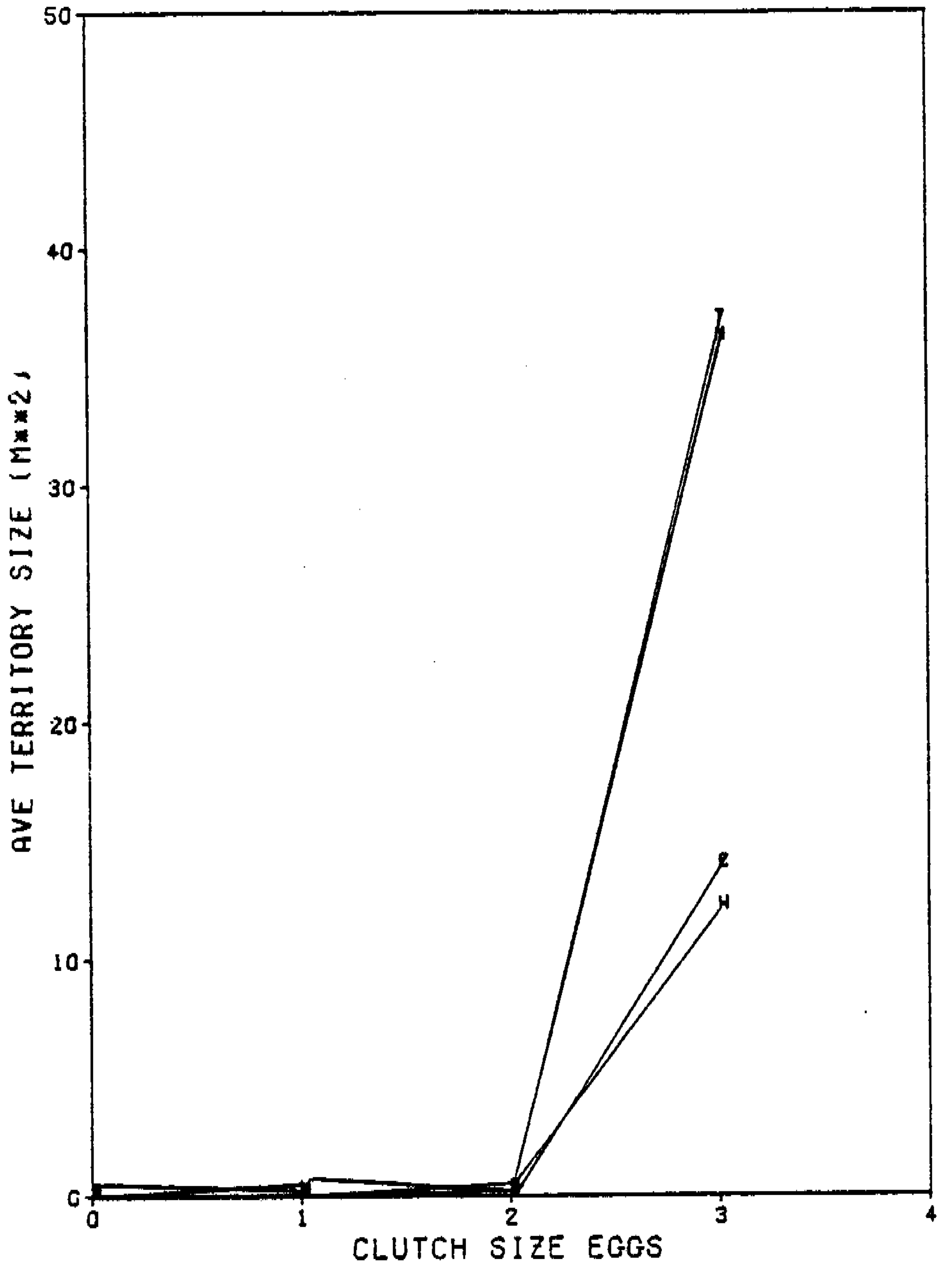


Figure 7. Clutch size plotted against average territory size, North Marble, 1973.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

East and West Colonies are close in average territory size, as are Top and North Colonies. However all colonies exhibit a high proportion of three-egg clutches.

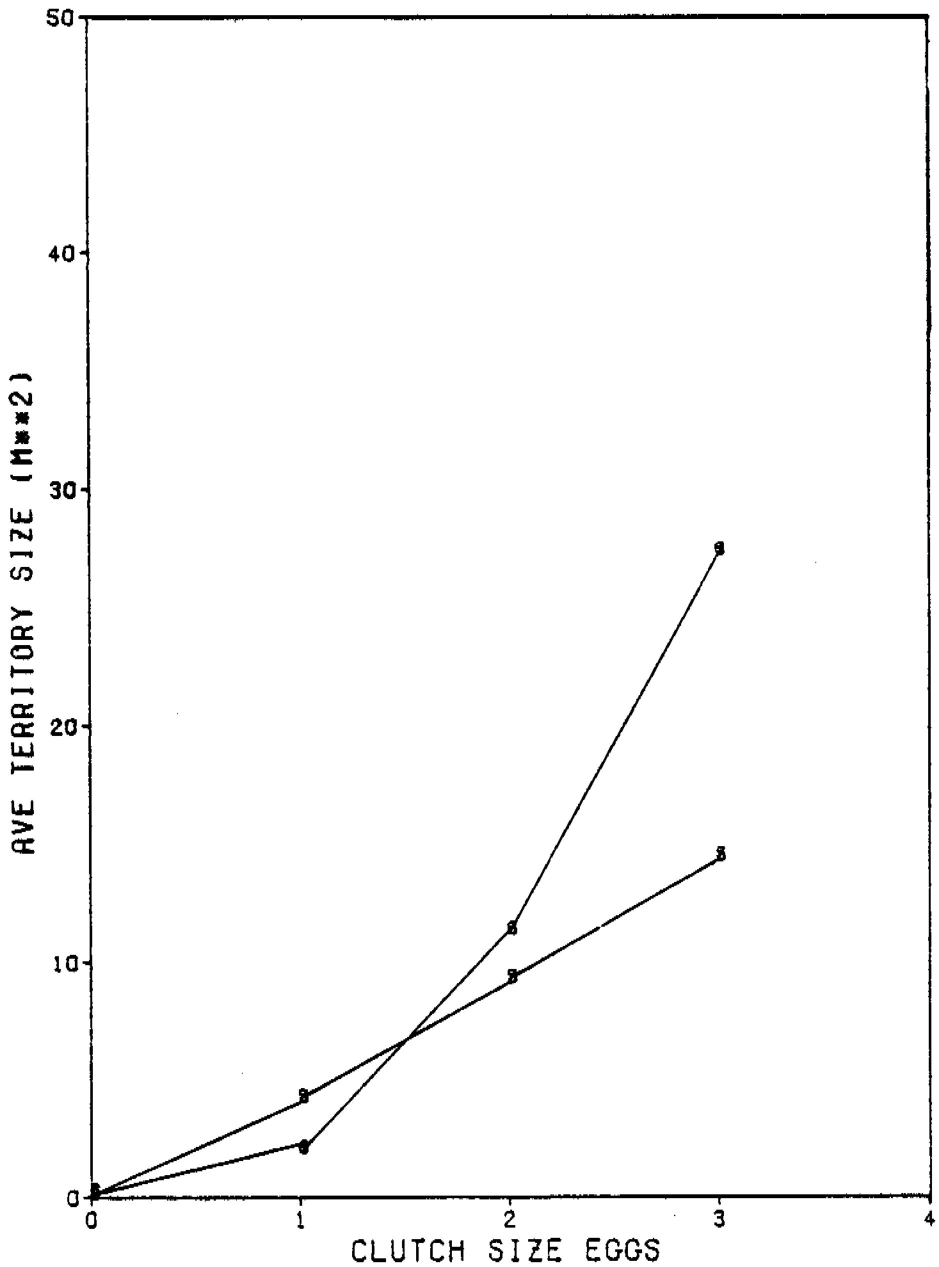


Figure 8. Clutch size plotted against average territory size, Egg Island 1975 - 1976.
5 = 1975 survey, 6 = 1976 survey.

Territory size is significantly larger on Egg Island compared to North Marble, with a smaller percentage of three-egg clutches and a greater proportion of one-egg and two-egg clutches. The conspicuous exception is the Top Colony in 1972 (Figure 6), with large territory size and high percentage of one-egg clutches.

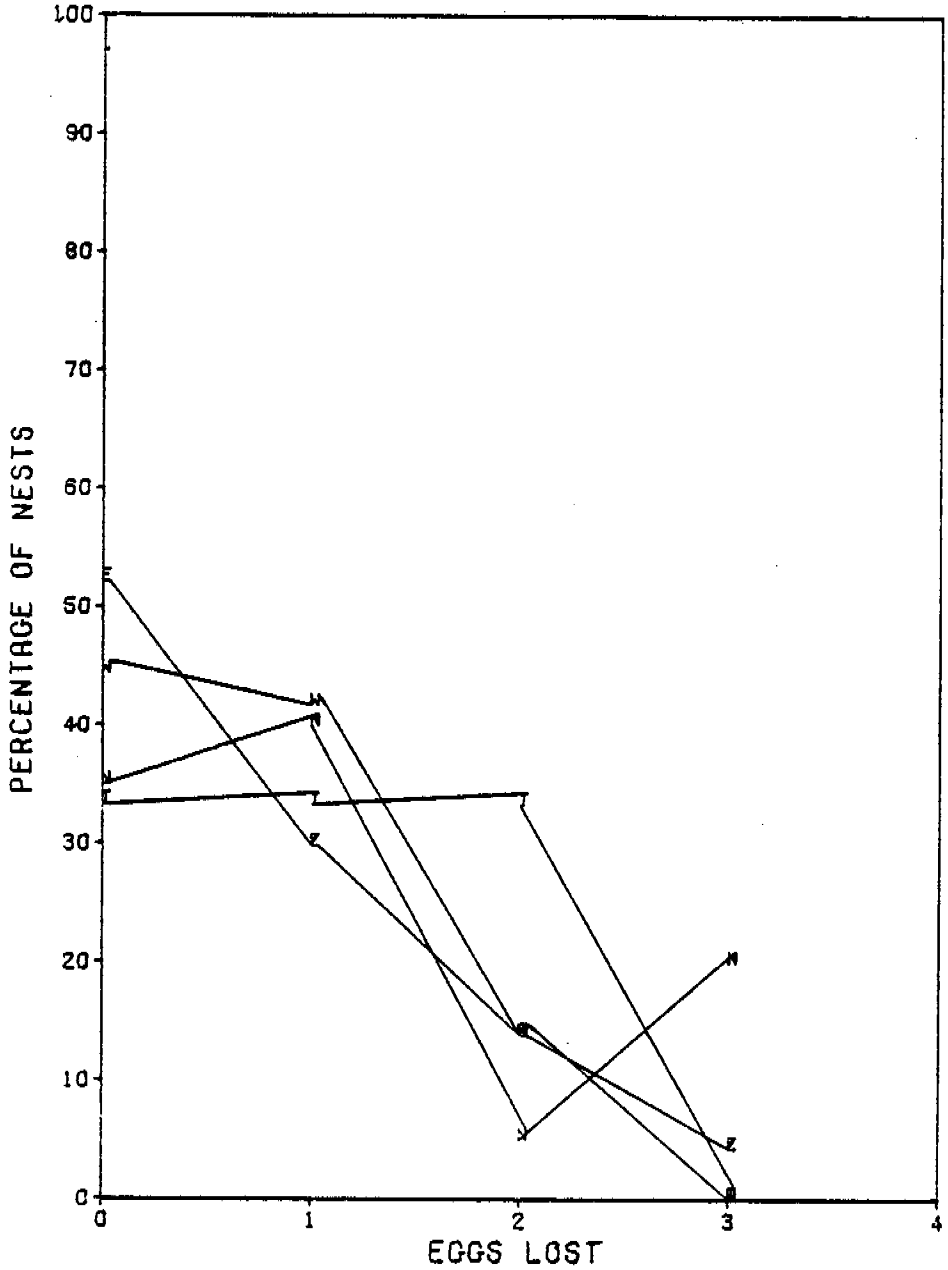


Figure 9. Eggs lost plotted against percentage of nests, North Marble, 1972.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

East and West Colonies are quite similar in percentage egg loss. Top Colony had a higher percentage 2-egg loss, and North Colony had 20% complete clutch loss.

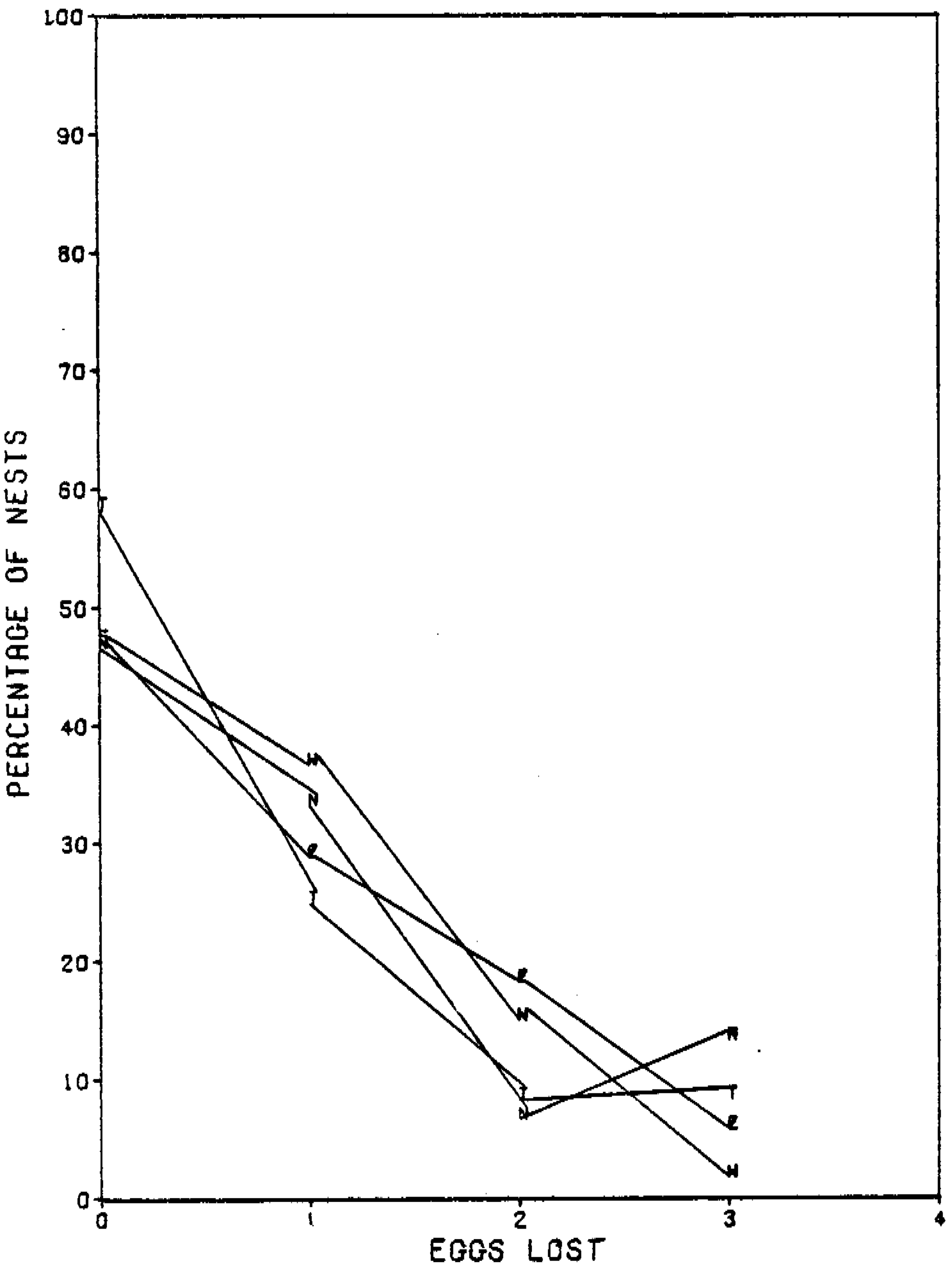


Figure 10. Eggs lost plotted against percentage of nests, North Marble, 1973.

All colonies show highly similar tendencies in eggs lost to predation. Predators are mostly conspecific adults.

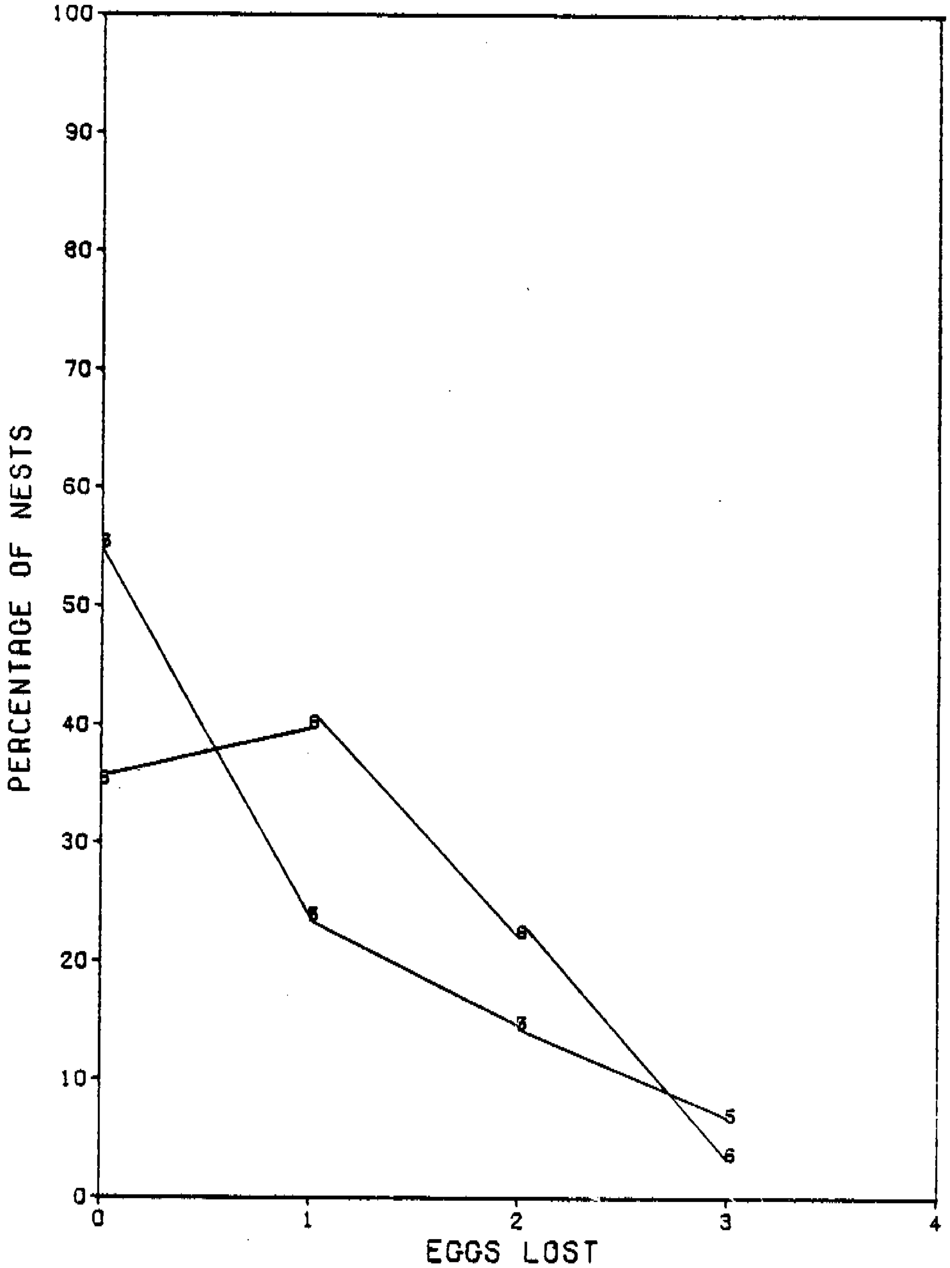


Figure 11. Eggs lost plotted against percentage of nests, Egg Island, 1975 - 1976. 5 = 1975 survey, 6 = 1976 survey.

Egg Island is similar to North Marble in egg loss to predation.

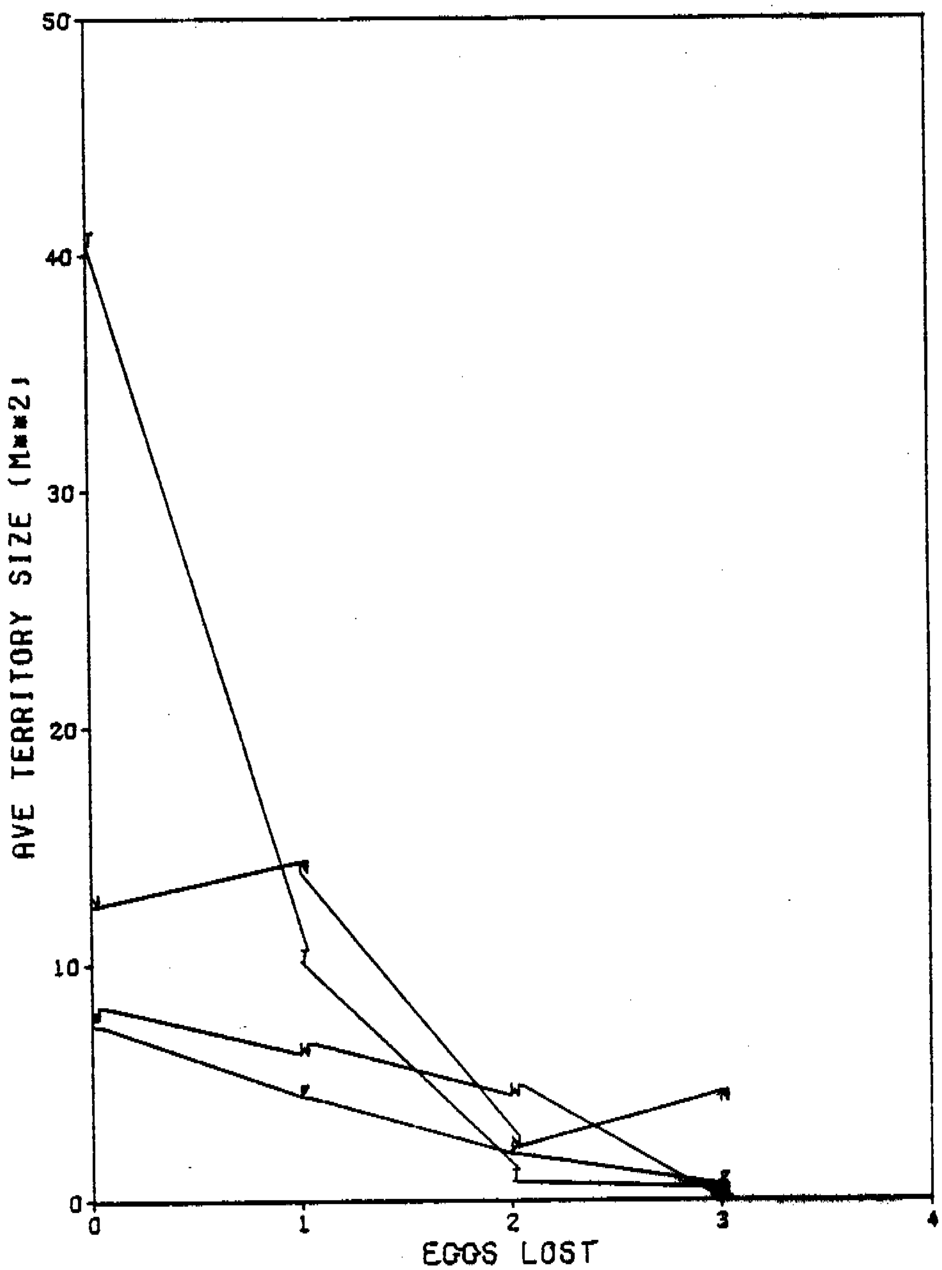


Figure 12. Eggs lost plotted against average territory size, North Marble, 1972.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

Although Top Colony is significantly larger in average territory size, proportionate egg loss is similar to other colonies.

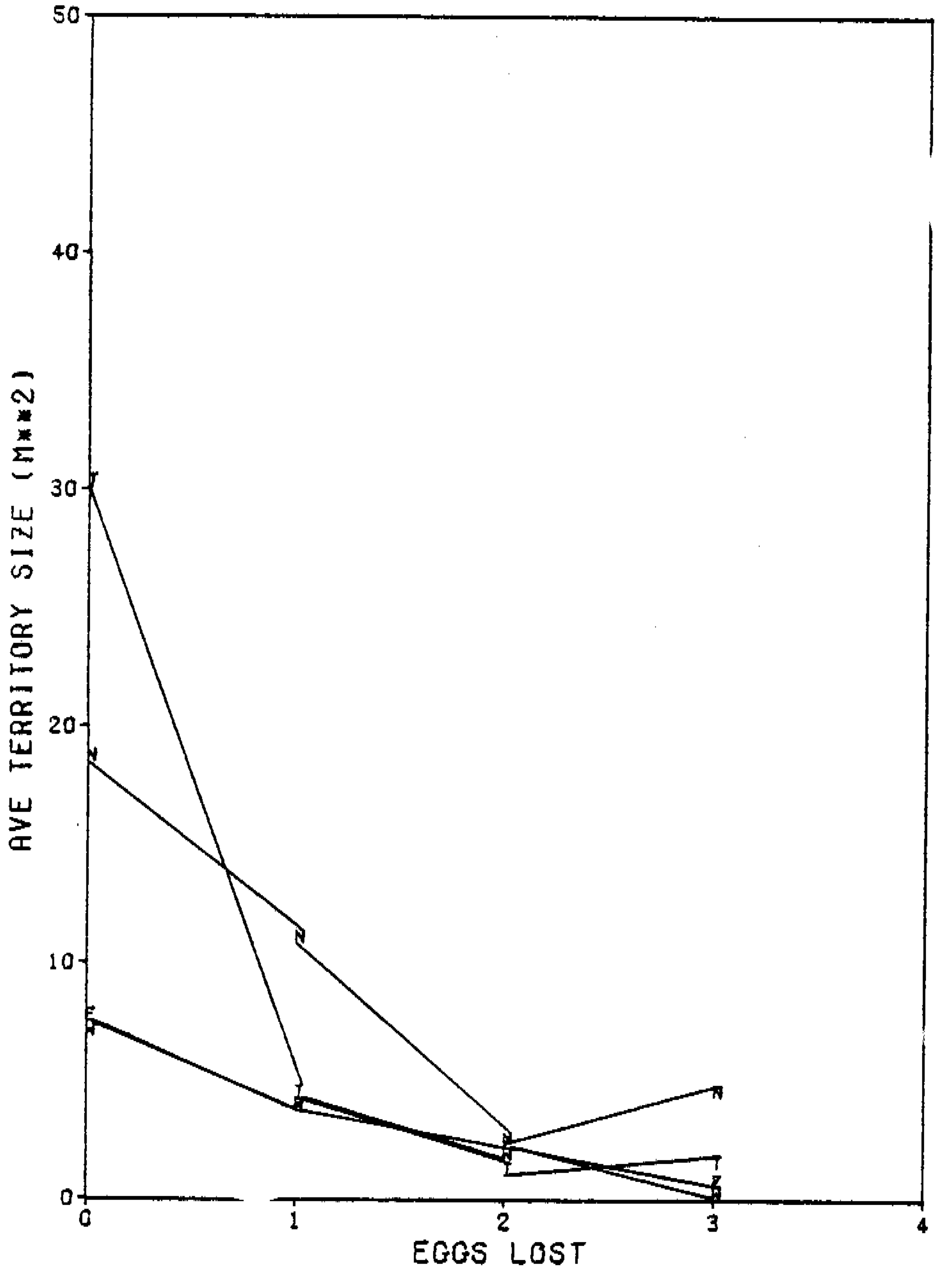


Figure 13. Eggs lost plotted against average territory size, North Marble, 1973.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.
All colonies show similar trends in eggs lost.

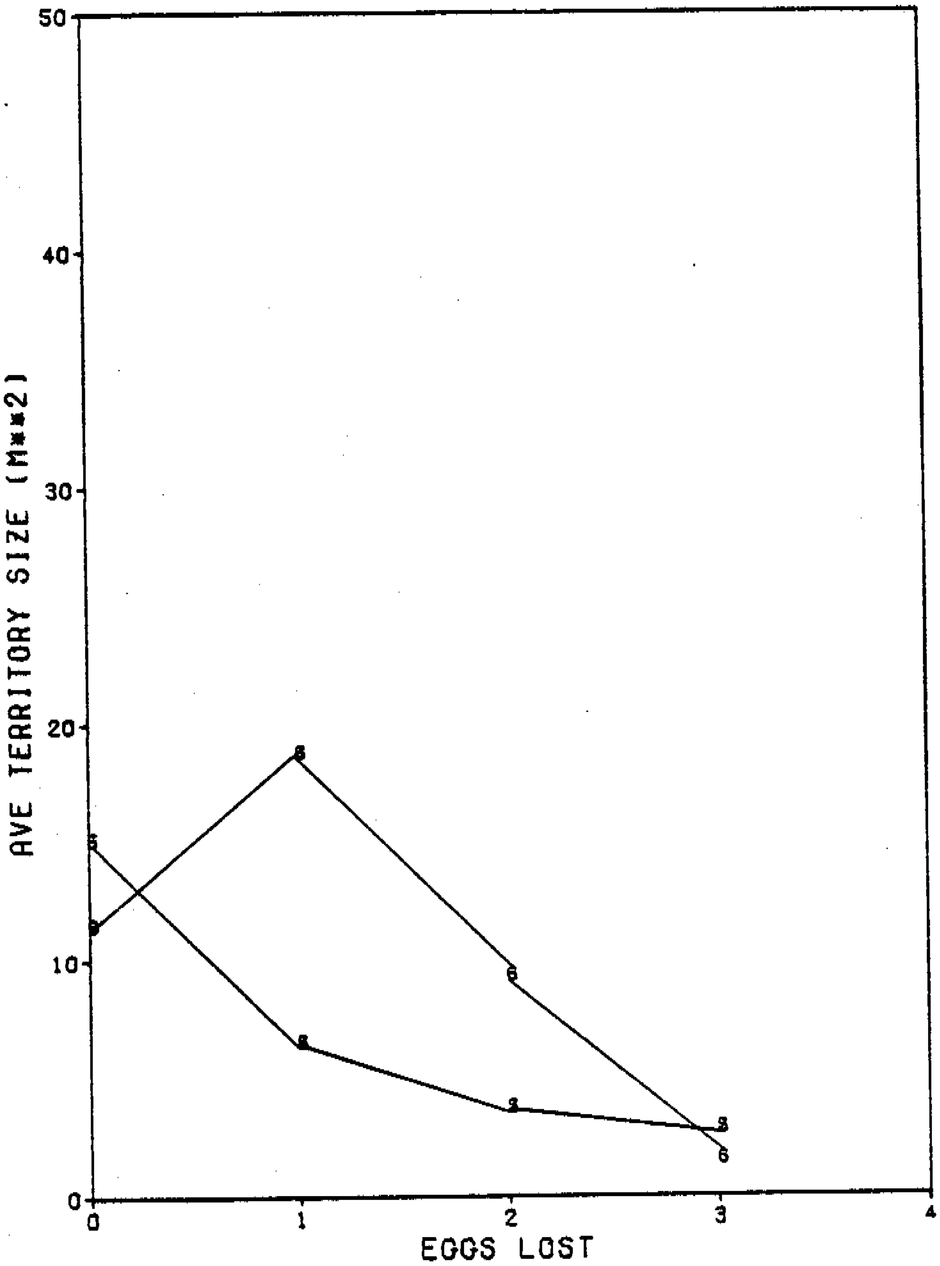


Figure 14. Eggs lost plotted against average territory size Egg Island, 1975 - 1976.
5 = 1975 survey, 6 = 1976 survey.

Gulls with larger territory sizes tended to loose one or two eggs in 1976.
Egg loss in 1975 resembled that of 1972 and 1973 on North Marble.

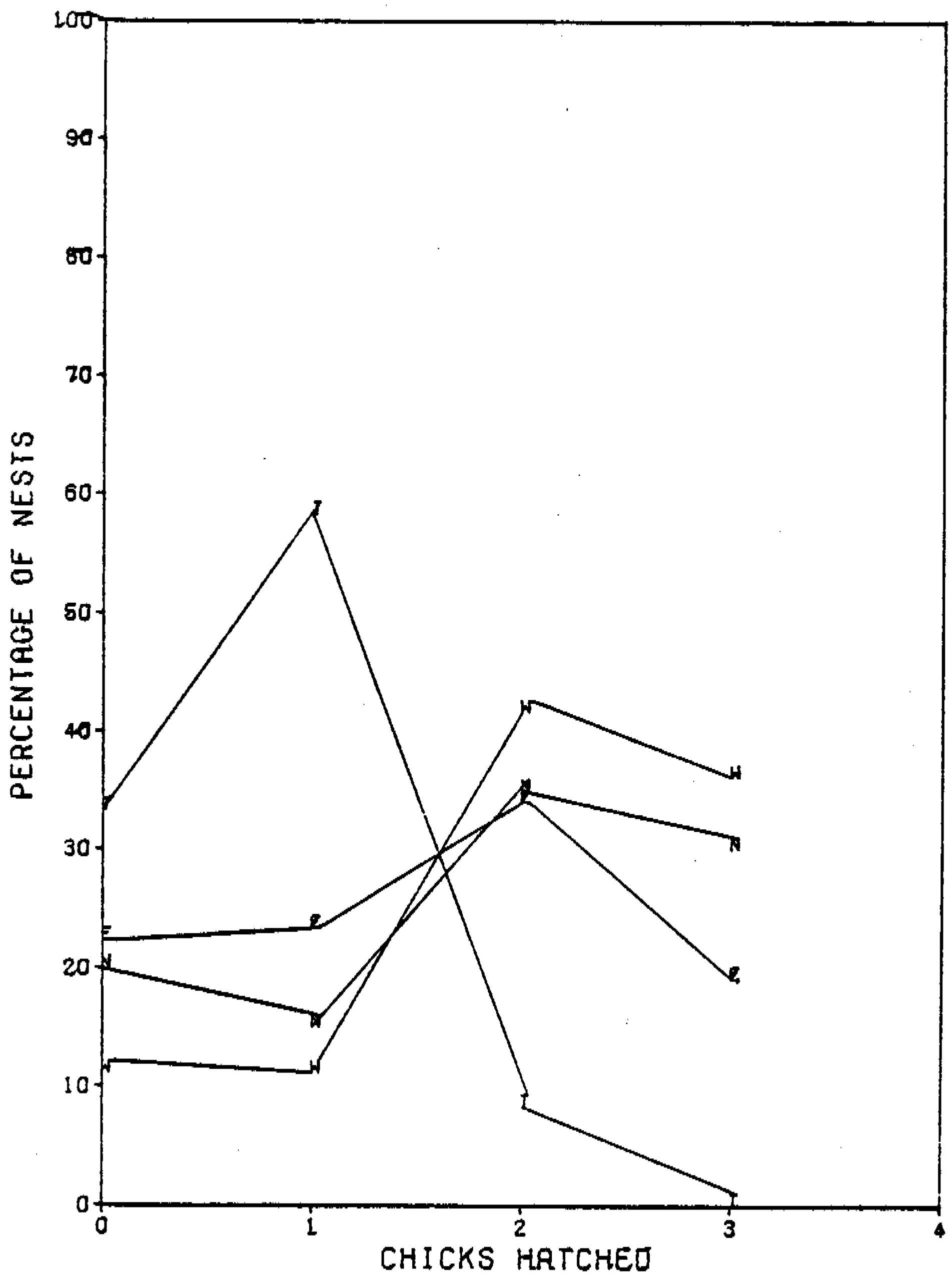


Figure 15. Chicks hatching plotted against percentage of nests, North Marble, 1972.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

East, West and North Colonies are quite similar in number of chicks hatching per nest. The Top Colony, due to smaller mean clutch size, produced fewer chicks hatching in proportion.

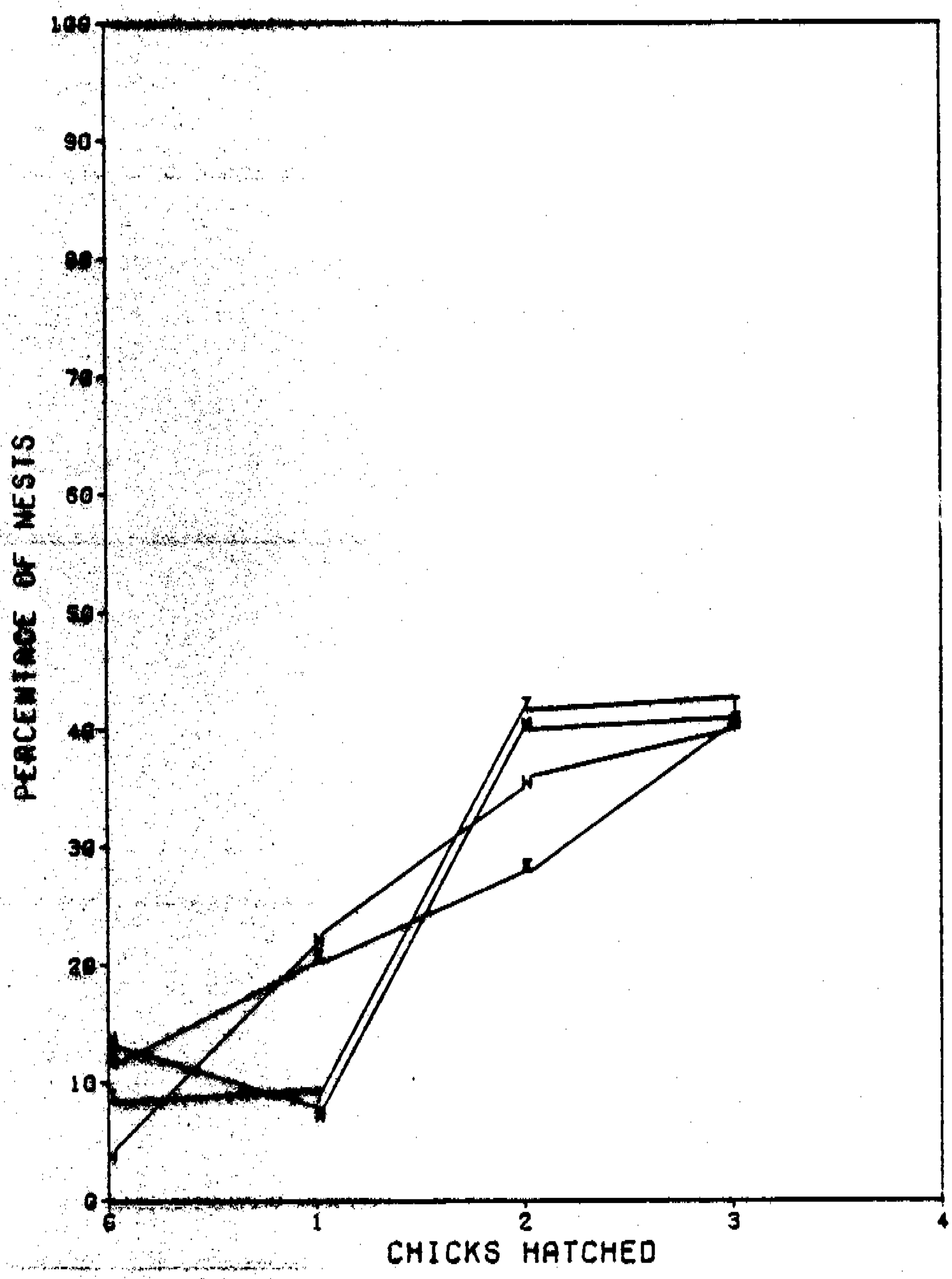


Figure 14. Chicks hatching plotted against percentage of nests, North Marble, 1973.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

All colonies show quite similar tendencies in proportion of chicks hatching due to similar mean clutch sizes and rate of predation.

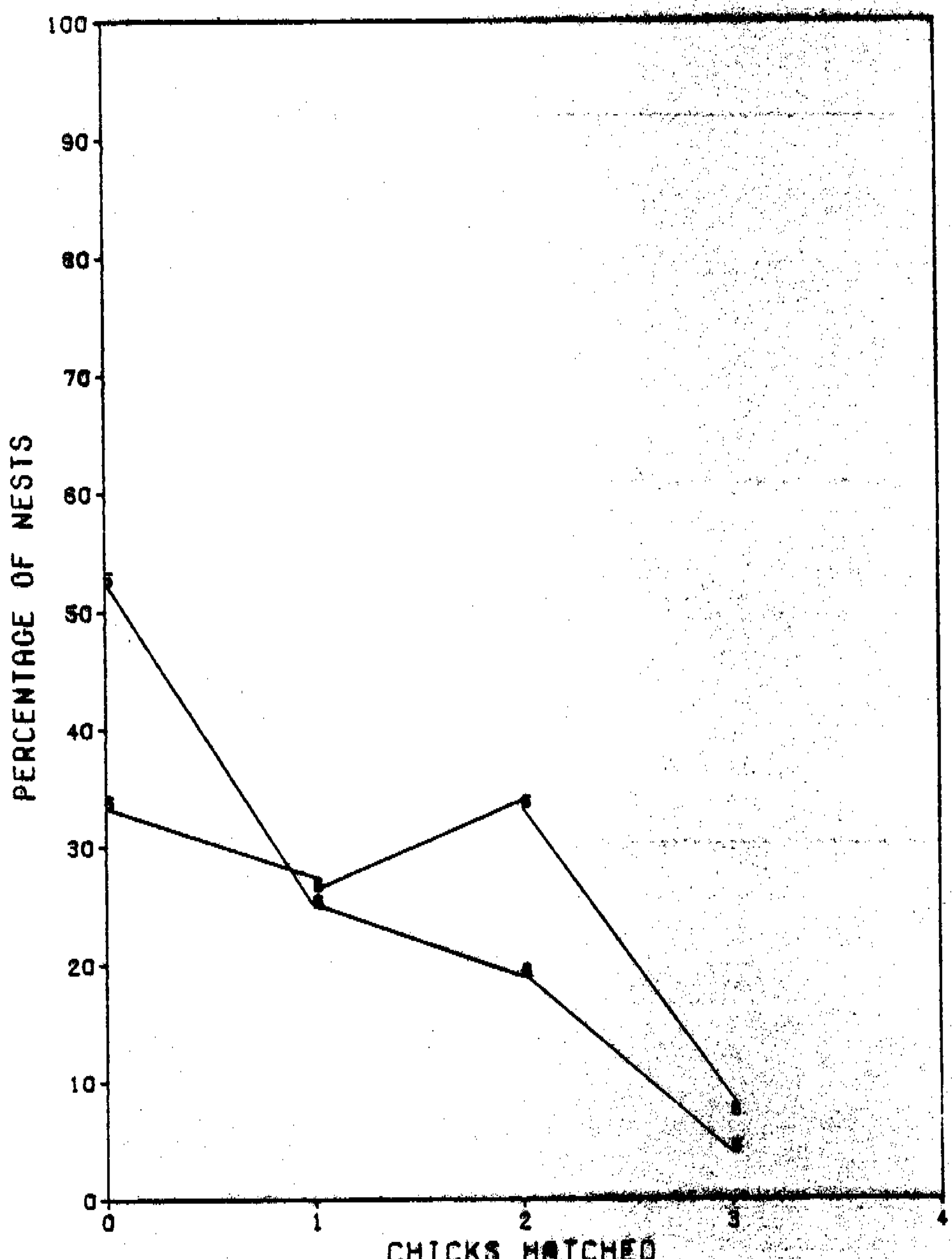


Figure 17. Chicks hatching plotted against percentage of nests, Egg Island, 1975 - 1976.
5 = 1975 survey, 6 = 1976 survey.

Egg Island, due to smaller mean clutch size, shows a reverse tendency in proportion of chicks hatching when compared to North Marble in 1973, but resembles the Top Colony on North Marble in 1972 (Figure 15), although not as extreme.

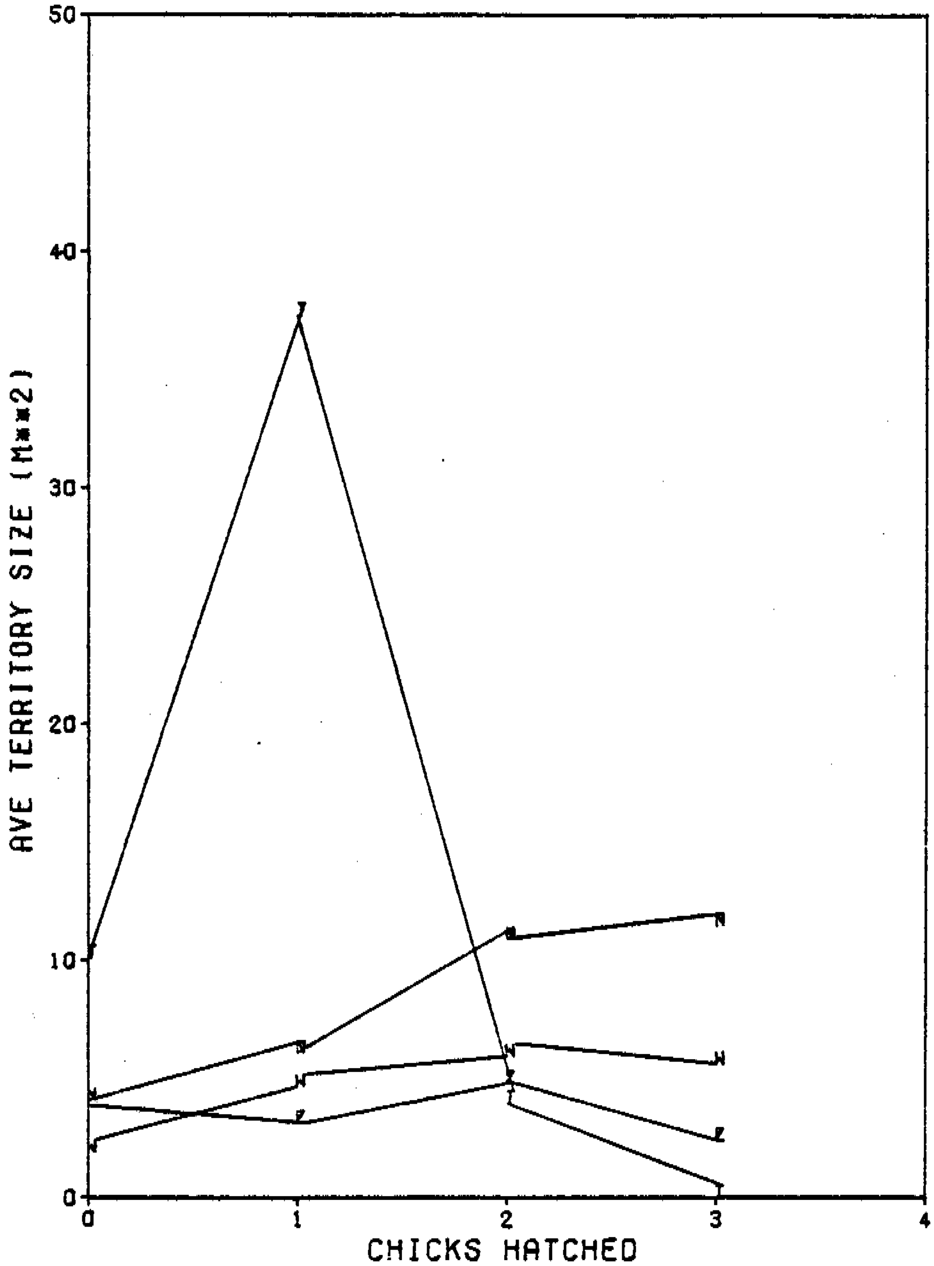


Figure 18. Chicks hatching plotted against average territory size, North Marble, 1972. E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

East, West and North Colonies are quite similar in number of chicks hatching in relation to average territory size. Top Colony is significantly different, with large territory size, smaller mean clutch size, and fewer chicks produced.

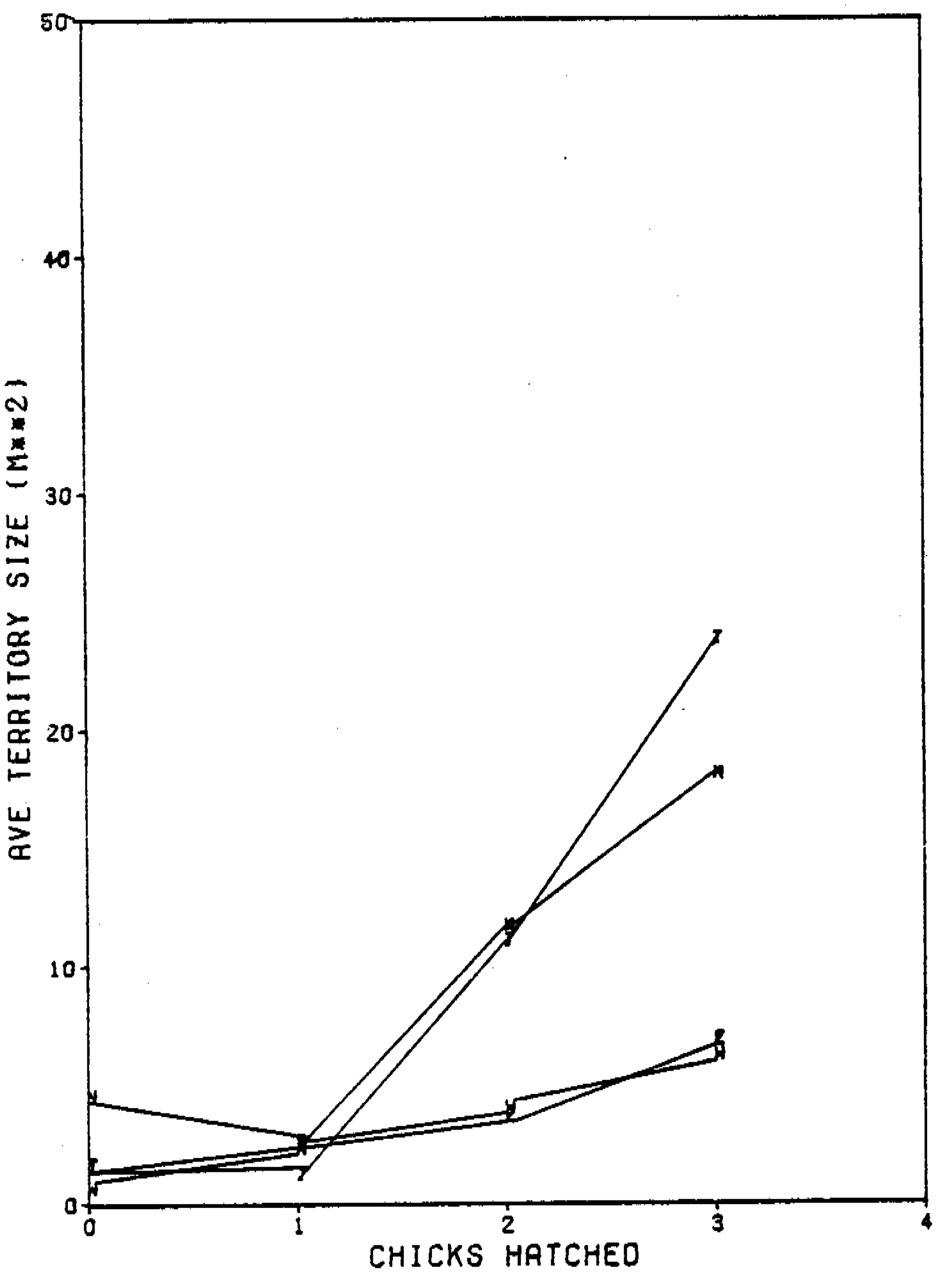


Figure 19. Chicks hatching plotted against average territory size, North Marble, 1973. E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

Top and North Colonies are similar in average territory sizes, as are East and West Colonies, but the two groups are different from each other, probably due to colony sizes. However, all colonies show similar tendencies in number of chicks hatched.

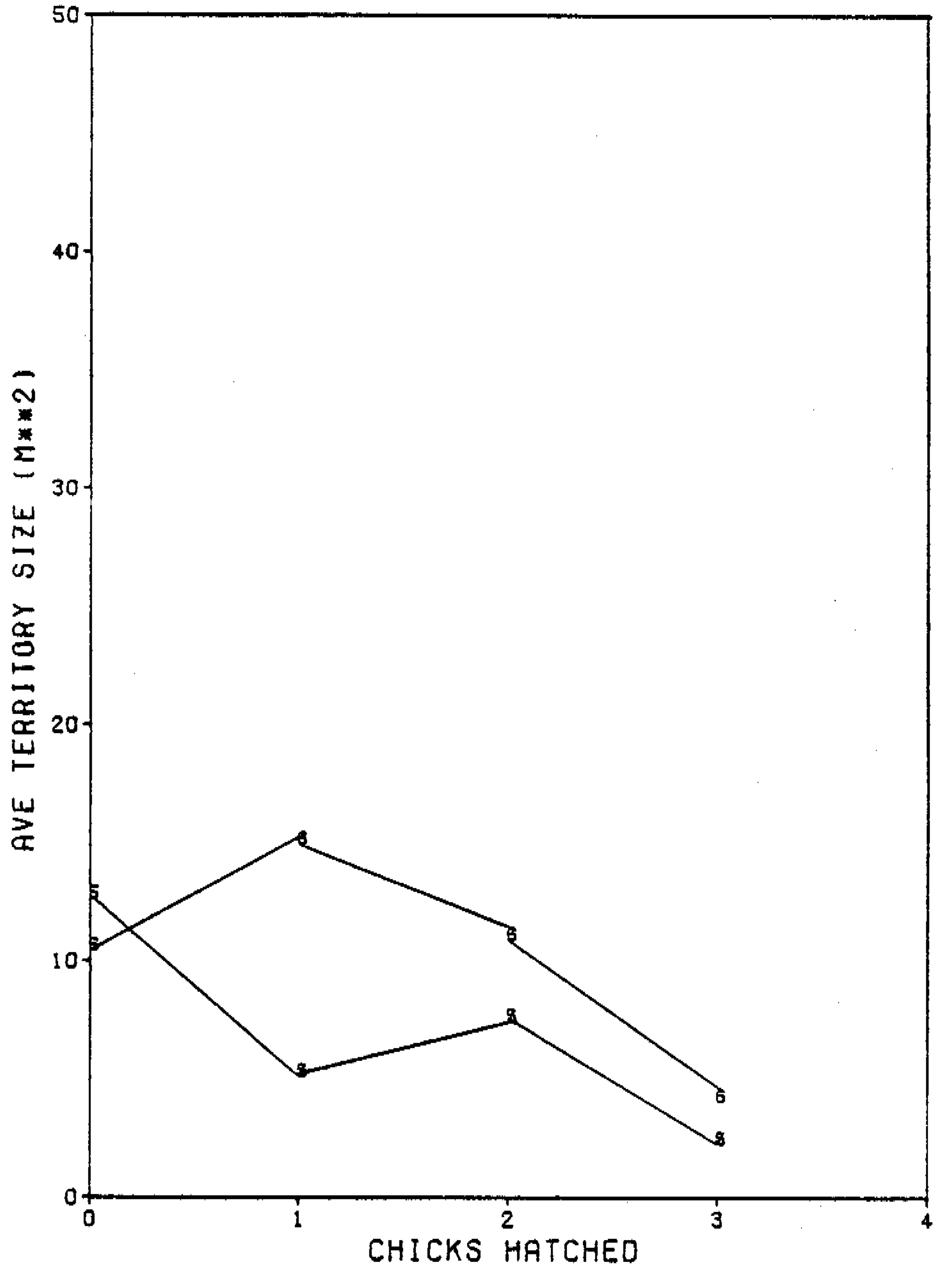


Figure 20. Chicks hatching plotted against average territory size, Egg Island, 1975 - 1976. 5 = 1975 survey, 6 = 1976 survey.

Average territory size on Egg Island in 1976 was larger than in 1975. Both years show a reverse trend from North Marble in 1973 due to smaller mean clutch size.

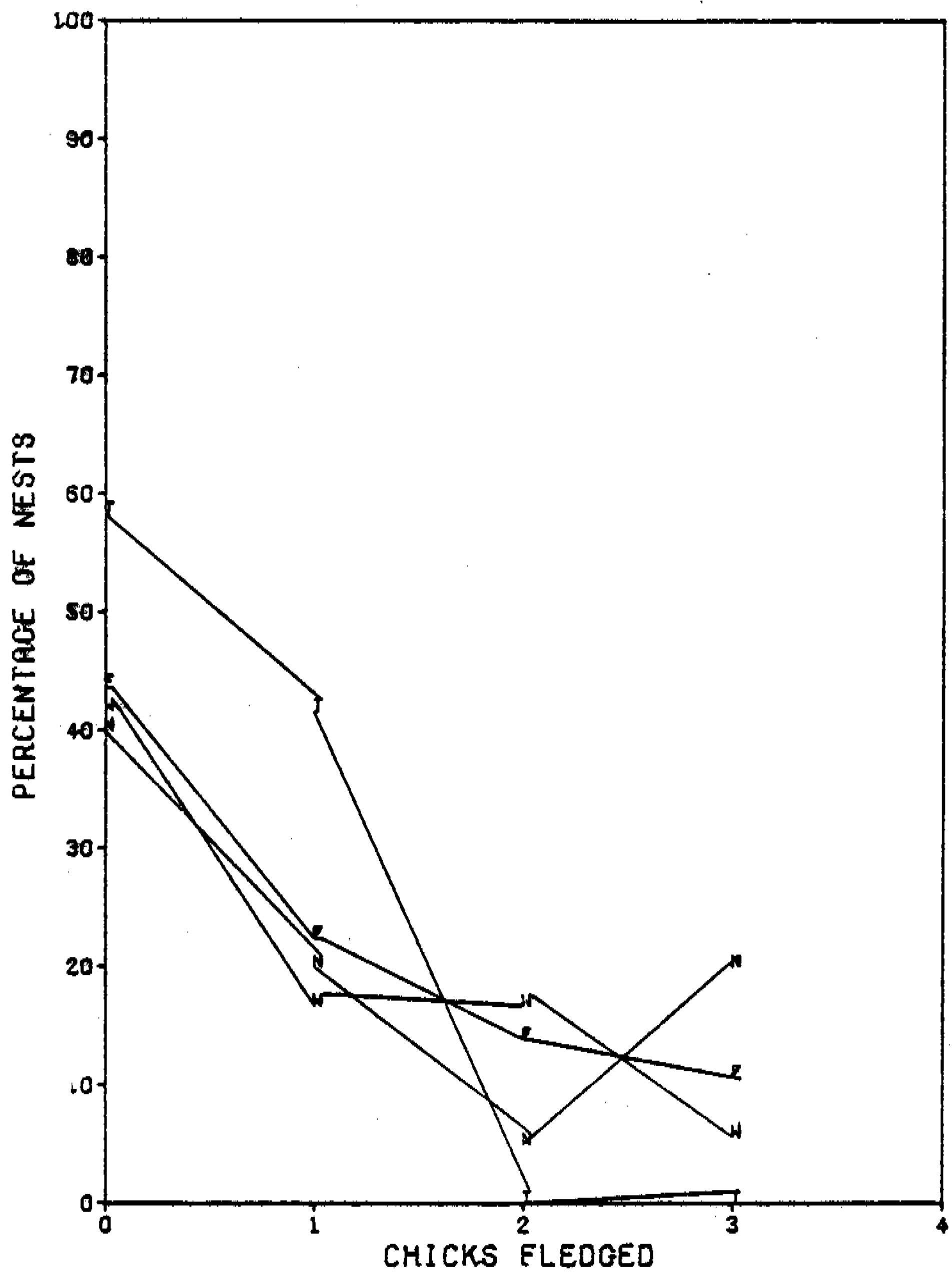


Figure 21. Chicks fledging plotted against percentage of nests, North Marble, 1972.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

Once again the East, West and North Colonies form a similar pattern and the Top Colony is aberrant, with large territory sizes, smaller clutches, fewer chicks hatching, greater chick loss, and fewer chicks fledging.

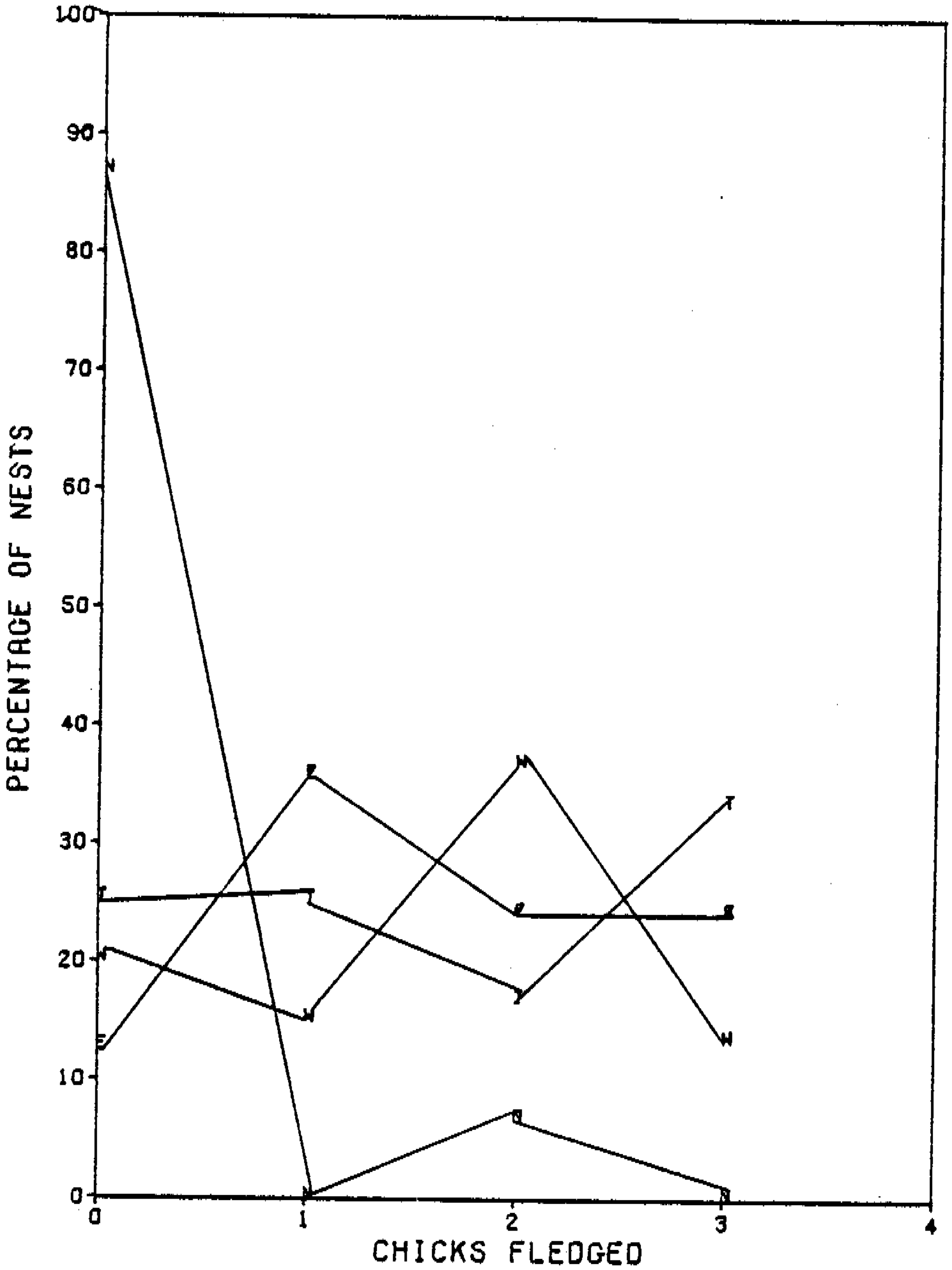


Figure 22. Chicks fledging plotted against percentage of nests, North Marble, 1973.
E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

The North Colony here presents an exception to the usual trend. The East, West and Top Colonies closely fluctuate around a mean, while the North Colony breaks the pattern, with many fewer chicks apparently fledged. This may be due to disturbance due to boat mooring near the colony, causing chicks to emigrate early.

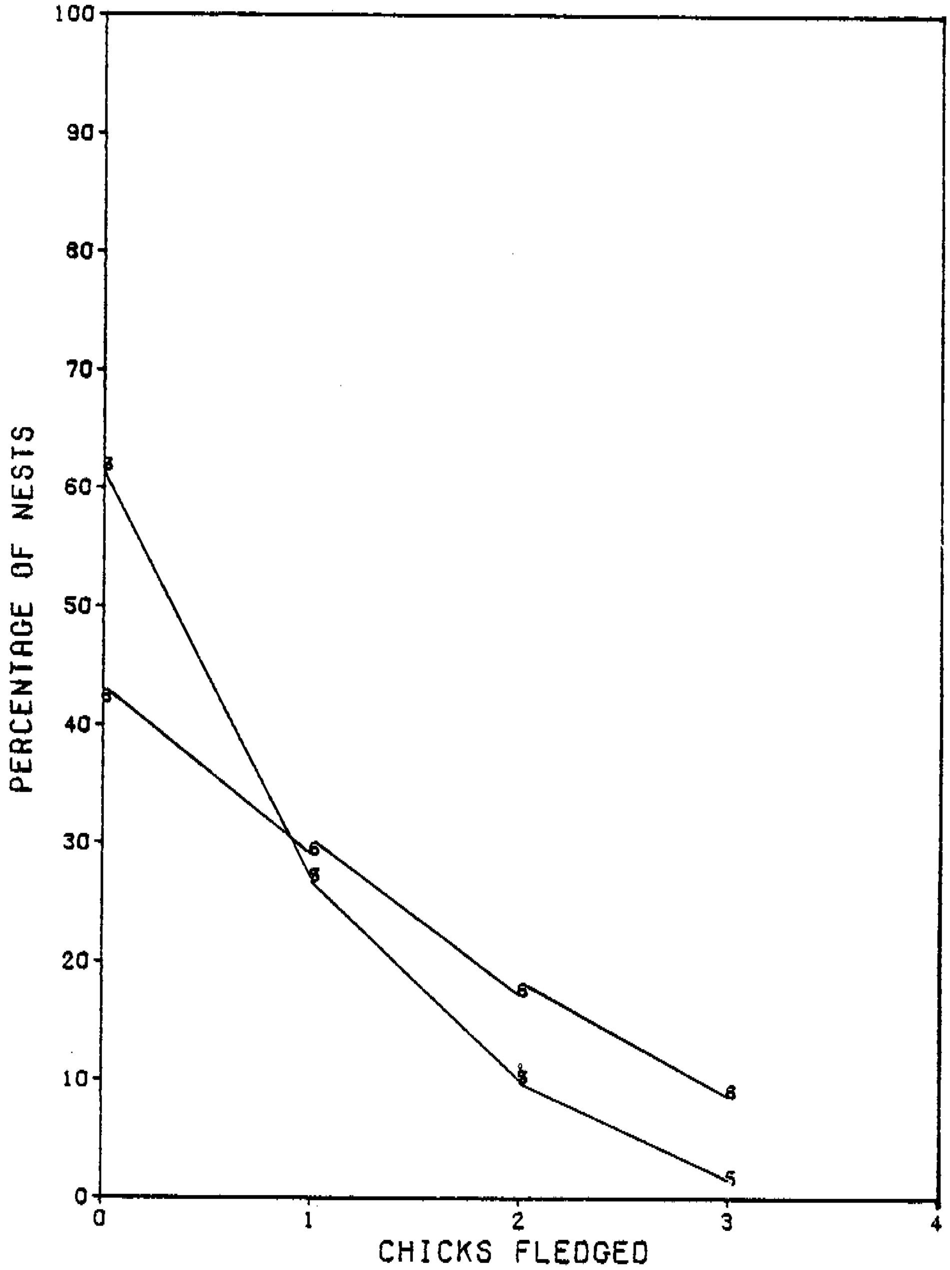


Figure 23. Chicks fledging plotted against percentage of nests, Egg Island, 1975 - 1976. 5 = 1975 survey, 6 = 1976 survey.

Egg Island gulls produce fewer chicks than those on North Marble, in proportion, but Egg Island resembles North Marble in 1972 in chicks fledged. The productivity on Egg Island is expected to increase as the proportion of experienced female breeders expands, given continued access to artificial food from human sources.

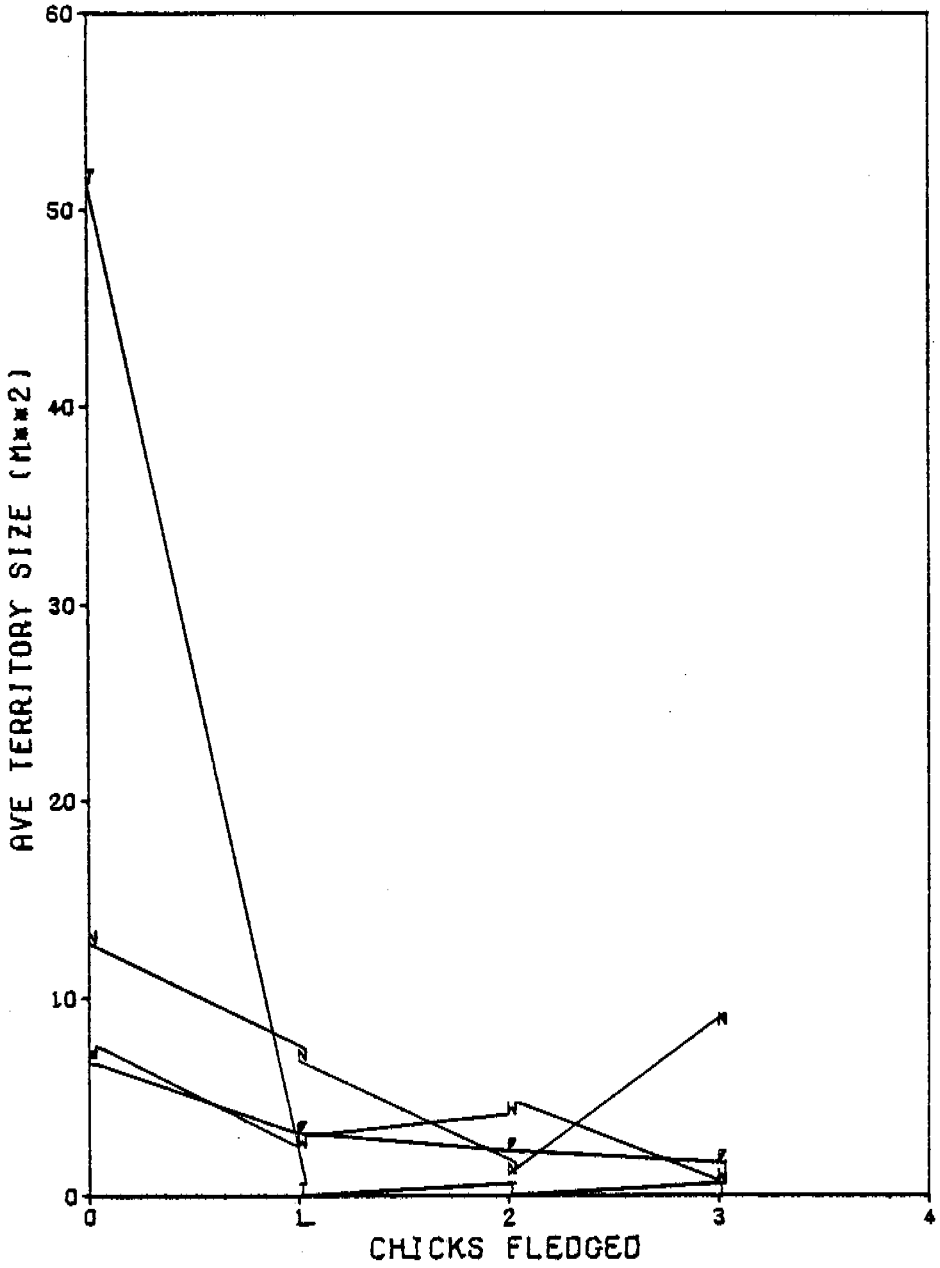


Figure 24. Chicks fledging plotted against average territory size, North Marble, 1972. E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

Gulls with large territory sizes and small clutch sizes in the Top Colony fledged no chicks. Only a few chicks survived from this colony this season. Territory size played only a moderate influence in chicks fledging in the other colonies, since they were all within the same general range.

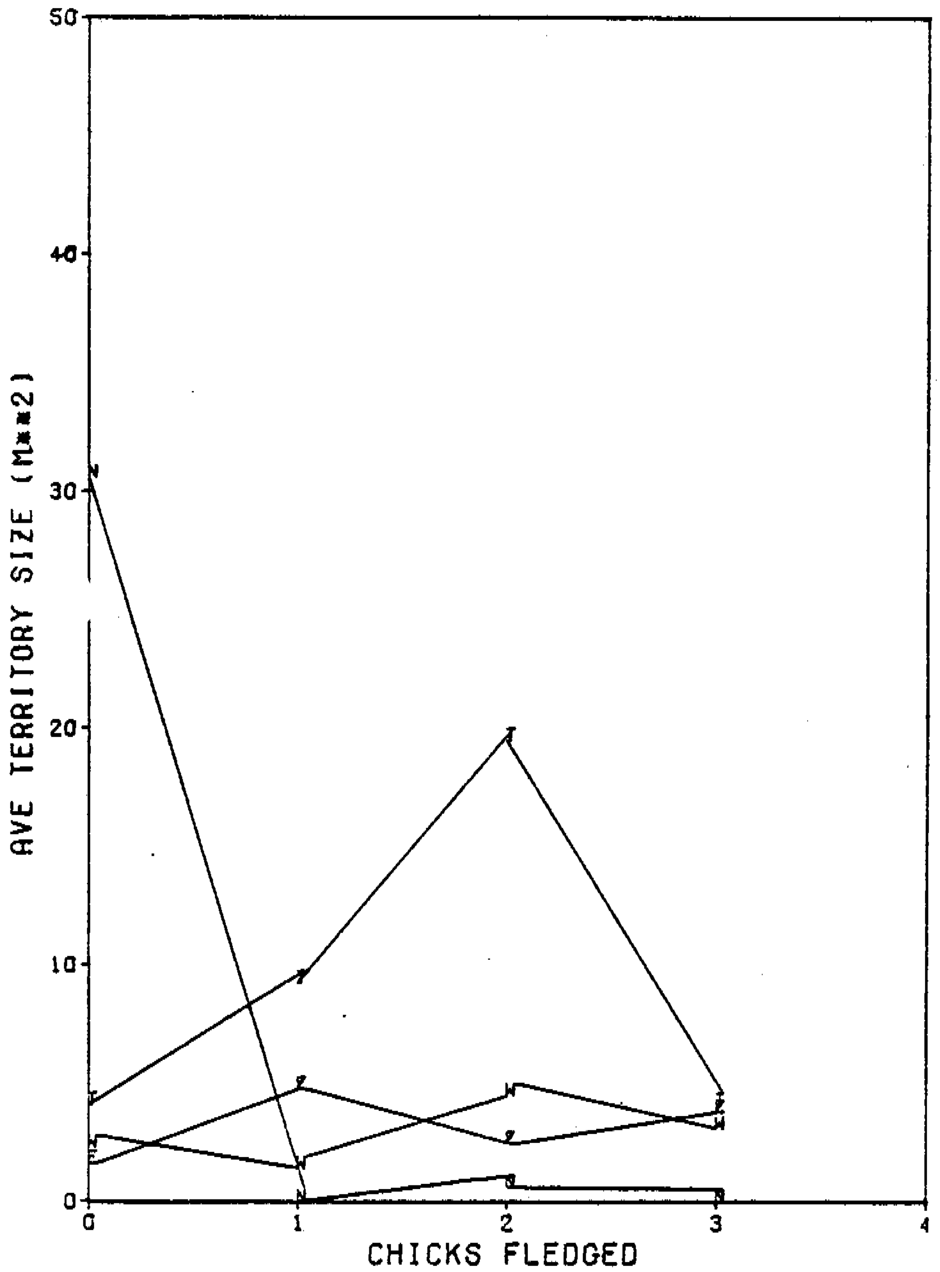


Figure 25. Chicks fledging plotted against average territory size, North Marble, 1973. E = East Colony, W = West Colony, N = North Colony, T = Top Colony.

Productivity was much greater in the Top Colony in 1973, with smaller average territory size, compared to 1972. The North Colony exhibits the unusual trend here, probably due to disturbance.

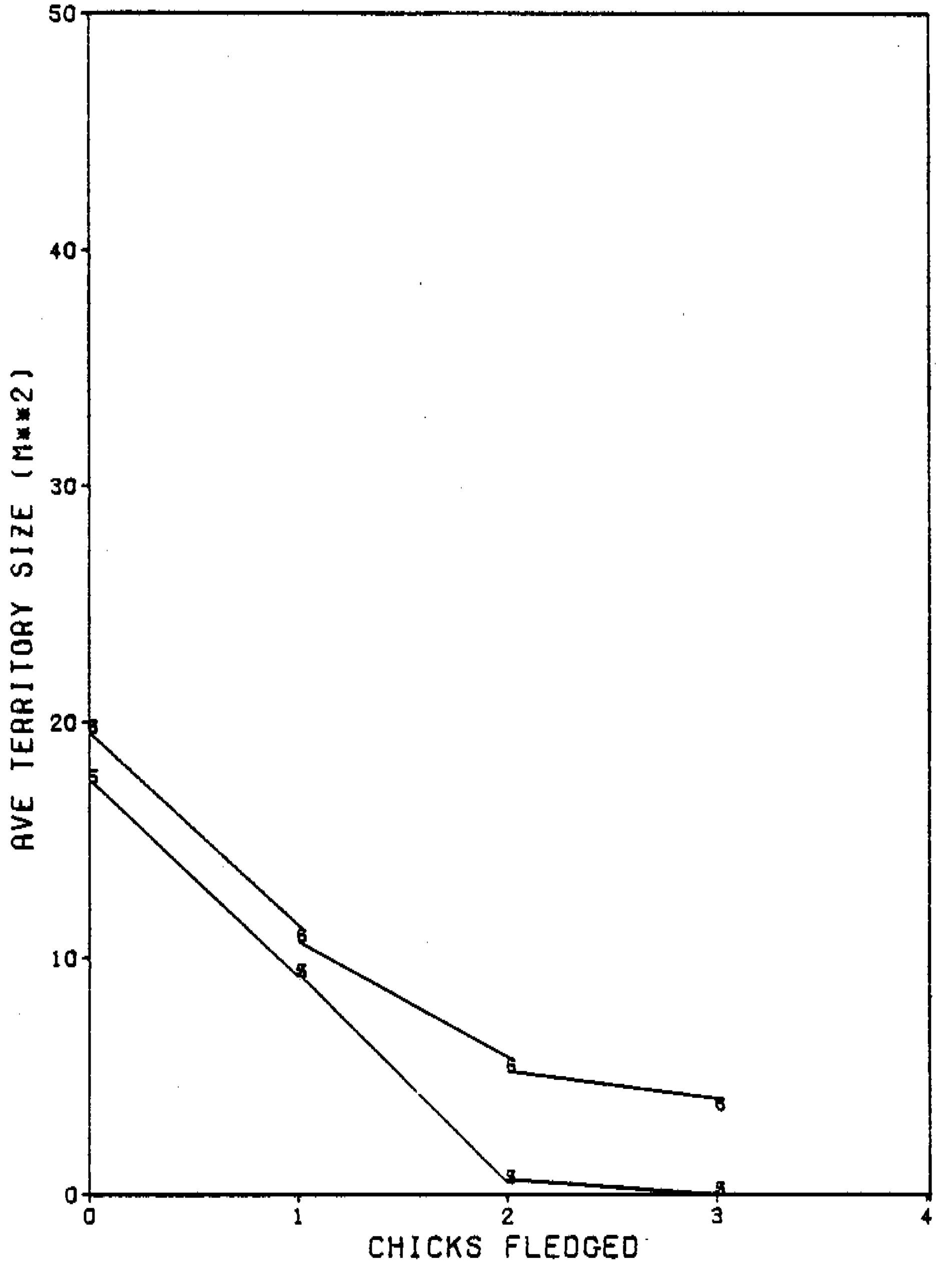
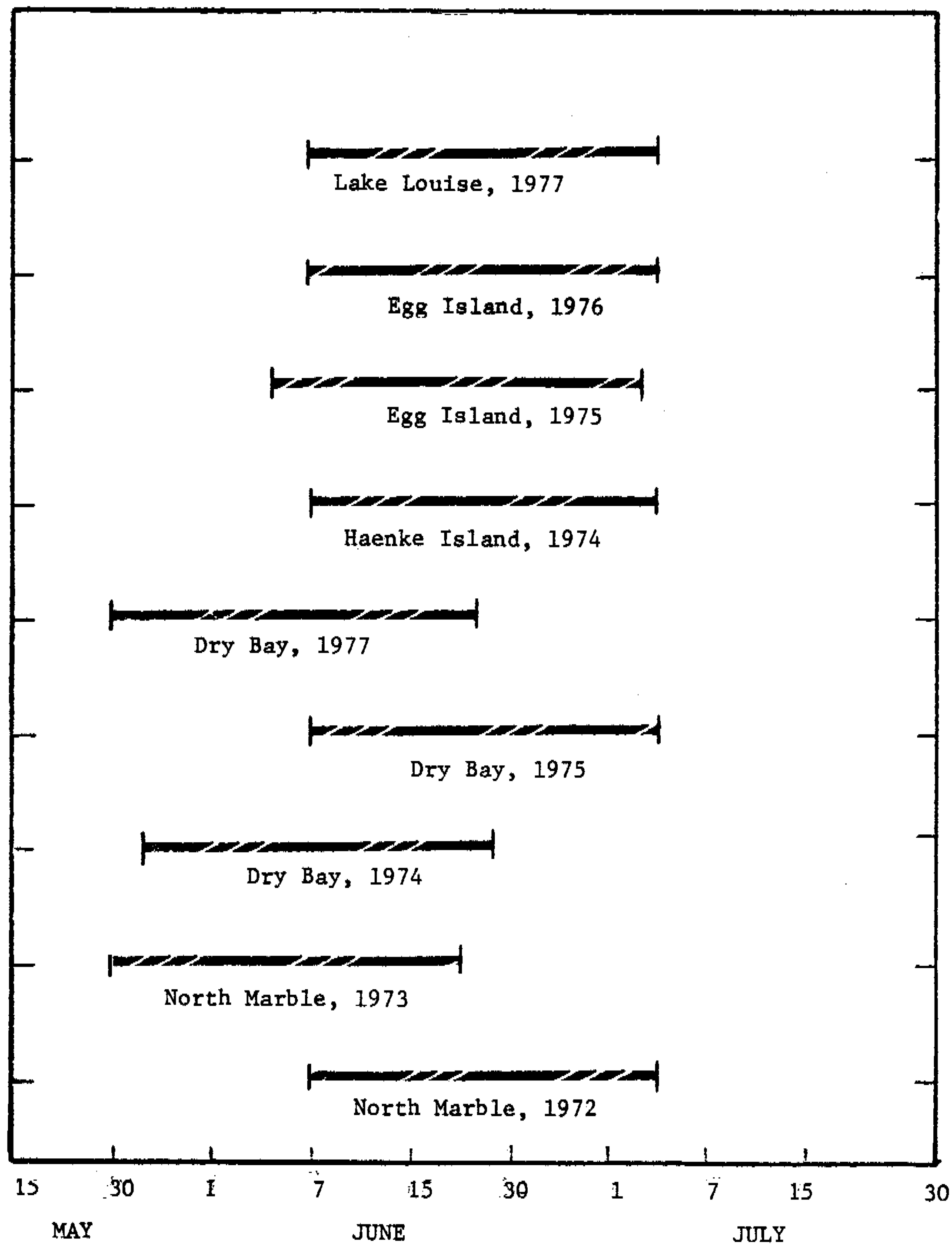


Figure 26. Chicks fledging plotted against average territory size, Egg Island, 1975 - 1976. 5 = 1975, 6 = 1976.

Territory size was slightly larger on the average in 1976, but productivity was also slightly better. However, both years the survey area shows a similar tendency, fledging mostly one chick per territory. Note larger territory size on Egg Island compared to North Marble (Figures 24, 25).

MEDIAN INCUBATION PERIODS BY COLONY



Quarterly Report

Research Unit Number 423

Task Number - N/A

Reporting Period Oct.-Dec. 1977

Influence of Petroleum on Egg Formation and Embryonic Development in Seabirds

by

[1]C. R. Grau

[2]David Ainley

[2]Steve Morrell

[1]Tom Roudybush

1. Department of Avian Science
   University of California, Davis
   Davis, CA 95616

2. Point Reyes Bird Observatory
   4990 State Route 1
   Stinson Beach, California 94970

January 1, 1978

Quarterly Report

I. Abstract on Highlights of Quarter's Accomplishments

Auklet burrows have been prepared for dosing auklets in the spring. A source of euphausiids has been secured. Application has been made for permits to continue field work. Progress has been made in spectrophotofluormetric and gas chromatographic analyses of yolks for petroleum hydrocarbons.

II. Task Objectives

1. To examine the effects of ingested petroleum on egg formation, on yolk composition, and developmental embryology of incubating eggs in Cassin's Auklet.

2. To examine the effects of ingested petroleum on hatching success of eggs incubated under natural field conditions, and on subsequent chick survival in Cassin's Auklets.

3. To compare bunker C fuel oil with Prudhoe Bay crude oil in the above two analyses.

III. Field or Laboratory Activities (PRBO)

A. Ship or Field Trip Schedule

1. Dates: October and November
2. Name of Vessel: Oceanic Society volunteer vessels
3. Aircraft: N/A
4. NOAA or Chartered: Volunteer

B. Scientific Party

1. Names: Steve Morrell, Ron LeValley
2. Affiliation: Point Reyes Bird Observatory
3. Role: Assemble and distribute auklet nest boxes. Prepare natural auklet burrows for access by investigators.

C. Methods

Field sampling or laboratory analysis. Nest boxes (270) were nailed together on Southeast Farallon Island. The assembled nest boxes were placed in the ground a few inches deep depending on the soil type. Natural burrows (130) were dug out to provide human access to the full length of the burrow. Human entrances were covered with pieces of pressboard or wood held in place with rocks.

D. Sample Locations/Ship or Aircraft Tracklines.

No samples were taken. All field work is being conducted on Southeast Farallon Island.

E. Data Collected or Analyzed

No data has yet been collected.

III. Field or Laboratory Activities (UCD)

A. Ship or Field Trip Schedule

None

B. Scientific Party

1. Names: C. R. Grau, T. Wootton, and T. Roudybush

2. Affiliation: UCD - Department of Avian Sciences

3. Role:

C. R. Grau - Principal Investigator

T. Wootton - Preparation of samples for hydrocarbon analysis by fluorescence spectroscopy and gas chromatography

T. Roudybush - Apply for permits, prepare reports, plan spring work, prefabricate nest boxes for assembly on Southeast Farallon Island. Secure supplies for spring work.

C. Methods

Laboratory Analysis

1) Samples of quail yolk were extracted with petroleum ether. The extract was cleaned by the addition of florisil and subsequent chromatography on the silica gel thin layer plates. The fluorescent spot near the solvent front was eluted with petroleum ether and injected into a gas chromatograph fitted with a capillary column.

2) Auklet nest boxes were prefabricated out of 3/8" AC plywood. All pieces were painted with primer and one coat of dark grey exterior paint.

3) Permits to continue field work have been applied for from:
California Department of Fish and Game
U.S. Fish and Wildlife Service and
San Francisco Bay National Wildlife Refuge Complex

D. Sample Locations/Ship or Aircraft

Tracklines - Does not apply

E. Data Collected or Analyzed

1. Number and Types of Samples/Observation

   One control yolk and one yolk from a quail fed bunker C oil.

2. Number and Types of Analyses

   Three gas chromatographic analyses of each sample

3. Miles of Trackline:

   N/A

IV. Results

Gas chromatographic analysis of control and oil eggs showed no peaks attributable to oil in the control egg, but several peaks which appear to be

C17-C28 n-alkanes in the oil eggs.

V. Preliminary Interpretation of Results

G.C. analyses of oil and control eggs shows that some petroleum hydrocarbons are incorporated in quail yolks after quail are fed a single dose of 200 mg bunker C oil.

VI. Auxiliary Materials

A. Bibliography of References

None

B. Papers in Preparation or in Print

Presence of Fluorescence Substances in Eggs of Birds. Grau, Wootton, and Roudybush.

C. Oral Presentations

None

VII. Problems Encountered/Recommended Changes

Yolks are high in materials which foul injectors of gas chromatographs. Frequent changing or cleaning of injectors or more complete clean up of injected material may be required to reduce injector fouling.

VIII. Estimate of Funds Expended

As of 31 December the following amounts have been expended:

Salaries		$22,065
Travel		2,382
Commodities and supplies		3,568
Equipment		48
	Total expenditures	$28,063
	Overhead	11,064
		$39,127

NOAA/BLM

QUARTERLY REPORT ON
OCSEAP PROGRAM

RU #454

BIOAVAILABILITY OF HYDROCARBONS AND HEAVY METALS TO MARINE DETRITIVORES FROM OIL-IMPACTED SEDIMENTS

BY

J. W. Anderson, J. Augenfeld
and E. A. Crecelius

BATTELLE
Pacific-Northwest Laboratories
Ecosystems Department
Marine Research Laboratory
Route 5, Box 1000
Sequim, Washington 98382

NOAA/BLM

QUARTERLY REPORT ON
OCSEAP PROGRAM

BIOAVAILABILITY OF HYDROCARBONS AND HEAVY METALS TO MARINE DETRITIVORES FROM OIL-IMPACTED SEDIMENTS (RU.454)

For purposes of tracking our research progress, you may wish to refer to the amended Milestones Chart. Task 1 on this chart concerns the long-term 60-day exposure of organisms to radio-labeled metals in oiled sediment. Before conducting this long exposure, we have initiated a one-week exposure of *Macoma* to radio-labeled natural detritus, with and without a coating of oil. This experiment consisted of four groups of clams in two small aquaria. Both aquaria contained a thin layer of detritus on the bottom, but only one contained detritus coated with Prudhoe Bay crude oil. Suspended near the surface of the water in each aquarium was a smaller group of clams which only had access to radio-labeled metals that were dissolved in the water, or on very fine suspended particles. At various intervals over the one-week exposure, clams in each group were counted collectively for gamma radiation. Initial and final detritus counts were made, and water was also counted at time intervals. We are presently analyzing the data generated at Sequim, and final samples of detritus and clams were sent to Richland, Washington for more detailed analyses of isotopic content. When these results have been examined, a full-scale experiment will be conducted over a longer time interval to evaluate the transport of heavy metals from sediment to detritivores.

Task 2 on the chart relates to the uptake of C^{14}-benzo(a)pyrene from sediment by *Macoma*, and Tasks 6 and 7 regard other polynuclear aromatics. Since a major consideration in these studies is the separation of parent compounds from their metabolites by high-pressure liquid chromatography (HPLC), initiation of exposures have been delayed somewhat until the analytical techniques have been thoroughly tested for sensitivity and accuracy. The use of daylight low tides, which begin in March, will also facilitate collection of large quantities of organisms.

Task 3 on the chart concerns the long-term exposure of 3 species (*Macoma, Protothaca,* and *Phascolosoma*) to oiled sediment in the field. This experiment was initiated in early January and will be terminated in early March. Tasks 4 and 5 relate to the analyses of *Macoma* from this experiment for "condition index" content of free pool amino acids, and content of petroleum hydrocarbons. Fortunately, an experiment conducted late in FY1977, answered several of the questions regarding this investigation. The results have been presented by Roesijadi (Roesijadi and Anderson, 1978) at a symposium on "Pollution and Physiological Effects of Marine Organisms," held in Georgetown, South Carolina, November 14-17, 1977. Enclosed you will find a copy of this paper, which will appear in the symposium proceedings, published by Academic Press. Since the differences observed for *Macoma* were statistically significant, there is little need to duplicate these studies on hydrocarbon uptake, condition index and free amino acid content of *Macoma*. However, the field experiment recently initiated is planned to provide information on the application of these techniques to determine uptake and effects of oil on *Protothaca* and *Phascolosoma*. Hydrocarbon content and free amino acid content will be measured on both species, and the condition index of *Protothaca* will be determined.

Finally, we have designed and implemented some investigations on still another species to broaden our view of bioavailability to detritivores. Preliminary experiments have been carried out on *Abarenicola pacifica*, a polychaete which presents several advantages for the assessment of bioavailability of PHC or other pollutants from muddy sediment. *A. pacifica* occupies an L-shaped burrow constructed in mud. The anterior 2/3 of the animal normally lies in the deep horizontal portion of the burrow (the gallery or head shaft), ca. 10 cm. below the surface, while the posterior 1/3 lies in the vertical tail shaft. Undulating movements of the body, especially the tail, bring in currents of water for respiration and, to some extent, for feeding. Micro and meio-organisms suspended in the respiratory current are filtered on the walls of the end of the head shaft and are ingested together with the surrounding sediment. The resulting excavation, as well as the hydraulic abrasion of the respiratory current, cause a subsidence of the sediment lying over the animal's anterior end. Thus, material lying on the surface of the sediment can, over a period of several days, be drawn down to the level of the head shaft and be ingested. At intervals, the posterior end of the animal is raised to the upper end of the tail shaft, and feces are deposited around the opening in a characteristic pattern.

As a result of this mode of life, materials adsorbed onto sediments may be presented to *A. pacifica* via several routes. Materials that remain attached to sediment may be ingested directly. Materials that are given off into the water column may be taken up through the respiratory current or be incorporated into suspended food organisms which will then be eaten. Furthermore, sediment at all levels above the head shaft is subject to ingestion. Since the fecal material from individual worms can be easily collected, it is possible to analyze changes in pollutant material resulting from passage through the digestive tract.

One experiment with this animal has been designed to learn whether they might respond to PHC-contaminated sediment simply by avoiding it. For this purpose, four plastic boxes with Nitex mesh bottoms were divided into two compartments by a teflon sheet. Clean sediment from the worms' habitat was placed in one half of each tray. The other half was filled with sediment into which 1,000 parts per million (PPM) of Prudhoe Bay crude oil had been stirred with a motor driven impeller. The teflon sheets were removed, one worm was introduced into each box at the dividing line between clean and oiled sediment, and the boxes were placed in tanks with flowing sea water.

The location of the worms after feeding could be determined by the location of the fecal casts surrounding the tail shafts. Two of the four worms moved into the oiled mud and two into clean mud. One worm later moved from the oiled to the clean mud, and one moved in the opposite direction. It seems that no absolute preference for oiled or clean sediment exists, though more sophisticated experiments using larger numbers of animals might demonstrate that more time is spent in one substrate than the other, or that other behavioral effects may be produced by oil.

Uptake and release of components of PBC from contaminated sediments have been studied in experiments carried out under four conditions. Sediments taken from the animals' habitats were mixed with PBC at levels of 100 and 1000 ppm. The oil-mud mixture was placed in mesh-bottomed trays in running sea water for four hours and flushed twice by changes in water level. Three worms were placed in each of several mesh-bottomed boxes containing either a high or a low level of contaminating oil. At each oil concentration, half the boxes were completely filled with oiled mud, and half contained a layer of non-oiled sediment overlain by several centimeters of oiled sediment. The boxes were kept in clean running sea water.

At intervals of several days, a box was removed and the worms it contained were washed free of surface contamination with a stream of distilled water. The intestinal tract of each animal was removed, slit opened and freed of its contents by flushing with distilled water. The cleaned guts, body wall, and part of the coelomic fluid of each animal was frozen together at -80°C in teflon-lined, hexane washed, centrifuge tubes and saved for later analysis. Worms exposed to high level-contaminated, layered mud for seven days were moved to clean sediment for depuration, and tissue samples were taken at intervals. Frozen tissue samples were thawed and analyzed for naphthalene, methylnaphthalenes, and dimethylnaphthalenes by UV spectrophotometry. Samples of sediment and fecal casts were taken for IR analysis of total hydrocarbons.

Analyses have been completed for tissue and sediment samples from the low and high-level exposures in layered sediment and from low-level exposure to total contaminated sediment. Among these sets, naphthalenes accumulated most rapidly in tissues of *Abarenicola* placed in high level layered sediment, reaching levels of up to 3 ppm within 4 days. These levels appear to reach a plateau within a week. Upon relocation in clean sediment, depuration takes place rapidly, leading to a 90% decrease in naphthalene content within 8 days. The tissue levels of naphthalenes were of the same order of magnitude as those calculated to occur in the upper, contaminated layers of sediment, based on IR spectrophotometric analysis of total hydrocarbons and published analysis of the naphthalene content of PBC. Since the preliminary flushing of the oiled sediment undoubtedly removed an unknown proportion of the naphthalenes, it is not possible to say whether a tissue magnification effect exists. The naphthalene content of worms exposed to lower levels of oil in a layered system reached a plateau over the same time scale, but at about 1/6 the level, roughly corresponding to the differences in original concentration of oil. Worms exposed to low levels of oil in boxes containing only contaminated mud had ca. twice as much naphthalenes as corresponding animals in layered boxes.

The most significant facts developed from this work so far are that *A. pacifica* can survive extended periods in heavily oil-contaminated sediment, and that it takes up at least some components of the oil from its environment. The fact that the tissue content of the components seems to reach a rough equilibrium with that of the environment suggests that some mechanism for removing these components exists.

Another problem now under investigation is the question of the rate of release of aromatic hydrocarbons from a sediment-bound state into solution in the interstitial water and, eventually, to the water column. Roesijadi and Anderson have found indirect evidence for such release from sandy sediments. An experiment has been initiated in which radio-labeled aromatic compounds, dissolved in oil, are dispersed in a quantity of muddy sediment which is then subjected to simulated tidal water movements. Samples of sediment and interstitial water are to be removed at intervals and their radioactivity measured. It is hoped that the rate of exchange of components of oil between the particle-bound and dissolved states will be related to the chemical characteristics of the components and the physical/chemical nature of the sediments.

QUARTERLY PROGRESS REPORT

BEAUFORT SEA BARRIER ISLAND-LAGOON ECOLOGICAL PROCESS STUDIES

Contract No. 03-6-022-35193

Research Unit No. 467

Reporting Period: 1 October 1977 - 31 December 1977

Number of Pages: 7

Project Director: Joe C. Truett
LGL Limited-U.S., Inc.
103-A Pleasant Street
Bryan, Texas 77801

PI, Aquatic Biology: Peter C. Craig
LGL Limited
53 Howard Avenue
Nanaimo, British Columbia V9R 3P9

PI, Ornithology: Stephen R. Johnson
LGL Limited
10110-124 Street
Edmonton, Alberta T5N 1P6

31 December 1977

BEAUFORT SEA BARRIER ISLAND-LAGOON

ECOLOGICAL PROCESS STUDIES

I. Highlights

This quarter's work involved laboratory analyses of otoliths to determine ages of fish in Simpson Lagoon, and analyses of invertebrates, and fish and bird stomach samples to determine food sources of these organisms. Spatial and temporal distribution and abundance of zoobenthos, fish, and birds were evaluated by synthesizing last quarter's field data.

Several preliminary results of interest are listed below.

- The primary energy source for the nearshore system is apparently carbon from terrestrial origins: Input from tundra erosion, and river detritus. Epibenthic invertebrates, primarily amphipods, mysids, and isopods, are major detrital consumers.

- Amphipods and mysids compose the preponderance of epibenthic fauna, and appear to be producing energy in excess of their consumers' requirements.

- Five species of fish account for over 90% of total fish in the nearshore environment: Arctic Cisco, Least Cisco, Char, Four-horned Sculpin, and Arctic Cod. These fish use the lagoon system for maturation, migration, and/or spawning; however, fish populations are probably limited by factors operative elsewhere, e.g., overwintering sites of anadromous fish.

- Important bird species use the lagoon primarily for feeding and/or moulting during the open-water season. These include Oldsquaws, Red and Northern Phalaropes, and Glaucous Gulls.

II. Task Objectives

This program's general objective is to design and carry out a series of integrated ecological process studies in a barrier island-lagoon ecosystem on Alaska's Beaufort Sea coast. The studies are designed for the following purposes:

- Identify and analyze the importance of selected ecosystem components and processes contributing importantly to the structure and productivity of nearshore ecosystems.

- Evaluate the feasibility of detecting and quantifying temporal change in those ecosystem components and processes identified as important.

- Identify mechanisms by which those components and processes could be tested for their sensitivity to man-caused change and, therefore, for their utility in predicting and analyzing impacts of OCS petroleum development.

This program is being implemented in conjunction with research efforts and data products of OCS Research Units No. 526, 529, 530, and 531, in oceanography, geomorphology, and sedimentology. It is the responsibility of LGL Limited to conduct studies in aquatic ecology and ornithology, to administer program data management, and to glean and synthesize information from all related research efforts to make a final assessment of petroleum development impact on the nearshore ecological processes of the Beaufort Sea.

Ecosystem modelling during the course of the program functions to create a common base for communication among PI's, program managers, and NOAA and BLM coordinators. Each stage of computer simulation of the geophysical and biological processes in the barrier island-lagoon system represents the current level of understanding. In successive interdisciplinary workshops investigators critically examine each research effort in light of data gaps revealed through in-depth workshop discussions and through evaluations of key processes represented by the model.

III. Activities

A. Field Work, Laboratory Analysis, Modelling Workshop

Aquatic biology and ornithology field teams left the Pingok Island base camp on 25 September 1977. At that time lagoon waters were beginning to freeze and sampling activities by boat became impractical.

Laboratory analyses of invertebrate, fish, and bird samples collected last quarter have been made. Other data collected in the field have been partially analyzed and writing of the Annual Report has commenced.

The most recent modelling and integration workshop, held at the University of British Columbia on 6-8 December 1977, was the first opportunity investigators had to test the model developed in earlier workshops against real field data.

B. Scientific Party

The scientists involved in this program, their roles, and their affiliations are listed below.

Name	Affiliation	Project Role
Alan Birdsall	LGL Limited*	General Management
Joe Truett	LGL Limited**	Project Director
Tom Wetmore	LGL Limited*	Data Management
Peter Craig	LGL Limited***	PI, Aquatic Ecology (fish)
William Griffiths	LGL Limited*	Aquatic Ecology (invertebrates)

Name	Affiliation	Project Role
Stephen Johnson	LGL Limited*	PI, Ornithology
Gary Searing	LGL Limited*	Ornithology
John Richardson	LGL Limited ****	Ornithology (bird migration)
Robert Dillinger	LGL Limited*	Laboratory Analysis

---

* 10110-124 Street, Edmonton, Alberta T5N 1P6
** 103-A Pleasant Street, Bryan, Texas 77801
*** 53 Howard Avenue Nanaimo, British Columbia V9R 3P9
**** 44 Eglinton Avenue West, Toronto, Ontario M4R 1A1

C. Methods

The data analysts employed standard statistical tests when necessary, and computerization of many kinds of research data has been routine.

Laboratory analyses have concentrated on the following determinations:

- Age of key fish species sampled
- Composition of epibenthic and water column invertebrate samples
- Composition of contents of fish and bird stomachs (largely invertebrates)

Most invertebrate analyses have been preliminary. Detailed taxonomic determinations have not yet been made. Laboratory procedures are described below.

1. Fish were aged by examination of otoliths.
2. Epibenthic and Otter trawl samples, fish stomachs, and bird stomachs were individually sieved (mesh size 79 μm), rinsed with water, sorted to major taxa using a binocular dissecting microscope, and counted.
3. Formalin (10%) wet weights for the major taxa of all individual invertebrate samples were obtained by transferring samples to filter paper to remove excess moisture and weighing them to the nearest 0.01 gram on a Mettler PL300 electronic balance.
4. Total zooplankton biomass for each station during each time period was determined using the method described above.
5. All invertebrate samples were stored in 10% formalin and set aside for more detailed analysis at a later date.

Refinement of the existing systems model was made during the course of the workshop, 6-8 December 1978.

D. Sample Localities (not applicable)

E. Data Analyzed

Biological Samples: As of 1 October, the following samples have been roughly sorted into major taxonomic groups and wet weighed.

300 fish stomachs
200 bird stomachs
28 Otter trawl samples
28 Faber trawl samples
90 zooplankton samples (biomass only)
7 sets of epibenthic trawl samples

At present the most important major taxa (amphipods and mysids) from the above samples are being speciated and biomass determinations are being made.

In addition to invertebrate analyses, fish otoliths have been read to establish age structures of key species.

Other Data: Abundance and distribution, by habitat and time period, of fish, invertebrates and birds have been calculated.

Pertinent life-history information for key vertebrate and invertebrate species has been gathered from literature and field data.

Energy requirements of major consumers in relation to food availability have been estimated.

IV. Results

Invertebrates: Initial results indicate that amphipods and mysids are the most important groups that comprise the epibenthic fauna. They are also the major food items in the diets of Oldsquaw ducks, Arctic Char, Arctic Cisco, Least Cisco, Arctic Cod, and Four-horned Sculpin.

Fish: The number of fish species (13) using Simpson Lagoon during the open-water season is low. Five species account for over 90% of all fish present: Three anadromous species (Arctic Cisco, Least Cisco, Char), and two marine species (Four-horned Sculpin and Arctic Cod). Principal uses of nearshore habitats are maturation and migration of anadromous fish; and spawning, maturation, and migration of marine fish. Important nearshore habitats are those areas bordering mainlands and barrier islands (promoting "edge effect").

Birds: Spring bird migrant use of the lagoon system was relatively insignificant. Spring migration was similar in the Simpson Lagoon area to that along other coastal areas of the Beaufort Sea, and is probably highly traditional with low annual variability.

Large numbers of Oldsquaw (up to 100,000) used the lagoon for moulting. Moulting and staging Oldsquaws used the lagoon heavily for feeding. Migrating Red and Northern Phalaropes concentrated primarily along island coasts during August to feed. Glaucous Gulls were abundant in feeding concentrations from late August through early September, and again in late September. Feeding dependencies of birds as determined by stomach analysis were as follows:

- Oldsquaws ate primarily mysids and amphipods.
- Phalaropes (Red and Northern) ate primarily copepods.
- Glaucous Gulls ate isopods, amphipods, and mysids.
- Oldsquaws were overwhelmingly the primary energy consumer in the system, and fed mostly away from the shoreline in deep (2-3 m) lagoon waters.

Modelling Workshop: Revision of the systems model during the course of the workshop provided the following evidence.

- Terrestrial carbon sources probably provide the principal energy source to nearshore systems; therefore, it may not be worthwhile to spend time and money evaluating primary production and inorganic nutrient transfer within the lagoon.

- Revised estimates of detritus input resulted in model prediction of benthos standing crops of the same order of magnitude as observed in the field.

- As predicted in earlier workshops, birds and fish appear to use only a small fraction of the zoobenthic production.

V. Preliminary Interpretation of Results

The numbers and biomass (computed as cal/m^2) of epibenthic invertebrates appears to be more than adequate to support the estimated numbers of birds and fish present, and therefore food does not appear to limit fish and bird populations.

Of several factors examined which might potentially influence the numbers and distribution of fish (parasites, predators and food and habitat availability), none was considered limiting in nearshore environments.

We think that the availability of overwintering sites in fresh water (away from the coastal environment) is probably the single most important factor determining the number of anadromous fish in the Alaskan Arctic.

Whether bird populations are limited by factors operative on the Beaufort Sea coast or by factors in other environments (wintering and flyway habitats) is uncertain. Further analysis and evaluation of the known life histories of key species may help to answer this question.

VI. Auxiliary Material (none submitted)

VII. Problems Encountered/Recommended Changes

Recommended changes in research priorities for FY 1978 are currently under evaluation.

VII. Estimate of Funds Expended

Approximately 75% of project funds have been expended.

☆U. S. GOVERNMENT PRINTING OFFICE 1978-777-067/1242 Reg. 8