for Kodiak

Environmental Assessment of the Alaskan Continental Shelf

Quarterly Reports of Principal Investigators
April - June 1978

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

U.S. DEPARTMENT OF INTERIOR
Bureau of Land Management

Environmental Assessment of the Alaskan Continental Shelf

Quarterly Reports of Principal Investigators for April - June 1978

Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado

September 1978

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

U.S. DEPARTMENT OF INTERIOR
Bureau of Land Management

CONTENTS

RU#	Scientific Discipline
3	Receptors - Birds
5	Receptors - Benthos
6	Receptors - Benthos
29	Receptors - Microbiology
59	Transport - Physical Oceanography
67	Receptors - Mammals
68	Receptors - Mammals
69	Receptors - Mammals
71	Effects - Laboratory
72	Effects - Laboratory
73	Effects - Laboratory
77	Effects - Ecosystems
78	Receptors - Intertidal
83	Receptors - Birds
87	Transport - Ice
88	Transport - Ice
91	Transport - Physical Oceanography
96	Effects - Laboratory
98	Hazards - Ice
105	Hazards - Permafrost
138	Transport - Physical Oceanography
152	Contaminant Baselines - Chemistry
162	Contaminant Baselines - Chemistry
172	Receptors - Birds
190	Receptors - Microbiology
194	Receptors - Mammals
196	Receptors - Birds
204	Hazards - Permafrost
205	Hazards - Ice
206	Hazards - Geology
208	Hazards - Strong Storms
229	Receptors - Mammals
230	Receptors - Mammals
232	Receptors - Mammals
237	Receptors - Birds
244	Transport - Ice
248	Receptors - Mammals
250	Transport - Ice
251	Hazards - Geology
253	Hazards - Permafrost
257	Transport - Ice
265	Transport - Ice
267	Transport - Ice
271	Hazards - Permafrost
275	Contaminant Baselines - Chemistry
289	Transport - Physical Oceanography
290	Hazards - Geology
332	Receptors - Microbiology
337	Receptors - Birds
341	Receptors - Birds
356	Receptors - Intertidal
359	Receptors - Plankton
362	Synthesis - Data
367	Transport - Physical Oceanography

RU#	Scientific Discipline
423	Effects - Laboratory
424	Receptors - Plankton
427	Receptors - Microbiology
430	Hazards - Geology
435	Transport - Physical Oceanography
441	Receptors - Birds
454	Effects - Laboratory
460	Effects - Ecosystems
467	Effects - Ecosystems
473	Hazards - Permafrost
480	Contaminant Baselines - Chemistry
483	Hazards - Geology
497	Synthesis - Data
500	Contaminant Baselines - Chemistry
512	Receptors - Fish
516	Hazards - Permafrost
519	Transport - Physical Oceanography
526	Transport - Physical Oceanography
527	Synthesis - Data
529	Transport - Coastal Morphology
530	Transport - Coastal Morphology
531	Transport - Physical Oceanography
537	Receptors - Microbiology
549	Transport - Physical Oceanography
551	Receptors - Fish
552	Receptors - Fish
553	Receptors - Fish
562	Transport - Ice
567	Transport - Ice
568	Transport - Ice

QUARTERLY REPORT

Contract #03-5-022-69

Research Unit #3

Reporting Period April 1, 1978

May 31, 1978

Pages 5

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

Paul D. Arneson

Alaska Department of Fish & Game

May 31, 1978

I. Task Objectives for 3rd Quarter, FY 1978

A. To determine the use of Kamishak Bay by birds during spring migration emphasizing use by Dunlin and Cackling Canada Geese.

II. Field Activities

A. Field Trip Schedule: On April 28, May 1, May 4 and May 11 aerial surveys were conducted in Kamishak Bay using a single-engine Otter owned by Kachemak Air Service, Homer, Alaska. Ground counts were made from April 23 to May 3 in Kachemak Bay and from May 4 to May 10 in McNeil Cove, Kamishak Bay.

B. Scientific Party: Observers for the surveys were Paul Arneson and Richard Johnston, Alaska Department of Fish and Game, Anchorage, Alaska.

C. Methods: Shoreline survey techniques used for counting birds during this report period are similar to those described in previous reports. The only variation was that extensive intertidal and supertidal areas were searched more frequently than other portions of the coastline because shorebirds and geese were the prime species under investigation.

Ground counts consisted primarily of Type III Sea Watches where all birds within a given area and time frame were enumerated. Beached bird surveys were conducted in the McNeil Cove area.

D. Sample Localities: See Figure 1.

E. Data Collected: The approximate distances surveyed during the four spring flights were as follows: April 28 - 160 Km, May 1 - 335 Km, May 4 - 260 Km, May 11 - 300 Km. The number of computer records for each of the four surveys were 143, 370, 418 and 497 respectively.

III. Results and Preliminary Interpretation

Original bird survey dates were planned to coincide with the peaks of waterfowl and shorebirds migration as determined from past records at Copper River Delta and Kachemak Bay. Storms prevented the surveys from being conducted during two of the planned time periods.

A cursory transcription of the survey data has been completed but no analysis is possible at this time. Only general observations can be given in this report.

Few Canada Geese were observed on any of the surveys. Small flocks were noted at the mouth of the Douglas River, McNeil Cove, Amakdedori, Iniskin Bay, Chinitna Bay, and Johnson River Flats. Geese were present in Kamishak on all four surveys but not abundant on any one survey.

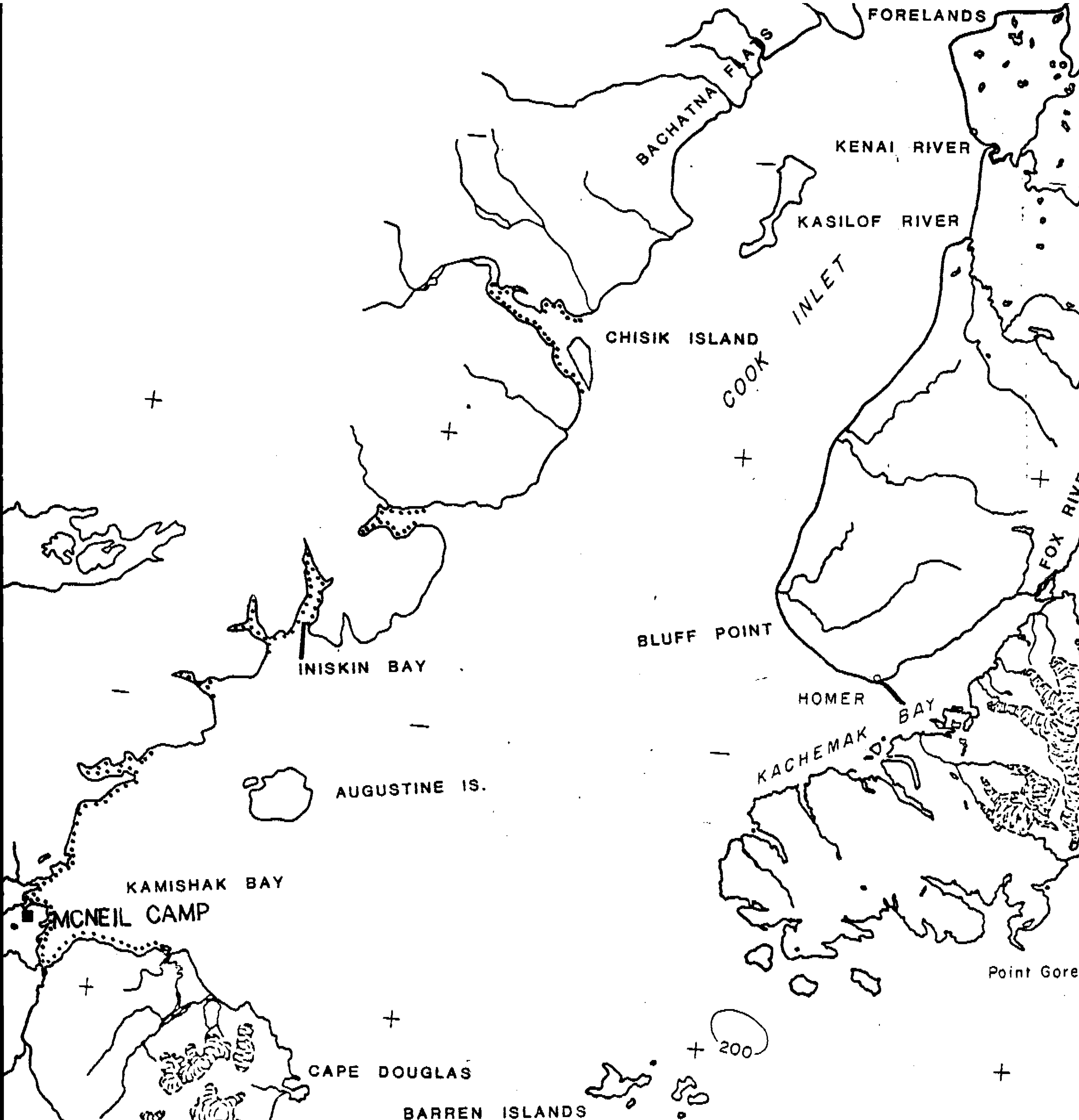


Figure 1. Approximate coverage of aerial bird surveys in Kamishak Bay during spring 1978 is represented by the dotted line. Ground observations were conducted at McNeil Camp and Homer.

On May 11 a flock of two large and 15 small Canada Geese were recorded in Chinitna Bay. This indicated that Cackling Canada Geese (*Branta canadensis minima*) were present on the study area. In talking with other observers on the Copper River Delta later in the month, the Cackler migration was just beginning on May 11 and lasted for several days after that. Migration may have been held up by the storm that was present in Lower Cook Inlet from 4 May to 10 May. Because we mistakenly left the field prior to Cackling Canada Goose migration, we were therefore unable to determine whether Kamishak Bay is used by large numbers of Cacklers for migration staging.

Shorebirds were most abundant on the 4 May survey when over 37,000 total shorebirds were recorded. The largest concentration was at the mouth of a small creek 11 Km northeast of the mouth of the Kamishak River where 12,000 medium and 500 small shorebirds were observed. Other concentration areas included Chinitna Bay (10,600), Iniskin Bay (8,500) Douglas River Flats (3,090), Bruin Bay (1,000) and Kamishak River Flats (850).

Unfortunately determining species of shorebirds from aircraft was difficult, and at times an accurate judgment as to whether they were small or medium shorebirds was impossible. Ground counts were planned for the McNeil Cove area to discern species composition of shorebird flocks. However, incessant inclement weather at McNeil precluded the completion of that objective. Strong northeast winds with rain made observation difficult and appeared to affect shorebird diel movements, but it was also noted that species composition of shorebirds did change slightly even during bad weather. We inferred from this that migration was not completely halted by the weather.

On 10 May when we departed McNeil Cove, weather had improved. During a survey on the following day, essentially no (less than 1,000) shorebirds were recorded for the entire Kamishak Bay area. The large number of birds recorded on May 4 had either migrated during the storm or had departed enmasse at the onset of good weather. It was learned on 15 May that a second influx of shorebirds had occurred on May 13-14 within Kachemak Bay (Erikson, pers. comm.). Western Sandpipers (*Calidris mauri*) comprised most of the second peak of shorebirds. At no time were Dunlin (*Calidris alpina*) identified as being abundant although, as mentioned earlier, identification from the air was difficult and perhaps many of the medium shorebirds were Dunlin.

Target species for the spring migration surveys had been Cackling Canada Geese and Dunlin because of the possibility that they relied heavily on intertidal habitats in western Lower Cook Inlet. Inclement weather and delayed migration precluded the complete achievement of the original objectives, but several other important observations were made. Most notable were concentrations of Greater Scaup (*Aythya marila*) that numbered from several hundred to several thousand in all major bays and coves of Kamishak on the 11 May survey. They were most frequently seen at the water's edge in the intertidal mudflat portions of the bays.

Scoters particularly Blacks (*Melanitta nigra*) congregated by the several thousands in two areas that were not documented in the 1976 surveys (cf. Erikson, 1977). One area was in the vicinity of intertidal bedrock between the mouth of the Douglas River and Akumwarvik Bay (Fig. 2). The other area was in the vicinity of Chenik Head where, on several of the surveys, seaducks, scaup and over a thousand gulls congregated.

Another unforeseen observation was the use of McNeil Lagoon and vicinity by Brant (*Branta bernicla nigricans*). As many as 550 were seen roosting and feeding in the lagoon during stormy weather. Several apparent attempts by Brant to migrate overland up the McNeil River Valley were observed. One attempt appeared successful when a flock of approximately 150 were not observed to return from an inland flight even though ceilings and visibility were low in the valley.

Dabbling ducks were most abundant during the 28 April survey and up to several hundred were found in all bays and lagoons. Pintails (*Anas acuta*) were the most abundant species but Mallards (*Anas platyrhynchus*) made up a larger percentage than expected. Percent of species composition is not yet available.

IV. Problems Encountered

The major problem was inclement weather delaying surveys and also likely delaying migration so that determination of the magnitude of use of western Lower Cook Inlet by Dunlin and Cackling Canada Geese was not possible.

V. Estimate of Funds Expended

Salaries	11,400
Per diem/travel	720
Contractural Services	3,000
Commodities	2,000
Equipment	150
TOTAL	17,270

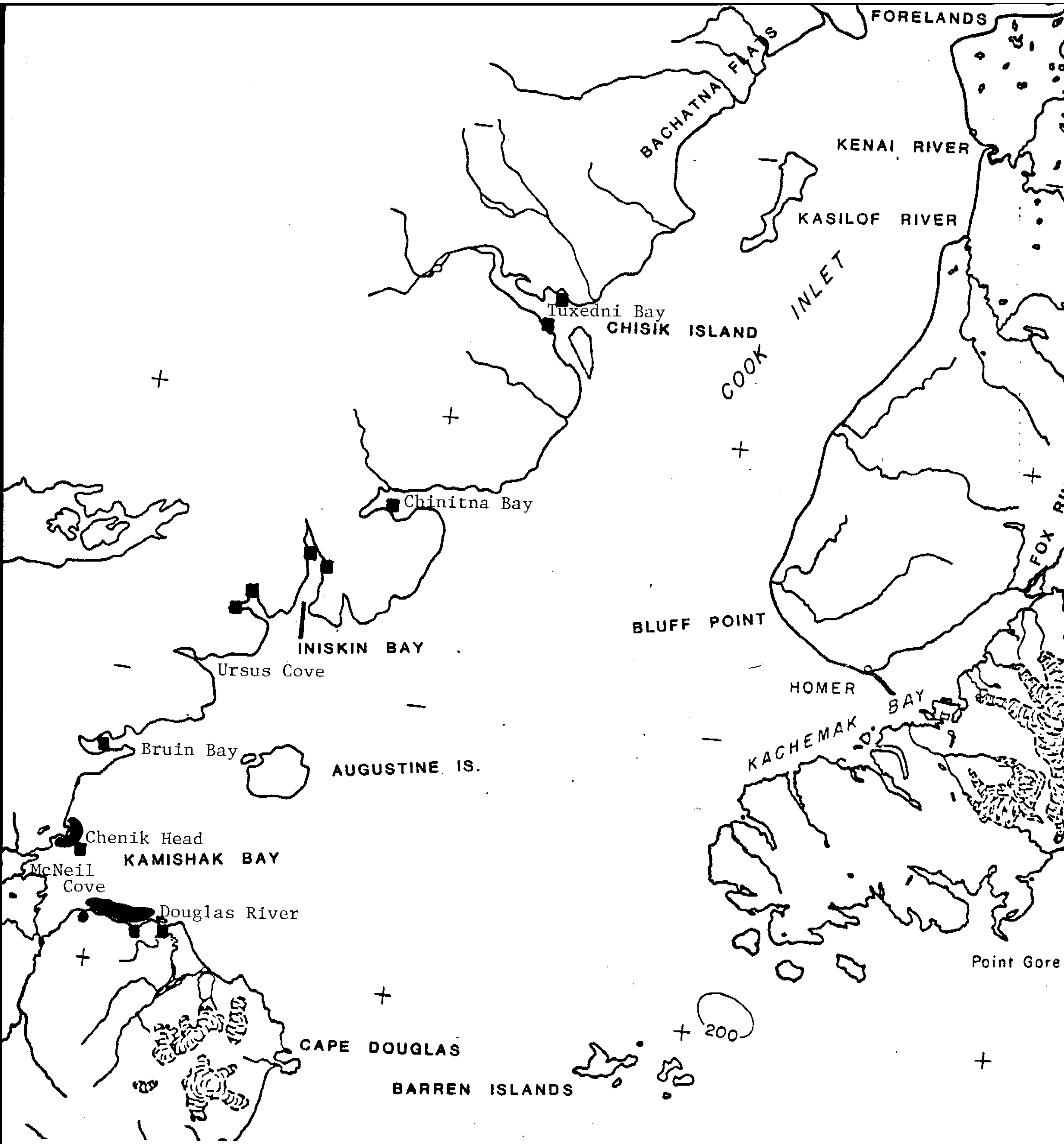


Figure 2. Concentration areas of scaup, scoters, and shorebirds during spring bird surveys, 1978.

■ Scaup — Scoters ● Largest shorebird concentration

QUARTERLY REPORT

Contract: #03-5-022-56
Task Order: #15
Research Unit: #5
Reporting Period: 4/11/78-6/30/78
Number of Pages: 13

DISTRIBUTION, ABUNDANCE, COMMUNITY STRUCTURE AND TROPHIC RELATIONSHIPS OF THE NEARSHORE BENTHOS OF THE KODIAK SHELF, COOK INLET, NORTHEAST GULF OF ALASKA, AND THE BERING SEA

Principal Investigator

Dr. Howard M. Feder

with

Max Hoberg, Stephen C. Jewett, John Rose
A. J. Paul, J. McDonald, P. Shoemaker

Institute of Marine Science
University of Alaska
Fairbanks, Alaska

June 1978

TABLE OF CONTENTS

KODIAK SHELF

I. TASK OBJECTIVES

A. Preliminary observations of biological interrelationships, specifically crab and shrimp trophic interrelationships, between selected segments of the benthic biota.

B. A qualitative and quantitative inventory of dominant epibenthic species within and near identified oil-lease sites.

C. A description of spatial distribution patterns of selected species within and near identified oil-lease sites.

II. FIELD AND LABORATORY ACTIVITIES

A. Trawl cruise March 21-24, 1978 via the NOAA Ship *Miller Freeman*.

1. Scientific party - Stephen C. Jewett and John Rose, IMS, responsible for collection of all invertebrate data.
2. Methods - samples were obtained via 400-mesh otter trawl at 30-minute durations per station. Stomachs of king and snow crabs were removed onboard ship.
3. Sample locality - Marmot Gulley off Kodiak Island.
4. Data collected - Twelve (12) trawls were examined for all invertebrates. Stomachs collected or examined: 95 snow crabs, 4 king crabs, 19 yellow Irish lords, 2 starry flounders, and 1 great sculpin.

B. Trawl cruise April 10-22, 1978 via the M/V *Yankee Clipper*.

1. Scientific party - Max Hoberg, IMS, responsible for collection of all invertebrate data.
2. Methods - samples were obtained via 20' try net at 10-minute durations per station. Stomachs of king crabs and snow crab were removed onboard ship.
3. Sample locality - Izhut and Kiliuda Bays of Kodiak Island.
4. Data collection - Thirteen (13) stations were sampled in Izhut Bay; 32 snow crab stomachs were collected; king crabs were absent. Only six stations were sampled in Kiliuda Bay; sixty-four (64) snow crab and 47 king crab stomachs were collected. Invertebrates were recorded from all stations.

C. Trawl cruise May 7-15, June 7-22, 1978 via the R/V *Commando* and the M/V *Yankee Clipper*.

   1. Scientific party - Stephen C. Jewett and John Rose, IMS, responsible for collection of all invertebrate data.

   2. Methods - samples were obtained via 400-mesh otter trawl on the R/V *Commando* and via 20' try-net on the M/V *Yankee Clipper*. Stomachs of snow and dungeness crabs, miscellaneous fishes and 1 sea star were collected or examined.

   3. Sample locality - Izhut Bay of Kodiak Island (R/V *Commando* and M/V *Yankee Clipper*). Near Island basin, McLinn Island, Kalsin Bay, and Womans Bay (SCUBA).

   4. Data collection - Three (3) stations were occupied by the R/V *Commando* and 15 stations were occupied by the M/V *Yankee Clipper*. Stomachs examined or collected included: snow crabs - 103; dungeness crabs - 17; Pacific cod - 18; *Myoxocephalus* spp. (sculpin) - 19; yellow Irish lord - 2; rock sole - 23; yellowfin sole - 4; *Pycnopodia helianthodes* (sea star) - 105; and approximately 2.5 kg of pink shrimps. Miscellaneous invertebrates were recorded at all stations.

III. RESULTS

1. Invertebrates taken by trawl have been verified and stomachs have been examined in the laboratory from the March 21-24 and April 10-22 cruises.
2. Data will be key punched in the near future.
3. The food of snow and king crabs taken by trawl appears to be dominated by polychaete worms, snails, and clams.

On May 4 and 5, exploratory diving via SCUBA was conducted near the city of Kodiak. Hundreds of king crabs were in the Near Island basin in the intertidal and shallow (< 9 m) subtidal regions. King crabs were feeding on barnacles (*Balanus rostratus*) attached to intertidal and shallow subtidal rocks. Many of these crabs were partially exposed by the receding tide during the feeding process. Other direct observations of king crabs included feeding on clams (*Protothaca staminea* and *Mya arenaria*), urchins (*Strongylocentrotus* sp.), sea stars (*Pycnopodia helianthodes* and unidentified species), polychaetes and algae. All crabs were of both sexes and had new shells. *Pycnopodia helianthodes* was observed feeding on *Clinocardium nuttallii*. Many small (length=10 mm) king crabs were located under rocks at the same depths (< 9 m).

A decision was made onboard ship by the IMS research assistant (Stephen Jewett) to not sample Kiliuda Bay in May. This decision was based on the minimal amount of invertebrate data collected by try-net on M/V *Yankee Clipper* for the amount of time spent in the field in May. Furthermore, the presence of large numbers of king crabs observed by SCUBA on May 4 and 5 in the shallow water in the Kodiak Harbor area indicated that time could be spent more effectively via diving activity. Also, it was considered advisable to investigate these crabs immediately during the short period of time they are resident in shallow waters.

On May 17, divers again examined the Near Island basin. The crabs were notably deeper (> 10 m). King crabs were observed feeding on *Clinocardium nuttallii*, *Pycnopodia helianthodes*, small *Mya arenaria* and barnacles attached to pieces of slate. *Pycnopodia* was feeding on *Mya* sp. Thirty-five (35) king crab digestive tracts were collected here.

On May 18, divers attempted to collect king crabs where they had been reported one week earlier, Kalsin and Womans Bay. Divers were unable to locate any crabs. The visibility was less than 1 meter in Womans Bay; extremely poor visibility often indicates that crabs are feeding (stirring up the bottom) nearby.

On May 19 five dives at different locations in Chiniak Bay were made. King crabs were found mainly inside of McLinn Island. Forty-nine digestive tracts were collected.

All king crabs collected by divers appeared to be full of food.

IV. PRELIMINARY INTERPRETATION OF RESULTS

OCSEAP studies were originally directed over the outer Alaskan continental shelf. Recently the thrust of research has been directed toward the nearshore environment where industrial development is expected make the greatest impact. Most of the stations sampled to date have been shallow (15-36 m). Recent diving activities have indicated that king crabs migrate into intertidal and subtidal regions not readily sampled by any other means than SCUBA. Subsequent conversations with herring fisherman and other long-time Kodiak residents attest to annual spring migrations of king crabs into shallow water in many parts of the island. The period of residence into this shallow depth zone appears to be as long as three months (April-June). Furthermore, many observations of king crab pods (average lengths of 61 to 84 mm) have been recorded at depths less than 18 m by Guy C. Powell of Alaska Department of

Fish and Game. In one pod, Powell estimated over 500,000 crabs were present. The vulnerability of this economically important crab while occupying the shallows cannot be overlooked.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES

The small try-net used to sample invertebrates, especially king and snow crabs, on the M/V *Yankee Clipper* appears to be inadequate. It is possible that the crabs were absent or in low numbers in the areas sampled. Nevertheless, catches of other invertebrates, as well as crabs, were nearly always small. It is difficult to say why sample numbers were low. Perhaps the gear is being towed at an improper speed or incorrect scope, or the net is not fishing properly. However, the trawl is picking up some small bottomfishes, therefore satisfying the objectives of ADF&G and FRI. At present, the objectives of our project are not being met by the gear currently in use.

A possible solution to the problem is to be able to sample 1 or 2 days per month in each bay (Izhut and Kiliuda) via the large trawl of the R/V *Commando*, in addition to the try-net sampling on the M/V *Yankee Clipper*.

Continued underwater SCUBA observations on feeding and other behavior of invertebrates and fishes is essential if objective A listed at the beginning of this report is to be fullfiled.

The Juneau Project Office has been informed of the continuing problems with this project, and they are presently seeking a solution. It is essential to emphasize that we are now in the summer field season and the inadequate logistics have interfered with the sample collections required by RU 5. It should be further pointed out that the change in sampling activity in the small bays (including a change in size of trawling gear) as compared to last year is not currently furnishing a long-range data base for these bays as had been anticipated by OCSEAP.

It has always been assumed, based on past cruises on the NOAA Ship *Miller Freeman*, that ship's equipment consisted of the large deck reel for the trawl, sorting baskets, sorting table, and scales. We discovered early in the field season that these items would be unavailable. The Juneau Project Office has been informed of this problem, and a solution for the Kodiak cruise (June-July) is anticipated.

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 completed.
3. Organization of data for a final report is in progress.

B. Trawl and Pipe Dredge Program

1. All trawl and pipe dredge material from the Bering Sea has been examined and data submitted for key punching.
2. Dominant clam species from Cook Inlet and the Bering Sea were examined for age and growth determinations. Data have been key punched and printed. Age-growth history tables were organized and have been drafted.

C. Microbiological/Detrital Studies

1. Initial experimental studies with sediment bacteria are continuing.

III. RESULTS

A. Grab Programs

1. Additional programs to further the analysis of NEGOA and the Bering Sea are now available.
2. The Final Report for NEGOA is in the final stages of organization.
3. The Final Report for the Bering Sea is in progress.

B. Trawl and Pipe Dredge Program

1. Trawl and pipe dredge data from the Bering Sea have been key punched and printed. Checking and analysis of this data is still in progress.

2. Clam species from the Bering Sea have been aged, measured, data recorded on computer forms, and subjected to analysis. Species examined were: *Spisula polynyma, Macoma calcarea, Tellina lutea, Nuculana fossa, Yoldia amygdalea.*

3. A report on the pinkneck clam, *Spisula polynyma*, funded primarily by the Alaska Sea Grant program but also based on activities partially funded by this project, has been published. It is available as basic data for the inshore areas adjacent to the Alaska Peninsula. The publication is H. M. Feder, A. J. Paul and J. M. Paul. 1978. The Pinkneck Clam *Spisula polynyma*, Growth, Mortality, Recruitment and Size at Maturity. Sea Grant Rep. No. 78-2. IMS Rep. No. R78-2. 26 pp.

4. The NEGOA Final Report is in the final stages of preparation.

5. The Bering Sea Final Report on trawl activities has been submitted to NOAA.

6. The Bering Sea grab and pipe dredge Final Report is 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 grab and pipe-dredge data, and food relationships will be included in the Final Report.

V. PROBLEMS ENCOUNTERED

No direct problems.

We have essentially no invertebrate food data from the northeast Gulf of Alaska, and Bering Sea food data is spotty. I would strongly suggest that further data on food habits of invertebrates and fishes in these regions be collected in the near future if oil-related activities are initiated in either area.

LOWER COOK INLET

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. Field Activities

Three cruises, 27 March to 2 April, 6 to 17 May, and 6 to 16 June have been completed. The following goals and activities were completed:

1. Distribution and abundance data were collected from several new areas and several established stations. A major nursery area for snow crab identified on previous cruises was reoccupied.
2. Spring feeding data for snow crab, king crab, hermit crab, pink shrimp, humpy shrimp, crangonid shrimp, and miscellaneous fishes were collected to complement existing winter data. Similar summer data will be collected.
3. Qualitative and quantitative benthic samples were collected from areas with major concentrations of snow crab. Prey abundance will be related to snow crab food preference.
4. Qualitative and quantitative benthic samples were collected in areas with major concentrations of clams.
5. Sediment samples were collected for Dr. Arnold Bouma of the Geologic Survey, Menlo Park, California.
6. Trawl surveys were conducted outward from Augustine Island to estimate distribution and abundance of volcanic pumice substrate now available for colonization by sessile invertebrates.

B. Laboratory Activities

Data on the following subjects have been collected:

1. Food consumption and digestion rates of live snow crab necessary to quantify predator prey relations are in progress.

2. Observations on mating behavior and reproductive biology of snow crab and king crab, critical to understanding population dynamics of these species, are in progress.

3. Prey densities and feeding responses in larval snow crab, king crab, and pink shrimp have been examined experimentally. These larval data will ultimately be used to determine the relationship of larval food densities to recruitment success.

4. Detailed stomach analysis of snow crab, king crab, hermit crabs, pink shrimp, humpy shrimp, and crangonid shrimp are underway.

5. Age, growth, mortality, and productivity estimations for selected species of clams are in progress.

6. Dry tissue weights are being determined for organisms from grab samples to determine the relative importance of the major groups of infauna to standing stock.

7. Techniques to study the sediment-detrital system at selected stations are currently being developed.

C. A new observational-experimental study concerning the feeding biology of the sand shrimp, *Crangon dalli*, in lower Cook Inlet has been initiated in the last quarter. In view of the apparent importance of this shrimp in lower Cook Inlet and elsewhere in the Gulf of Alaska, *C. dalli* is now being intensively examined as part of a graduate thesis. The study proposed is presented below.

Introduction

The 1977 and 1978 Annual Reports by Feder have indicated the importance of crangonid shrimps in the food web of Lower Cook Inlet. These shrimps are utilized by a number of invertebrates and fishes of biological and commercial importance. In addition, these shrimps are abundant and widely distributed. However, little is known of their feeding biology. To characterize the feeding relationships of these animals, research has been undertaken to further delineate their trophic status.

Work in Progress

Shipboard observations (NOAA Ship *Surveyor*, March 1978) of more than 100 *Crangon dalli* stomachs resulted in some dietary information. Sediment was frequently present in the gut contents, suggesting a relationship with the detrital system, or at least with deposit feeding species. However, few prey items were recognizeable under

30X magnification. Thus the following investigations were initiated in the laboratory:

(1) Detailed microscopic (compound) evaluation of gut contents of *Crangon dalli* collected on LCI cruises March and May 1978. Thus far, in general terms, identified prey include polychaetes (mostly deposit feeding) benthic foraminifera, small crustacea and amphipods.

(2) Caustic alkali (KOH) digestion of gut contents to determine fraction of sediment present. This work will characterize the extent of the so-called "sediment/detrital" feeding. This work is currently in progress and results are not yet available.

The above work when completed will indicate major prey items, as well as the extent of "sediment/detrital" feeding in crangonids. The probable relationship between these shrimps and the detrital system is of great ecological interest.

Work Planned

The following research is planned to expand on the above, and clarify further the feeding biology of *Crangon dalli*:

(1) A bacterial biomass assay of gut contents to determine the importance of carbon of bacterial origin in the energetics of these shrimps. Again, the role of bacteria in the detritus system, and hence potentially in these shrimps, is of great interest.

(2) Organic carbon and bacterial biomass determinations of sediment samples where *Crangon* are collected. This work will further typify the extent of "sediment/detrital" feeding.

(3) Carbon-14 radiotracer experiments. Laboratory experiments using an appropriate food source will be employed to measure carbon flux in these shrimps.

III. RESULTS

A. Laboratory and field programs are progressing. Data on most of the objectives of the project are now available for analysis (see Field and Laboratory Activities section of this Quarterly Report for details).

B. Clams species have been aged, measured, data recorded on computer forms and printed out for analysis. Species examined were: *Spisula polynyma, Nuculana fossa, Tellina nuculoides, Glycymeris subobsoleta, Macoma calcarea, Nucula tenuis.*

C. Snow crabs and king crabs are being maintained in tanks at the Seward Marine Laboratory. Experimental studies on food habits and reproductive biology are continuing.

D. Release of larvae of pink shrimp, snow crab and king crab in the tanks at the Seward Marine Laboratory have made it possible to initiate a series of experiments on food density and larval responses to these densities. These types of experiments had not been accomplished prior to this study, and should contribute to the understanding of the Lower Cook Inlet system and its potential "response" to oil contamination.

E. The Report for the first year of the lower Cook Inlet benthic invertebrate investigations was submitted during this past quarter as part of the Annual Report.

IV. PRELIMINARY INTERPRETATION OF RESULTS

General interpretations of all initial data are included in the 1978 Lower Cook Inlet Annual Report. Additional comments on the work in progress, field studies and laboratory experiments will be included in the Annual Report for the current year.

V. PROBLEMS ENCOUNTERED

Basically the research program is going very well with very adequate ship time. Both the NOAA Ship *Surveyor* and *Miller Freeman* have proven excellent vessels in Cook Inlet to complete the field studies listed in our objective (see 1978 proposal to NOAA). The laboratory and deck space on the *Miller Freeman* have been especially valuable to us, and have enabled us to expand all programs satisfactorily.

The one problem not anticipated on the NOAA Ship *Miller Freeman* concerns the expected availability of the ship's full trawling capability (based on our past cruises on this vessel) and the presence on shipboard of all facilities essential to process trawl material (again, based on our many past experiences on cruises with this vessel). We have been somewhat hampered in some areas by not being able to use a large trawl (which we had always assumed to be ship's equipment), and instead had to use a very small try-net not designed to use on a large vessel. Thus, we have seldom been able to collect large samples of adult and juvenile snow and king crabs.

It is anticipated that one additional problem will arise after each cruise. Live material will often 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 easy transfer of 50-gallon drums of sea water and crabs from ship to shore.

Milestones

It is intended to maintain a consistent schedule. Some of the report submission dates have been altered from that included in the quarterly report of December 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 tentative schedule for report submissions are as follows:

1. Kodiak (Alitak and Ugak Bays) - Completed and submitted.
2. Norton Sound-Chukchi Sea - Completed and submitted.
3. Cook Inlet - Completed and submitted with Annual Report.
4. Bering Sea Trawl Report - Completed and submitted, June.
5. NEGOA grab and trawl report - late July.
6. Bering Sea grab and pipe dredge report - late August.

QUARTERLY REPORT

NOAA-OCSEAP
Contract No. 03-5-022-68, Task Order 5
Research Unit #6
Reporting Period: 1 April - 30 June, 1978

The distribution, abundance, composition, and variability of the western Beaufort Sea benthos.

Andrew G. Carey, Jr., Principal Investigator
School of Oceanography
Oregon State University
Corvallis, Oregon 97331

June 26, 1978

Andrew G. Carey, Jr.
Principal Investigator

I. Task Objectives

A. General Nature and scope of the study.

The ecological studies of the shelf benthos include functional, process-oriented research that is built on a strong base of descriptive work on ecological patterns and their relationship to the environment. Seasonal changes in the numerical abundance and biomass of the large macro-infauna (>1.0 mm) are defined at stations across the continental shelf. The benthic food web and its relationship to bird, fish and mammalian predators are under investigation.

The species composition, distribution and abundance of the benthos are being defined in the southwestern Beaufort Sea. Sepcies and station groupings are statistically analyzed and the relationships to the bottom environment explored. Dominant species are identified. These patterns provide an insight into the relative importance of various features of the environment in determining the distribution and abundance of the benthic invertebrate fauna.

B. Specific Objectives

The major emphasis of the ongoing research (FY-78) is the delineation of the benthic food web and description of the coastal benthos. Efforts to characterize the composition of the Beaufort Sea fauna to the species level are continuing since this is a critical step toward understanding the dynamics of the benthic ecosystem.

1) Objective 1 - Beaufort Sea benthic foodweb analysis

a) The numerical density, biomass, and gross taxonomic composition of the benthic macro-infauna at selected 1977 water column foodweb stations will be obtained.

b) The identification of prey species important in the benthic foodweb will be undertaken.

c) The gut contents of selected species of benthic invertebrates will be analyzed as far as possible to determine the foodweb links within the benthic communities.

2) Objective 2 - Beaufort Sea coastal benthos

The numerical density, biomass, and gross taxonomic composition of the coastal benthic macro-infauna will be obtained from grab samples taken at stations on the inner continental shelf and coastal zone. These samples were collected during the summer of 1976 on the R/V ALUMIAK. This research is in large part supported by supplemental funds from NOAA/BLM in response to a letter proposal of April 5, 1977. This research will continue throughout the FY-78 contract year.

3) Objective 3 - Benthic macro-infaunal ecology

a) Further identifications of abundant species will be undertaken from samples collected in the southwestern Beaufort Sea during the WEBSEC and OCS field trips and cruises.

b) Statistical analyses of species and station groups will be run, and correlations between these and various characteristics of the benthic environment will be made.

4) Objective 4 - Summary and synthesis of benthic environment characteristics

a) Sediment samples from OCS benthos stations will be analyzed for particle size, organic carbon, and Kjeldahl nitrogen by a subcontract to Dr. S. Naidu, University of Alaska.

b) The bottom water characteristics of the southwestern Beaufort Sea continental shelf will be summarized as far as possible with the available information.

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

a. Andrew G. Carey, Jr. Principal Investigator
Associate Professor

Responsibilities: coordination, evaluation, analysis, and reporting

b. James Keniston Research Assistant (Part-time)

Responsibilities: data management (NB: Gish resigned from the position on 9 March 1978. Mr. Keniston was hired as a part-time temporary replacement.)

c. Paul Montagna Research Assistant

Responsibilities: sample processing, biomass measurements, harpacticoid copepod and crustacean systematics, and field collection.

d. R. Eugene Ruff Research Assistant

Responsibilities: species list compilation, sample processing, reference museum curation, polychaete systematics, field collection and laboratory management.

e. Paul Scott Research Assistant

Responsibilities: sample processing, data summary, molluscan systematics and sample collection.

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. 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 laboratory analyses.

Forty-five 0.1 m^2 Smith-McIntyre bottom grab samples have been picked and sorted into major taxa in the laboratory. The large macro-faunal organisms (>1.0 mm) in each category have been counted and wet-weighed (wet-preserved weight). The 45 samples were collected during the 1977 summer USCGC GLACIER cruise to the western Beaufort Sea (OCS-7). Five standard benthic stations on the Pitt Point Transect line (PPB) and 4 stations on the Demarcation Point Transect (DPB) were sampled. Both station lines transect the continental shelf. The PPB samples represent the second year of summer collections (August) from the same geographic locations as a continuing effort to define year-to-year variability.

3. Miles of trackline.

No fieldwork was undertaken during this quarter.

F. Milestone chart and data submission schedule.

1. The 1977-78 laboratory schedule is shown in Figure 1.

2. Explanation of schedule changes.

a) Milestone numbers 1-4 have been reached owing to a concentrated effort by laboratory staff.

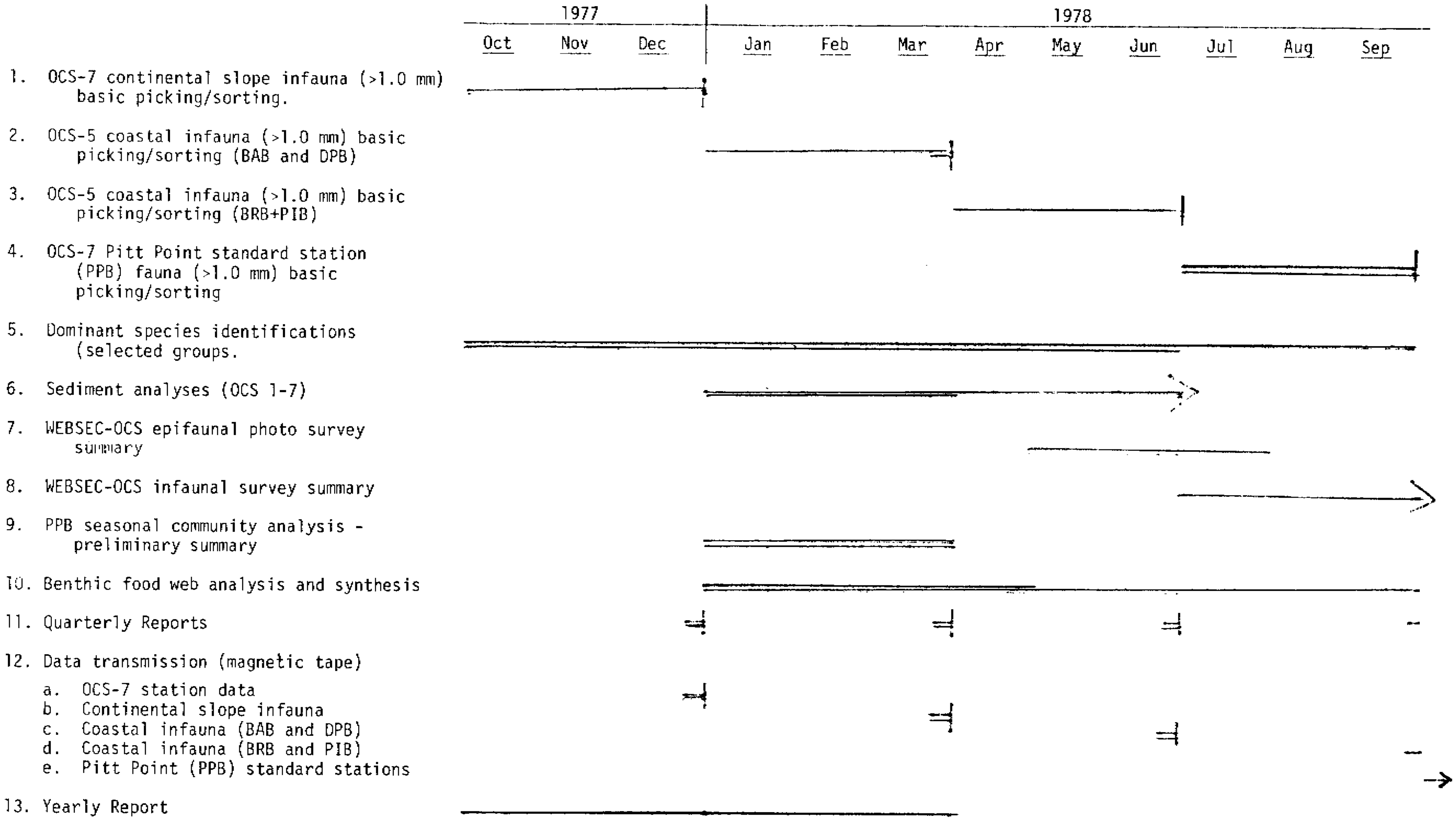
b) Milestone number 5 has not yet been reached; this is a continuing effort. Major emphasis is now being placed on the identification of fauna. A status report will be included in the next quarterly report at the end of the contract year (30 September 1978).

c) Milestone 6 has been extended to the end of the contract year to better conform with the subcontractor's schedule (D.S. Naidu).

d) Milestone number 8 will have to be extended because of the empty Data Manager-Computer Programmer-Statistical Analyst's position. (N.B. If the FY-79 contract budget allows, a full-time person will be hired to refill this necessary specialty slot in the OSU Benthos program.)

F. MILESTONE CHART and DATA SUBMISSION SCHEDULE

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



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.

KEY:
- ⊣ = accomplished
- ═ = continuing effort
- ⇒ = milestone extended
- → = future milestone to be extended

e) Milestone number 9 was accomplished and resulted in the submittal of a manuscript to SCIENCE. (N.B. M.S. declined because data were too preliminary.)

III. Laboratory Results

A. Numerical density of macro-infauna

Faunal densities for the 45 grabs from the 9 stations collected on OCS-7 are listed in Tables 1 through 5 and 11 through 14.

B. Biomass of macro-infauna

Wet-preserved weights for the 45 grabs from the 9 stations collected on the August 1977 USCGC GLACIER cruise (OCS-7) are listed in Tables 6 through 10 and 15 through 18.

C. Systematics

(1) Polychaete Species Identifications:

Species identifications have been initiated on the polychaetous annelids collected on the 1976 R/V ALUMIAK cruise (OCS-5) from the shallow continental shelf (5-25 m) along five transects between Point Barrow and Barter Island. To date, 30 species have been identified from the 11 polychaete families examined (Table 19). This includes five new species and possibly 3 genera new to science. A total of 5196 specimens have been identified so far, leaving 10,551 individuals from 24 families still to be examined.

(2) Pelecypod Mollusc Species Identifications:

All pelecypod molluscs from OCS-5 (August-September 1976) stations along the Point Barrow (BRB), Pingok Island (PIB) and Barter Island (BAB) transects have been sorted to family by P.H. Scott. This material includes 65 grab samples from thirteen stations between 5 and 25 meters. Representatives of fifteen pelecypod families were found. In addition, tentative species data for twelve of these families has been generated. A list of families and species encountered is summarized on Table 20. Consultation with Dr. Frank Bernard of the Fisheries Research Board of Canada (Nanaimo, B.C.) has led to verification of these identifications.

(3) Harpacticoid Copepod Species Identifications:

A publication describing the harpacticoids (>1.0 mm) of the southwest Beaufort Sea has been submitted by P.A. Montagna for publication. The identified species have been verified by Montagna with the cooperation of Dr. Bruce A. Coull of the University of South Carolina. The title of the manuscript submitted to the Journal of the Microscopical Society is: "*Cervinia* and *Pseudocervinia* (Copepoda: Harpacticoides) from the Beaufort Sea (Alaska, U.S.A.) with a description of a new species."

Table 1: Animal densities for PPB-25 (OCS-7) collected on 11 August 1977.

Phylum	Class	Order	Grab Number 1558	1562	1565	1566	1567	Total per m^2	% of fauna
Cnidaria:	Anthozoa		1	1	--	--	1	6	0.4
Nematoda			1	1	6	2	4	28	2.1
Nemertinea			4	3	4	6	3	40	3.0
Annelida:	Polychaeta		47	66	122	46	77	716	53.7
Arthropoda:	Crustacea:	Amphipoda	2	1	4	1	1	18	1.3
		Harpacticoida	--	--	2	3	--	10	0.7
		Isopoda	--	1	--	1	--	4	0.3
		Ostracoda	1	--	2	2	--	10	0.7
		Tanaidacea	2	3	--	3	5	26	1.9
		Cumacea	3	--	3	1	2	18	1.3
Mollusca:	Pelecypoda		47	47	34	42	32	404	30.3
	Gastropoda		6	3	3	5	5	44	3.3
Echinodermata:	Ophiuroidea		--	--	2	--	--	4	0.3
	Holothuroidea		--	--	2	--		6	0.4
TOTAL			114	126	184	112	131	1334	100.0

Table 2: Animal densities for PPB-40 (OCS-7) collected on 11 August 1977.

Phylum	Class	Order	Grab Number 1549	1550	1552	1556	1557	Total per m^2	% of fauna
Cnidaria:	Anthozoa		4	3	4	2	6	38	0.9
Nematoda			36	138	100	79	59	824	19.7
Nemertinea			8	8	8	9	5	76	1.8
Kinorhyncha			--	1	--	--	--	2	--
Annelida:	Polychaeta		108	164	187	182	146	1574	37.7
	Oligochaeta		2	4	2	1	--	18	0.4
Echiura			--	--	2	--	--	4	0.1
Arthropoda:	Crustacea:	Decapoda	--	1	--	--	--	2	--
		Amphipoda	86	99	25	37	61	616	14.8
		Nebaliacea	--	--	--	1	--	2	--
		Harpacticoida	1	3	1	1	3	18	0.4
		Isopoda	--	1	1	1	1	8	0.2
		Ostracoda	21	23	15	15	29	206	4.9
		Tanaidacea	21	45	2	19	29	232	5.6
		Cumacea	38	70	13	39	38	396	9.5
Mollusca:	Pelecypoda		11	16	7	6	2	84	2.0
	Gastropoda		6	1	3	4	--	28	0.7
Echinodermata:	Ophiuroidea		9	3	6	--	--	36	0.9
Hemichordata			--	--	1	2	2	10	0.2
Chordata:	Ascidacea		--	--	--	-	1	2	--
TOTAL			351	580	377	398	382	4176	100.0

Table 3: Animal densities for PPB-55 (OCS-7) collected on 11 August 1977.

Phylum	Class	Order	Grab Number 1541	1542	1543	1545	1546	Total per m^2	% of fauna
Porifera			1	--	2	--	2	10	0.1
Cnidaria:	Anthozoa		11	10	3	4	7	70	0.6
Nematoda			103	75	56	11	58	606	5.3
Nemertinea			11	9	14	3	5	84	0.7
Annelida:	Polychaeta		278	278	276	134	173	2278	19.8
Sipuncula			7	30	28	2	15	164	1.4
Arthropoda:	Crustacea	Decapoda	--	--	--	--	2	4	--
		Amphipoda	636	452	280	199	485	4104	35.7
		Harpacticoida	24	13	9	1	6	106	0.9
		Isopoda	20	23	6	2	10	122	1.1
		Ostracoda	523	271	196	91	155	2472	21.5
		Tanaidacea	68	45	23	26	33	390	3.4
		Cumacea	45	49	41	41	31	414	3.6
	Arachnida:	Acarina	2	--	--	--	--	4	--
	Pycnogonida		--	--	--	1	1	4	--
Mollusca:	Pelecypoda		81	52	56	19	41	498	4.3
	Gastropoda		13	8	4	3	7	70	0.6
Brachiopoda			1	2	--	1	--	8	0.1
Echinodermata:	Ophiuroidea		3	1	7	8	2	42	0.4
	Holothuroidea		--	--	1	--	--	2	--
Hemichordata			--	2	--	--	1	6	0.1
Chordata:	Ascidacea		8	2	5	--	7	44	0.4
TOTAL			1835	1322	1007	546	1041	11502	100.0

Table 4: Animal densities for PPB-70 (OCS-7) collected on 11 August 1977.

Phylum	Class	Order	Grab Number 1570	1571	1572	1573	1574	Total per m^2	% of fauna
Cnidaria:	Anthozoa		8	7	6	--	2	46	0.4
Porifera			1	--	--	--	--	2	--
Nematoda			74	45	32	74	46	542	4.8
Nemertinea			10	5	4	2	4	50	0.4
Annelida:	Polychaeta		267	329	230	217	191	2468	21.8
	Oligochaeta		--	1	--	--	--	2	--
Sipuncula			20	16	4	12	9	122	1.1
Echiura			--	--	1	--	--	2	--
Priapulida			--	1	--	--	--	2	--
Arthropoda:	Crustacea:	Amphipoda	537	1344	355	244	184	5328	47.1
		Cirripedia	--	--	1	--	--	2	--
		Harpacticoida	18	1	3	3	2	54	0.5
		Isopoda	11	6	6	4	1	56	0.5
		Ostracoda	304	146	114	100	45	1418	12.5
		Tanaidacea	69	28	28	20	22	334	2.9
		Cumacea	68	72	33	22	21	432	3.8
Mollusca:	Pelecypoda		40	35	35	35	28	346	3.1
	Gastropoda		8	3	4	6	2	46	0.4
Brachiopoda			--	1	3	2	1	14	0.1
Echinodermata:	Ophiuroidea		2	3	4	4	4	34	0.3
Hemichordata			--	--	1	--	--	2	--
Chordata:	Ascidacea		2	1	4	--	4	22	0.2
TOTAL			1439	2044	868	745	566	11324	100.0

Table 5: Animal densities for PPB-100 (OCS-7) collected on 12 August 1977.

Phylum	Class	Order	Grab Number 1575	1756	1577	1578	1579	Total per m^2	% of fauna
Porifera			--	1	1	1	--	6	0.1
Cnidaria:	Anthozoa		2	1	1	--	--	8	0.1
Nematoda			91	124	152	109	237	1426	23.1
Nemertinea			2	5	--	--	1	16	0.3
Annelida:	Polychaeta		208	250	278	209	286	2462	39.8
Sipuncula			1	3	4	7	2	34	0.6
Priapulida			2	--	2	--	3	14	0.2
Arthropoda:	Crustacea:	Amphipoda	59	23	55	42	81	520	8.4
		Harpacticoida	--	1	3	2	2	16	0.3
		Isopoda	--	2	4	1	7	28	0.5
		Ostracoda	90	64	93	57	115	838	13.6
		Tanaidacea	3	4	3	3	9	44	0.7
		Cumacea	24	27	40	28	35	308	5.0
	Pycnogonida		--	--	1	--	--	2	--
Mollusca:	Pelecypoda		22	17	27	24	19	218	3.5
	Gastropoda		4	7	5	8	2	52	0.8
	Polyplacophora		--	--	1	--	--	2	--
	Aplacophora		1	--	1	1	1	8	0.1
Brachiopoda			--	3	4	2	1	20	0.3
Echinodermata:	Ophiuroidea		8	12	17	17	15	138	2.2
Hemichordata			2	2	1	1	1	16	0.3
Chordata:	Ascidacea		--	1	2	--	--	6	0.1
TOTAL			519	547	695	512	817	6182	100.0

Table 6: Biomass, preserved wet weight per 0.1 m^2 from PPB-25 (OCS-7), collected on 11 August 1977.

Group	Grab Number 1558	1562	1565	1566	1567	Total Weight per m^2	% of biomass
Anthozoa	-	-	-	-	-	-	-
Sipuncula	-	-	-	-	-	-	-
Annelida	2.78	.47	3.10	1.19	1.20	17.48	41.9
Arthropoda	.15	.40	.15	2.49	.15	6.68	16.0
Mollusca	.17	.86	1.76	3.29	1.55	15.26	36.6
Echinodermata	-	-	.72	-	-	1.44	3.5
Misc.	.09	.05	.20	.04	.05	.86	2.0
TOTAL	3.19	1.78	5.93	7.01	2.95	41.72	100.0

- = absence

Table 7: Biomass, preserved wet weight per 0.1 m^2 from PPB-40 (OCS-7), collected on 11 August 1977.

Group	Grab Number 1549	1550	1552	1556	1557	Total Weight per m^2	% of biomass
Anthozoa	.17	.04	.21	.15	.44	2.02	3.4
Sipuncula	.11	.25	-	.10	-	.92	1.5
Annelida	2.08	1.23	3.17	3.36	.86	21.40	35.8
Arthropoda	.46	.99	.75	.26	.92	6.76	11.3
Mollusca	.36	1.12	1.95	.85	7.95*	24.46	40.9
Echinodermata	.29	.21	.84	-	-	2.68	4.5
Misc.	.04	.09	.11	.47	.08	1.58	2.6
TOTAL	3.51	3.93	7.03	5.19	10.25	59.82	100.0

- = absence
* = Biomass biased by rare large specimen

Table 8: Biomass, preserved wet weight per 0.1 m^2 from PPB-55 (OCS-7), collected on 11 August 1977.

Group	Grab Number 1541	1542	1543	1545	1546	Total Weight per m^2	% of biomass
Anthozoa	.30	.15	.21	-	.08	1.48	2.3
Sipuncula	.02	.08	.08	.01	.09	.56	0.9
Annelida	1.87	1.12	1.37	1.34	.80	13.00	20.4
Arthropoda	1.19	1.98	1.11	1.38	1.69	14.70	23.0
Mollusca	4.51	2.83	1.44	.34	.82	19.88	31.2
Echinodermata	2.00	+	3.04	1.24	+	12.56	19.7
Misc.	.19	.13	.24	.07	.17	1.60	2.5
TOTAL	10.08	6.29	7.49	4.38	3.65	63.78	100.0

+ = presence, not weighable
- = absence

Table 9: Biomass, preserved wet weight per 0.1 m^2 from PPB-70 (OCS-7), collected on 11 August 1977.

Group	1570	1571	1572	1573	1574	Total Weight per m^2	% of biomass
	Grab Number						
Anthozoa	.11	.07	.13	–	.04	.70	0.7
Sipuncula	.06	.05	.01	.06	.06	.48	0.5
Annelida	.44	3.28	1.00	1.51	1.66	15.78	14.8
Arthropoda	1.41	6.13	.98	1.46	1.60	23.16	21.8
Mollusca	3.04	14.54	.42	.31	6.96	50.54	47.5
Echinodermata	2.44	.96	.53	.35	.23	9.02	8.5
Misc.	.07	3.04	.08	.08	.09	6.72	6.3
TOTAL	7.57	28.07	3.15	3.77	10.64	106.40	100.0

– = absent

Table 10: Biomass, preserved wet weight per 0.1 m^2 from PPB-100 (OCS-7), collected on 12 August 1977

Group	1575	1576	1577	1578	1579	Total Weight per m^2	% of biomass
	Grab Number						
Anthozoa	.02	–	+	–	–	.04	–
Sipuncula	–	.10	.01*	.13**	.02	.52	0.4
Annelida	5.05	2.79	3.20	6.08	4.82	43.88	35.3
Arthropoda	.71	.39	.68	.46	.83	6.14	4.9
Mollusca	4.90	6.82	1.72	6.57	4.37	48.76	39.2
Echinodermata	.81	2.04	2.54	2.76	3.33	22.96	18.5
Misc.	.20	.39	.10	.02	.34	2.10	1.7
TOTAL	11.69	12.53	8.25	16.02	13.71	124.40	100.0

+ = presence, not weighable
– = absence
* = three large sipunculids weighed 47.63 g.
** = one large sipunculid weighed 15.63 g.

Table 11: Animal densities for Station 36 (400 m, OCS-7) collected on 25 August 1977.

Phylum	Class	Order	Grab Number 1623	1624	1625	1626	1627	Total per m^2	% of fauna
Cnidaria:	Anthozoa		1	1	--	1	1	8	0.2
Nematoda			5	17	6	45	29	204	4.2
Nemertinea			3	6	4	8	11	64	1.3
Annelida:	Polychaeta		238	333	208	335	287	2802	57.0
Sipuncula			52	62	57	69	70	620	12.6
Arthropoda:	Crustacea:	Amphipoda	3	5	3	5	1	34	0.7
		Harpacticoida	2	2	1	5	6	32	0.7
		Isopoda	1	4	1	8	2	32	0.7
		Ostracoda	1	5	3	3	2	28	0.6
		Tanaidacea	6	7	3	9	4	58	1.2
		Cumacea	1	--	2	5	2	20	0.4
Mollusca:	Pelecypoda		71	87	62	131	107	916	18.6
	Gastropoda		1	2	--	1	2	12	0.2
	Aplacophora		--	3	6	3	7	38	0.8
Echinodermata:	Ophiuroidea		--	4	--	2	--	12	0.2
	Holothuroidea		--	1	--	--	--	2	--
	Asteroidea		--	--	--	1	1	4	0.1
Hemichordata			--	4	--	6	3	26	0.5
TOTAL			385	543	356	637	535	4912	100.0

Table 12: Animal densities for Station 37 (25m, OCS-7) collected on 25 August 1977

Phylum	Class	Order	Grab Number 1629	1630	1631	1632	1633	Total per m^2	% of fauna
Cnidaria:	Anthozoa		--	1	--	--	2	6	0.2
Nematoda			6	38	12	21	205	564	17.1
Nemertinea			1	4	4	7	8	48	1.5
Annelida:	Polychaeta		26	118	117	44	469	1548	46.9
Sipuncula			--	1	--	--	--	2	0.1
Echiura			--	--	--	--	1	2	0.1
Priapulida			--	1	--	--	2	6	0.2
Arthropoda:	Crustacea:	Decapoda	--	--	--	1	--	2	0.1
		Amphipoda	--	7	5	--	3	30	0.9
		Harpacticoida	--	--	1	2	19	44	1.3
		Isopoda	--	1	1	1	3	10	0.3
		Ostracoda	--	7	6	7	108	256	7.7
		Tanaidacea	1	12	1	4	29	94	2.8
		Cumacea	7	2	6	--	2	34	1.0
Mollusca:	Pelecypoda		3	53	48	35	125	530	16.0
	Gastropoda		6	8	4	3	19	80	2.4
	Polyplacophora		--	1	--	--	--	2	0.1
Echinodermata:	Ophiuroidea		1	4	1	--	7	26	0.8
	Holothuroidea		--	3	2	4	1	20	0.6
TOTAL			51	261	208	129	1003	3304	100.0

Table 13: Animal densities for Station 39 (50 m, OCS-7) collected on 26 August 1977.

Phylum	Class	Order	Grab Number 1637	1638	1639	1640	1641	Total per m^2	% of fauna
Cnidaria:	Anthozoa		5	2	5	1	7	40	0.8
Nematoda			108	139	160	101	174	1364	27.1
Nemertinea			9	12	11	14	7	106	2.1
Annelida:	Polychaeta		124	140	230	170	263	1854	36.8
Sipuncula			7	2	2	1	2	28	0.6
Arthropoda:	Crustacea:	Amphipoda	12	10	15	9	12	116	2.3
		Harpacticoida	3	5	6	--	6	40	0.8
		Isopoda	1	4	--	2	--	10	0.2
		Ostracoda	18	26	28	8	72	304	6.0
		Tanaidacea	9	7	7	2	12	74	1.5
		Cumacea	18	26	22	9	26	202	4.0
	Pycnogonida		1	--	--	--	2	6	0.1
Mollusca:	Pelecypoda		44	95	63	74	86	724	14.4
	Gastropoda		2	2	13	3	6	52	1.0
	Aplacophora		--	--	1	--	--	2	--
Brachiopoda			--	--	2	--	--	4	0.1
Echinodermata:	Ophiuroidea		9	11	12	7	4	86	1.7
	Holothuroidea		--	2	2	--	--	8	0.2
	Asteroidea		--	--	1	--	1	4	0.1
Hemichordata			3	1	--	2	1	14	0.3
TOTAL			373	484	580	403	681	5042	100.0

Table 14: Animal densities of Station 40 (155 m, OCS-7) collected on 26 August 1977.

Phylum	Class	Order	Grab Number 1643	1644	1645	1646	1647	Total per m^2	% of fauna
Cnidaria:	Anthozoa		13	15	5	7	10	100	2.3
Nematoda			74	97	55	99	59	768	18.0
Nemertinea			2	2	3	5	3	30	0.7
Annelida:	Polychaeta		198	190	203	199	212	2004	47.0
Sipuncula			2	9	12	5	12	80	1.9
Arthropoda:	Crustacea:	Amphipoda	4	8	10	11	19	104	2.4
		Harpacticoida	--	20	4	5	8	74	1.7
		Isopoda	--	3	1	1	--	10	0.2
		Ostracoda	25	30	20	30	47	304	7.1
		Tanaidacea	16	49	42	77	36	440	10.3
		Cumacea	7	10	3	8	6	68	1.6
	Pycnogonida		--	1	--	--	--	2	--
Mollusca:	Pelecypoda		12	13	6	24	44	198	4.6
	Gastropoda		1	3	--	--	1	10	0.2
Echinodermata:	Ophiuroidea		3	6	1	--	9	38	0.9
	Holothuroidea		1	1	1	--	--	6	0.1
	Asteroidea		--	--	--	--	1	2	--
Hemichordata			6	2	2	--	2	24	0.6
TOTAL			364	459	368	471	469	4262	100.0

Table 15: Biomass, preserved wet weights in grams per 0.1 m^2 from Station 36 (400 m, OCS-7) collected on 25 August 1977.

Group	Grab Number 1623	1624	1625	1626	1627	Total weight per m^2	% of biomass
Anthozoa	.46	.02	-	.26	.04	1.56	4.0
Sipuncula	.13	.13	.12	.19	.13	1.40	3.6
Annelida	3.59	2.50	3.45	2.78	2.14	28.92	74.6
Arthropoda	.08	.07	.03	.10	.04	.64	1.7
Mollusca	.53	.55	.54	.53	.49	5.28	13.6
Echinodermata	-	.04	-	.03	.02	.18	0.5
Misc. Phyla	.05	.04	.21	.03	.06	.78	2.0
TOTAL	4.84	3.35	4.35	3.92	2.92	38.76	100.0

- = absence

Table 16: Biomass, preserved wet weights in grams per 0.1 m^2 from Station 37 (25 m, OCS-7), collected on 26 August 1977.

Group	Grab Number 1629	1630	1631	1632	1633	Total weight per m^2	% of biomass
Anthozoa	-	-	-	-	+	-	-
Sipuncula	-	+	-	-	-	-	-
Annelida	.57	1.28	.45	.17	.92	6.78	22.7
Arthropoda	.05	.10	.10	.72	.23	2.40	8.0
Mollusca	.26	3.39	.98	.87	3.29	17.58	58.8
Echinodermata	.01	.02	.48	-	.76	2.54	8.5
Misc. Phyla	.02	.02	.11	.08	.08	.62	2.0
TOTAL	.91	4.81	2.12	1.84	5.28	29.92	100.0

+ = presence, not weighable
- = absence

Table 17: Biomass, preserved wet weights in grams per 0.1 m^2 from Station 39 (50 m, OCS-7) collected on 26 August 1977.

Group	Grab Number 1637	1638	1639	1640	1641	Total weight per m^2	% of biomass
Anthozoa	.46	.01	.17	-	3.95*	9.18	7.0
Sipuncula	.17	.04	.01	.08	+	.60	0.5
Annelida	1.51	1.70	2.19	1.26	1.62	16.56	12.6
Arthropoda	.93	.50	.28	.14	.51	3.71	2.8
Mollusca	9.45*	15.24*	2.60	6.63	3.06	73.96	57.0
Echinodermata	.51	.84	.47	.51	9.94*	24.54	18.6
Misc. Phyla	.05	.15	.07	.48	.28	2.06	1.5
TOTAL	13.08	18.48	5.79	9.10	19.36	131.62	100.0

+ = presence, not weighable
- = absence
*Biomass biased by rare large specimen

Table 18: Biomass, preserved wet weights in grams per 0.1 m^2 from Station 40 (155 m, OCS-7) collected on 26 August 1977.

Group	Grab Number 1643	1644	1645	1646	1647	Total weight per m^2	% of biomass
Anthozoa	.05	.01	+	.02	.01	.18	.4
Sipuncula	+	.04	.06	.09	.11	.60	1.3
Annelida	.71	1.06	1.50	1.37	2.20	13.68	29.5
Arthropoda	.16	.30	.09	.26	.19	2.00	4.3
Mollusca	6.14	1.03	.07	.34	2.76	20.68	44.7
Echinodermata	1.51	.27	.01	-	.71	5.00	10.8
Misc. Phyla	.05	1.14	.46	.28	.15	4.16	9.0
TOTAL	8.62	3.85	2.19	2.36	6.13	46.30	100.0

+ = presence, not weighable
- = absence

Table 19: Polychaete families and species identified from the collections made aboard the R/V ALUMIAK in 1976.

Family: Ampharetidae
- *Ampharete acutifrons*
- *Ampharete arctica*
- *Ampharete vega*
- *Amphicteis sundevalli*
- *Lysippe labiata*
- *Neosabellides* n. sp.
- *Sabellides borealis*
  - genus A
  - genus B

Family: Arenicolidae
- *Arenicola glacialis*

Family: Hesionidae
- *Bonuania* n. sp.
- *Nereimyra aphroditoides*

Family: Nephtyidae
- *Aglaophamus malmgreni*
- *Micronephthys minuta*
- *Nephtys ciliata*
- *Nephtys discors*
- *Nephtys incisa*
- *Nephtys longosetosa*

Family: Orbiniidae
- *Scoloplos acutus*
- *Scoloplos armiger*

Family: Pectinariidae
- *Cistenides hyperborea*

Family: Scalibregmidae
- *Scalibregma inflatum*

Family: Sigalionidae
- *Pholoë minuta*

Family: Sternaspidae
- *Sternaspis scutata*

Family: Terebellidae
- *Artacama proboscidea*
- *Lanassa venusta*
- *Polycirrus medusa*
- *Proclea graffii*
  - genus A

Family: Trichobranchidae
- *Terebellides stroemi*

Table 20. Tentative species information for pelecypod molluscs from OCS-5 (August-September 1976) transects BRB, PIB and BAB (5-25 meters).

Nucalidae
- *Nucula bellotii*

Pandoridae
- *Pandora glacialis*

Pectinidae
- *Cyclopectin greenlandicus*

Lyonsiidae
- *Lyonsia arenosa*

Myidae
- *Mya pseudoarenaria*
- *Mya truncata*

Hiatellidae
- *Hiatella arctica*
- *Cyrtodaria kurriana*

Astartidae
- *Astarte borealis*
- *Astarte montagai*

Tellinidae
- *Macoma moesta*
- *Macoma loveni*

Veneridae
- *Liocyma fluctosa*
- *Liocyma viridis*

Nuculanidae
- *Yoldia hyperborea*
- *Yoldia scissurata*
- *Nuculana radiata*
- *Nuculana pernula*
- *Portlandia arctica*
- *Portlandia intermedia*
- *Portlandia lenticula*
- *Portlandia frigida*

Cardiidae
- *Serripes groenlandicus*

Thraciidae
- *Thracia devexa*
- *Thracia myopsis*

Families still in progress
- Thyasiridae
- Montacutidae
- Mytilidae

IV. Preliminary Interpretation of Results

As noted in the summary prepared for the May 1978 NOAA-OCSEAP Marine Biota Review, RU #6 has been able to draw further preliminary conclusions concerning patterns in the distribution and abundance of the large benthic macro-infauna (>1.0 mm). Across-shelf trends in numerical density are apparent when the inner shelf fauna from 5-25 meters depth are included.

A. Coastal Fauna (5-25 meters depth) Abundance Patterns

The coastal large macrofauna (>1.0 mm) are generally more abundant inshore at 5 or 10 meters depth. Polychaetes comprise 70-85% of the total infauna in this zone. Biomass, in contrast, does not peak with density indicating that these organisms are small in size on the average.

The minimum numerical abundance zone at 15-25 meters depth coincides with the sea ice shear zone between the landfast ice and the moving polar pack. However, detailed studies of the effects of ice gouging on the benthic community are necessary before causality is assigned to this physical phenomonon.

When a grab sample contains a high concentration of peat, it often has a large number of organisms associated with it. Perhaps the peat acts as a source of detritus and organic materials for the benthic food web.

The range and variability of the biomass of the large macro-infauna (>1.0 mm) across the continental shelf off Pitt Point are similar to the remainder of the southwestern Beaufort Sea observed from grab samples taken in 1971.

B. Continental Shelf Abundance Patterns

Abundance patterns on the continental shelf have been analyzed using two measures of standing stock, numerical density (Figure 4). In the southwestern Beaufort Sea animal numbers appear to follow a bimodal distribution with increasing depth. Densities of up to 5000 organisms/m^2 can be found near shore between 5-15 m. Numbers decrease in the ice-gouging zone (20-40 m) and then increase again reaching maxima over the shelf edge on the upper slope. However, this pattern is not true east of Barter Island where numbers do not increase past the ice-gouging zone, indicating a different ecological environment. The deep-sea environment is also very different exhibiting very low density and standing stocks.

Similar trends can be defined in the biomass data for the Beaufort Sea as with numerical density, though less clearly defined. High standing stocks are encountered on the nearshore shelf between 5-15 meters. These decrease through the ice-gouging zone and increase again to the upper slope, particularly in the Cape Halkett region. But east of the Colville River the trend is less clear and seems to reverse east of Prudhoe Bay, rather than as far east as Barter Island as in numerical density. Again, deep-sea values are very low.

It appears as if the inshore communities are comprised of numerous but small organisms, which decrease as an available food source in the ice-gouging zone. The shelf slope community are large and of larger sized organisms.

The zone east of the Canning River is probably ecologically different than other inshore areas.

C. Seasonal Abundance Patterns

Findings from grab samples taken seasonally across the Beaufort Sea continental shelf off Pitt Point in 1975-76 have revealed that the biomass and total numerical abundance of the benthic community change throughout the year. On the outer shelf, the magnitude and periodicity of the fluctuations are indicative of an annual reproductive cycle with a seasonal peak in recruitment. These fluctuations are not encountered at the shallowest shelf station. Further detailed analyses of the size-frequence structure and reproductive activity of species populations are necessary to test this hypothesis, however.

V. Problems encountered/recommended changes.

The lack of time to work up the small macro-infauna (0.5-1.0 mm in size) to identify species of dominant fauna, and to work up year-round species population data from our samples continues to be a basic problem. Continuation of these objectives for next contract year is recommended.

VI. Estimate of Funds Expended (6/30/78)

	Budget	Spent	Spent This Quarter
Salaries & Wages	$166,965	$140,245	$15,408
Materials & Services	31,235	26,756	1,422
Travel	13,350	12,616	876
Equipment	47,617	47,431	--
Payroll Assessment	26,291	21,310	2,534
Overhead	85,367	66,770	4,855
	$370,825	$315,128	$25,095

Quarterly Report

Contract # 03-5-022-85
Research Unit 29
Period 4/1 - 6/30

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

June 1, 1978

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 Activities

Samples were collected for microbiological studies in Lower Cook Inlet during April - May. The sampling vessel was the Discoverer. The sampling party was Mr. Amikam Horowitz, Mr. Alan Sexstone and Ms. Anne Bronner. Table 1 shows a list of samples collected and for which tests each was processed.

Sediment-oil trays in Elson Lagoon were sampled during April. Under ice-oil cylinders were also recovered during April. Miniature oil spills were released under ice in April to develop prototypes for future oil under ice degradation experiments. The movement of the oil under the ice was filmed.

B. Laboratory Activities

Samples from the under ice and sediment exposure experiments have been extracted and are now being analysed. To date 300 samples have been analysed by capillary column gas liquid chromatography. An additional 100 extracts are ready for analysis. The chromatograms have not yet been interpreted to give a comprehensive picture of compositional changes in the oil. The gas chromatograph-mass spectrometer now appears to be functional after repeated delays in installation and repair of factory defects. Gas chromatograph-mass spectrometer analyses of the under ice and sediment oil extracts are thus just beginning. The NOAA intercalibration oil-sediment standard will be extracted and analysed together with these samples.

Some microbial enumeration procedures have been completed for samples obtained in Lower Cook Inlet during April-May. Direct and viable counts are shown in Table 2. Hydrocarbon utilizer counts have not yet been determined. Similarly hydrocarbon biodegradation and denitrification potential measurements for these samples have not yet been determined.

Laboratory testing for taxonomic analyses of microbial isolates from the November Cook Inlet cruise has been completed. The data has been transmitted to NIH but no analyses have yet been performed on that data.

III. Results

See Table 2.

IV. New Interpretation of Results

None since annual report.

V. Problems Encountered

None.

VI. Estimate of Funds

It is estimated that 80% of the years budget was expended as of May 31, 1978.

TABLE 1 Enumeration of bacteria from samples collected during April-May, 1978 in Lower Cook Inlet.

*STATION #	VIABLE **HETEROTROPHS	TOTAL COUNTS
330W	1.2×10^{3}	1.1×10^{5}
331W	3.1×10^{2}	9.3×10^{4}
331S	3.3×10^{6}	3.3×10^{8}
333W	3.2×10^{2}	8.2×10^{4}
333S	3.8×10^{6}	6.5×10^{8}
358W	1.4×10^{2}	8.3×10^{4}
358S	6.8×10^{5}	--
350W	2.5×10^{1}	6.0×10^{4}
350S	2.2×10^{6}	8.2×10^{8}
360W	6.0×10^{1}	8.2×10^{4}
360S	2.8×10^{5}	4.9×10^{8}
368W	1.8×10^{1}	8.5×10^{4}
368S	1.4×10^{5}	4.6×10^{7}
378W	2.4×10^{3}	1.1×10^{5}
370W	2.4×10^{1}	5.2×10^{4}
370S	1.2×10^{6}	6.4×10^{8}
380W	6.9×10^{1}	5.6×10^{4}
380S	1.2×10^{6}	5.0×10^{8}
394W	7.3×10^{0}	9.5×10^{4}
394S	4.7×10^{4}	4.0×10^{8}
388W	1.4×10^{2}	6.2×10^{4}
388S	1.3×10^{5}	--
395W	8.8×10^{0}	3.9×10^{4}
390W	4.4×10^{1}	8.5×10^{4}
390S	8.7×10^{5}	3.5×10^{8}
249W	1.1×10^{3}	6.6×10^{4}
246W	8.2×10^{2}	4.9×10^{4}
266W	2.2×10^{2}	1.1×10^{5}
255W	3.2×10^{2}	1.6×10^{5}
242W	2.1×10^{2}	8.2×10^{4}
245W	1.7×10^{2}	6.4×10^{4}
247W	3.5×10^{2}	4.9×10^{4}
233W	7.7×10^{1}	9.3×10^{4}
233S	7.0×10^{5}	4.8×10^{8}
248W	8.0×10^{1}	6.8×10^{4}
203W	6.2×10^{1}	9.9×10^{4}
203S	1.4×10^{6}	7.9×10^{3}
201W	9.8×10^{2}	1.2×10^{5}
201S	7.9×10^{6}	5.8×10^{8}
211W	9.5×10^{1}	8.2×10^{4}
212W	7.5×10^{1}	6.2×10^{4}
212S	4.6×10^{4}	--
VW	5.9×10^{3}	1.1×10^{5}
VS	6.8×10^{6}	4.4×10^{8}
UW	4.5×10^{3}	1.2×10^{5}
US	8.5×10^{6}	4.8×10^{8}

*STATION #	VIABLE **HETEROTROPHS	TOTAL COUNTS
395S	$1.1 \times 10^{[illegible]}$	$5.8 \times 10^{[illegible]}$
207W	$5.4 \times 10^{[illegible]}$	1.2×10^{5}
207S	1.8×10^{5}	$3.7 \times 10^{[illegible]}$
205W	1.5×10^{3}	1.1×10^{5}
105W	1.5×10^{3}	1.4×10^{5}
106W	6.4×10^{3}	7.6×10^{4}
CB1 (204) W	2.8×10^{4}	7.8×10^{4}
CB1 (204) S	1.3×10^{6}	4.3×10^{8}
CB2 (214) W	2.0×10^{4}	7.4×10^{4}
CB7 (high tide) W	1.2×10^{4}	1.8×10^{5}
CB7 (low tide) W	6.0×10^{3}	7.4×10^{4}
CB7 (low tide) S	6.9×10^{6}	3.4×10^{8}
CB7 W	4.5×10^{4}	7.2×10^{4}
229W	7.8×10^{2}	7.8×10^{4}
229S	1.1×10^{6}	--
265W	4.2×10^{2}	1.1×10^{5}
213W	--	1.1×10^{5}
236 W	--	7.0×10^{4}
216 W	--	6.0×10^{4}
206 W	--	9.3×10^{4}
398 W	--	5.0×10^{4}
M W	--	8.9×10^{4}
AW W	--	6.0×10^{4}
AW S	--	8.9×10^{6}
J W	--	$6.4 \times 10^{[illegible]}$

*STATION #	VIABLE **HETEROTROPHS	TOTAL COUNTS
234W	$3.7 \times 10^{[illegible]}$	9.7×10^{4}
235W	9.5×10^{2}	9.7×10^{4}
229A (CB8) W	--	6.2×10^{4}
CB3 W	--	6.4×10^{4}
CB4 W	--	7.6×10^{4}
CB5 W	--	6.6×10^{4}
CB6 W	--	5.4×10^{4}
AB W	--	6.8×10^{4}
W CB7 (high tide)	--	1.0×10^{5}
W CB7 (low tide)	--	1.4×10^{5}
W CB7 (high tide)	--	4.5×10^{4}
W CB7 (low tide)	--	7.2×10^{4}
W CB7 (high tide)	--	3.7×10^{4}
W CB 7 (low tide)	--	4.9×10^{4}
W K	--	5.4×10^{4}
W CB10 (high tide)	--	8.2×10^{4}
W CB10 (low tide)	--	9.5×10^{4}
W CB10 (high tide)	--	8.9×10^{4}
W CB10 (low tide)	--	1.7×10^{5}
W CB10 (high tide)	--	4.3×10^{4}
W CB9 (high tide)	--	6.2×10^{4}
W CB9 (low tide)	--	1.0×10^{5}
W CB9 (high tide)	--	4.9×10^{4}
S CB9	--	3.8×10^{8}

* w = water sample; s = sediment sample.

** bacteria per ml or per g dry weight sediment.

TABLE 2

STATION NUMBER	SAMPLE NUMBER	LATITUDE N	LONGITUDE W	DEPTH	SALINITY	TEMP	ANALYSES 1	2	3	4	5	6	7
330	GW 601	56 22.3	154 17.9	1	32.222	4.47	+	+	+	+			
331	GW 602	56 46.0	154 20.3	1	32.059	3.52	+	+	+	+		+	
331	GB 602	56 46.0	154 20.3	52	32.065	3.51	+	+	+	+		+	
333	GW 603	57 04.2	155 01.2	1	31.973	4.88	+	+	+	+		+	+
333	GB 603	57 04.2	155 01.2	188	32.418	4.46	+	+	+	+	+	+	+
358	GW 604	57 18.1	154 56.0	1	32.049	4.45	+	+	+	+			
358	GB 604	57 18.1	154 56.0	148	32.397	4.51			+	+			
350	GW 605	57 31.2	155 33.8	1	31.903	4.42	+	+	+	+		+	
350	GB 605	57 31.2	155 33.8	265	32.470	4.57	+	+	+	+		+	
360	GW 606	57 56.2	154 40.6	1	31.766	4.44	+	+	+	+			
360	GB 606	57 56.2	154 40.6	228	32.406	4.51	+	+	+	+			
368	GW 607	57 43.9	154 09.0	1	32.134	4.59	+	+	+	+			
368	GB 607	57 43.9	154 09.0	53	32.291	4.38	+	+	+	+			
378	GW 608	58 01.3	153 29.6	1	32.108	4.93	+	+	+	+			
370	GW 609	58 17.2	154 01.9	1	31.468	3.97	+	+	+	+		+	
370	GB 609	58 17.2	154 01.9	112	31.977	4.65	+	+	+	+		+	
380	GW 610	58 38.9	153 24.7	1	31.425	3.88	+	+	+	+			
380	GB 610	58 38.9	153 24.7	-	31.500	3.99	+	+	+	+			
394	GW 611	58 40.9	153 00.5	1	31.928	4.55	+	+	+	+			
394	GB 611	58 40.9	153 00.5	153	32.281	4.67	+	+	+	+			
388	GW 612	58 27.2	152 58.0	1	32.026	4.93	+	+	+	+			
388	GB 612	58 27.2	152 58.0	215	32.420	4.58	+	+	+	+	+		
395	GW 613	58 53.2	152 54.9	1	31.915	4.73	+	+	+	+			
395	GW 613	58 53.2	152 54.9	166	32.247	4.70	+	+	+	+			

Table 2 (Continued)

STATION NUMBER	SAMPLE NUMBER	LATITUDE N	LONGITUDE W	DEPTH	SALINITY	TEMP	ANALYSES 1	2	3	4	5	6	7
207	GW 614	58 59.9	152 53.3	1	31.980	4.77	+	+	+	+			
207	GB 614	58 59.9	152 53.3	166	32.120	4.80	+	+	+	+			
390	GW 615	58 52.7	153 11.1	1	31.262	3.81	+	+	+	+		+	
390	GB 615	58 52.7	153 11.1	170	32.121	4.67	+	+	+	+			
229	GW 616	59 39.9	151 14.8	1	31.557	4.66	+		+	+			
229	GB 616	59 39.9	151 14.8	38	31.688	4.17	+		+	+			
249	GW 617	59 51.3	152 01.6	1	-	-	+	+	+	+			
246	GW 618	60 05.5	151 45.7	1	-	-	+	+	+	+			
266	GW 619	60 42.7	151 25.5	1	-	-	+	+	+	+		+	
265	GW 620	60 34.9	151 41.9	1	-	-	+	+	+	+			
255	GW 621	60 19.3	151 46.5	1	30.023	3.26	+	+	+	+			
242	GW 622	60 09.0	152 25.7	1	30.778	3.72	+	+	+	+			
245	GW 623	60 06.3	152 15.5	1	30.574	3.78	+	+	+	+			
247	GW 624	59 587	152 34.4	1	30.741	3.96	+	+	+	+			
233	GW 625	59 49.7	152 56.0	1	31.022	3.87	+	+	+	+		+	+
233	GB 625	59 49.7	152 56.0	15	31.023	3.88	+	+	+	+	+	+	+
248	GW 626	59 50.1	152 24.2	1	30.948	3.76	+	+	+	+			
203	GW 627	59 06.3	153 27.8	1	29.987	4.08	+	+	+	+			
203	GB 627	59 06.3	153 27.8	41	31.085	3.99	+	+	+	+			
201	GW 628	59 12.5	153 52.9	1	30.708	4.29	+	+	+	+			
201	GB 628	59 12.5	153 52.9	20	30.739	4.26	+	+	+	+			
211	GW 631	59 26.1	153 37.0	1	31.255	4.01	+	+	+	+			
212	GW 632	59 32.7	153 20.9	1	31.243	4.00	+	+	+	+			
212	GB 632	59 32.7	153 20.9	26	31.273	4.02	+		+	+	+		
V	GW 633	60 13.4	152 45.6	1	30.5	4.0	+	+	+	+			
V	GB 633	60 13.4	152 45.6	-	-	-	+	+	+	+			

Table 2 (Continued)

STATION NUMBER	STATION NUMBER	LATITUDE N	LONGITUDE W	DEPTH	SALINITY	TEMP	ANALYSES 1	2	3	4	5	6	7
V	GW 634	60 12.8	152 36.0	1	29.0	4.0	+	+	+	+			
V	GB 634	60 12.8	152 36.0	-	-	-	+	+	+	+	+		
234	GW 635	59 37.8	152 55.8	1	31.277	4.14	+	+	+	+			
213	GW 636	59 29.6	153 13.9	1	31.354	4.20	+		+	+			
213	GB 636	59 29.6	153 13.9	33	31.362	4.16	+		+	+	+		
225	GW 637	59 31.5	152 39.6	1	31.734	4.43	+		+	+			
235	GW 638	59 42.6	152 37.3	1	31.157	4.11	+	+	+	+			
236	GW 639	59 41.7	152 14.2	1	31.909	4.79	+		+	+			
226	GW 640	59 32.8	152 18.3	1	31.909	4.73	+		+	+			
216	GW 641	59 18.1	152 15.4	1	31.917	4.81	+		+	+			
205	GW 642	59 06.7	152 40.0	1	31.884	4.81	+	+	+	+		+	
206	GW 643	59 08.7	153 05.0	1	31.871	4.81	+		+	+			
390	GB 644	58 53.4	153 11.6	126	32.104	4.98	+	+	+	+		+	
398	GW 645	58 49.0	152 12.3	1	32.203	5.09	+		+	+			
105	GW 646	58 49.7	151 19.3	1	32.100	5.04	+	+	+	+			
106	GW 647	59 00.6	152 01.2	1	31.920	4.92	+	+	+	+			
AW	GW 649	59 38.0	153 37.8	1	27.2	5.5	+		+	+			
AW	GB 649	59 38.0	153 37.8	-	-	-	+		+	+			
M	GW 650	59 43.3	153 22.6	1	27.6	8.0	+		+	+			
M	GB 650	59 43.3	153 22.6	-	-	-	+		+	+			
J	GB 651	59 34.6	151 11.0	1	36.2	4.0	+		+	+			
(CB8) 229A	GW 652	59 37.8	151 18.4	1	31.426	5.99	+		+	+			
(CB8) 229A	GB 652	59 37.8	151 18.4	64	31.778	4.29	+		+	+			
CB1	GW 653	59 13.7	153 40.1	1	31.368	4.40	+	+	+	+		+	
CB1	GB 653	59 13.7	153 40.1	31	31.369	4.37	+	+	+	+		+	

Table 2 (Continued)

STATION NUMBER	STATION NUMBER	LATITUDE N	LONGITUDE W	DEPTH	SALINITY	TEMP	ANALYSES 1	2	3	4	5	6	7
CB2	GW 654	59 16.6	153 20.3	1	-	-	+	+	+	+		+	
CB3	GW 655	59 19.9	153 58.3	1	-	-	+		+	+			
CB4	GW 656	59 23.3	152 38.7	1	-	-	+		+	+			
CB5	GW 657	59 25.6	152 19.4	1	-	-	+		+	+			
CB6	GW 658	59 28.9	152 00.6	1	-	-	+		+	+			
CB7	GW 659	59 35.4	151 45.9	1	31.774	5.60	+	+	+	+			
CB7	GW 660	59 35.4	151 45.9	1	31.765	5.32	+	+				+	
CB7	GB 660	59 35.4	151 45.9	57	31.790	5.13	+	+	+	+		+	
CB7	GW 661	59 35.4	151 45.9	1	31.778	5.76	+	+	+	+			
AB	GW 662	59 27.6	151 43.2	1	29.5	5.0	+		+	+			
CB7	GW 663	59 35.4	151 45.9	1	31.769	5.3	+		+	+			
CB7	GW 664	59 35.4	151 45.9	1	31.776	5.73	+		+	+			
CB7	GW 665	59 35.4	151 45.9	1	31.688	5.42	+		+	+			
CB7	GW 666	59 35.4	151 45.9	1	31.809	5.87	+		+	+			
CB7	GW 667	59 35.4	151 45.9	1	31.766	5.37	+		+	+			
CB7	GW 668	59 35.4	151 45.9	1	31.798	5.54	+		+	+			
K	GW 669	59 36.5	151 25.5	1	29.0	6.0	+		-	-			
K	GB 669	59 36.5	151 25.5	-	-	-			+	+			
CB10	GW 670	60 31.5	151 30.9	1	29.514	4.11	+		+	+			
CB10	GW 671	60 31.5	151 30.9	1	-	-	+		+	+			
CB10	GW 672	60 31.5	151 30.9	1	29.579	4.19	+		+	+			
CB10	GW 673	60 31.5	151 30.9	1	29.277	4.41	+		+	+			
CB10	GW 674	60 31.5	151 30.9	1	29.480	4.24	+		+	+			
CB9	GW 675	60 28.2	152 12.2	1	30.664	4.70	+		+	+			
CB9	GW 676	60 28.2	152 12.2	1	30.442	4.70	+		+	+			

Table 2 (Continued)

STATION NUMBER	STATION NUMBER	LATITUDE N	LONGITUDE W	DEPTH	SALINITY	TEMP	ANALYSES 1	2	3	4	5	6	7
CB9	GW 677	60 28.2	152 12.2	1	30.461	4.92	+			+			

1. Direct count - epifluorescent total counts.
2. Viable heterotrophs - counts on marine agar 2216 at 5 C.
3. Most probable number of hydrocarbon utilizers
4. Hydrocarbon biodegradation potential
5. Denitrification potential in sediment.
6. Numerical taxonomy.
7. Effect of crude oil on indigenous microbial population study.

QUARTERLY PROGRESS REPORT

July 1, 1978

RU - 59

CONTRACT 03 - 5 - 022 - 82

TASK - D - 4

COASTAL MORPHOLOGY, OIL SPILL VULNERABILITY AND SEDIMENTOLOGY OF KOTZEBUE SOUND AND KODIAK ISLAND

Miles O. Hayes - Principal Investigator

Christopher H. Ruby - Co-Investigator

COASTAL RESEARCH DIVISION
DEPARTMENT OF GEOLOGY
UNIVERSITY OF SOUTH CAROLINA

I. Quarter Accomplishments:

This quarter's primary emphasis was placed on preparation for field work in Kotzebue Sound and on Kodiak Island. That field work is presently in progress and is explained below in Section III. Additionally, we have now completed a computer program which permits the data output from our 200 cm Hydraulic Equipment Sediment Analyzer (settling tube) to be input into our Fortran programs and submitted on magnetic tape. We would like to have our Milestone Chart updated to indicate the submission of all beach profiles (including those to be run this summer) and all sediment data from our Kotzebue Sound study area with the October 1 Progress Report.

II. Task Objectives:

The major emphasis of this project falls under task D4, which is to: evaluate present rates of change in coastal morphology, with particular emphasis on rates and patterns of man-induced changes, and locate areas where coastal morphology is likely to be changed by man's activities, if any. The relative susceptability of different coastal areas will be evaluated, especially with regard to potential oil spill impacts.

III. Field and Laboratory Activities:

A. Ship and Field Trip Schedule:

We are presently working on Kodiak Island. Our work began here on June 18, 1978 and will continue until July 17, 1978, at which time we will begin work in Kotzebue Sound. The Kodiak work is being supported by a NOAA helicopter or fixed wing aircraft full time.

The Kotzebue Sound field work will begin on July 18, 1978. We will charter our own aircraft for this facet of the summer field program. The aircraft will probably be a Super Cub specially outfitted for extremely tight short-field landings on sand-gravel beaches.

Following the Kotzebue Sound work, we will be working out of the NARL in Barrow from August 11, 1978 to August 19, 1978. For this work we will again use a NOAA helicopter.

Finally, we plan a two day stay at the Geophysics Institute of the University of Alaska in Fairbanks to analyze vertical photography of our three study areas.

B. Scienfitic Party:

1. Kodiak Island Study Site

Miles O. Hayes - Principal Investigator

Scientific Party (cont'd)

Dr. Hayes will direct all field work on Kodiak Island.

Christopher H. Ruby - Co-Investigator

Mr. Ruby will coordinate logistics and assist in all aspects of the field work. If it is necessary to split into two separate field parties, Mr. Ruby will direct the second party.

Ken Finkelstein - Field Assistant

Mr. Finkelstein will assist with all field work and later lab analysis. This work will be used for his Masters of Science data base.

Peter Reinhart - Field Assistant

Mr. Reinhart will assist with all field related work.

2. Kotzebue Sound Study Site

   Christopher H. Ruby - will direct all field work in Kotzebue Sound.

   Peter Reinhart - will act as a field assistant.

   Ken Finkelstein - will act as a field assistant.

3. Beaufort Sea Study Site

   Christopher H. Ruby - will direct all field work.

   Peter Reinhart - will act as a field assistant.

Note: All of the personnel are workers of:

Coastal Research Division
Department of Geology
University of South Carolina
Columbia, SC 29208

C. Methods:

1. Kodiak Study Site

The island shoreline has been divided into 130 separate sample sites. Each site is 15 km apart. These sites will be photographed and described on tape, then they will be sampled for beach sediment grain size, composition, sorting, shape, etc. At 65 sites a beach profile will be measured and a sketch made in addition to the above. Gross biologic productivity and distribution will be described. The surrounding geomorphology will be used to make inferences regarding recent historic changes (i.e. progradation, erosion, seismic movements, etc.). Any areas of specific interest or importance will be analyzed in greater detail as time and necessity dictates.

2. Kotzebue Sound Study Site

The 66 permanent beach profiles established during the summer of 1976 will be occupied to determine short-term beach changes. The remainder of the field work will concentrate on the Barrier Island complex between Cape Prince of Wales and Cape Espenberg. Detailed nearshore process data will be collected in order to predict longshore transport volumes and rates. Analysis of the numerous wash-through channels will be used to estimate the frequency and quantity of barrier overtopping during storms. These data will be compared to estimates based on analysis of weather data. Nearshore bathymetry will be investigated using a Bloodworth fathometer. Finally, a three-dimensional investigation of a few selected sites will be used to estimate long-term barrier-island behavior.

3. Beaufort Sea Study Site

The coastal segment between Lonely and Pt. Barrow will be divided into study sites 5 km apart on both mainland beaches and barrier-island shorelines. The data collected will be similar to number 1 (above).

IV. Results:

Preliminary results will be sent with our next Quarterly Report.

Quarterly Report

Contract No. R7120804
Research Unit 67
1 April - 30 June 1978

Baseline Characterization of Marine Mammals in the Bering Sea: Distribution and Abundance

Principal Investigators

Braham et al.

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

June 1978

Date submitted 28 June 1978

Reporter's initials [signature]

PI QUARTERLY PROGRESS REPORT - RU67
Reporting Period 1 April - 30 June 1978

Project Title: Baseline characterization of marine mammals in the Bering Sea: distribution and abundance.

I. Abstract

Most aerial survey data collected to date have been computerized. The reformatting program is nearing completion, which will allow cross-referencing of all data for 1975, 76, and 77. The "Quality Control Program" (QCP-2 and -3) are being written for final quality checks of transposed data (see Mercer, et al, 1978). Upon conclusion of processing of data through these programs, the data will be ready for delivery on magnetic tapes.

Our report on "California Gray Whale (Eschrichtius robustus)fall migration through Unimak Pass, Alaska," was presented to the 1978 International Whaling Commission (see Appendix A).

An abstract of results from the harbor seal studies was sent to the AAAS. meeting (see Appendix B).

All 1976 density plots for all ice seal species and for walrus have been completed including data from John Burns. (RU). These plots have been photo reduced, which is the final step before publication. Final code analysis, including abundance estimates, is being made and a discussion of the results will be presented October 1.

II. Objectives

The objective of research unit 67 is to summarize important life history information on marine mammals in the Bering Sea to serve as a basis for management decisions related to man's activities. Specifically, a comprehensive liberature review coupled with field survey research is used to (1) determine seasonal distribution and abundance; (2) delineate major migration pattersn; (3) define traditionally important habitats, such as breeding and feeding areas; and (4) where practical, define species as composition and general population condition (sometimes termed "health" - an indicator of present and future viability and vulnerability).

The objectives of this quarter were to complete data processing for final computer treatment, and to prepare research topics on northern sea lions, harbor seals, walruses, ice seals, and gray whales for final reporting and for publication.

III. Field and Laboratory Activities

A. Ship or field trip schedule. None

B. Scientific party. N/A

C. Methods.

Data were processed in computerized quality control programs; distribution charts delivered records of selected species in a manner to be used in the final report. Report writing continues for those components prepared for narrative description.

D. Sample collection localities.

All data in our files under RUs 67 and 14 were collected over the continental shelf of the Bering and southern Chukchi Seas.

E. Data collected and/or analyzed.

1. No new data was collected during this quarter.

2. Analysis of ice seal data for distribution and abundance is under final preparation following completion of the computerized density plotting and abundance estimates.

3. A preliminary abundance estimate for gray whales has been established and the final results of spring and fall migration patterns prepared.

4. All aerial survey data through 1977 have been punched on computer cards.

IV. Results

No papers have been finalized during this quarter. Results from ongoing analysis will be reported in the final product following the next quarter. All conclusions are tentative until completion of our results in the proposed publications.

The paper on the spring migration of the California gray whale will be completed by the end of July. A paper on the distribution and abundance of harbor seals along the Alaska Peninsula will be completed by mid to late July. The results of these and other "sub-projects" of RU67, will be submitted separately as they are completed (e.g. Braham, et al. 1978, "Preliminary evidence of a northern sea lion... population decline in the eastern Aleutian Islands"--submitted during the second quarter of FY1978).

V. Preliminary Interpretation of Results

Gray whale study.

1. Sighting evidence indicates that gray whales remain coastal throughout their entire spring migration, and probably during the fall migration.

2. Food may be the reason why gray whales migrate along the coast, rather than landmark areas as previously proposed. Quantitative data have yet to be collected on this topic, however.

VI. Auxiliary Material

A. Literature cited

Mercer, R. W., B. D. Krogman and R. M. Sonntag. 1978 Marine mammal data documentation for the Platforms of Opportunity Project and Outer Continental Shelf Environmental Assessment Program. Processed report, U.S. Dep. Commer., NOAA, NMFS, Mar. Mammal Div., Seattle, WA 23 p.

B. Papers in preparation during this quarter.

Braham, H. W. 1978. California gray whale in Alaska: Evidence for a coastal spring migration route (accepted by Téchnica Pesquera; in second revision).

Braham, H. W., D. J. Rugh, R. D. Everitt, B. D. Krogman, M. K. Nerini, R. G. Punsley, R. M. Sonntag and D. E. Withrow. Marine mammals of the Bering Sea: their seasonal distribution and abundance. (planned final report for RU67; completion date September 30, 1978).

Braham, H. W., G. A. Fedoseev, J. J. Burns and B. D. Krogman. 1978. Distribution and abundance of Phocine seals and walruses in the Bering Sea pack ice in the spring, 1976. (accepted as a book chapter, US-USSR Convention for Environmental Conservation of Marine Mammals; revised draft due November 1, 1978)

Braham, H. W., B. D. Krogman, R. M. Sonntag and R. G. Punsley. Spring 1976 distribution and abundance of the Pacific walrus, *Odobenus rosmarus*. (in preparation for processed report; final draft revised schedule for August 1978).

Everitt, R. D., and H. W. Braham. Harbor seal, *Phoca vitulina richardii*, population on the north side of the Alaska Peninsula and the eastern Aleutian Islands. (in preparation; preliminary draft expected by July 15, 1978).

Sonntag, R. M. A comprehensive World Data Bank computerized mapping and plotting routine. (manuscript in second draft stage)

C. Oral presentations

1. H. W. Braham--summary talks of NWAFC Marine Mammal Studies to Office of Management and Budget represetnatives, Seattle, WA.

D. Updated milestone chart

See FY1978 second quarter.

VII. Problems Encountered and Recommended Changes

None

VIII. Estimated Funds Expended[1/]

Salaries/Benefits	$ 2,400
Computer	1,000
	$ 3,400

1/ Funding projection for remainder of FY1978 are on schedule,

Quarterly Report

Contract No. R7120806
Research Unit 68
1 April - 30 June 1978

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

Principal Investigators

Braham et. al

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

June 1978

Date submitted 28 June 1978

Reporter's initials 7/11/78

PI QUARTERLY PROGRESS REPORT - RU68
Reporting period 1 April - 30 June 1978

Project Title: Seasonal distribution and relative abundance of marine mammals in the Gulf of Alaska

I. Abstract

During the third quarter all data used for RU68 final reporting were reviewed for appropriateness with regards to sample testing (i.e. for relative abundance and effort information) and plotting routines. A variety of plotting routines for gray whales and Dall porpoise by month have been prepared for establishment of a standard format for final reporting for all species.

II. Objectives

The objective of research unit 68 is to summarize all available information on the distribution and relative abundance of marine mammals in the Gulf of Alaska. Marine mammal sightings reported from the Platforms of Opportunity Program, the Marine Mammal Division's pelagic fur seal research program and the OCSEAP Marine Operations and Station Abstracts form our data base. More emphasis is placed on the collection of pelagic than on-shore sighting data because sources of information are primarily observers onboard government and private vessels at sea.

The summarization and analysis of these data will be used as the basis for evaluating the implications of outer continental shelf oil and gas exploration and development with regard to marine mammals and their ecological interaction.

III. Field or Laboratory Activities

A. Ship or field trip schedule. None.

B. Scientific party. N/A

C. Methods.

In order to reduce the possibility that less than adequate or reliable data enter the data bank, each logbook is carefully scrutinized for logic conformity and accuracy. Acceptable data are then coded for computer checking, verification, processing and, ultimately, archival for EDS submission. Two manual and two computer checks assure that the highest quality of precision exists.

D. Sample collection localities.

Marine mammal sighting data were collected from southeast Alaska to the eastern Aleutian Islands and the southern Bering Sea north to Nunivak Island.

E. Data collected and/or analyzed. None

IV. Results

No new results to report on above those discussed in the last quarterly report (April 1978).

V. Preliminary Interpretation of Results

See FY 1978 second quarterly report.

VI. Auxiliary Material

A. List of references. None

B. Papers in preparation or in print.

In preparation:

Braham, H. W. California gray whale in Alaska: Evidence of a coastal spring migration route. (Accepted by Téchnica Pesquera; second draft due by the end of July, 1978)

Braham, H. W., and R. W. Mercer. Cetacean distribution in the Gulf of Alaska: Yakutat Bay to Unimak Island; (expected completion date September 30, 1978.)

Braham, H. W., R. W. Mercer, P. D. McGuire, C. E. Peterson and R. M. Sonntag. Marine mammal distribution and relative abundance in the Gulf of Alaska and southern Bering Sea, (Planned final draft for RU68; completion date September 30, 1978.)

Mercer, R. W., H. W. Braham and M. Tillman. Distribution of Dall porpoise, *Phocoenoides dalli*, in Alaska. (Completion date September 30, 1978.)

Rugh, D. J., and H. W. Braham. California gray whale (*Eschrichtius robustus*) fall migration through Unimak Pass, Alaska, 1977. (In review as processed report; submitted to the International Whaling Commission, June 1978).

Severinghaus, N. C. Annotated bibliography on marine mammals of Alaska -- an update. (in revised final preparation).

Sonntag, R. M. A comprehensive World Data Bank computerized mapping and plotting routine. (Manuscr. in review for processed report.)

C. Oral presentations. None.

D. Revised milestones. See second quarterly report.

VII. Problems and Recommended Changes. None

VIII. Estimate of Funds Expended*

Salaries and benefits	1.5K
Travel and per diem	N/C
Computer costs	0.5K
	2.0K

*Funding projections for the remainder of FY 1978 are on schedule.

Quarterly Report

Contract #R7120807
Research Unit # 69
1 April - 30 June 1978

Seasonal Distribution and Abundance of Bowhead and Beluga Whales in the Bering Sea and Arctic Ocean

Principal Investigators

Braham et. al

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

June 1978

Date Submitted 28 June 1978

Reporter's Initials [handwritten initials]

PI Quarterly Progress Report

Reporting Period 1 April - 30 June 1978

Project Title: Seasonal distribution and abundance of bowhead and beluga whales in the Bering Sea and Arctic Ocean

I. Abstract

All ice camp and aerial survey data logged from 1976 and 1977 surveys were reviewed for consistency and clarity in preparation for final analysis. These data are now ready for integration with data collected in 1978 under the new NOAA expanded bowhead whale study. All will be summarized during the final FY 1978 quarter, and an evaluation made of existing data gaps. A serious gap remains in our understanding of the specific movement of bowheads in and near the Colville river - Prudhoe Bay oil lease area. An evaluation of the 1976 and 1977 population indeces for bowhead whales has not substantially changed from our original estimate of 700-800 whales observed in the nearshore lead passing Barrow during late April to early June only. The expanded FY 1978 bowhead whale research program sponsored by NOAA has resulted in a revised estimate of 2,264 whales. A detailed discussion of these findings will be provided to the OCS project office after a final revised version of the research paper (submitted to the International Whaling Commission 6 June 1978) has been made.

II. Objectives

Objectives for the last quarter were: 1) finish the analysis of data collected during 1976 and 1977 to identify bias in sampling techniques; 2) complete the development of a computer format for storage and analysis of field data collected from a fixed shore (ice) station; and 3) evaluate the ice camp index as a measure of bowhead whale population abundance.

III. Field or Laboratory Activities

A. Ship or field trip schedule. None

B. Scientific party. N/A

C. Methods. See FY 1978 second quarter report.

D. Sample collection localities. N/A

E. Data collected and/or analyzed. N/A

IV. Results

This quarter's activities continued along the lines outlined in the last quarterly report. No new results are ready for discussion at this time.

V. Preliminary Interpretation see Abstract

A. Papers in preparation.

Braham, H. W. Ingutuk: Morphological variation in the bowhead whale. (draft submitted to International Whaling Commission; revised draft to be submitted to OCS project office during the next quarter).

Braham, H. W., B. D. Krogman, and G. M. Carroll. Population biology of the bowhead whale (*Balaena mysticetus*) and beluga whale (*Delphinapterus leucas*) in Alaska I: distribution and abundance. (planned final report for RU69; completion date September 30, 1978)

Sonntag, R. M. A comprehensive World Data Bank computerized mapping and plotting routine. (manuscript in final edit stage)

B. Oral presentations.

8-9 June. H. Braham met and discussed bowhead whale critical habitats in the Beaufort Sea with BLM and NOAA representatives; Anchorage.

C. Updated milestone chart. See second FY 1978 quarterly report.

VII. Problems Encountered and Recommended Changes

None

VIII. Estimate of Funds Expended

Salaries	$ 1,300
Computer costs	1,000
	$ 2,300

Quarterly Progress Report
Research Unit #71
May - June, 1978

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:

I. Highlights of the May-June Quarter 1978.

During this Quarter we captured our 5th and final sea otter. To date we have conducted eight 6 hr. metabolic measurements on this animal. In April we discovered that one of our otters (Jenny) was pregnant and June 1 she gave birth to a 1 kg female sea otter pup. We also have designed and built a floating collar assembly for the radio transmitters and depth recorders. These collars have been tested on one of our sea otters and we are now building units for testing in Alaska this July. A significant amount of time has been spent preparing for our expedition to Prince William Sound, Ak. in July 1978.

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-Associate investigator
3. Randall Davis-Assist. in data analysis and experimental runs

4. Michael Bergey-Animal Caretaker

5. Conrad Doxey-NMFS-NOAA paid Volunteer

6. Rick Price-Student Volunteer

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 continuous 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 64 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).

All information concerning the results of the oiling experiments have been explained in the yearly progress report and will not be dealt with here.

V. Problems Encountered:

The pregnancy of otter 4 (Jenny) has precluded any oiling experiments on her. However, we are continuing with our plans to oil otter 5 (Shannon).

QUARTERLY REPORT

Contract No.
Research Unit #72
Report Period - April 1, to June 30, 1978
Number of Pages - 9

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

June 30, 1978

SUMMARY

New experiments were started in the April-June quarter and a study to determine effects of salinity on oil toxicity to several species was almost completed. Data collecting and experiments are on schedule, while data analysis, work-up, report writing, manuscript synthesis, etc. are progressing more slowly.

A major breakthrough occurred with the development of a new system to maintain stable concentrations of aromatic hydrocarbons in water. The system, which injects dissolved aromatics, can be used with any number of aromatics simultaneously. This will allow synthetic WSF tests and continuous-flow isotope uptake studies.

TASK OBJECTIVES AND PROGRESS[1/]

A. Toxic components and synergism of toxic components: We are continuing studies of the contribution of individual toxic components of petroleum hydrocarbons to determine which compounds are primarily responsible for most of the observed toxicity.

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 completed. We have developed a new system for maintaining constant concentrations of aromatics in water. The system consists of injecting a solution containing aromatic hydrocarbons (solid aromatics dissolved in a solvent) into a rapid stream of water through a small-bore needle so the droplets of solvent aromatic mixture are rapidly dissolved into the stream of water. Several aromatics can be injected in the test solution to create the desired synthetic water soluble fraction. Exposures are scheduled for late summer 1978.

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

---

1/ Primary objectives and secondary objectives are underlined.

synergistic, this would help explain why simplistic experiments with single compounds have under-estimated 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 is completed. A similar test with pink salmon fry was completed this quarter and data analyses is in progress. Additional synergistic assays have been completed with *Mytilus edulis*, and *Colus jordani*.

b. Determine if toluene and naphthalene have synergistic effects on uptake and/or depuration in pink salmon fry and *Eualus* shrimp.

Progress: Tests with *Eualus* shrimp were attempted in April. Problems were encountered with static exposures because the concentration of aromatics declined during the tests. We have redesigned the experiment to use continuous-flow exposure methods. The newly developed injection technique will be used. Radiolabeled toluene and naphthalene will be injected into a water stream to insure stable concentrations during the experiments. This study is rescheduled for summer 1978.

B. Larval Studies

1. Determine the sensitivity of eggs and larvae from several noncommercial species, e.g. barnacles, mussels, snails, starfish, and sea urchins. Static exposures will be used for these microscopic larvae, and will include tests with WSF's, toluene, and naphthalene.

Progress: Eggs from two snail species, Natica clausa sp. and Fusitriton oregonensis and one nudibranch, Tochuina tetraquadra have been reared in the laboratory and challenged with toluene, naphthalene, and Cook Inlet WSF, until hatching. Control and exposed eggs of Fusitriton are near hatching. Natica eggs are apparently very sensitive and difficult to rear as both control and exposed eggs died. Control and exposed nudibranch eggs are near hatching.

Tests with the eggs and larvae of the starfish, Evasterias troschelii, have been the most successful to date. Fertilization success of gametes in the presence of toluene, naphthalene, and Cook Inlet WSF have been determined for this species. Both gametes and the bipinaria larvae seem to be quite resistant to oil exposures.

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: Inability to swim will be monitored in bioassays using Fusitriton oregonensis, and Evasterias troshcelii larvae this summer if we obtain successful rearing.

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 napththalene in shrimp gonad, muscle, and hepatopancreas has been determined using radiolabeled compounds. This study has been repeated on shrimp with newly extruded eggs, and again with shrimp carrying old eggs, just before their release.

An earlier uptake study was completed in December 1977. Shrimp with new eggs were exposed to Cook Inlet WSF's continuously for 10 days. Samples of eggs and muscle have been analyzed by GC-MS by the National Analytical Laboratory, Seattle. The isotope studies will determine the rate of uptake for toluene and naphthalene, and the WSF-GC analysis studies will determine the concentrations at equilibrium for many compounds. Both studies have been completed, and mansucript preparation will begin next quarter.

C. Sensitivity increase of smolts in sea water. Through bioassays, we have found that the sensitivity of sea water-adpated 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 completely answer the question.

1. Determine the uptake of isotopes into tissues of fresh water and sea water-adapted salmonid smolts. Although whole body uptake was essentially the same, the uptake into different tissues may be different.

Progress: Coho salmon smolts in fresh water and in sea water were exposed to ^{3}H toluene and ^{14}C naphthalene continuously for 24 h. The concentration of aromatic hydrocarbon in brain, liver, and muscle was determined by scintillation spectrometry. Data analyses is in progress.

2. Determine the osmotic and ionic composition of blood in fresh water and sea-water-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, is co-investigator for this experiment.

Progress: A study to meet the above objectives is two-thirds completed. Coho salmon smolts were exposed to several concentrations of toluene and naphthalene continuously for 96 h. TLm values were generated with both toxicants at 0, 10, 20, and 30 °/oo salinity. Exposures were repeated while animals were sampled periodically to analyse blood serum osmolarity, sodium content, chloride content, and potassium content. This series of studies will be completed in early July 1978.

D. Long-term exposures: Long-term exposures have recently been possible because of improvements in flow-through exposure techniques. Most previous flow-through tests have been crude attempts, without verification of stable concentrations during exposure. We will conduct long-term exposures and compare the result 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 and construction of the apparatus is completed with experiments scheduled for July 1978.

2. Determine the survival of two tolerant and two sensitive species to flow-through exposures of toluene and naphthalene.

Progress: Study has been completed with six species. An abstract submitted for possible presentation at the Oil Effects Spill Conference at Los Angeles, California March 1979. (See abstract attached).

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: Bioassays with *Hemigrapsus nudis* to toluene and naphthalene are scheduled for summer 1978.

2. Determine the uptake, and especially the depuration pattern, of intertidal animals exposed to labeled toluene and naphthalene, with and without exposure to air.

Progress: Manuscript preparation is in progress.

F. Dispersant testing: Literature review and R&D on methods of analysis and exposure will be probed to prepare for expanded testing in FY 79.

Progress: Literature review has been completed. Dispersants have been obtained with preliminary tests with fish and shrimp and are scheduled for late summer 1978.

G. Writing-up of previous results: Manuscripts describing FY 77 research projects will be completed.

Progress: The manuscripts "Sensitivity of Alaskan Marine Organisms to Cook Inlet Oil and No. 2 Fuel Oil" and "Toxicity of Static vs Flow-through Exposures of Toluene and Naphthalene to Six Marine Animals" were submitted for possible presentation and publication to the 1979 Oil Spill Conference, Los Angeles, California. Astracts are attached.

The manuscript "Effects of temperature on the median tolerance limit of pink salmon and shrimp exposed to toluene, naphthalene, and Cook Inlet crude oil" was accepted for publication by the Bulletin Environmental Contamination and Toxicology.

INTERPRETATION OF RESULTS

Interpretations of results will be supplied in reviewed manuscripts.

PART IV. PROBLEMS ENCOUNTERED

An error in projecting Leave surcharge on all laboratory budgets that was corrected midway (April 15) through the fiscal year caused budget problems. Layoffs within our section were averted when OCSEAP granted a supplemental $10.0k increase. This was not sufficient to hire all the summer help we needed, and supervisory personnel are actively collecting data, maintaining animals, analyzing doses etc.-- causing delays in our response to the recent RFP from OCSEAP and manuscript synthesis.

Estimate of Funds Expended to May 31, 1978

	Funds Expended
Salary Costs	$150.3
Travel	9.2
Contracts	8.3
Equipment & Supplies	44.1
Other Direct & Indirect Costs	79.2
Total	$291.1

Sensitivity of Alaskan Marine Organisms to Cook Inlet Crude Oil and No. 2 Fuel Oil

by

Stanley Rice, Tamara Taylor, and John Karinen
Auke Bay Laboratory
P.O. Box 155
Auke Bay, Alaska 99821

ABSTRACT

We determined the sensitivities of 35 subarctic Alaskan species of marine fish and invertebrates to water-soluble fractions of Cook Inlet crude oil and No. 2 fuel oil. This is the largest group of animals ever tested with the same oils, and under similar exposure conditions and temperatures. Organisms assayed represent 6 phyla, and several habitats, and included species of 7 fish, 8 crustaceans, 14 molluscs, 4 echinoderms, one annelid, and one nemertean. Sensitivities were determined by 96 h static bioassays. Concentrations of total aromatics were determined by gas chromatography and paraffins by infra-red spectrophotometry.

The No. 2 fuel oil was more toxic than the Cook Inlet crude oil to most of the species. Fish were generally more sensitive than invertebrates with 96 h TLm's ranging from 1 ppm to 3 ppm total aromatics, although bottom dwelling flounders and intertidal blennies were found to be quite tolerant. Crustaceans, especially shrimp, were nearly as sensitive as fish while mollusks and echinoderms were generally more tolerant. Intertidal animals, including intertidal fish, were consistently among the most tolerant species of all groups. Many species, but especially the intertidal invertebrates, were so tolerant they could not be killed in 96 h static exposures.

While there is a general trend of increased sensitivity from lower invertebrates to higher invertebrates to fish, there is a better correlation of sensivitiy with habitat: subtidal animals are more sensitive than intertidal species. A few comparisons of sensitivities published for warm water species tested similar were made: the Alaskan species had lower TLm's but probably because of the exposure temperatures (toxic aromatic hydrocarbons last longer at lower temperatures) than because of differences in sensitivity.

Toxicity of Static vs Flow-Through Exposures of Toluene and Naphthalene to Six Marine Animals

by

C.C. Brodersen and S. D. Rice
Auke Bay Laboratory
P.O. Box 155
Auke Bay, Alaska 99821

ABSTRACT

Sensitivity of marine organisms exposed to a variety of oils have been tested by two general methods: static and flow-through bioassays. We determined the quantitative differences between the two test procedures by exposing six representative species (including salmon, shrimp, crabs snails, sea cucumbers, and mussels) to static and flow-through exposures of toluene and naphthalene (96 h bioassays). Toluene and naphthalene are two aromatic hydrocarbons found in relatively high concentrations of crude oil water-soluble fractions.

As expected, the TLm's for flow-through exposures were consistently lower than TLm's determined in static exposures, but the magnitude of the differences between the two test procedures varied considerably for each species. For the "sensitive" species (pink salmon, shrimp, and crabs), the flow-through TLm's for toluene and naphthalene were 60-70% of the static TLm's while the flow-through TLm's for the tolerant species (snails sea cucumbers, and mussels) were 17-41% of the static tests. The more sensitive animals (e.g. fish and shrimp) were fast in their reaction to the toxicants, usually dying during the first 24 h were generally alive after 96 h. The more tolerant species were slower to react, and often had many deaths in the flow-through exposures after 24 h.

For species that react fast to toxicants, reasonable estimate of sensitivity can be made with static tests, even for volatile and biodegradable toxicants, such as toluene, naphthalene, and water-soluble fractions of oil. For the fast reacting species, the lethal damage is done during the first 24 h, when chemical differences between static and flow-through exposures are minimal. For the slower reacting animals, 96 h static tests are poor estimates compared to flow-through tests, because much of the lethal damage occurs after 24 h of exposure, when the chemical differences between flow-through and static exposures are extreme.

SUBLETHAL EFFECTS OF PETROLEUM HYDROCARBONS AND TRACE METALS, INCLUDING BIOTRANSFORMATIONS, AS REFLECTED 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

April 1 to June 30, 1978

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

ABSTRACT

The responses of marine organisms to environmental contaminants are reflected in numerous changes that are detectable at population and organismic levels, as well as at cellular and molecular levels. The general scope of this study is to evaluate effects caused by behavioral, physiological, pathological, morphological, and chemical changes in subarctic and arctic marine animals exposed to petroleum hydrocarbons and trace metals.

Behavior

The chemosensory mediated defense response of the green sea urchin (Strongylocentrotus drobachiensis) was reduced by 50% following exposure for 24 hr to 30-50 ppb of the saltwater soluble fraction (SWSF) of Prudhoe Bay crude oil (PBCO). Similar exposure of sea urchins to toluene (a major component of the SWSF) elicited an identical response, but at concentrations one order of magnitude greater than for the PBCO SWSF.

Physiology

Mussel larvae, herring larvae, and shrimp larvae were exposed to seawater containing tritiated naphthalene. The newly hatched herring larvae metabolized naphthalene, thereby producing three to four metabolic products. The shrimp larvae were tested with and without live food. The shrimp with live food had one additional metabolic product that was not produced in the unfed shrimp. The additional product was a major metabolic component derived from the food source. It is speculated that the route of entry was via the ingestion of the food species.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

English sole (Parophrys vetulus) and rock sole (Lepidopsetta bilineata) were exposed together on both a high-silt and a coarse-sand type of sediment contaminated with PBCO. Each experiment was terminated prior to 1 mo due to significant mortalities among the rock sole in both the control and oil-exposed groups. Although English sole exposed to high-silt sediment with approximately 2,000 μg/g (dry wt.) total extractable petroleum hydrocarbons had very low tissue levels of aromatic hydrocarbons (<32 ng/g dry wt.), all of the oil-exposed fish had histopathological changes in their livers.

Effects of Petroleum on Fish Disease Resistance

Rock sole exposed for 2 weeks to sediment containing 3,000 ppm PBCO showed no demonstrable alteration in resistance to infection by pathogenic bacteria.

Morphology

Tissues from 13 species of Alaskan adult fish and the egg and larval stages of three species were sampled and processed in preparation for sectioning and examination by light and electron microscopy. Additionally, two studies on the adherence of PBCO to living herring eggs revealed that some oil sticks to the surface membrane when the eggs are exposed to droplets which break away from a mildly agitated slick. If the egg clusters are drawn through an oiled-surface film to simulate tidal action and subsequently submerged in clean water, a number of oil droplets remain on the surface of most eggs. The petroleum adhering to the developing embryo may significantly lengthen the time of exposure.

Chemistry

Metabolism of Hydrocarbons in Demersal Fish

Rock sole and starry flounder (Platichthys stellatus) fed tritiated naphthalene accumulated significant concentrations of both naphthalene and its metabolic products in various tissues and organs. Compared to starry flounder, rock sole accumulated and retained larger amounts of dietary naphthalene. The accumulation of naphthalene did not seem to be related to the lipid content of tissues.

Biotransformation of Petroleum Hydrocarbons

A preliminary experiment was conducted on the food-chain transfer of 2,6-dimethylnaphthalene (2,6-DMN) from seawater to the seaweed Fucus distichus, and ultimately to sea urchins feeding on treated seaweed. Rock sole and English sole exposed to benzene and/or oiled sediments were assayed for organic free radical load via electron paramagnetic resonance (EPR) methodology. Evidences suggest the formation of free-radicals of the hydrocarbons during metabolic transformations to water-soluble metabolites. The presence of free radicals also is suggestive of potential tissue damage via radical reactions, which should be considered in future assessments of biochemical effects of hydrocarbons in marine fish.

Effects of Cadmium and Lead

Herring eggs were exposed to varying concentrations of cadmium, lead, a saltwater-soluble fraction of PBCO, and a chemical dispersant. Preliminary studies indicate that exposure to levels of 2-4 ppm SWSF from PBCO severely retards herring egg development. In addition, cadium ions (100 ppb) with SWSF (2-4 ppm) appear to retard egg development either additively or synergistically. The presence of lead (to 100 ppb), cadmium (to 100 ppb), Corexit 9527 (to 1 ppm) or SWSF (to 4 ppm) did not appear to have a marked effect on fertilization success.

OBJECTIVES

There is a series of objectives in this multidiciplinary study to evaluate the effects of petroleum on marine organisms. The specific objectives of work performed during the current quarterly period of April 1 to June 30, 1978, are as follows:

Behavior

To evaluate the effect of petroleum hydrocarbons on chemoreception of selected marine invertebrate organisms.

Physiology

To determine (1) the naphthalene concentrations at which the previously found abnormalities in mussel larvae occur; (2) if the metabolic components of spot shrimp larvae exposed to naphthalene are different according to the mode of exposure; and (3) if newly hatched herring can metabolize naphthalene.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

To define the uptake and disposition of petroleum hydrocarbons by flatfish exposed to crude-oil-contaminated sediments and to characterize possible pathological effects resulting from long-term exposure.

Effects of Petroleum on Fish Disease Resistance

To determine if exposure to oil-contaminated sediment alters disease resistance in selected species of flatfish.

Morphology

(1) To obtain eggs and larval fish, as well as tissues from fish indigenous to Alaskan waters,for comparative studies of normal structure of species which may be oil-impacted; and (2) to initiate a study on petroleum adhesion to herring egg surfaces.

Chemistry

Metabolism of Hydrocarbons in Demersal Fish

To define the metabolism and disposition of dietary naphthalene in starry flounder and rock sole.

Biotransformation of Petroleum Hydrocarbons

To determine the accumulation of 2,6-DMN in the seaweed Fucus and the transfer of this compound to sea urchins. To study the free radical load in liver of various flatfish species exposed to petroleum in order to evaluate potentially harmful effects of the transitory oxygenated products on cellular components.

Effects of Cadmium and Lead

To determine the synergistic or antagonistic effects of lead or cadmium and SWSF on the fertilization and development of the eggs of marine species, and to determine the effects of metals on the egg membrane.

FIELD OR LABORATORY ACTIVITIES

SHIP OR FIELD TRIP SCHEDULE - N/A

SCIENTIFIC PARTY

The following persons affiliated with the Environmental Conservation Division of the Northwest and Alaska Fisheries Center participated in the planning, development, and performance of experiments presented in this report.

Name	Role
D. Malins, PhD, DSc	Principal investigator; hydrocarbon metabolism
W. Roubal, PhD	Research chemist; hydrocarbon metabolism
A. Friedman	Chemist; assistant to Dr. Roubal
H. Sanborn	Oceanographer; invertebrate zoology
C. Short	Graduate student; assistant to Mr. Sanborn
U. Varanasi, PhD	Research chemist; metal/hydrocarbon studies
D. Gmur	Chemist; assistant to Dr. Varanasi
W. Reichert, PhD	Research chemist; metals/hydrocarbons studies
D. Federighi	Chemist; assistant to Dr. Reichert
E. Gruger, Jr.,PhD	Principal investigator; coordinator of chemical analyses and reports to OCSEAP
D. Weber	Principal investigator; behavioral studies
F. Johnson	Fishery biologist; part-time behavioral studies
J. Parker	NOAA Corps Officer; assistant in pathology studies
T. Scherman	Physical science technician; part-time assistant in pathology and behavioral studies
N. Karrick	Principal investigator; chemical investigations
H. Hodgins, PhD	Principal investigator; physiological and pathological studies

B. McCain, PhD	Microbiologist; effects of petroleum in sediments on flatfish, coinvestigator with Dr. Hodgins
W. Gronlund	Fishery research biologist; assistant in pathology and behavior studies
K. Pierce	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
P. Scordelis	Fishery biologist; part-time assistant to Mr. Schiewe
J. Hawkes, PhD	Fishery research biologist; electron microscopy
C. Stehr	Technician; assistant to Dr. Hawkes

METHODS

Behavior

Green sea urchins were placed in 2 liter flow-through aquaria and supplied with filtered seawater at 11°-12°C. The SWSF of PBCO used for exposure was generated by a system described by Roubal et al. (1977a); for toluene exposure a modification of the method employed by Benville et al. (1978) was used. Water samples were analyzed for petroleum components by gas chromatography.

On the dorsal surface of sea urchins are several types of pedicellaria (pincer-like structures on the distal end of articulated stalks). The pedicellaria are used for anti-fouling or defensive purposes. The defensive globiferous pedicellaria pincers contain poison glands and are responsive (even when detached) to exudates of natural predators such as the starfish.

After 24-hr hydrocarbon exposure the sea urchins were tested for their defense by addition of starfish (Pycnopodia helianthoides) exudate. The number of globiferous pedicellaria extending and opening fully in response to the exudate were counted and percent response calculated. The starfish exudate was made by placing a 3 kg starfish in 6,000 ml of filtered seawater for 1 hr. Aliquots of the exudate water were passed through a 5 μm filter, frozen, and thawed immediately prior to use.

Physiology

The gametes of mussels were added to seawater containing 60, 50, 20, 14, and 5 ppb tritiated naphthalene. Water and animal samples were taken at appropriate intervals for 48 hr and prepared for future analysis.

Newly hatched herring were placed in seawater containing 13 ppb tritiated naphthalene for 9 hr. The animals were then removed, weighed, and prepared for high pressure liquid chromatography (HPLC) analysis.

First stage spot shrimp, brine shrimp, or spot shrimp with brine shrimp were each placed in 15 ppb solutions of tritiated naphthalene. After 9 hr the animals were removed, weighed, and prepared for HPLC analysis.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

English sole and rock sole were exposed to oil-contaminated sediments in flow-through seawater aquaria containing a 5 cm layer of sediment alone or sediment containing 0.5% PBCO. Approximately 40 fish of each species were placed in each aquarium. Sediment, above-sediment water, and interstitial water samples were collected at 0-time and at 2-wk intervals thereafter and analyzed for total extractable petroleum hydrocarbons (TEPH). At the same intervals, 3-6 fish from both the control and oil-exposed groups were sacrificed and tissue samples were taken and subjected to histology, hematology, electron microscopy, and analyses for aromatic hydrocarbons by gas chromatography/mass spectrometry (GC/MS).

Effects of Petroleum on Fish Disease Resistance

Disease resistance of rock sole maintained either on oil containing 3,000 ppm of PBCO or control sediment was compared after exposures of 2 and 6 wk. Test and control fish were challenged with varying concentrations of the marine fish pathogen, Vibrio anguillarum, and LD_{50} were determined.

Morphology

A bottom and a midwater trawl were used to obtain the adult fish from which tissues were taken for scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

Ichthyoplankton samples were taken with Bongo nets and neuston tows and eggs and larval fish from these samplings were fixed for ultrastructural analysis.

Chemistry

Metabolism of Hydrocarbons in Demersal Fish

Rock sole and starry flounder (82 $\pm$ 30 g) were each force-fed 56 µCi of tritiated naphthalene dissolved in 250 µl of salmon oil. Three to six fish were analyzed at 24, 48, 168, and 1008 hr after the feeding. Samples of epidermal mucus, skin, muscle, liver, brain, gills, blood, kidney, stomach, intestine, and bile were collected and tested for radioactivity associated with both naphthalene and total metabolites by a solvent-partition method (Varanasi et al. 1978). Lipid content of liver, muscle, and skin were determined by the method of Hanson and Olley (1963).

Data were statistically analyzed for significant differences using Student's t test. Also, rates were obtained by assuming a lognormal distribution and using a one-tailed F-test (Sokal and Rohlf 1969).

Biotransformation of Petroleum Hydrocarbons

The time-course study of the uptake and accumulation of 2,6-DMN and its metabolites in Fucus and sea urchins was performed using tissue extracts and digests prepared from tissues as reported earlier for fish tissue (Roubal et al. 1977b). Organic free radicals in livers of flatfish were quantitated using EPR instrumentation (Roubal 1972) and the procedures of Roubal (1965).

Effects of Cadmium and Lead

Eggs were stripped from ripe herring, deposited on glass slides and fertilized. The slides with the fertilized eggs were then transferred to aerated beakers at 10.5°C containing varying concentrations of lead (5, 100, 1000 ppb), cadmium (5, 100, 1000 ppb), cadmium and SWSF of PBCO (2 and 4 ppm), lead and SWSF, and a dispersant (Corexit 9527) (0.5 and 1.0 ppm). In addition, groups of herring eggs were fertilized in the presence of SWSF (2 and 4 ppm), lead (100 ppb), cadmium (100 ppb), or Corexit 9527 (500 and 1000 ppb). One exposure was run at each concentration. The eggs exposed to these pollutants during fertilization were then placed in aerated beakers filled with clean seawater. All eggs were examined during development to hatching. Samples were taken from cadmium exposures at varying times to examine effects of cadmium on the chorion thickness and to evaluate possible induction of chorionases by cadmium.

SAMPLE LOCATION LOCALITIES

All experiments in saltwater were conducted at the Mukilteo facility of NWAFC.

Behavior

Sea urchins were collected in Puget Sound.

Physiology

The shrimp larvae were reared in the laboratory from captured gravid shrimp. Mussels were collected as ripe adults and spawned in the laboratory. The herring larvae were from eggs that were hatched in the laboratory.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment - N/A

Effects of Petroleum on Fish Disease Resistance - N/A

Morphology

Eggs and larval fish were collected from the Bering Sea on a cruise of the Miller Freeman (NOAA) - Feb. 27-May 9. Herring were collected from Puget Sound.

Chemistry

Metabolism of Hydrocarbons in Demersal Fish - N/A

Biotransformation of Petroleum Hydrocarbons

Samples of Fucus and sea urchins were taken from rocks and pilings near the NWAFC Mukilteo facility. Flatfish species were collected at the mouth of the Columbia River.

Effects of Cadmium and Lead

Ripe herring were obtained from northern Puget Sound.

DATA COLLECTED AND/OR ANALYZED

Behavior

Ten sea urchins were tested at each of the 30 SWSF of PBCO or toluene concentrations. Replicate test water samples and a control water sample were taken at each hydrocarbon concentration, for 90 gas chromatography analyses.

Physiology

(1) Samples of the exposed spot shrimp, brine shrimp, and herring larvae were separated into metabolic components by HPLC, for a total of 15 analyses.

(2) Water samples from the experiments were sampled and analyzed by liquid scintillation counting, for a total of 100 samples.

(3) Mussel larvae samples taken at varying intervals from each of the replicate test conditions were preserved in formalin for future analysis; these comprised a total of 150 samples.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

(1) Number and types of samples: Tissue samples for histology (546); blood for hematology (54); sediment for hydrocarbon analyses (18); water samples for hydrocarbon analyses (36); tissues for hydrocarbon analyses (66).

(2) Number and type of analyses: Microscopic examination of histological specimens (450); hematology (hematocrit, hemoglobin, total blood cell count, differential white cell count) (324); sediment and water samples for TEPH analyses (54); tissues for hydrocarbon analyses (26).

Effects of Petroleum on Fish Disease Resistance

(1) Number and types of samples: Rock sole for disease resistance tests (120); sediment samples for hydrocarbon analyses (6); tissue samples for hydrocarbon analyses (12).

(2) Number and type of analyses: Hydrocarbon analyses of sediment (6); LD_{50} determinations (4)--5 fish per group and 4 groups per determination.

Morphology

Tissues of 13 species of fish were sampled for electron microscopy. Kidney, liver, intestine, and skin were taken for TEM and gill, intestine, and skin for SEM. Three species of fish larvae were collected at five ichthyoplankton stations and fixed for SEM and TEM.

Laboratory studies were performed on living herring eggs from Puget Sound which were held in a container with a surface slick of PBCO for 24 hr. The eggs were sampled after either drawing or not drawing directly through the slick. All eggs were rinsed in clean water and checked for adherence of oil droplets.

Chemistry

Biotransformation of Petroleum Hydrocarbons

(1) Number and type of samples: Whole Fucus tissue and sea urchin digestive tracts and gonads were assayed for radioactivity (in the form of 2,6-DMN and its total aromatic metabolites). Seawater used in the exposure aquarium and control aquarium was also assayed for the level of 2,6-DMN remaining in solution. Livers of flatfish species were analyzed for free radical content.

(2) Number and type of analyses: Triplicate 10 g samples of Fucus were assayed for radioactivity at 0, 1, 2, 4, 10, 22, 28, 46, 70, 94, 118, 142, and 166 hr from the time of introducing 2,6-DMN into static aquarium water, for a total of 42 samples. Seawater samples were taken for analysis (control aquarium and exposure aquarium) at each time Fucus was sampled for a total of 13 water samples analyzed. The gonads and digestive tracts (3 urchins per data point) were assayed for 2,6-DMN and its total metabolites at 2, 4, 6-1/2, 22-1/2, 41, and 65 hr from onset of feeding on Fucus exposed to 2,6-DMN for 166 hr, for a total of 72 analyses. Livers from rock sole and English sole exposed to benzene (≈0.2 ppm) for 1-2 wk or to oiled sediments were analyzed for their content of organic free radicals for a total of 10 control livers and 8 test livers.

RESULTS

Behavior

Following exposure to the SWSF of PBCO for 24 hr at 30-50 ppb only 50% of the pedicellaria responded to starfish exudate; at 120-140 ppb only 10% responded. When tested following 24 hr exposure to toluene, approximately 50% responded at 200-400 ppb, and 10% responded at 1,200-1,600 ppb.

Preliminary tests on avoidance of green sea urchins to starfish exudate following hydrocarbon exposure indicated that the sea urchins escape response remained viable though the defense response was impaired.

Physiology

Mussel larvae samples are being processed. Herring larvae metabolized naphthalene into 3 or 4 different compounds within 48 hr after hatching. Stage I spot shrimp larvae also metabolized naphthalene into 3 or 4 compounds. Brine shrimp formed 6 to 8 compounds and the metabolic profiles of the spot shrimp that had fed on brine shrimp indicated the presence of a metabolic compound that was not formed by the unfed spot shrimp. The additional compound found in the spot shrimp that had been fed brine shrimp was the compound formed in highest concentration from the metabolism of naphthalene by brine shrimp. The method of transfer of this compound to the spot shrimp is not known at present but the transfer of metabolites from one level of the food chain to another level via ingestion of the animal is likely.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

Of three experiments in which English sole and rock sole were exposed to oil-contaminated sediments, one experiment was performed using a silty sediment and two were performed using a sediment consisting of coarse sand. In all cases the sediment was mixed with PBCO to give an initial 0.5% (v/v) mixture. Sediment with the high-silt content contained 2260 μg/g (dry wt) of total extractable petroleum hydrocarbons (TEPH) after washing and lost only 15% during the 29-day experiment. About 10 μg/g (dry wt) TEPH were in the interstitial water during this period. Very low levels of aromatic hydrocarbons (<32 ng/g dry wt) were detected in the tissues of the oil-exposed fish. Nevertheless, all of the oil-exposed fish examined at 14 and 29 days (8/8) had severe hepatocellular lipid vacuolization (HLV). Only 3 of 8 control fish had a mild form of the HLV; the remaining control fish had normal-appearing livers. On the 24th day of this experiment a 12-hr interruption of the water flow to both the control and test aquaria resulted in the death of 61 and 17% of the control and oil-exposed rock sole, respectively; the English sole had no detectable adverse effects. Since the purpose of this experiment was to compare the effects of oil on two species of flatfish, the test was terminated after 29 days.

The experiments employing rock sole and English sole exposed to coarse-sandy sediment were both terminated after 21 days due to high mortalities, primarily among rock sole. The mortalities appeared to be the result of microbial infections and not oil-related.

Effects of Petroleum on Fish Disease Resistance

Results of tests in which rock sole were exposed for 2 wk to sediment containing 3,000 ppm PBCO showed that essentially no alteration occurred in disease resistance. LD_{50} values computed from mortality data following challenge with Vibrio anguillarum were 1.5×10^7 and 3.8×10^7 organisms for oil-exposed and control fish, respectively.

Morphology

Samples from the Bering Sea have been processed for electron microscopy. Examinations of egg surfaces and larvae are in progress. The experiments with oil adherence indicates that a few small droplets sometimes do adhere to the surface of some herring eggs, which were not pulled through the surface slick. Petroleum was not found on all of these eggs nor more than one or two droplets on any one egg. However, when clusters of herring eggs were drawn through the slick, 4-5 droplets were observed on almost all the eggs even though the cluster had been rinsed in clean water.

Chemistry

Metabolism of Hydrocarbons in Demersal Fish

Radioactivity (dpm/mg) in all tissues of rock sole was greater than the radioactivity in the corresponding tissues of starry flounder. For example, at 24 hr after feeding 56 μCi of tritiated naphthalene, liver, gills, and skin of the rock sole contained 7.7, 3.3, and 4.3 times, respectively, as much naphthalene and 5.6, 3.8, and 4.9 times, respectively, as much metabolites as the liver, gills, and skin of the starry flounder. At 168 hr, liver, gills, and skin of rock sole contained 16.6, 6.7, and 16.0 times, respectively, as much naphthalene and 4.2, 2.3, and 5.6 times, respectively, as much metabolites as the liver, gills, and skin of starry flounder. Values for naphthalene and metabolite concentrations in tissues of rock sole were significantly ($P<0.001$) different from the corresponding values for starry flounder. Liver, skin, and muscle of starry flounder contained 11.6, 3.0, and 1.7 g of lipid, respectively, per 100 g of wet tissue; whereas, liver, skin, and muscle of rock sole contained 4.3, 1.5, and 1.0 g of lipid, respectively, per 100 g of wet tissue.

Biotransformation of Petroleum Hydrocarbons

Fucus readily incorporates 2,6-DMN when exposed to this compound in a static system, reaching the highest observed level of incorporated radioactivity of 35,000 dpm/g wet wt of tissue in 166 hr. More than 95% of the radioactivity is in the form of unmetabolized 2,6-DMN. Concommitant with the uptake in radioactivity by Fucus, radioactivity in the water dropped.

When sea urchins were allowed to feed on Fucus exposed for 166 hr to 2,6-DMN, radioactivity was detected in samples of digestive tracts and the gonads taken 2 hr from the onset of feeding. The data for later times are presently being compiled.

Livers of rock sole and English sole exposed to benzene and/or oiled sediments contained significantly less ($P<0.05$) organic free radicals than did livers of fish not exposed to hydrocarbons.

Effects of Cadmium and Lead

Herring eggs were exposed to varying regimes of lead, cadmium, and/or SWSF during fertilization and development. All eggs which had been exposed to SWSF and metals, and SWSF alone at SWSF concentrations of 2-4 ppm failed to hatch.

At six days post fertilization, the eggs exposed to SWSF or SWSF and metals were retarded in growth. After ten days many embryos had died. Those eggs which had been exposed to 100 and 1,000 ppb cadmium along with the SWSF had no embryos with detectable heartbeats at 10 days. Exposure of eggs to 100 ppb cadmium and 1,000 ppb cadmium without SWSF resulted in a decrease in embryonic heartbeat rate, whereas 5 ppb cadmium and the lead exposures alone had no apparent effect on this physiological parameter. Herring larvae that hatched in 1 ppm lead had their heads bent downward at a 90° angle. A few of the hatched larva at 100 ppb lead also exhibited this deformity.

Fertilization of herring eggs in the presence of up to 4 ppm SWSF, Corexit 9527 (to 1 ppm), lead (100 ppb), or cadmium (100 ppb) resulted in up to a 7% decrease in fertilization success.

Samples of herring eggs exposed to cadmium were taken for analysis of possible effects of cadmium on chorion thickness and chorionases. The data are being analyzed and will be reported later.

PRELIMINARY INTERPRETATION OF RESULTS

Behavior

Inhibition of the green sea urchins defensive behavior following exposure to the SWSF of PBCO and toluene have several important connotations: (1) A principal component of the SWSF, toluene, is not acting alone as an inhibitor; (2) the results suggest the pedicellaria defense inhibition resulting from hydrocarbon exposure is a chemosensory specific reaction and not general narcosis; and (3) low ppb concentrations of water-soluble petroleum hydrocarbons have an inhibitory effect on this chemosensory mediated behavior. The bottom line implication of this observation of course lies in the interaction of both predator and prey exposed to petroleum hydrocarbons simultaneously. In field ecological studies, considerable attention should be paid to behavioral parameters which are induced by chemical stimuli for they appear to be among the most sensitive to disruption by petroleum hydrocarbons.

Physiology

The metabolism of oil components by larval herring implies that exposure to oil may lead to the formation of additional compounds which may interact with the continued embryological developments taking place. The spot shrimp data indicates that metabolites of oil may be passed from one level of a food web to another. Both these results may intimately relate to the ecological fitness of the organism.

Pathology

Pathological Changes in Flatfish from Exposure to Oil-contaminated Sediment

Considerable variation between the ability of different sediment types to take up and release petroleum hydrocarbons was observed. For example, in a previous experiment (McCain et al. 1978) with a sediment of high sand content contaminated with PBCO (0.2% v/v) about 40% of the TEPH was lost during the first month. This compares with a 15% loss from the high-silt sediment when using the same crude oil. Also, the levels of aromatic hydrocarbons in the tissues of English sole on oiled high-silt sediments were 10 to 40 times lower than those from the same species on sandier sediment containing about 1/4 the amount of TEPH (McCain et al. 1978).

In spite of the lower tissue concentrations of aromatic hydrocarbons in English sole on oiled high-silt sediments, these fish developed severe HLV, much the same as was previously reported for fish of this species exposed to the above-mentioned coarse, sandy sediments. Two explanations which may account for this observation are (1) low, marginally detectable, levels of certain petroleum compounds may be able to induce lipid accumulation in English sole livers, and (2) some petroleum compounds which cause liver changes may be quickly metabolized and are therefore undetectable by conventional GC/MS.

Effects of Petroleum on Fish Disease Resistance

Tests completed to date suggest a short-term exposure to sediment containing PBCO does little to alter disease resistance of rock sole. Future work will concentrate on repeating this observation in other flatfish species, on juveniles, and on assessment of disease resistance following a longer exposure to oil-containing sediment.

Morphology

Adherence of petroleum to the surface of herring eggs indicates that these droplets of petroleum, while not massive in amount, may cause localized damage or provide a source for continuous oil absorption into the egg. Herring eggs may be particularly vulnerable to exposure from slicks at the intertidal zone where petroleum could coat the egg masses and remain adhered. The surface characteristics of teleost eggs from various species are so different (See OCSEAP Annual Report, Morphology, April 1978) that the degree of adherence of petroleum would be expected to vary.

Chemistry

Metabolism of Hydrocarbons in Demersal Fish

The present results show that pleuronectids, similar to salmonids (Varanasi and Malins 1977, Collier et al. 1978, Roubal et al. 1977b), are able to absorb and metabolize dietary naphthalene, and, that the naphthalene and its metabolic products are broadly distributed throughout the body. The findings show that rock sole contained significantly larger concentrations of naphthalene and its metabolic products than did starry flounder. Certain differences were observed in the digestive tracts of flounder and sole; the gut of the latter contained several fingerlings of pyloric caeca; whereas, the gut of the former was devoid of such structures. The results suggest that differences observed in the levels of accumulation of naphthalene in these fish may be due, at least partly, to the structural and functional differences between the digestive tracts of the two species.

These results suggest that compared to starry flounder, rock sole accumulate and retain larger amounts of dietary naphthalene and its oxygenated products. Whether such a difference is also observed when the hydrocarbon is present in the water is not yet known.

Because of their solubility in lipid, it was proposed (Whittle et al. 1977) that the extent of accumulation of hydrocarbons in organisms may be related to the lipid content of tissues. The accumulation of naphthalene in tissues of the fish in the present study did not seem to be related solely to the lipid content; in fact, liver, muscle, and skin of starry flounder were richer in lipid than the respective tissues of the rock sole.

Biotransformation of Petroleum Hydrocarbons

The results of the food-chain transfer of 2,6-DMN to *Fucus* to sea urchins are significant. The data show that the sea urchin does not avoid food contaminated with 2,6-DMN. Therefore, the potential for exposure to hydrocarbons remains when the primary producers are exposed even though the water may be cleared of residual hydrocarbons through the action of current flow and/or dispersion.

With regard to the free radical burden in liver, it should be pointed out that many short-lived radical species are damaging agents (Roubal and Tappel 1966), and mimic ionizing radiation in their effects (Roubal and Tappel 1967). Moreover, evidence points to the formation of short-lived free radical intermediates, derived from hydrocarbons, during the metabolic conversion of hydrocarbons to water-soluble metabolites.

The significantly lower levels of organic free radicals in liver of fish exposed for a week or more to hydrocarbons is of interest. The lower levels of radicals may indicate that enzymes or other macromolecular species have undergone activation and are effectively scavenging radicals and/or are preventing additional radical formation. The results indicate that attention ought to be given to the significance of radicals in marine organisms exposed to hydrocarbons, and to the possible damaging effects of free radicals.

Effects of Cadmium and Lead

Preliminary interpretation of the results suggests that concentrations of 2-4 ppm SWSF in the water column may severely retard development of herring embryos and could result in the failure of eggs to hatch. The results also suggest that cadmium may act additively or synergistically with SWSF in retarding the development of herring eggs.

The presence of SWSF (up to 4 ppm), Corexit 9527 (up to 1 ppm), cadmium (100 ppb), or lead (up to 100 ppb) does not appear to have a major effect on the successful fertilization of herring eggs.

AUXILIARY MATERIAL

BIBLIOGRAPHY OF REFERENCES

BENVILLE, P.E., JR., T. YOCUM, P. NUNEZ, and J.M. O'NEILL (1978) Simple continuous flow-through system for dissolving the water-soluble components of crude oil in seawater for acute or chronic exposure of marine organisms. Mar. Biol. (Submitted).

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).

HANSON, S.W.F. and J. OLLEY (1963) Application of Bligh and Dyer method of lipid extraction to tissue homogenates. Biochem. J. 89:101.

McCAIN, B.B., H.O. HODGINS, W.D. GRONLUND, J.W. HAWKES, D.W. BROWN, M.S. MYERS, and J.H. VANDERMEULEN (1978) Bioavailability of crude oil from experimentally oiled sediments to English sole (*Parophrys vetulus*) and pathological consequences. J. Fish. Res. Board Can. 35:657-64.

ROUBAL, W.T. (1965) Ph.D. Thesis, Univ. California, Davis.

ROUBAL, W.T. and A.L. TAPPEL (1966) Polymerization of proteins induced by free-radical lipid peroxidation. Arch. Biochem. Biophys. 113:150.

ROUBAL, W.T. and A.L. TAPPEL (1967) Damage to ATP by peroxidizing lipids. Biochim. Biophys. Acta 136:402.

ROUBAL, W.T. (1972) Spin-labeling with nitroxide compounds. A new approach to the in vivo and in vitro study of lipid-protein interaction. IN: Progress in the Chemistry of Fats and Other Lipids (R.T. Holman, ed.), Pergamon Press, New York.

ROUBAL, W.T., D.H. BOVEE, T.K. COLLIER, and S.I. STRANAHAN (1977a) Flow-through system for chronic exposure of aquatic organisms to seawater-soluble hydrocarbons from crude oil: Construction and application. IN: Proceedings 1977 Oil Spill Conference (Prevention, Behavior, Control, Cleanup), p. 55-5. American Petroleum Institute, Washington, D.C.

ROUBAL, W.T., T.K. COLLIER, and D.C. MALINS (1977b) Accumulation and metabolism of carbon-14 labeled benzene, naphthalene and anthracene by young coho salmon (Oncorhynchus kisutch). Arch. Environ. Contam. Toxicol. 5:513-29.

SOKAL, R.R. and F.J. ROHLF (1969) Biometry. IN: The Principles and Practices of Statistics in Biological Research. W.H. Freeman and Co., San Francisco.

VARANASI, U. and D.C. MALINS (1977) Metabolism of petroleum hydrocarbons: Accumulation and biotransformation in marine organisms. IN: Effects of Petroleum on Arctic and Subarctic Marine Environments and Organisms (D.C. Malins, ed.), Vol. II, p. 175-270. Academic Press, New York.

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).

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. (In press).

WHITTLE, K.J., J. MURRAY, P.R. MACKIE, R. HARDY, and J. FARMER (1977) Fate of hydrocarbons in fish. Int. Counc. Explor. Sea 139-42.

PAPERS IN PREPARATION, IN PRINT, OR IN PRESS

HAWKES, J.W. and S. GAZAREK. The effects of petroleum on the lens of rainbow trout: Hydration and cataract formation (In preparation).

HAWKES, J.W. and S. GAZAREK. Comparative ultrastructure of lenses from representative demersal teleosts (In preparation).

HODGINS, H.O., B.B. McCAIN, and J.W. HAWKES. Pleuronectid fishes of the northeastern Pacific Ocean: A synopsis of their biology, pathology, and vulnerability to oil pollution. (In preparation).

HAWKES, J.W., Chairperson, Histopathology Panel Report. IN: Results of Alaskan Workshop on Oil Spill Ecological Damage Assessment, EPA, NOAA. (In press).

HAWKES, J.W. The morphological effects of petroleum and chlorobiphenyls on fish tissues. Proc. Natl. Acad. Sci. (In press).

McCAIN, B.B., H.O. HODGINS, W.D. GRONLUND, J.W. HAWKES, D.W. BROWN, M.S. MYERS, and J.H. VANDERMEULEN. Bioavailability of crude oil from experimentally oiled sediments to English sole (Parophrys vetulus), and pathological consequences. J. Fish. Res. Board Can. 35:657-64.

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. 7:237-44.

VARANASI, U. Factors influencing disposition and biochemical modification of petroleum in marine organisms. (In preparation).

VARANASI, U., D.J. GMUR, and P.A. TRESELER. Metabolism of naphthalene in vivo in three species of pleuronectids. (In preparation).

ORAL PRESENTATIONS

HODGINS, H.O. (1978) Current Research on the Effects of Petroleum on Marine Organisms at the Northwest and Alaska Fisheries Center. Second Annual Dept. of Energy West Coast Marine Science Contractors Program Review/Information Exchange Meeting, La Jolla, Calif., April 12, 1978.

VARANASI, U. (1978) Metabolism and Disposition of Naphthalene in Starry Flounder (Platichthys stellatus). 62nd Annual Meeting of Federation of American Biological Societies, Atlantic City, N.J., April 1978.

VARANASI, U. (1978) Naphthalene Metabolism in Pleuronectidae: Characterization of Individual Metabolites in the Bile. 69th Annual Meeting of American Society of Biological Chemists, Atlanta, Georgia, June 1978.

VARANASI, U. (1978) Xenobiotic Metabolism in Marine Organisms. A seminar given at Skidaway Institute of Oceanography, Savannah, Georgia, June 1978.

VARANASI, U. (1978) Influence of Environmental Conditions on Metabolism and Disposition of Aromatic Hydrocarbons in Marine Organisms. 33rd American Chemical Society's Northwest Regional Meeting, Seattle, Washington.

PROBLEMS ENCOUNTERED AND RECOMMENDED CHANGES

BEHAVIOR

The flatfish avoidance studies are behind the original time schedule. This is due partially to effort devoted to preliminary planning for studies of effects of dispersants, which will be discontinued because of a change in emphasis by OCSEAP, and partially to problems with design of suitable testing apparatus. It is anticipated that flatfish avoidance studies will be in progress in the near future.

PATHOLOGY

A problem common to a number of experiments described in this report has been the apparent fragility of rock sole held under laboratory conditions. They appear to be much more susceptible to diseases and to changes in temperature and oxygen concentrations than do English sole and starry flounder.

Efforts will be continued to improve the survival rate of this species by using gentler capture techniques and improved aquarium conditions. However, if similar mortalities continue to occur, then a substitute species, such as flathead sole (Hippoglossoides elassodon) may have to be chosen.

CHEMISTRY

Lack of fish for testing has slowed progress. Improving our fish transportation facilities and greater fish availability during spring and summer should help alleviate this problem.

Some difficulties were experienced in successfully fertilizing sufficient quantities of eggs from starry flounder and flathead sole. Most of the problems have been resolved; however, these species will not be available until the next spawning season.

ESTIMATE OF FUNDS EXPENDED - 292 K

QUARTERLY REPORT

Contract No: R7120810
Research Unit No: RU-77
Reporting Period: April 1-June 30, 1978
Number of Pages: 1

NUMERICAL ECOSYSTEM FOR THE EASTERN BERING SEA

Co-Principal Investigators

T. Laevastu and F. Favorite

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

June 1978

QUARTERLY PROGRESS REPORT
Reporting Period: April 1-June 30, 1978

Project Title: Numerical Ecosystem Model for the Eastern Bering Sea, RU-77

I. Highlights of Quarter's Accomplishments

The extended model (DYNUMES III) has been optimized, the model deck has been complemented with numerous comments and operation instruction cards and this optimized model has been debugged and tested. The magnitudes of natural fluctuations in the ecosystem and possible effects of oil exploration/exploitation on fishery resources have been studied with preliminary computer runs (with model in predictive mode). However, final evaluation of these processes can be made when latest input data have been obtained from OCSEAP.

We have had no response from OCSEAP offices to our previous requests (see quarterly reports submitted in December and March) for biological data for the Bering Sea, obtained by other OCSEAP projects, nor estimates of the nature, magnitude, and effects on individual organisms of possible oil exploration/exploitation leaks, spills, or disasters. When these data are provided we are prepared to simulate ecosystem responses.

II. Task Objectives

(same as in previous quarterly report)

III. Field and Laboratory Activities

(same as in previous quarterly report)

IV. Results

(see I above)

V. Preliminary Interpretation of Results

(see I above)

VI. Auxiliary Material

N.A.

VII. Problems Encountered/Recommended Changes

(same as in previous quarterly report) In addition, we would appreciate analyzed data on transport and mixing in the Bering Sea from other pertinent OCSEAP tasks.

VIII. Estimate of Funds Expended

$39K

QUARTERLY REPORT

Contract No.
Research Unit #78
Reporting Period-April 1,-June 30, 1978
Number of Pages - 2

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

July 1, 1978

I. Abstract

During this quarter we analyzed data from quantitative samples collected primarily in the Pribilof Islands and at two sites (Spectacle Island and Cape Nukshak) on the southern coast of the Alaska Peninsula. A report on the results of the analyses is being prepared for submission in July 1978. Problems associated with converting data to the NODC format have caused delays in submission of data to NODC.

II. Objectives

Our objectives are to describe the distribution and abundance patterns of benthic plants and invertebrates in intertidal communities at representative sites along the coast of Alaska, to compare the patterns within and between sites, and to try to relate them to community structure.

III. Field or Laboratory Activities

No field studies were conducted. Laboratory activities involved graphical and numerical analyses of species composition and weights and abundances of plants and invertebrates in intertidal communities in the vicinity of the Alaska Peninsula and the Pribilof Islands (St. George Basin).

IV. Results

We are writing up the results of our analyses of species-abundance/size data for St. George Basin and the southern part of the Alaska Peninsula. A report on our studies in these areas will be submitted in July 1978.

V. Auxiliary Material

A. Papers in preparation.

Calvin, N.I. and R.J. Ellis. 1978. Quantitative and qualitative observations on Laminaria dentigera and other subtidal kelps of southern Kodiak Island, Alaska. Marine Biology (in press).

Zimmerman, S.T., N.I. Calvin, J.T. Fujioka, J.A. Gharrett, J. Hanson, 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).

B. Oral presentations.

On February 22, 1978 N.I. Calvin and C.E. O'Clair gave the following papers at the 1978 Annual Meeting of the Alaska Chapter American Fisheries Society in Sitka, Alaska:

Quantitative and qualitative observations on *Laminaria dentigera* and other subtidal kelps of southern Kodiak Island, Alaska., N.I. Calvin.

Intertidal communities as indicators of stress in the marine environment, C.E. O'Clair.

On April 17-21, 1978, Ted Merrell participated in a Program Review of OCSEAP hydrobiology projects at Santa Cruz, California, and presented a summary of "Baseline/Reconnaissance Characterization: Littoral Biota Bering Sea (Norton Sound, Bristol Bay, St. George Basin) Kodiak, Northeast Gulf of Alaska".

VI. Problems Encountered and Recommended Changes

We have recently had difficulty converting certain types of data on magnetic tape to the NODC format. Because of the expense in processing large amounts of data we have used a low priority on the computer while attempting to correct the problem. The resulting delays and limitations on access to the computing system have caused us to fall behind in submitting to NODC data collected in the Eastern Gulf of Alaska (NEGOA), Bristol Bay, and the Pribilof Islands in 1975 and at Kodiak Island in 1976. J. Grimm of the Biometrics and Resource Management Analysis group at the Auke Bay Lab is attempting to rectify the problem.

VII. Estimate of FY 1978 Funds Expended through May 31, 1978.

Salaries	$44.4k
Travel	2.1
Contracts (Computer Services)	6.8
Equipment & Supplies	1.9
Other Direct & Indirect Costs	17.6
TOTAL	$72.8k

13th Quarterly Report

Contract No. 03-5-022-72

Research Unit 083

Reporting Period 1 April 1978-
30 June 1978

REPRODUCTIVE ECOLOGY OF PRIBILOF ISLAND SEABIRDS

George L. Hunt, Jr.

Department of Ecology
and Evolutionary Biology

University of California

Irvine, California 92717

1 July 1978

I. Abstract

During the 13th quarter emphasis has been placed on preparing for and starting the 1978 field season. Personnel went to Alaska in mid-April in order to join the _Surveyor_ in Kodiak for five days of censusing near the Pribilofs. This work went very well and showed bird distribution to be different from that found when nesting is underway. In particular, Murres were more dispersed at sea and not as clumped near the island, and many more waterfowl were seen than on previous cruises. Field work on both St. Paul and St. George Islands is now underway, with birds returning and cormorants on St. Paul nesting unusually early following a mild winter. We have also put NOAA funded personnel on two PROBES cruises in order to study the relationship between physical and biological oceanographic data and bird distribution.

II. Task Objectives

1) Prepare for field season
2) Participate in _Surveyor_ cruise April-May (5 days)
3) Set up study sites and commence colony work on St. Paul and St. George Islands
4) Participate in PROBES cruises

III. Laboratory Activities

A. Trips

1) Naughton, Rodstrom and Squibb joined the _Surveyor_ in Kodiak and then were left on the Pribilofs.
2) Naughton flew to Dutch Harbor to join the PROBES vessel for a three week cruise.
3) Hunt flew to Dutch Harbor to join the PROBES vessel for a two week cruise and Naughton returned to St. Paul.
4) Braun and Pitts flew to St. Paul and St. George Islands respectively to aid in colony work.

Laboratory:

1) Burgeson continues to work on food samples from 1977 that required further checking and is rechecking some early 1975 identifications.
2) Bush is cleaning up the last of the 1975-1977 data for punching and submission

B. Scientific Party

George L. Hunt, Jr.	Associate Professor, UCI, P.I.
Barbara Braun	Graduate STudent, UCI, participating in colony work, St. Paul Is., aiding with data management in the field.
Barbara Burgeson	Administrative Assistant I, UCI, administrative chores, food sample work-up.
Grace Bush	Coder, UCI, data management
Maura Naughton	Laboratory Assistant II, UCI, participating in colony work, St. Paul Is., and on at-sea surveys.
Mary Pitts	Laboratory Assistant I, UCI, participating in colony work St. George Is.
William Rodstrom	Laboratory Assistant II, UCI, in charge, colony work, St. Paul Is. and participating on at-sea surveys.
Ron Squibb	Laboratory Assistant II, UCI, in charge, colony work, St. George Is. and participating on at-sea surveys.

C. Methods

We are using the same methods as used in previous years. Please see the 1977 Annual Report (1 April 1978).

D. Sample Locations/Tracklines

Field work is being conducted on St. Paul and St. George Islands in the Pribilof Islands.

Tracklines for the Surveyor cruise are appended.

E. Data collected:

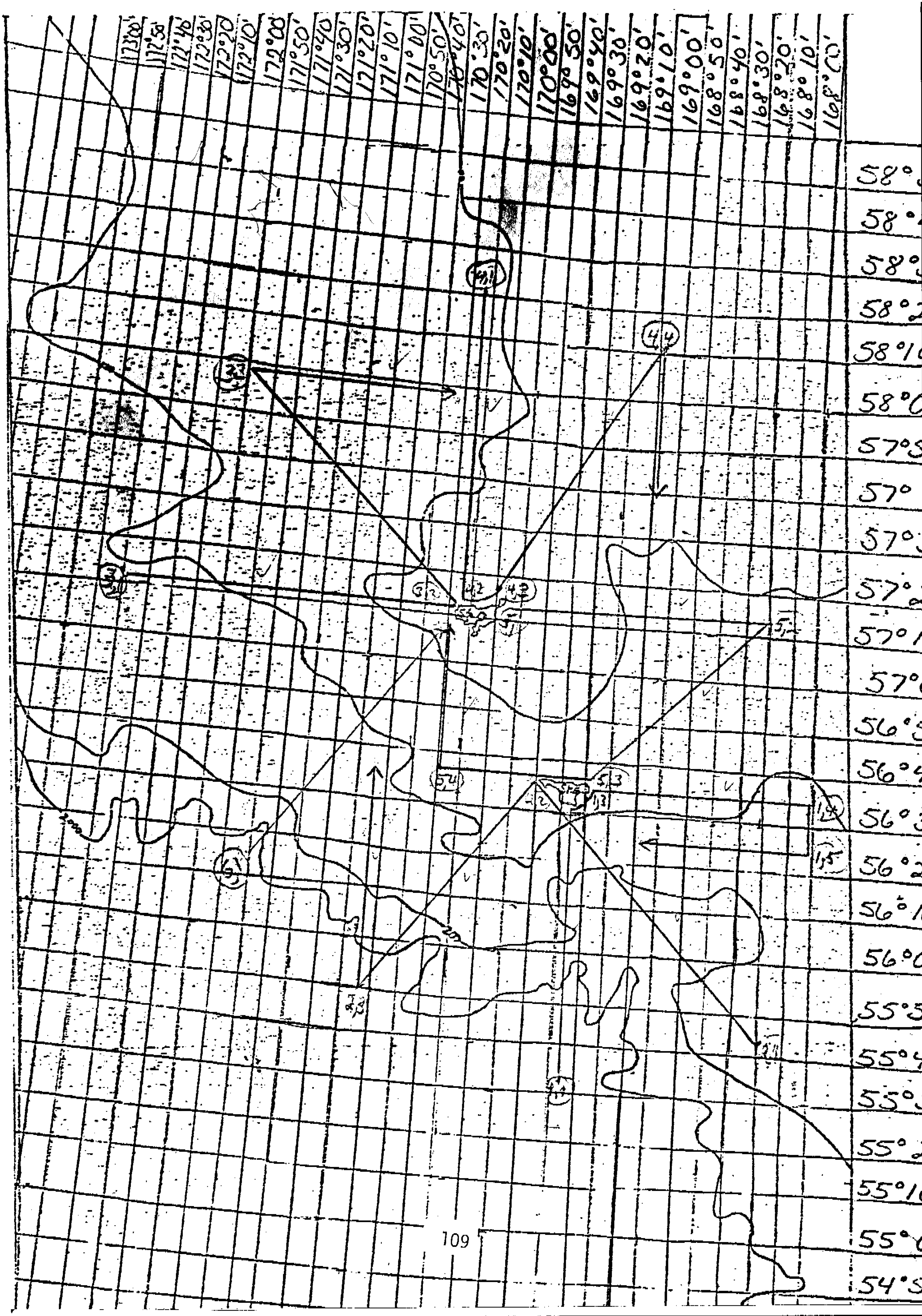
1) The first Surveyor cruise yielded 423 10 minute transect segments plus four hours of helicopter survey. Tabulations of the number of segments run on the PROBES cruises are not yet available.
2) Study sites have been set up on St. Paul and St. George Islands and collections of data on phenology, reproductive success and food habits is underway.

Data analysed:

Little data analysis was involved during this quarter.

IV, V. Results and Preliminary Interpretation

None available for 1978 data, save the impressions mentioned in the abstract.



Pribilof Island Bird Survey

VI. Auxiliary Material

None

VII. Problems Encountered

No serious problems have been encountered.

VIII. Estimate of funds expended (Direct Costs)

	Total appropriated 1975 - 1978	Total expended 1975-30 Apr '78	Balance as of 30 April 1978
Salaries	108,714	83,029	25,685
Employee Benefits	16,028	8,778	7,250
Supplies	20,499	14,046	6,453
Equipment	8,647	8,790	(143)*
Travel	37,966	27,457	10,509
Other	7,538	2,311	5,227
Total	199,392	144,411	54,981

* deficit - does not yet reflect $7,500 appropriated for data entry system.

There have been several increases in costs and the need to hire Barbara Burgeson four months before originally anticipated to work up food samples that we were unable to complete sorting or rechecking by last April. These additional costs have increased our projected expenditures, but it is still anticipated that we will complete the work contracted for with the funds allocated.

MILESTONE CHART

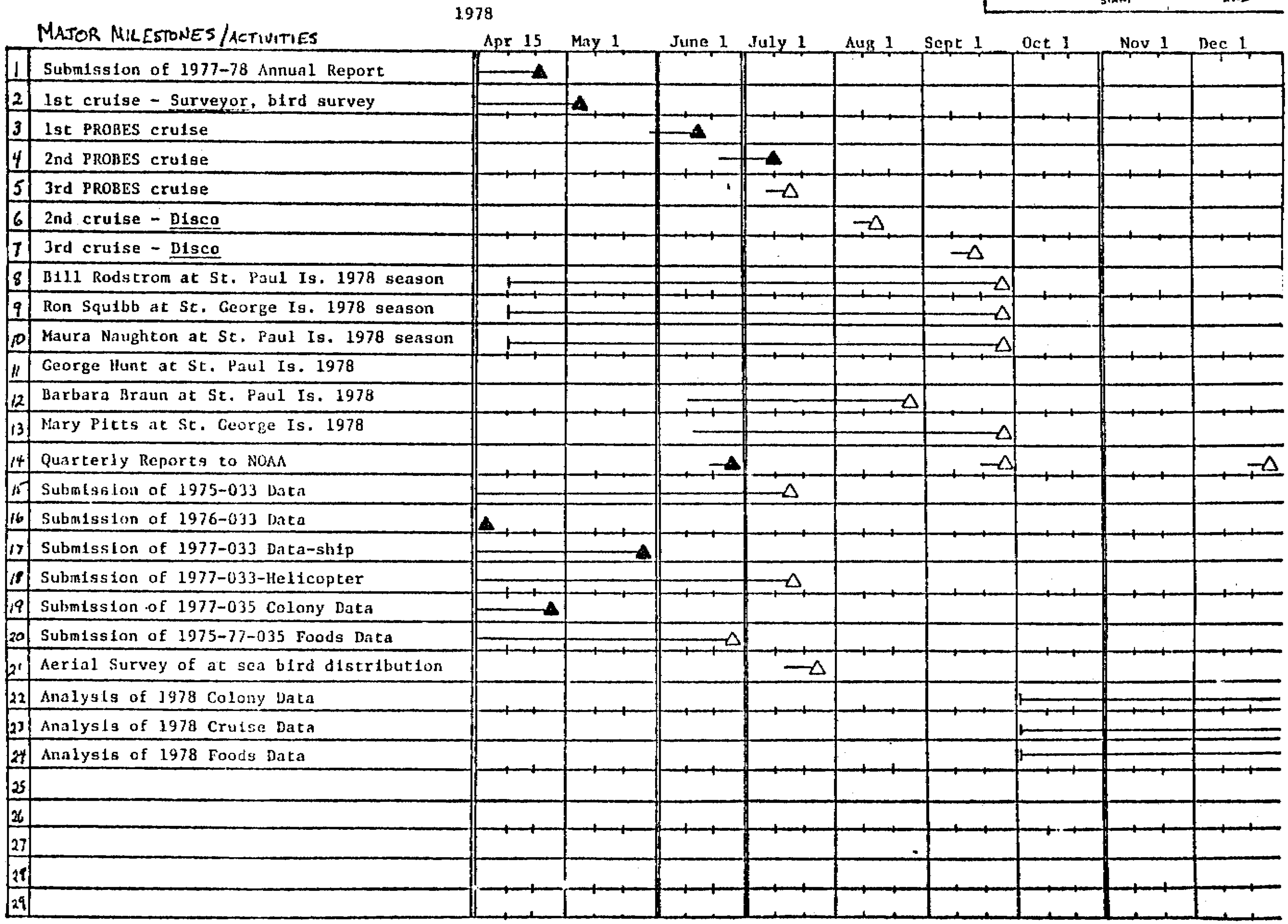
PROJECT: PRIBILOF ISLAND SEABIRDS

PRINCIPAL INVESTIGATOR: GEORGE L. HUNT JR

DATE: 1 July 1978

MILESTONE: PLANNED △ COMPLETED ▲

ACTIVITY START END



QUARTERLY REPORT

Contract # 03-5-22-67, Task Order 6
Research Unit # 87
Reporting Period: 1 April 1978 -
30 June 1978

Number of Pages: 6

THE INTERACTION OF OIL WITH SEA ICE

Seelye Martin
Department of Oceanography WB-10
University of Washington
Seattle, Washington 98195

20 June 1978

I. Task Objectives: To understand the small scale interaction of petroleum and sea ice. Our eventual aim is to predict how an oil spill or a well blow-out would interact with pack ice.

II. Field or Laboratory Activities

II-1. Laboratory Activities: During the past quarter, we carried out a series of experiments on the interaction of pollutants and grease ice. We find when waves propagate into grease ice, that because of the non-linear viscosity of grease ice, the wave amplitude decays linearly, with the grease ice nature undergoing a transition from a liquid to a solid as the waves' amplitude becomes small. On one side of this transition, the waves propagate as water waves; on the other, they propagate as elastic waves. When oil is released into this wave-agitated ice, it accumulates at the liquid-solid transition. This work will be described further in a report to be submitted in September.

II-2. Field Activities: (Because our annual report was submitted before we left for our March field traverse, we will summarize the results of that traverse here.)

A. Field Trip Schedule:

1. Dates: 3-22 March 1978

2. Aircraft: Bell 205 helicopter supplied by NOAA

B. Scientific Party:

Seelye Martin, University of Washington, Chief Scientist
Peter Kauffman, University of Washington, Research Scientist
Steven Soltar, University of Washington, Marine Technician

C. Methods: We studied the ice properties in Norton Sound, Kotzebue Sound, and off Cape Lisburne. We filmed the propagation of waves in grease ice, and analyzed ice cores for their temperature, salinity, and crystal structure.

D. Sample Localities: The attached charts show the location of our ice cores. Because the ice blew out in Norton Sound just after we arrived, we were restricted to working with shorefast ice in that region. The symbols on the traverse lines in Kotzebue Sound and off Cape Lisburne stand for Kivalena, Thompson, and Lisburne, respectively.

E. Data Collected or Analyzed:

1. Numbers and types of sample/observations: 24 ice cores.

2. Number and types of analysis: We measured the temperature and salinity profiles of the ice cores as well as photographed their crystal structure.

3. Miles of trackline: Approximately 180 nautical miles.

III. Results: A formal data report will be submitted to the OCSEAP office by 15 August.

IV. Preliminary Interpretation of Results

During the traverse, we occupied 22 surface stations, and took about 10 minutes of movie film of ocean waves propagating into grease ice. Specifically, our stations consisted of the following work:

a. Nome, 3-10 March. The day after we arrived in Nome, the pack ice blew out, so that by 6 March, it was 10-20 n.m. offshore, or well beyond the range of safe, over-water flying. Because the blowing-out of the pack ice was accompanied by high winds and cold air temperatures, considerable grease ice formation took place. Most of our time at Nome was spent on examination of this grease ice; we took aerial films of the ice and worked from a spit of ice which extended from the shorefast ice out to Sledge Island. From this spit, we looked at some of the downwind piling-up of the grease ice, and were able to measure a grease ice depth in one case which was greater than 1 m. We saw, however, very little evidence of grease ice being forced underneath the pack ice by the action of wind and waves. We also obtained several cores from nilas, and made many observations of the interaction of ice and waves.

b. Kotzebue, 11-22 March. From our base in Kotzebue, we ran three different sections from Kivalena, Cape Thompson, and Cape Lisburne, which we discuss in that order.

i. Kivalena. Working on a line based out of the village of Kivalena, we ran a traverse line 60 n.m. in length with stations at 10 n.m. intervals on 200°T. This line ran through the pack ice in Kotzebue Sound, which varied from open water and thin ice at the northern end, to heavily-ridged pack ice at the southern end. The mean depth of the pack ice was 1.1 m, and we observed a great deal of ridging. With the exception of the absence of multi-year ice, this traverse could have taken place in the Beaufort Sea.

ii. Cape Thompson. We ran a 50 n.m. line with stations at 10 n.m. intervals on 200°T. This line ran through an area which satellite photographs show is periodically swept clean of ice by strong NE winds. At our stations, the ice had been formed only recently, because its thickness was only about 0.4 m, and its crystal structure was almost entirely frazil. In other words, all of the ice on this section showed evidence of forming in a strongly wind-mixed sea.

At the 40 and 50 n.m. stations, the ice surface consisted of pancakes which had diameters of about 1.0 m and thicknesses of 0.1 m. These pancakes lay above the deeper layer of frozen frazil ice and were rafted into a chaotic surface terrain, which a quick aerial survey showed extended over 100's of km^2. These observations are consistent with our laboratory studies, which show that pancake ice forms from the surface solidification of a much deeper layer of grease ice. At the inner stations, the ice surface was also rough, however, the roughness looked more like nilas rather than pancake ice. Again, the ice thickness was only 0.4 m, and the lower 0.1 - 0.2 m of the core was very soft and porous.

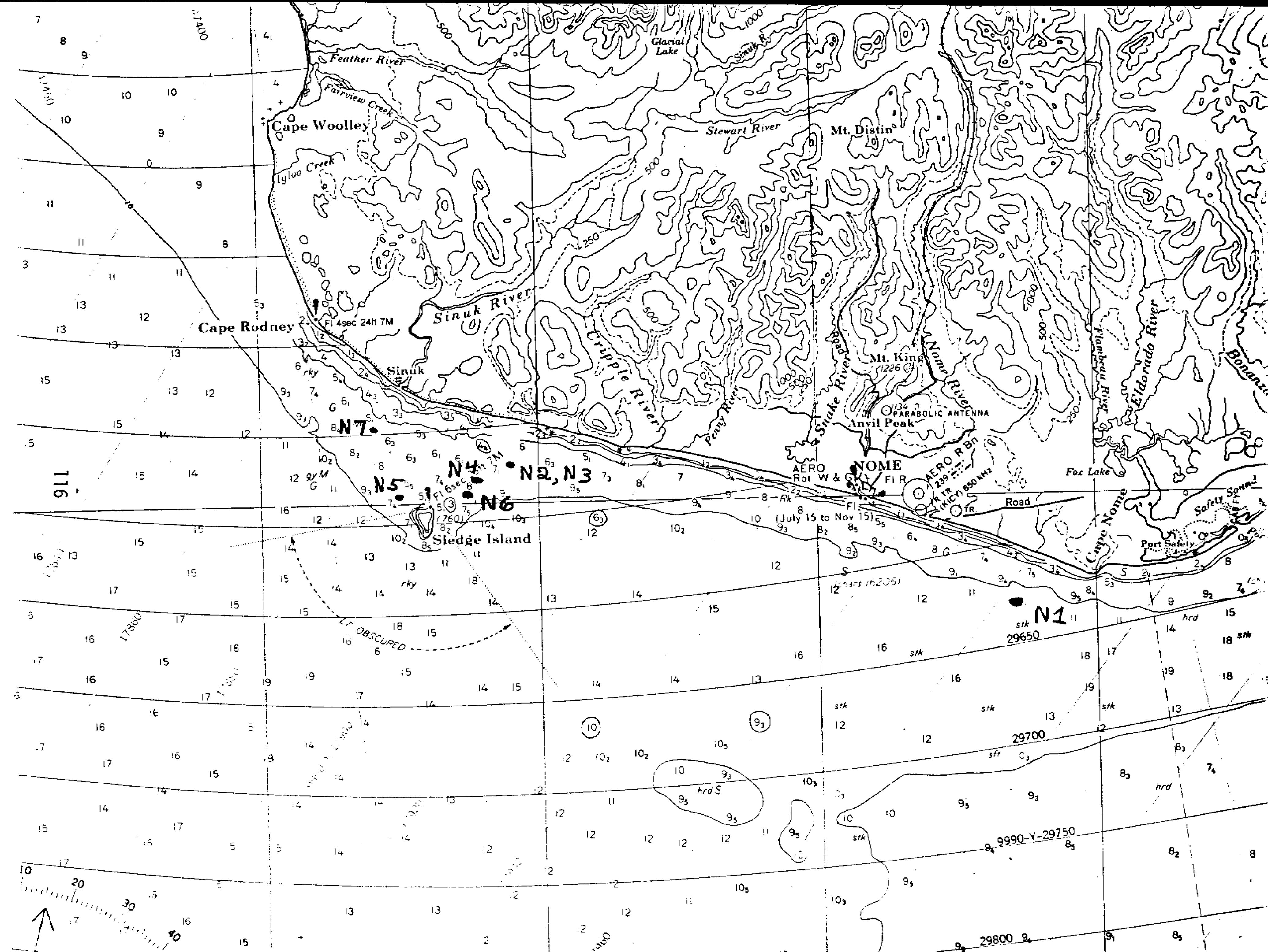
iii. Cape Lisburne. We ran a 60 n.m. line with stations at 10 n.m. intervals on 305°T out across the shear zone of the Chukchi Sea.

The ice observed on this line including the shore-fast ice, consisted of all first-year ice measuring 1.0 - 1.1 m in thickness. Immediately offshore of Cape Lisburne, there was a region of large leads and polynyas out to 10 - 20 n.m. Beyond this distance the ice cover was mostly closed. By chance, our station at 20 n.m. was immediately adjacent to one of Pat Martin's satellite-tracked buoys, which had been put down two days earlier.

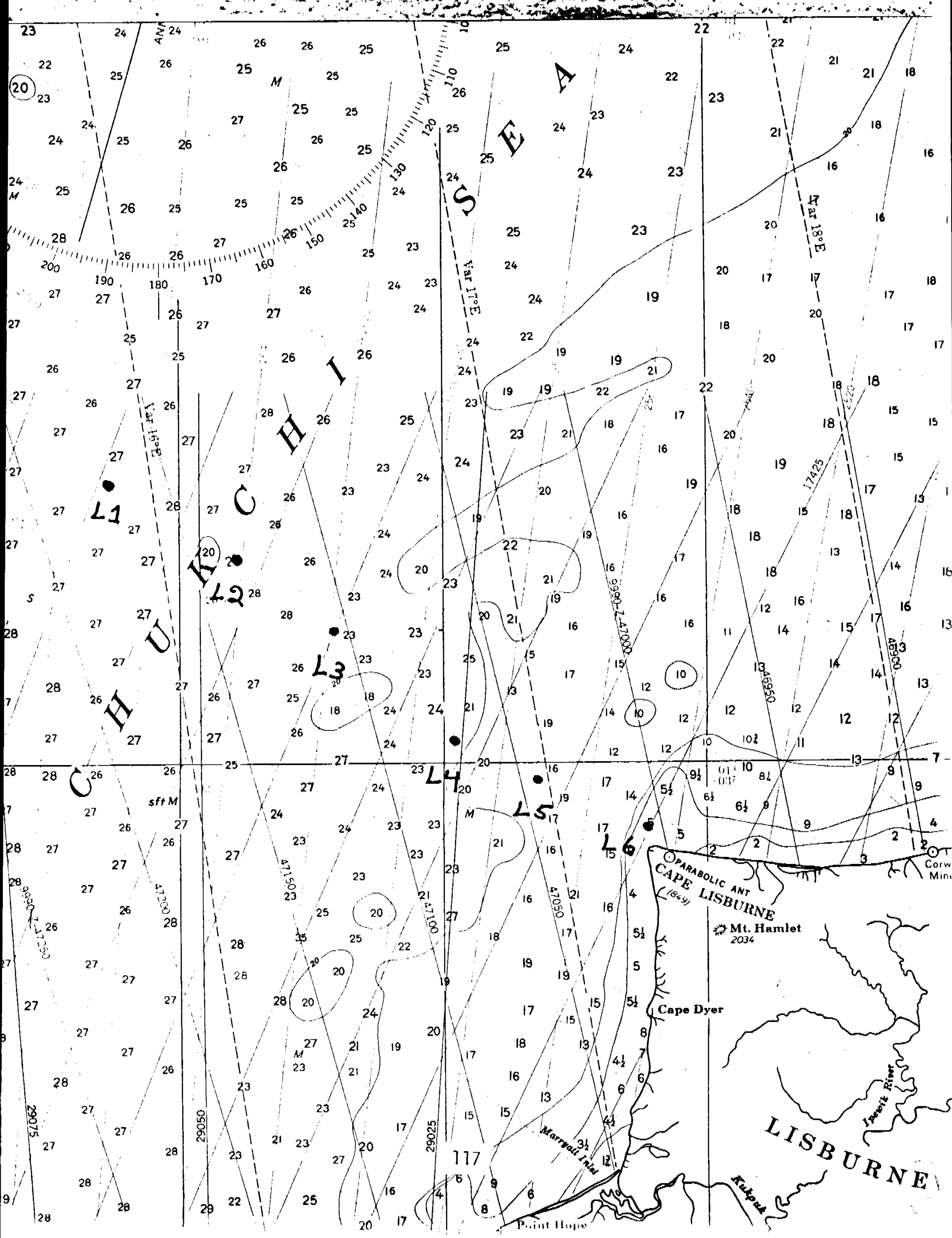
To summarize, our stations were much more interesting than our last year's work at Prudhoe Bay. In particular, combination of our filmed observations, the Cape Thompson traverse, and our laboratory work give us a greater understanding of how ice forms in regions of intense wind-mixing.

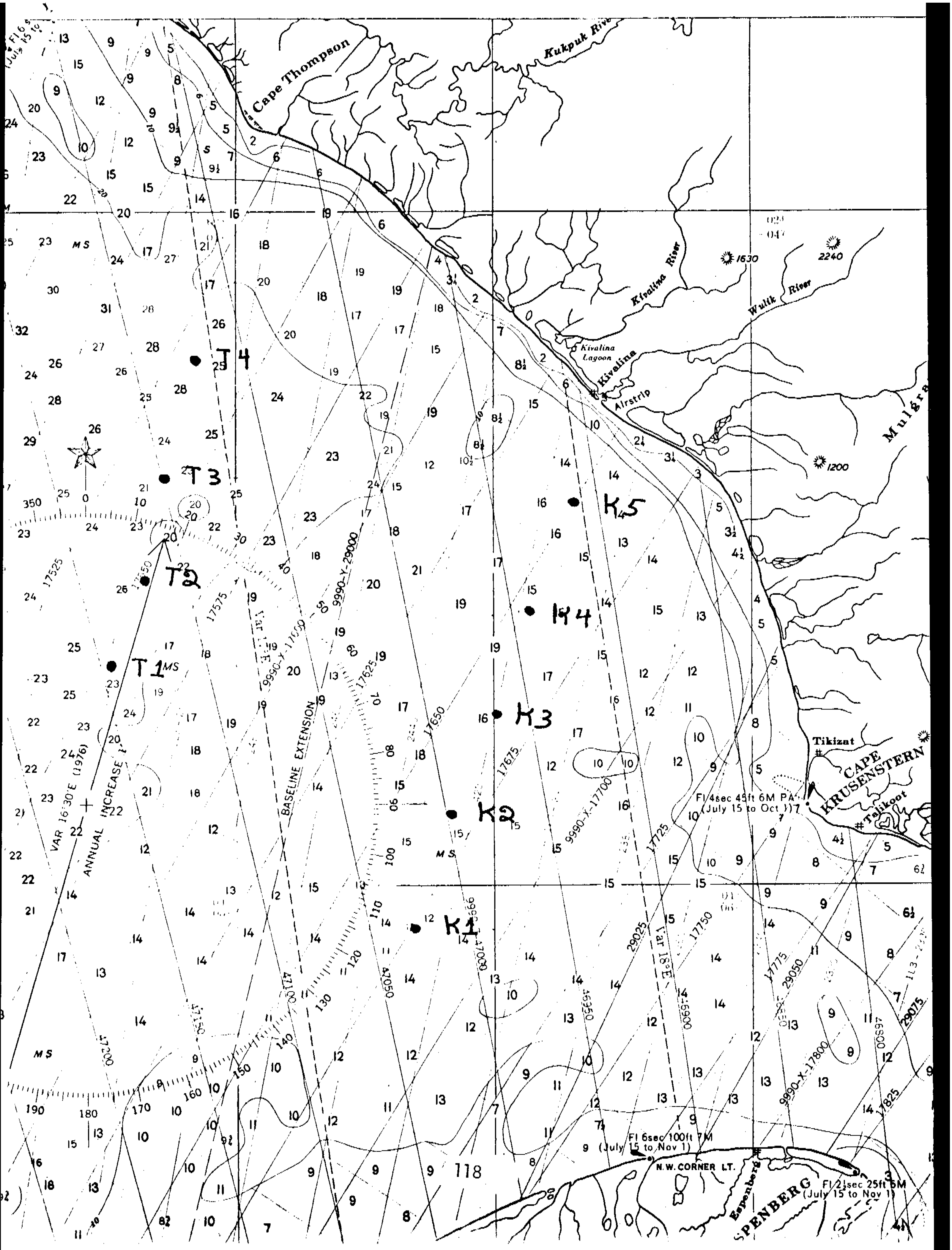
V. Problems Encountered/Recommended Changes: None.

VI. Estimate of Funds Expended: 75%.



Feather River
Fairview Creek
Cape Woolley
Igloo Creek
Glacial Lake
Sinuk R.
Stewart River
Mt. Distin
Sinuk River
Cripple River
Penny River
Snake River
Nome River
Flambeau River
Eldorado River
Bonanza
Cape Rodney
Fl 4sec 24ft 7M
Sinuk
Mt. King
1226
134 PARABOLIC ANTENNA
Anvil Peak
NOME
AERO Rot. W & G
AERO R Bn 239
TR (KICY) 850 kHz
Fl R
Fl
(July 15 to Nov 15)
Road
Fox Lake
Cape Nome
Safety Sound
Port Safety
Sledge Island
(760)
Fl 6sec
N1
N2, N3
N4
N5
N6
N7
LT OBSCURED
29650
29700
29800
9990-Y-29750
116


CHUKCHI SEA
LISBURNE
CAPE LISBURNE
PARABOLIC ANT
Mt. Hamlet
2034
Cape Dyer
Point Hope
Marryatt Inlet
Kukpuk
Ipewik River
Var 17°E
Var 18°E
L1
L2
L3
L4
L5
L6


Cape Thompson
Kukpuk River
Kivalina River
Wulik River
Kivalina Lagoon
Kivalina
Airstrip
Tikizat
CAPE KRUSENSTERN
Fl 4sec 45ft 6M PA (July 15 to Oct 1)
Fl 6sec 100ft 7M (July 15 to Nov 1)
N.W. CORNER LT.
Espenberg
SPENBERG
Fl 2½sec 25ft 5M (July 15 to Nov 1)
T4
T3
T2
T1
K5
K4
K3
K2
K1
BASELINE EXTENSION
VAR 16°30'E (1976)
ANNUAL INCREASE
Var 17°E
Var 18°E
9990-Y-29000
9990-X-17650
9990-X-17700
9990-X-17800
MS

QUARTERLY REPORT

R.U.#88: Dynamics of Near-Shore Ice
P.O.: 01-5-022-1651
Reporting Period: 1 April 1978 to 30 June 1978
Number of Pages: 5

DYNAMICS OF NEAR - SHORE ICE

Principal Investigators: A. Kovacs and W.F. Weeks

Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755

20 June 1978

I. Task Objectives

The purpose of this project is to:

a. study the motion of the fast ice and near-shore sea ice north of Prudhoe Bay and in the vicinity of the Bering Strait,

b. make observations on major ice deformation features that occur near the edge of the pack ice/fast ice boundary,

c. explore the use of a pulsed radar system to measure the characteristics of sea ice,

d. study the internal structure of near-shore sea ice,

e. characterize the spatial and temporal variations in sea ice pressure ridging via the use of laser profilometery and side-looking airborne radar (SLAR).

II. Field and/or Laboratory Activities

During this quarter, field observations were made by two separate field parties consisting of Kovacs and Morey and of Gow, Kohnen and Weeks. Subjects studied included under-ice morphology, crystal orientation in sea ice, anisotropy of the electrical properties of sea ice and shore-ice pile-ups.

A report on shore-ice piling is currently in preparation. The analysis of the laser profiles of near-shore ridging is nearly completed. A report entitled "Environmental Hazards to Offshore Operations Along the Coast of the Beaufort Sea" was prepared for the Arctic OCS Synthesis Report.

A visit was made to Tin City to try to diagnose and correct the electronic problems with the sea ice radar system that were caused by a power surge. Progress is being made but the system is still not running at full capacity. The new camera system appears to be quite satisfactory.

III. New Results

The results of the field programs are as follows:

a. Kovacs and Morey - Observations were made of under-ice morphology (see also R.U.#562) as well as of sea ice anisotropy and shore ice pile-ups. Impulse radar studies confirmed the findings of Kovacs and Morey (1978) that below the transition zone in first year ice the "bottom ice" has a preferred horizontal c-axis azimuthal orientation which is aligned with the prevailing current. DC resistivity measurements on first-year sea ice revealed no variation which could be correlated with the preferred crystal structure of the bottom ice. Shore ice piling up to 5 m high was observed on the beaches of Thetis, Pingok, and Cottle Islands. Ice ride-up and piling to a distance of 25 m and more from the waters edge was also observed. The field observations were carried out during April and May 1978.

b. Gow, Kohnen, and Weeks - A total of 36 sites were sampled in the coastal fast ice between Shishmaref in the Chukchi Sea on the west to Camden Bay in Beaufort Sea on the east. 32 of the 36 sites examined showed the development of a strong c-axis alignment in the columnar zone ice. This strongly supports the earlier suggestion that such alignments are typical of the Alaskan fast ice. Orientation patterns as well as the agreement with spot current readings strongly suggest that the controlling factor is the mean current direction under the ice. Excellent agreement was observed between crystal orientation and directional variations in the electrical resistivity of the ice. Temperature and salinity profiles were also obtained at all sites. Field observations were made between late March and early May 1978.

Studies of the laser data shows that a simple exponential distribution appears to give a reasonable fit to the observed ridge heights. Large variations in the amount of deformed ice were observed from season to season and from place to place. Invariabily the ice in a zone from 20 to 120 km off the coast was more deformed than ice further seaward. An analysis of the encounter probability of a fixed point offshore of Barter Island with large ridges indicates that on the average a ridge with a sail of 15 ft. (4.6 m) or greater is to be expected every time 13.3 km of sea ice drift over the spot.

The status of reports listed as submitted to journals in our last progress report is as follows:

a) Kovacs, A. (1978) Iceberg thickness and crack detection. In In "Proceedings of First International Iceberg Utilization Conference" (A. Huesseiny, ed.), Pergamon Press.

b) Kovacs, A. Radar profile of a multiyear pressure ridge. Arctic. (accepted for publication).

c) Tucker, W.B., III, Weeks, W.F., Kovacs, A., and Gow, A.J., (1977) Near-shore ice motion at Prudhoe Bay, Alaska. AIDJEX Sea Ice Symposium. Univ. of Washington Press. (accepted for publication).

d) Weeks, W.F., Tucker, W.B. III, Frank, M., and Fungcharoen, S. (1977) Characterization of the surface roughness and floe geometry of the sea ice over the continental shelves of the Beaufort and Chukchi Seas. AIDJEX Sea Ice Symposium. Univ. of Washington Press. (accepted for publication).

e) Weeks, W.F. and Gow, A.J. Preferred crystal orientations in the fast ice along the margins of the Arctic Ocean. Journal of Geophysical Research (Oceans and Atmospheres) (Accepted for publication).

f) Kovacs, A. and Morey, R.M. Radar anisotropy of sea ice due to preferred azimuthal orientation of the horizontal c-axes of ice crystals. Journal of Geophysical Research. (accepted for publication).

g) Kovacs, A. Some problems associated with radar sea ice profiling. Cold Regions Research and Engineering Laboratory Tech. Note, 6 p.

h) Kovacs, A. Remote detection of water under ice covered lakes on the North Slope. Cold Regions Research and Engineering Laboratory Report. (in press).

IV. Estimate of Funds Expended (as of 8 June 1978)

1. Narwhal Island:

Total	64,949.00
Spent	27,808.27
Remainder	37,140.73

2. Bering Strait/Remote Sensing:

Total	76,433.00
Spent	53,695.33
Remainder	22,727,67

3. Ice Conditions of the Beaufort and Chukchi Seas:

Total	31,994.00
Spent	6,362.26
Remainder	25,631.74

Overall Summary

Total	173,376.00
Spent	87,865.86
Remainder	85,510.14

Quarterly Report

Contract No:

03-5-022-67, T.O. #3

Research Unit No:

91

Reporting Period:

1 April - 30 June 1978

Number of Pages:

2

Current Measurements in Possible Dispersal Regions of the Beaufort Sea

Knut Aagaard

Department of Oceanography
University of Washington
Seattle, Washington 98195

22 June 1978

A78-14

I. Objectives

The objective of this work has been to obtain long-term Eulenair time series of currents at selected locations on the outer shelf of the Beaufort Sea. Such measurements are necessary to describe and understand the circulation on the outer shelf. It is this circulation which transports and dispenses the plankton, substances of biological and geological consequence, and pollutants. The water motion also influences the ice distribution and drift. The current time series must be long enough to define the important temporal scales of motion.

II. Field Activities

Recovery of the moorings presently deployed is scheduled for August-September 1978.

III. Results, and IV. Preliminary Interpretation of Results

Analysis of current records is continuing.

V. Problems Encountered

None.

VI. Estimate of Funds Expended to 31 May 1978.

Total allocation 10/1/77 - 9/30/78		$94,132
1. Salaries: faculty & staff	$ 5,638	
2. Benefits	865	
3. Indirect Costs	2,931	
4. Supplies & other direct costs	27,650	
5. Equipment	14,213	
6. Travel	3,166	
Total Expenditures	$54,463	
Remaining Balance		$39,669

Research Unit #96
Reporting Period - 1 April 1978-
30 June 1978

Quarterly Report

EFFECTS OF NORTH SLOPE CRUDE OIL EXPOSURE ON MARINE BIRD REPRODUCTION

by
Renee Patten
Sam Patten

The Johns Hopkins University
School of Hygiene and Public Health
615 North Wolfe Street
Baltimore, Maryland 21205

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

DEPARTMENT OF PATHOBIOLOGY

Middleton Island, Alaska
June 30, 1978

RU# 96

QUARTERLY REPORT

I. Schedule: April: completion and submission of Annual Report
May: Transit from Baltimore, Maryland to Alaska
Survey of Middleton Island; begin petroleum experiments.
June: Continue petroleum experiments; visits to Juneau, Fairbanks NOAA Project Offices; OBS-CE, Anchorage.

II. Objectives: Carry out continued experiments on North Slope Crude Oil exposure, both weathered and raw oil, effects on marine bird reproduction.

III. Site: Middleton Island, Alaska, 110 km S. of Cordova, Alaska, off Hinchenbrook Entrance, in the tanker lanes from Valdez. Residence facilities kindly provided by the Federal Aviation Administration through a cooperative agreement with the U.S. Fish & Wildlife Service, OBS-CE, for which we are very grateful.

IV. Research Personnel: Sam and Renee Patten, Department of Pathobiology, School of Hygiene & Public Health, The Johns Hopkins University, 615 North Wolfe Street, Baltimore, Maryland

V. Target Species: Glaucous-winged Gull *Larus glaucescens*
Black-legged Kittiwake *Rissa tridactyla*
Common Murre *Uria aalge*
Pelagic Cormorant *Phalacrocorax pelagicus*

VI. Methods: Egg exposure: drops from microliter syringes (20, 50, 100 µl)
Chick exposure: partial immersion or spray of petroleum
Adult exposure: partial immersion in oil-water slick to test transfer to eggs or chicks
Control: mineral oil

VII. Preliminary Interpretation of Results:
Kittiwakes are apparently more resistant to raw or weathered petroleum than are Glaucous-winged Gulls (egg experiment).

VIII. Problems Encountered: Gull predation on Murre and Cormorant eggs and Kittiwake chicks is intense and continuing.

IX. Other: 67 Glaucous-winged Gull chicks, 160 Kittiwakes, 1 Cormorant, 21 Semipalmated Plover chicks banded to date.

Samuel M. Patten, Jr.
Associate Investigator

QUARTERLY REPORT

Contract: 03-5-022-67
Research Unit: 98
Reporting Period: 1 Jan. - 30 June 1978
Number of Pages: 6

DYNAMICS OF NEAR SHORE ICE

Roger Colony

Polar Science Center
Division of Marine Resources
University of Washington
Seattle, Washington 98105

June 14, 1978

I. TASK OBJECTIVES

The University of Washington under Task Order No. 5 of the NOAA Contract 03-5-022-67 agreed to deploy drifting buoys to gather data on the ice movement and atmospheric conditions in the region of the continental shelf of the Beaufort and Chukchi Seas. It was agreed that 4 buoys would be purchased and deployed to track the motion of the ice cover, with one of these buoys to contain a barometric pressure sensor to determine the atmospheric condition. Data from these buoys shall be interpreted to help explain the physical behavior of the ice in this region. This information will help to increase the geographic coverage of previous buoy deployment programs so that we might know more about different regions and will help to determine year to year variability of the ice behavior in the near shore environment.

II. FIELD AND LABORATORY ACTIVITIES.

A. Field Trips Scheduled

None

B. Scientific Party

None

C. Methods

All buoys discussed in this report are sampled by the Random Access Measurement System on board Nimbus VI satellite.

D. Sample Location

Four data buoys were deployed in March 1978 over the continental shelf in the Beaufort and Chukchi Seas from east of Point Barrow to Cape Lisbourne.

E. Data Collected or Analyzed

The latitude and longitude of the four buoys have been monitored since March 1978. Atmospheric pressure data is being collected from one of the buoys.

III. RESULTS

The satellite data is received weekly from NASA, Goddard Space Flight Center. The proceedure is to decode the NASA data, sort the appropriate buoy platform numbers, make a long track correction to position, edit bad fixes, and smooth and interpolate the position and pressure time series. Figures 1-8 show latitude and longitude time series from the edited position data. The pressure data has not yet been processed. The smoothing and interpolation proceedure has not been done. The data is for the period March - May.

IV. PRELIMINARY INTERPRETATION OF THE RESULTS

None

V. PROBLEMS ENCOUNTERED AND RECOMMENDED CHANGES

NONE

VI. ESTIMATE OF FUNDS EXPENDED

As of 30 November 1977 actual expenditures under this contract total $255,431.97. The estimated obligations for June are anticipated to be $600.

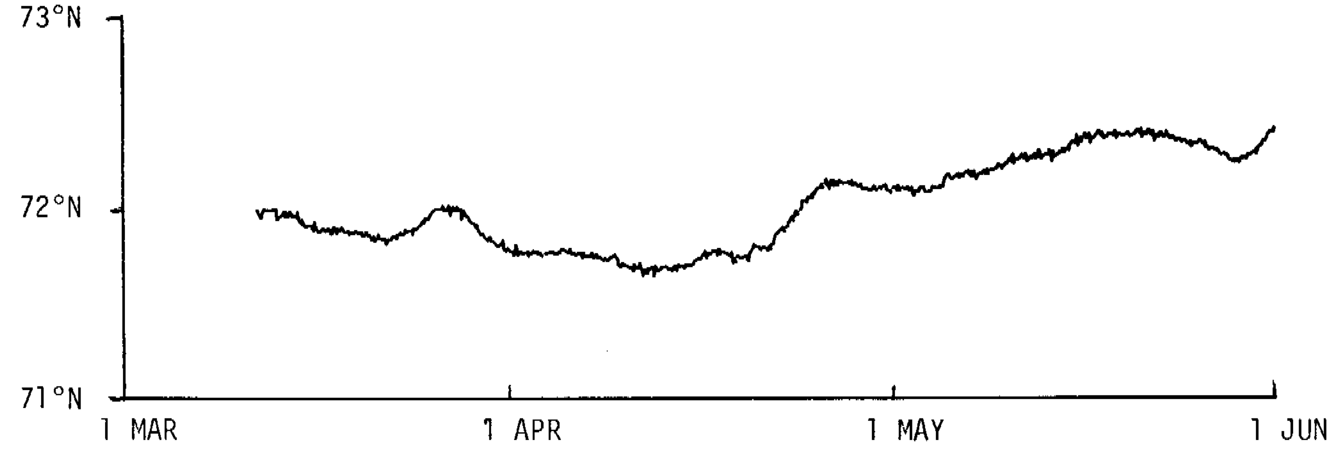


Figure 1: Latitude of buoy 413

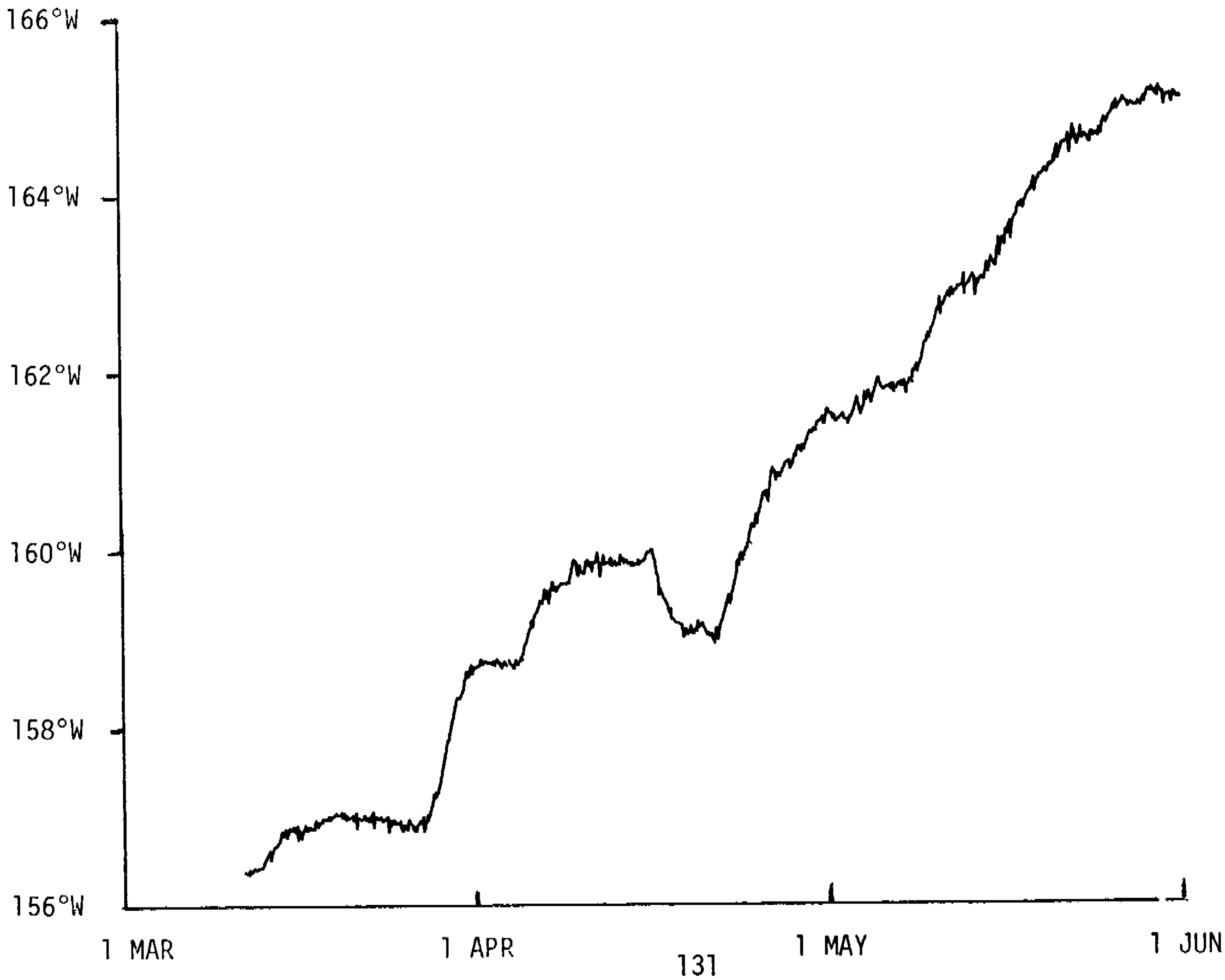


Figure 2: Longitude of buoy 413

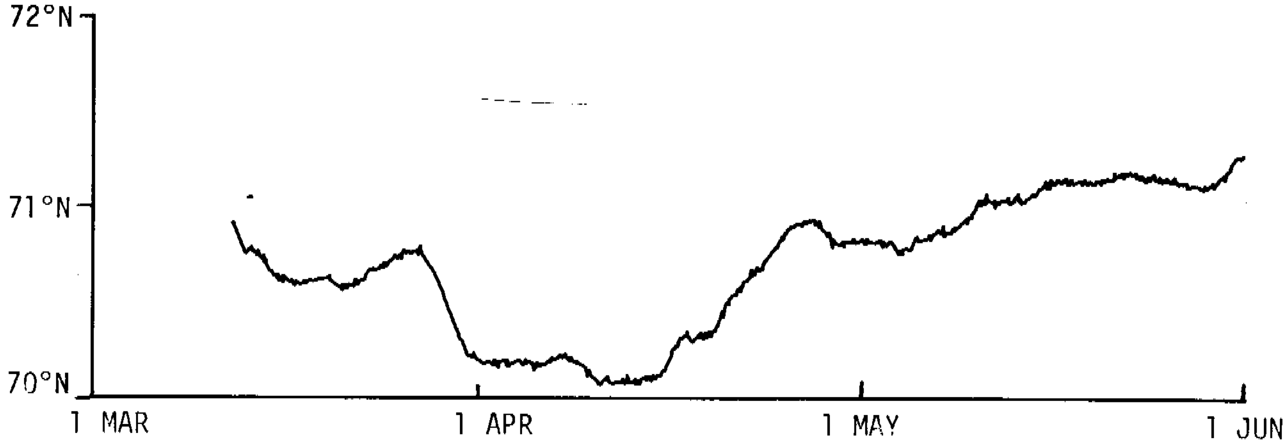


Figure 3: Latitude of buoy 425

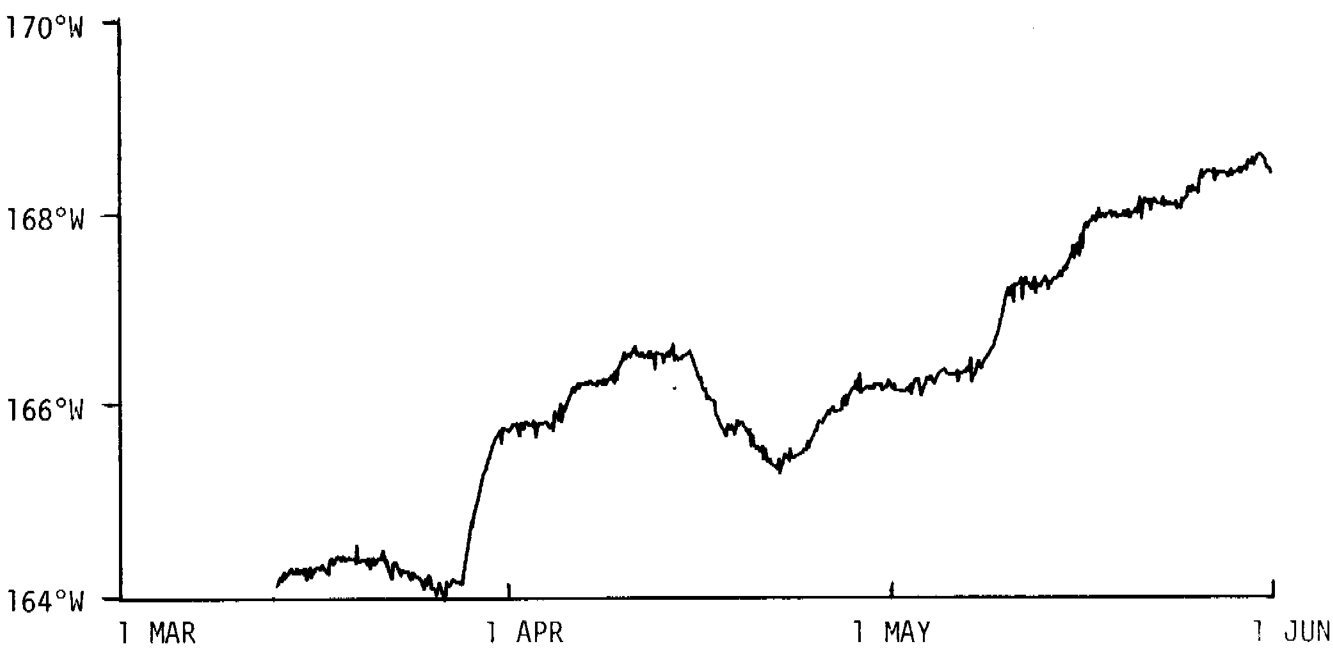


Figure 4: Longitude of buoy 425

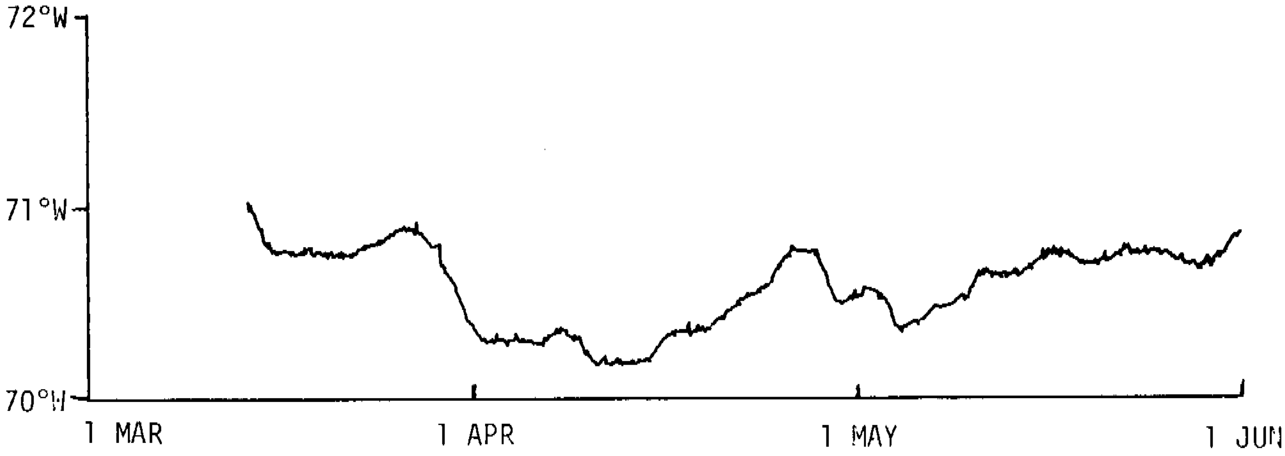


Figure 5: Latitude of buoy 1003

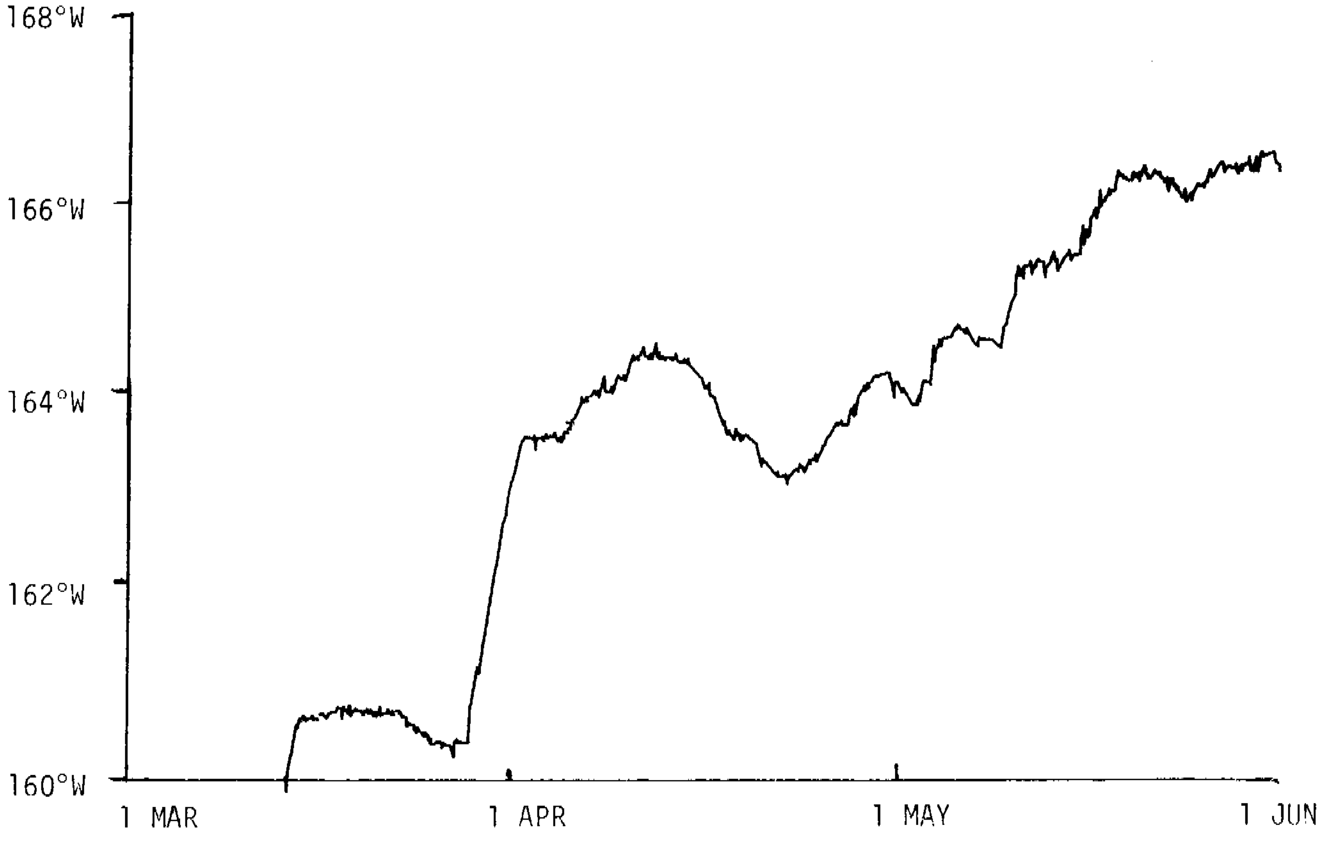


Figure 6: Longitude of buoy 1003

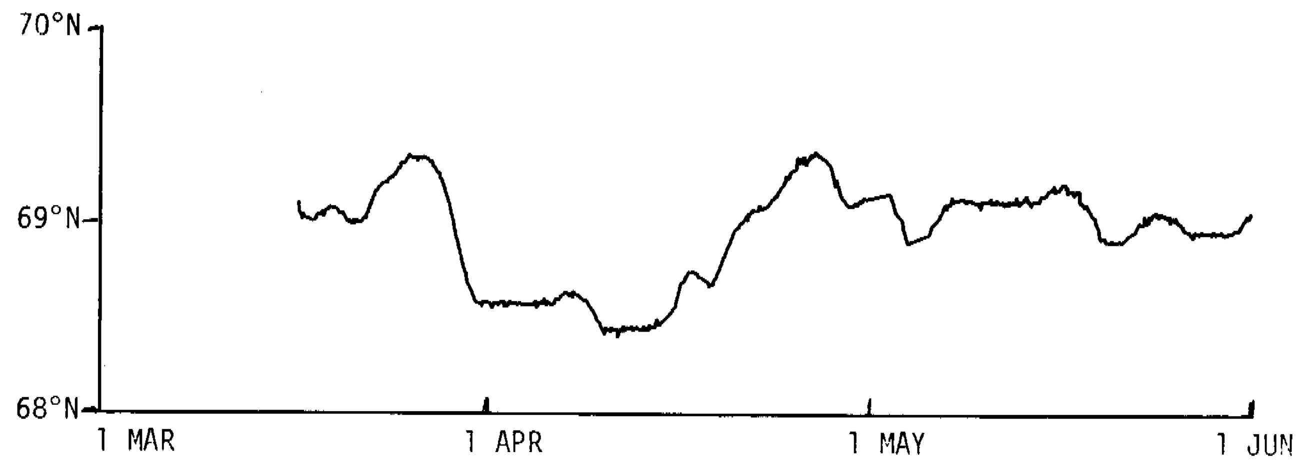


Figure 7: Latitude of buoy 1301

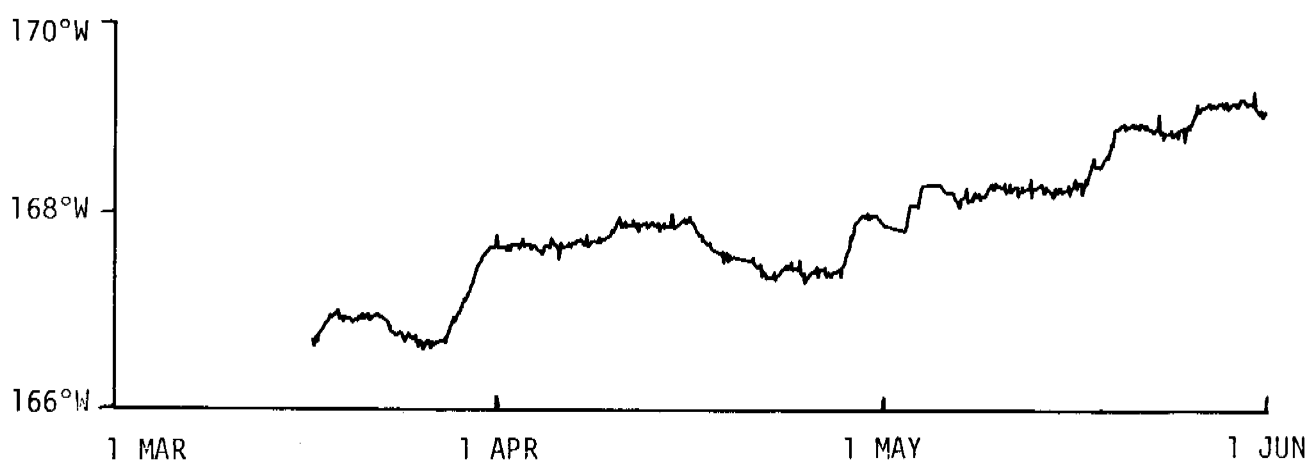


Figure 8: Longitude of buoy 1301

Research Unit No. - 105
Reporting Period - 1 April 1978
30 June 1978
Number of Pages - 1

Quarterly Report
to

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Arctic Projects Office
Fairbanks, Alaska

DELINEATION AND ENGINEERING CHARACTERISTICS OF PERMAFROST BENEATH THE BEAUFORT SEA

Principal Investigators:
P.V. Sellmann
E. Chamberlain

Associate Investigators:
S. Arcone
S. Blouin
A. Delaney
I. Iskandar
F. Page

June 30, 1978

CORPS OF ENGINEERS, U.S. ARMY
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE

I. TASK OBJECTIVES:

The project will attempt to provide regional data on permafrost distribution in the Beaufort Sea. This will be done by reprocessing and examining commercially available seismic records for an indication of the position of the top of bonded permafrost. Analysis of drill cores and other available supplementary data will also be carried out, with no drilling done as part of this year's program.

II. - IV. FIELD AND LABORATORY ACTIVITIES:

Analysis of the engineering properties of all remaining samples was completed and the final report on engineering properties is now being prepared. The methods employed for this study have been discussed in other OCSEAP reports. Final preparations were made to present some of the results of the chemistry and engineering properties studies at the 3rd International Permafrost Conference. Arrangements have now been made to process the original field tapes of approximately 560 km of commercially acquired offshore seismic data. The data were selected based on local geology and water depth. Additional contacts have been established that could provide several thousand kilometers of marine and ice survey data if results from the first block indicate further acquisitions are warranted. The data processed for this study will provide a fairly uniform coverage from Stockton Island to just west of Harrison Bay.

The line locations of much of the available data have now been transferred to charts for more detailed comparison with water depth. Results of the laboratory study of engineering properties have not significantly changed those stated in the last annual report.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES:

The project continues to be approximately three months behind schedule due to emphasis being placed on completing the analysis of all remaining engineering property determinations and delay in starting the program. There are no significant problems other than the delay in the seismic study, although emphasis is now being placed on this part of the program.

VI. ESTIMATE OF FUNDS OBLIGATED:

As of 30 June 1978, a total of approximately 80K of the original 102K was obligated. The 12K transferred from last year was also obligated.

QUARTERLY REPORT

Contract #R7120846
#7120847

Research Unit #138, 139, 147

Reporting Period: 1 April 1978
30 June 1978

Number of Pages: 2

GULF OF ALASKA STUDY OF MESOSCALE OCEANOGRAPHIC PROCESSES (GAS-MOP)

Dr. S. Hayes

Dr. J. D. Schumacher

Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration
3711 - 15th Avenue N.E.
Seattle, Washington 98105

July 1, 1978

I. TASK OBJECTIVES

- Eulerian measurements of the velocity field at several positions and levels

- CTD measurements in Lower Cook Inlet, Kodiak, and Western Gulf region

- Measurements of the along- and cross-shelf sea surface slope

- Process study to understand the interrelations among the velocity field, the bottom pressure gradient, and density field, and the wind field in order to determine the dynamics of the circulation on the continental shelf.

II. FIELD OR LABORATORY ACTIVITIES

A. Cruises:

1. DISCOVERER RP-4-D1-78A, Leg IV

2. MILLER FREEMAN RP-4-MF-78A, Leg II

B. Methods:

Plessey 9040 CTD

Plessey 8400 Digital Data Logger

Aanderaa RCS-4 current meters

PTG pressure temperature gauges

AMF releases

C. Sample Localities: (see cruise reports)

D. Data Collected or Analyzed:

1. A total of 21 moorings with current meters and/or pressure gauges were deployed. Five NIMBUS drift buoys were deployed and 1000 drift cards were deployed.

III. The following publications have been submitted or are in press:

1. Schumacher, J.D., D. Dreves, R. Muench (1978).

   Winter circulation and hydrography over the continental shelf of the northwest Gulf of Alaska. NOAA Tech. Rept., (in press).

2. Hayes, S.P., J. Glenn, N.N. Soreide (1978).

   A shallow water pressure-temperature gage: design, calibration, and operation. NOAA Tech. Memo (in press).

3. Feely, R.A., E. T. Baker, J.D. Schumacher, and W.M. Landing (1978).

   Processes affecting the distribution and transport of suspended matter in the Northeast Gulf of Alaska. Deep Sea Res. (in press).

4. Hayes, S.P. (1978)

   Variability of current and bottom pressure across the continental shelf in the Northeast Gulf of Alaska. J. Phys. Oceanogr. (submitted).

IV. Problems encountered are discussed in the cruise reports.

CRUISE REPORT

RP-4-DI-78A - LEG IV

21 May - 8 June 1978

Chief Scientist: Robin D. Muench, PMEL/NOAA

Other Scientific Personnel: H. Reed Stevens, PMEL/NOAA
Richard Beach, NMFS/NOAA
Tom Crawford, NMFS/NOAA

Objectives:

This cruise was carried out under the auspices of the Outer Continental Shelf Environmental Assessment Program, by NOAA, under sponsorship by the Bureau of Land Management. General objectives of this program are to: (1) provide comprehensive environmental information on the Alaska Outer Continental Shelf lease areas; (2) define the probable ecological impact of oil exploration, production, storage and transshipment on the outer continental shelf; (3) refine our comprehension of key ecological dynamic processes; and, (4) provide a basis for predictive or diagnostic models of ecosystem response to loading by petroleum or petroleum by-products.

Primary objectives of this cruise were to obtain physical oceanographic data adequate to: (1) verify and further define the apparent bifurcation in the westward-flowing Alaska Current east of Kodiak Island; (2) Better define the circulation in lower Cook Inlet; (3) elucidate circulation and mixing processes in the bank and trough region south of Kodiak Island, in particular, Kiliuda Trough; (4) Define extent of and transport in the Alaska Current along the shelf break south of Kodiak Island; and, (5) continue the ongoing definition of seasonal variation in the regional scale oceanographic conditions. A secondary cruise objective was to continue monitoring the regional distribution of marine mammals.

Accomplishments

During this leg, we occupied 196 CTD stations. Most of these were along NW-SE traverses covering the region from Portlock Bank east of Kodiak Island to the southern end of Shelikof Strait (Table 1 and Figure 1). This station coverage, entirely east, south and southwest of Kodiak Island, will be supplemented by CTD data acquired from the NOAA vessel MILLER FREEMAN over the same time period in lower Cook Inlet and Shelikof Strait.

The CTD station coverage was adequate to define oceanic temperature and salinity distribution over the Kodiak Island banks and in the Alaska Current as it flowed along the shelf break (roughly, the 200 meter isobath).

Regional surface water temperatures were 6 - 8°C, with higher temperatures along the Alaska Current in agreement with previous observations. Surface salinities were 32 - 32.5 °/oo, the higher salinities farther offshore. Water temperature decreased, and salinity increased, monotonically with depth. Vertical stratification in both temperature and salinity was virtually negligible over the shallow banks around Kodiak Island; stratification was maximum in the Alaska Current. This preliminary examination of the temperature and salinity data suggests that regional oceanographic conditions were normal for the time of year.

In addition to acquiring CTD data, two different types of drift indicators were deployed at the eastern, or upstream, end of the operating region. Ten bundles of surface drift cards, 100 cards per bundle, were deployed at the locations given in Table 2 and Figure 2. In addition, five satelite-tracked Nimbus drift buoys equipped with windowshade drogues were deployed at locations given in Table 3 and Figure 3. These drift indicators will yield direct information on the movement of water through this system. They were deployed in such a pattern, in particular, as to test the hypothesis that part of the westward flowing Alaska Current splits landward from the shelf break to flow through Shelikof Strait.

Problems Encountered

Substantial problems were encountered in failures of scientific gear and unavailability of spare parts suitable for correcting these failures. Specifically:

(1) CTD fish failed early in cruise; replacement was obtained from SURVEYOR, which required an unscheduled touch-and-go in Kodiak.

(2) Plessey DDL unit failed; repaired with spare circuit board from MILLER FREEMAN, obtained during same touch-and-go as replacement fish. First sixty CTD casts obtained on DDL were no good, but data were obtained on the back-up PDP-11 based system.

(3) Time code generator on the PDP-11 system failed; repaired with parts from PMC on a second unscheduled touch-and-go in Kodiak.

(4) Repeated failures of the line printer, required for checkout of other systems which had malfunctioned. This unit was kept operational only through considerable effort on the part of Mike Wallace, Chief ET.

(5) The level-wind system on the Marco-built CTD winch malfunctioned repeatedly. It slowed down when the cable reached the end of the drum, necessitating reversing the winch and manual adjustment of the level-wind. At its worst, the effective winch uphaul speed was 15 m/min on a 1500 meter deep cast instead of the ideal 120 m/min. This one problem alone cost us more than a day of cumulative ship time. We consider the winch unacceptable as presently designed. Unfortunately the alternate winch (Jered) was judged unsafe due to a faulty brake. No spares were available for either winch.

The magnitude of the problems stemming from lack of spare or replacement parts cannot be overemphasized. We estimate 3-4 days of lost ship time, plus considerable added overtime for the shipboard ET's required to service the gear during this leg. Despite requests, most parts (for the Plessey DDL, the Marco winch, the line printer) were not received by the vessel.

Acknowledgements

We wish to sincerely thank Captain Sid Miller, LCDR Emerson Wood, the officers and crew of the DISCOVERER for making this a successful cruise despite less-than-ideal conditions. Special credit goes to the ETs, led by Mike Wallace, for nursing some very shaky electronic gear through the leg.

TABLE 1. List of CTD Stations; RP-4-DI-78A -IV

Station No.	Cast No.	Julian Day (GMT)	Hour (GMT)	Latitude	Longitude	Depth(M)
630	001	141	2104	57°45.0'	152°00.3'	110
629	002	141	2224	57°51.0'	152°03.0'	102
628	003	141	2302	57°55.0'	152°02.0	192
593	004	141	2357	57°59.9'	152°04.0'	175
594	005	142	0056	58°02.5'	151°56.5'	148
595	006	142	0154	58°04.8'	151°45.2'	162
596	007	142	0303	58°05.2'	151°36.8'	157
597	008	142	0407	58°07.7'	151°28.1'	150
598	009	142	0510	58°11.6'	151°18.8'	164
599	010	142	0602	58°10.7'	151°11.4'	139
592	011	142	0655	58°12.0'	151°00.9'	98
591	012	142	0745	58°16.8'	151°02.8'	124
590	013	142	0830	58°21.5'	151°07.7'	115
589	014	142	0927	58°23.4'	151°18.6'	126
588	015	142	1014	58°24.5'	151°28.8'	164
587	016	142	1107	58°25.0'	151°37.6'	170
586	017	142	1156	58°27.0'	151°46.1'	190
585	018	142	1254	58°27.8'	151°54.2'	91
584	019	142	1349	58°32.4'	151°45.2'	168
583	020	142	1441	58°36.6'	151°44.2'	143
582	021	142	1547	58°40.9'	151°45.4'	139
581	022	142	1646	58°46.6'	151°46.4'	206
580	023	142	1739	58°50.6'	151°39.6'	133
579	024	142	1839	58°54.7'	151°46.4'	118
578	025	142	1928	59°00.2'	151°47.3'	126
576	026	142	2017	59°03.2'	151°45.0'	118
575	027	142	2118	59°02.2'	151°37.0'	172
574	028	142	2249	58°59.5'	151°25.4'	126
573	029	142	2354	58°57.7'	151°16.2'	150
552	030	143	0057	58°56.9'	151°06.2'	162
529	031	143	0151	58°57.6'	150°55.6'	157
525	032	143	0252	59°01.6'	150°44.3'	157
524	033	143	0338	59°04.7'	150°39.1'	109
523	034	143	0432	59°06.8'	150°30.6'	107
522	035	143	0530	59°11.6'	150°21.0'	181
521	036	143	0631	59°12.3'	150°11.4'	115
520	037	143	0718	59°16.8'	150°06.5'	183
501	038	143	0812	59°20.3'	150°07.3'	167
502	039	143	0909	59°16.3'	150°03.0'	197
503	040	143	1021	59°10.5'	150°01.7'	142
Deploy Buoy #1775						
504	041	143	1124	59°04.6'	149°59.4'	192
505	042	143	1222	59°00.0'	149°56.9'	206
506	043	143	1321	58°54.0'	149°54.9'	239
507	044	143	1422	58°51.7'	149°45.8'	240
Deploy Buoy #1450						
508	045	143	1526	58°48.4'	149°36.5'	219
509	046	143	1631	58°44.7'	149°27.5'	181
510	047	143	1729	58°41.0'	149°17.3'	137
511	048	143	1825	58°37.8'	149°07.5'	128
Deploy Buoy #1473						

TABLE 1 continued

Station No.	Cast No.	Julian Day (GMT)	Hour (GMT)	Latitude	Longitude	Depth(M)
512	049	143	1927	58°34.7'	148°59.2'	108
513	050	143	2028	58°32.0'	148°48.2'	114
514	051	143	2133	58°28.1'	148°38.3'	125
515	052	143	2255	58°24.6'	148°27.1'	670
516	053	144	0029	58°21.9'	148°17.3'	1150
517	054	144	0215	58°18.7'	148°06.6'	1408
518	055	Aborted				
518	056	144	0445	58°14.1'	147°54.0'	2012
548	057	144	1859	57°50.5'	148°27.1'	2250
547	058	145	0112	57°53.6'	148°29.6'	1500
546	059	145	0338	57°55.9'	148°39.3'	1164
644	060	146	0123	57°30.4'	151°55.0'	89
645	061	146	0248	57°17.0'	151°41.6'	62
646	062	146	0401	57°06.2'	151°35.5'	122
647	063	146	0453	57°03.0'	151°29.6'	168
648	064	146	0553	56°58.2'	151°25.4'	640
649	065	146	0740	56°52.7'	151°20.5'	896
650	066	146	0905	56°47.6'	151°16.3'	950
651	067	146	1037	56°43.0'	151°10.1'	1445
652	068	146	1227	56°40.5'	151°07.5'	1751
653	069	146	1441	56°30.6'	151°02.2'	4239
654	070	146	1647	56°21.6'	150°55.3'	5121
643	071	146	2002	56°40.5'	150°43.6'	2926
642	072	146	2220	56°46.6'	150°47.2'	2100
641	073	147	0127	56°51.3'	150°53.8'	1678
640	074	147	0313	56°56.4'	150°57.3'	992
639	075	147	0501	57°02.9'	151°03.4'	560
638	076	147	0614	57°06.9'	151°07.6'	335
637	077	147	0731	57°11.7'	151°15.4'	144
636	078	147	0821	57°16.6'	151°17.6'	148
635	079	147	0922	57°21.8'	151°22.3'	148
634	080	147	1017	57°27.1'	151°25.7'	162
633	081	147	1126	57°31.8'	151°33.7'	142
632	082	147	1215	57°34.9'	151°41.4'	117
631	083	147	1316	57°36.8'	151°53.2'	153
614	084	147	1541	57°56.5'	151°32.9'	75
615	085	147	1658	57°48.6'	151°20.6'	62
616	086	147	1752	57°43.6'	151°08.4'	70
617	087	147	1901	57°37.8'	150°52.9'	82
618	088	147	1958	57°34.0'	150°38.8'	95
619	089	147	2116	57°27.4'	150°26.7'	212
620	090	147	2221	57°24.0'	150°20.4'	419
621	091	147	2343	57°22.7'	150°13.0'	528
622	092	148	0118	57°16.9'	150°06.4'	1511
623	093	148	0304	57°12.9'	150°00.5'	1695
624	094	148	0501	57°08.9'	149°55.9'	1517

TABLE 1 continued

Station No.	Cast No.	Julian Day (GMT)	Hour (GMT)	Latitude	Longitude	Depth(M)
625	095	148	0706	57°03.9'	149°48.1'	2223
626	096	148	0910	56°59.8'	149°40.9'	3600
772	097	148	1453	56°52.9'	148°11.7'	4389
771	098	148	1703	57°01.2'	148°23.9'	4512
770	099	148	1922	57°08.9'	148°39.4'	4938
769	100	148	2131	57°16.4'	148°49.6'	3500
768	101	148	2344	57°22.8'	149°00.2'	2600
767	102	149	0159	57°31.0'	149°12.6'	2570
572	103	149	0327	57°33.7'	149°17.3'	1870
571	104	149	0519	57°38.8'	149°24.9'	1216
570	105	149	0724	57°41.1'	149°29.5'	792
569	106	149	0841	57°44.5'	149°35.7'	490
568	107	149	0955	57°48.4'	149°40.7'	275
567	108	149	1107	57°53.6'	149°47.3'	243
566	109	149	1203	57°56.2'	149°53.6'	257
565	110	149	1305	57°59.7'	150°00.9'	265
564	111	149	1418	58°05.0'	150°06.6'	320
563	112	149	1517	58°06.8'	150°16.3'	228
562	113	149	1603	58°08.9'	150°19.4'	182
561	114	149	1651	58°11.4'	150°26.3'	87
560	115	149	1800	58°18.4'	150°37.9'	65
559	116	149	1907	58°24.5'	150°48.5'	80
533	117	149	2005	58°32.1'	150°44.5'	135
532	118	149	2110	58°39.1'	150°47.6'	199
531	119	149	2211	58°45.2'	150°50.7'	171
530	120	149	2316	58°51.7'	150°52.6'	163
529	121	150	0016	58°58.6'	150°56.1'	140
528	122	150	0106	59°02.1'	150°56.5'	160
527	123	150	0158	59°05.9'	150°58.6'	179
526	124	150	0246	59°08.8'	151°00.0'	82
Deploy Buoy #42*		150	0502	58°59.4'	151°50.4'	84
Deploy Buoy #43*		150	1007	59°00.2'	149°56.4'	84
*No CTD Taken						
336	125	153	1430	56°48.2'	156°25.3'	91
337	126	153	1543	56°49.8'	156°25.8'	144
338	127	153	1637	56°47.4'	156°15.3'	188
339	128	153	1733	56°45.5'	156°06.8'	225
340	129	153	1836	56°43.0'	155°54.9'	300
341	130	153	1937	56°40.7'	155°50.9'	278
342	131	153	2037	56°38.3'	155°43.8'	248
343	132	153	2148	56°38.1'	155°43.6'	248
344	133	153	2231	56°34.3'	155°27.5'	90
345	134	153	2324	56°31.9'	155°19.1'	62
346	135	154	0004	56°30.0'	155°11.8'	45
701	136	154	0438	55°40.0'	155°09.4'	427
702	137	154	0545	55°34.3'	155°04.8'	605
703	138	154	0710	55°27.8'	155°02.5'	738

TABLE 1 continued

Station No.	Cast No.	Julian Day (GMT)	Hour (GMT)	Latitude	Longitude	Depth(M)
704	139	154	0841	55°21.8'	154°54.6'	1521
705	140	154	1050	55°15.4'	154°50.5'	2390
706	141	154	1233	55°11.9'	154°45.7'	3160
707	142	154	1423	55°06.3'	154°41.9'	3680
776	143	154	2124	55°12.3'	152°47.0'	4500
775	144	154	2340	55°12.6'	152°46.4'	4500
774	145	155	0200	55°28.3'	153°09.2'	5000
773	146	155	0420	55°37.2'	153°19.1'	4140
770	147	155	0620	55°42.4'	153°25.2'	3017
699	148	155	0820	55°46.0'	153°30.4'	1298
698	149	155	1016	55°50.0'	153°37.0'	1340
697	150	155	1148	55°55.1'	153°40.6'	230
696	151	155	1233	55°58.9'	153°44.0'	91
695	152	155	1351	56°07.5'	153°55.7'	195
694	153	155	1512	56°14.8'	154°06.3'	135
693	154	155	1632	56°23.7'	154°15.5'	38
678	155	155	2311	56°12.9'	152°09.7'	3840
677	156	156	0103	56°18.2'	152°15.9'	1862
676	157	156	0254	56°22.5'	152°20.5'	613
675	158	156	0418	56°25.6'	152°23.1'	345
674	159	156	0540	56°32.8'	152°29.5'	212
673	160	156	0636	56°38.1'	152°27.8'	155
672	161	156	0719	56°42.3'	152°28.7'	174
671	162	156	0818	56°49.0'	152°29.1'	168
670	163	156	0902	56°53.3'	152°33.0'	160
669	164	156	0955	56°55.9'	152°38.7'	150
668	165	156	1041	57°00.1'	152°43.5'	146
667	166	156	1138	57°03.6'	152°51.3'	91
600	167	156	1938	58°05.9'	150°59.3'	108
601	168	156	2036	58°02.3'	150°50.5'	145
602	169	156	2122	57°58.7'	150°45.7'	119
603	170	156	2218	57°56.2'	150°36.1'	134
604	171	156	2305	57°53.1'	150°28.4'	123
605	172	156	2356	57°49.2'	150°20.4'	106
606	173	157	0034	57°46.3'	150°13.9'	120
607	174	157	0123	57°42.9'	150°06.2'	179
608	175	157	0210	57°40.1'	149°58.2'	250
609	176	157	0317	57°34.7'	149°51.7'	635
610	177	157	0423	57°30.4'	149°48.5'	1152
611	178	157	0558	57°26.9'	149°43.3'	1591
612	179	157	0746	57°22.7'	149°38.8'	1920
613	180	157	0946	57°18.5'	149°32.7'	2100
548	181	157	1622	57°50.6'	148°27.1'	2359
547	182	157	1822	57°52.9'	148°33.3'	1680
546	183	157	2019	57°54.8'	148°40.8'	1307
545	184	157	2235	57°57.0'	148°46.3'	1030

TABLE 1 continued

Station No.	Cast No.	Julian Day (GMT)	Hour (GMT)	Latitude	Longitude	Depth(M)
544	185	158	0040	57°59.9'	148°53.0'	435
543	186	158	0155	58°01.7'	149°01.4'	116
542	187	158	0302	58°03.8'	149°09.8'	97
541	188	158	0441	58°07.5'	149°22.4'	129
540	189	158	0539	58°09.6'	149°30.6'	105
539	190	158	0647	58°13.3'	149°41.3'	56
538	191	158	0738	58°15.6'	149°50.0'	66
537	192	158	0837	58°20.0'	150°02.8'	58
536	193	158	0927	58°22.2'	150°11.9'	65
535	194	158	1025	58°25.9'	150°23.4'	76
534	195	158	1122	58°28.3'	150°33.7'	80

Table 2. Drift Card Deployment Log; RP-4-DI-78A-IV

JD/hr (GMT)	CTD Sta ID	Latitude	Longitude	Card Nos.
143/0812	501	59°20.3'N	150°07.3'W	3101-3200
143/1030	503	59°10.3'	150°00.7'	3801-3900
143/1145	504	59°04.6'	149°59.4'	3401-3500
143/1239	505	58°59.9'	149°56.7'	3301-3400
143/1451	507	58°51.3'	149°45.4'	3201-3300
143/1553	508	58°48.3'	149°36.1'	3001-3100*
143/1631	509	58°44.7'	149°27.5'	3501-3600
143/1825	511	58°37.8'	149°07.5'	3601-3700**
143/2028	513	58°32.0'	148°48.2'	3901-4000***
143/2317	515	58°24.5'	148°27.0'	3701-3800

*except 3001, 3035
**except 3622
***except 3973

Table 3. NIMBUS Buoy Deployment Log; RP-4-DI-78A-IV

JD/hr(GMT)	CTD Sta ID	Latitude	Longitude	Buoy ID No.
143/1038	503	59°10.2'N	150°01.2'W	1775
143/1450	507	58°51.3'	149°45.4'	1450
143/1843	511	58°37.8'	149°07.6'	1473
150/0502	None	58°59.4'	151°50.4'	0045
150/1007	505	59°00.2'	149°56.4'	0043

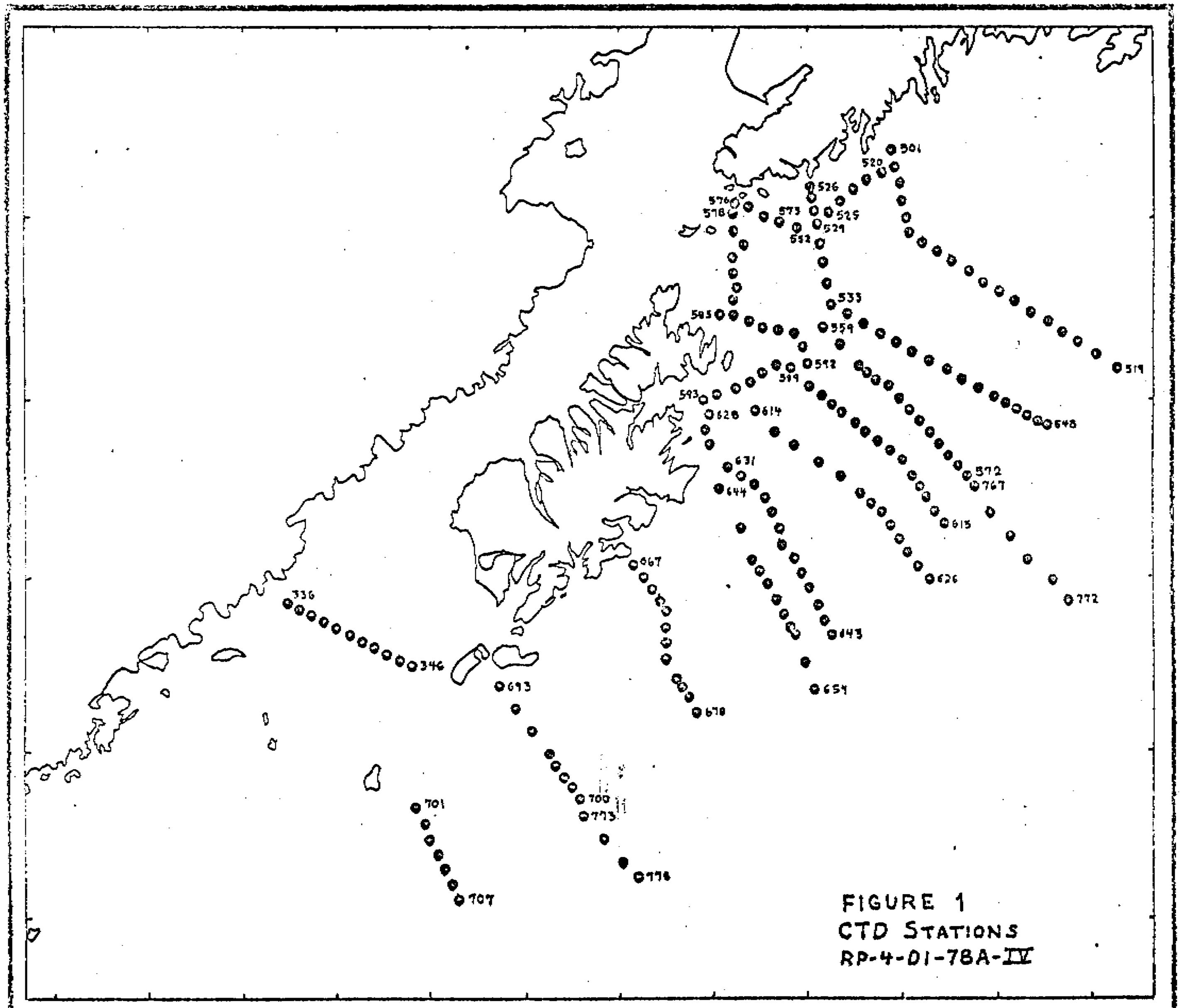


FIGURE 1
CTD STATIONS
RP-4-DI-78A-IV

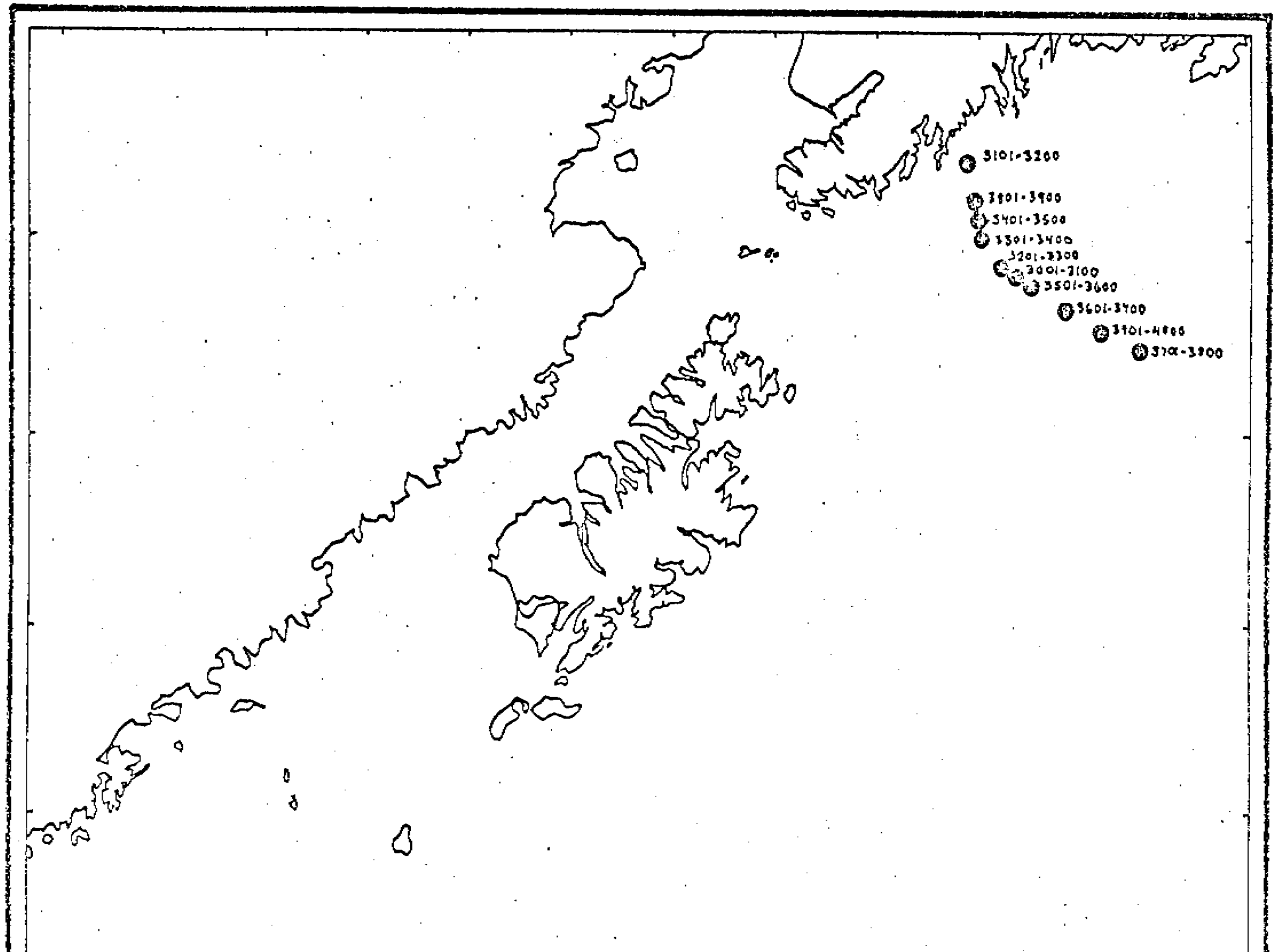


FIGURE 2
DRIFT CARD DEPLOYMENTS
RP-4-DI-78A-IV
23 MAY 1978

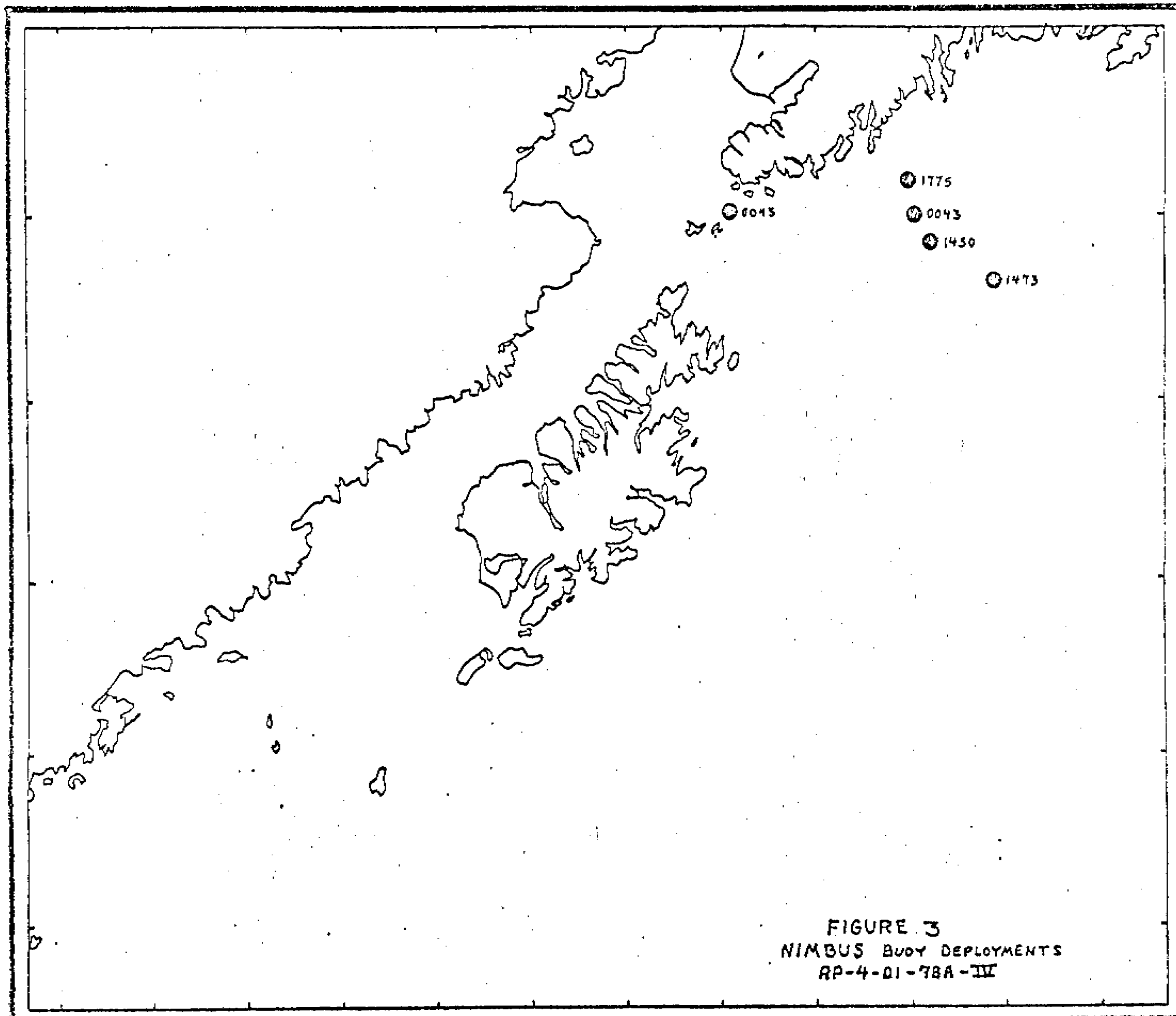


FIGURE 3
NIMBUS BUOY DEPLOYMENTS
RP-4-01-78A-III

Cruise Report, RP-4-MF-87A--Leg II

I. Introduction

The general objectives are stated in the project instructions. The specific objectives were to carry out a physical oceanographic study in Lower Cook Inlet and around Kodiak Island and a suspended matter dynamics program in Lower Cook Inlet. The physical oceanography operation involved current meter deployments and CTD casts. Sediment traps were deployed in conjunction with current meters at three locations for the suspended matter program. The purpose of this experiment is to determine vertical fluxes of suspended matter. The locations of the moorings and CTD stations are summarized in tabular and chartlet form at the end of the report.

The scientific personnel were Richard Carlone, Richard Feely, and James Haslett, Chief Scientist, all from PMEL.

II. Acknowledgements

The work load for this leg was substantial: twenty-seven (27) moorings and 191 CTD casts. I am relaying the sentiments of the other two members of the scientific party when I say we were most grateful for the professional attitude and performance of the personnel of the Miller Freeman. Because of the vagaries of the weather in these areas, we highly appreciated the attitude of deploying as many of the moorings as possible during available working time. In particular we wish to heartily thank the deck and survey departments for their excellent performance and attitude. I also wish to thank the electronics technicians for doing what they could on the CTD equipment.

III. Problems

There were no difficulties associated with the deployments. However, there were serious problems associated with the CTD operations; the fundamental one being the lack of sufficient back-up equipment. The operation during this leg was to be a cooperative CTD effort between the Miller Freeman and the Discoverer. As far as could be determined, there were not enough spare parts and equipment to adequately support one ship. This resulted in borrowing between the ships in an effort to make things work. Only the deficiencies encountered on the Miller Freeman will be given.

1. No back-up Plessey sensor unit was on board nor was one immediately available at Kodiak. An ODEC unit was aboard, but there were problems with it which will be discussed later.

2. A list of spare parts (boards, components) for the Plessey system could not be found, if it was put aboard.

3. The electronics technician did not have formal or in-house training in maintaining and repairing Plessey CTD equipment. This is emphasized because often field repairs are the only recourse available. While the competence of the technician is not being questioned, certainly the fact that they must learn to make repairs under pressure makes the work slow, with a higher probability of error.

4. The "unit" replacement concept for electronics repairs works if there are replacements on board. In this case, there were none. If a return to port is necessary to pick up a new unit, three or four days can easily be lost to a cruise.

5. There is no way of knowing if the data being collected are recorded on the magnetic tape correctly, or at all. Weeks of observation have been taken and lost because of this. A reader of some kind to determine data quality is definitely required.

6. A digitizer wired for three measurand rather than four was installed on board the Miller Freeman with no indication. This condition was only recognized when attempts to read a tape at PMEL showed the three measurand format. This could apparently be corrected by simply moving a few wires. This did not work correctly. If the electronics technician on board had been trained, he could have identified the additional problem and corrected it. As it was, it was necessary to contact Ekert, who could only suggest several things to try.

Two problems not associated with the CTD support should be mentioned:

1. For back-up and comparison purposes a unit built by ODEC was put aboard the Miller Freeman. The tape reader never did function correctly, so no aboard-ship comparison could be made. The battery pack did not seem to have sufficient capacity to operate the unit for ten to twenty minutes per hour without charging between casts. A molded connecter required for the operation of the unit had to be removed and the charger plugged in by way of a molded connector on the top of the housing. This was a drawback since the connectors were not designed to be repeatedly connected and disconnected. The unit was removed since the connector on the housing developed an intermittent fault which would prevent the unit from operating and charging properly.

2. During the deployment of C-8B, the mooring apparently became detached from the release hook and fell some 35 meters. The release responded to interrogation. The possibility of disabling damage to the release seems slight since there is a 2-foot length of chain between the release and anchor which prevented severe mechanical shock. The primary concern is whether the rotors were ripped out of the current meter.

Chartlets and Tables

The number of deployments was twenty-seven: twenty-one current meter moorings and six marker buoys. Standard 150 CTD casts were taken on the PMEL NGOA grid; CTD casts were taken at each mooring so 171 separate CTD stations were occupied. The positions of the moorings and CTD stations are shown on the accompanying chartlet. Since some of the stations were repeated, the total number of casts was 191.

Table 1 summarizes the current meter deployments, while Table 2 does likewise for the CTD operation.

Table I – page 1

MOORING I.D. ORG.	POSITION LAT. LONG.	LORAN C	RCM UPPER LOWER	METER DEPTH METERS	TG S/N TYPE	RELEASE S/N RCVR.# TYPE	FLOAT(ORE) SIZE S/N	DEPTH METERS fm	GMT DATE TIME
C-1B	59-10.7	X 12047.42	2504	18	205	601029	398	40 m	147
	153-18.8	Y 3184795	Sed. Trap	30		Rx 6-242		22 fm	2116
			3286	35					
C-2B	59-13.5	X 12093.17	3176	18	—	605962	524	62 m	147
	153-07.9	Y 31852.95	2505	48		Rx 1-395		34	2240
C-3B	59-24.4	X 12229.72	598	25	—	601229	420	64	148
	152-53.6	Y 31897.90	3180	55		Rx 3-242		35	0357
C-4B	59-16.7	X 12147.20	3294	19	189	702264	456	83	148
	152-54.9	Y 31858.57	3290	64		Rx-4-395		45	0606
			Sed. Trap	73					
C-5B	59-09.9	X 12678.00	2156	27	—	151	660	135	147
	152-53.9	Y 31821.97	3184	72		Rx 2-242		74	1900
			1815	127					
C-6B	59-18.7	X 12201.11	3173	26	~	503235	455	77	148
	152-37.9	Y 31854.72	3295	71		Rx 10-242		42	0218
C-7B	59-18.5	X 12258.33	2249	17	—	601529	436	68	148
	152-16.5	Y 31528.90	2500	62		Rx 5-242		37	0841
C-8B	59-01.9	X 12097.88	3179	~~17~~ 63	—	~~39~~ 701964	397	190	~~490~~ 1
	152-03.5	Y 31730.19	2252	64		Rx 1-395		104	~~104~~ 22
			1682	179					

MOORING I.D. ORG.	POSITION LAT. LONG.	LORAN C	RCM UPPER LOWER	METER DEPTH METERS	TG S/N TYPE	RELEASE S/N RCVR.# TYPE	FLOAT(ORE) SIZE S/N	DEPTH METERS fm	GMT DATE TIME
C-9B	58-46.7	X=11963.62	1973	66	229	501653	458	124	148
	152-16.3	Y 31660.32	2501	67		Rx 5-242		65	1505
			2248	114					
C-10B	~~X~~ 59-33.4	X 11636.71	3171	25	—	503035	433	175	148
	153-11.9	Y 31631.92	3175	70		Rx 7-242		96	1711
			1669	165					
C-11B	59-33.4	X 12495.52	Sed. Trap	77	—	702714	526	87	149
	151-39.8	Y 31584.72	1451	83		Rx 4-322		48	0237
C-12A	59-31.6	X 12388.60	2358	20	—	603361	499	50	145
	152-14.0	Y31963.70	3291	46		Rx 9-242		27	0703 ~~0515~~
C-13A	59-28.2	X 12294.48	3293	26	—	124	523	68	148
	152-40.6	Y 31967.45	2356	56		Rx 4-242		37	0515
K-6B	57-13.7	7X 11010.40	3296	32	—	702464	422	82	140
	152-23.2	7Y 32411.3	1676	72		Rx 6-395		45	2141
		9X 18724.77							
		9Y 31175.41							
K-7B	57-05.6	9X 18721.13	2513	29	—	606667	497	54	140
	152-12.9	9Y 32431.50	1675	74		Rx 7-395		46	2000
		7Y 31118.97							

157

MOORING I.D. ORG.	POSITION LAT. LONG.	LORAN C	RCM UPPER LOWER	METER DEPTH METERS	TG S/N TYPE	RELEASE S/N RCVR.# TYPE	FLOAT(ORE) SIZE S/N	DEPTH METERS fm	GMT DATE TIME
K-8B	57-06.8	9X18721.11	3174	30	232	606967	~~606967~~ 441	155	140
	152-43.4	9Y32476.47	1827	75		Rx 8 - 395		85	2351
		7Y31170.83							
K-9B	56-59.6	9Y32487.10	3172	13	107	503135	525	146	141
	152-33.7	7Y31120.44	3185	58		Rx 9 - 242		80	0253
			2498	142					
K-10B	56-49.8	9Y32513.10	2512	24	234	602229	746	153	141
	152-23.6	7Y31055.98	2502	69		Rx 10 - 242		84	0444
			3287	149					
K-11B	56-01.8	9X18658.24	2355	25	—	702364	747	60	141
	155-05.8	9Y32975.79				Rx 5 - 395		33	2349
		9Z44225.04							
K-12B	55-59.9	9X18648.58	3183	24	—	602029	748	212	142
	156-19.6	9Y44676.15	1671	208		Rx 9 - 242		116	0400
K-13B	56-23.8	9X18674.20	2178	28	—	601429	749	115	142
	156-49.1	9Y44822.41	3289	111		Rx 5 - 242		63	0716

Table 2

CTD Lines Occupied

Stations	
Beginning	Ending
2	7
15	20
27	51
38	49
88	95
97	105
108	113
127	132
144	150
301	314
316	319
321	323
325	335
351	361
661	655
761	691

CTD casts were taken at all current meter moorings.

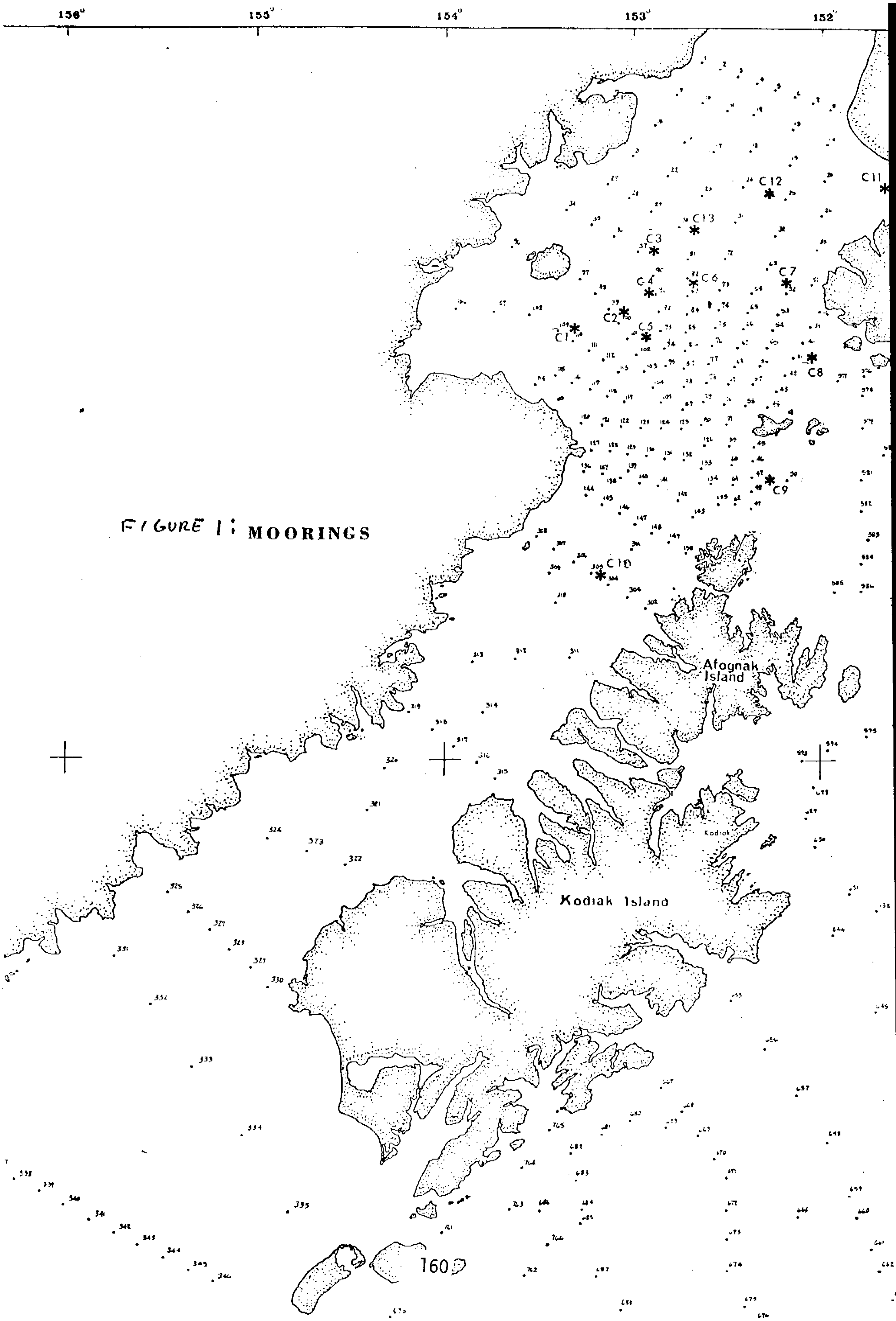


FIGURE 1: MOORINGS

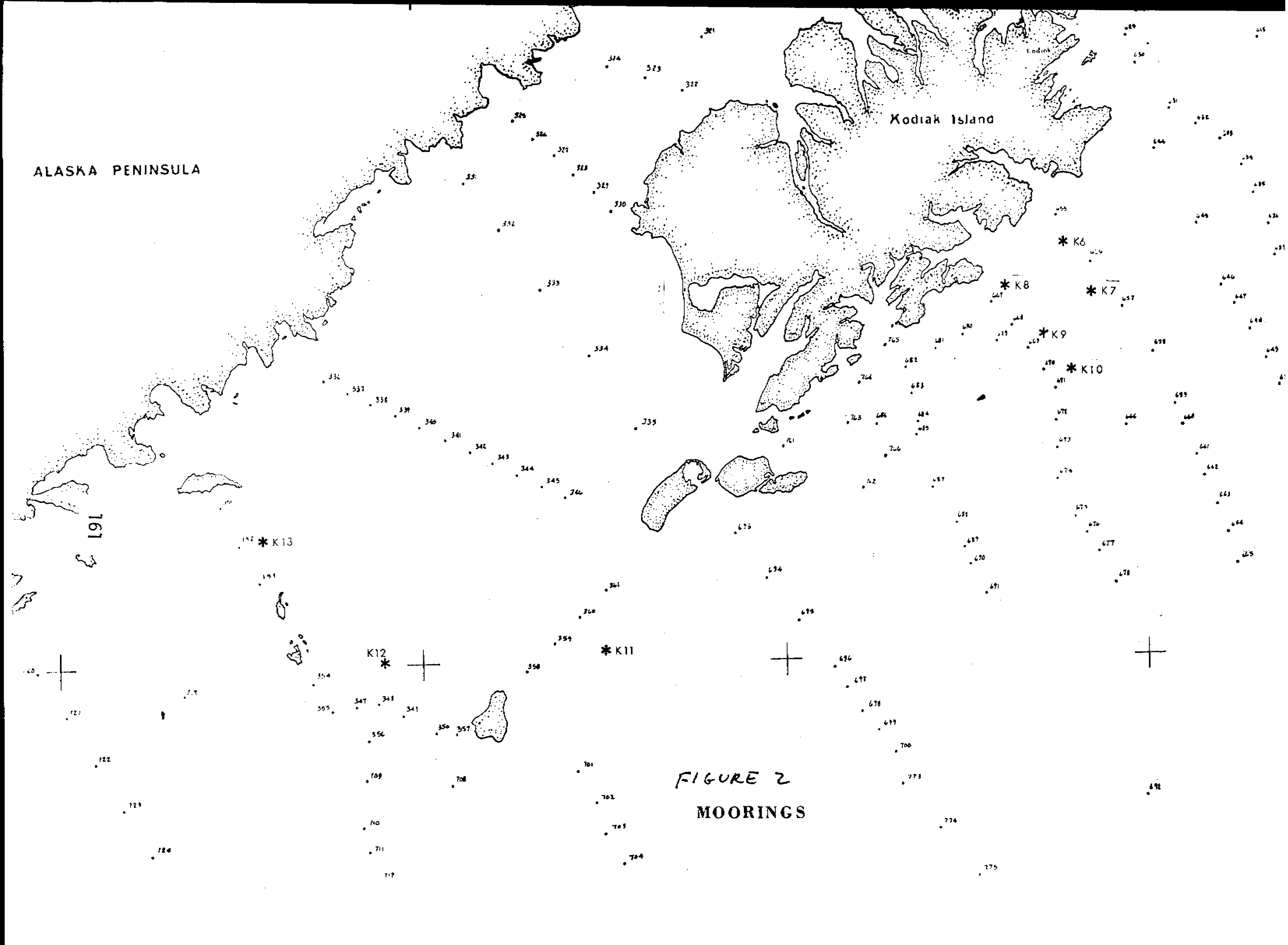


FIGURE 2

MOORINGS

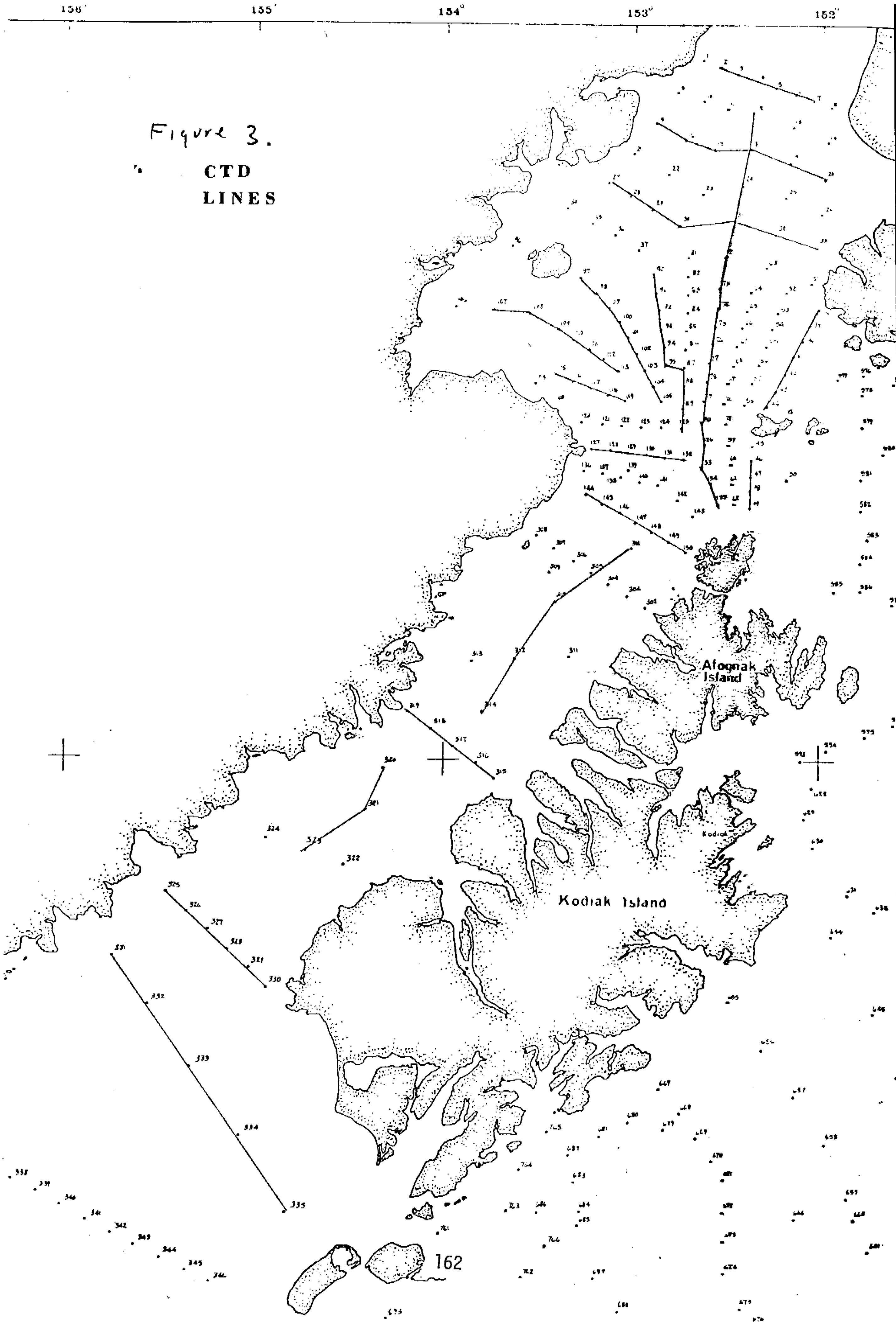


Figure 3.
CTD
LINES
156°
155°
154°
153°
152°
Afognak Island
Kodiak Island
Kodiak

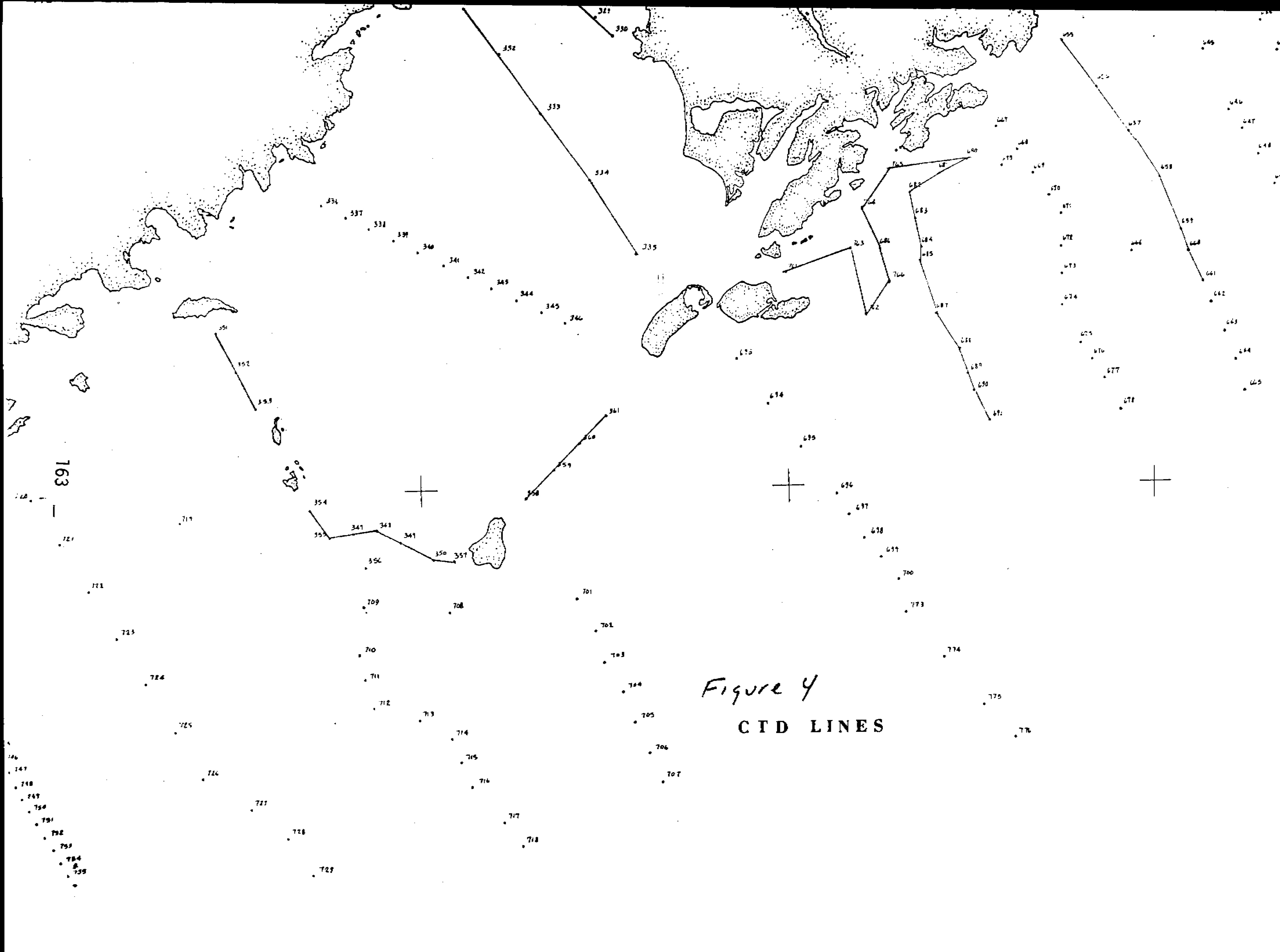


Figure 4

CTD LINES

Quarterly Report

Research Unit: #152
Reporting Period: 4/1/78 - 6/30/78
Number of Pages:
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 and Gary J. Massoth

Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration
3711 15th Avenue N.E.
Seattle, Washington 98105

June 30, 1978

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 an interdisciplinary study of the partitioning of several 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 and Laboratory Activities

A. Field Activities

1. Ship Schedule
    a. DISCOVERER Cruise RP-4-DI-78A-III (4-17 May 1978)
    b. MILLER FREEMAN Cruise RP-4-MF-78A-II (19 May-4 June 1978)
2. Participants from PMEL
    a. Dr. Richard Feely, Oceanographer
    b. Mr. Gary Massoth, Oceanographer
    c. Ms. Jane Hannuksela, Oceanographer
    d. Mr. William Landing, Research Assistant, UW
3. Methods
    a. Particulate Matter - Water samples were collected in General Oceanics 1070 10L PVC Top-Drop Niskin bottles from preselected depths. Nominally these included: 0-2 m, 10 m, 20 m, 40 m, 60 m, 80 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 analysis. 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 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. Bottom Sediment - Bottom sediment samples were collected with a Shipek grab sampler, a three-inch gravity corer equipped with a plastic core liner, and a HAPS corer. One gravity corer sample and all HAPS corer samples were sectioned into 1 cm segments upon collection and frozen in individual plastic bags. All remaining bottom sediment samples were immediately frozen and returned to the laboratory intact.

c. Nephelometry - The vertical distribution of suspended matter was determined with a continuously recording integrating analog nephelometer. The instrument was interfaced with 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.

d. 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 with the ship's data acquisition system. This resulted in computer listings of continuous (uncorrected) data for conductivity, temperature, depth, salinity, sigma-t, and light scattering for all vertical sampling stations.

e. Sediment Trap/Vertical Particulate Flux Studies - During cruise RP-4-MF-78A-II (19 May - 4 June 1978) three moorings, each supporting one set of tandem sediment traps located 10 m above the bottom, were deployed along a transect line extending from Kamishak Bay to Kachemak Bay in Lower Cook Inlet. The sediment trap capture period was set (trap closure to be activated by self-contained timers approximately 80 days after deployment) to obtain a long-term average of the particulate vertical flux mass (rate) and composition. Recovery of the sediment traps is scheduled for fall 1978.

4. Station Locations

Figure 1 shows the locations of suspended matter stations occupied during Cruise RP-4-DI-78A-III (4-17 May 1978) and RP-4-MF-78A-II (19 May - 4 June 1978) in Lower Cook Inlet. Stations ST-1, ST-2 and ST-3 were the only positions occupied during the latter cruise which was conducted entirely for sediment trap deployment operations.

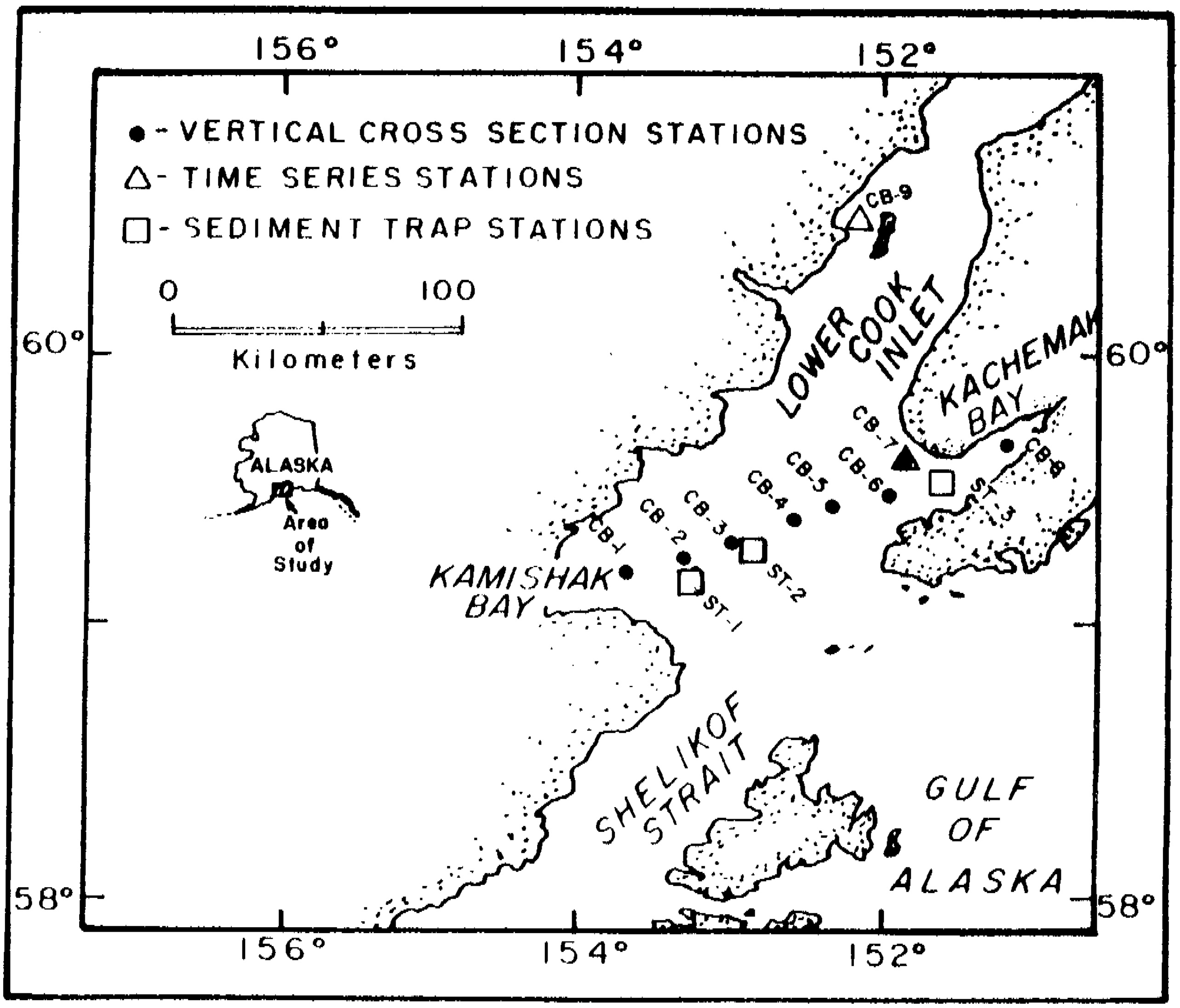


Figure 1. Locations of suspended matter stations in Lower Cook Inlet (Cruises RP-4-DI-78A-III, 4-17 May 1978 and RP-4-MF-78A-II, 19 May - 4 June 1978).

5. Samples and Data Collected

We have completed the first of two interdisciplinary cruises scheduled for FY 78 in Lower Cook Inlet. During this cruise (RP-4-DI-78A-III, 4-17 May 1978) we collected 283 suspended particulate matter samples, five gravity and HAPS corer samples, 59 nephelometer profiles and 72 CTD profiles. In addition, nine suspended matter samples were processed in support of hydrocarbon studies conducted in Upper Cook Inlet (Cline: RU 153). A total of 12 stations were occupied including two 48-hour time series studies at stations CB-7 and CB-9 (Figure 1).

B. Laboratory Activities

1. Sample and Data Status

Analysis of samples and data collected on Cruise RP-4-DI-78A-III (4-17 May 1978) and a laboratory investigation of crude oil-suspended matter interactions are currently under way and will be discussed in a future report.

III. Problems Encountered

We have no significant problems to report at this time.

IV. Estimate of Funds Expended

	Allocated	Expended	Balance
Salaries and Overhead	$108.7 K	$ 86.3 K	$22.4 K
Travel and Shipping	8.3	3.2	5.1
Equipment	12.0	8.1	3.9
Publications, Reports and Data Processing	1.7	1.2	0.5
Other Direct Costs	6.7	6.5	0.2
	$137.4 K	$105.3 K	$32.1 K

QUARTERLY REPORT

Contract: #03-5-022-56
Research Unit: 162
Task Order: #12
Reporting Period: 4/1/78-6/30/78
Number of Pages: 27

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

June 1978

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 indigenous biota in those geographical areas for which no background data exist; (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.
   OSS *Surveyor*, 27-31 March 1978
   Personnel: Donna Weiks

   Further winter collection of subtidal benthic species. These samples were collected *via* trawl in cooperation with the benthic biology program. A few grab samples were also retained but those are, of course, not to be used for heavy metal analysis. Samples collected are listed in Table I. Additional five samples of the intertidal *Macoma baltica* were subsequently collected at the termination of the cruise for laboratory aquaria experiments.

2. Resurrection Bay.
   R/V *Acona* No. 260, 23-24 April 1978
   Personnel: D. C. Burrell
   T. Owens
   D. Weiks

   Spring survey of hydrography, nutrient distribution and other chemical parameters as shown in Table II. The primary objective of this cruise was to research the distribution and flux of metals across the sediment-water interface. Closely spaced water column and interstitial water samples were taken.

TABLE I

LOWER COOK INLET OSS *SURVEYOR*
27 - 31 March 1978
Biota samples collected for heavy metal analysis

Station No.	Trawl	Sample No.	Species	Sex	Size (mm)	Wt (g)
5		a	tanner crab	F		
		b	tanner crab	F		
		c	*Neptunea*			
		d	Greenland cockles			
8		a	tanner crab	M		
		b	tanner crab w/eggs	F		
18		a	tanner crab	M		
		b	yellow finned sole			
23		a	tanner crab	F		
	radial trawl E	1	tanner crab	M		
		2	tanner crab	M		
		3	*Crangon*			
		4	*Pandalus* shrimp			
T3	radial trawl NE	a	King crab	F		
		b	tanner crab	M		
		c	rock sole			
56A		1	tanner crab	M		
		2	tanner crab	M		
		3	tanner crab	M		
		4	tanner crab	M		

TABLE I (cont'd)

Station No.	Trawl	Sample No.	Species	Sex	Size (mm)	Wt (g)
		5	sponges			
		6	*Pandalus* shrimp			
		7	*Modiolus* mussel			
62A	2	1	*Pandalus* shrimp			
	7	a	*Pandalus* shrimp			
		b	*Crangon*			
	8	1	King crab	M		
	9	2	tanner crab	M	84	140
		3	tanner crab	M	105	350
		4	tanner crab	M	102	
		5	tanner crab	F	95	230
	10	6	tanner crab	M	109	
		7	tanner crab	M	102	
		8	tanner crab	M	93	260
	11	10	tanner crab	M	115	520
		11	tanner crab	M	106	390
		12	tanner crab	M	95	250
		13	tanner crab	M	97	290
	12	14	tanner crab	M	98	
		15	tanner crab	M	106	
	13	a	tanner crab	M	105	350
		b	tanner crab	M	112	454
		c	tanner crab	M	99	290

TABLE I (cont'd)

Station No.	Trawl	Sample No.	Species	Sex	Size (mm)	Wt (g)
		d	tanner crab	M	109	
		e	tanner crab	F	86	140
		f	tanner crab	F	94	200
	14	a	tanner crab	F	90	200
		b	tanner crab	F	86	
		c	tanner crab	M	108	420
		d	tanner crab	M	118	538
56		1	*Pandalus* shrimp			
45A		1	rock sole			
43A		1	rock sole			
38A		1	*Pandalus* shrimp			
37		1	coon stripe shrimp			
		2	herring			
38		a	sole			
48		1	coon stripe shrimp			

TABLE II

RESURRECTION BAY
R/V *Acona* 260 - 23-24 April 1978
Operations

Station	Depth (m)	Operations
Res 5	267	Hydro, STD
Res 4	263	Hydro, STD
Res 3.5	195	STD
Res 3	292	Hydro, STD
Res 2.5 A	285	STD
Res 2.5 B	285	STD
Res 2	193	Hydro, STD
Res 2.5	288	Hydro, STD, T.M., vertical and horizontal tows, benthos cores
Res 1		STD
Res 4	260	STD
Res 2.5	289	STD

3. Lower Cook Inlet
OSS *Discoverer*, 4-16 May 1978
Personnel: D. Weiks
T. Owens

The primary purpose of this cruise was to collect the samples for heavy metal analysis on the two time series stations as requested by OCSEAP Boulder. Operations are given in Table III.

B. Scientific Parties

As noted above.

C. Field Collection Methods

As discussed in 1977-78 Annual Report.

D. Sample Localities

1. Lower Cook Inlet: Sample localities for benthos and sediment samples for the March 27-31 cruise are given in Table IV and shown in Figure 1. The two time series stations occupied on the May 4-16 cruise are shown in Figure 2.

2. Resurrection Bay. Figure 3 gives the stations occupied on R/V *Acona* cruise No. 260. The standard stations occupied for this R.U. are as given in previous reports.

E. Laboratory Analysis Program

As given in previous Quarterly Report.

III. RESULTS

A. Heavy metal contents of benthos. Additional data for epibenthic species collected in Lower Cook Inlet on the 3-17 November 1977 *Surveyor* cruise are given in Tables V and VI.

B. Environmental data for NEGOA specific study sites. These series of data are essential ancillary information required to interpret the heavy metal research program. Hydrographic data for R/V *Acona* cruise No. 246 to Yakutat Bay and cruise No. 254 in Resurrection Bay are given in Figures 4-7 and Figures 8-16.

TABLE III

LOWER COOK INLET
O.S.S. *Discoverer* 4-16 May 1978
Operations

Date	Time	Cd Samples F	Cd Samples UF	Doc/Poc	Plankton	NAA water samples
A. Station CB 7 59°33.3'N, 151°40.0'W 48 hour time series station Kachemak Bay (47 m)						
5-7	0	X	X	X	X	X
	6	X	X	X		X
	12	X	X	X	X	X
	18	X	X	X		X
5-8	24	X	X	X	X	X
	30	X	X			X
	36	X	X		X	X
	42	X	X			X
5-9	48	X	X		X	
B. Station CB 9 69°30.0'N, 152°10.0'W 48 hour time series station Redoubt Bay (50 m)						
5-12	0	X	X	X	X	X
	6	X	X	X		X
	12	X	X	X	X	X
	18	X	X	X		X
5-13	24	X	X	X	X	X
	30	X	X			X
	36	X	X		X	X
	42	X	X			X
5-14	48	X	X		X	

TABLE IV

LOWER COOK INLET OSS *SURVEYOR*
27 - 31 March 1978
Operations

Station No.	Location		Depth (m)	Sample type
5	59°00	152°42	172	Trawl
8	59°00	153°24	137	Trawl
18	59°10	153°49	50	Trawl, grab
23	59°16	152°50	91	Trawl, grab
25	59°16	153°09	58	
E	from St. Augustine			Trawl
T_3	NE of St. Augustine			Trawl
NS	N of St. Augustine			
56A	59°33	152°14	33	Trawl
62A	59°50	152°57	25	Trawl
56	59°37	153°02		Trawl
47A	59°27	152°45	66	Grab
45A	59°27	152°26	56	Trawl, grab
43A	59°17	152°06	78	Trawl, grab
42			47	Grab
41				Grab
38A			50	Trawl
37			53	Trawl
38			66	Trawl
48			33	Trawl
56B				Grab

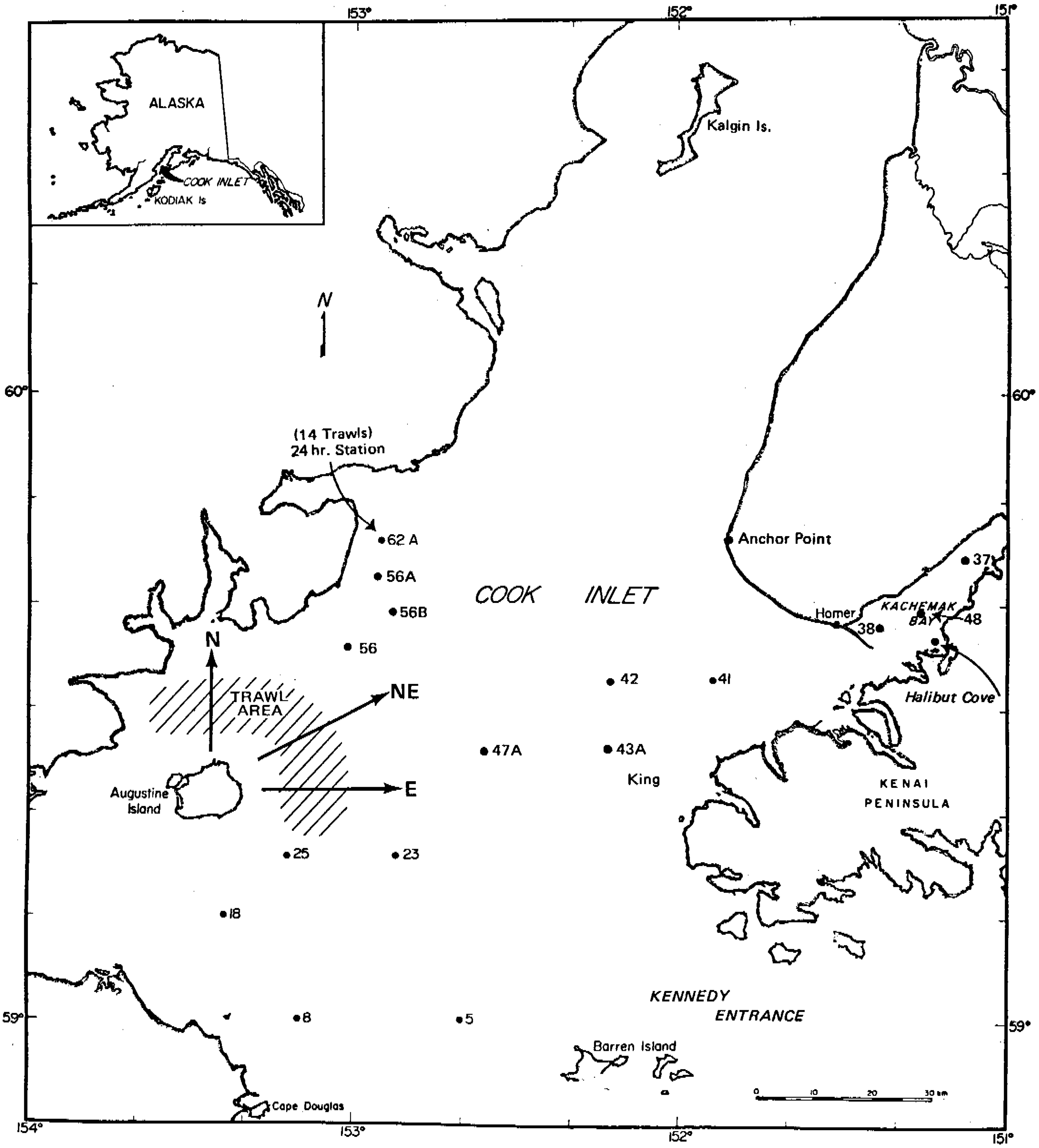


Figure 1. Stations occupied on OSS *Surveyor* cruise, Lower Cook Inlet, March 27-31.

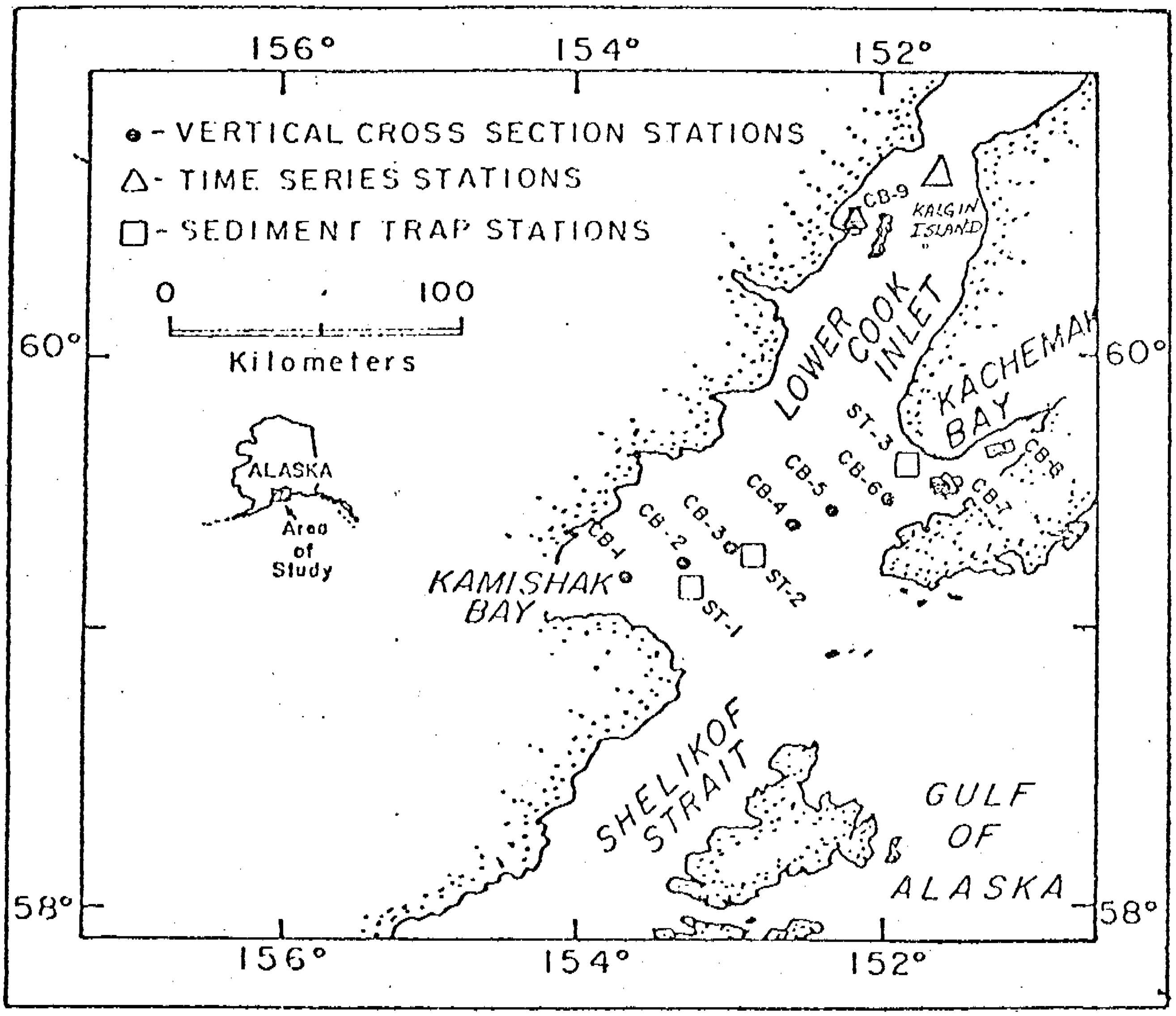


FIGURE 2. IMS-PMEL Sampling Grid

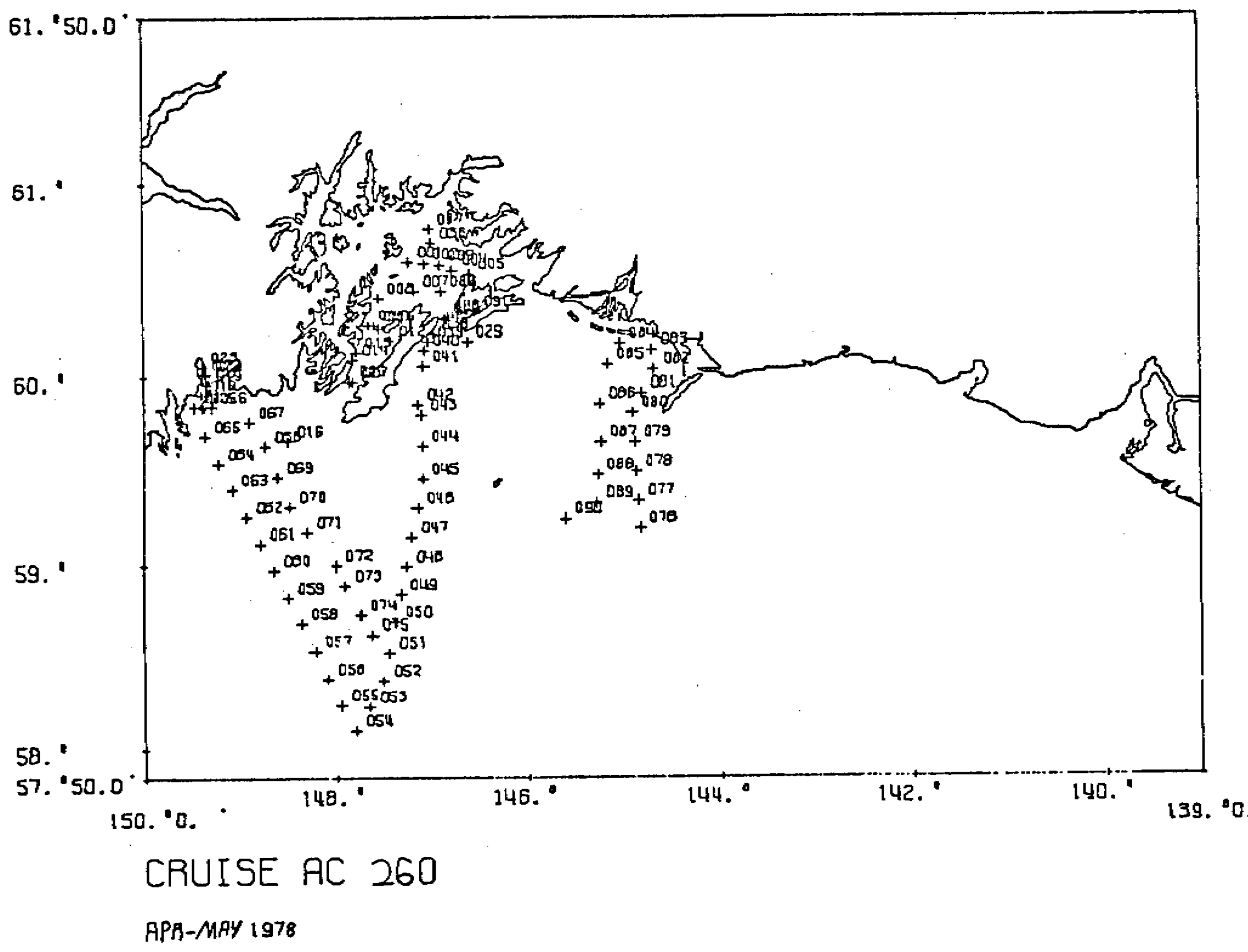


Figure 3. R/V *Acona* Cruise No. 260, April-May 1978.

TABLE V

LOWER COOK INLET
O.S.S. *Surveyor* 3-17 November 1977
Heavy metal contents of Tanner crab
(μg/g dry weight; mean of triplicate determinations)

Station No.	Tissue	Cd	Ni	Cu	Zn
40 g	eggs	<0.13	0.5[a]	13.1[a]	125[a]
	muscle	<0.13	0.6	26.7	200[a]
	gut	32.5	0.8	59.0	166
40 e	muscle	<0.13	<0.25	54.0	98
40 f	muscle	0.31	0.50	47.2	110
62 d	muscle	<0.13	0.50	54.0	118
35 a	muscle			78[a]	
41 b	muscle			57.5	
41 c	muscle			59.6	
41 d	muscle			46.2	
41 e	muscle			45.0	
41 g	muscle			43.7	

a = Single determinations

TABLE VI

LOWER COOK INLET
O.S.S. *Surveyor* 3-17 November 1977
Heavy metal contents of biota (μg/g dry weight)

Station No.	Organism	Cd	Ni	Cu	Zn
B	sole	2.80	<0.25	0.49	28
41 a	King crab	<0.13	<0.25	61.0	175
40	Cockles		0.81	2.5	63
	Cockles		1.0	<1.3	65
	Cockles		1.8	29	--

```
AC   CRUISE 246 CONSECUTIVE STATION NO.   2.   YAK  3     28/ 7/77
                                                          6.6 HOURS GMT

  LATITUDE = 59  52.5N   LONGITUDE = 139  40.0W   SONIC DEPTH =  256 M

  1-DIGIT WEATHER CODE IS (X1) AND INDICATES PARTLY CLOUDY
  CLOUD TYPE --- (3) ---ALTOCUMULUS
  CLOUD AMOUNT --- (2) ---2/8
  VISIBILITY --- (6) ---4-10 KM
---------------------------------------------------------------------------
I            DIRECTION          SPEED                                     I
I WIND       15 -  24 DEGR       KNOTS                                    I
---------------------------------------------------------------------------
I            DIRECTION         HEIGHT      PERIOD                         I
I SEA       215 - 224 DEGR     1.0 M.        SECS                         I
I SWELL        - .    DEGR        M.         SECS                         I
---------------------------------------------------------------------------
I TEMPERATURES -DRY =          DEGR C.   BAROMETRIC PR. =1015.4 MB       I
I              -WET =          DEGR C.   TRANSPARENCY   =         M      I
---------------------------------------------------------------------------
```

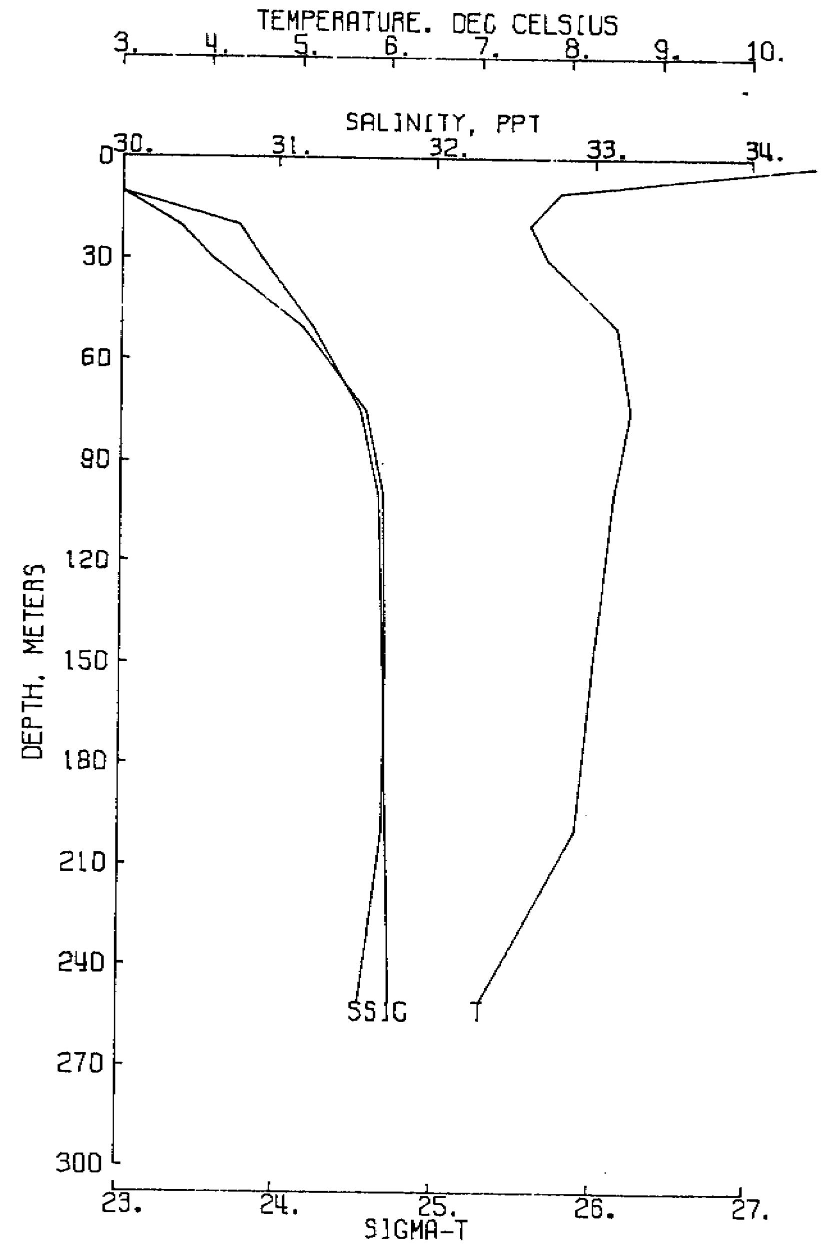
STANDARD DEPTHS

DEPTH	TEMP	SALIN	SIG-T	SPVOL	DEL-D
0.	15.07	21.600	15.72	1188.8	0.
10.	7.88	29.199	22.79	508.2	0.085
20.	7.53	30.363	23.75	416.7	0.131
30.	7.74	30.578	23.89	403.4	0.172
50.	8.51	31.145	24.22	371.8	0.250
75.	8.67	31.569	24.53	342.9	0.339
100.	8.49	31.680	24.64	332.4	0.423
150.	8.27	31.685	24.68	329.6	0.589
200.	8.07	31.681	24.70	327.7	0.753
250.	7.05	31.545	24.74	324.7	0.916

OBSERVED DEPTHS

0.	15.07	21.600	15.72
10.	7.88	29.199	22.79
20.	7.53	30.363	23.75
30.	7.74	30.578	23.89
50.	8.51	31.145	24.22
75.	8.67	31.569	24.53
100.	8.49	31.680	24.64
150.	8.27	31.685	24.68
200.	8.07	31.681	24.70
250.	7.05	31.545	24.74

Figure 4. Yakutat Bay hydrographic data
July 1977 R/V *Acona* cruise No. 246.



CRUISE 246 STATION 2

CRUISE 246 ... STATION ... YAK 05 28/ 7/77
8.3 HOURS GMT

LATITUDE = 59 44.0N LONGITUDE = 139 40.5W SONIC DEPTH = 183 M

3-DIGIT WEATHER CODE IS ( ) AND INDICATES NOT RECORDED
CLOUD TYPE --- ( ) ---NOT RECORDED
CLOUD AMOUNT --- ( ) ---NOT RECORDED.
VISIBILITY --- ( ) ---NOT RECORDED

	DIRECTION	SPEED
WIND	- DEGR	KNOTS

	DIRECTION	HEIGHT	PERIOD
SEA	215 - 224 DEGR	0.5 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES		BAROMETRIC PR. =1014.7 MB
-DRY =	DEGR C.	
-WET =	DEGR C.	TRANSPARENCY = M

STANDARD DEPTHS

DEPTH	TEMP	SALIN	SIG-T	[illegible]	DEL-D
0.	13.53	24.039	17.88	[illegible]	0.
10.	12.01	29.995	22.75	[illegible]	0.075
20.	12.56	31.181	23.54	[illegible]	0.122
30.	11.33	31.531	24.04	[illegible]	0.163
50.	9.77	31.705	24.44	[illegible]	0.236
75.	8.80	[illegible]	24.6[illegible]	[illegible]	.321
100.	8.51	[illegible]	24.75	[illegible]	.402
150.	7.17	[illegible]	24.89	[illegible]	.560

OBSERVED DEPTHS

0.	13.53	24.039	17.88
10.	12.01	29.995	22.75
20.	12.56	31.181	23.54
30.	11.33	31.531	24.04
50.	9.77	31.705	24.44
75.	8.80	31.792	24.68
100.	8.51	31.818	24.75
150.	7.17	31.760	24.89
175.	6.96	31.763	24.92

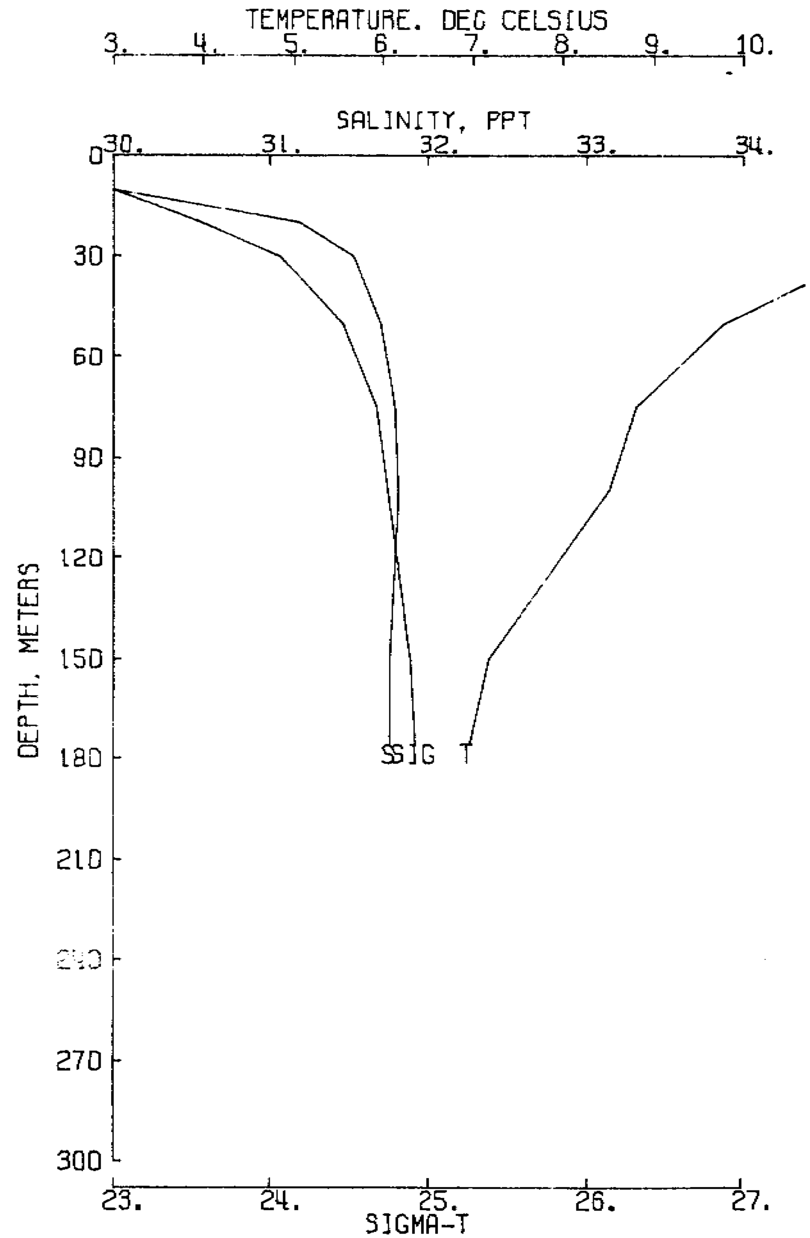


Figure 5. Yakutat Bay hydrographic data
July 1977 R/V Acona Cruise No. 246.

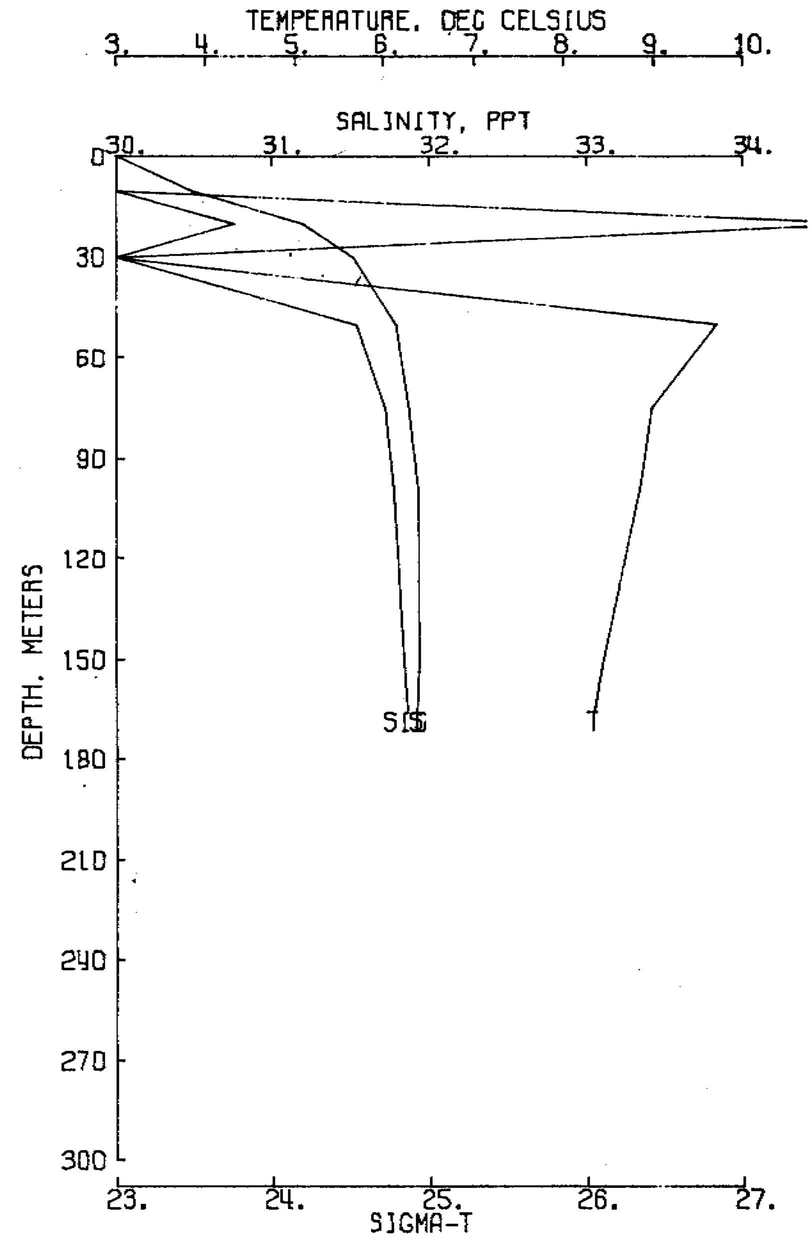
```
AC   CRUISE 246 CONSECUTIVE STATION NO.   1.   YAK  7    27/ 7/77
-------------------------                             20.5 HOURS GMT

 LATITUDE = 59  40.0N   LONGITUDE = 139  59.5W   SONIC DEPTH =  172 M

 1-DIGIT WEATHER CODE IS (X1) AND INDICATES PARTLY CLOUDY
 CLOUD TYPE --- (3) ---ALTOCUMULUS         ,
 CLOUD AMOUNT --- (4) ---4/8            ,
 VISIBILITY --- (6) ---4-10 KM
----------------------------------------------------------------------
I           DIRECTION          SPEED                                  I
I WIND      245 - 254 DEGR      7 KNOTS                               I
----------------------------------------------------------------------
I           DIRECTION         HEIGHT      PERIOD                      I
I SEA       215 - 224 DEGR   1.0 M.         SECS                      I
I SWELL          -    DEGR      M.          SECS                      I
----------------------------------------------------------------------
I TEMPERATURES -DRY =        DEGR C.   BAROMETRIC PR. =1019.3 MB  I
I              -WET =        DEGR C.   TRANSPARENCY   =        M  I
----------------------------------------------------------------------
```

STANDARD DEPTHS

DEPTH	TEMP	SALIN	SIG-T	SPVOL	DEL-D
0.	0.	24.634	0.	0.	0.
10.	0.	30.485	0.	0.	0.
20.	11.58	31.194	23.76	415.9	0.
30.	10.33	31.521	24.14	379.3	0.
50.	9.71	31.790	24.54	341.7	0.
75.	8.99	31.860	24.72	324.4	0.
100.	8.85	31.928	24.78	319.2	0.
150.	8.45	31.928	24.84	314.1	0.

OBSERVED DEPTHS

0.	0.	24.634	0.
10.	0.	30.485	0.
20.	11.53	31.194	23.76
30.	0.	31.521	0.
50.	9.71	31.790	24.54
75.	8.99	31.880	24.72
100.	8.85	31.928	24.78
150.	8.45	31.928	24.84
165.	8.34	31.926	24.86



CRUISE 246 STATION 1

Figure 6. Yakutat Bay hydrographic data July 1977 R/V *Acona* cruise No. 246.

AC CRUISE 246 CONSECUTIVE STATION NO. 4, YAK-9 28/ 7/77
18.5 HOURS GMT

LATITUDE = 59 40.0N LONGITUDE = 139 59.5W SONIC DEPTH = 158 M

1-DIGIT WEATHER CODE IS ( ) AND INDICATES NOT RECORDED
CLOUD TYPE --- ( ) ---NOT RECORDED
CLOUD AMOUNT --- ( ) ---NOT RECORDED,
VISIBILITY --- (6) ---4-10 KM

	DIRECTION	SPEED
WIND	- DEGR	KNOTS

	DIRECTION	HEIGHT	PERIOD
SEA	195 - 204 DEGR	0.5 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES -DRY = DEGR C.	BAROMETRIC PR. =1013.3 MB	
-WET = DEGR C.	TRANSPARENCY = M	

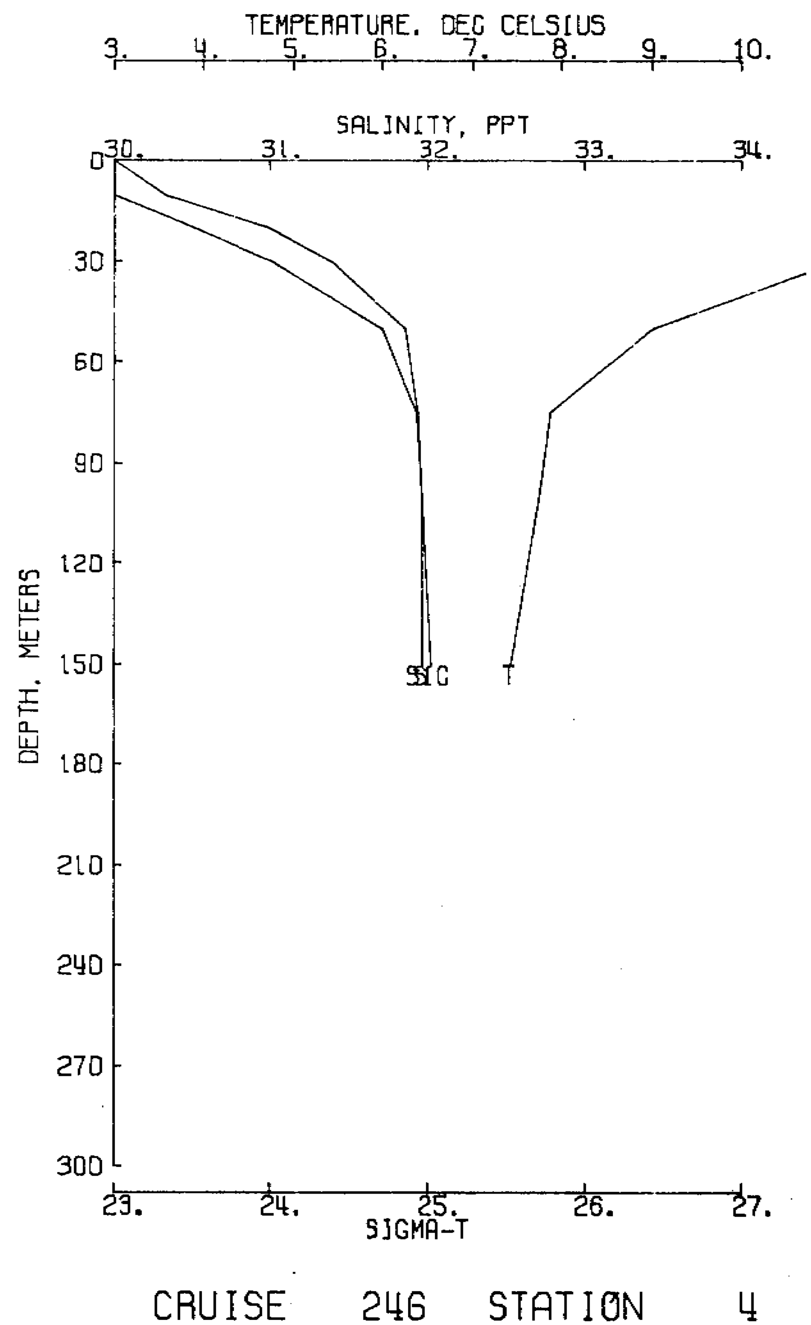
STANDARD DEPTHS

DEPTH	TEMP	SALIN	SIG-T	SPVOL	DEL-D
0.	13.56	24.429	18.17	951.2	0.
10.	14.06	30.324	22.61	525.5	0.074
20.	12.09	30.990	23.50	439.9	0.122
30.	11.06	31.396	24.00	392.3	0.164
50.	9.00	31.961	24.71	325.7	0.235
75.	7.38	31.939	24.93	304.3	0.314
100.	7.76	31.966	24.97	300.9	0.390
150.	7.44	31.972	25.02	296.8	0.539

OBSERVED DEPTHS

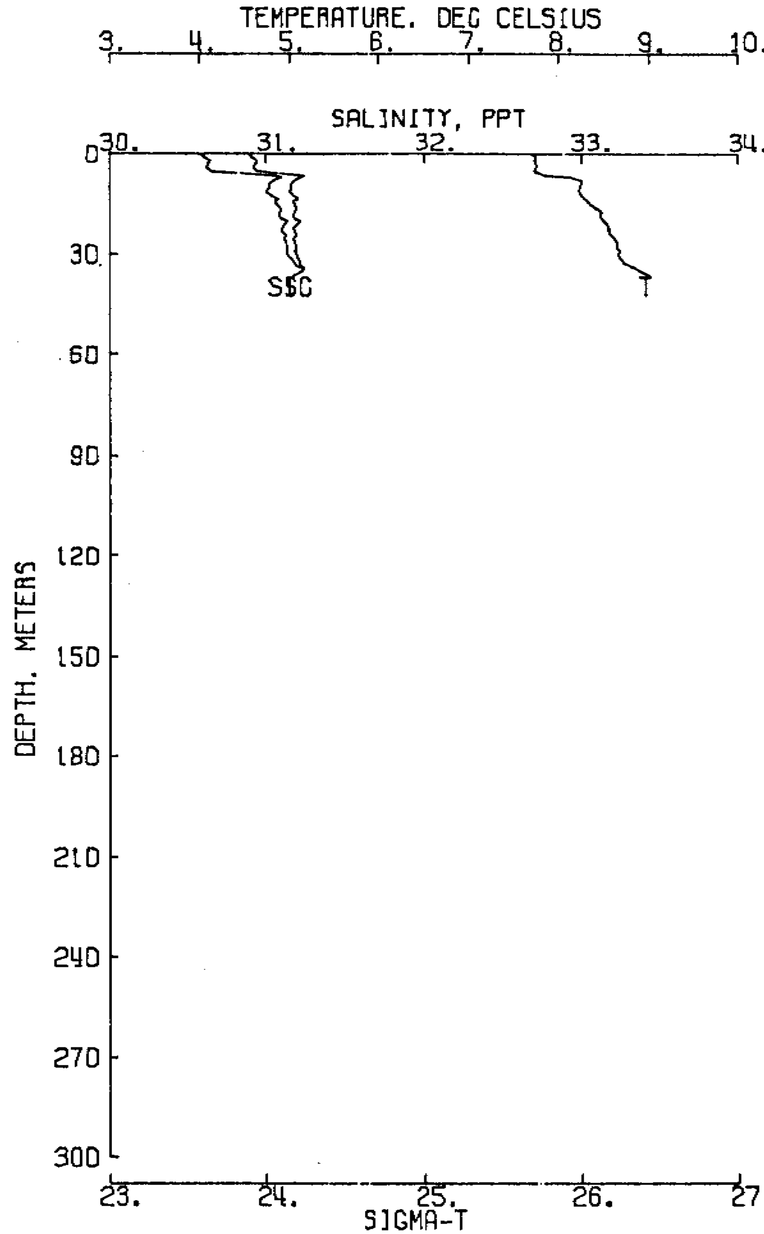
0.	13.56	24.429	18.17
10.	14.06	30.324	22.61
20.	12.09	30.990	23.51
30.	11.06	31.396	24.01
50.	9.00	31.961	24.71
75.	7.38	31.939	24.93
100.	7.76	31.966	24.97
150.	7.44	31.972	25.02

Figure 7. Yakutat Bay hydrographic data
July 1977 R/V *Acona* cruise No. 246.



```
AC   CRUISE 254 CONSECUTIVE STATION NO.   1    RES  1     28/11/77
--------------------------                                19.0 HOURS GMT

  LATITUDE = 60   6.5N   LONGITUDE = 149  23.8W   SONIC DEPTH =   38 M

  1-DIGIT WEATHER CODE IS (X1) AND INDICATES PARTLY CLOUDY
  CLOUD TYPE --- (6) ---STRATOCUMULUS
  CLOUD AMOUNT --- (3) ---3/8
  VISIBILITY --- (8) ---20-50 KM
---------------------------------------------------------------------
I          DIRECTION        SPEED                                   I
I WIND       0 -   0 DEGR   20 KNOTS                                I
---------------------------------------------------------------------
I          DIRECTION       HEIGHT      PERIOD                       I
I SEA        0 -   0 DEGR  0.3 M.         SECS                      I
I SWELL        -     DEGR      M.         SECS                      I
---------------------------------------------------------------------
I TEMPERATURES -DRY =  -1.1 DEGR C.   BAROMETRIC PR. = 988.3 MB     I
I              -WET =       DEGR C.   TRANSPARENCY   =       M      I
---------------------------------------------------------------------
```

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
2.0	7.74	30.642	23.94	0.008
1.0	7.75	30.606	23.91	0.004
5.0	7.73	30.651	23.94	0.020
10.0	5.25	31.019	24.16	0.039
15.0	8.37	31.072	24.18	0.058
20.0	8.56	31.135	24.22	0.076
25.0	8.63	31.109	24.18	0.095
30.0	8.67	31.140	24.19	0.114
35.0	8.91	31.234	24.23	0.133



CRUISE 254 STATION 1

Figure 8. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.

AC CRUISE 254 CONSECUTIVE STATION NO. 9. RES 2 29/11/77
11.1 HOURS GMT

LATITUDE = 60 3.5N LONGITUDE = 149 23.4W SONIC DEPTH = 168 M

1-DIGIT WEATHER CODE IS (X2) AND INDICATES CONTINUOUS LAYER
CLOUD TYPE --- ( ) ---NOT RECORDED
CLOUD AMOUNT --- ( ) ---NOT RECORDED.
VISIBILITY --- ( ) ---NOT RECORDED

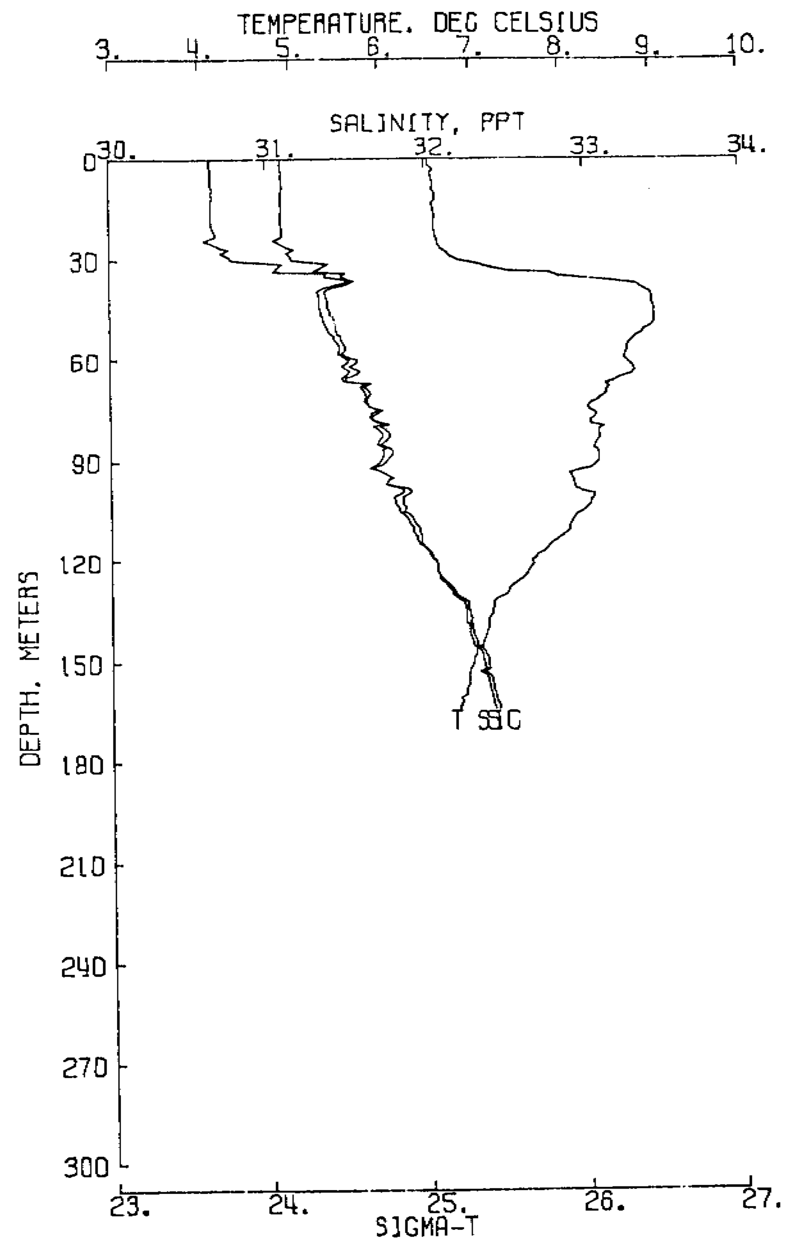
	DIRECTION	SPEED	
WIND	345 - 354 DEGR	20 KNOTS	

	DIRECTION	HEIGHT	PERIOD
SEA	345 - 354 DEGR	1.0 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES -DRY = -1.1 DEGR C. BAROMETRIC PR. = 991.8 MB
-WET = DEGR C. TRANSPARENCY = M

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
3.0	6.60	30.656	24.10	0.012
1.0	6.54	30.644	24.09	0.004
5.0	6.59	30.656	24.10	0.019
10.0	6.62	30.655	24.09	0.038
15.0	6.59	30.657	24.10	0.058
20.0	6.60	30.652	24.09	0.077
25.0	6.64	30.659	24.09	0.096
30.0	6.96	30.773	24.16	0.115
35.0	7.98	31.372	24.47	0.133
40.0	9.01	31.352	24.31	0.151
45.0	9.04	31.401	24.34	0.169
50.0	9.01	31.440	24.38	0.187
60.0	8.72	31.571	24.52	0.222
70.0	8.50	31.660	24.62	0.256
75.0	8.31	31.724	24.70	0.273
80.0	8.47	31.714	24.67	0.289
90.0	8.42	31.751	24.71	0.322
100.0	8.37	31.915	24.84	0.354
125.0	7.54	32.085	25.09	0.430
150.0	7.01	32.361	25.38	0.499

Figure 9. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.



CRUISE 254 STATION 9

AC CRUISE 254 CONSECUTIVE STATION NO. 17. RES 25 1/12/77
7.6 HOURS GMT

LATITUDE = 60 1.2N LONGITUDE = 149 21.5W SONIC DEPTH = 289 M

1-DIGIT WEATHER CODE IS (X1) AND INDICATES PARTLY CLOUDY
CLOUD TYPE --- (3) ---ALTOCUMULUS
CLOUD AMOUNT --- (1) ---1/? OR LESS ,
VISIBILITY --- (?) ---20-50 KM

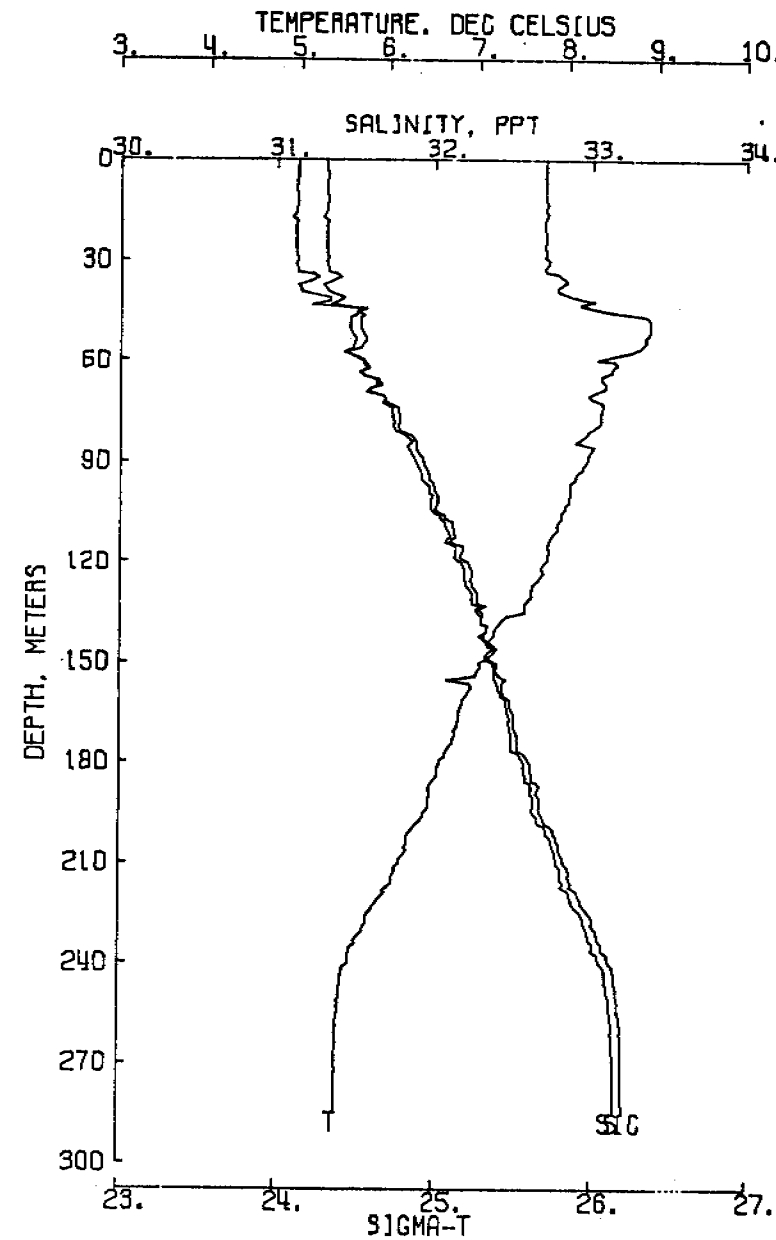
	DIRECTION	SPEED	
WIND	325 - 334 DEGR	35 KNOTS	

	DIRECTION	HEIGHT	PERIOD
SEA	325 - 334 DEGR	2.0 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES -DRY = -3.[illegible] DEGR C.	BAROMETRIC PR. =1014.8 MB	
-WET = DEGR C.	TRANSPARENCY =	M

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
2.0	7.73	31.122	24.31	0.007
1.0	7.73	31.122	24.31	0.004
5.0	7.72	31.126	24.32	0.018
10.0	7.71	31.120	24.31	0.036
15.0	7.72	31.116	24.31	0.054
20.0	7.71	31.115	24.31	0.073
25.0	7.71	31.115	24.31	0.091
30.0	7.77	31.126	24.31	0.109
35.0	7.91	31.262	24.40	0.127
40.0	7.85	31.132	24.31	0.145
45.0	8.49	31.505	24.51	0.163
50.0	8.91	31.528	24.46	0.180
60.0	8.51	31.550	24.54	0.215
70.0	8.22	31.677	24.68	0.249
75.0	8.37	31.770	24.73	0.265
80.0	8.30	31.754	24.73	0.281
90.0	8.20	31.933	24.88	0.313
100.0	8.00	32.028	24.99	0.343
125.0	7.66	32.235	25.20	0.416
150.0	7.01	32.383	25.40	0.483
175.0	6.67	32.496	25.53	0.547
200.0	6.27	32.717	25.76	0.606
250.0	5.46	33.118	26.17	0.709

Figure 10. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.



CRUISE 254 STATION 17

AC CRUISE 254 CONSECUTIVE STATION NO. 10, RES25A 29/11/77
13.3 HOURS GMT

LATITUDE = 60 1.2N LONGITUDE = 149 23.0W SONIC DEPTH = 278 M

1-DIGIT WEATHER CODE IS (X) AND INDICATES CONTINUOUS LAYER
CLOUD TYPE --- ( ) ---NOT RECORDED
CLOUD AMOUNT --- ( ) ---NOT RECORDED.
VISIBILITY --- ( ) ---NOT RECORDED

	DIRECTION	SPEED	
WIND	5 - 14 DEGS	16 KNOTS	

	DIRECTION	HEIGHT	PERIOD
SEA	5 - 14 DEGR	1.0 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES -DRY = -1.7 DEGS C. BAROMETRIC PR. = 993.0 MB
-WET = DEGS C. TRANSPARENCY = M

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
2.0	6.59	30.652	24.09	0.008
1.0	6.59	30.652	24.09	0.004
5.0	6.62	30.677	24.11	0.019
10.0	6.65	30.673	24.10	0.038
15.0	6.64	30.674	24.10	0.057
20.0	6.63	30.674	24.11	0.077
25.0	6.77	30.697	24.11	0.096
30.0	6.81	30.790	24.17	0.115
35.0	6.87	30.785	24.16	0.134
40.0	6.91	30.746	24.13	0.153
45.0	7.93	31.658	24.71	0.171
50.0	8.99	31.426	24.37	0.188
60.0	8.71	31.531	24.49	0.224
70.0	9.77	31.599	24.54	0.258
75.0	8.49	31.694	24.67	0.275
80.0	8.23	31.724	24.71	0.291
90.0	8.27	31.871	24.82	0.323
100.0	8.20	31.932	24.88	0.354
125.0	7.49	32.140	25.15	0.430
150.0	6.85	32.452	25.48	0.497
175.0	6.55	32.596	25.63	0.559
200.0	6.26	32.701	25.75	0.617
250.0	5.47	33.104	26.16	0.721

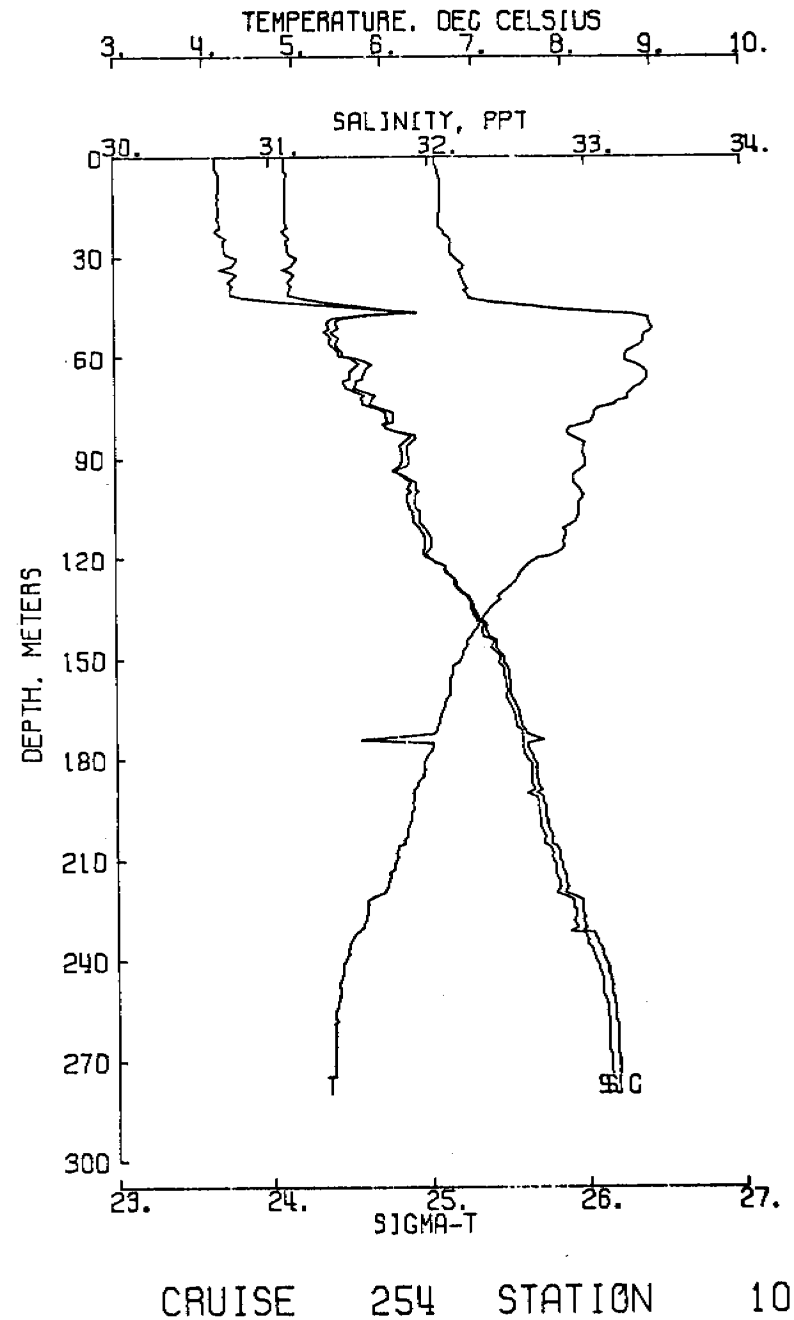


Figure 11. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.

AC CRUISE 254 CONSECUTIVE STATION NO. 11. RES25B 29/11/77
16.5 HOURS GMT

LATITUDE = 60 1.2N LONGITUDE = 149 20.6W SONIC DEPTH = 275 M

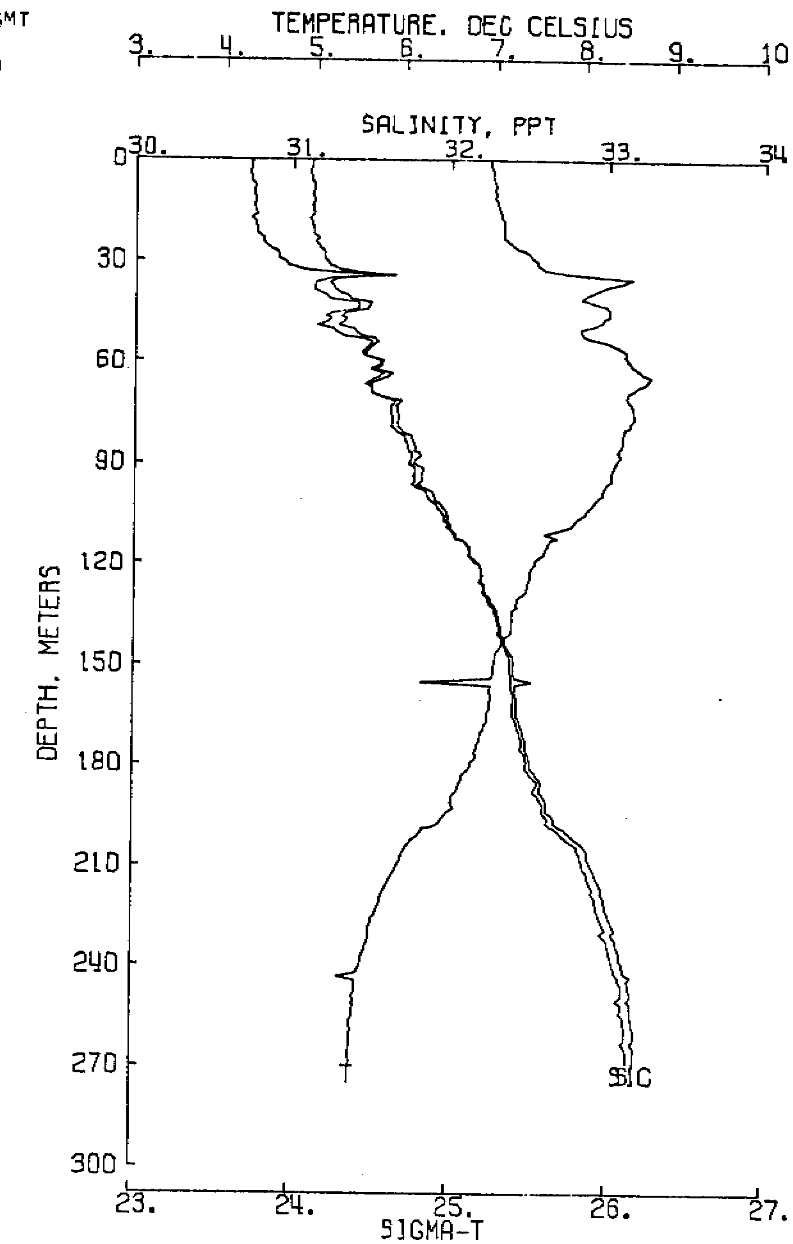
1-DIGIT WEATHER CODE IN (X) AND INDICATES CONTINUOUS LAYER
CLOUD TYPE --- ( ) ---NOT RECORDED
CLOUD AMOUNT --- ( ) ---NOT RECORDED.
VISIBILITY --- ( ) ---NOT RECORDED

	DIRECTION	SPEED	
WIND	335 - 344 DEGS	25 KNOTS	

	DIRECTION	HEIGHT	PERIOD
SEA	5 - 14 DEGS	1.0 M.	SECS
SWELL	- DEGS	M.	SECS

TEMPERATURES -DRY =	-1.7 DEGS C.	BAROMETRIC PR. =	996.2 MB
-WET =	DEGS C.	TRANSPARENCY =	M

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
2.0	6.93	30.729	24.11	0.008
1.0	6.93	30.729	24.11	0.004
5.0	6.95	30.734	24.11	0.019
10.0	6.96	30.746	24.12	0.038
15.0	7.03	30.760	24.12	0.057
20.0	7.07	30.766	24.12	0.076
25.0	7.18	30.826	24.16	0.095
30.0	7.46	30.956	24.22	0.114
35.0	8.53	31.238	24.29	0.132
40.0	8.02	31.206	24.34	0.150
45.0	8.27	31.249	24.34	0.168
50.0	7.93	31.256	24.39	0.186
60.0	8.50	31.571	24.55	0.221
70.0	8.46	31.574	24.56	0.255
75.0	8.54	31.668	24.62	0.272
80.0	8.43	31.666	24.64	0.288
90.0	8.34	31.774	24.74	0.321
100.0	8.18	31.903	24.86	0.353
125.0	7.37	32.190	25.20	0.426
150.0	7.00	32.384	25.40	0.493
175.0	6.81	32.457	25.49	0.558
200.0	6.19	32.702	25.76	0.618
250.0	5.47	33.080	26.14	0.720



CRUISE 254 STATION 11

Figure 12. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.

AC CRUISE 254 CONSECUTIVE STATION NO. 14, RES 35 29/11/77
24.0 HOURS GMT

LATITUDE = 59 57.9N LONGITUDE = 149 20.7W SONIC DEPTH = 193 M

1-DIGIT WEATHER CODE IS (X1) AND INDICATES PARTLY CLOUDY
CLOUD TYPE --- (3) ---ALTOCUMULUS
CLOUD AMOUNT --- (6) ---6/8
VISIBILITY --- (8) ---20-50 KM

	DIRECTION	SPEED
WIND	0 - 0 DEGR	20 KNOTS

	DIRECTION	HEIGHT	PERIOD
SEA	0 - 0 DEGR	1.0 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES -DRY =	-1.1 DEGR C.	BAROMETRIC PR. =	1002.1 MB
-WET =	DEGR C.	TRANSPARENCY =	M

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
2.0	6.65	30.657	24.09	0.008
1.0	6.65	30.657	24.09	0.004
5.0	6.23	30.660	24.14	0.019
10.0	6.65	30.663	24.10	0.038
15.0	6.65	30.660	24.09	0.058
20.0	6.66	30.660	24.09	0.077
25.0	6.65	30.662	24.09	0.096
30.0	6.66	30.672	24.10	0.115
35.0	6.73	30.741	24.15	0.134
40.0	7.31	30.941	24.23	0.153
45.0	7.36	31.099	24.35	0.171
50.0	7.40	31.177	24.40	0.189
60.0	7.78	31.298	24.45	0.224
70.0	7.95	31.432	24.53	0.259
75.0	8.62	31.568	24.53	0.276
80.0	8.54	31.614	24.58	0.293
90.0	8.10	31.691	24.71	0.326
100.0	8.25	31.908	24.86	0.358
125.0	7.57	32.193	25.18	0.432
150.0	7.43	32.369	25.33	0.500
175.0	6.69	32.523	25.56	0.565

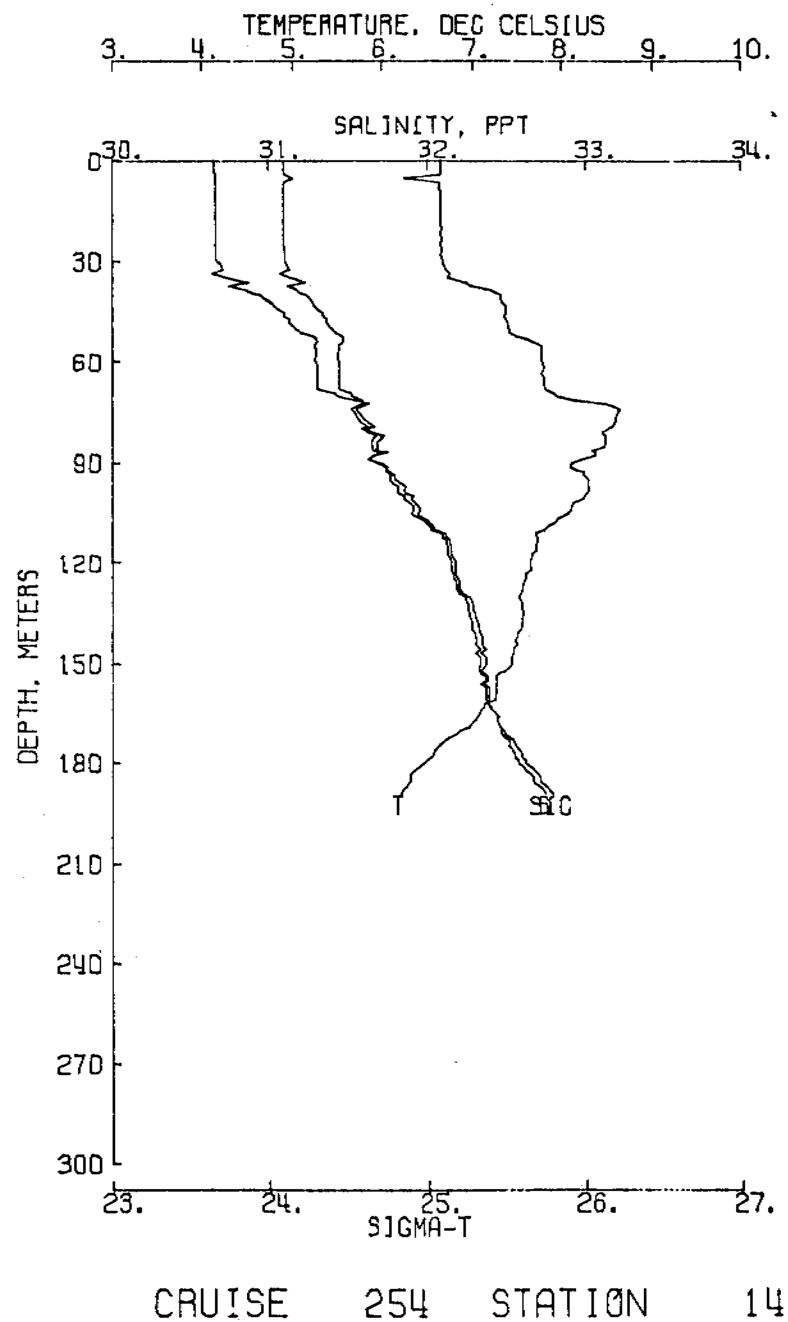


Figure 13. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.

AC CRUISE 254 CONSECUTIVE STATION NO. 15. RES 4 30/11/77
1.4 HOURS GMT

LATITUDE = 59 54.7N LONGITUDE = 149 24.5W SONIC DEPTH = 255 M

1-DIGIT WEATHER CODE IS (X2) AND INDICATES CONTINUOUS LAYER
CLOUD TYPE --- (3) ---ALTOCUMULUS
CLOUD AMOUNT --- (7) ---7/8
VISIBILITY --- (7) ---10-20 KM

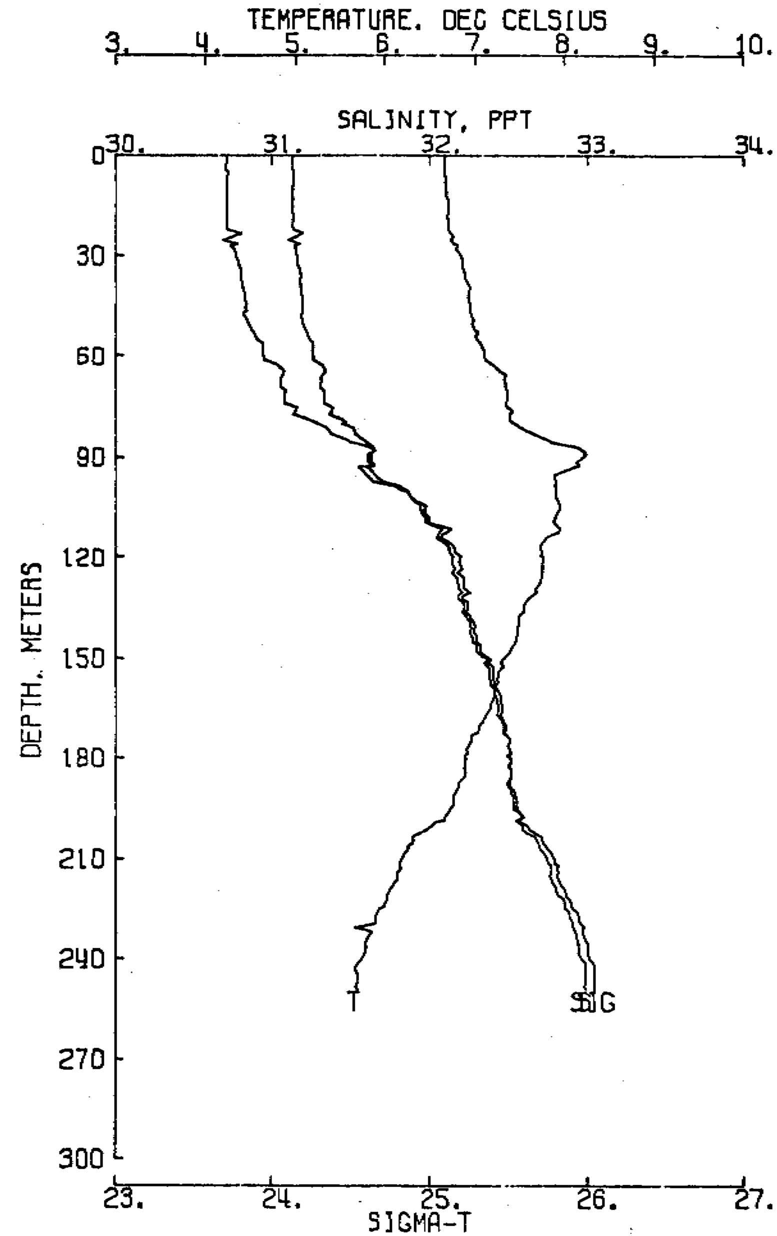
	DIRECTION	SPEED
WIND	355 - 4 DEGR	20 KNOTS

	DIRECTION	HEIGHT	PERIOD
SEA	355 - 4 DEGR	1.0 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES -DRY =	-1.1 DEGR C.	BAROMETRIC PR. =1003.2 MB
-WET =	DEGR C.	TRANSPARENCY = M

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
2.0	6.67	30.706	24.13	0.008
1.0	6.67	30.706	24.13	0.004
5.0	6.66	30.717	24.14	0.019
10.0	6.69	30.708	24.13	0.038
15.0	6.70	30.712	24.13	0.057
20.0	6.71	30.711	24.13	0.076
25.0	6.73	30.687	24.10	0.095
30.0	6.84	30.772	24.16	0.114
35.0	6.88	30.805	24.18	0.133
40.0	6.93	30.818	24.18	0.152
45.0	6.94	30.830	24.19	0.170
50.0	6.99	30.848	24.20	0.189
60.0	7.11	30.945	24.26	0.226
70.0	7.36	31.085	24.33	0.263
75.0	7.37	31.157	24.39	0.281
80.0	7.45	31.248	24.45	0.298
90.0	8.20	31.608	24.63	0.332
100.0	7.92	31.865	24.87	0.365
125.0	7.76	32.215	25.17	0.439
150.0	7.31	32.391	25.37	0.508
175.0	6.94	32.508	25.51	0.572
200.0	6.52	32.591	25.63	0.635

Figure 14. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.



CRUISE 254 STATION 15

AC CRUISE 254 CONSECUTIVE STATION NO. 20. A 1 2/12/77
1.3 HOURS GMT

LATITUDE = 59 53.7N LONGITUDE = 149 41.4W SONIC DEPTH = 193 M

1-DIGIT WEATHER CODE IS (X0) AND INDICATES CLEAR
CLOUD TYPE --- ( ) ---NOT RECORDED
CLOUD AMOUNT --- ( ) ---NOT RECORDED.
VISIBILITY --- (6) ---20-50 KM

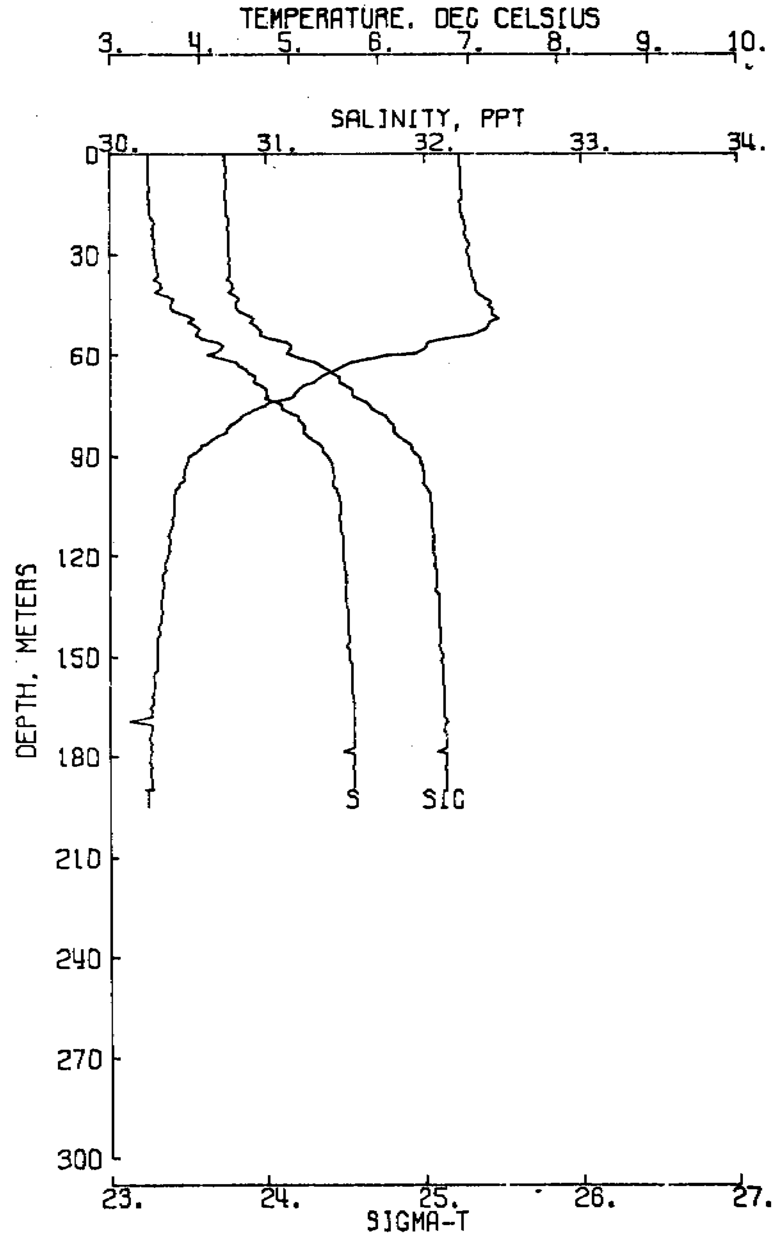
	DIRECTION	SPEED	
WIND	335 - 344 DEGR	18 KNOTS	

	DIRECTION	HEIGHT	PERIOD
SEA	335 - 344 DEGR	0.6 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES -DRY =	6. DEGR C.	BAROMETRIC PR. =1010.5 MB
-WET =	DEGR C.	TRANSPARENCY = M

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
2.0	6.89	30.246	23.74	0.008
1.0	6.89	30.246	23.74	0.004
5.0	6.90	30.249	23.74	0.021
10.0	6.90	30.254	23.74	0.042
15.0	6.92	30.253	23.74	0.063
20.0	6.94	30.277	23.76	0.084
25.0	6.97	30.290	23.75	0.104
30.0	6.99	30.296	23.76	0.125
35.0	7.03	30.308	23.77	0.146
40.0	7.07	30.338	23.79	0.167
45.0	7.21	30.381	23.80	0.187
50.0	7.23	30.503	23.90	0.208
60.0	6.16	30.615	24.12	0.247
70.0	5.10	30.999	24.54	0.282
75.0	4.72	31.102	24.66	0.299
80.0	4.30	31.220	24.78	0.315
90.0	3.88	31.386	24.97	0.346
100.0	3.73	31.447	25.03	0.376
125.0	3.60	31.502	25.08	0.449
150.0	3.53	31.534	25.11	0.522
175.0	3.45	31.555	25.14	0.593

Figure 15. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.



CRUISE 254 STATION 20

AC CRUISE 254 CONSECUTIVE STATION NO. 24. A-3 2/12/77
17.5 HOURS GMT

LATITUDE = 59 45.7N LONGITUDE = 149 41.3W SONIC DEPTH = 289 M

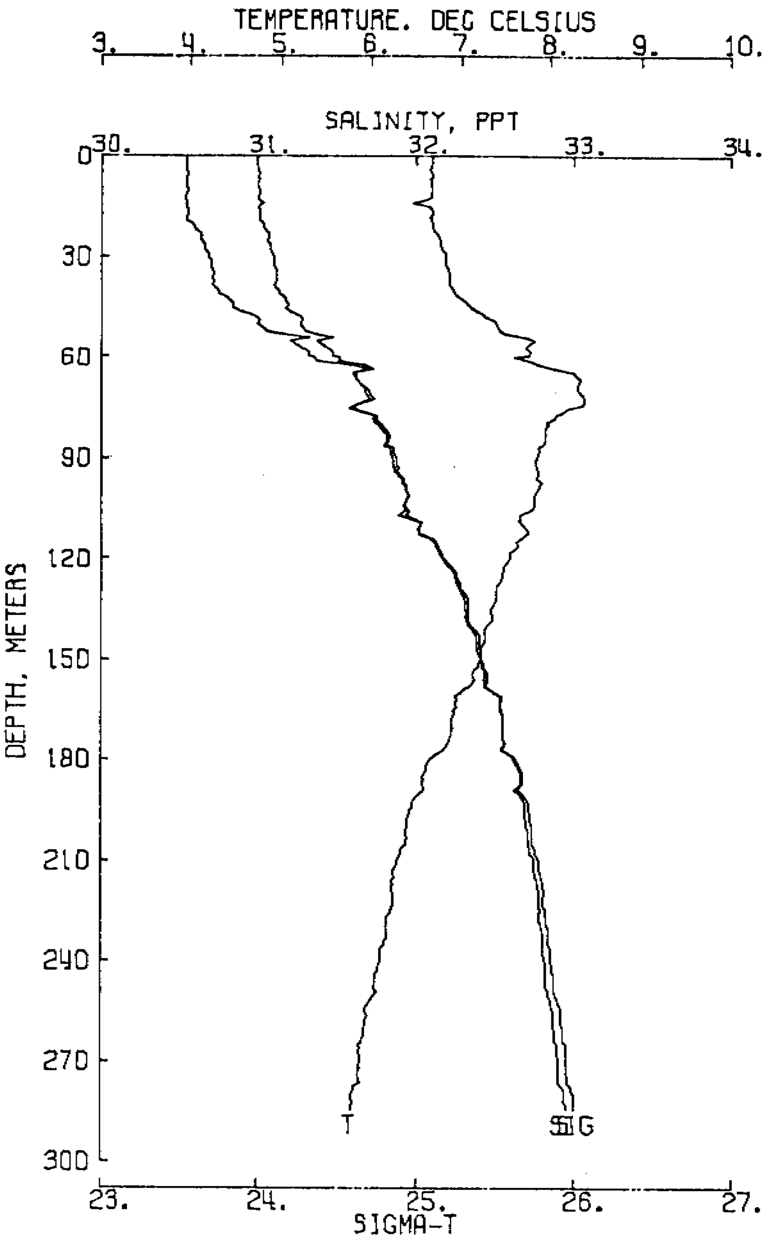
1-DIGIT WEATHER CODE IS (X1) AND INDICATES PARTLY CLOUDY
CLOUD TYPE --- ( ) ---NOT RECORDED
CLOUD AMOUNT --- ( ) ---NOT RECORDED,
VISIBILITY --- ( ) ---NOT RECORDED

	DIRECTION	SPEED
WIND	0 - 0 DEGR	40 KNOTS

	DIRECTION	HEIGHT	PERIOD
SEA	0 - 0 DEGR	2.0 M.	SECS
SWELL	- DEGR	M.	SECS

TEMPERATURES -DRY = -3.3 DEGR C.	BAROMETRIC PR. =1007.8 MB
-WET = DEGR C.	TRANSPARENCY = M

DEPTH METERS	TEMPERATURE DEG C	SALINITY PPT	SIGMA-T	DELTA-D DYN M
2.0	6.66	30.546	24.00	0.008
1.0	6.66	30.546	24.00	0.004
5.0	6.66	30.555	24.01	0.020
10.0	6.67	30.557	24.01	0.039
15.0	6.65	30.545	24.00	0.059
20.0	6.65	30.579	24.03	0.078
25.0	6.76	30.636	24.06	0.098
30.0	6.81	30.690	24.10	0.117
35.0	6.86	30.716	24.11	0.136
40.0	6.91	30.745	24.13	0.155
45.0	7.10	30.835	24.17	0.174
50.0	7.40	31.001	24.26	0.193
60.0	7.60	31.354	24.51	0.228
70.0	8.33	31.700	24.68	0.262
75.0	8.21	31.570	24.60	0.278
80.0	7.99	31.761	24.78	0.294
90.0	7.84	31.852	24.87	0.326
100.0	7.96	31.940	24.94	0.357
125.0	7.45	32.261	25.25	0.430
150.0	7.20	32.423	25.41	0.496
175.0	6.84	32.562	25.56	0.559
200.0	6.39	32.710	25.74	0.618
250.0	6.01	32.840	25.89	0.729



CRUISE 254 STATION 24

Figure 16. Resurrection Bay hydrographic data November 1977 R/V *Acona* cruise No. 254.

IV. PRELIMINARY INTERPRETATION

Not included in this report.

V. PROBLEMS ENCOUNTERED

A. The FY 78 budget was not finalized until May, six months after the start of the contract year. This has had repercussions on the analysis program this quarter since much needed replacement equipment could not be purchased. This, coupled with the problem reported in (B) below, pretty much insured that very little analysis work could be done this quarter. Fortunately, a considerable amount of field work was scheduled as reported above and this fully occupied the single technician available to this project this quarter.

B. We have experienced an unusual amount of equipment breakdown this quarter. Most importantly, the plasma furnace had to be returned to the manufacturer and has been unavailable to us for most of the quarter. This deleted most of the biota analysis work. The spectrometer x-y recorder (not purchased on OCSEAP funds) had to be replaced and the delay in approving the contract caused problems here. The new particle size analyser malfunctioned one week after receipt and that also has been returned to the manufacturer. The distillation system has been out of commission for over a month because a replacement silica tube could not be fabricated in Alaska.

C. We have had many problems with the aquaria used for our clam transfer studies. Many valuable organisms have been lost because of problems with the temperature regulation. These items were not purchased by OCSEAP but have been on loan from EPA and the latter agency want them back. Permission will be requested to transfer funds to replace these.

D. Although we have still heard nothing officially from OCSEAP Boulder, we believe that this project will not receive additional funds in FY 79. Because of this the technician who was especially trained in the OCSEAP analysis procedures resigned in April and we have as yet not completed the training of a temporary replacement.

E. Some problems have been experienced with the sub-contract to D. Weiss because of the late approval of the contract. Fortunately much of the field work will not be done until later this summer, which will allow the analysis work to be done late in 1978 and in the first part of 1979.

QUARTERLY REPORT

Contract No. 03-5-022-84
Research Unit #172
Reporting Period: 1 April-30 June 1978
Number of Pages: 2

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: June 20, 1978

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 undisturbed arctic littoral and near-littoral habitats.

2. Comparison of seasonal habitat use by shorebirds in disturbed habitats, as models predicting the effects of OCS develop-related disburbances.

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

II. Field Activities

A. Field season begun in Kotzebue Sound on 23 May 1978 and at Prudhoe Bay 31 May 1978, continuing through end of quarter.

B. Scientific Party

Research coordinator: Peter G. Connors, University of California, Bodega Marine Laboratory

Research assistants: Carolyn S. Connors, U.C., BML
Katherine Hirsch, U.C., Davis
Craig Hohenberger, California State University, Humboldt
Douglas Woodby, U.C., Davis

C. Methods

Marked transects were established in a variety of habitats at each site, usually 0.5 or 1.0 km in length, and 50 m or 100 m in width, depending upon spatial characteristics of the habitats. All transects at continuously occupied sites were censused every 5 days, recording all species by age and sex whenever possible. Other sites were censused less often, as limited by logistics considerations.

Shorebirds foraging on mud on ice in lagoons in the Noatak Delta and on zooplankton along the shore at Cape Krusenstern, in two situations of high potential susceptibility to oil-related disturbances (see Results) were collected, and stomachs were preserved to determine the principal prey species.

D. Transects have been established at Cape Krusenstern, Sisaulik, Kotzebue, Shishmaref and at widely scattered sites in the Prudhoe Bay area.

E. Data collected

Approximately 270 transect censuses have been completed. Approximately 50 shorebird stomachs have been collected and preserved.

III. Results

Spring phenology was advanced approximately 7-10 days by comparison with 1977 events in Kotzebue Sound. Early opening coastal waters at Cape Krusenstern were apparently responsible for a brief period of heavy shoreline zooplankton foraging by northward migrant Red Phalaropes, a phenomenon not seen in 1977.

We documented another instance of heavy use of littoral habitat by spring migrant shorebirds, probably more consistent from year to year, at Sisaulik on the Noatak Delta. In the shallow brackish lagoons of this area (and probably other areas as well), wind conditions during freeze-up frequently produce low tides and extensive areas of exposed mud. The mud surface freezes to depths of several centimeters and is floated to the surface as tidal waters return. By this process a thick layer of mud with associated benthic infauna and plant material is incorporated into the winter ice cover of the lagoon. With the spring meltoff, this mud layer is exposed on the surface of the lagoon ice, providing a food source for migrant waterfowl and shorebirds. Our comparative measurements showed this ephemeral habitat to be much more heavily used by shorebirds than were other littoral and tundra habitats nearby during late May.

IV. Preliminary Interpretation

Interpretation of these two phenomena awaits analysis of stomach and plankton samples. The obvious importance of both situations arises from the resultant susceptibility of large numbers of pre-breeding migrant shorebirds to oil or other contaminants potentially introduced into these habitats during the previous year. Our studies at Beaufort coastal sites have never found a comparably high exposure of spring migrant shorebirds to potential disruption of littoral habitats. At these northern sites shoreline ice conditions limit heavy littoral zone use by most species to periods in late summer.

V. Problems: None

VI. Estimate of Funds Expended

Funds expended from April 15, 1975 through June 1, 1978 totaled approximately $113,424. This rate of expenditure is on schedule with work accomplished.

Quarterly Report

Task Numbers A-27; B-9
Contract # 03-5-022-68
Research Unit # 190
Report Period 1 April to
30 June, 1978

Number of pages: 41

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-Senior Research
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 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 effects 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.

2. To continue collecting data on relative microbial activity and respiration percentages in this region during the August-September, 1978 North Wind 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 and microbial activity in marine sediments.

II. Field and Laboratory Activities

A. Field trip schedule

In April, Mr. McNamara and Ms. Steven conducted a series of experiments on the sediment trays removed from Elson Lagoon, Barrow, AK. We also participated in a cruise in the Cook Inlet on the NOAA ship, "Discoverer", from 25 April to 17 May, 1978.

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 with the following exceptions. All data reported for the April Cook Inlet cruise and the Beaufort Sea study were taken in the field. For the first time, all nitrogen fixation and crude oil effects measurements were taken during the cruise. In Beaufort Sea study, all sediment and water samples were collected at the plexiglass tray experiment site in Elson Lagoon.

1. Crude oil degradation experiments.

a. In the field, 10 ml of sediment was added to a screw capped test tube to which 0.1 ml of crude oil was added. The sample was transported to our laboratory at OSU at or below the *in situ* temperature of the collection site. When the sample was received in the laboratory, 5 ml of an enriched mineral salts solution was added to the sample and the sample was allowed to incubate at 5 to 8°C for at least 4 weeks. The "Enriched Mineral Salts Solution" (EMSS) is the basal medium of Mulkins-Phillips and Stewart (Can. J. Microbiol. 20: 955-962., 1974).

b. The enrichment cultures were maintained by transfer of 1.0 ml of the original enrichment into 19.0 ml of EMSS containing 0.2 ml of crude oil. The enrichments were incubated in 125 ml French-square bottles. Beaufort Sea samples were enriched with Prudhoe Bay crude oil and the Cook Inlet samples were enriched with Cook Inlet crude oil.

c. The temperature effects study was designed to compare the effects of incubation temperature on crude oil degradation in a composite of several crude oil enrichment cultures. These cultures were made from sediment samples collected in the Beaufort Sea and in the Cook Inlet. Two composite enrichment cultures were established; the one from the Beaufort Sea (BS) contained 6 enrichment cultures and the one from the Cook Inlet (CI) contained 9 cultures. The composite enrichment cultures contained 1 ml from each of the original cultures, 200 ml of EMSS and 1.0 ml of the appropriate crude oil. These cultures were incubated at 8°C for 16 days by which time growth was evidenced by turbidity and emulsification of the oil. From these cultures 1.0 ml inocula were added to duplicate subsamples containing 0.2 ml of crude oil, and 19.0 ml of EMSS. The BS culture contained Prudhoe Bay crude oil and the CI culture contained Cook Inlet crude oil. One uninoculated control was also used for each temperature. These cultures were incubated for 36 days at 0, 1.5, 5, 2, 15 and 20°C. At the end of the experiment, the bottles were cooled to 0°C and extracted with 10 ml spectrograde benzene. The benzene layer was transfered to centrifuge tubes and centrifuged under a force of 27,000 x g for 5 min at 0°C. Five ml of the supernatant was placed into preweighed weighing dishes and allowed to evaporate at room temperature for 18-24 h. A 3 ml subsample was dried with approximately 0.5 g anhydrous Na_2SO_4 and sealed in 5 ml glass tubes. These subsamples were used in the gas chromatographic analysis.

d. The benzene extracts were analyzed on a Hewlett Packard model HP 5830A gas chromatograph fitted with dual flame ionization detectors, 2 meter, 1/8" stainless steel columns packed with 3% OV-17 on 80/100 Chromosorb WHP. Operating conditions were as follows; column temperature, 50°C, isothermal for 6 min increasing at 6°C/min to a maximum temperature of 250°C then isothermal for 15 min. The detector temperature was 300°C, the injector temperature was 275°C and the carrier gas flow (nitrogen) was 25 ml/min. The sample injection volume was 1.0 μl. Results were compared with a mixture of know hydrocarbons for presumptive identification of some sample components. The signal from the second column was subtracted from the signal from the column on which the sample was placed to compensate for baseline drift. The results of each analysis was entered into a calculator from the gas chromatograph integrator using a digital data interface. Three types of determinations were made; benzene alone, the control crude oil which had not been degraded and the degraded samples. The calculator was used to correct for injection volume variations using the benzene peak as

the standard. All peaks found in the benzene were subtracted from the control and degraded sample. The corresponding peaks in the control and degraded samples were then compared and a percent degradation calculated from this comparison. These comparisons were made on a peak by peak basis and by comparing total response areas over a range of retention times.

2. Analyses of total adenylate pools in marine sediments

a. Adenylate pool extraction procedure.

The procedure used is a modification of the method described by Karl and LaRock (Appl. Environ. Microbiol. 33:940-946. 1977). One ml of the sediment was added to 4 acid-washed 15 ml centrifuge tubes within an hour of their collection. The tubes and all reagents were kept on ice while the samples were being processed. Five ml of 0.6N H_2SO_4 was added to each tube and the contents were mixed twice on a vortex mixer for a total of 1 min. One ml of 10^{-7} M ATP was added to one tube, one ml of a suspension of live marine bacteria from a pure culture was added to the second tube and one ml of 20 mM tris buffer was added to two tubes containing duplicate subsamples. The samples were mixed again and the tubes were centrifuged in a clinical centrifuge for 5 min. Four ml of the supernatant was then removed and placed into a 15 ml glass screw capped vial. One ml of solution containing 0.048 M EDTA and 20 mM tris buffer was then added and the pH was adjusted to 7.8 with NaOH. The volume was increased to 10 ml with 20 mM tris and frozen at -20 C until they could be analyzed.

Once every 24 h when ATP determinations were made in the field, a total adenylate extract was prepared on the pure culture cell suspension. Five ml of a solution containing 20 mM tris and 2 mM EDTA adjusted to a pH of 7.75 was added to an acid washed scintillation vial which was brought to a temperature of 100 C in a boiling water bath. One ml of the cell suspension was then added and the resulting mixture was kept at 100°C for 5 min. The vial was then placed in an ice bath and the volume was brought up to 15 ml with 20 mM tris buffer and frozen.

b. Analyses of extracted adenylate pools.

Each sample was divided into 3 subsamples. For the determination of ATP, 1.80 ml of the extract was added to 0.45 ml of a buffer made up of 1.6 g, K_3PO_4; 0.305 g, $MgCl_2 \cdot 6H_2O$; and 100 ml, H_2O adjusted to a pH of 7.3 with phosphoric acid (buffer 1). The determination of ATP and ADP was made by adding 1.80 ml of the extract to 0.2 ml of a pyruvate kinase solution and 0.45 ml of a buffer made in the same manner as buffer 1 except 0.01 ml of phosphoenol-pyruvate solution (0.01 g/100 ml H_2O) was added. The resulting mixture was incubated at 30°C for 15 min. then held on ice until the extract could be assayed. The determination of ATP, ADP and AMP was made in the same manner as the above procedure except a solution of 0.05 ml of adenylate kinase was added to the mixture.

The assay itself was run by adding 1.0 ml of one of the above mixtures with 0.5 ml of an arsenate buffer containing both luciferin and luciferase. The arsenate buffer contained 3.75 g, glycine; 1.20 g, $MgSO_4$; 1.80 g, potassium arsenate; 0.29 g, EDTA; and one liter distilled water. The pH was adjusted to 7.4-7.5 with KOH. The luciferin solution was made up of 10 mg luciferin (Sigma, synthetic, crystalline), 4.5 mg $NaHCO_2$, and 2.5 ml distilled H_2O. The luciferase solution was made up of 2.0 mg, luciferase, Type IV (Sigma, purified, lyophilized); 7.5 mg, glycine; and 2.0 ml, distilled H_2O. Both of these solutions were dispensed into vials and frozen until just before they were to be used in the assay. The arsenate-luciferin-luciferase buffer solution (ALLBS) was made up of 10 ml arsenate buffer, 0.1 ml luciferin solution and 0.2 ml luciferase solution.

3. Nutrient analysis

a. Water sample nutrients

1. Frozen samples were thawed in a warm water bath and then aspirated into a four channel Technicon Autoanalyzer system. The samples were subdivided with a stream divider into four sample flows which were used to analyze ammonia, phosphate, nitrate and nitrite concentrations.

2. The total concentrations of nitrate and nitrite were made following the procedures of Callaway et. al. (Callaway, J.C., R.D. Tomlinson, L.I. Gordon, L. Barsrow, P.K. Park, August, 1972, An instruction manual for use of the Techincon Autoanalyzer II in precision seawater analysis. OSU Tech. Report Revision 1). The following modifications were made to this procedure: sample, 0.8 cc/min; DDW diluture, 1.2 cc/min; ammonium chloride, 1.0 cc/min; sulfanilamide, 0.1 cc/min; N-1-naphylethylene 0.1 cc/min; flow cell draw, 1.0 cc/min. The debubbler before the cadmium column is pumped out of the system (1.0 cc/min) with the remaining water forced through the cadmium column.

3. The nitrite concentration was determined using the same chemistry as the above analysis except there is no ammonium chloride, cadmium column, DDW diluter, or first air bubble. A 2.3 cc/min. sample tube was used.

4. The phosphate concentration determinations were made using the method of Calloway et. al. (1972) without modification.

5. The ammonium ion concentration was made using the technique of Head (1971). (Head, P.C., 1971. An automated phenolhypochlorite method for the determination of ammonia in seawater. Deep-Sea Research 8: 531-532.

b. Sediment samples

1. Sediment samples were thawed in a warm water bath, mixed and then centrifuged for 30 min at 0°C and 8000 RPM.

2. Five to fifteen ml of the supernatant was removed and used in the nutrient analysis. Approximately 20 ml of the diluted sediment water was placed into quartz tubes with 0.3 ml of H_2O_2. These samples were then treated with UV light for 4 hours.

3. Soluble oxidizable nitrogen was determined as nitrate on the Autoanalyzer. The remainder of the diluted sediment water was diluted further for the ammonia determination.

4. When H_2S was present, approximately 0.15 ml of a 2% $CuSO_4$ solution was added to remove sulfide ions from solution which would interfere with the nutrient assays.

5. The total carbon content of the sediment was determined by the following procedure. A subsample of the sediment was treated with HCL to remove all traces of inorganic carbon. The sediment was centrifuged and the supernatant removed. The sediment was dried and combusted using the technique of Pella and Colombo (1973). (Pella, E. and B. Colombo, 1973. Study of carbon, hydrogen and nitrogen determination by combustion-gas chromatography. Microchim Acta. 5: 679-719).

III. Results

A. Field studies

1. Beaufort Sea (Elson Lagoon)

In April, 1978, we conducted another series of experiments on the oiled sediment trays that were placed at the bottom of Elson Lagoon this last January. A total of 5 sediment samples and 3 water samples were collected at the diving site (station 3) and analyzed. Sediment sample BB501 was a 3 month oiled tray, sample BB502 was a new tray that was oiled (0 time for the new series), sample BB503 was a non-oiled control sediment taken at the dive site, sample BB504 was a new tray oiled for 24 h and sample BB505 was a new tray oiled for 72 h. Glucose and glutamic acid uptake and respiration were measured in all samples and nitrogen fixation rates were measured in all sediment samples (Table 1).

The following measurements were also made on selected samples; the effects of freezing and crude oil on substrate uptake and respiration (Table 2) and the effects of the dispersant Corexit 9527 and Corexit 9527 with crude oil on substrate uptake and respiration (Table 3). Two concentrations of Corexit were used, 15 and 150 ppm. In addition, the effects of crude oil on the kinetics of glucose and glutamic acid uptake were measured in all samples except BW503 (Table 4). Subsamples of water and sediment were frozen for nutrient analysis.

2. Cook Inlet

During April and May, we participated in a joint cruise with the chemical oceanographers. There were two phases of this cruise on the NOAA ship "Discoverer"; the first was primarily a microbiological cruise starting at the south end of Kodiak Island and proceeding north through the Shelikof Strait and into Cook Inlet (Fig. 1). During this phase, all stations that we did not have in common with the chemists from PMEL and IMS were sampled. During the second phase, we occupied 3 time series stations. At these stations, we collected samples, in coordination with the chemists, on both the high and low slack tides. The original plan also called for a common set of stations to be sampled on a transect from Kamishak to Kachemak Bay (stations C1-C6 and ST1 and ST2). Due to equipment problems experienced by the chemists, most of these stations were not sampled by the chemists.

During this cruise, a total of 83 water and 31 sediment samples were collected and analyzed from 56 offshore and 8 beach locations. The station locations, water column depth, and temperature and salinity measurements made in the surface and bottom waters are given in Table 5. Relative microbial activity and respiration percentages were measured in all samples using both glucose and glutamic acid (Tables 6-9; Fig. 2-4). The effects of Cook Inlet crude oil on glucose and glutamic acid uptake and respiration were measured in 31 and 35 water samples respectively (Tables 6 and 7; Fig. 5 and 6). The effects of crude oil on glucose and glutamic acid uptake and respiration were measured in 27 and 7 sediment samples respectively (Tables 8 and 9). In addition to these studies, the effects of the dispersant Corexit 9527 both with and without crude oil was measured in a number of water and sediment samples (Table 3). The kinetics of glucose and glutamic acid uptake in water and sediment samples were also measured in the presence of crude oil (Table 4).

The rates of nitrogen fixation were measured in all sediment samples collected during this cruise (Table 10; Fig. 7). The effects of crude oil on nitrogen fixation was measured in 18 of these sediments. In 7 of the sediments, the effect of crude oil on nitrogen fixation rates in sucrose amended sediment samples was also measured.

During this cruise, sediment and water samples were frozen and returned to our lab for nutrient analysis. In addition, total adenylate pools were extracted from approximately 1/2 of the sediment samples. The results of all of these measurements will be given in a future quarterly report.

3. Nutrient analysis measurements

The measurement of the following nutrient concentrations are reported for the water and sediment samples collected during the April and November, 1977 Cook Inlet cruises and the January sampling trip to Elson Lagoon; NH_3, NO_2, NO_3, PO_4, and total available nitrogen (TAN) (Table 11).

B. Laboratory studies

1. We now have the results of a study on the effects of temperature on crude oil biodegradation as measured by gas chromatography (Table 12). There were two oil enrichment cultures tested; one isolated from Beaufort Sea sediments and one isolated from Cook Inlet sediments.

VI. Preliminary interpretation of results

A. Seasonal and geographical variations in relative microbial activity and respiration percentages.

1. The rates of glucose uptake and the percent respiration were essentially the same in both water and sediment samples collected during the April, 1978 Elson Lagoon study as they were at the same location during the January, 1978 and April, 1976 field trips (Table 1 this report and Table 8 in annual report). There were, however, differences observed in glutamate uptake between the January and April samples. The uptake of glutamate in the water samples was lower in April than in January; however, the uptake of glutamate in the sediments was higher in April than in January.

2. In general the patterns of substrate uptake and respiration in the Cook Inlet area are the same as we have observed in the past. The relative levels of microbial activity were higher in the northern section of Cook Inlet and within the bays (Fig. 1 and 2). There were, however, differences observed in certain details of surface water relative microbial activity. During the November cruise, the highest rates of microbial activity were observed along the western coast of the Shelikof Strait; during the April cruise, the reverse pattern was observed. These data suggest that the overall pattern of water mass movement in the Cook Inlet still followed the trends we have observed in the past; however, the movement of these waters through the Shelikof Strait may vary.

As we have seen in the past, the respiration percentages were lowest in the north-eastern section of Cook Inlet (Fig. 2). For some reason, the patterns were not as well defined as those observed in previous Cook Inlet cruises.

3. The pattern of relative microbial activity observed in the Cook Inlet sediments during the April cruise was similar to that observed before. The highest activity levels were found in the muddy sediments of inshore stations taken in the smaller bays (Fig. 4). The relative microbial activity in the sediments along the western edge of Shelikof Strait were higher than those observed to the east. This is similar to the pattern normally found in the surface waters in this region. If our hypothesis is correct (see annual report) that the suspended matter observed in the northern waters of Cook Inlet end up in the sediments of Kamishak Bay and

the Shelikof Strait, then it can be assumed that the flow of most microbially active water is normally along the west coast. However, at the time of the April cruise, the more active waters were observed to the east.

B. Observations made during the April Cook Inlet time series stations.

After looking at the microbiological data from the time series stations at least two factors have emerged: (i) there was no significant correlation between tide state and any of the variables that we have analyzed (Table 13), and (ii) many of the surface water samples that we took at station CB7 appear to have been contaminated by the ship's effluent. We have come to this conclusion for two reasons. Those samples that appear to be contaminated have much higher microbial activity than one would anticipate at the location in question and the ratio of glucose to glutamic acid uptake is much lower than that normally found in natural marine waters (Table 13). For example, water samples number 661 and 662 were taken at about the same time and in locations that were not far apart (stations CB7 and AA respectively). From our past experience in this region, we would expect that the uptake rate and glutamic acid/glucose ratios would be about the same in these samples. As can be seen in Table 13, the uptake rates and glutamic acid/glucose ratio for sample 661 was more similar to sample 669 taken in the polluted Homer boat basin than to sample 662. Of the other surface water samples taken during this cruise, those that appear to be contaminated by the ship's effluent are samples numbered 601,659,660,661, 663,668, and 683. We felt that there are two reasons why many of the samples taken at station CB7 were contaminated whereas those taken during the time series at stations CB9 and CB10 were not. The first reason is that there was relatively poor coordination between the ship's engineers and the ship's operations during the initial time series. On at least one occasion, the ship's effluent was pumped just prior to a sampling sequence instead of just after a sequence. The sample that we took at that time was 661 which was one of the most contaminated samples that we collected. The second reason is that the tidal current at station CB7 was much less vigorous than that observed at stations CB9 and CB10. It is thus much more likely that the water column, if contaminated with ship's effluent, would remain near the ship where it could be sampled. This information was sent to the chief scientist of the cruise, Dr. John Calder, in a letter dated June 12, 1978.

C. The effects of crude oil on the uptake and respiration of glucose and glutamic acid by microbial populations in sediment and water samples.

1. In the Elson Lagoon sediment samples, crude oil decreased glucose uptake but did not affect glutamic acid uptake (Table 1). Contrary to what we would have anticipated, the effect of crude oil on glucose uptake in the nonoiled control was minimal. The lack of measurable effect on microbial activity in the water samples may have in some way related to the extremely low activity observed in these

samples. The activities were at the limit of detection by the method used.

Although the results of these experiments were not as dramatic as those observed in the past when Beaufort Sea sediment samples were analyzed, there is no doubt that Prudhoe Bay crude oil has an adverse effect on the uptake of glucose by natural marine bacteria found in the sediments of the Beaufort Sea. During the January, 1978 field trip, the average percent reduction in respiration rates for glucose was 45. The average percent reduction in glucose respiration rates observed in sediments collected in the Beaufort Sea during the summer, 1977 cruise was 35% (see Tables 22 and 23 of the last annual report). The effects of crude oil on glucose uptake and respiration on Beaufort Sea water and sediment samples will be studied further during the August North Wind cruise.

2. During the April Cook Inlet cruise, the effect of Cook Inlet crude oil on glucose and glutamic acid uptake in surface water samples was measured (Tables 6 and 7). The average reduction in glutamic acid uptake was 33% in the presence of crude oil (Table 7). The samples exposed to crude oil also decreased glucose uptake by an average of 45%. This is very close to the 41% depression observed in water samples collected from this region during the November cruise (Table 22 of the annual report).

The effect of crude oil on the uptake of these two substrates was less pronounced in sediment samples collected during the same cruise (Tables 8 and 9). Glucose and glutamic acid uptake was depressed on the average of 14 and 18% respectively; however, these differences were not statistically significant. It is curious that crude oil would affect the uptake of these substrates in sediment samples taken from the Beaufort Sea but would not affect the sediment samples collected in the Cook Inlet. We intend to continue our study of crude oil effects in sediments collected in these two regions in the months to come.

3. The effects of crude oil on the kinetics of glucose and glutamic acid uptake was measured in a number of sediment samples collected in both the Beaufort Sea and Cook Inlet. We initiated these studies to determine what type of inhibition might be taking place and also to determine if crude oil affects the bound and pooled material associated with the cell fraction (Table 4). We measured the kinetics of glucose uptake in five sediment samples that we transported to our lab at OSU after the January field trip to Barrow. The results of these studies were inconclusive (Table 24 of annual report). In the sediment samples analyzed at Barrow during the April trip, there was a statistically significant difference between the V_{max} values observed in the oiled and nonoiled sediment samples exposed to labeled glucose. In the same samples, the turnover time did not vary significantly between these two groups. The transport constant and the natural substrate uptake concentration value (K_t+S_n) was generally lower in the oiled samples but the

difference was not statistically significant using a Student's T test. Of the other samples that were studied, only the water samples collected in the Cook Inlet show a decrease in V_{max} values when the samples were exposed to crude oil. In this study the T_t values were generally higher in the oiled group than in the controls but this difference was not significant as determined by Student's T test.

During the course of this same series of experiments, we wanted to determine if the presence of crude oil affects the level of substrate binding as we have defined it in a recent article (Baross et al., J. Fish. Res. Board. Can., 32:1876-1879). If crude oil did affect binding or pooling, we should observe a proportionaly higher effect in cells that had not been treated with acid. (The samples that we normally assay have been acidified during preparation). This was not what we observed; in fact, the differences observed between oiled and non-oiled samples was greater in the acidified group. This work will have to be continued in the future to determine if this pattern appears in other samples.

4. It was felt that if crude oil affects the cells at the level of the cell membrane, perhaps another known stress to the membrane might further reduce substrate uptake by the microorganisms. A pilot study of crude oil effects in samples that had been frozen and then thawed produced inconclusive results.

5. Using a similar line of reasoning, we decided to evaluate the effects of the dispersant Corexit 9527 on the uptake and respiration of glucose and glutamic acid both by itself and in combination with crude oil. With the exception of the Cook Inlet sediment samples, all water and sediment samples showed some adverse effect of substrate uptake in the presence of 15 ppm Corexit 9527. In most cases, the oil alone or the Corexit 9527 by itself had an effect on uptake; however, in all cases, the uptake was the lowest when both the Corexit 9527 and the crude oil were present.

In two sediment samples collected at Barrow, we studied the effects of Corexit 9527 on substrate uptake at two concentrations. As can be seen in Table 3, the higher the Corexit 9527 concentration, the greater the effect on substrate uptake. Although we must study this problem further before any conclusions can be drawn, it does appear that the dispersant Corexit 9527 can act as another environmental stress which can, in turn, act as a selective agent on microbial populations. A recent study has been made in conjunction with the CEPEX project off Vancouver Island, B.C. In one set of experiments, crude oil and the dispersant Corexit were added to one of the bags. After 14 days, only one type of bacterium could be found in the water column (Dr. G. Geesey, personal communication). This observation substantiates our supposition.

It is quite likely that the presence of Corexit 9527 or some other surfactant might measureably increase crude oil degradation rates but it might also act in concert with crude oil to significantly alter other microbial functions.

6. From the data collected during the crude oil effects studies, we calculated the percent reduction in glucose and glutamic acid uptake in the presence of crude oil in various geographical locations (Figs. 5 and 6). This reduction in uptake should act as an indicator of the relative susceptability of natural microbial populations to crude oil perturbation. From what is known about the adaptive potential of microbial populations in general, we would anticipate that where there is a chronic input of crude oil or components of crude oil, the effects of crude oil on the natural microbial populations would be less than in areas without this input. There are some indications that this might indeed be the case. The effects of crude oil on glucose uptake were minimal in the stations taken nearest to the existing drilling platforms north of Kalgin Island (stations 266 and 265). In fact, the uptake rate in the water sample taken at station 266 was higher in the presence of crude oil than without oil. The effects of Cook Inlet crude oil on glutamic acid uptake was measured in all water samples taken during the time series stations at CB7, CB9 and CB10 (Fig. 6). The effect was significantly less at stations CB9 and CB10 than they were at CB7. Both of these stations are close to oil drilling rigs in the Upper Cook Inlet.

Another interesting feature of the distribution pattern seen in Fig. 5 is the comparison between the effects observed in the water sample taken in Oil Bay (station AA) and the sample taken in Cottonwood Bay (station AW) as shown in Fig. 5 and 6. The effect of crude oil on the uptake of both glucose and glutamic acid was less in Oil Bay than in Cottonwood Bay. Oil Bay is so named because of a natural oil seep found in that bay.

At one point in the cruise, we collected consecutive water samples along a track line running from Kamishak Bay within a 24 h period (Fig. 6). Moving from west to east, the percent reduction due to the presence of crude oil decreased as the samples were taken closer to the center of the shipping channel. At station CB5 the uptake was actually higher in the sample exposed to crude oil. As samples were taken further towards shore in the east side of the inlet, the effects became increasingly greater as the percent reduction increased. It is possible that the surface waters toward the center of the inlet have been exposed to higher levels of petroleum hydrocarbons because of the constant input from passing freighters.

When taken as a whole, these data suggest that the degree to which the natural microbial population in seawater is exposed to chronic inputs of petroleum hydrocarbons may affect the degree to which that population is perturbed by crude oil. This same phenomenon may not occur in sediments however. The results of two Elson Lagoon oiled sediment studies suggest that the exposure of sediments to crude oil may not act to decrease the effect of crude oil when the sediments are exposed to fresh crude oil during a short term substrate uptake study.

D. Nitrogen fixation

1. Rates of nitrogen fixation were once again measured in sediment samples collected in Elson Lagoon and in the Cook Inlet during April, 1978 (Table 10). The rates observed in the Elson Lagoon sediment samples were higher than those observed in the Cook Inlet area (mean values of 1.3 and 0.4 ng nitrogen/g dry wt/h respectively). The mean value observed in the Elson Lagoon samples was also higher than that observed in the Beaufort Sea sediment samples collected during the summer, 1977 Glacier cruise (the mean value was 0.06 ng/g/h). Unfortunately these two studies are not directly comparable for two reasons: (1) the samples were collected in different geographical areas (one set taken from one site in Elson Lagoon and the other set was taken from offshore locations, (2) the nitrogen fixation assay was performed on location in the Elson Lagoon study but the other set was analyzed at our OSU laboratory after a minimum of 4 weeks sample storage time.

2. The pattern of nitrogen fixation in the sediments of Cook Inlet and the Shelikof Strait as observed during the April cruise (Fig. 7) were similar to those observed during the April and November, 1977 cruises in the same area (also see Tables 18, 19, and 20 of the annual report). The highest values observed were again in the Kachemak Bay area and in the Shelikof Strait.

3. In both the Elson Lagoon and the Cook Inlet studies, we also measured the effects of crude oil on nitrogen fixation rates (Table 10). As we have observed in the past, there was no significant difference between the rates observed in the oiled and non-oiled sediments. This was also the case in sediment samples that were treated with sucrose. We have made these comparisons in a number of field studies to date using both samples returned to our laboratory at OSU for analysis and studies in which these analyses have been conducted in the field. In none of these studies have we observed a consistant negative effect of crude oil on nitrogen fixation rates. Knowles and Wishart (1977, Environ. Pollut. 13: 133-149) reported that they were unable to see any effects of Normal Wells crude oil on nitrogen fixation rates in sediment samples taken from the Beaufort Sea and Eskimo Lakes, Northwest Territories, Canada. Taken as a whole, these data suggest that there is probably no short term effect of crude oil on nitrogen fixation rates in Arctic and Subarctic marine sediments. It will not be known what the longer term effects might be until total nitrogen budget information becomes available from oiled sediment experiments.

E. Laboratory studies

We are currently analyzing some of the data that we have been accumulating on rates of crude oil biodegradation. One such study involved measuring the effects of incubation temperature on the degradation of various crude oil components as determined by gas chromatographic analysis. Two crude oil enrichment cultures were compared, one isolated from sediments collected in the Beaufort Sea and the other from sediments collected in the Cook Inlet. It was felt that there might be some significant differences in the utilization of crude oil at various temperatures in the cultures isolated from these two regions. More specifically, it was felt that microorganisms taken from the Beaufort Sea would have a greater ability to degrade crude oil at lower temperatures than microorganisms taken from the Cook Inlet where the average surface water temperatures are somewhat warmer. The results of our experiment did not support that assumption. In fact, the opposite trend was observed. In the Beaufort Sea culture, there was significant biodegradation of only the lightest fractions at 0 and 1.5 C. In the Cook Inlet culture, on the other hand, there was significant degradation in most of the fractions at these two temperatures.

There is not much that can be stated at this point without more information, but one interesting observation can be made from these temperature profile data. At the temperature normally found in the surface waters of the Cook Inlet (4-5 C) and after 36 days incubation, 89% of the components of the Cook Inlet crude oil that were seen in the chromatogram were degraded by the Cook Inlet culture. At the temperature that was closest to that normally found in Beaufort Sea surface waters (0 and 1.5 C) there was little or no Prudhoe Bay crude oil degradation by the Beaufort Sea microorganisms. Further investigation should be made to determine if there are organisms present in the Beaufort Sea that are uniquely suited to degrading crude oil to a significant degree at temperatures found in the Arctic marine environment. A recent search of the NIH data base for bacteria isolated from the Beaufort Sea by RU 29 showed that out of the hundreds of hydrocarbon utilizing bacteria analyzed, only a few were truely psychrophilic, i.e. they had a maximum growth temperature below 20 C.

V. Problems encountered, recommended changes, acknowledgement.

A. Problems encountered.

1. The sediment sampling devices available to us routinely by NOAA ships are not satisfactory for our work. We were able to obtain adequate samples only by using sediment samples supplied by other PIs. We have made a request for an adequate sediment sampling device in our FY79 proposal.

2. An analysis of our substrate uptake measurements in surface water samples collected during the time series experiments (Cook Inlet) indicate that there was a substantial problem obtaining clean surface water samples during this operation. At least part of this problem was probably caused by a lack of coordination between the ship's engineers and the ship's scientific operations.

Hopefully this problem will be resolved before a future time series of this nature is attempted.

3. We were not able to measure nitrogen fixation rates in the guts of selected benthic organisms during the April Cook Inlet cruise because no organisms were collected. We were supposed to analyze the guts of organisms collected by the benthic ecologists on the Miller Freeman. No organisms were available when samples were transferred from the Miller Freeman.

B. Recommended changes

See our FY79 research proposal for details concerning changes we have recommended in our future research goals. After the end of the North Wind cruise in the Beaufort Sea this August and September, we will be spending most of our research effort conducting initial studies on the effects of crude oil on microbial function in the detrital food web. We also recommend that less effort be placed on short term crude oil effects experiments on nitrogen fixation rates in marine sediments.

C. Acknowledgements

We would like to thank the crew of the NOAA ship Discoverer for their assistance during the April, 1978 Cook Inlet cruise.

Table 1. Relative levels of microbial activity and percent respiration of glucose and glutamic acid in sediment and water samples collected in Elson Lagoon in April, 1978.

A. Glucose

	*Substrate Uptake		Percent Respiration		
Sample number	No Oil	Oil	No Oil	Oil	Sample Treatment
BB501	3.2	2.7	29	28	Oiled 3 months
BB502	3.4	3.5	40	34	No oil control
BB503	12.2	9.4	19	19	Oil 0 time
BB504	1.7	3.7	43	38	Oil 24 hours
BB505	10.5	2.0	43	24	Oil 72 hours
BW501	0.3	0.3	43	35	
BW502	0.3	0.3	47	37	
BW503	0.1	0.1	42	31	

B. Glutamic acid

BB501	393	358	62	54	Oiled 3 months
BB502	128	160	52	44	No oil control
BB503	479	598	44	36	Oil 0 time
BB504	76	89	52	41	Oil 24 hours
BB505	95	72	60	60	Oil 72 hours
BW501	0.6	0.5	64	65	
BW502	0.4	0.4	60	60	

*Substrate uptake reported as ng substrate/unit/h. In sediment samples, the unit is one gram dry weight and in water it is one liter.

Table 2. Effects of freezing and crude oil on relative microbial activity in two samples collected in Elson Lagoon.

		*Uptake Rate				Percent Respiration			
Sample number	Substrate	No Oil	Oil	Freezing	Freezing + crude oil	No Oil	Oil	Freezing	Freezing + crude oil
BW501	glucose	0.3	0.3	0.1	0.1	43	35	44	24
BW501	glutamate	0.6	0.5	0.2	0.2	64	65	81	67
BB505	glucose	10.5	2.0	0.8	2.6	43	24	36	15
BB505	glutamate	95	72	97	88	60	60	53	40

*Uptake rates reported as ng/liter/h for water and ng/g dry wt/h for sediment.

Table 3. The effects of crude oil and the dispersant Corexit on relative microbial activity in samples collected in Elson Lagoon and Cook Inlet.

Sample number	Substrate Uptake (ng/unit/h) No Oil	Oil	Corexit (15ppm)	Corexit (150ppm)	Corexit (15ppm) + Oil	Corexit (150ppm) + Oil	Percent Respiration No Oil	Corexit (15ppm) + Oil	Corexit (150ppm) + Oil
A. Elson Lagoon (Beaufort Sea) (Glucose)									
BB503	12.2	9.4	7.1	2.7	4.2	1.4	19	20	39
BB505	10.5	2.0	1.4	0.7	0.6	0.5	43	54	68
B. Elson Lagoon (Glutamic acid)									
BB503	479	598	612	410	327	112	44	40	64
BB505	95	72	45	14	54	35	60	53	65
C. Cook Inlet (Glutamic acid)									
GB652	380	427	496		416		42	34	
GB653	48	41	55		48		46	30	
GB669	1277	1374	1325		1325		51	43	
GB677	253	252	281		172		35	40	
GW649	10	3.3	2.0		1.2		50	53	
GW652	33	16	12		7		61	65	
GW672	69	41	49		26		33	43	
GW677	15.1	5.8	6.3		3.8		41	51	
GW682	4.6	4.4	4.4		2.5		48	59	
D. Cook Inlet (Glucose)									
GW648	0.7	0.8	0.1		0.2		24	8	
GW649	3.8	1.5	0.8		0.4		34	25	
GB649	16	14	18		21		27	23	

Table 4. Effects of crude oil on the kinetics of glucose and glutamic acid uptake in water and sediment samples.

A. Glucose (Elson Lagoon - Acidified cells)

	V_{max} (ng/unit/hr)		T_t (hour)		K_t+S_n (ng/unit/hr)	
Sample number	No Oil	Oil	No Oil	Oil	No Oil	Oil
BB501	8.2	7.3	2137	2115	17.6	16.9
BB502	9.6	7.3	1850	1458	17.9	10.7
BB503	3.5	7.1	345	407	4.7	2.9
BB504	8.6	6.8	1953	1534	16.9	10.5
BB505	9.3	2.1	786	2670	7.3	5.7
BW501	0.5	0.3	5617	2240	2.8	0.8
BW502	4.0	4.0	7319	5511	3.2	2.3

B. Glucose (Cook Inlet-Acidified Cells)

GB649	30.7	24.6	234	299	7.2	7.4
GW648	1.4	1.2	3019	3258	4.5	4.0

C. Glutamic acid (Cook Inlet-Acidified Cells)

GB649	210	160	149	86	31	14
GB652	250	220	198	105	50	23
GB653	40	30	23	95	1	3
GB669	590	660	32	37	19	25
GB677	170	190	119	123	20	23
GW649	9.7	5.8	97	674	1.0	3.9
GW652	79	21	94	121	7.5	2.5
GW672	150	80	45	71	6.8	5.6
GW677	19	11	103	262	2.0	3.0
GW682	9	9	559	527	4.9	4.6

D. Glutamic acid (Cook Inlet-Non Acidified cells)

GB649	340	340	111	174	38	59
GB652	370	350	77	59	29	21
GB653	140	190	655	668	92	126
GB669	830	1050	12	18	10	19
GB677	300	350	124	111	37	38
GW648	5	4	1073	1715	5.8	7.1
GW649	10	6	97	674	0.9	3.9
GW652	110	90	31	58	3.4	5.3
GW672	180	130	20	24	3.6	3.2
GW677	30	30	72	120	2.4	3.6
GW682	20	10	93	120	2.0	1.6

Table 5. Summary of station numbers, station position, water column depth, and salinity and temperature measurements made during the April, 1978 Cook Inlet cruise.

Station #	Sample #	Temp. Surf.	Temp. Bottom	Salinity Surf.	Salinity Bottom	Lat.		Long.		Depth.
330	GW601	4.47	4.48	32.222	32.227	56	22.3	154	17.9	44
331	GW602	3.52	3.51	32.059	32.065	56	46.0	154	20.3	52
333	GW603	4.88	4.46	31.973	32.418	57	04.2	155	01.2	188
358	GW604	4.45	4.51	32.049	32.397	57	18.1	154	56.0	148
350	GW605	4.42	4.57	31.903	32.470	57	31.2	155	33.8	265
360	GW606	4.44	4.51	31.766	32.406	57	56.2	154	40.6	228
368	GW607	4.59	4.38	32.134	32.291	57	43.9	154	09.0	53
378	GW608	4.93	4.62	32.108	32.392	58	01.3	153	29.6	82
370	GW609	3.97	4.65	31.468	31.977	58	17.2	154	01.9	112
380	GW610	3.88	3.99	31.425	31.500	58	38.9	153	24.7	-
394	GW611	4.55	4.67	31.928	32.281	58	40.9	153	00.5	153
388	GW612	4.93	4.58	32.026	32.420	58	27.2	152	58.0	215
395	GW613	4.73	4.70	31.915	32.247	58	53.2	152	54.9	166
207	GW614	4.77	4.80	31.980	32.120	58	59.9	152	53.3	166
390	GW615	3.81	4.67	31.262	32.121	58	52.7	153	11.1	170
229	GW616	4.66	4.17	51.557	31.688	59	39.9	151	14.8	38
249	GW617	-	-	31.854	-	59	51.3	152	01.6	40
246	GW618	-	-	31.749	-	60	05.5	151	45.7	33
266	GW619	-	-	27.266	-	60	42.7	151	25.5	43
265	GW620	-	-	29.993	-	60	34.9	151	41.9	16
255	GW621	3.26	3.25	30.023	30.026	60	19.3	151	46.5	42
242	GW622	3.72	3.69	30.778	30.781	60	09.0	152	25.7	36
245	GW623	3.78	3.78	30.574	30.756	60	06.3	152	15.5	84
247	GW624	3.96	3.97	30.741	30.755	59	58.1	152	34.4	21
233	GW625	3.87	3.88	31.022	31.023	59	49.7	152	56.0	15
248	GW626	3.76	4.38	30.948	29.663	50	50.1	152	24.2	70
203	GW627	4.08	3.99	29.987	31.085	59	06.3	153	27.8	41
201	GW628	4.29	4.26	30.708	30.739	59	12.5	153	52.9	20
204	GW629	3.89	3.89	31.228	31.232	59	14.1	153	39.5	34
214	GW630	4.08	4.26	31.512	31.666	59	17.9	153	13.2	53
211	GW631	4.01	4.03	31.255	31.300	59	26.1	153	37.0	20
212	GW632	4.00	4.02	31.243	31.273	59	32.7	153	20.9	26
*V	GW633	4.0	-	30.5	-	60	13.4	152	45.6	-
*U	GW634	4.0	-	29.0	-	60	12.8	152	36.0	-
234	GW635	4.14	4.13	31.277	31.276	59	37.8	152	55.8	36
213	GW636	4.20	4.16	31.354	31.362	59	29.6	153	13.9	33
225	GW637	4.43	4.46	31.734	31.743	59	31.5	152	39.6	61
235	GW638	4.11	4.19	31.157	31.225	59	42.6	152	37.3	39
236	GW639	4.79	4.79	31.909	31.888	59	41.7	152	14.2	37
226	GW640	4.73	4.74	31.909	31.903	59	32.8	152	18.3	49
216	GW641	4.81	4.81	31.917	31.936	59	18.1	152	15.4	80
205	GW642	4.81	4.89	31.884	32.034	59	06.7	152	40.0	140
206	GW643	4.81	4.88	31.871	31.971	59	08.7	153	05.0	84
390	GW644	4.44	4.98	31.544	32.104	58	53.4	153	11.6	62
398	GW645	5.09	5.01	32.203	32.249	58	49.0	152	12.3	126

Table 5. (Cont'd.)

Station #	Sample #	Temp. Surf.	Temp. Bottom	Salinity Surf.	Salinity Bottom	Lat.		Long.		Depth.
105	GW646	5.04	5.11	32.100	32.430	58	49.7	151	19.3	118
106	GW647	4.92	5.11	31.920	32.311	59	00.6	152	01.2	201
*AA	GW648	5.0	-	28.0	-	59	39.5	153	16.5	-
*AW	GW649	5.5	-	27.2	-	59	38.0	153	37.8	-
*M	GW650	8.0	-	27.6	-	59	43.3	153	22.6	-
*J	GW651	4.0	-	31.2	-	59	34.6	151	11.0	-
229A	GW652	5.99	4.29	31.426	31.778	59	37.8	151	18.4	64
CB1	GW653	4.40	4.37	31.368	31.369	59	13.7	153	40.1	31
CB2	GW654	-	-	-	-	59	16.6	153	20.3	36
CB3	GW655	-	-	31.875	-	59	19.9	152	58.3	-
CB4	GW656	-	-	31.940	-	59	23.3	152	38.7	-
CB5	GW657	-	-	31.965	-	59	25.6	152	19.4	-
CB6	GW658	-	-	31.850	-	59	31.9	512	00.6	-
CB7	GW659	5.60	4.84	31.774	31.836	59	35.4	151	45.9	51
CB7	GW660	5.32	5.13	31.765	31.790	59	35.4	151	45.9	51
CB7	GW661	5.76	4.92	31.778	31.836	59	35.4	151	45.9	51
*AB	GW662	5.0	-	29.5	-	59	27.6	151	43.2	-
CB7	GW663	5.30	5.11	31.769	31.790	59	35.4	151	45.9	51
CB7	GW664	5.73	4.87	31.776	31.832	59	35.4	151	45.9	51
CB7	GW665	5.42	5.15	31.688	31.790	59	35.4	151	45.9	51
CB7	GW666	5.87	4.97	31.809	31.839	59	35.4	151	45.9	51
CB7	GW667	5.37	5.20	31.766	31.796	59	35.4	151	45.9	51
CB7	GW668	5.54	5.08	31.798	31.826	59	35.4	151	45.9	51
*K	GW669	6.0	-	29.0	-	59	36.5	151	25.5	-
CB10	GW670	4.11	4.11	29.514	29.509	60	31.5	151	30.9	24
CB10	GW671	-	-	-	-	60	31.5	151	30.9	24
CB10	GW672	4.19	4.12	29.579	29.559	60	31.5	151	30.9	24
CB10	GW673	4.41	4.30	29.277	29.262	60	31.5	151	30.9	24
CB10	GW674	4.24	4.24	29.480	29.482	60	31.5	151	30.9	24
CB9	GW675	4.70	4.70	30.664	30.661	60	28.2	152	12.2	37
CB9	GW676	4.70	4.70	30.442	30.474	60	28.2	152	12.2	37
CB9	GW677	4.92	4.75	30.461	30.681	60	28.2	512	12.2	37
CB9	GW678	4.77	4.74	30.522	30.479	60	28.2	152	12.2	37
CB9	GW679	4.81	4.82	30.639	30.644	60	28.2	152	12.2	37
CB9	GW680	4.94	4.78	30.220	30.595	60	28.2	152	12.2	37
CB9	GW681	4.89	4.84	30.529	30.634	60	28.2	152	12.2	37
CB9	GW682	4.84	4.77	30.364	30.480	60	28.2	152	12.2	37
CB9	GW683	5.12	4.91	30.474	30.619	60	28.2	152	12.2	37

*Shore stations

Table 6. Relative levels of microbial activity and percent respiration of glucose in water samples collected in the Cook Inlet during the April cruise. A comparison is made between samples that had been exposed to crude oil and those that were not exposed.

Sample number	Station number	*Glucose Uptake No Oil	*Glucose Uptake Oil	Percent Respiration No Oil	Percent Respiration Oil	@Tide State
GW601	330	30.9		32		
°GW602	331	0.5		29		
GW603	333	0.3		34		
GW604	358	0.8		40		
GW605	350	0.1		11		
GW606	360	0.7		28		
GW607	368	1.8		38		
GW608	378	4.9		37		
GW609	370	0.8		40		
GW610	380	0.3		36		
GW611	394	0.5		36		
GW612	388	9.3		38		
GW613	395	0.6		34		
GW614	207	0.6		42		
GW615	390	0.7		26		
GW616	229	3.1		44		
GW617	249	2.8	1.2	31	32	
GW618	246	2.6	1.5	30	35	
GW619	266	1.4	2.0	14	16	
GW620	265	2.9	2.6	15	15	
GW621	255	5.5	2.4	12	18	
GW622	242	1.4	0.7	19	24	
GW623	245	1.3	0.8	18	17	
GW624	247	3.5	1.1	14	26	
GW625	233	1.0	0.6	18	25	
GW626	248	1.3	0.6	16	21	
GW627	203	2.0	1.1	49	38	
GW628	201	6.4	3.7	31	31	
GW629	204	5.2	0.3	84	15	
GW630	214	0.5	0.2	24	18	
GW631	211	1.4	0.3	14	28	
GW632	212	0.7	0.3	14	17	
GW633	V	22.8	3.3	22	27	
GW634	U	1.3	0.4	18	29	
GW635	234	0.8	0.3	15	31	
GW636	213	0.5	0.3	17	20	
GW637	225	0.8	0.5	35	28	
GW638	235	0.1	0.2	17	10	
GW639	204	0.2	0.2	24	16	
GW640	226	0.1	0.2	17	7	

Table 6. (Cont'd.) (glucose uptake)

Sample number	Station number	*Glucose Uptake No Oil	*Glucose Uptake Oil	Percent Respiration No Oil	Percent Respiration Oil	@Tide State
GW641	216	0.2	0.5	31	12	
GW642	205	0.1		49		
GW643	206	0.2		53		
GW644	390	0.5	0.4	28	15	
GW645	398	0.5	0.3	46	30	
GW646	105	0.2		51		
GW647	106	1.2		39		
GW648	AA	0.7	0.8	24	48	
GW649	AW	3.8	1.5	34	35	
GW650	M	75.6		23		
GW651	J	43.3	40.8	36	36	
GW652	229a	20.1	8.0	40	44	
GW653	CB1	1.3	0.6	14	23	
GW654	CB2	1.1		43		
GW655	CB3	4.0		38		
GW656	CB4	8.6		30		
GW657	CB5	0.9		19		
GW658	CB6	5.9		34		
GW659	CB7	23.8		50		H
°GW660	CB7	153		41		L
°GW661	CB7	102		46		H
GW662	AB	6.0		35		
GW663	CB7	24.6		49		L
°GW664	CB7	40.9		48		H
GW665	CB7	10.3		81		L
GW666	CB7	8.5		23		H
GW667	CB7	13.3		44		L
°GW668	CB7	53.3		47		H
GW669	K	109		38		
GW670	CB10	34.2		7		H
GW671	CB10	21.6		12		L
GW672	CB10	14.0		12		H
GW673	CB10	12.1		13		L
GW674	CB10					H
GW675	CB9					H
GW676	CB9	3.1		16		L
GW677	CB9	4.3		18		H

*Glucose uptake rates reported as ng glucose/liter/h.
°These samples appear to have been contaminated by the ship's effluent.
@The tide state reported for the time series stations only. H - high slack tide. L = low slack tide.

Table 7. Relative levels of microbial activity and percent respiration of glutamic acid in water samples collected in the Cook Inlet during the April cruise. A comparison is made between samples that had been exposed to crude oil and those that were not exposed.

Sample number	Station number	*Glutamate Uptake No Oil	Oil	Percent Respiration No Oil	Oil	@Tide state
°GW601	330	20.7		66		
GW602	331	1.0		67		
GW603	333	1.0		80		
GW604	358	0.5		80		
GW605	350	0.2		43		
GW606	360	1.5		73		
GW607	368	6.6		69		
GW608	378	7.0		60		
GW609	370	1.7		65		
GW610	380	0.4		65		
GW611	394	1.9		61		
GW612	388	8.1		70		
GW613	395	2.5		62		
GW614	207	1.9		71		
GW615	390	2.3		50		
GW616	229	4.8		64		
GW617	249	10.8		61		
GW618	246	2.9		64		
GW619	266	3.0		41		
GW620	265	11.2		32		
GW621	255	11.4		37		
GW622	242	2.4		43		
GW623	245	2.7		35		
GW624	247	12.7		33		
GW625	233	2.4		36		
GW626	248	4.2		32		
GW627	203	0.6		34		
GW628	201	6.1		45		
GW629	204	0.5		15		
GW630	214	1.7		49		
GW631	211	3.8		36		
GW632	212	3.8		32		
GW633	V	149		52		
GW634	U	3.7		58		
GW635	234	3.2		33		
GW636	213	3.5		33		
GW637	225	0.9		67		
GW638	235	0.3		50		
GW639	204	0.2		53		
GW640	226	0.1		32		

Table 7. (Cont'd.)

Sample number	Station number	*Glutamate Uptake No Oil	Oil	Percent Respiration No Oil	Oil	@Tide state
GW641	216	0.2		57		
GW642	205	0.2		52		
GW643	206	0.2		64		
GW644	390	0.9		66		
GW645	398	1.1		66		
GW646	105	0.2		41		
GW647	106	4.4		59		
GW648	AA	1.7	1.5	38	59	
GW649	AW	10.0	3.3	50	61	
GW650	M	143		50		
GW651	J	93.2	43.5	57	62	
GW652	229a	33.3	15.8	61	66	
GW653	CB1	2.5	1.3	52	57	
GW654	CB2	4.3	2.6	57	55	
GW655	CB3	7.2	4.3	59	49	
GW656	CB4	24.6	18.1	58	54	
GW657	CB5	6.8	10.0	66	51	
GW658	CB6	15.1	11.4	61	25	
GW659	CB7	10.0	5.6	66	74	H
°GW660	CB7	71.9	24.3	63	71	L
°GW661	CB7	63.3	27.8	65	77	H
GW662	AB	9.9	5.8	63	71	
GW663	CB7	17.7	6.5	64	75	L
°GW664	CB7	17.2	12.7	67	74	H
GW665	CB7	13.4	9.7	82	84	L
GW666	CB7	10.2	7.1	50	53	H
GW667	CB7	20.2	10.9	64	73	L
°GW668	CB7	33.5	17.3	66	72	H
GW669	K	103	40.7	59	67	
GW670	CB10	58.3	51.0	39	37	H
GW671	CB10	61.1	34.2	33	40	L
GW672	CB10	69.4	40.5	33	42	H
GW673	CB10	81.2	62.3	32	37	L
GW674	CB10	94.8	83.4	31	31	H
GW675	CB9	21.7	21.7	30	33	H
GW676	CB9	9.7	9.5	36	22	L
GW677	CB9	15.1	5.8	41	43	H
GW678	CB9	21.0	23.5	37	40	L
GW679	CB9	15.0	11.4	41	47	H
GW680	CB9	9.7	4.1	51	58	L
GW681	CB9	2.5	2.3	59	60	H
GW682	CB9	4.6	4.4	48	48	L
°GW683	CB9	30.1	14.1	34	45	H

*Glutamic acid uptake rates reported as ng glutamate/liter/h.
°These samples appear to have been contaminated by the ship's effluent.
@The tide state reported for the time series stations only. H = high slack tide. L = low slack tide.

Table 8. Relative levels of microbial activity and percent respiration of glucose in sediment samples collected in the Cook Inlet during the April cruise. A comparison is made between samples that had been exposed to crude oil and those that were not exposed.

Sample number	Station number	*Glucose Uptake No Oil	*Glucose Uptake Oil	Percent Respiration No Oil	Percent Respiration Oil
GB602	331	0.3	0.9	22	20
GB603	333	0.3	0.3	28	20
GB604	358	0.2	0.3	28	22
GB605	350	0.2	0.8	32	4
GB606	360	1.5	2.6	66	16
GB607	368	1.1	0.8	32	33
GB609	370	2.8	1.8	42	36
GB610	380	0.8	0.8	27	27
GB611	394	0.3	0.4	43	30
GB612	388	0.1	0.7	26	30
GB613	395	0.5	0.9	24	11
GB614	207	2.2	0.9	30	31
GB616	229a	0.9	1.1	38	24
GB625	233	0.6	0.5	35	33
GB627	203	2.9	3.4	28	33
GB628	201	38.4	26.7	10	36
GB629	204	0.3	0.4	22	18
GB630	214	3.6	3.5	21	21
GB632	212	3.5	2.3	28	27
GB633	V	2.6	1.6	43	30
GB634	U	0.4	0.4	39	25
GB636	213	2.9	2.4	25	25
GB644	390	2.5	1.8	29	38
GB649	AW	16.4	14.5	27	31
GB650	M	17.8		33	
GB652	229	22.9	23.5	22	19
GB653	CB1	4.5	4.3	30	21
GB654	CB2	6.5		33	
GB660	CB7	4.9		26	
GB669	K	165		19	

*Glucose uptake reported in ng glucose/g dry wt. sediment/h.

Table 9. Relative levels of microbial activity and percent respiration of glutamic acid in sediment samples collected in the Cook Inlet during the April cruise. A comparison is made between samples that had been exposed to crude oil and those that were not exposed.

Sample number	Station number	*Glutamate Uptake No Oil	*Glutamate Uptake Oil	Percent Respiration No Oil	Percent Respiration Oil
GB602	331	7.7		55	
GB603	333	10.9		56	
GB604	358	6.0		61	
GB605	350	6.3		30	
GB606	360	24.3		66	
GB607	368	29		31	
GB609	370	20		43	
GB610	380	34		47	
GB611	394	8.9		41	
GB612	388	4.7		31	
GB613	395	15		45	
GB614	207	38		49	
GB616	229a	17		43	
GB625	233	10		49	
GB627	203	58		61	
GB628	201	495		43	
GB629	204	4.7		39	
GB630	214	67		41	
GB632	212	105		48	
GB633	V	126		51	
GB634	U	25		62	
GB636	213	56		43	
GB644	390	50		31	
GB649	AW	284	264	39	42
GB650	M	329		40	
GB652	229	380	427	42	36
GB653	CB1	48	41	46	47
GB654	CB2	67	51	49	52
GB660	CB7	92	54	56	59
GB669	K	1277	1374	51	43
GB677	CB9	595	229	41	43

*Glutamic acid uptake reported as ng glutamic acid/g dry wt sediment/h.

Table 10. The effects of crude oil on nitrogen fixation in sediment samples*.

A. Beaufort Sea, April, 1978

Sample #		No Sucrose		Sucrose	
		No Oil	Oil	No Oil	Oil
501		1.9	1.7		
502		0.8	0.9		
503		1.4	0.6		
504		1.4	1.7		
505		0.9	0.9		
	$\bar{x}$	1.3	1.2		

B. Cook Inlet, April, 1978

Sample #		No Sucrose		Sucrose	
		No Oil	Oil	No Oil	Oil
602		0.4	0.4	0.8	0.7
603		0.4	0.4	0.6	0.6
604		0.3	0.2		
605		0.8	0.6		
606		1.1	0.5	0.8	1.3
607		0.4	0.3		
609		0.3	0.2		
610		0.3	0.3	0.3	0.3
611		0.4	0.3		
612		0.3	0.4		
613		0.9	0.7		
614		0.6	0.4		
616		0.6	0.9	$ 2.6	0.5
625		0.1	0.1	0.3	0.1
627		<0.1			
628		<0.1			
629		<0.1			
630		0.15			
632		<0.1			
633		<0.1			
634		<0.1			
636		0.1			
644		0.15			
649		0.4			
652		1.1	1.2		
653		0.2			
654		0.5			
660		0.3	0.3		
669		2.2	2.1	1.3	1.1
	$\bar{x}$	0.4	0.5	1.0	0.7

*All values reported as ng nitrogen fixed per g dry wt per h.
$This high value probably due to experimental error.

Table 11. Inorganic nutrient data in samples taken in the Cook Inlet and Beaufort Sea. All concentrations reported in μM.

A. Beaufort Sea (Elson Lagoon), January, 1978

Sample #	NH_3	NO_2	NO_3	TAN	PO_4
1. Water					
BW403	2.90	0.09	7.24		1.44
BW408	2.93	0.09	6.95		1.49
2. Sediment					
BB402	52.74	0.36	3.87		4.32
BB403	14.01	0.04	0.30	30.46	0.74
BB404	14.01	0.06	0.29	13.54	4.02
BB405	92.88	1.08	0.40	46.92	18.48
BB406	16.80	0.73		15.16	2.43
BB407	84.69	0.81	1.26		10.8
BB408	15.24	0.11	0.28	23.66	1.64
BB409		3.66			
BB410	23.34	0.17	0.16	95.20	8.40

B. Cook Inlet, April, 1977

Sample #	NH_3	NO_2	NO_3	TAN	PO_4
1. Water					
GW401	1.00	0.21	1.12	6.29	1.22
GW402	1.94	0.21	14.30	20.03	1.55
GW403	1.81	0.05	16.14	20.00	1.66
GW405	1.44	0.17	15.73	19.54	1.46
GW406	1.75	0.30	10.53	19.40	1.27
GW407				20.46	
GW408	1.22	0.19	16.31	21.35	1.71
GW409	1.90	0.23	16.05	19.09	1.75
GW412	1.88	0.24	12.74	15.17	1.43
GW413	4.01	0.23	16.34	21.55	2.29
GW417	3.30	0.28	15.92	20.92	1.65
GW418	4.00	0.57	14.10	18.91	3.36
GW419	2.97	0.24	15.74	18.02	2.00
GW422	1.72	0.14	16.53	20.20	1.31
GW423	2.50	0.57	15.22	18.92	
GW424	1.58	0.53	16.01	19.50	
GW425	1.58	0.43	14.33	18.04	1.67
GW427	1.03	0.33	15.43	17.91	
GW428	1.15	0.29	15.55	18.09	
GW430	1.50	0.10	0.10	8.09	0.52

Table 11. (Cont'd.)

B. Cook Inlet, April, 1977

Sample #	NH_3	NO_2	NO_3	TAN	PO_4
1. Water					
GW432		0.15	10.46	27.8	1.91
GW433	3.62	0.19	10.01	16.2	1.72
GW434	2.68	0.25	12.35	11.6	2.10
GW437	0.28	0.06	7.76	12.6	1.15
GW438	1.67	0.13	10.71	9.5	1.82
GW441	2.26	0.28	15.05	20.2	1.42
GW442	2.33	0.22	12.13	15.6	1.36
GW444	1.75	0.23	14.34	20.4	1.48
GW439	2.23	1.71	8.22	13.8	1.51
2. Sediment					
GB410		28.2	20.77		73.5
GB411	>362	16.6			76.3
GB412	>432	137			60.5
GB421	>161	0.30	0.06	147.2	48.6
GB425	109.8	1.32	1.80	113.7	10.3
GB431	116.6	1.14	1.92	380.2	5.3
GB432	70.4	14.5			24.6
GB434	>161	3.74	6.04		24.9
GB437	42.7	7.56	5.94	197.2	11.2
GB440	150.8	0.42	1.20	420.7	12.5
GB442	64.7	0.54	2.04	83.5	13.4
GB444	22.2	0.31	0.13	13.9	2.40
GB445	14.6	0	0.18	22.7	1.25

C. Cook Inlet, November, 1977

Sample #	NH_3	NO_2	NO_3	TAN	PO_4
1. Water					
GW501	1.42	0.35	9.34	14.7	1.45
GW502	0.83	0.28	15.04	19.2	1.71
GW503	1.48	0.24	15.80	20.4	1.89
GW504	0.90	0.24	13.90	16.2	1.58
GW505	3.00	0.50	9.10	13.9	1.61
GW506	2.71	0.40	9.46	14.2	1.36
GW507	1.45	0.34	9.59	11.5	1.23
GW508	1.13	0.31	8.98	12.4	1.18
GW509	0.85	0.31	8.84	11.8	1.17
GW510	1.10	0.31	8.78	10.1	1.19
GW511	1.01	0.13	11.25	1.4	1.38
GW514	0.82	0.24	10.55	12.4	1.30
GW515	0.92	0.24	11.53	13.8	1.32

Table 11. (Cont'd.)

C. Cook Inlet, November, 1977

	NH_3	NO_2	NO_3	TAN	PO_4
1. Water					
GW516	0.62	0.35	8.78	10.4	1.22
GW518	0.62	0.29	9.96	11.4	1.29
GW519	1.12	0.32	8.52	11.1	1.22
GW520	1.36	0.27	13.3	16.2	1.49
GW521	0.55	0.33	9.21	13.2	1.18
GW522	0.95	0.31	9.37	10.8	1.21
GW523	0.93	0.33	8.77	10.7	1.18
GW524	1.05	0.33	8.77	11.2	1.22
GW525	0.58	0.26	6.30	8.2	0.99
GW526	1.66	0.36	9.61	14.0	1.21
GW527	1.35	0.30	9.14	10.8	1.30
GW528	1.48	0.30	9.17	12.6	1.19
GW529	1.27	0.26	9.12	1.6	1.22
GW530	1.03	0.35	9.53	12.2	1.26
GW531	0.65	0.32	9.92	11.3	1.20
GW532	1.31	0.22	11.87	13.5	1.38
GW533	0.99	0.21	11.66	13.6	1.35
GW534	0.85	0.23	11.76	15.2	1.36
GW535	0.62	0.29	11.01	13.6	1.30
GW536	0.80	0.29	11.07	14.4	1.35
GW537	1.05	0.38	10.05	12.7	1.33
GW539	1.70	0.39	9.26	11.4	1.18
GW540	1.50	0.30	8.57	10.7	1.12
GW541	1.11	0.07	12.90	15.5	1.45
GW542	1.47	0.39	10.68	14.1	1.26
GW543	1.49	0.12	11.20	13.6	1.37
GW544	1.45	0.35	10.15	14.2	1.25
GW545	1.25	0.35	9.76	12.5	1.28
GW547	1.15	0.34	10.22	12.5	1.25
GW549	1.23	0.44	10.60	12.6	0.91
GW550	1.25	0.43	10.18	12.4	1.18
GW556	1.26	0.23	11.65	12.6	1.52
GW557	1.75	0.39	10.44	18.1	1.43
GW558	1.67	0.46	10.26	12.7	1.41
GW559	1.78	0.16	12.96	16.2	1.43
GW560	0.95	0.10	10.72	1.45	1.32

Table 12. Crude oil degradation by two crude oil enrichment cultures at various incubation temperatures; one isolated from Beaufort Sea and one isolated from Cook Inlet sediments. The value given is the percent reduction for all peaks within the interval shown.

A. Beaufort Sea

Peak retention times in min.	2-9	9-18	18-27	27-36	36-45	2-45
°C			Percent Reduction			
0	100	16	2	10	15	13
1.5	100	3	15	0	0	4
5	77	78	64	65	59	69
8	0	92	64	82	95	77
15	0	97	75	96	7	83
20	0	95	79	100	100	89

B. Cook Inlet

0	99	48	42	55	78	50
1.5	73	49	53	20	0	44
5	100	94	87	93	52	89
8	0	94	87	99	33	89
15	0	96	84	98	2	85
20	0	100	96	100	96	98

Table 13. The uptake of glucose and glutamic acid and the effects of crude oil on glutamic acid uptake at various tidal states.

Sample #	Station #	* Tide	@ DPM glucose	DPM glutamate	glutamate / glucose	Percent reduction in uptake with crude oil
659	CB7	H	896	432 ¢	0.5	44
660	"	L	5740	3045 ¢¢	0.5	66
661	"	H	3830	2682 ¢¢	0.7	56
663	"	L	923	749 ¢	0.8	63
664	"	H	1537	729 ¢¢	0.5	26
665	"	L	389	567	1.5	27
666	"	H	319	433	1.4	31
667	"	L	501	858	1.7	46
668	"	H	2006	1420 ¢¢	0.7	49
670	CB10	H	1284	2472	1.9	13
671	"	L	813	2590	3.2	44
672	"	H	525	2942	5.6	42
673	"	L	455	3442	7.6	23
674	"	H		4016		7
675	CB9	H		918		0
676	"	L	115	411	3.6	2
677	"	H	160	638	4.0	61
678	"	L		890		-12
679	"	H		636		24
680	"	L		409		57
681	"	H		108		11
682	"	L		195		5
683	"	H		1276 ¢		
601	330		1161	879 ¢¢	0.8	
669	K		4086	4383 ¢¢	1.1	
662	AB		225	419	1.9	

*Tide state: H = high slack L = low slack.
@DPM = disintegrations per minute per hour incubation time.
¢Those samples that were probably contaminated to some degree.
¢¢Those samples that were probably grossly contáminated.

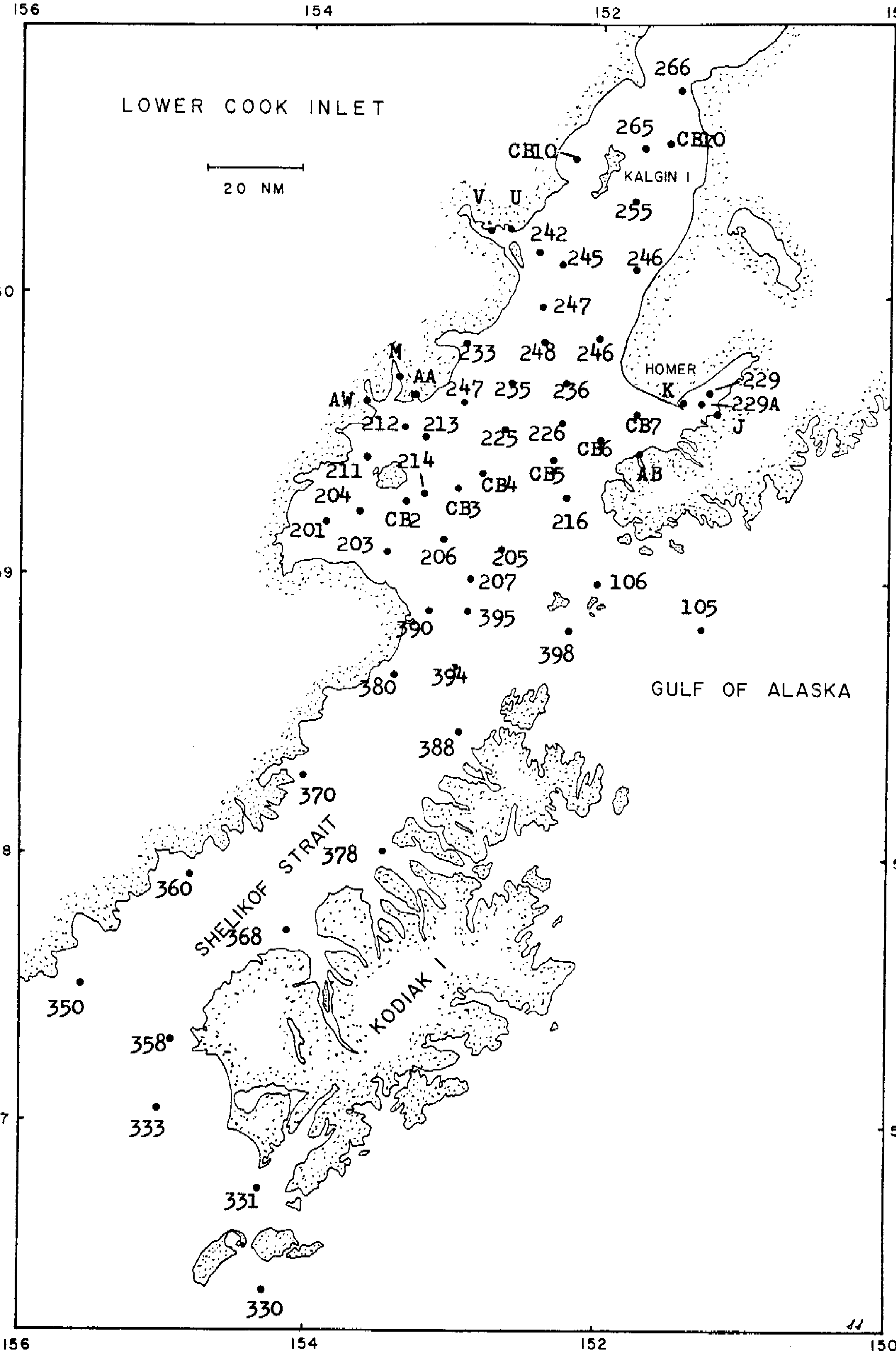


Figure 1. Location of stations sampled during the April, 1978 Cook Inlet cruise.

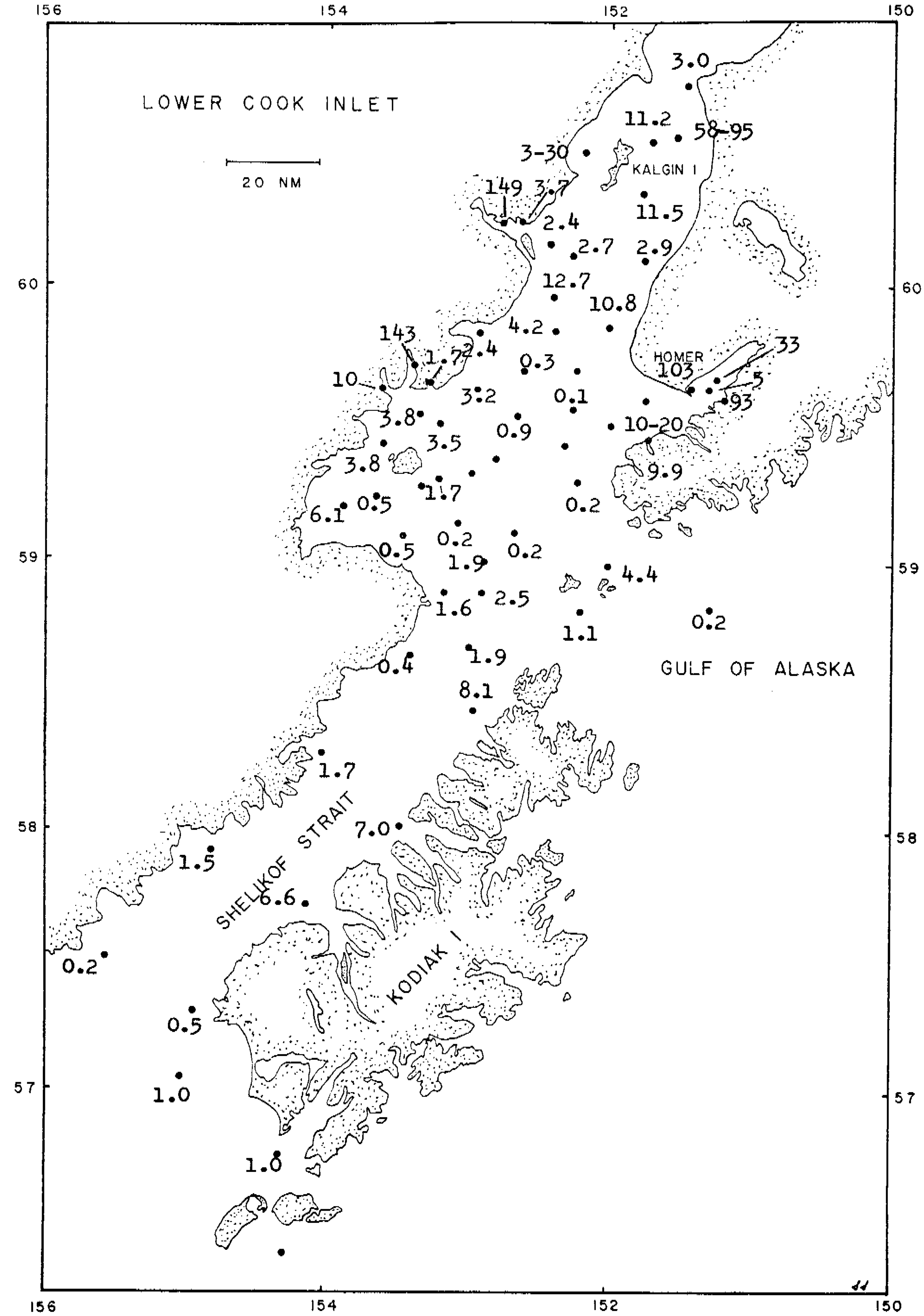


Figure 2. Relative microbial activity as measured using glutamic acid during the April, 1978 Cook Inlet cruise. The units are ng/l/h. Water samples only.

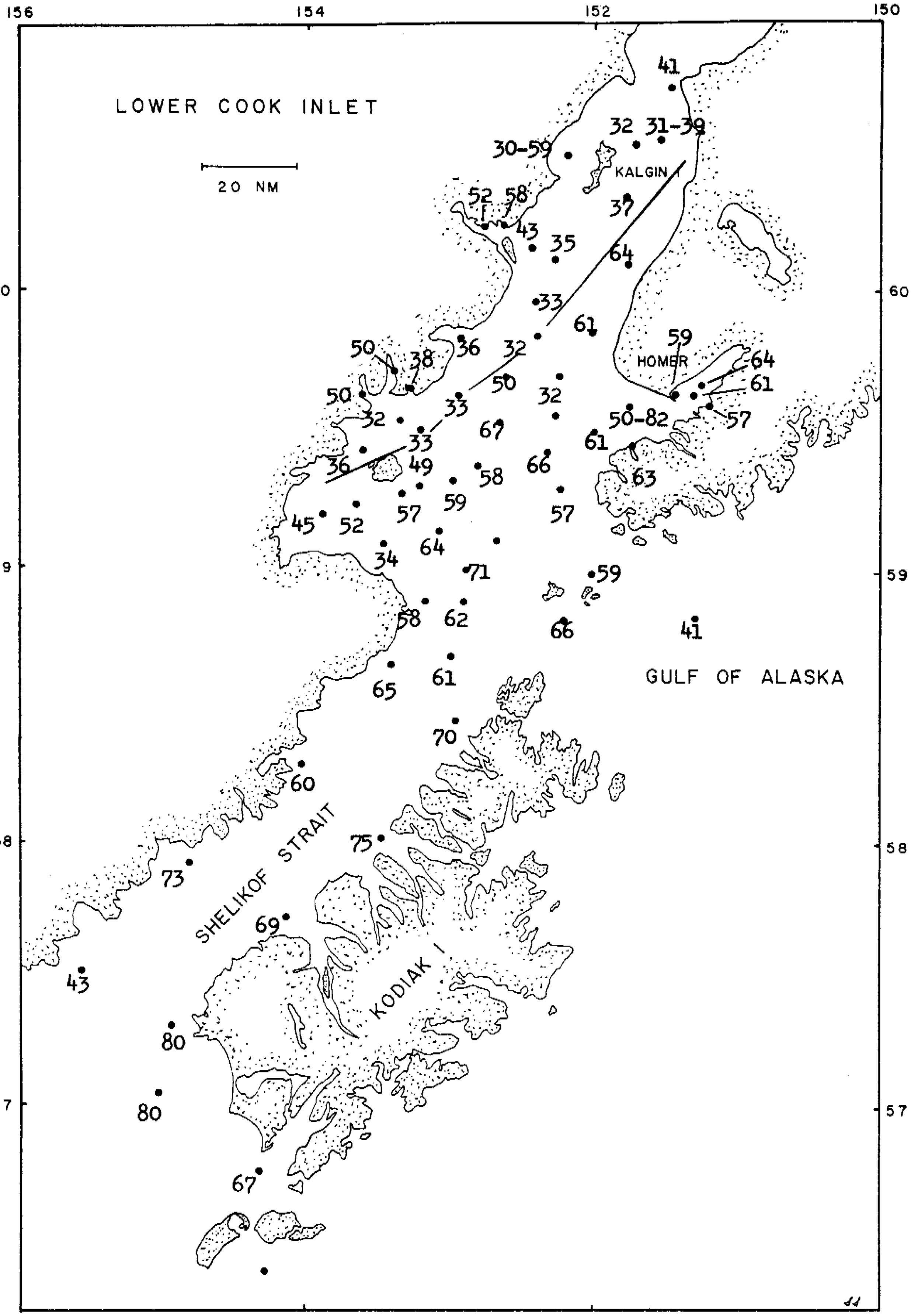


Figure 3. Percent respiration in water samples exposed to glutamic acid. These samples were collected during the April, 1978 Cook Inlet cruise.

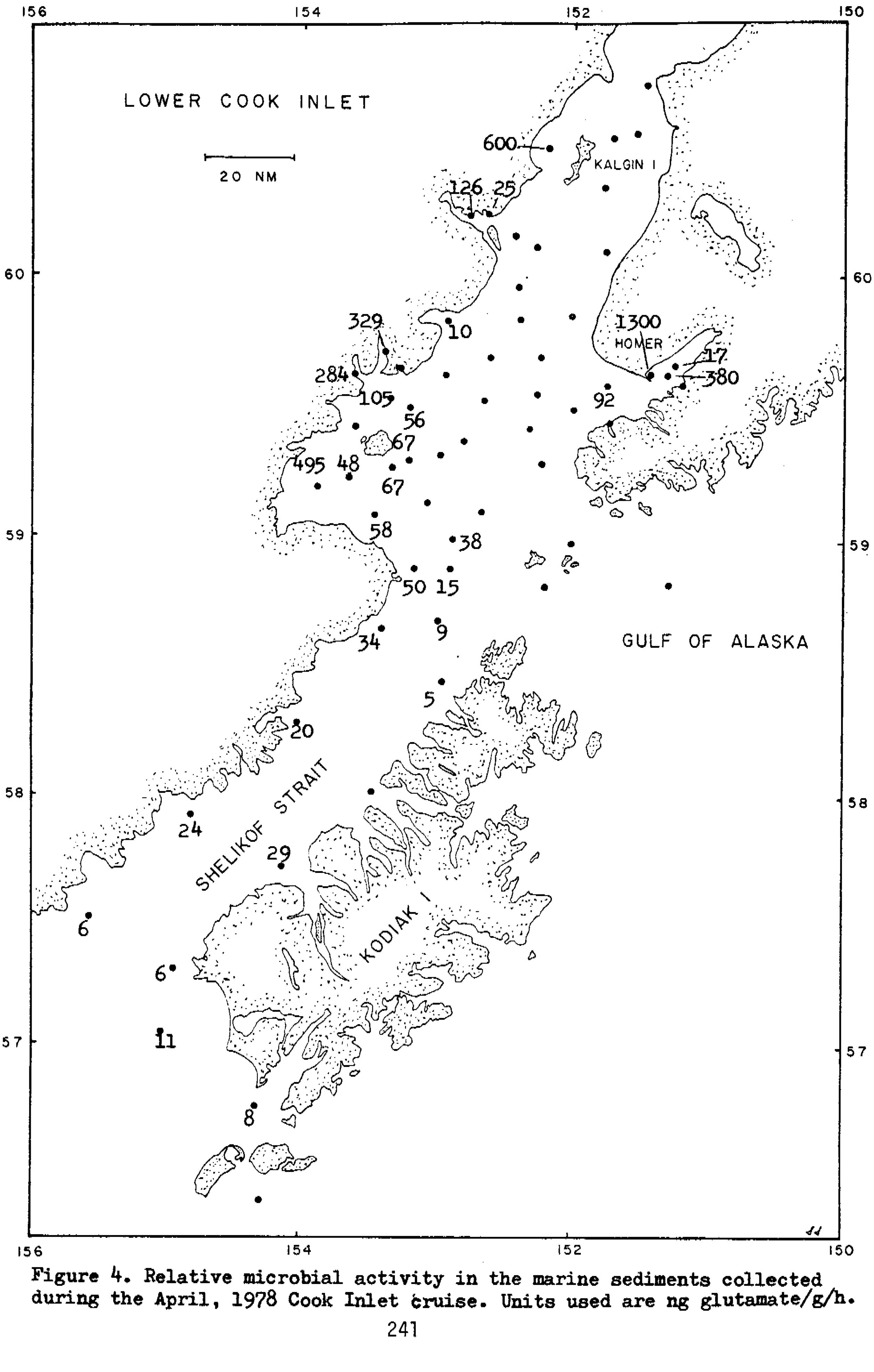


Figure 4. Relative microbial activity in the marine sediments collected during the April, 1978 Cook Inlet cruise. Units used are ng glutamate/g/h.

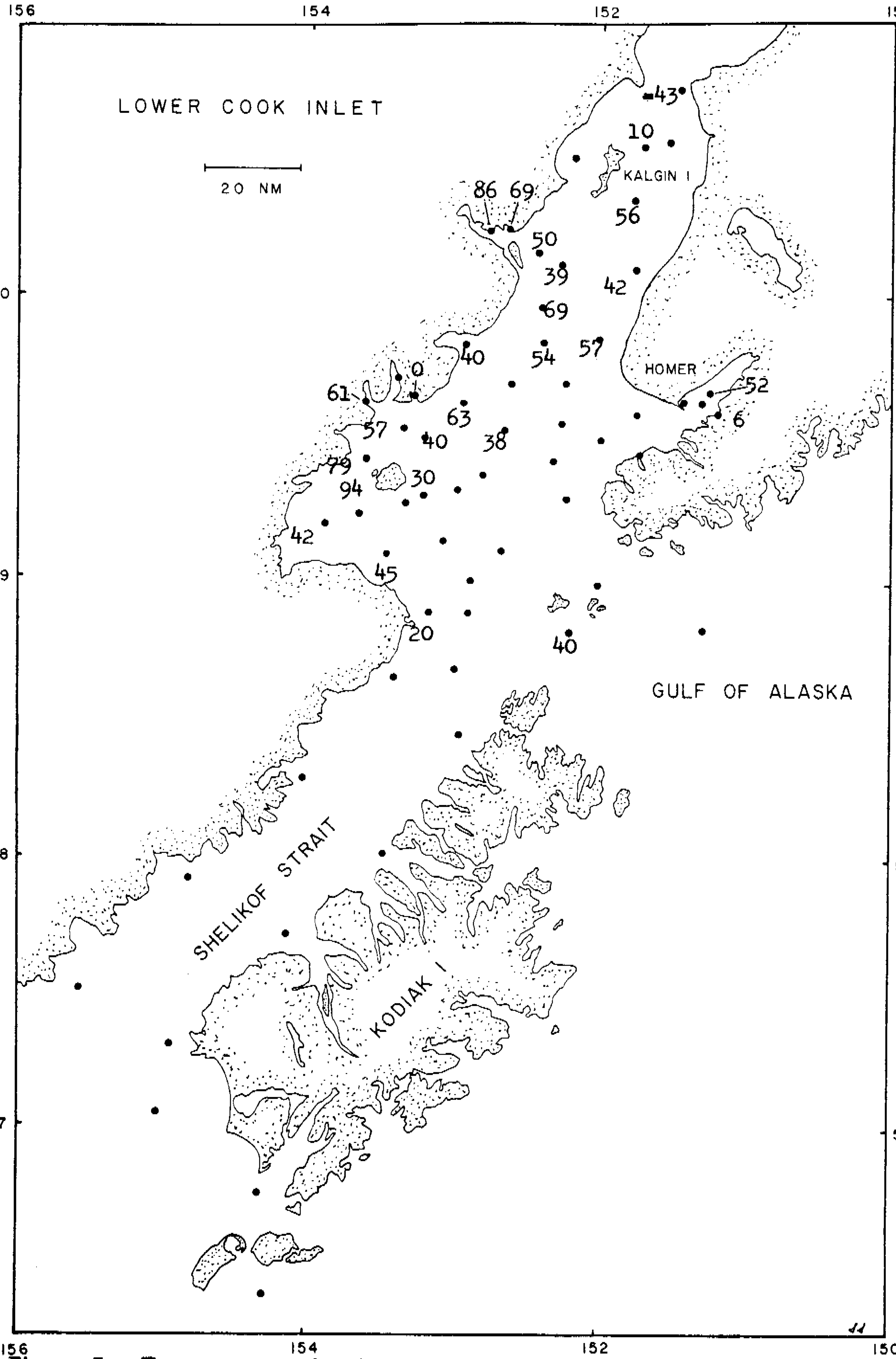


Figure 5. The percent reduction in glucose uptake rates in water samples exposed to crude oil relative to nonoiled controls.

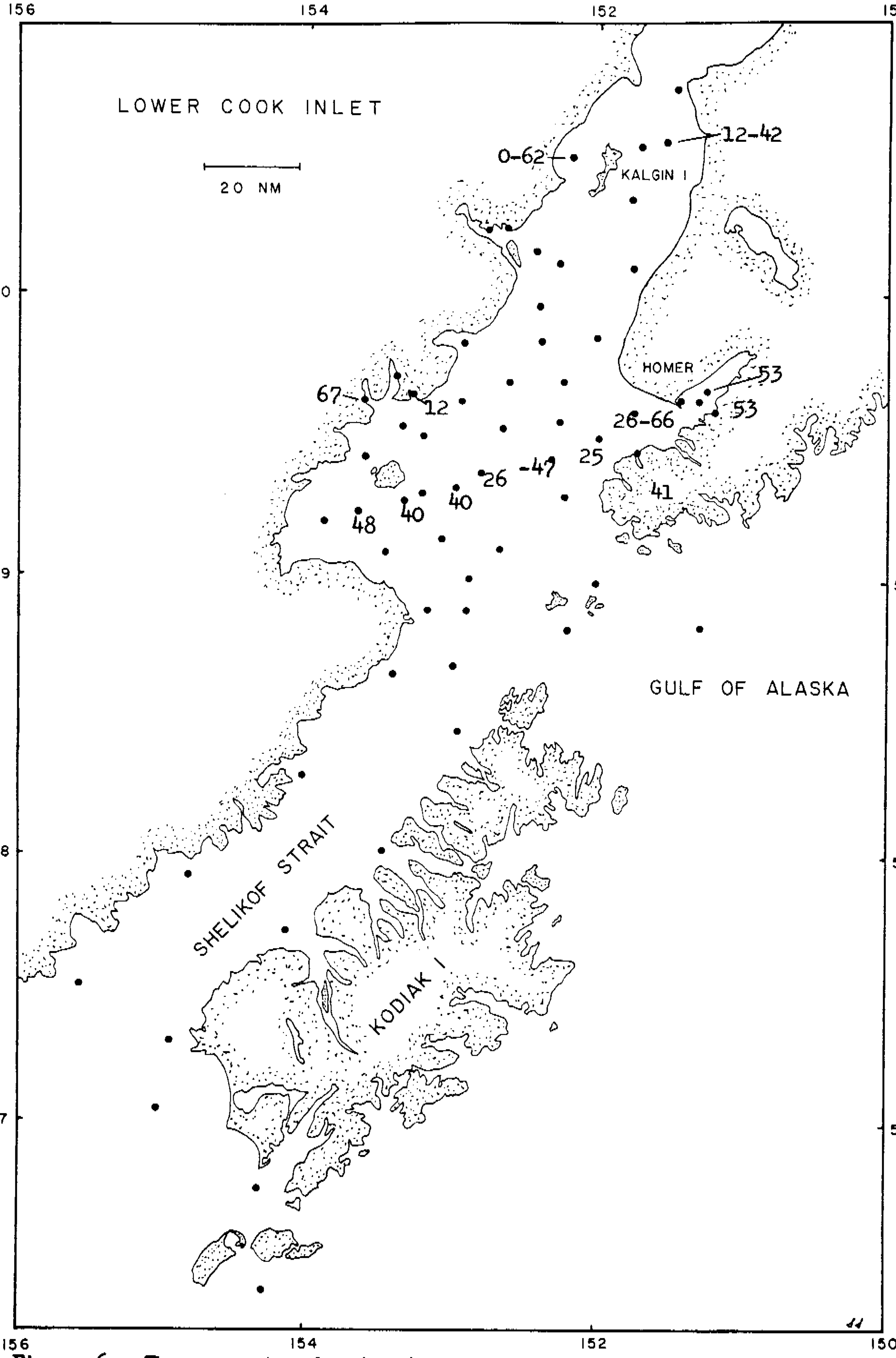


Figure 6. The percent reduction in glutamate uptake rates in water samples exposed to crude oil relative to nonoiled controls.

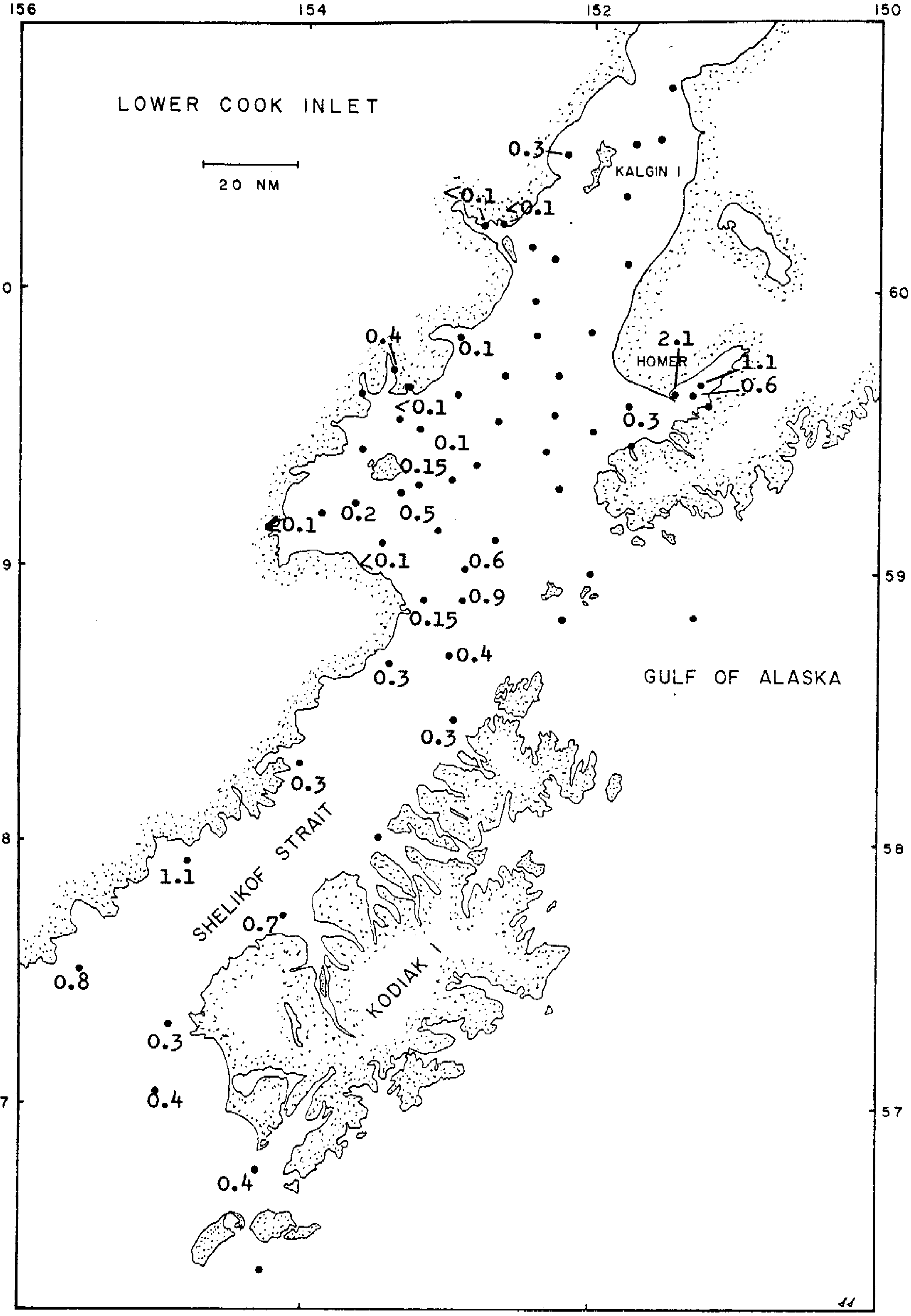


Figure 7. Nitrogen fixation rates in sediment samples collected during the April, 1978 Cook Inlet cruise. Units used are ng N_2/g dry wt./h.

Table 5. Summary of station numbers, station position, water column depth, and salinity and temperature measurements made during the April, 1978 Cook Inlet cruise.

Station #	Sample #	Temp. Surf.	Temp. Bottom	Salinity Surf.	Salinity Bottom	Lat.		Long.		Depth.
330	GW601	4.47	4.48	32.222	32.227	56	22.3	154	17.9	44
331	GW602	3.52	3.51	32.059	32.065	56	46.0	154	20.3	52
333	GW603	4.88	4.46	31.973	32.418	57	04.2	155	01.2	188
358	GW604	4.45	4.51	32.049	32.397	57	18.1	154	56.0	148
350	GW605	4.42	4.57	31.903	32.470	57	31.2	155	33.8	265
360	GW606	4.44	4.51	31.766	32.406	57	56.2	154	40.6	228
368	GW607	4.59	4.38	32.134	32.291	57	43.9	154	09.0	53
378	GW608	4.93	4.62	32.108	32.392	58	01.3	153	29.6	82
370	GW609	3.97	4.65	31.468	31.977	58	17.2	154	01.9	112
380	GW610	3.88	3.99	31.425	31.500	58	38.9	153	24.7	-
394	GW611	4.55	4.67	31.928	32.281	58	40.9	153	00.5	153
388	GW612	4.93	4.58	32.026	32.420	58	27.2	152	58.0	215
395	GW613	4.73	4.70	31.915	32.247	58	53.2	152	54.9	166
207	GW614	4.77	4.80	31.980	32.120	58	59.9	152	53.3	166
390	GW615	3.81	4.67	31.262	32.121	58	52.7	153	11.1	170
229	GW616	4.66	4.17	51.557	31.688	59	39.9	151	14.8	38
249	GW617	-	-	31.854	-	59	51.3	152	01.6	40
246	GW618	-	-	31.749	-	60	05.5	151	45.7	33
266	GW619	-	-	27.266	-	60	42.7	151	25.5	43
265	GW620	-	-	29.993	-	60	34.9	151	41.9	16
255	GW621	3.26	3.25	30.023	30.026	60	19.3	151	46.5	42
242	GW622	3.72	3.69	30.778	30.781	60	09.0	152	25.7	36
245	GW623	3.78	3.78	30.574	30.756	60	06.3	152	15.5	84
247	GW624	3.96	3.97	30.741	30.755	59	58.1	152	34.4	21
233	GW625	3.87	3.88	31.022	31.023	59	49.7	152	56.0	15
248	GW626	3.76	4.38	30.948	29.663	50	50.1	152	24.2	70
203	GW627	4.08	3.99	29.987	31.085	59	06.3	153	27.8	41
201	GW628	4.29	4.26	30.708	30.739	59	12.5	153	52.9	20
204	GW629	3.89	3.89	31.228	31.232	59	14.1	153	39.5	34
214	GW630	4.08	4.26	31.512	31.666	59	17.9	153	13.2	53
211	GW631	4.01	4.03	31.255	31.300	59	26.1	153	37.0	20
212	GW632	4.00	4.02	31.243	31.273	59	32.7	153	20.9	26
*V	GW633	4.0	-	30.5	-	60	13.4	152	45.6	-
*U	GW634	4.0	-	29.0	-	60	12.8	152	36.0	-
234	GW635	4.14	4.13	31.277	31.276	59	37.8	152	55.8	36
213	GW636	4.20	4.16	31.354	31.362	59	29.6	153	13.9	33
225	GW637	4.43	4.46	31.734	31.743	59	31.5	152	39.6	61
235	GW638	4.11	4.19	31.157	31.225	59	42.6	152	37.3	39
236	GW639	4.79	4.79	31.909	31.888	59	41.7	152	14.2	37
226	GW640	4.73	4.74	31.909	31.903	59	32.8	152	18.3	49
216	GW641	4.81	4.81	31.917	31.936	59	18.1	152	15.4	80
205	GW642	4.81	4.89	31.884	32.034	59	06.7	152	40.0	140
206	GW643	4.81	4.88	31.871	31.971	59	08.7	153	05.0	84
390	GW644	4.44	4.98	31.544	32.104	58	53.4	153	11.6	62
398	GW645	5.09	5.01	32.203	32.249	58	49.0	152	12.3	126

Table 5. (Cont'd.)

Station #	Sample #	Temp. Surf.	Temp. Bottom	Salinity Surf.	Salinity Bottom	Lat.		Long.		Depth.
105	GW646	5.04	5.11	32.100	32.430	58	49.7	151	19.3	118
106	GW647	4.92	5.11	31.920	32.311	59	00.6	152	01.2	201
*AA	GW648	5.0	-	28.0	-	59	39.5	153	16.5	-
*AW	GW649	5.5	-	27.2	-	59	38.0	153	37.8	-
*M	GW650	8.0	-	27.6	-	59	43.3	153	22.6	-
*J	GW651	4.0	-	31.2	-	59	34.6	151	11.0	-
229A	GW652	5.99	4.29	31.426	31.778	59	37.8	151	18.4	64
CB1	GW653	4.40	4.37	31.368	31.369	59	13.7	153	40.1	31
CB2	GW654	-	-	-	-	59	16.6	153	20.3	36
CB3	GW655	-	-	31.875	-	59	19.9	152	58.3	-
CB4	GW656	-	-	31.940	-	59	23.3	152	38.7	-
CB5	GW657	-	-	31.965	-	59	25.6	152	19.4	-
CB6	GW658	-	-	31.850	-	59	31.9	512	00.6	-
CB7	GW659	5.60	4.84	31.774	31.836	59	35.4	151	45.9	51
CB7	GW660	5.32	5.13	31.765	31.790	59	35.4	151	45.9	51
CB7	GW661	5.76	4.92	31.778	31.836	59	35.4	151	45.9	51
*AB	GW662	5.0	-	29.5	-	59	27.6	151	43.2	-
CB7	GW663	5.30	5.11	31.769	31.790	59	35.4	151	45.9	51
CB7	GW664	5.73	4.87	31.776	31.832	59	35.4	151	45.9	51
CB7	GW665	5.42	5.15	31.688	31.790	59	35.4	151	45.9	51
CB7	GW666	5.87	4.97	31.809	31.839	59	35.4	151	45.9	51
CB7	GW667	5.37	5.20	31.766	31.796	59	35.4	151	45.9	51
CB7	GW668	5.54	5.08	31.798	31.826	59	35.4	151	45.9	51
*K	GW669	6.0	-	29.0	-	59	36.5	151	25.5	-
CB10	GW670	4.11	4.11	29.514	29.509	60	31.5	151	30.9	24
CB10	GW671	-	-	-	-	60	31.5	151	30.9	24
CB10	GW672	4.19	4.12	29.579	29.559	60	31.5	151	30.9	24
CB10	GW673	4.41	4.30	29.277	29.262	60	31.5	151	30.9	24
CB10	GW674	4.24	4.24	29.480	29.482	60	31.5	151	30.9	24
CB9	GW675	4.70	4.70	30.664	30.661	60	28.2	152	12.2	37
CB9	GW676	4.70	4.70	30.442	30.474	60	28.2	152	12.2	37
CB9	GW677	4.92	4.75	30.461	30.681	60	28.2	512	12.2	37
CB9	GW678	4.77	4.74	30.522	30.479	60	28.2	152	12.2	37
CB9	GW679	4.81	4.82	30.639	30.644	60	28.2	152	12.2	37
CB9	GW680	4.94	4.78	30.220	30.595	60	28.2	152	12.2	37
CB9	GW681	4.89	4.84	30.529	30.634	60	28.2	152	12.2	37
CB9	GW682	4.84	4.77	30.364	30.480	60	28.2	152	12.2	37
CB9	GW683	5.12	4.91	30.474	30.619	60	28.2	152	12.2	37

*Shore stations

QUARTERLY REPORT

Contract 03-5-022-56
Task Order 8
Quarter Ending: 6/30/78

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

June 30, 1978

QUARTERLY REPORT

I. Task Objectives This Quarter

A. To conduct field work in NEGOA, Kodiak, LCI, and Bering Sea study areas.

B. To begin processing of materials collected in this quarter.

II. Field and Laboratory Activities

A. Field Trip Schedule

1. 3-7 April (Fay) Investigation of sea lion abortions, Cape St. Elias, and Survey of beached mammals, Cordova-Kayak Island.

2. 6-20 April (Fay, Shults, Murray) Necropsy of collected specimens and surveys of beached carcasses, LCI and Kodiak, via Surveyor 78A leg IV.

3. 1-19 May (Shults, Kelly) Necropsy of collected specimens, Bering Sea, via Surveyor 78A leg V.

4. 20 May-16 June (Fay, Shults) Necropsy of collected specimens and surveys of beached carcasses, Bering Sea, via Surveyor 78A leg VI.

5. 21 May-15 June (Murray) Interview survey of beached mammals, Cook Inlet.

6. 27-31 May (Dieterich) Survey of beached mammals, Alaska Peninsula, via UH-1H helicopter.

7. 30 May-30 June (Kelly) Survey of beached mammals, Tugidak Island.

8. 19 June-5 July (Shults, Ritter) Necropsy of collected speciments and surveys of beached carcasses, NGOA, via Surveyor 78A leg VII.

B. Laboratory Activities

Collected samples were shipped to Fairbanks, were they were stored, pending the return of project personnel from the field or forwarded to appropriate laboratories for analysis.

C. Methods

Necropsy of collected specimens and of beached carcases was by standard methods, described previously. All beached mammal surveys were via helicopter at elevations of about 100 to 150 ft.

III. Results

As of 16 June, a total of 96 collected specimens of the following species had been necropsied this quarter:

Steller sea lion, *Eumetopias jabatus*	8
Pacific harbor seal, *Phoca vitulina richardsi*	18
Spotted seal, *Phoca largha*	21
Ringed seal, *Phoca hispida*	6
Ribbon seal, *Phoca fasciata*	30
Bearded seal, *Erignathus barbatus*	13

These were specimens taken primarily for the purposes of other OCSEAP projects (R.U. #229, 230, 232, 243) and utilized by this project on a cooperative basis.

A total of about 875 nm of beaches were surveyed for dead and moribund marine mammals. The number of mammals found was low, relative to findings during summer and autumn surveys. The actual numbers will not be known until all personnel have returned from the field with their reports. Necropsies were performed on at least 13 speciments, as follows:

Belukha, *Delphinapterus leucas*	1
Steller sea lion, *Eumetopias jubatus*	1
Walrus, *Odobenus rosmarus*	6
Harbor seal, *Phoca vitulina richardsi*	1
Sea otter, *Enhydra lutris*	4

IV. Preliminary Interpretation of Results

The kinds and frequencies of occurrence of gross pathological conditions seen in the collected specimens did not appear to be remarkably different from those seen in previous years' collections. The numbers of beached carcasses, their distribution, and their composition by species and age were about as indicated by early spring surveys in previous years.

V. Problems Encountered/Recommended Changes

None.

VI. Milestone Chart

One activity scheduled for this quarter was deleted: "Norton Sound collections and necropsies (NOAA helo)". This was due to a change in the helicopter schedule in that area and inability of project personnel to adjust to that change, due to other scheduled commitments. However, two other activities were added: "Tugidak Island stranding survey" (still underway, in conjunction with other field work in that area), and "Cook Inlet Interview survey of strandings" (just completed).

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

MAJOR MILESTONES	1977 O	N	D	1978 J	F	M	A	M	J	J	A	S	O	N	D		
NEGOA collections and necropsies (SURVEYOR)	▲																
NGOA/PWS collections and necropsies (RESOLUTION)		▲															
C. St. Elias sea lion study (charter)							▲										
LCI-KODIAK collections and necropsies (SURVEYOR-IV)							▲										
Bering Sea collection and necropsy (SURVEYOR-V)								▲									
Bering Sea collection and necropsy (SURVEYOR-VI)									▲								
Bristol Bay stranding survey (UH1H)								▲									
Cook Inlet interview survey of strandings									▲								
Tugidak Island stranding survey									▲								
GOA collections and necropsy (SURVEYOR-VII)										△							
Bristol Bay stranding survey (charter)										△							
Kodiak collection and necropsy (Pitcher charter)											△						
LCI stranding survey (SURVEYOR/helo)											△						
St. Lawrence I. stranding survey (charter)												△					
Kodiak collection and necropsy (SURVEYOR)												△					

△ Planned completion date ▲ Actual completion date

Quarterly Report

Contract #: 03-7-022-35140
Research Unit: 196
Report Period: 1 April - 30 June 1978
Number of Pages: 2

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

George J. Divoky
Principal Investigator

Assisted by:

A. Edward Good
Kenneth Wilson
Douglas A. Woodby

Point Reyes Bird Observatory
4990 Shoreline Highway
Stinson Beach, California 94970

July 1, 1978

I. Task Objectives

Determine the relationship of pelagic seabirds to the ice environment on a seasonal basis.

II. Field Activities

A. Ship and field trip schedule

Dates	Ship & Location	Personnel
8 April - 1 May	THOMPSON Bering Sea	Woodby
2 May - 19 May	SURVEYOR Bering Sea	Divoky, Good and Wilson
22 May - 15 June	SURVEYOR Bering Sea	Good and Wilson

B. Data collected

THOMPSON cruise

15 - minute transects	= 230

First SURVEYOR cruise

15 - minute transects	= 254
Specimens collected	= 28

Second SURVEYOR cruise

15 - minute transects	= 312
Specimens collected	= 121

III. Results

None

IV. Preliminary interpretation of results

None

V. Problems encountered

None

VI. Estimates of funds expended

Expenditure estimates not available at this time

Research Unit #204
Reporting Period-April 1-
September 30

Quarterly Report

OFFSHORE PERMAFROST STUDIES, BEAUFORT SEA, ALASKA

By

D. M. Hopkins

United States Geological Survey
Menlo Park, California

Research Unit # 204: Quarterly Report, April-May-June, 1978

OFFSHORE PERMAFROST STUDIES, BEAUFORT SEA, ALASKA

I. Abstract of Highlights:

D. M. Hopkins visited offices of the Geological Survey of Canada in Ottawa on April 25 and 26 to compare notes on the distribution of offshore permafrost on Canadian and Alaskan segments of the Beaufort Sea shelf and to discuss the source of the exotic boulders that are scattered on the Alaskan shelf and that appear as ice-rafted boulders in exposures of the Pleistocene Flaxman Formation along the coast.

Hopkins later spent one week in Hanover, N.H. at CRREL (May 8-12), integrating his results with those of the CRREL investigators.

Completion of amino-acid racemization studies from samples collected from borehole PB-2, several vibracore samples collected by Reimnitz and Barnes, and samples from several outcrops along the Beaufort Sea coast. Comparison shows that sediment from PB-2 is very old, probably deposited during an interglacial period.

II. Task Objective: D-9

III. Field and Laboratory Activities:

A. Field Activities: None

B. Scientific Party:

D. M. Hopkins, geologist and Principal Investigator

P. S. Smith, technician, pick radiocarbon samples

C. Methods of Analysis:

Radiocarbon dates in progress

Synthesis of field observations and laboratory data

D. Sample Localities:

As in previous Quarterly reports (seven offshore boreholes and one onshore borehole in the Prudhoe Bay area)

E. Data Collected or Analyzed:

Completion of amino-acid racemization studies

IV. and V. Results and Interpretation:

Studies conducted during the early 1970's near Point Barrow by R. E. Lewellen (funded by the Office of Naval Research) and on the Canadian segment of the Beaufort Sea shelf by the Canadian Department of the Environment showed that, contrary to expectations, permafrost is widely distributed offshore. The permafrost is evidently largely relict. Calculations by Lachenbruch (R.U. 204) and Osterkamp and Harrison (R.U. 253) indicate that the prolonged persistence of permafrost on the continental shelf must indicate a considerable ice content distributed through a thick vertical section. Osterkamp and Harrison showed that salt advection and salt diffusion may also play a considerable role in the rate at which ice-bonded permafrost is dissipated after submergence. Ice-rich permafrost in sub-sea sediments can pose a serious hazard to the integrity of structures associated with the exploration, recovery, and transportation of petroleum on the continental shelf, and so a joint effort by the U.S. Army Cold Regions Research and Engineering Laboratory (R.U. 105) and the U.S. Geological Survey (R.U. 204) was undertaken to determine the temperature, ice- or water-content, pore-water chemistry, lithology, and engineering characteristics of sub-bottom sediments on the Beaufort Sea shelf in and near Prudhoe Bay.

During spring, 1976, four boreholes ranging in depth from 15 to 50 m were completed, and experiments were conducted by some of the CRREL participants in order to develop a probe technique that would let us quickly and cheaply extend the results obtained by drilling. In spring, 1977, five additional boreholes were completed, and many probe holes were punched down, giving us a detailed three-dimensional picture of the distribution of thawed ground and underlying permafrost in and near Prudhoe Bay. Our efforts were focused in the Prudhoe Bay area mainly for logistic reasons, but the information obtained can be generalized to other parts of the Beaufort Sea shelf. We felt some pressure to distribute our study over a larger area. However, the intense local variability of permafrost only became apparent as a result of concentration of our effort in this critical area. Our boreholes are supplemented by a series of auger, probe, and water-jet holes by Osterkamp and Harrison (R.U. 253) and by seismic reflection and refraction profiles by J. C. Rogers (R.U. 271). The distribution of ice-bonded permafrost and of surficial fine-grained sediments encountered in the boreholes can be related to studies of bottom sediments by E. Reimnitz and P. Barnes (R.U. 205).

Taken together, these surveys have begun to provide us with a good picture of the distribution of sediment types and of the distribution of permafrost in the area immediately offshore from Prudhoe Bay and the Sagavanirktok River delta. A model for the distribution of offshore permafrost can now be constructed to be tested by drilling in other parts of the lease area.

Drilling has shown that much of the Beaufort Sea lease area is mantled by about 10 m of dense, tough, overconsolidated silt and clay containing scattered ice-rafted boulders and commonly littered by a boulder residuum. Similar material is exposed at many points on the coast, where it is known as the Flaxman Formation. The overconsolidated clay is ancient, probably ranging in age from about 30,000 to about 125,000 years. It was exposed to cold air temperatures during the last reduction in sea level, when the shoreline evidently lay somewhere seaward of the 20-m isobath.

Much softer marine fine sand, silt, and clay ranging in thickness from 1 to 10 m occupies a much smaller part of the shelf. This material seems to occupy shallow valleys carved by removal of the overconsolidated clay and a little of the underlying gravel, which forms a sheet at least 100 m thick throughout the inner shelf. It consists of marine mud deposited down-current from the present-day rivers during the past few thousand years.

The drilling, probing, and seismic studies have established that ice-bonded permafrost is present almost everywhere on the Beaufort Sea shelf seaward to at least the 20-m isobath, but depths to the top of the ice-bonded layer are extremely variable. Permafrost is no more than a few meters below the bottom in recently submerged areas and in shoals shallow enough for winter sea ice to rest on the bottom. Permafrost lies at variable depths but is commonly shallower than 20 m and locally as shallow as 8 or 10 m in the overconsolidated silt and clay. In the sea valleys filled with Holocene sediment, however, permafrost lies tens of meters and in some places more than 100 m below the bottom.

These observations suggest the following model to explain and predict the distribution of permafrost on the Beaufort Sea shelf.

During the height of the world-wide continental glaciation about 18,000 years ago, sea level was lowered. The Bering Sea shelf was exposed seaward to about the present-day 90-m isobath. The position of the shoreline in the Beaufort Sea 18,000 years ago is not yet established, but lay somewhere seaward of the 20-m isobath. The cover of ancient marine silt and clay became frozen as did the underlying gravel. The total thickness of bonded permafrost formed at any particular place depended partly upon the duration of exposure to subaerial temperatures, but thicknesses of several hundred meters were formed in most areas of the shelf landward of the present 20-m isobath.

The major rivers from Alaska aggraded and formed outwash fans extending across much of the present-day coastal plain, but the edges of most fans lay within a kilometer inland of or seaward of the present coast. Seaward from the edges of the fans, the rivers removed the ancient marine silt and clay to form broad, shallow valleys graded to the shoreline of the time. By analogy with the braided gravel floodplains of present-day North Slope rivers we may assume that the top of the ice-bonded layer lay at depths of several tens of meters beneath the river channels but at depths of less than a meter beneath uplands mantled with overconsolidated silt and clay.

When sea level began to rise, the shallow valleys were flooded early. In the absence of a cover of ancient, overconsolidated marine silt and clay, the cold but salty sea water gained ready access to the underlying gravel. Ice in the gravel was thawed rapidly and deeply by salt advection. Ultimately these valleys began to collect Holocene marine sediment carried by currents from the river mouths.

When the sea transgressed over the slightly higher plains away from the sea valleys, salt water was prevented from gaining access to the potentially porous gravel substrate by the mantle of tight overconsolidated clay. Consequently, thawing of ice in the shallow bonded permafrost could progress only by heat diffusion and salt diffusion. The water temperatures are below zero, and salt diffusion progresses only slowly. Consequently, thawing has progressed extremely slowly and only to very limited depths in most areas mantled by the overconsolidated clay.

If this model is correct, then we can expect to find deep permafrost throughout the area of Holocene sediments shown by P. Barnes and E. Reimnitz as extending westward from the mouth of the Sagavanirktok River to a point northwest of Oliktok Point, where it is joined by another belt of Holocene sediment extending northward from the mouth of the Colville River to the shelf break. We should expect to find similar belts of Holocene sediment and deep permafrost in as-yet undiscovered sea valleys extending from the Shaviovik and Canning Rivers, and we should expect to find overconsolidated clay and shallow, potentially ice-rich permafrost in other parts of the Beaufort lease area.

R.U. 204

D. M. Hopkins visited office of the Geological Survey of Canada in Ottawa on April 25 and 26 to compare notes on distribution of offshore permafrost on Canadian and Alaskan segments of the Beaufort Sea shelf and to discuss the source of the exotic boulders that are scattered on the Alaskan shelf and that appear as ice-rafted boulders in exposures of the Pleistocene Flaxman Formation along the coast. Discussions were held with Jean-Serge Vincent (Quaternary geology of the Banke Island), Vernon Rampton (Quaternary geology of the coast of the Yukon and Northwest Territories), Tom Frisch (bedrock geology of Ellesmere Island), and Fred Campbell (bedrock geology of the Slave Province of northwestern Canada). Boulders from the Flaxman Formation and the Alaskan shelf were displayed and compared with erratic boulders from Banks Island and with some hand specimens from Canadian sources.

The Canadian Quaternary geologists demonstrated that ice tongues on the MacKenzie Valley and the Amundsen Gulf were relatively thin in late Quaternary time and were not likely to have been involved in an Arctic ice shelf extending to the longitude of Prudhoe Bay and Barrow. Many of the exotic rock types of the Beaufort Sea shelf could come from either the Amundsen Gulf region or from Ellesmere Island. One minor but persistent type--a banded cherty dolomite--seems definitely to be derived from the Dismal Lake Group, a pre-Cambrian rock unit from the Slave Province southeast of the Amundsen Gulf. On the other hand, the common ultramafic rocks seem more likely to come from Ellesmere Island.

Hopkins later spent one week in Hanover, N.H., at CRREL (May 8-12) integrating his results with those of Paul Sellman, Ed Chamberlain, and Scott Blouin. While there, he learned of an observation by Austin Kovaks (R.U. 88), of large, angular blocks of an andesite breccia on multi-year ice during a helicopter flight northwest from Narwhal Island. With the help of Canadian geologists, Kovaks was able to establish that this multiyear ice had originated in Disraeli Fjord, Ellesmere Island, and was carrying material derived from a rock fall from the nearly vertical walls of the fjord.

Inquiries thus far seem to indicate that the ice-rafted boulders in the Flaxman Formation and scattered as a residuum on the sea floor are derived from both Ellesmere Island and the Amundsen Gulf region.

VI. Problems Encountered and Recommended Changes:

No insurmountable problems encountered.

VII. Estimate of Funds Expended to Date: All

VIII. Bibliography: None

QUARTERLY REPORT

Contract: RK6-6074
Research unit: 205
Reporting period: April 1 - June, 30, 1978

MARINE ENVIRONMENTAL PROBLEMS IN THE ICE-COVERED BEAUFORT SEA SHELF AND COASTAL REGIONS

Peter Barnes

Erk Reimnitz

Pacific-Arctic Branch of Marine Geology
345 Middlefield Road
Menlo Park, California 94025

1 July, 1978

Ru-205 - P. Barnes - E. Reimnitz - U.S. Geological Survey

INTRODUCTION

This abbreviated quarterly report consists of four parts: a report of field activities and three attachments.

Attachment A- Comparative bathymetric map of the Alaska Beaufort Sea shelf

Attachment B- Eolian sand deflation; a cause for gravel barrier islands in the arctic?

Attachment C- Metamorphosis of the twenty-meter contour

There have been no insurmountable problems, nor changes in program plans and goals during the last quarter.

FIELD ACTIVITIES:

Field studies on the fast ice, as a part of our objective to study the configuration of the undersurface of undeformed first-year ice (P-5, task), were undertaken in the Prudhoe Bay area from 29 April to 15 May.

SCIENTIFIC PARTY

P. Barnes	U.S. Geological Survey, Geologist
E. Reimnitz	U.S. Geological Survey, Geologist
L. Toimil	U.S. Geological Survey, Geologist
H. Hill	U.S. Geological Survey, Electronics Technician
W. Harrigan	N.O.A.A. Pilot
R. Nield	N.O.A.A. Mechanic

Three differing ice and oceanographic environments were chosen for the main experiments; one in the shallow protected environment of Prudhoe Bay, one in the deeper, more open section of Stefansson Sound, and one in the deep and narrow scour inlet to Simpson Lagoon between Egg Island and Long Island (Fig. 1). A road was plowed to each site and a cross on the ice was cleared, oriented so one arm was perpendicular to the sastrugi pattern. A mechanical ditching machine was used to cut a 20 cm wide trench through the ice in the center of the plowed cross. Each trench was 100 m long. A 1.5 x 1.5 m block was also cut out with the ditcher and the ice block lifted out with a fork lift. The ditcher left the bulk of the ice chips in the trench, thus a tedious task of "mucking out" the trenches and dive hole ensued. After final clearing and cleaning a sled carrying the sensors, electronics and recorders was propelled back and forth in the trenches. These sensors included upward directed side-scanning sonar and precision fathometer, pressure transducers, and underwater television. In addition, snow depth, ice thickness and free board were measured. Aerial photos were also obtained at each site. We also carried on several ancillary observations during this same field effort (Fig. 1).

1) Aerial examination was carried out at the stamukhi zone, in particular over the shoals to the northwest of Prudhoe Bay.

2) Ice cores were obtained with a sipre corer over a variety of fast ice environments in the Prudhoe Bay Area (Fig. 1). Sub-ice temperature and salinity were also measured. These cores were subsampled for sediment content.

3) Ice level recorders were placed on the floating ice at three sites to measure the tidal and non-tidal motion of the fast ice. In addition an Aanderaa pressure gauge was used at the site off the west dock to determine if there was any discrepancy between water level and ice level.

4) An Aanderaa current meter was emplaced 1 m below the ice in the dive hole at the Stefansson Sound site for three days between 12 and 15 May.

5) Snow and sediment samples were gathered downwind from Egg Island to assess the importance of deflation as a process influencing the barrier island regime.

6) Time lapse photography was obtained from the vicinity of the West Dock over most of the two week field effort. Our aim here was to assess the stability and fates of change of the sastrugi pattern on the ice.

Preliminary Observations

The problem of how the shoals of the stamukhi zone interact with ice to control ice zonation is critical to ice management in the seaward part of the lease area. During the past winter there was no multi-year ice on the shelf during freeze-up. Our observations this spring showed massive ridges composed of first year ice clearly associated with shoals northwest of Prudhoe Bay. We also recovered sediments from the stamukhi ridges containing marine shells suggesting displacement from the nearby sea floor. An enigma exists where first year ice, not nearly thick enough to contact the crests of shoals, focused the major ridge building over these bathymetric features.

Apparently freeze-up in the fall of 1977 was accompanied by considerable turbulence as most of the ice cores (Fig. 1) cortained significant quantities of particulate material over 10 to 100 cm of the core length. The ice contained vastly larger concentrations of sediment than in the winters of 1971-72 and 1972-73 when we drilled many holes in the fast ice. The quantity and distribution of material remains to be determined, however the significance in terms of redistribution, retention and ice rafting of potential pollutants is obvious.

Vertical tidal motions of the sea ice on the order of 15 to 20 cm were observed at the inlet to Simpson Lagoon and off the West Dock. Inside Prudhoe Bay no ice motion was observed which strongly suggests that our earlier conclusions that the Prudhoe Bay channel remains open in winter is incorrect.

Windblown sand desposited with snow downwind from the gravel barrier islands was of sufficient quantity to suggest deflation of the islands by about 2 mm during the past winter. Wind erosion of the fines may partially explain the coarse texture of these islands, and is further evidence of their ephemeral nature.

The time lapse photography covered several days of record with wind velocities above 20 knots when considerable snow was in transit. The imagery suggests that, in addition to the blowing clouds of snow, transient bedforms of snow are moving across a more stable semi-permanent sastrugi pattern. This may be related to the ice thickness patterns discussed below.

Data from each of the main sites shows that the significant variaton in the fast ice thickness (up to 30 cm) is associated with a ridge and runnel pattern which in turn shows good correlation with the overlying sastrugi pattern. The wave lengths are on the order of 10 to 20 m with swales in the sastrugi pattern corresponding to the thicker sections of ice. This suggests that there is some permanence to the sastrugi pattern although close examination of the snow surface shows abundant evidence of cut and fill patterns suggesting migrating bedforms - another enigma.

Diving observations on the undersurface of the ice were surprisingly similar at the three distinctly different environments. The broad undulations seen by side-scan and upward looking sonar are not visible to the eye, even with 5-10 m visibility. Smaller undulations, forming 5 to 8 cm deep diver-exhaust air pools with 2 to 5 m diameter, were observable only because of the trapped air. The smallest air pools marked 2 x 10 cm long depressions that are about 0.5 to 1 cm deep, and oriented parallel to the ice crystal fabric. Under proper lighting this fabric was distinct, and over distances of 1 to 3 m, parallel. Randomly distributed ice stalactites, about 2 m apart, and 3 to 50 cm long were the most distinct features. These stalactites consist of a very fragile crystal matrix. The large ones apparently have hollow cores. The stalactites mark brine channel openings of various dimensions from 0.5 to 7 or 8 cm in diameter (large enough to insert all four fingers of a gloved hand). One of the stalactites we observed closely was about 10 cm long and was actively spilling brine from the tip which appeared as a plume, 10 to 20 cm long, marked by light diffraction. The large stalactites obviously were the result of our activities as we supplied much sea water to the ice surface during trenching and mucking. Under the prevailing conditions of open brine channels, our breath exhaust leaked through the fast ice very rapidly so that 3 m diameter, 5-8 cm deep pools disappeared in several minutes. Bubbling on the ice surface was observed by the diving tender.

Further data analysis will quantify and more closely delineate the preliminary observations outlined above. We were pleased with the ultimate success of the field effort and look forward to analyzing the data.

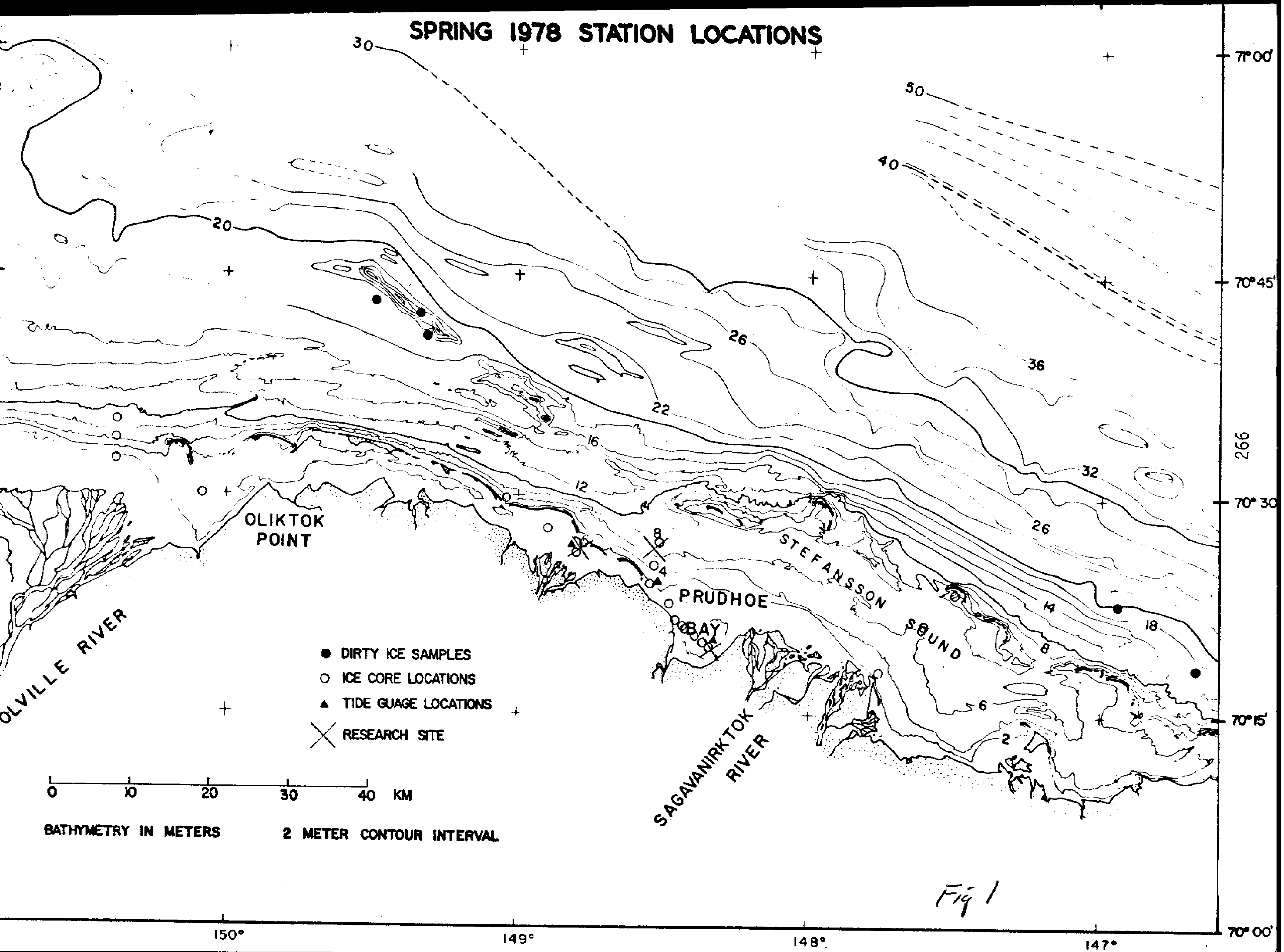

SPRING 1978 STATION LOCATIONS
OLIKTOK POINT
PRUDHOE BAY
STEFANSSON SOUND
COLVILLE RIVER
SAGAVANIRKTOK RIVER
DIRTY ICE SAMPLES
ICE CORE LOCATIONS
TIDE GUAGE LOCATIONS
RESEARCH SITE
0 10 20 30 40 KM
BATHYMETRY IN METERS
2 METER CONTOUR INTERVAL
71°00'
70°45'
70°30'
70°15'
70°00'
150°
149°
148°
147°
30
50
40
20
26
36
22
16
12
32
26
8
4
14
18
8
6
2

Fig 1

New Bathymetric Map of the Alaskan Beaufort Sea Shelf

Peter Barnes, David McDowell

BACKGROUND - DATA SOURCES, AND METHODS

The surface morphology of the sea bed has always been a prime ingredient in the marine geologist's interpretaton of the geologic environment of a particular area. In the Beaufort Sea, the existing charts and bathymetric data has been, and to a large part still is, rather crude and imprecise, often raising as many geologic questions as answers. There are many "reported" shoals between 10 and 25 m of water that have "appeared" since the initiation of marine transport to the oil field at Prudhoe Bay (NOS Chart 16004). Several of our own sounding lines have found features not charted and conversely, we could not always locate features that were reported by earlier surveys. In the work of the earlier hydrographers they noted "holidays" in their data due to the persistance of grounded ice in certain regions when they were trying to gather data. Recently we have suggested that there is a definite relationship between ice zonation and the configuration of the coast and sea floor (Reimnitz and others, 1977). Thus when a new unified set of well controlled bathymetric data became available, we were anxious to examine the shelf morphology to compare these data with earlier surveys, and to make further analyses of geologic processes in line with what we know of movement of ice and water.

During 1973, ice conditions were ideal for an extensive survey of the shelf of the Alaskan Beaufort Sea and a rather complete set of bathymetric records from the shelf break to the 15-20 m isobath was obtained by the Geophysical Corporation of Alaska in conjunction with running precisely controlled seismic operations (inset in Fig. 1). Lateral control for the survey was accurate to ± 50 m. The fathometer trace could be read to the nearest 0.5 fathom and has a reported accuracy of 2%. The velocity of sound used in computing depth was 4750'/sec (written commun., Resource Marketing Services, 1977).

The original GCA data was in the form of 1:96,000 UTM charts with data points every 2000 m plotted in feet to the nearest 0.5 fathom (3 ft). Subsequently this data was digitized for computer storage, then retrieved as a plot at 1:350,000 on a Mercator projection. Depths on this plot were converted from feet to the nearest meter. The depth data was contoured at 2 m intervals and a shoreline added from a projection of the 1:250,000, U.S.G.S. Alaska Topographic Series Maps. The Geophysical Corporation of Alaska data extended from approximately the shelf break to the 15-20 m isobath. Bathymetry inshore of the GCA data was taken from the 1:80,000 metrically contoured charts which were ultimately derived from the 1950-55 U.S. Coast and Geodetic Survey hydrographic work sheets (Reimnitz and others, 1972, Melchior, 1976). In addition, 1976 and 1977 bathymetric data from the R/V KARLUK was used to delineate shoal features northeast of Oliktok Point (Reimnitz and Maurer, 1978). The resulting 1:350,000 map was then photographically reduced to 1:700,000 for purposes of comparison.

It should be rather obvious from the variety of data sources, scales and quality, and the multiplicity of data transfers used, that the bathymetric map generated is not a precision product. We hasten to add, however, that its quality as a comparative and research document is more accurate than documents in use, primarily due to the continuity of the broad and precisely controlled data base.

COMPARISON WITH OLDER DATA

Comparison of bathymetric features between the 1975 compilation (Fig. 2) (primarily from 1950's Coast and Geodetic data as published on Chart 9403) and the 1978 compilation presented here (Fig. 1) (Primarily from the 1973 Geophysical Corporation of Alaska data) shows several new and significant features and some consistent shifts in isobaths.

In the eastern third of the 1978 map (145° to 148°) the contours inshore of the 20 m isobath and the sparse contours seaward of 100 m (145°) are within 2 km of the earlier map (Fig. 2). However, along 145° the 30, 40, 50 and 60 m contours consistently plot further seaward (up to 10 km) on the newer data set, suggesting an apparent shoaling of this part of the shelf. The maximum apparent shoaling amounts to 10 m. This discrepancy in isobath location and depth decreases to the west and the maximum observed in the vicnity of 148° was 4 km and 5 m.

In the central portion of the 1978 map (148° - 151°) the limited offsore data from the GCA survey is insufficient for comparison. Inshore the new data clearly delineate new shoals and topographic highs that are significantly changed from the earlier versions of the bathymetry. In particular Stamukhi and Cat Shoals (Reimnitz and Maurer, 1978) are delineated and located. Two other shoals in 24 - 18 m water depths north of the Colville River are also clarified on the 1978 data. The 18 - 26 m isobaths make an excursion well offshore compared to the rest of the shelf.

West of Harrison Bay toward Barrow (151° - 157°) the form of shelf bathymetry differs only slightly from the earlier data set although the GCA data is rather limited on this part of the shelf. The noselike protruberance of the shelf break northeast of Barrow is similar in shape and depth on both the 1978 and earlier maps.

SOME COMMENTS

The widely spaced sounding lines on the eastern and western portions of the 1978 GCA map grid (Fig. 1 - inset) show a much less complex bathymetry than is seen in the central portion of the Beaufort Shelf where the sounding lines of both the GCA data set and our own data are most concentrated. This suggests that the morphology of the shelf is perhaps oversimplified in poorly studied areas, simply due to a scarcity of sounding data. It is also possible, however, that the shelf morphology is fundamentally different in the eastern, central, and western portions of the shelf. This suggestion is supported when shelf profiles are compared. East of Prudhoe Bay the profile shows a gently sloping surface between 20 and 40 m and an apparent terrace between 40 and 50 m, while to the west of Cape Halkett the sea floor slopes gently from 10 m or less out to only the 30 m isobath before sloping more steeply to the shelf break. Additional bathymetric data will have to be gathered and analyzed before morphlogy can be completely interpreted.

SUMMARY

The new version of the Beaufort shelf bathymetry provides two main contributions. First, the overall morphology of the shelf takes another step towards its precise definition. Secondly, the presence of a string of major shoals stretching northwestward from Stefansson Sound to at least Cape Halkett is confirmed.

REFERENCES CITED

Melchior, John, 1976, Bathymetric contour chart, Tigvariak Island to Flaxman Island (Scale 1:80,000); in Barnes and others, Marine environmental problems in the ice-covered Beaufort Sea shelf and coataal regions, Quarterly report to NOAA, Environmental Assessment of the Alaskan Continental Shelf: Principal Investigators Reports, April-June, 1976, p. 724-728.

Reimnitz, Erk, Wolf, S.C, and Rodeick, C.A., 1972, Preliminary interpretation of seismic profiles in the Prudhoe Bay area, Beaufort Sea Alaska, U.S. Geol. Survey Open-file Report no. 548, 11 p.

Reimnitz, Erk, and Maurer, D.K., 1978, Stamukhi shoals of the arctic - some observations for the Beaufort Sea, in Barnes, P.W., and Reimnitz, Erk, Annual Report to NOAA, Environmental Assessment of the Alaskan Continental Shelf: Principal Investigators Reports, 10 p.

Reimnitz, Erk, Toimil, L.J., and Barnes, P.W., 1977, Arctic continental shelf processes and morphology related to sea ice zonation, Beaufort Sea, Alaska: AIDJEX BUll., v. 36 May, 1977, p 15-64.

ATTACHMENT B

EOLIAN SAND DEFLATION: A CAUSE FOR GRAVEL BARRIER ISLANDS IN THE ARCTIC?

by

Erk Reimnitz and Douglas K. Maurer

ABSTRACT

Eolian sand deposits are found on the fast ice downwind of gravelly barrier islands in the arctic. One small island exposure lost over 300 tons of sand in eight months, suggesting a deflation rate of 2 mm per winter. Wind winnowing of island surfaces is effective year round, while sediment suppy by waves is effective for only two to three months in the arctic. This suggests wind removal of sand as a possible mechanism to explain their coarseness relative to those of lower latitudes, where sand dominates.

INTRODUCTION

The need for enormous amounts of sand and gravel to develop the petroleum resources on the arctic shelf has focused attention on the chains of barrier islands along the North Slope of Alaska which are composed of sandy gravel. The problem of why the barrier islands of high latitudes are so different in particle size from sandy barrier islands of lower latitudes has received little attention.

Glaeser (1978) has taken a global view of the distribution of barrier islands in relationship to tectonic setting, availability of source materials, shelf physiography, and presence or absence of a flat coastal plain; but differences in physical environments and composition were not considered. Davies (1973) in his study of geographical variation in coastal development, has considered the importance of pebbles as a beach constituent on a global perspective. He showed that pebbles are of greatest importance on high latitude beaches, and are generaly lacking on those in lower latitudes. The direct and indirect effects of glaciation providing the coarse source material is emphasized as a factor causing this relationship. We will briefly consider this and several other possible causes for differences in particle size between high latitude and low latitude barrier islands, and then discuss our own observations that indicate eolian sand deflation during winter may be the most important single mechanism responsible for the anomaly.

REGIONAL SETTING

The barrier islands along the Beaufort Sea coast of Alaska are very low (1 to 2 m) and narrow (less than 100 m) sandy gravel islands, generally devoid of vegetation, which for about 9 months of the year barely protrude from a sea of ice and snow (Fig. 1). Morphological features related to ice-push can generally be seen on any island. It is mostly a fall phenomenon, involving ice less than .5 m thick. But in general, arctic beach morphology is primarily related to processes operating during the short open-water season (Wiseman et al. 1973) when the presence of sea ice allows only short small waves to develop. The seasonal fast ice forming around the islands reaches a thickness of 1.5 to 2 m by the end of the winter. Its surface generally slopes up slightly onto the beach face and where free-floating it has a freeboard of 10+ cm and is covered by about 10-20 cm of snow. In some years an ice foot develops on the foreshore, protecting it from winter processes. But even without an ice foot, one usually finds only the highest parts of the islands exposed.

GRAVEL COMPOSITION OF ARCTIC BARRIER ISLANDS AND POSSIBLE CAUSES

The barrier islands and beaches in the Alaskan Beaufort Sea are composed of sandy gravel (Rex, 1964; Naidu and Sharma, 1971; Labell, 1973; Wiseman et al., 1973, Burrell et al., 1974). Predominantly gravel barrier islands extend along the Alaskan coast south to the Arctic Circle. Possible explanations for the coarse natures of the islands are: 1) a high level of wave energy, 2) ice rafting 3) the source material for island construction is coarse, and 4) effects of glaciations. All of these are discounted rather readily:

1)The low level of wave energy in the high arctic, and the short time during the year when waves are active (Short, 1974, Wiseman et al., 1973) is the most obvious factor suggesting that the barrier island composition is anomalous.

2)Ice rafting has been shown to be of very little importance in the modern sedimentary environment of the Beaufort Sea shelf (Barnes and Reimnitz, 1974). Observations on the clean sand shoals of the stamukhi zone, where the ice residence time during the summer melt season is long (Reimnitz and Barnes, 1974; Reimnitz and Maurer, 1978) are directly applicable to the question of ice rafting as a cause for gravel barrier islands. The sand shoals receive no drop stones today, and therefore the barrier islands can not recieve a significant amount.

3) The rivers of the North Slope wind for a hundred kilometers across a barely sloping tundra surface and do not supply gravel to the marine environment, thus they are not a source for the gravel islands (Rodeick, 1975). In extreme contrast to this condition is the Copper River draining into the Gulf of Alaska. This torrential, alpine river carries a very large load of gravel to within a short distance from the sea, yet the barrier islands along its delta front are composed of sand (Reimnitz, 1966). Looking to the nearshore zone of the Beaufort Sea as a possible source of gravel, Barnes and Reimnitz (1974) report insignificant amounts, when viewed on a large scale. From numerous nearshore diving traverses we know that sediment distribution in detail is very patchy. Small amounts of surficial gravel can be found in spots but the bottom in general is covered with a muddy fine sand. Many of the barrier islands in arctic Alaska have formed by rapid thermal erosion of the Gubic Formation resulting in islands recently separated from the coastal plain by thermokarst collapse. The Gubic Formation contains scattered pebbles, but along most of the coast is muddy sand, with sand predominating. The change from predominantly chemical weathering in warm, humid regions of low latitudes to predominantly physical weathering, and consequently coarser products at high latitudes, may be partly responsible for the anomalous composition of

barrier islands. But, as pointed out above the potential sources for the construction of barrier islands provide plenty of sand and little gravel.

4)On a global scale Davies (1973) found a correlation between areas with a history of glaciation and beaches containing significant amounts of gravel. But if we look at Alaska as an example in more detail we find negative correlation. Along the Gulf of Alaska, where a number of tidal glaciers still supply coarse material to the sea and where very recent moraines are found on the inner shelf, the beaches are generally composed of sand. Proceeding northward along the Alaskan coast to the arctic regions where glaciers apparently did not reach the coast, the barrier islands change from sand to gravel.

The four possible causes for the gravelly nature of barrier islands in the arctic, briefly examined above, do not answer the question. Our observations suggest another possibility, that sand removal by wind is a mechanism by which normal barrier islands are turned into gravel.

WIND WINNOWING OF BARRIER ISLAND SURFACES IN THE ARCTIC

The crests of arctic barrier islands are exposed to wind-winnowing throughout the winter (Figs. 1 and 2), and such wind driven materials are commonly seen on the snow downdrift from the exposures. Leffingwell (1919, p. 176) reports that along this coast "Stones half an inch (1.25 cm) in greatest diameter have been observed on the sea ice a mile (1.6 km) from their probable source. They were scattered in a wide belt in the lee of a sand spit." We have only seen indirect evidence for eolian transport of such large clasts (Reimnitz and Barnes, 1974), but plumes of sand are a common sight. The dominant wind direction along the North Slope, as recorded by sediment plumes seen in LANDSAT images trailing away from oilfield roads and camps (Barnes and Reimnitz, 1976), by the sastrugi pattern, the orientation of elongate lakes, and by dunes on river flood plains, is from the northeast.

A sediment plume similar to the one shown in figure 2, was seen in early May, 1978 trailing away from the western part of Egg Island. As sketched from the air, the visible plume was .7 km wide and 1.7 km long (Fig. 3). The exposed source area on Egg Island was about .1 km^2, but some of this surface was covered by actively moving sastrugi. Several portions of the sediment plume were inspected on the lagoon ice. The snow thickness, measured at 35 spots at 5 m intervals, ranged from 8 to 47 cm, with a mean of 17 cm. Sand was found in about the upper 8 cm of the snow canopy. The lower portion appeared clean. On the snow surface the sand distribution was patchy due to higly active processes reshaping the sastrugi every few days. A small area about 20 m downwind from the island outcrop, was sampled and found to contain 421 gm/m^2 of sand, all within the upper 8 cm. The snow surface in this area is shown in figure 4.

In order to estimate the amount of sand contained in the Egg Island plume, we assumed a linear decrease in gm/m^2 from the sample site to zero at a point 300 m beyond the plume terminus visible from the air.

Our sketchy data show the plume contained 309 tons, or about 206 m^3 of sand, suggesting that the island was eroded down by about 2.3 mm.

The grain size distribution of the material sampled was determined by sieving, and the results are given as cumulative frequency percents in figure 5. The curve shows that Egg Island is being impoverished of very well sorted sand, with a mean of 1.83 ϕ and nearly normal grain size distribution (Folk, 1974).

DISCUSSION

We have not analyzed the grain size distribution of the source area on Egg Island, but observed it to be paved by a veneer of pebbles similar to that shown in figure 1, underlain by gravel with a sand matrix. The setting and processes around Oliktok (Fig. 3) are very similar, and therefore grain size distribution curves representing berm material from that area (Dygas, et al., 1972) can be related to the situation at Egg Island (Fig. 5). The beach berms stand highest, and remain best exposed during the winter. They consist of a bi-modal distribution of sand and gravel, from which the sand is being winnowed by wind. The significance of an estimated wind deflation rate of about 206 m^3 per winter to the sediment budget of Egg Island is not known, but it should be noted that the amount of sediment moved past the island by longshore transport is thought to be about $10^4 m^3/yr$ (Short, 1973), and most of the material being passed from island to island by this process would be sand.

A gravel pavement capping the barrier islands, if not disturbed, will eventually become thick enough to protect the island from further wind erosion. But the surface is occasionally modified by ice push and reworked by waves and currents during storm surges (Reimnitz and Maurer, 1978), bringing to the surface some of the remaining sand. Thus the rate of the process will slow down with time, as the islands become more gravelly.

We should not close without mentioning complications to this otherwise simple story. Not all islands had sand plumes visible from the air in the spring of 1978. This may be explained by a lack of good lighting on the days of overflight; or it may be that on days following a period of drifting snow, little sand is exposed on the surface. We did note that on one of the barrier islands a rather sandy gravel surface was damp during sub-freezing temperatures, and the material tasted salty. Thus the content of salt brine, which may be caused by salt spray from surf, may enter into the process. Surf action commonly is very variable from island to island due to patchy ice distribution in the previous summer thereby explaining changes in the effectiveness in wind erosion from one island to another. We were also puzzled by the lack of sand in the lower, firmer, and older portion of the snow blanket covering the sea ice. The sastrugi were measured to be migrating actively during an 18 day period of field work in early May, and probably does so all winter. Not knowing how a deposit consisting of a mixture of snow and sand moves during 25 knot or stronger winds, one might assume that sand concentrates in a layer at the base of troughs between sastrugi. This was not the case. As suggested by its position in the snow section, sand may only be a late winter contribution from the island.

Because of the dominant northeasterly wind on the North Slope, much of the sand eroded from barrier islands is deposited in lagoons behind islands. Along the Chukchi Sea much of the material is being blown out to sea. Small lakes on some of the islands catch eolian sand, as shown by the similarity between the grain size distributon of the Egg Island plume and lake sediments from Thetis Island (Dygas, et al., 972). Some barrier islands have small, rather deep lakes (4.5 m on Cross Island), which could be filled by largely eolian sand, resulting in a large lens of clean sand in a sandy gravel deposit.

CONCLUSION

The barrier islands of the arcitc are exposed to reworking by wave action, effective for only 2 to 3 months of the year, and sand removal by wind, effective all year. In this environment the balance of the sediment budget appears to be tilted toward sand removal. The result is a gravely composition of high latitude barrier islands, contrastng with a sandy composition at low latitudes. It may be that the end product is a result of thousands of years of wind winnowing suggesting that these features are very fragile and sensitive to exploitation by industry.

REFERENCES CITED

Barnes, P.W., and Reimnitz, Erk, 1974, Sedimentary processes on arctic shelves off northern coast of Alaska, in The Coast and Shelf of the Beaufort Sea: Proc. of the Arctic Institute of North American Symposium on Beaufort Sea Coast and Shelf Research, Arlington, VA., p. 439-476.

Barnes, P.W., and Reimnitz, Erk, 1976, Flooding of sea ice by the rivers of northern Alaska in ERTS-1 A New Window on Our Planet: U.S.G.S. Prof. Paper 929, p. 356-359.

Burrell, D.C., Dygas, J.A., and Tucker, R.W., 1973, Beach morphology and sedimentation of Simpson Lagoon in Environmental studies of an Arctic Estuarine System: Final Report # R 74-1: Institute of Marine Science, University of Alaska, 539 p.

Davies, J.L., 1973, Geographical variation in coastal development, Clayton, K.M., ed.: Hafner Pub. Co., New York, 204 p.

Dygas, J.A., Tucker, R., Naidu, A.S., and BUrrell, D.C., 1972, A preliminary sedimentological investigation of the Colville River and Oliktok Point coastal region in Baseline Study of the Alaskan Arctic Aquatic Environment: Institute of Marine Science, U. of Alaska, Report #R 72-3, p. 48-82.

Folk, R.L., 1974, Petrology of Sedimentary Rocks, Hemphill Pub. Co., Austin, TX, 182 p.

Glaeser, J.D., 1978, Global distribution of Barrier Islands in terms of tectonic setting: Journal of Geology, v. 86, no. 3, p. 283-297.

Labelle, J.C., 1973, Fill materials and aggregate near Barrow Naval Petroleum Reserve No. 4, Alaska: Arctic Institute of North America, Washington, D.C., 143 p.

Leffingwell, E. de K., 1919, The Canning River region, northern Alaska: U.S. Geol. Survey Prof. Paper 109, 251 p.

Moore, G.W., 1966, Arctic beach sedimentation, in Wilimovsky, N.J., and Wolfe, J.N., eds., Environments of the Cape Thompson Region, Alaska: U.S. Atomic Energy Comm., Oak Ridge, TN, p. 587-608.

Naidu, A.S., and Sharma, G.E., 1971, Texture, mineralogy and chemistry of Arctic Ocean sediments, Progress Report 1970-71#R 74-1: Institute of Marine Science, U. of Alaska, 539 p.

Reimnitz, Erk, 1966, Late Quaternary history and sedimentation of the Copper River delta and vicinity, Alaska: Ph.D. Thesis, Univ. Calif., San Diego, 160 p.

Reimnitz, Erk, and Barnes, P.W., 1974, Sea ice as a geologic agent on the Beaufort Sea shelf of Alaska, in The coast and shelf of the Beaufort Sea: Proceedings of the Arctic Institute of North American Symposioum on Beaufort Sea Coast and Shelf Research, Arlington, VA, p. 439-476.

Reimnitz, Erk, and Maurer, D.K., 1978, Stamukhi shoals of the arctic - Some observations from the Beaufort Sea: U.S.G.S. Open-file Report #58-666, 17 p.

Rex, R.W., 1964, Arctic beaches: Barrow, Alaska, in ed., Miller, R.L.: Papers in Marine Geology, p. 384-400.

Short, A.D., 1973, Beach dynamics and nearshore morphology of the Alaskan arctic coast, Unpublished Ph.D. dissertation: Louisiana State Unviersity, Baton Rouge, LA, 140 p.

Wiseman, W.J., Jr., Coleman, J.M., Gregory, A., Hsu, S.A., Short, A.D., Suhayda, J.N., Walters, D.C., Jr., and Wright, L.D., 1973, Alaskan arctic coastal processes and morphology: Tech. Report #149: Louisiana State University, 171 p.

The photographs which were submitted for this section have been omitted because they could not be reproduced. If you desire further details, please contact the author.

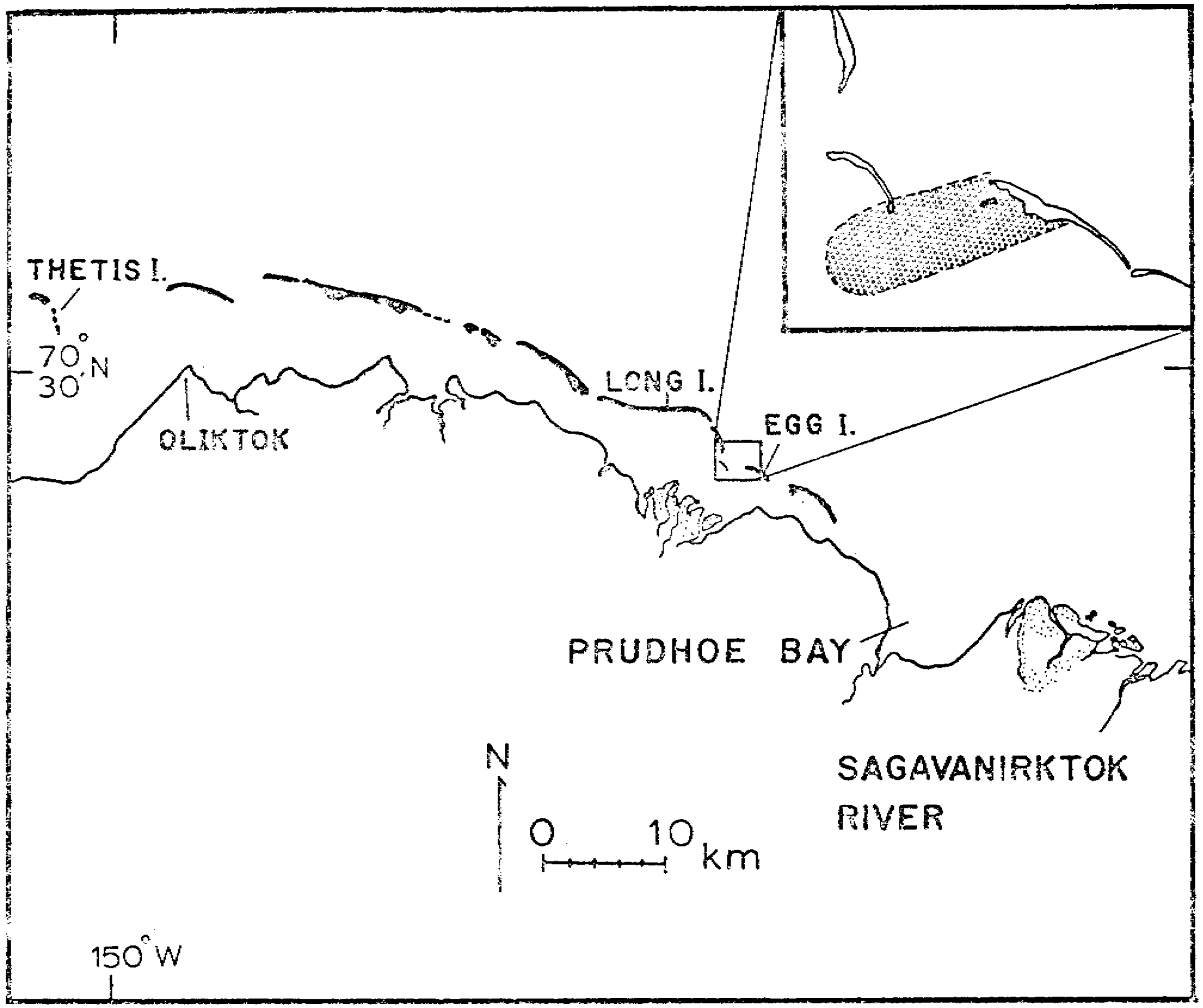


Figure 3. Map of typical barrier island - lagoon system along the North Slope of Alaska near Prudhoe Bay. The Egg Island sand plume (shaded) is sketched in inset.

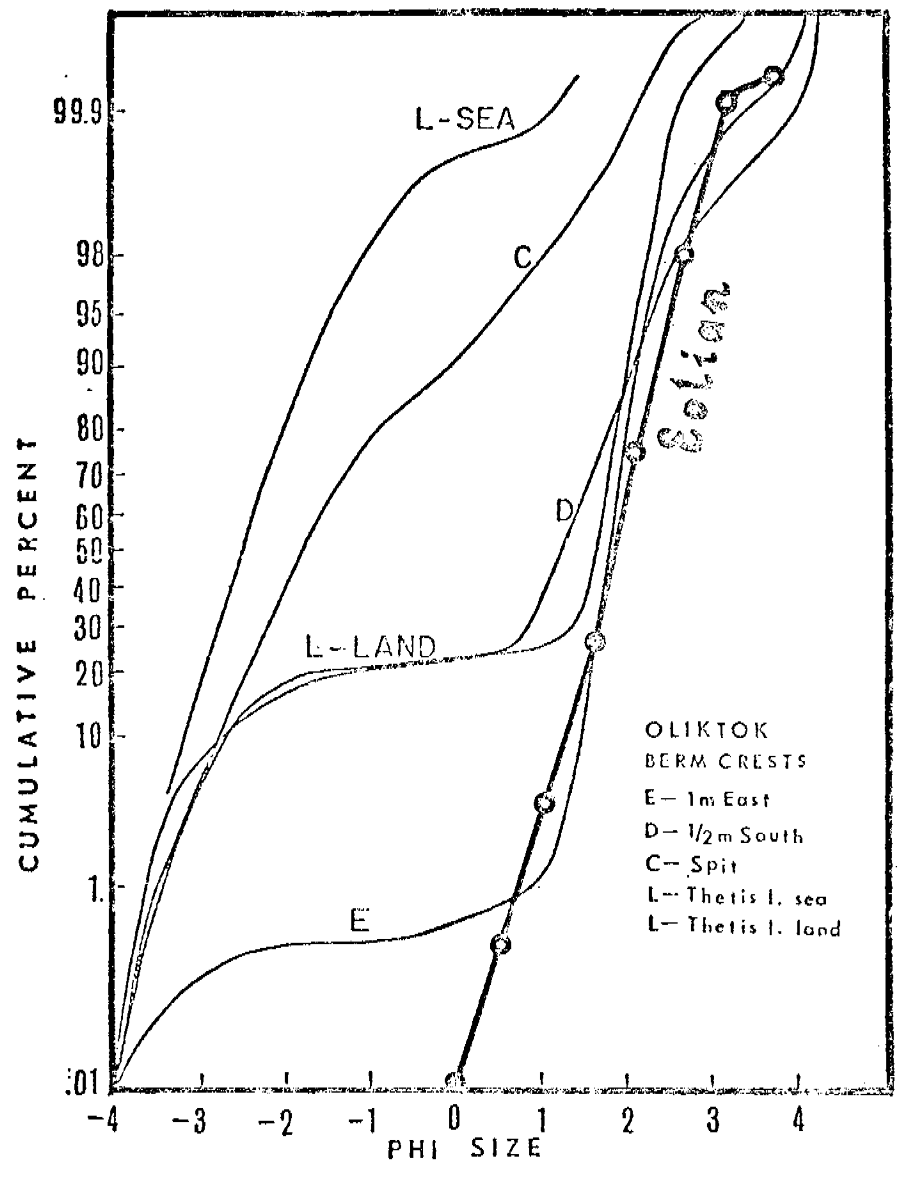


Figure 5. Grain size distribution of eolian sediment in Egg Island plume, superimposed on curves representing berm crest sediments from the Oliktok area (Figure 3) with depositional environment similar to that of Egg Island. (Figure modified after Dygas, et.al., 1972).

ATTACHMENT C

METAMORPHOSIS OF THE TWENTY METER CONTOUR

"Anonymous"

The twenty meter contour has been referenced for this and that and just when you think you have it nailed down, off it goes to another place (Figs. 1-5). Its ultimate location is critical as in many instances this contour has almost reached the status of a diety. It has unjustifiably been called upon to render decisions on ice boundaries. Icebreakers are known to revere the territory inside this isobath as never-never land. We have even heard some talk about its magical powers with politicians and bureaucrats. Furthermore the little demon tries to hide under several different pseudonyms -- Twenty M. Contour, Ten Fm. Contour, Sixty Ft. Contour - its surname is also suspect - Contour, Isobath, Curve, Depth, etc.

The elusive twenty meter contour was most recently seen in the 1978 version of shelf bathymetry, where it was located very precisely, although one can be sure that it will move again and again (Fig. 1). Historically the poor devil has covered a lot of territory but it is believed that in the process of maturing its movements may be ascribed to simple growing pains.

The maturization can be traced from its earliest fetal form as the ten fathom curve (alias - 18 or sometimes 20 meter curve) of the 1950's vintage Coast and Geodetic Survey Chart 9403 (Fig. 2). This primitive jewel was nurtured into a full-fledged twenty meter contour in the early 1970's (Fig. 1). However, others were having their influence on the child. AEIDC taught it a new line, while the National Ocean Survey, in its great wisdom, decreed it back to the ten fathom status but in an updated form - that is, with a longer ID number - 16004 (Fig. 2). Its silver anniversary was celebrated by raising its status back to twenty meters in an upgraded position in the past few months. Newly gathered data attested to the integrety of this award. Over the ensuing years, though, the wanderings of this errant child have extended across ten or more kilometers of the sea floor (Fig. 3) appearing in places where later it wasn't wanted.

We have attempted to determine why an inanimate object would be subject to such excursions and gyrations (Figs. 1-5). Our conclusion is that we are probably dealing with well understood arctic phenomenon. Stefansson wrote at length about the Mysteries of the Arctic. We believe that we may have another to add to his list. We felt compelled to eliminate the possibility that the variability was due to other arctic phenomenon such as 'ice blink', mirages; navigation errors due to the magnetic dip at high latitudes. High altitude sickness was also ruled out. However, the recent reports of lost or moving islands on the Beaufort shelf are still considered viable alternatives to the simple mystery category. in fact, they may explain my contour excursions with a better story.

Another explanation we have been reticent to consider is the possibility that the isobath has been stamukhing. In many parts of the shelf it is known to exist in a no stamukhing area and it is a well known fact that the Department of Interior has determined that stamukhing may be hazardous to your health. The reluctance of most to stamukh in public may explain why it has been difficult to precisely locate the 20 m isobath. Or, one might suspect that it has indeed been hard to locate because of the stamukh screen hiding it. This whole hypothesishas been impossible to confirm as other confirmed stamukhers have been impossible to locate.

We conclude our scientific observations with the well known OCSEAP maxim that "more work is necessary"!

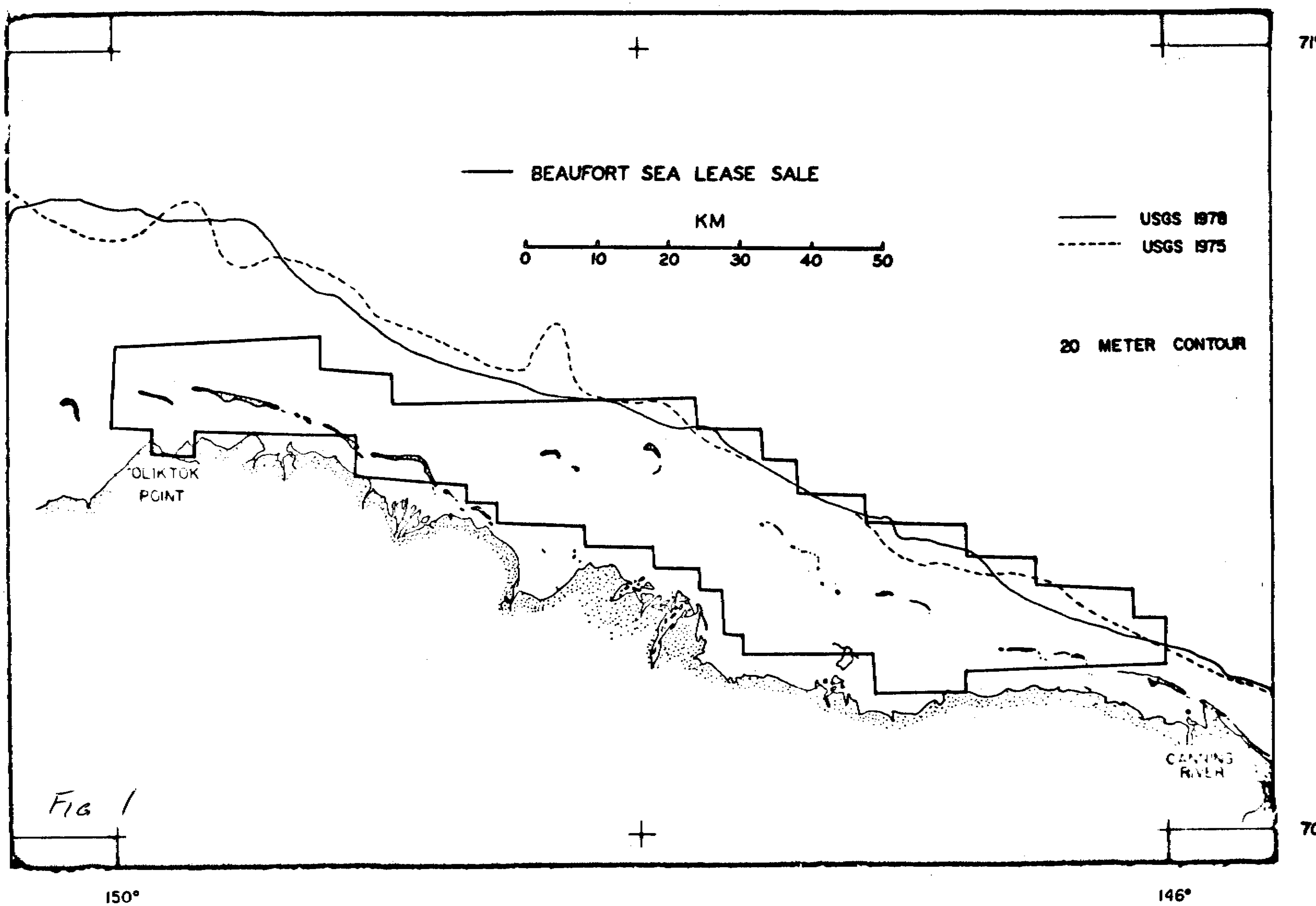
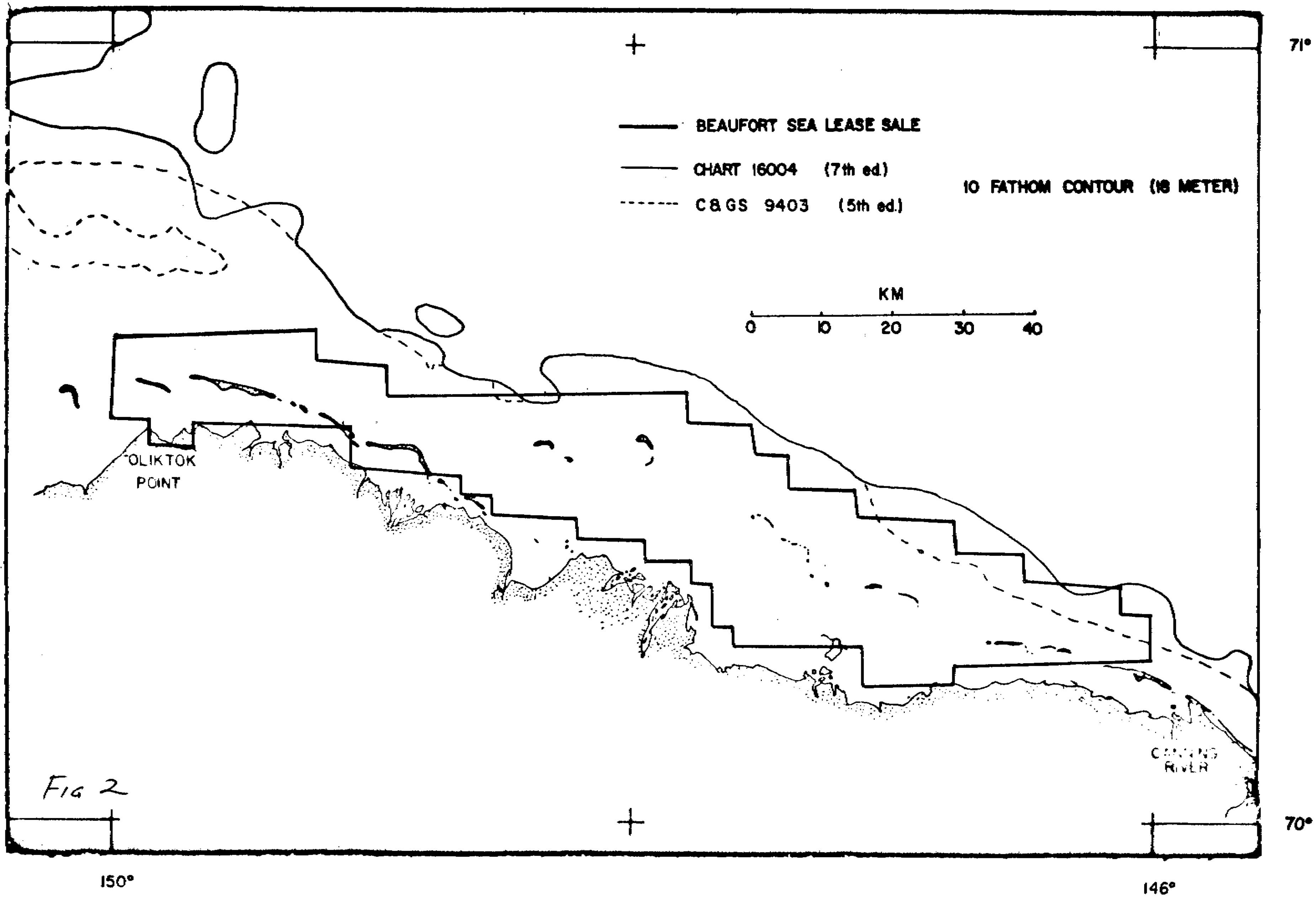

BEAUFORT SEA LEASE SALE
KM
0
10
20
30
40
50
USGS 1978
USGS 1975
20 METER CONTOUR
OLIKTOK
POINT
CANNING
RIVER
71°
70°
150°
146°

Fig 1


71°
BEAUFORT SEA LEASE SALE
CHART 16004 (7th ed.)
C&GS 9403 (5th ed.)
10 FATHOM CONTOUR (18 METER)
KM
0 10 20 30 40
OLIKTOK POINT
CANNING RIVER
70°
150°
146°
Fig 2

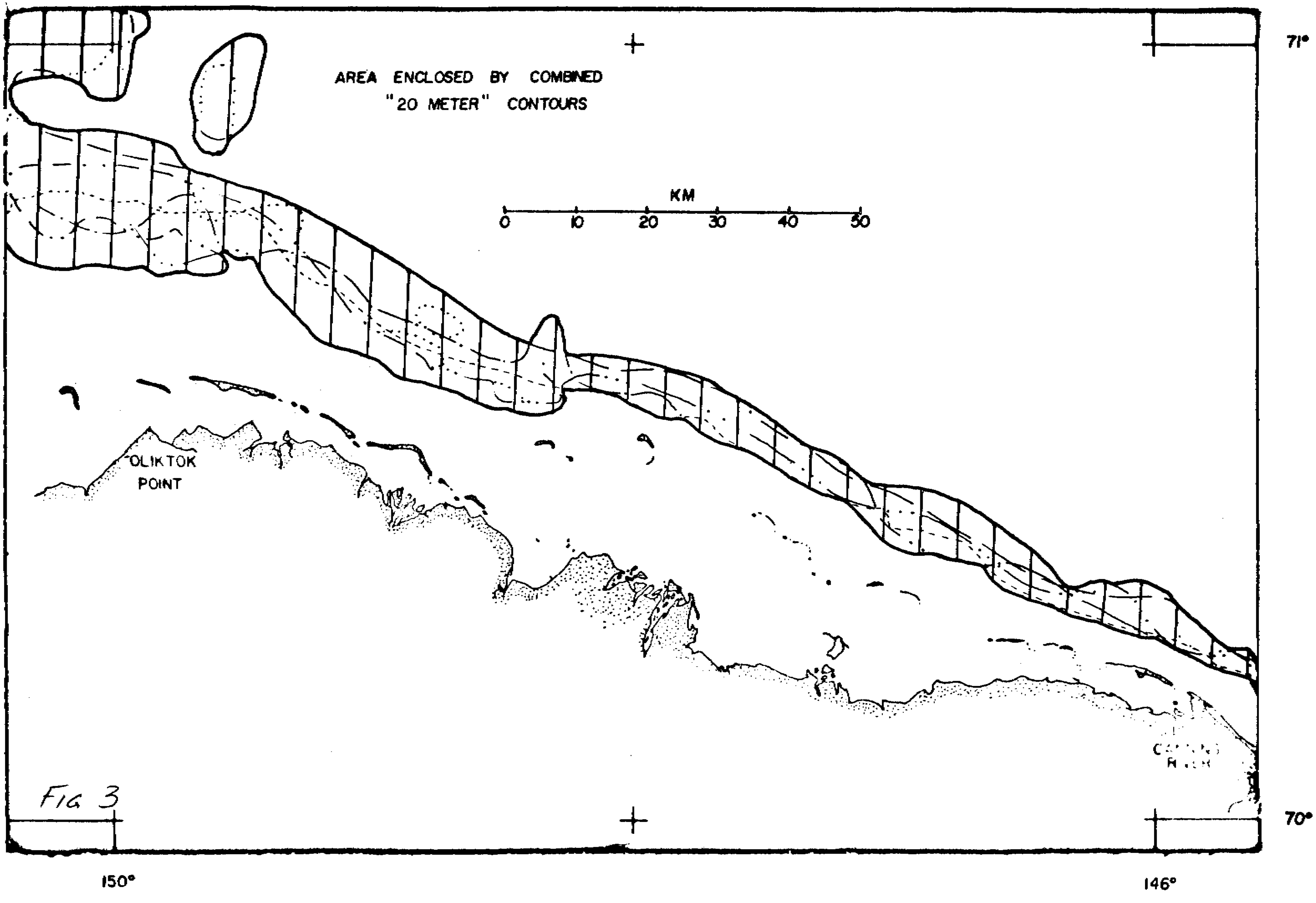

AREA ENCLOSED BY COMBINED
"20 METER" CONTOURS
KM
0 10 20 30 40 50
OLIKTOK
POINT
71°
70°
150°
146°

Fig. 3

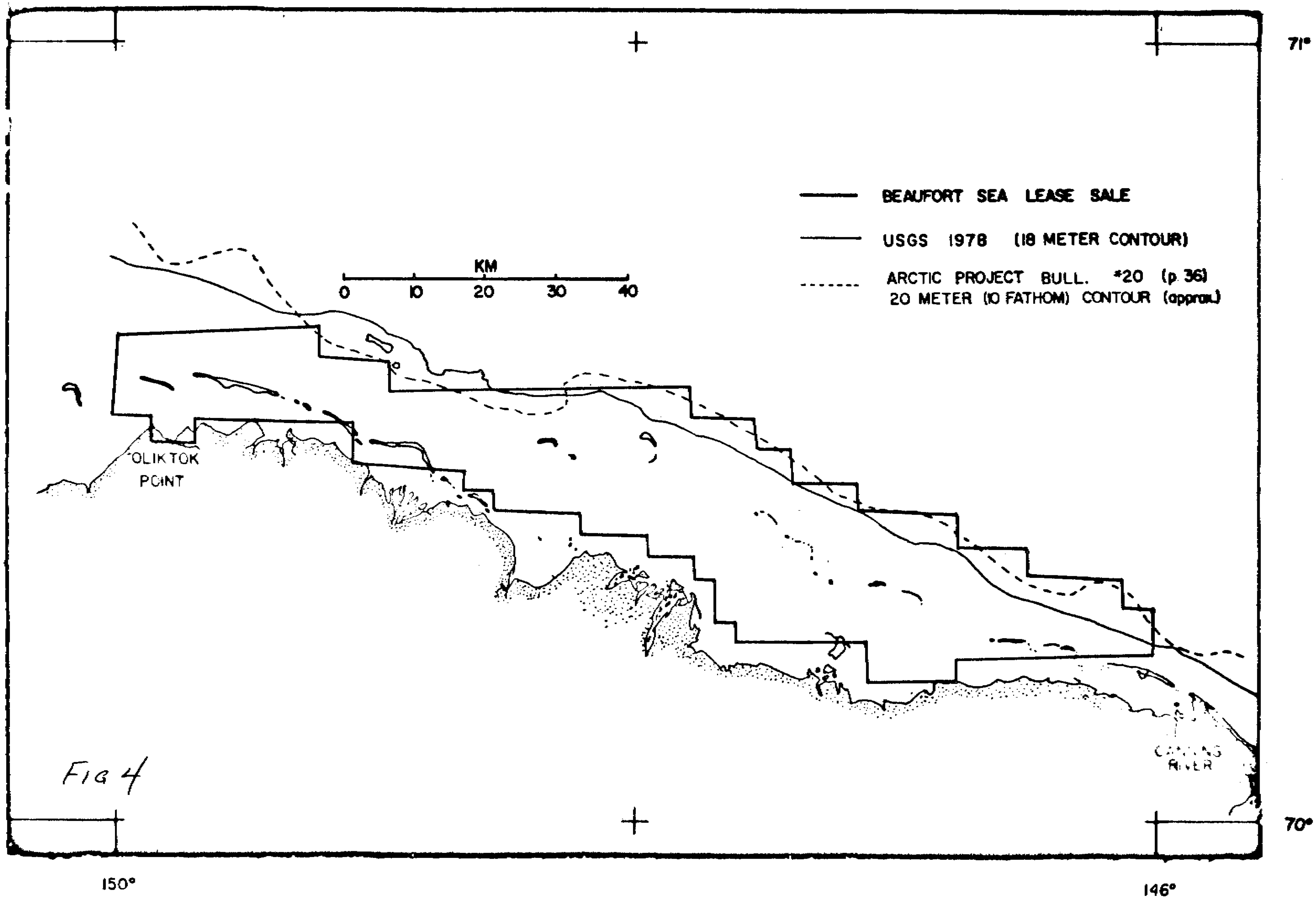

BEAUFORT SEA LEASE SALE
USGS 1978 (18 METER CONTOUR)
ARCTIC PROJECT BULL. *20 (p. 36)
20 METER (10 FATHOM) CONTOUR (approx.)
KM
0
10
20
30
40
OLIKTOK
POINT
CANNING
RIVER
71°
70°
150°
146°

Fig 4

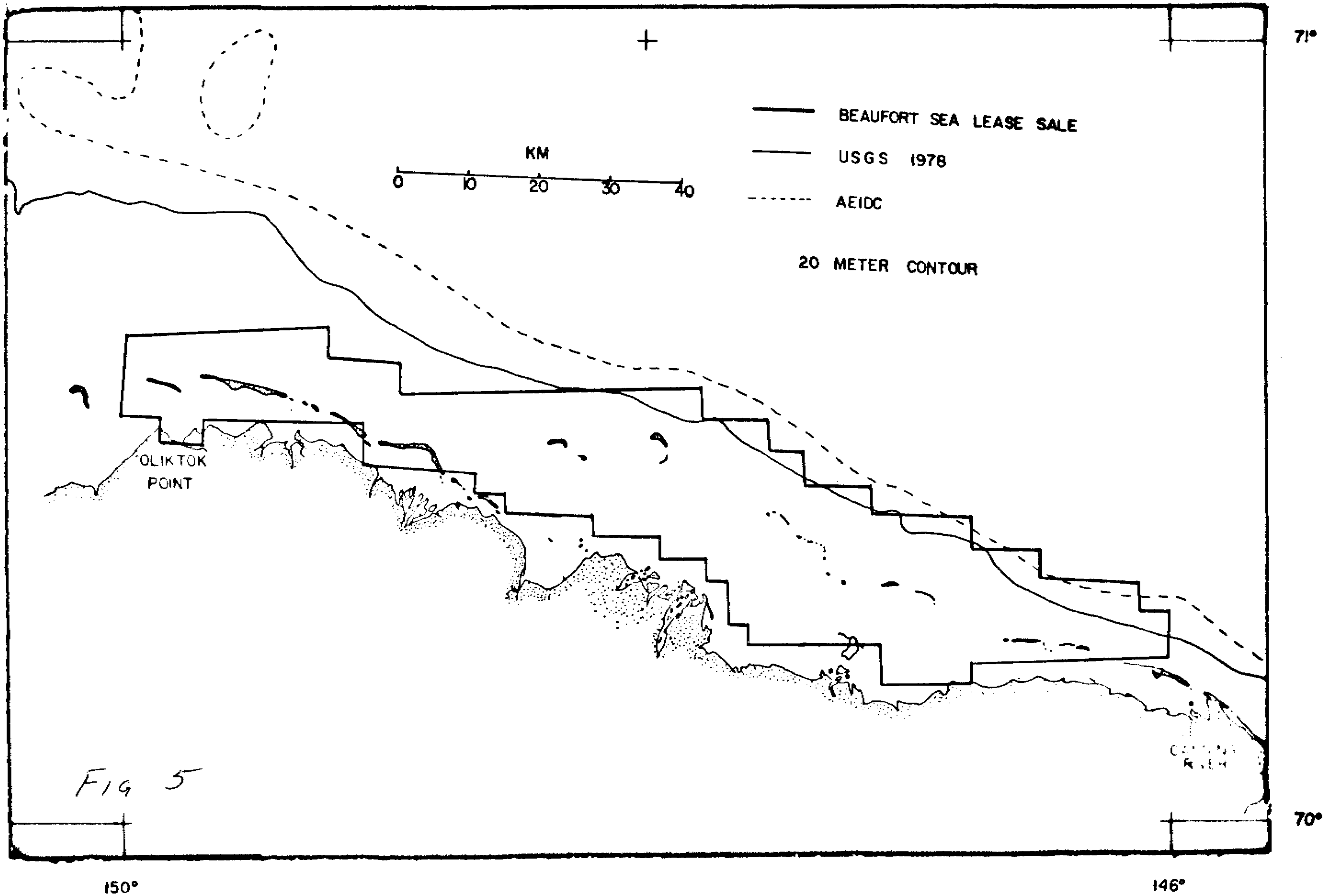

BEAUFORT SEA LEASE SALE
USGS 1978
AEIDC
20 METER CONTOUR
KM
0 10 20 30 40
OLIKTOK
POINT
71°
70°
150°
146°

Fig 5

QUARTERLY REPORT

CONTRACT: RK6-6074

RESEARCH UNIT: 206

REPORT PERIOD: April-July 1978

NO. OF PAGES: 3

AREAS OF FAULTING AND UNSTABLE SEDIMENTS IN THE ST. GEORGE BASIN REGION, SOUTHERN BERING SEA

J. V. Gardner and T. L. Vallier

Pacific-Arctic Branch of Marine Geology

U. S. Geological Survey

Menlo Park, California 94025

July 1978

I. ABSTRACT OF HIGHLIGHTS OF QUARTER'S ACCOMPLISHMENTS

Isopach maps of four acoustic reflectors have been compiled. The maps all show a gentle dip of each reflector from the outer shelf toward the St. George Basin. The maps are based on approximately 10,000 km of high-resolution Uniboom data but, because of varied record quality, each map utilizes less than the total.

A series of Q-mode factor analyses have been run on the accumulated grain size, heavy and light minerals, clay minerals, total carbon, and inorganic geochemistry data. The analyses resolved 50 variables down to 3 factors which can explain over 90% of the original variance. The three factors represent sediment provinances of the Aleutians-Alaska Peninsula, mainland Alaska, and an organic rich, fine-grained provinance in the St. George Basin. In addition, analyses of variance show that the important gradients of the region are on a 10's-of-kilometer scale but not a 10's-of-meter scale. This is important in understanding that local variations are unimportant relative to the regional variations.

A study was initiated to investigate the possible contribution of ice-rafted debris to the outer-most shelf. We found that ice-rafted sand-size quartz grains are more abundant in certain stratigraphic levels and that three cores, each separated from each other by approximately 50 km, have correlatable ice-rafted curves. This implies that ice-rafting by sea-ice was a process which occurred during glacial periods of the global climate and it also gives a possibility for a chronostratigraphy for the area.

Preliminary studies of dredge hauls suggest that environments of sediment deposition and the oceanographic and tectonic regimes have not changed significantly along the outer continental margin since the middle Miocene. Upper Jurassic boulders dredged from the Pribilof Ridge near St. George Island are correlative with the Naknek Formation that is exposed on the Alaska Peninsula.

II. TASK OBJECTIVES

The major task objectives are to outline and document problems related to faulting and seafloor instability (see Gardner and Vallier, Annual Report to OCSEAP, April 1977). In addition, we are studying sediment distributions to determine the sediment dynamics on the seafloor.

III. FIELD OR LABORATORY ACTIVITIES

A. Ship or field trip schedule: none

B. Scientific party: none

C. Methods: (1) We have analysed over 10,000 km of high-resolution Uniboom data in order to correlate four acoustic reflectors over the region. (2) We ran approximately 100 grain-size analyses for the ice-rafting study. In addition, we hand-picked about 500 sand-sized quartz grains and investigated them under S.E.M. (3) We ran a variety of statistical analyses on our accumulated sediment data. The analyses include analysis of variance, Q-mode factor analysis, and correlation analysis.

D. Sample localities: none

E. Data collected or analysed: See IIIC

IV. RESULTS. See I above.

V. PRELIMINARY INTERPRETATION OF RESULTS: See I above.

VI. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES

Because both Gardner and Vallier will be spending extended periods at sea during the late summer and fall of 1978, we request that the deadline for our final report for RU 206 be extended to at least May 1, 1979. This delay will give us the necessary time to collate the data into a meaningful report.

VII. ESTIMATE OF FUNDS EXPENDED: All funds have been expended.

VIII. BIBLIOGRAPHY

Dean, W. E., Gardner, James V., and Vallier, T. L., 1978, Inorganic geochemistry and sedimentology of surface sediments, outer continental shelf, Southern Bering Sea, Alaska: (abs.) 10th Int'l. Sedimentological Congress, Israel, 1978.

Karl, Herman A., and Gardner, James V., 1978, Pribilof Canyon, Alaska and San Gabriel Canyon, California: Examples of the influence of canyon scale and continental shelf width on the shelf sediment transport system: (abs.) 10th Int'l. Sedimentological Congress, Israel, 1978.

Gardner, J. V. and Vallier, T. L., 1978, Underway seismic data collected on U.S.G.S. cruise S6-77, Southeastern Bering Sea: U.S. Geol. Survey Open-File Rept. 78-322, 5 p.

Quarterly Report

Research Unit # 208
Reporting Period 4/1/78 - 6/30/78
Number of pages:

Yukon Delta Coastal Processes Study

William R. Dupré
Department of Geology
University of Houston
Houston, Texas 77004

June 30, 1978

QUARTERLY REPORT

I. Task Objectives

The overall objective of this project is to provide data on geologic processes active within the Yukon-Kuskokwim delta in order to aid in the evaluation of the potential impact of scheduled oil and gas exploration and possible production. In particular, attention has been focused on the following:

1) Study the processes along the Yukon-Kuskokwim delta shoreline (e.g., tides, waves, sea-ice, river input) in order to develop a coastal classification including morphology, coastal stability, and dominant direction of longshore transport of sediments. (Task D-4, B-2).

2) Study the hydrology and sediment input of the Yukon and Kuskokwim Rivers as they largely determine the sediment budget of the northern Bering Sea. (Task B-11, B-2).

3) Determine the type and extent of Quaternary faulting and volcanism in the region. (Task D-6).

4) Reconstruct the late Quaternary chronology of the delta complex in order to determine:

    a) frequency of major shifts in the course of the Yukon River.
    b) effects of river diversion on coastal stability.
    c) relative age of faulting and volcanism.
    d) frequency of major coastal storms as recorded in chenier-like sequences along the coast.

II. Field and Laboratory Activities

A. Field trip schedule: N/A

B. Scientific party: N/A

C. Methods

1) Field Studies: N/A

2) Laboratory Studies:

a) Radiocarbon analyses (in progress): University of Texas Radiocarbon Labs, Austin, Texas.

b) Pollen analysis (in progress) by Tom Ager (U.S.G.S., Reston, Virginia).

c) Sample analyses (in progress

(1) Short cores:

frozen, split, x-rayed and analyzed for grain size and composition

(2) Grab samples:

analyzed for grain size and composition

d) Landsat and NOAA VHRR satellite imagery are being studied in conjunction with synoptic weather maps to determine seasonal variation in ice movement as well as map sub-ice channels along the delta margin.

D. Sample localities (see previous reports)

E. Data collected or analyzed

1) Number and types of samples collected: N/A

2) Number and type of analyses:

a) Textural analyses - 40 completed, 30 in progress

b) Radiocarbon dates - 7 in progress

c) Pollen analysis - 20 in progress

F. Milestone Chart and Data Submission Schedule

No changes

III. Results and interpretations:

Most of the time this quarter has been spent on interpreting satellite imagery to define patterns of ice movement in the Norton Sound area. This work is largely finished, however the results will be included in a subsequent progress report. Other work on sample analysis and photo interpretation remains in progress.

IV. Problems Encountered/Recommended Solutions

None

QUARTERLY REPORT

Contract 03-5-002-69
Research Unit 229
1 April - 30 June 1978

Number of Pages - 1

Biology of the Harbor Seal, *Phoca vitulina richardi*, in the Gulf of Alaska

Principal Investigators:

Kenneth Pitcher, Marine Mammals Biologist
Donald Calkins, Marine Mammals Biologist

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

This quarterly report will briefly review activities since 1 April. Intensive field work is underway and little time has been spent on laboratory or data management activities. A cruise aboard the NOAA ship SURVEYOR was conducted between 6 and 20 April. Eighteen harbor seals were collected in the Lower Cook Inlet lease area. A field camp was established on Tugidak with the Bell 206 helicopter from the SURVEYOR. On 5 May additional supplies and personnel were transported to Tugidak with the NOAA UH-IH helicopter.

Between 6 and 30 May, 22 harbor seals were captured on Tugidak Island and fitted with radio transmitters and visual tags. Since 16 May, daily radio checks and observations have been made on the southwest hauling area of Tugidak. On 10, 11 and 12 June radio tracking surveys were flown along the coast of the Kodiak archipelago. Harbor seals which were radio-tagged on Tugidak were located on Ugak, Sitkalidak and Aiaktalik Islands.

Preparations are underway for the 19 June - 3 July SURVEYOR cruise. Harbor seals research to be conducted includes collection of animals for summer food habit information and radio tracking surveys with the helicopter.

Quarterly Report

Contract #03-5-022-53
Research Unit #230
Reporting Period: 1 April - 30 June 1978
Number of Pages: 3

The Natural History and Ecology of the Bearded Seal (*Erignathus barbatus*) and the Ringed Seal (*Phoca hispida*)

Principal Investigators:

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

Assisted by: Lloyd Lowry, Glenn Seaman, Richard Tremaine, Dan Strickland, and Robin Lynn

30 June 1978

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 seals.

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

Effort this quarter was devoted primarily to field collection of specimen material. Village collections were made at Nome, Diomede, Gambell, Savoonga, Point Hope, Shishmaref, and Wales. In addition, a collection effort was made in Nome in April with the aid of a NOAA UH1H helicopter. Project personnel participated in a northern Bering Sea ice remnant cruise aboard the NOAA ship SURVEYOR in May and June.

Data management continued on an intermittent basis. Data check programs became available from Michael Crane, AEIDC, Anchorage and were used to check, correct, and resubmit data. Negotiations continued for the purchase of a data microprocessor to facilitate data input and analysis.

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 April - 30 June 1978.

Activity	Dates	Personnel
Specimen Collections:		
Nome	10-13 April	T. Eley, L. Lowry
Point Hope	9 April - 16 May	G. Seaman
Gambell	May, June	ADF&G personnel
Savoonga	May, June	ADF&G personnel
Diomede	May, June	ADF&G personnel
Nome	May, June	ADF&G personnel
Wales	May, June	D. Strickland
Shishmaref	8-24 June	R. Tremaine
Bering Sea ice remnant (SURVEYOR)	1 May - 15 June	K. Frost, J. Burns, L. Lowry
Ringed seal survey - Beaufort Sea	5-9 June	J. Burns, D. James
Preparation of FY 79 proposal	June	J. Burns
Preparation of quarterly report	27-28 June	K. Frost
Data management	intermittent	K. Frost, R. Lynn
Laboratory processing of specimen material	intermittent	J. Burns, T. Eley, R. Lynn, D. Strickland
Negotiations for purchase of microprocessor	intermittent	K. Frost, L. Lowry, J. Burns

Methods

For a discussion of methods, refer to RU #230 Annual Report, 1 April 1978.

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

Data Collected

Table 2 summarizes the results of our collection effort from 1 April to 30 June 1978.

Table 2. Seal specimens obtained during the period 1 April - 30 June 1978.

Location	*Phoca (Pusa) hispida*	*Erignathus barbatus*
Point Hope	21	1
Shishmaref	113	27
SURVEYOR	6	13
Nome	27 - samples have not been recovered from the field	
Gambell	80-90 - samples have not been recovered from the field	
Savoonga	70-80 - samples have not been recovered from the field	
Diomede	50-60 - samples have not been recovered from the field	
Wales	70-80 - samples have not been recovered from the field	

III. and IV. Results and Preliminary Interpretation

A detailed presentation and discussion of results was provided in our 1978 annual report. Further results and discussion of data will be presented upon completion of additional laboratory work and data analysis.

V. Problems Encountered/Recommended Changes

None.

VI. Estimate of Funds Expended

As of 31 May we have expended the following amounts during FY 78:

Salaries and benefits	$ 65,700
Travel and per diem	10,200
Contractual services	5,400
Commodities	3,400
Equipment	200
Total Expenditures	$ 84,900

Quarterly Report

Contract #03-5-022-53
Research Unit #232
Report Period: 1 April - 30 June 1978
Number of Pages: 4

Trophic Relationships Among Ice Inhabiting Phocid Seals

Principal Investigators:

Lloyd F. Lowry, Kathryn J. Frost and John J. Burns
Marine Mammals Biologists
Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701

Assisted by: Robin Lynn, Glenn Seaman, Dan Strickland, Richard Tremaine, and Paul Strickland

30 June 1978

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 extensive effort was directed to laboratory processing of specimen material. All seal stomachs on hand were processed. These included large collections from Shishmaref, Gambell, Point Hope, Barrow, and Prudhoe Bay, and totaled about 300 stomachs.

Extensive field work was also conducted. Project personnel participated in a northern Bering Sea ice remnant cruise aboard the NOAA ship SURVEYOR. Seal specimens were collected and otter trawls conducted to sample local availability of prey species. Seal specimen collections were obtained from Nome, Point Hope, Wales, Gambell, Savoonga, Diomede, and Shishmaref.

A collection system was set up in the eastcentral Bering Sea along the coast between the Yukon and Kuskokwim Rivers. A few specimens were obtained from this area.

Data management occurred on an intermittent basis as most project personnel were in the field. Negotiations were continued for the purchase of a data microprocessor to facilitate data entry and data analysis. We anticipate delivery of this equipment by the end of FY 78.

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 April - 30 June 1978.

Activity	Dates	Personnel
Specimen Collections:		
Nome	10-13 April	L. Lowry, T. Eley
Point Hope (seals & belukhas)	9 April - 16 May	G. Seaman
Nome	May, June	ADF&G personnel
Gambell	May, June	ADF&G personnel
Savoonga	May, June	ADF&G personnel
Diomede	May, June	ADF&G personnel
Wales	May, June	D. Strickland
Wainwright	May	R. Tremaine
Shishmaref	8-24 June	R. Tremaine
Buckland (belukhas)	6-27 June	G. Seaman
Ice remnant cruise - N Bering Sea - seal specimens & otter trawls	1 May - 15 June	K. Frost, J. Burns, L. Lowry
Beaufort Sea trophics cruise planning meeting	27-28 April	K. Frost
Preparation of Beaufort Sea Synthesis trophics report	April	K. Frost, L. Lowry
Preparation of FY 79 RU #232 proposal	May, June	L. Lowry, K. Frost

Preparation of quarterly report	28-30 June	K. Frost
Data management	intermittent	K. Frost, R. Lynn
Laboratory processing of specimen material	intermittent	L. Lowry, K. Frost, T. Osborne, D. Strickland, P. Strickland
Negotiations for purchase of data microprocessor	intermittent	K. Frost, L. Lowry, J. Burns

Methods

Field collection procedures at coastal hunting villages and methods for laboratory analyses are described in the 1978 Annual Report for RU #232. At Nome in April a NOAA UH1H helicopter was used for collecting seals. The SURVEYOR cruise was utilized to collect seals for food habits, parasitology, and natural history information (RU #230, 232, and 194), and to do aerial surveys in conjunction with RU #230 and 248. Collecting was done with the use of small boats and a Bell 206 helicopter. Animals were collected, returned to the ship, and processed. Stomach contents were analyzed immediately, as were the contents of the small intestines.

Trawls were conducted to assess local availability of prey species. They were conducted with a 19-foot otter trawl for a duration of 20 minutes at a ship speed of 3 to 4 knots. Contents of each trawl were identified, enumerated, and weighed. Natural history information was noted for key prey species of fish and invertebrates.

Whenever feasible, when collections were made by ADF&G personnel, usable meat from seals was given to residents of coastal communities.

Data Collected or Analyzed

Table 2 summarizes the results of our seal specimen collection efforts from 1 April to 30 June 1978. In addition, 16 belukha stomachs from Point Hope and 72 belukha stomachs from Elephant Point near Buckland were collected or examined.

Table 2. Seal stomachs collected during the period 1 April - 30 June 1978. Not all stomachs contained food.

Location	*Phoca hispida*	*Phoca fasciata*	*Phoca largha*	*Erignathus barbatus*
Point Hope	21			1
Shishmaref	113	4	28	27
SURVEYOR	6	30	21	13
Wainwright	3			
Nome	27 - samples have not been received from the field			
Gambell	80-90 - samples have not been received from the field			
Savoonga	78-80 - samples have not been received from the field			
Diomede	50-60 - samples have not been received from the field			
Wales	70-80 - samples have not been received from the field			

III. and IV. Results and Discussion

A detailed presentation and discussion of results was provided in our 1978 annual report. Further results and discussion of results will be presented upon completion of additional laboratory work and data analysis.

V. Problems Encountered/Recommended Changes

None.

VI. Estimate of Funds Expended

As of 31 May we have expended approximately the following amounts during FY 78:

Salaries and benefits	$ 65,600
Travel and per diem	5,800
Contractual services	8,300
Commodities	5,600
Equipment	200
Total Expenditures	$ 85,500

Quarterly Report

Research Unit #237
Reporting Period: April 1, 1978 to June 30, 1978
Number of Pages: 4

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

William H. Drury
College of the Atlantic
Bar Harbor, Maine 04609

17 July 1978

I. 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.

II. Field or Laboratory Activities

A. Ship or Field trip schedule:
Members of the field party arrived in Nome May 25 and 27, and began to make arrangements for logistics.

A survey of events while seabirds took up territories at Bluff Cliffs was carried out during the last days of May and the first days of June.

The first running of the grid established to survey the distribution of seabirds feeding in the Cherekov Basin and Bering Strait was done between 8 June and 12 June. This survey was delayed by bad weather.

A party began the season's work at Bluff Cliffs on 12 June and was joined by two additional members on June 16. Unusually bad weather has continued and has interferred with the work.

Two people travelled to Wales on June 20, intending to go to Little Diomede Island, but no transportation was available during the next five days as a result of bad weather. We decided to cancel the trip because the further weather outlook was very poor and because it is important to make the second run of the grid in early July.

It is possible that the early breakup of sea ice in 1978 will release the NARL vessel Natchik from Barrow during mid-July and it is of highest priority to make full use of her. This includes having the grid of transects completed on schedule.

B. Scientific Party:

William H. Drury, Principal Investigator — College of the Atlantic, Bar Harbor, Maine

John B. French, Jr.
Cathy Ramsdell
David M. Rand
Alan Watson

C & D, Methods and Sample localities:

a) Study sites set up in previous years are being used again to study phenology, feeding, reproductive success, and the effects of predation at Bluff Cliffs.

b) The grid of over water transects has been established which has both ends of each transect line identifiable in topographic features on Saint Lawrence Island or the Seward Peninsula.

E. Data Collected or analyzed:

a) Data on Pelagic Cormorants, Glaucous Gulls, Black-legged Kittiwakes, Common Murres and Horned Puffins have been gathered at the study sites at Bluff Cliffs.

b) Birds and sea mammals seen during approximately 27 hours of flying have been recorded. The data are subdivided into subsets collected at 5 minute periods.

F. Milestone chart and digital data submission schedule

The details of codes to be used in entering digital data into format 035 have not yet been made available to us from Boulder or, apparently, to Leo Karl. We will not be able to begin to enter our data until Leo has prepared the suitable software. Thus we may need to extend our schedule of submission of data according to when we get the necessary programs.

III. Results

None

IV. Preliminary interpretation of results

None

V. Problems encountered/recommended changes

The unusually early break up of the sea ice (early May in 1978 as compared to mid-June in 1977) made it impossible to carry out our plans for observing the taking up of territories by seabirds at the cliffs at Bluff. However the early spring seems to allow the birds to begin breeding early. Early breeding has been reported to be associated with larger clutches and higher breeding success.

Delays in getting the annual report written and new restrictions on air surveys issued from the Boulder office led to our decision to cut out running the grid of transects over the Cherekov Basin in late April and early May.

VI. Estimate of funds expended during the quarter

CPF 1.	9500
CPF 2.	6000
CPF 3.	1200
CPF 4.	200

QUARTERLY REPORT

Contract #03-5-022-91

Research Unit #244

Reporting period: 1 April 1978 -
30 June 1978

STUDY OF CLIMATIC EFFECTS ON FAST ICE EXTENT AND ITS SEASONAL DECAY ALONG THE BEAUFORT-CHUKCHI COASTS

Principal Investigator

R.G. Barry

Associate Director, Professor of Geography

Institute of Arctic and Alpine Research

University of Colorado 80309

30 June 1978

OFFICE ACTIVITIES

Personnel

R.G. Barry	-	Principal Investigator
J.C. Rogers	-	Graduate Research Assistant (25%)
A. Jane Reynolds	-	Graduate Research Assistant
B. Warmerdam	-	Graduate Research Assistant
G. Wohl	-	Graduate Research Assistant

Data Analyzed

A. Ice Maps: Summary charts of fast-ice extent along the Beaufort and Chukchi sea coasts are currently being prepared for drafting to accompany manuscripts in preparation.

B. Synoptic Climatology: The emphasis this Quarter has been on several aspects of the meteorological conditions relating to the summer ice-decay season. Four topics are being examined:

(1) an evaluation of the NMC mean-sea-level pressure maps for the Beaufort Sea area during July-August, 1975, when the detailed AIDJEX analyses were available.

(2) a study of the synoptic pressure patterns associated with pack-ice incursions along the Beaufort Sea coast.

(3) analysis of pressure patterns during summer months when Barter Island is substantially warmer than Barrow, and when Barrow is warmer than Barter Island.

(4) analysis of temperature anomalies at Barrow in relation to synoptic patterns, using the Chukchi Sea catalog to enable a comparison with the earlier study for Kotzubue.

Topics B (1) and (2) will be written up in detail by G. Wohl in a Master's thesis.

MEETINGS

1. J.C. Rogers attended the Second Beaufort Sea Synthesis Meeting, 24-28 January, in Barrow. Material has subsequently been provided for the revised synthesis report.

2. R.G. Barry presented a paper to the special sessions on Coastal Zone Meteorology at the Annual Meeting of the American Meteorological Society, 30 January - 2 February, in Savannah, Georgia. (Abstract attached.)

ABSTRACT

Bull. Amer. Met. Soc. v. 58 (10) 1977, p. 1131.

Studies of cliamte and fast-ice interaction in relation to offshore petroleum development along the Beaufort and Chukchi sea coasts.

R.G. Barry, R.E. Moritz and J.C. Rogers

The characteristics of the shorefast ice and its seasonal regime are major determinants of any risk assessment relating to petroleum development in the nearshore zone of northern Alaska. This study discusses the controls of the patterns of summer decay of shorefast ice along the Beaufort and Chukchi sea coasts, based on remote sensing data and synoptic climatological analysis of conditions for 1973-76.

The timing of ice breakup events correlates well with accumulated thawing degree-days. Wind or pressure parameters are shown to be of only secondary importance, although temperature conditions can be closely specified according to types of pressure pattern over Alaska. Climatic data at Barrow since 1921 suggest that years with only limited retreat of the pack ice offshore have become more frequent since 1953.

Quarterly Report

Contract #03-5-022-55
Research Unit Number: 248
Report Period: 1 April - 30 June 1978
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

30 June 1978

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

24 March-10 April (Burns,Eley) Beaufort Sea/ Barrow & Prudhoe (NOAA helo)

10-13 April (Lowry,Eley) Nome-Norton Sd (NOAA helo)

1-21 May (Burns, Frost) Bering Sea (SURVEYOR Leg V)

21 May-15 June (Fay,Lowry) Bering Sea (SURVEYOR Leg VI)

5-12 June (Burns) Chukchi-Beaufort/ Barrow (NARL charter fixed-wing)

B. Laboratory Activities

Inactive; all personnel fully occupied with field work in this and other projects this quarter.

III. Results

Data not yet analyzed; will be incorporated into Final Report.

IV. Preliminary Interpretation of Results

None feasible at this time.

VI. Estimate of Funds Expended This Quarter

$23,000

Quarterly Report

Contract # 03-5-022-55
Research Unit # 250
Task Order # 11
Reporting Period 4/1/78 - 6/30/78
Number of Pages: 3

MECHANICS OF ORIGIN OF PRESSURE RIDGES SHEAR RIDGES AND HUMMOCK FIELDS IN LANDFAST ICE

Lewis H. Shapiro
William D. Harrison
Howard F. Bates
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

June 30, 1978

OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Quarter Ending June 30, 1978

Project Title: Mechanics of Origin of Pressure Ridges, Shear Ridges and Hummock Fields in Landfast Ice.

Contract Number: 03-5-022-55

Task Order Number: 11

Principal Investigators: Lewis H. Shapiro, William D. Harrison, and Howard F. Bates.

I. Task Objectives:

To determine the mechanics of origin of pressure ridges, shear ridges and hummock fields in landfast ice.

II. Schedule:

Field work and analysis.

III. Results:

1. During the past quarter we discovered a large ice override on Tapkaluk Island about 15 km east of Barrow, and a second smaller one on another island to the east. Tapkaluk Island was overflown and visited to verify that the ice did, in fact, completely override the island. Subsequently, an additional visit was made to the island to establish the dimensions of the ice piles.

The ice was either piled on the island or shoved completely across it into Elson Lagoon along a front 700 m wide. The highest crest along the pile reached 10 m, and the thickest ice slab which could be observed through the snow cover was about 60 cm.

Investigation is continuing in cooperation with Mr. A. Hanson of NARL who has obtained aerial photographs of the override on Tapkaluk Island as well as the second override noted above. In addition, he noted an example of ice shore on the shore east of Elson Lagoon, where the barrier islands are absent.

2. Break-up in the Barrow area this summer occurred without an episode of ice shore. In previous years the ice has been piled on the beach in response to southwesterly winds occurring after the development of a shore lead. This year the weather systems which normally cause such winds (a low pressure system northeast of Barrow) never appeared. As a result, the

ice largely rotted in place and drifted offshore as a single sheet on approximately July 10-11.

IV. Problems Encountered:

None

V. Estimated Funds Expended:

$5,000

Quarterly Report

Contract #03-5-022-55
Research Unit #251
Task Order #C1
Reporting Period: 03/31/78
06/30/78

SEISMIC AND VOLCANIC RISK STUDIES WESTERN GULF OF ALASKA

H. Pulpa.
J. Kienle

Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

June 30, 1978

TABLE OF CONTENTS

OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Period Ending June 30, 1978

Project Title:	Seismic and Volcanic Risk Studies Western Gulf of Alaska
Contract Number:	03-5-022-55
Task Order Number:	C1
Principal Investigators:	H. Pulpan, J. Kienle

I. Abstract

A magnitude 5.8 earthquake occurred off Kodiak Island during the report period. First motion plots and aftershock activity indicate the event to represent rupture on a low angle thrust fault, compatible with the concept of plate subduction. The strong motion instrument on Sitkinak Island apparently was not triggered by this event. The high level seismic activity in the Iliamna volcano region continued, as did the shallow, east-west striking cluster of small magnitude events in the area of the Ukinrek Maars on the Alaska Peninsula.

II. Task Objectives

It is the purpose of this research to determine the seismicity of the lower Cook Inlet, Kodiak Island, and the Alaska Peninsula, and to evaluate the seismic risk to onshore and offshore development and also to evaluate eruption potential and volcanic risk of Redoubt and Augustine Volcanoes in Cook Inlet.

III. Field and Laboratory Activities

Laboratory activities concentrated about preparation for the annual service trips to the seismic stations. A maintenance trip was made by a technician to the recording site in Homer. The seismic system continued to operate well, with the Alaska Peninsula and Kodiak network performing almost trouble-free. Some problems that still exist in the lower Cook Inlet will be attended to during this year's maintenance trip (see Table 1 for station performance). A preliminary field investigation, concerning the pyroclastic flows off Augustine Island is presently in progress.

IV. Results and Preliminary Interpretation

The most significant seismic event during the report period was a magnitude 5.8 earthquake that occurred on April 12, 1978 off the southwest coast of Kodiak Island. This area had been pointed out in previous reports as one with a rather high rate of shallow seismic activity before and during the aftershock activity period of the 1964 Prince William Sound earthquake and continuing presently. The area is of special interest for OCSEAP studies as the source regions of the earthquakes underlie proposed lease tract areas.

Preliminary studies of the April 12, 1978 event and its aftershock sequence indicate that the event reflects the plate subduction process. This is based upon the following evidence:

1.) First Motion Studies

Stauder and Bollinger (1966) provide a number of fault plane solutions for aftershocks, in the Kodiak area, of the 1964 Prince William Sound earthquake. The similarity of these solutions, most of which are for events which are within 50 km of the April 12, 1978 event, is remarkable (Figure 3). Stauder and Bollinger (using WWSSN data) state that only one steeply dipping nodal plane is determinable from the P-wave first motion data. For the second (slightly dipping) nodal plane S-wave data were required. The same holds for 1964 main event and its solution is very similar to the solutions near Kodiak Island (Figure 4). While the solutions presented by Stauder and Bollinger, taken individually, are subject to ambiguity, based upon criteria advanced from the interrelationship of the foci and motion at the source, they favor motion on a shallow dipping thrust. Also, Kanamoori (1970), using normal mode solutions to obtain surface wave motions for various dislocations, interprets long period records of the 1964 main event to correspond to motion on a low-angle thrust fault. Thus, shallow thrusting is now the preferred interpretation of the dislocation solution for the 1964 main event and the majority of its larger aftershocks.

Using first motion P-wave data from our own local network we find the station distribution to be such that we cannot determine even one nodal plane. However, the distribution of first motion for the April 12, 1978, event and some of the major aftershocks is not only compatible but highly indicative of a solution almost identical to those presented by Stauder and Bollinger (Figure 5 through 7). The azimuthal distribution of stations is just too limited to define the azimuth of the steeply dipping nodal plane. Use of the short period records of the neighboring networks should eventually allow at least the definition of one nodal plane. Since the number of horizontal component installation, on a regional basis, is insufficient for fault plane solution work, determination of the second nodal plane, based upon S-wave arrivals, will have to be done with records from WWSSNstations, on a world-wide basis. The magnitude of the April 12, 1978 event is somewhat marginal for the use of world-wide data; we shall, however, attempt such a solution. It will, however, take several months to obtain records of WWSSN stations.

2.) Aftershock Distribution

Aftershock location is in a generally broad zone, striking in a southeast-northwest direction, with the main event in the center of the aftershock zone (Figure 1). This zone has fairly sharp boundaries on its eastern and western sides. The general trend of the aftershock zone coincides with the plate motion direction. Hence, the aftershock distribution is much more in accord with an event along a shallow dipping thrust rather than a normal fault along a steeply dipping plane.

Hypocentral control is not very good as all events lie outside the network proper. Only a relatively small number of events are really well located (horizontal and vertical error less than 10 km, RMS travel time residual less than one second) as comparison of Figure 1 with Figure 2 shows. However, the same general trend of the aftershock zone is indicated by the better located events.

The epicenter of the main shock was approximately 100 km from our installation at Sitkinak Island (SII) where we have also placed a strong motion instrument which is interfaced with the amplifier of the conventional seismometer at the site in such a fashion that, in case of the strong motion instrument being triggered, the amplifier is short circuited for a few seconds after completion of the strong motion record. This permits to see on the records of the short period instrument (which is telemetered continuously to a central recording site at Homer) whether the strong motion instrument has been triggered.

The short period record from SII does not indicate triggering of the strong motion instrument by the main event or any of the larger aftershocks. This could be a malfunctioning of the interface system or of the strong motion instrument itself. In any case, most likely the event would have triggered it. The level of maximum acceleration at SII to be expected from the event depends upon the source mechanism, the intervening medium and the local site conditions. Using the relationships suggested by Trifunac and Brady (1976) based upon a regression analysis of strong motion data (from the western United States) we obtain for a hard rock site (which describes the situation at SII well), the given magnitude and source-site distance, the following values:

Vertical Component:

average peak acceleration: 0.015 g

interval corresponding to one standard deviation:

.009 g to .024 g

Horizontal Component:

average peak acceleration: .023 g

interval corresponding to one standard deviation:

.001 g to .055 g

The strong motion instrument has, according to manufacturer's specifications, a trigger level of between 0.005 g and 0.05 g (adjustable). We have set the trigger level of the instrument at the lowest possible level, but absolute calibration is not possible without shake table. A trigger level of .01 is probably a conservative value. Hence, the above numbers indicate that the instrument would most likely have been triggered. A more definite statement about the reasons of the non-triggering will be possible only after visiting the site.

Otherwise, the seismicity of the report period shows no unusual activity, and confirms previously indicated patterns, e.g., (1) the high level activity beneath the area of Iliamna volcano associated with the Benioff zone; (2) continued shallow clustering in the area of the Ukinrek Maars; latest activity confirms the east-west trend of that cluster, observed since January 1978.

Percent Downtime of Seismic Stations

Station	April 1 - June 15, 1978
AUF	100
AUK	0
AUM	0
AUP	100
BMT	0
CDA	0
CHI	100
CHO	0
DMB	100
FLP	0
HOM	0
MAA	0
MCN	0
OPT	0
PNM	0
PUB	0
RAI	0
RED	0
SHU	50
SII	0
SKS	0
SPL	0
UKL	0
YCB	0

Table 1

Percent downtime of seismic stations -- April 1 - June 15, 1978

Table 2. Hypocenter parameters of main shock and aftershocks of April 12, 1978, magnitude 5.8 earthquake off Kodiak Island.

DATE	ORIGIN		LAT	LONG W	DEPTH	MAG	NO	GAP	DMIN	RMS	ERH	ERZ	QM
780412	342	3.82	56-20.65	152-37.27	30.53	5.80	20	252	95.5	0.47	7.7	3.0	D1
780412	405	0.83	56-22.99	152-47.60	31.40	3.38	11	271	87.8	0.61	19.9	5.0	D1
780412	409	49.15	56- 9.05	152-33.27	21.56	3.14	9	289	117.4	0.51	34.7	13.2	D1
780412	416	2.62	56-21.21	152-27.40	14.79	4.56	16	266	98.0	0.78	17.1	6.7	D1
780412	419	2.11	56-25.90	152-48.12	21.07	3.45	9	267	83.3	0.58	17.5	6.2	D1
780412	420	32.05	56-51.60	153- 9.15	31.59	2.30	4	340	234.4	0.26	0.	0.	C1
780412	426	57.71	56-46.46	153-10.16	0.13	4.32	15	226	43.7	1.29	14.4	17.2	D1
780412	436	53.37	56-44.12	153- 5.19	0.74	2.56	4	253	47.8	1.46	0.	0.	D1
780412	443	15.63	56-27.59	152-25.45	24.86	3.47	8	324	88.1	0.31	65.9	11.7	D1
780412	447	19.50	56-25.96	152-44.78	33.56	5.10	16	248	84.0	0.44	7.7	2.8	D1
780412	509	29.80	56-42.79	152-57.93	5.00	1.47	3	265	50.7	0.10	0.	0.	C1
780412	510	27.63	56-13.42	152-36.26	26.42	3.64	10	281	104.4	0.47	20.4	5.9	D1
780412	522	19.31	56-31.60	152-54.03	32.99	3.30	8	259	71.8	0.39	13.8	3.3	D1
780412	527	10.35	56-34.95	152-23.81	23.33	3.10	7	319	77.0	0.27	40.5	8.7	D1
780412	537	21.09	56-33.23	152-39.54	28.88	3.27	7	323	72.7	0.27	44.5	6.8	D1
780412	538	57.47	56-34.28	152-58.67	29.43	3.40	9	255	66.3	0.48	11.6	3.8	D1
780412	544	55.35	56-23.13	152-37.51	22.85	2.82	5	325	91.1	0.33	9.2	2.2	D1
780412	600	45.00	56-28.34	152-39.03	27.04	3.22	6	265	81.4	1.19	54.8	16.1	D1
780412	711	18.28	56-26.43	152-48.86	31.96	3.52	14	281	82.2	0.53	19.4	6.0	D1
780412	719	31.84	56-47.39	152-23.39	23.39	2.91	7	306	59.2	0.27	19.2	5.1	D1
780412	722	5.77	56-19.96	152-54.64	33.16	3.83	14	268	82.5	0.47	11.7	3.1	D1
780412	731	50.15	56-54.02	153-45.92	0.51	3.16	6	288	50.9	0.77	495.9	305.6	D1
780412	736	8.43	56- 3.62	152-19.66	3.00	3.81	9	263	131.3	0.48	18.5	23.1	D1
780412	802	55.19	56- 2.19	152- 3.31	3.31	3.41	9	280	144.0	0.32	18.0	16.7	D1
780412	809	26.36	55-43.11	152-15.89	192.28	2.54	4	324	168.7	0.62	0.	0.	D1
780412	819	53.89	56-23.14	152-36.61	20.75	3.10	8	271	91.3	0.46	16.4	6.2	D1
780412	856	18.59	56-15.34	152-32.88	26.79	3.60	11	272	106.3	0.43	15.0	5.0	D1
780412	922	46.91	56-10.27	152-27.50	24.63	3.65	13	275	114.9	0.41	14.8	5.1	D1
780412	933	36.86	56-25.43	152-43.57	32.47	4.50	19	249	85.2	0.37	5.8	2.2	D1
780412	955	19.65	56- 6.72	152-14.86	14.92	3.12	10	277	127.9	0.35	15.5	5.7	D1
780412	957	59.04	56-20.46	152-55.31	32.55	3.51	13	267	81.4	0.51	14.0	3.6	D1
780412	1040	48.37	56-12.68	152-22.63	21.70	4.41	18	274	114.5	0.55	15.6	7.4	D1
780412	1126	39.94	56-59.63	152-56.36	32.37	3.21	8	312	20.8	0.37	10.7	2.5	D1
780412	1205	56.55	56-26.92	152-38.64	31.47	3.20	11	263	84.0	0.42	11.6	3.4	D1
780412	1456	52.53	56-29.70	153- 2.33	27.12	3.41	15	261	70.8	0.54	9.5	3.0	D1
780412	1507	0.58	56-17.60	152-46.44	20.44	3.10	7	278	91.9	0.29	17.3	6.0	D1
780412	1620	25.49	56-11.35	152-17.71	15.94	3.34	9	285	118.7	0.33	23.5	9.1	D1
780412	1710	34.21	56-17.58	152-17.98	13.66	3.84	7	326	108.2	0.32	77.3	23.4	D1
780412	1720	28.36	56-31.16	152-31.21	26.19	3.40	7	324	79.5	0.34	82.1	13.4	D1
780412	1731	57.41	56-46.41	153-23.58	5.00	1.19	3	220	47.5	0.08	0.	0.	C1
780412	1747	25.23	56-20.20	152-41.38	28.11	3.49	13	269	95.2	0.76	22.3	7.8	D1
780412	1838	43.85	56-28.92	152-35.22	26.33	3.01	6	324	81.7	0.26	53.9	9.9	D1
780412	1747	25.23	56-20.20	152-41.38	28.11	3.49	13	269	95.2	0.76	22.3	7.8	D1
780412	1838	43.85	56-28.92	152-35.22	26.33	3.01	6	324	81.7	0.26	53.9	9.9	D1
780412	1945	51.15	56-29.97	152-23.57	25.83	2.37	6	322	85.1	0.21	46.4	7.3	D1
780412	2046	55.76	56-27.76	152-57.75	23.23	3.19	11	265	75.9	0.55	12.7	4.8	D1
780412	2107	13.71	56-56.32	152-34.95	25.11	2.88	9	298	39.3	0.38	15.2	4.3	D1
780412	2125	45.43	56-25.93	152-19.97	21.56	3.25	8	323	93.4	0.32	54.5	13.5	D1
780412	2310	50.76	56-32.60	153- 3.33	28.20	3.51	15	257	69.2	0.52	8.6	2.8	D1
780412	2345	9.39	55-38.45	152- 6.43	30.07	3.50	5	332	378.9	0.39	173.9	613.6	D1
780413	51	54.75	56- 8.45	152-40.71	25.39	3.51	8	308	116.6	0.52	53.5	16.4	D1
780413	201	1.66	55-41.97	152-19.93	38.87	3.05	4	331	369.7	0.15	0.	0.	C1
780413	239	9.84	56-49.75	152-31.15	25.70	3.09	6	307	50.6	0.40	30.9	7.8	D1
780413	337	44.37	56-28.20	152-58.59	27.70	2.77	7	264	74.9	0.58	19.6	6.7	D1
780413	600	49.95	56-23.32	152-43.58	31.91	4.04	14	271	89.0	0.51	13.5	3.6	D1
780413	739	33.20	56-22.71	152-45.25	19.09	3.36	10	272	89.7	0.63	20.0	7.8	D1
780413	812	36.32	56-57.03	153-14.93	33.16	2.78	4	270	25.9	0.11	0.	0.	C1
780413	950	52.64	56-24.12	152-47.31	32.38	3.45	14	267	86.7	0.46	11.0	3.2	D1

Table 2. Continued.

780413	1247	13.63	56-44.80	152-28.68	23.41	2.77	7	249	59.2	0.20	6.7	3.0	D1
780413	1359	59.36	56-12.21	152-24.31	26.28	4.62	18	274	114.7	0.49	12.5	4.4	D1
780413	1623	20.71	56-31.27	152-41.39	25.02	4.09	14	261	75.5	0.58	11.3	4.5	D1
780413	1649	45.81	56-34.72	152-35.51	29.87	3.11	7	323	71.7	0.34	73.1	9.5	D1
780413	1829	18.78	56-27.77	152-34.85	25.79	3.57	8	278	83.9	0.36	27.3	7.9	D1
780414	423	20.71	56-25.97	153- 8.41	32.08	2.01	4	315	81.5	0.04	0.	0.	C1
780414	1459	44.95	56-29.41	153-12.46	31.69	2.24	4	311	75.5	0.06	0.	0.	C1
780414	531	32.62	56-52.27	153-37.82	5.00	2.10	3	179	46.7	0.01	0.	0.	C1
780414	1255	34.81	56-37.81	152-37.03	36.15	2.72	4	322	264.6	0.09	0.	0.	C1
780414	1308	23.17	56-30.28	152-10.61	10.97	1.83	4	321	91.9	0.94	0.	0.	D1
780414	1613	28.00	56-35.27	152-28.16	25.82	3.05	8	259	74.2	0.33	10.7	3.8	D1
780414	1827	9.04	56-15.36	152-58.54	32.56	3.79	13	281	81.8	0.41	14.7	3.0	D1
780414	1829	50.60	56-14.90	152-59.29	34.07	3.76	10	285	81.5	0.38	18.6	3.1	D1
780414	2229	36.87	56-49.66	152-35.43	27.90	2.81	7	310	47.9	0.26	19.7	3.3	D1
780414	2335	46.56	56- 8.13	152-19.47	0.14	3.38	7	276	123.6	0.32	17.2	34.1	D1
780415	1340	47.26	56-55.12	152-39.53	28.09	2.78	5	304	37.5	0.24	19.8	4.8	D1
780415	1843	11.51	56- 9.31	152-11.57	10.87	3.80	8	285	124.8	0.25	12.8	12.2	D1
780415	1843	40.75	55-41.64	152-10.62	27.56	4.17	5	331	372.2	0.22	71.6	262.8	D1
780415	2221	2.81	56-23.86	152-18.91	19.99	3.49	6	324	97.3	0.17	41.0	10.7	D1
780415	2308	31.50	56-11.65	152-25.82	21.37	3.91	9	283	115.1	0.33	16.5	5.8	D1
780416	950	51.92	56-32.39	152-50.77	26.37	4.60	18	243	71.0	0.59	8.9	3.2	D1
780416	1037	32.91	56-19.72	152-31.95	2.73	3.34	9	295	98.9	0.55	33.8	36.0	D1
780416	1050	59.17	56-30.77	152-23.35	21.59	3.17	6	322	83.9	0.16	33.0	8.0	D1
780416	1102	57.07	56-32.43	152-33.30	99.88	2.44	4	283	76.5	0.04	0.	0.	C1
780416	1111	23.79	56-15.75	152-41.72	29.66	3.43	8	271	103.1	0.37	15.8	6.0	D1
780417	1014	9.38	56-18.34	152-49.07	33.11	3.36	8	277	88.9	0.36	15.5	3.8	D1
780417	1047	9.04	56-16.55	152-32.29	20.23	3.39	7	272	104.4	0.31	17.9	7.4	D1
780417	1654	44.49	55-43.63	152-37.02	16.29	2.86	5	323	162.5	0.17	67.9	22.5	D1
780417	2040	32.39	56-30.69	152-42.24	24.79	4.75	16	262	76.2	0.57	10.2	3.8	D1
780417	2115	41.60	56-56.33	152-28.27	21.49	2.82	5	304	44.6	0.31	145.7	33.4	D1
780418	6	48.24	56-44.31	152-43.71	32.13	3.18	6	334	52.0	0.27	176.5	12.1	D1
780418	218	6.92	56-15.95	152-52.05	31.09	4.09	17	247	87.5	0.61	13.1	4.0	D1
780418	1632	40.82	56-26.83	152-43.51	30.77	3.43	10	266	82.7	0.49	16.3	4.3	D1
780419	47	9.08	56-59.62	153-36.34	5.00	1.42	3	157	37.1	0.	0.	0.	C1
780419	437	53.31	56-29.81	153-10.31	31.73	2.80	4	312	74.5	0.03	0.	0.	C1
780419	623	22.63	56-27.12	152-59.71	25.45	3.49	11	265	74.1	0.55	12.9	4.4	D1
780419	1118	55.95	55-57.27	152-41.99	43.00	2.52	8	313	136.7	0.67	84.6	953.6	D1
780419	1355	7.60	55-38.44	152-42.12	39.36	3.07	8	319	171.2	0.68	115.9	961.0	D1
780419	223	10.64	56-53.37	152-35.99	26.43	2.81	7	305	42.3	0.36	19.7	5.2	D1
780420	3242	54.57	56-21.99	152-41.86	34.51	2.17	4	279	91.9	0.	0.	0.	C1
780420	545	14.50	56-28.83	152-59.66	34.50	2.83	6	280	73.7	0.28	21.0	2.9	D1
780420	1418	4.66	56- 5.20	152-53.38	28.91	2.69	7	315	120.6	0.47	67.6	17.7	D1
780420	2302	41.72	56-26.20	152-37.24	27.89	3.15	7	325	85.7	0.54	138.6	26.0	D1
780421	309	8.54	55-31.03	152-28.04	4.50	2.67	5	327	187.3	0.16	68.3	63.2	D1
780421	325	46.36	56-56.70	152-56.53	34.69	2.46	4	314	25.8	0.23	0.	0.	C1
780422	921	50.82	56-38.36	153-19.13	8.37	1.67	4	247	53.8	0.51	0.	0.	D1
780422	1324	2.18	56-11.57	152-49.22	30.62	3.50	17	254	93.5	0.48	9.2	3.6	D1
780422	1329	48.43	56-25.61	152-55.97	21.31	3.33	13	268	78.3	0.63	14.0	5.4	D1
780422	1342	26.03	56- 0.47	152-42.40	1.13	3.10	8	301	130.8	0.44	40.6	68.7	D1
780422	1400	28.93	56-13.00	152-45.66	27.88	3.07	8	283	95.7	0.36	19.5	5.9	D1
780422	1406	48.71	56-15.85	152-44.48	29.64	2.93	8	296	102.3	0.41	30.3	9.0	D1
780422	1411	28.56	56-10.86	152-49.72	5.00	2.97	7	308	110.6	0.57	53.3	53.9	D1
780422	1836	2.54	56-36.98	153-10.25	33.66	2.96	5	259	61.2	0.04	1.7	0.6	C1
780423	357	15.95	56-58.31	152-51.33	33.04	1.82	4	313	25.4	0.03	0.	0.	C1
780423	615	27.70	56-58.63	153-18.04	34.44	2.50	4	264	24.7	0.68	0.	0.	D1
780423	1755	16.15	56-13.62	152-38.23	31.29	1.53	4	288	102.3	0.04	0.	0.	C1
780424	1113	6.72	56-58.82	152-55.02	34.55	2.52	4	313	22.7	0.21	0.	0.	C1
780424	1121	55.57	56-27.19	152-59.89	27.41	3.04	9	265	73.9	0.50	13.7	4.2	D1
780424	1359	16.03	56- 0.74	152-56.11	24.77	3.26	6	313	128.6	0.43	62.0	18.7	D1
780425	223	33.66	56-28.92	153-29.38	13.16	3.21	6	258	43.5	0.68	12.2	102.5	D1
780427	141	15.43	56-23.77	152-40.13	32.48	4.60	18	242	89.2	0.48	8.1	3.0	D1
780427	2127	11.28	56-49.48	153-31.95	5.00	2.88	3	197	46.7	0.43	0.	0.	D1
780428	252	48.24	56-26.92	152-52.97	26.92	3.80	13	265	80.6	0.54	11.8	3.6	D1
780428	1347	57.03	56-57.77	152-34.20	31.96	2.67	4	303	38.2	0.60	0.	0.	D1
780430	1541	44.33	56-45.01	153-44.99	6.63	1.85	5	190	33.9	0.78	55.3	88.1	D1
780430	1640	46.71	56-46.50	153-36.20	15.20	2.80	5	200	42.8	0.12	3.1	2.7	D1
780501	548	16.55	56-45.03	152-18.38	18.32	0.	5	306	65.8	0.05	6.7	2.2	D1
780502	710	7.24	56-29.36	152-46.36	23.91	3.05	8	263	77.5	0.66	19.3	6.8	D1
780512	22 4	7.32	56-14.73	152-40.90	34.62	3.25	4	287	99.0	0.	0.	0.	C1
780514	632	6.49	56-10.84	152-42.17	29.22	2.71	10	285	100.6	0.40	18.1	4.4	D1
780514	1252	47.57	56-19.16	152-53.88	33.98	2.94	8	276	83.7	0.29	12.2	2.7	D1
780518	1445	56.67	56-35.69	152-38.50	39.36	3.36	4	270	68.8	0.	0.	0.	C1
780518	2133	31.46	56- 9.05	153-15.76	33.15	3.46	9	294	72.8	0.52	30.4	4.8	D1
780519	048	53.74	55-38.06	153- 5.09	29.67	2.77	6	318	123.6	0.27	90.3	17.2	D1
780521	1455	27.36	56- 2.65	152-20.71	19.50	4.30	12	273	127.4	0.61	21.7	8.6	D1
780525	1449	21.15	55-58.61	152-17.36	17.61	3.30	13	280	134.0	0.46	21.6	8.3	D1
780528	1334	6.40	56- 4.68	152-46.10	25.24	3.61	9	310	122.5	0.49	48.3	14.6	D1

Table 3. Azimuth, angle of incidence, and first motion (C = compression, D = dilitation of local and regional stations; see Figure for station location and Table 4 for station names and coordinates).

Station (code)	Azimuth	Angle of Incidence	Motion
SKS	341	103	C
KDC	1	55	C
MMC	311	55	C
RAI	349	55	C
CHO	263	55	C
FLP	304	55	C
UKL	294	55	C
MAA	305	55	C
BMT	310	55	C
PNM	280	55	C
MCN	342	55	C
YCB	275	55	C
SVW	341	55	C
PMS	18	55	C
PWA	15	55	C
TOA	30	55	C
TTA	345	55	C
PAX	28	55	C
NRA	332	55	C
RDS	14	55	D
GIL	16	55	C
GLM	16	55	D
FYU	19	55	D
DMA	330	55	C
KTA	336	55	C

Table 4

Seismographic Stations

* DENOTES NOAA STATION
& DENOTES USGS STATION
ALL OTHERS ARE UNIVERSITY OF ALASKA STATIONS

STATION NAME	CODE	LATITUDE (NORTH)	LONGITUDE (WEST)	ELEVATION (METERS)
ANVIL MOUNTAIN	ANV	64° 34.60'	165° 22.20'	327
AUGUSTINE ISLAND	AUG	59 20.05	153 25.62	259
BIG MOUNTAIN&	BIG	59 23.34	155 13.02	570
BARTER ISLAND #1	BI1	70 07.91	143 38.50	10
BARTER ISLAND #2	BI2	69 37.41	145 53.71	1100
BARTER ISLAND #3	BI3	69 35.08	144 22.24	690
BARTER ISLAND #4	BI4	69 31.21	142 58.80	745
BLACK RAPIDS*	BLR	63 30.10	145 50.70	810
BLUE MOUNTAIN	BMT	58 02.80	156 20.20	548
CAPE DOUGLAS	CDA	58 57.32	153 31.77	386
CHIRIKOF ISLAND	CHI	55 48.50	155 38.60	250
CHOWIET ISLAND	CHO	56 02.00	156 42.70	160
DONNELLY DOME	DDM	63 47.23	145 51.70	920
DEVIL MOUNTAIN	DMA	66 18.60	164 31.20	243
DEADMAN BAY	DMB	57 05.23	153 57.63	300
FEATHERLY PASS	FLP	57 42.70	156 15.90	485
FORT YUKON	FYU	66 33.63	145 12.60	137
FORT YUKON #1	FY1	67 16.00	148 58.17	939
FORT YUKON #2	FY2	67 07.47	147 05.83	671
FORT YUKON #3	FY3	68 08.83	145 42.00	1439
FORT YUKON #4	FY4	67 27.20	146 12.58	792
FORT YUKON #5	FY5	67 08.40	143 15.00	558
GOLD KING CREEK	GKC	64 10.72	147 56.08	490
GILMORE DOME	GLM	64 59.24	147 23.34	820
GRANITE MOUNTAIN*	GMA	65 25.72	161 13.92	860
HARDING LAKE	HDA	64 24.35	146 57.23	450
HOMER	HOM	59 39.50	151 38.60	198
INDIAN MOUNTAIN*	IMA	66 04.11	153 40.72	1380
KNIK GLACIER&	KNK	61 24.75	148 27.34	595
KOTZEBUE	KTA	66 51.00	162 36.60	26
MAARS	MAA	57 51.40	156 29.37	131
LEVY	LVY	64 13.00	149 15.20	230
MCKINLEY PARK	MCK	63 43.94	148 56.10	610
MCNEIL RIVER	MCN	59 06.06	151 11.99	273
MIDDLETON ISLAND*	MID	59 25.67	146 20.33	37
MIDDLE CAPE	MMC	57 20.00	154 38.10	340
NENANA	NEA	64 34.63	149 04.63	365
NORTH RIVER	NRA	63 53.40	160 30.60	107
OIL POINT	OPT	59 39.16	153 13.78	625
PAXSON	PAX	62 58.25	145 28.12	1130
PORT MOLLER*	PMA	55 58.72	160 29.83	315
PALMER OBSERVATORY*	PMR	61 35.53	147 07.85	100
ARCTIC VALLEY (PALMER SOUTH)*	PMS	61 14.68	149 33.63	716
PINNACLE MOUNTAIN	PNM	56 48.30	157 35.00	442
PAVLOF VOLCANO	PVV	55 22.85	161 48.45	180
PUALE BAY	PUB	57 46.40	155 31.00	280
HOUSTON (PALMER WEST)*	PWA	61 39.05	149 52.72	137
RASPBERRY ISLAND	RAI	58 03.63	153 09.55	520
RICHARD D. SIEGRIST	RDS	64 49.59	148 08.68	510
REDOUBT VOLCANO	RED	60 25.14	152 46.32	1067
SAWMILL&	SAW	61 48.49	148 19.98	740
SHEEP MOUNTAIN	SCM	61 50.00	147 19.66	1020
SHUYAK ISLAND	SHU	58 37.68	152 20.93	34
SITKINAK ISLAND	SII	56 33.60	154 10.92	500
SITKA OBSERVATORY*	SIT	57 03.62	135 19.47	19
SITKALIDAK ISLAND	SKS	57 09.85	153 04.82	135
SELDOVIA&	SLV	59 28.28	151 34.83	91
SPIRIDON LAKE	SPL	57 45.55	153 46.28	600
SPARREVOHN*	SVW	61 06.49	155 37.30	762
TIN CITY	TNA	65 33.60	167 55.20	76
TANANA	TNN	61 15.40	151 54.70	504
TOLSONA*	TOA	62 06.28	146 10.34	909
TATALINA*	TTA	62 55.80	156 01.31	914
UGASHIK LAKE	UKL	57 24.10	156 51.30	410
YELLOW CREEK BLUFF	YCB	56 38.90	158 40.90	320

Figure 1. Epicenter location Main Event and aftershocks (all locatable events) of April 12, 1978 magnitude 5.8 earthquake off Kodiak Island. Location of events is at left hand lower corner of letter. Letter code represents hypocentral depth range (A: 0 to 25 km B: 26-50 km etc.). Size of letter is propotional to magnitude, Size of geographic coordinates corresponds to magnitude m = 2.

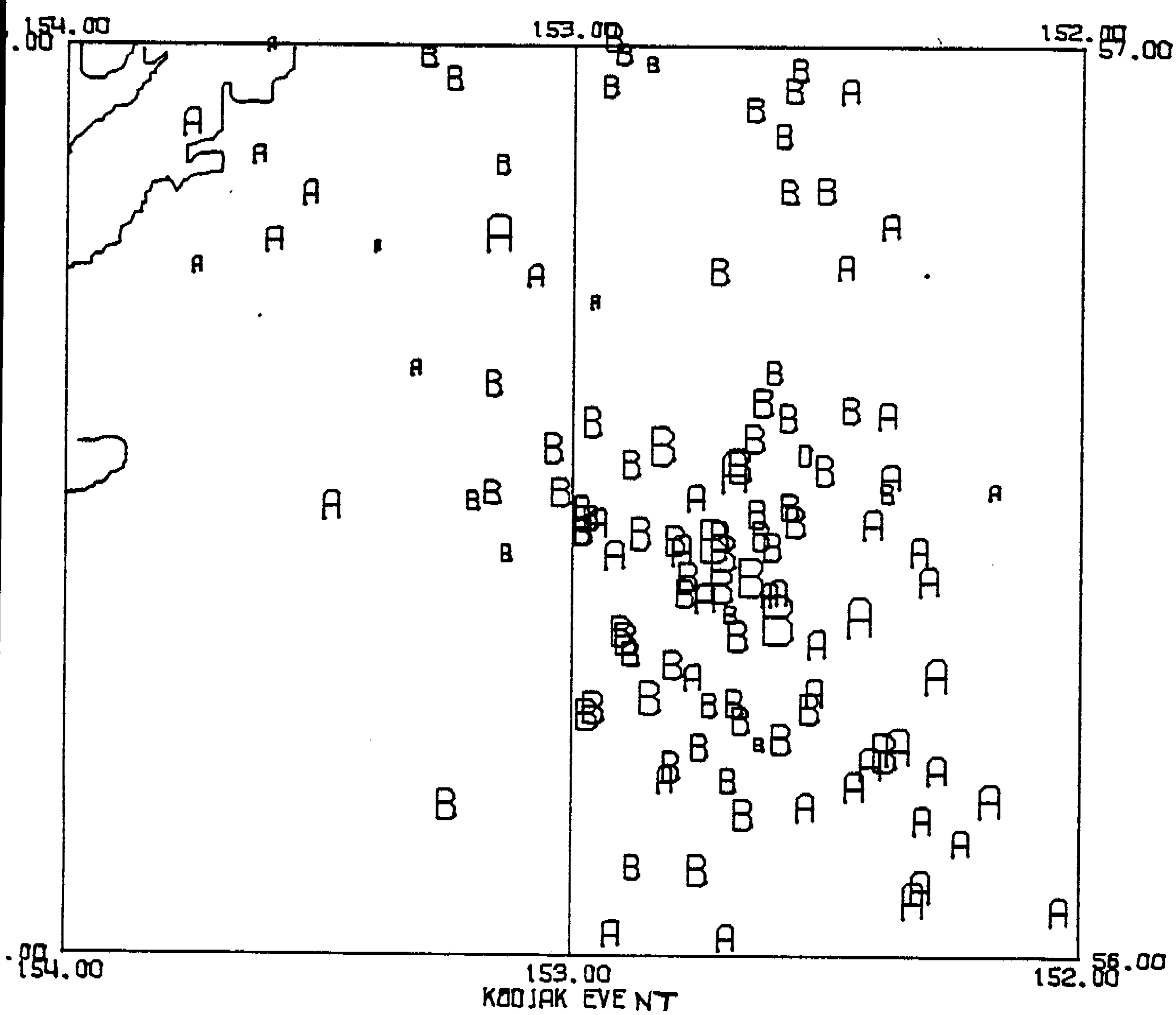
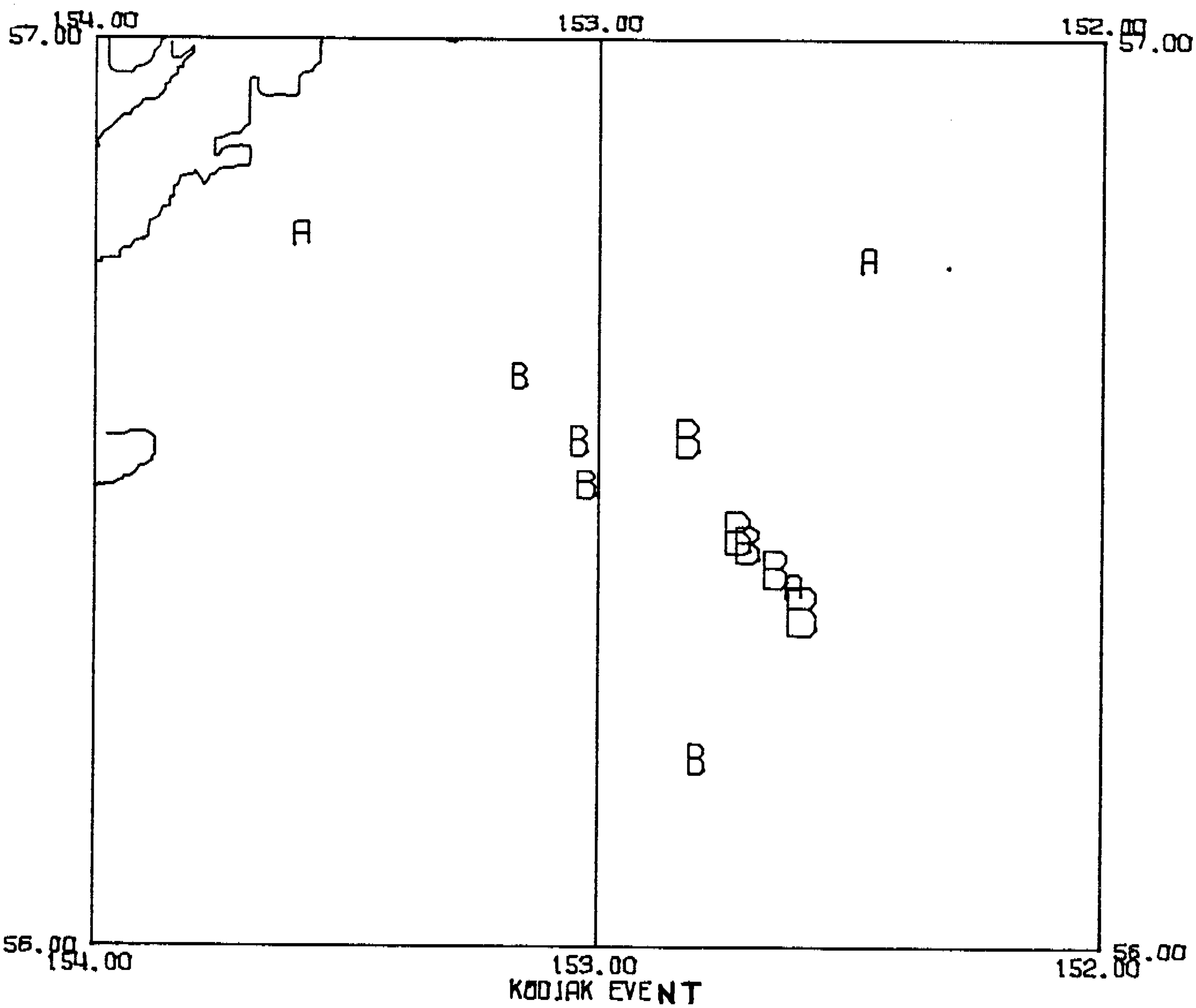


Figure 2. Epicenter location of main event and aftershocks (class 1 events) of April 12, 1978, magnitude M = 5.8 earthquake off Kodiak Island. See Figure 1 for symbols.



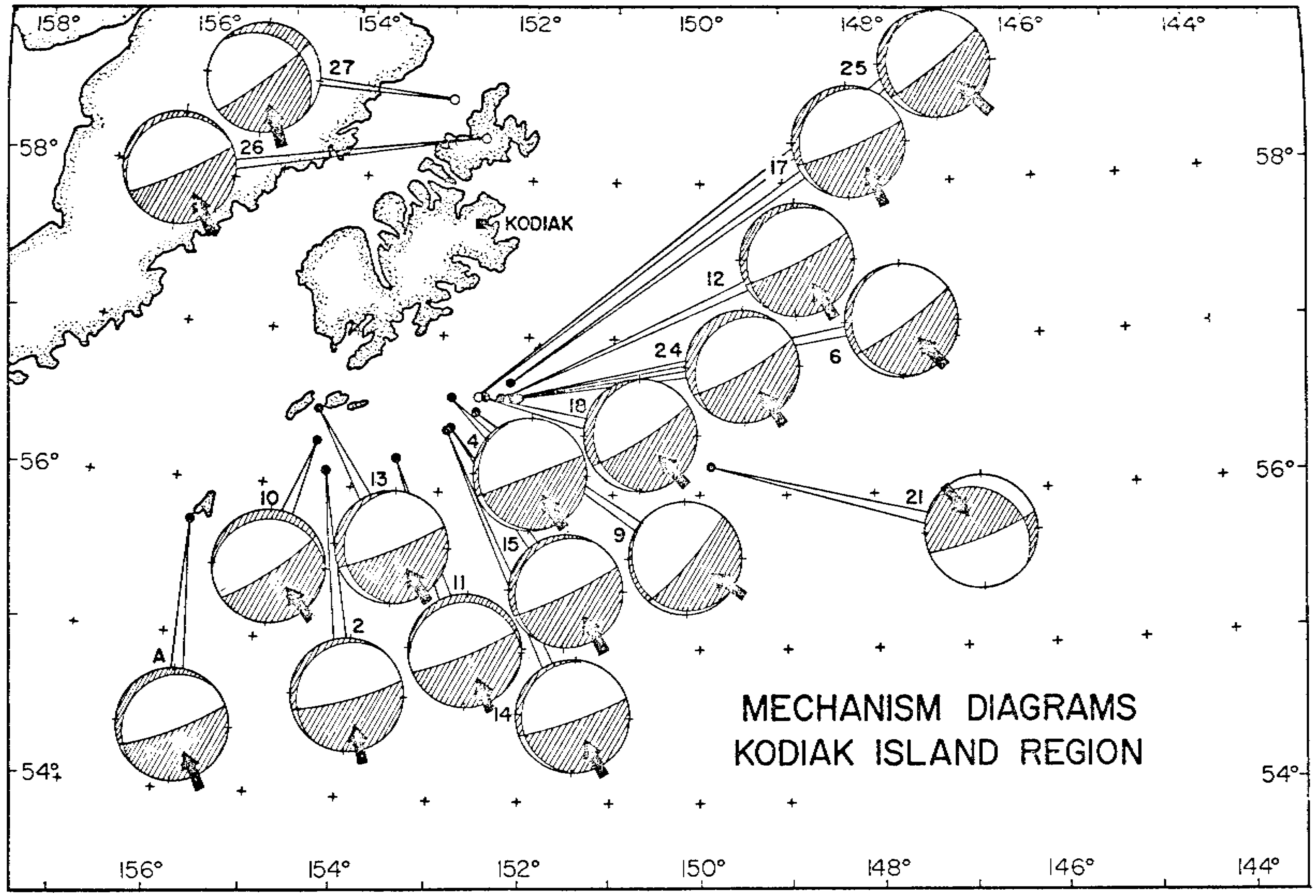


Figure 3. Mechanism diagrams (stereographic projections) of earthquakes in the Kodiak Island region. Shaded areas represent rarefaction quadrants; arrows represent direction of P (pressure) axes (from Stauder and Bollinger).

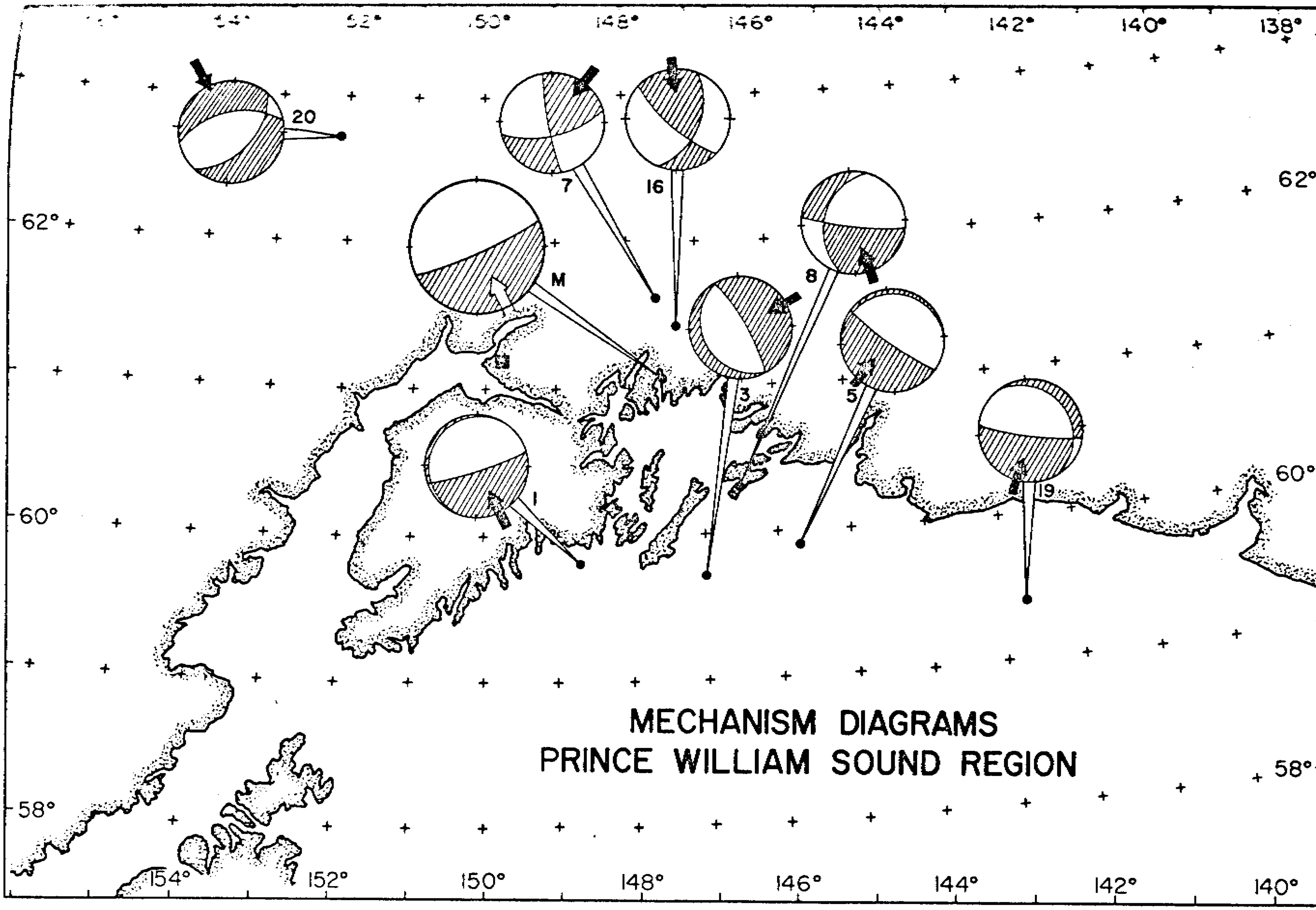


Figure 4 . Mechanism diagrams for earthquakes in the Prince William Sound region. The shock labeled M is the main shock. (From Stauder and Bollinger.)

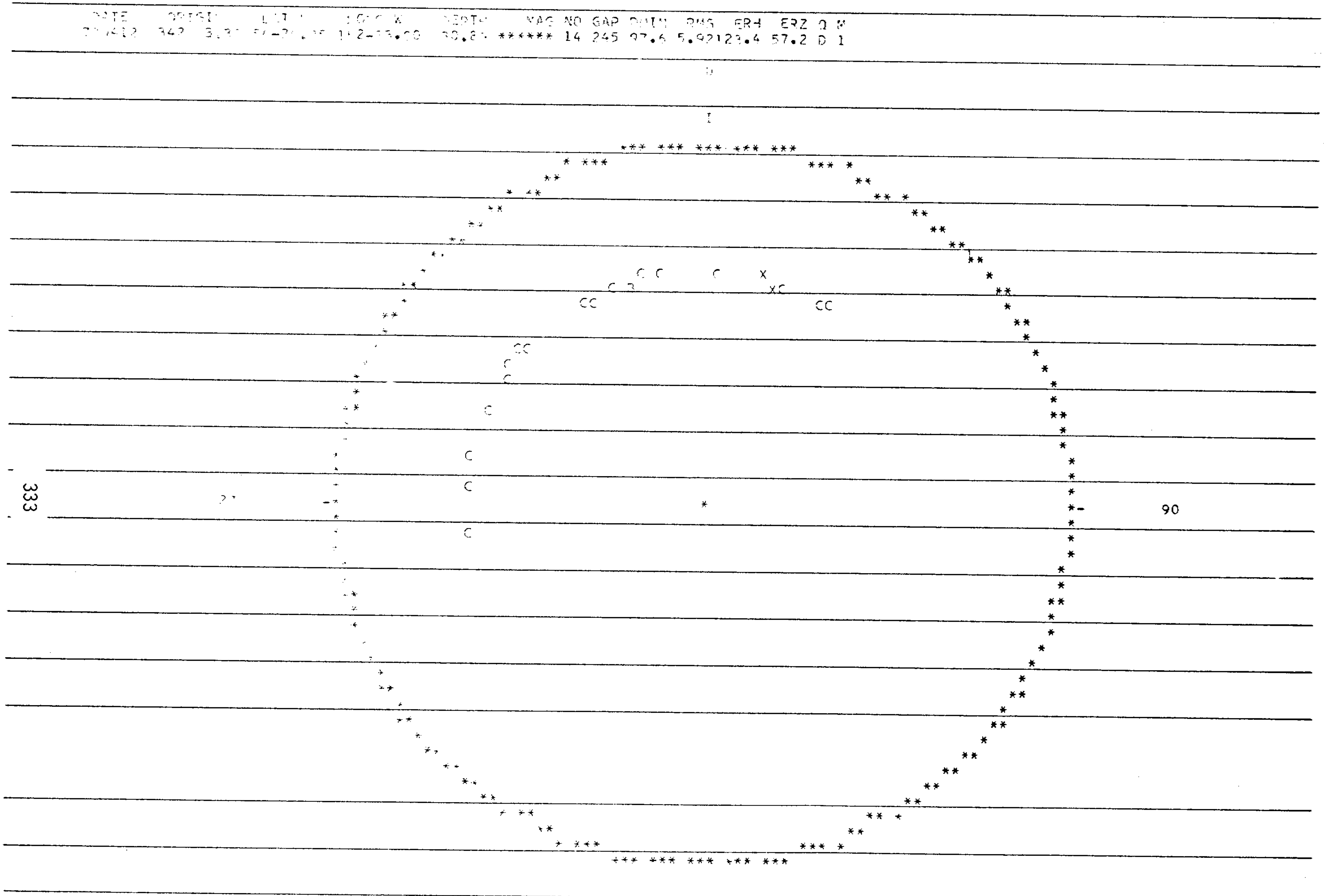


Figure 5. First motion plot (stereographic projection of the lower hemisphere) for the April 12, 1978, magnitude 5.8 earthquake off Kodiak Island. (C = compression, B = two compression, X = one dilitation and one compression)

DATE ORIGIN LAT N LONG W DEPTH MAG NO GAP DMIN RMS ERH ERZ Q M
[illegible] 447 18.12 [illegible] [illegible] 21.02 5.1 15 250 [illegible] 0.47 [illegible] 4.3 D 1

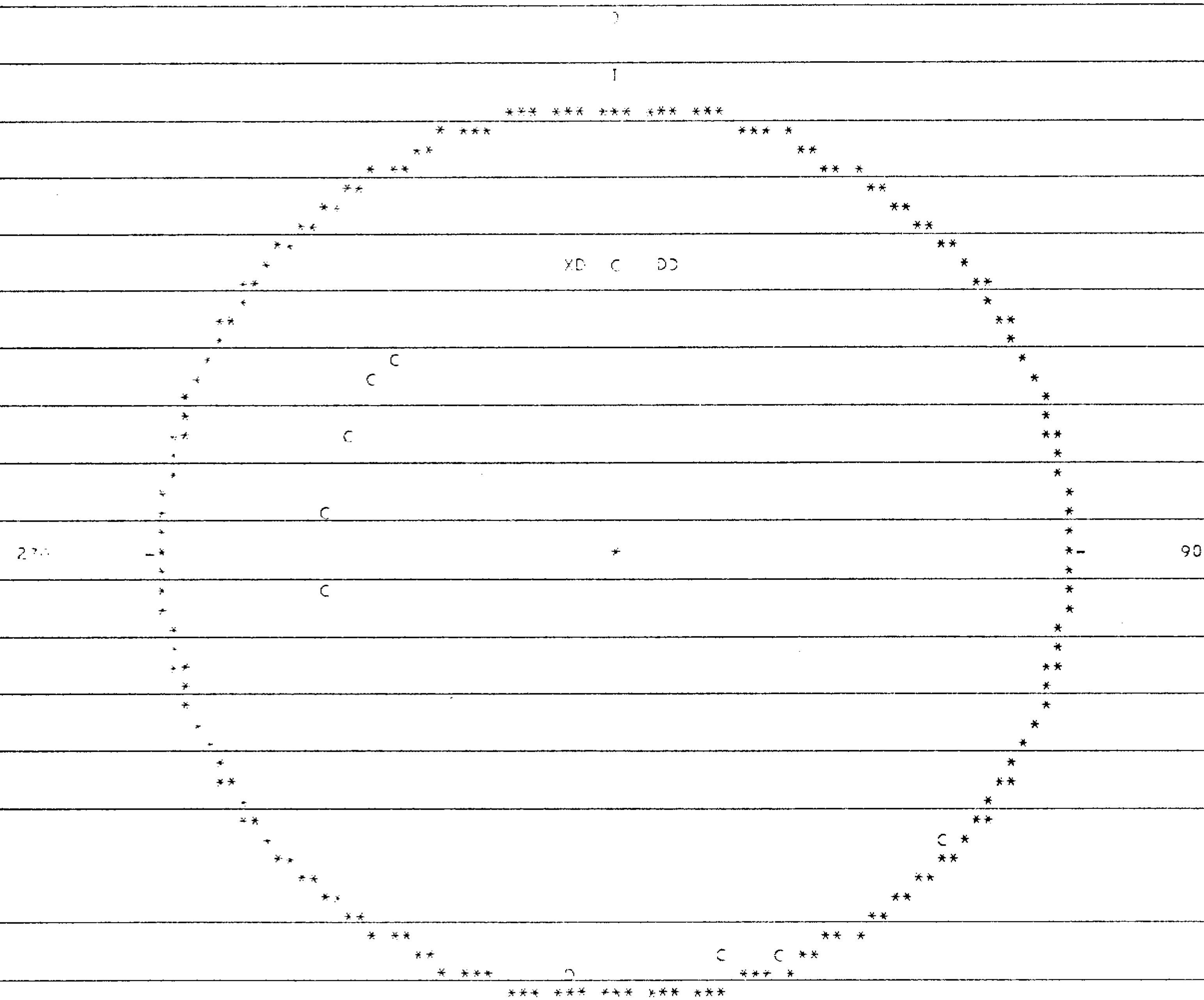


Figure 6. First motion plot (stereographic projection of the lower hemisphere) for the April 12, magnitude 5.1 aftershock of 0447.

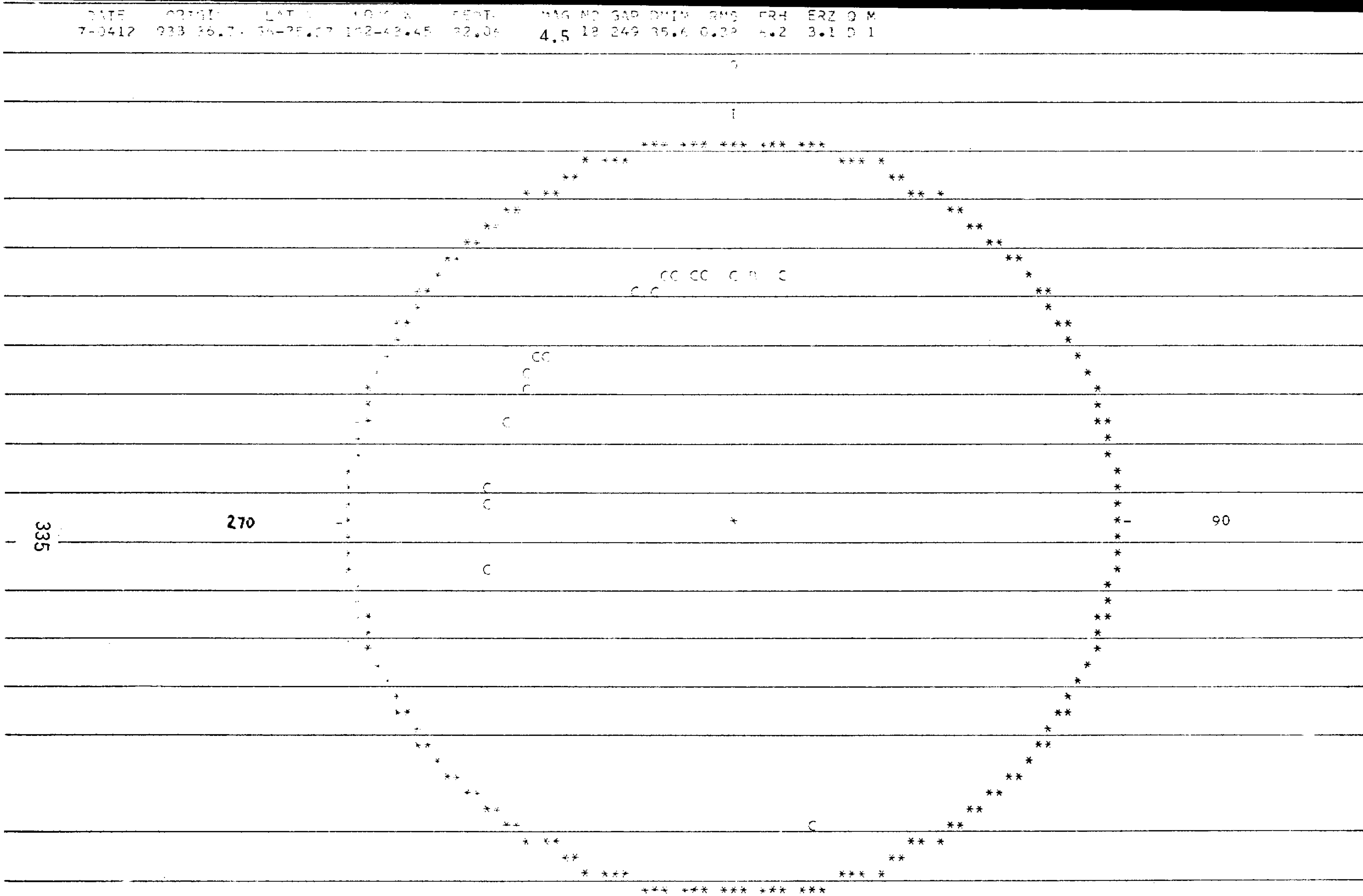


Figure 7. First motion plot (stereographic projection of the lower hemisphere) for the April 12, magnitude 4.5 aftershock of 0933.

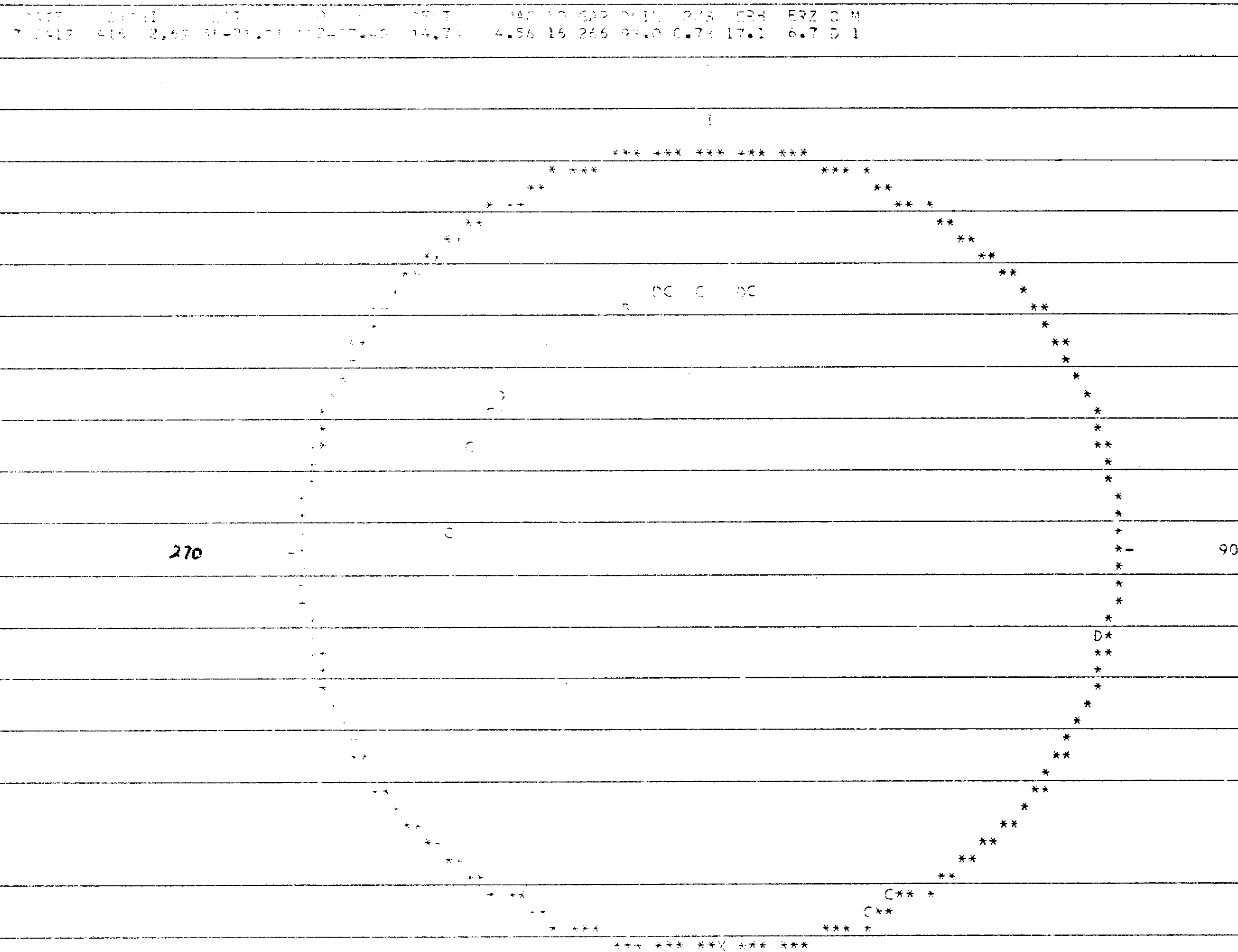


Figure 9. First motion plot (stereographic projection of lower hemisphere) for the April 12, magnitude 4.6 aftershock at 0416.

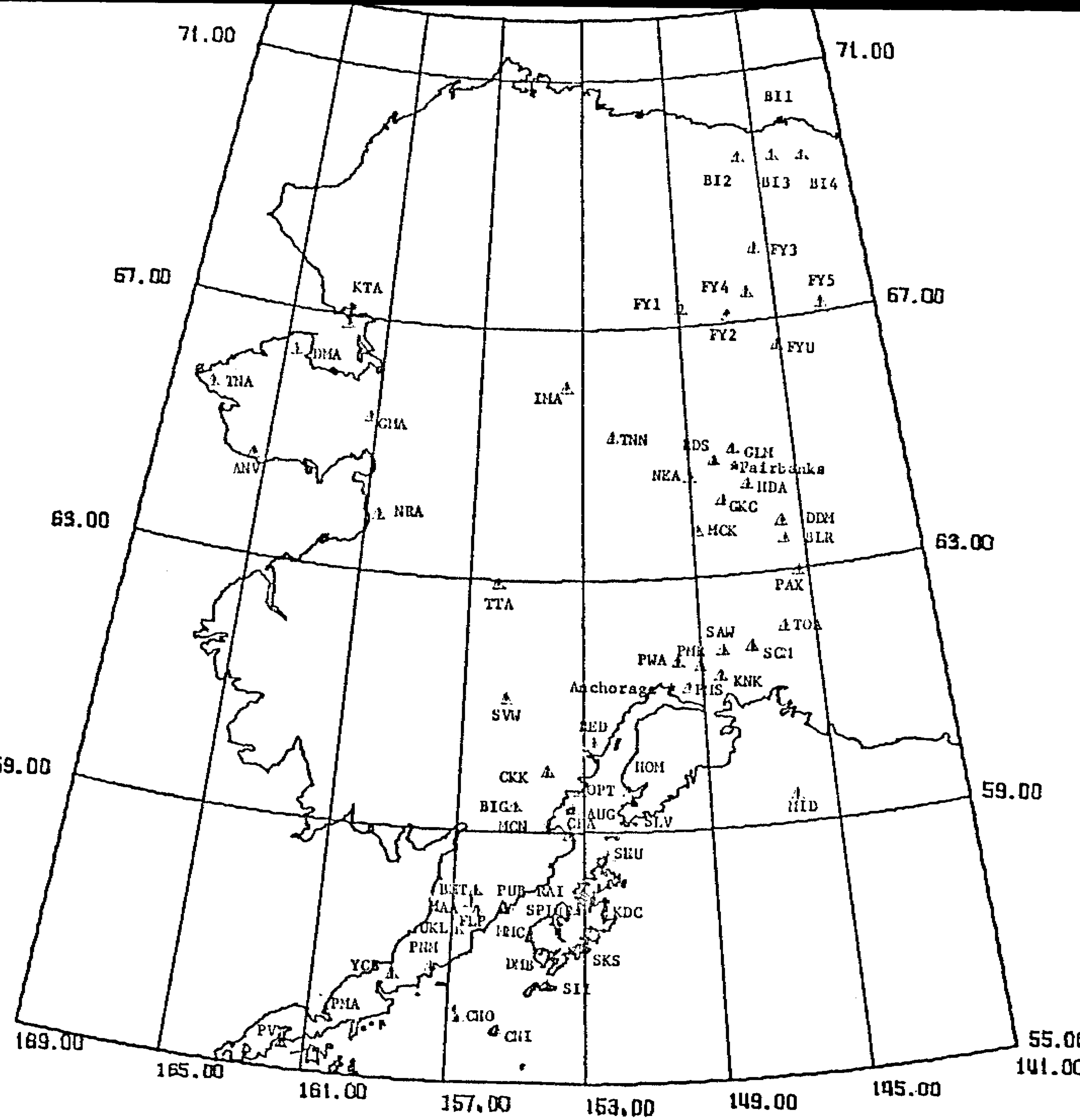


Figure 10. GEOGRAPHIC LOCATIONS OF SEISMOGRAPHIC STATIONS

5

Appendix 1

Hypocenter Listings for Cook Inlet, Kodiak, and Alaska Peninsula

March 1978 through May 1978

Table A1-1 All Events

This appendix lists origin times, focal coordinates, magnitudes, and related parameters for earthquakes which occurred in the lower Cook Inlet, Kodiak, and Alaska Peninsula areas. The following data are given for each event:

(1) Origin time in Greenwich Civil Time (GCT): date, hour (HR), minute (MN), and second (SEC). To convert to Alaska Standard Time (AST), subtract ten hours.

(2) Epicenter in degrees and minutes of north latitude (LAT N) and west longitude (LONG N).

(3) DEPTH, depth of focus in kilometers.

(4) MAG, magnitude of the earthquake. A zero means not determined.

(5) NP, number of P arrivals used in locating earthquake.

(6) NS, number of S arrivals used in locating earthquake.

(7) GAP, largest azimuthal separation in degrees between stations.

(8) DM, epicentral distance in kilometers to the closest station to the epicenter.

(9) RMS, root-mean-square error in seconds of the travel time residuals:

$$RMS = \sum_i (R^2_{Pi} + R^2_{Si}) / (NP + NS)$$

Where R_{Pi} and R_{Si} are the observed minus the computed arrival times of P and S waves, respectively, at the i-th station.

(10) ERH, largest horizontal deviation in kilometers from the hypocenter within the one-standard-deviation confidence ellipsoid. This quantity is a measure of the epicentral precision for an event.

(11) ERZ, largest vertical deviation in kilometers from the hypocenter within the one-standard-deviation confidence ellipsoid. This quantity is a measure of the depth precision for an event.

(12) Q, quality of the hypocenter. This index is a measure of the precision of the hypocenter and is the average of two quantities, QS and QD, defined below:

QS	RMS (sec)	ERH (km)	ERZ (km)
A	< 0.15	≤ 1.0	≤ 2.0
B	< 0.30	≤ 2.5	≤ 5.0
C	< 0.50	≤ 5.0	
D	Others		

QD is rated according to the station distribution as follows:

QD	NO	GAP	DMIN
A	≥ 6	≤ 90°	≤ DEPTH or 5 km
B	≥ 6	≤ 135°	≤ 2x DEPTH or 10 km
C	≥ 6	≤ 180°	≤ 50 km
D	Others		

The following table is included:

Table A1-1 Cook Inlet, western Gulf of Alaska
All Events

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

ORIGIN TIME HR MN	SEC	LAT N DEG MIN	LONG W DEG MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
1 0 13	22.7	60 0.4	152 58.9	138.0	3.8	14	104	43	0.37	4.1	6.7	C
1 14 34	19.5	59 5.0	153 1.0	51.0	2.3	5	170	49	0.19	5.1	12.5	D
2 6 43	34.4	59 21.1	152 56.9	95.4	2.9	9	133	34	0.23	3.1	4.7	C
2 7 25	10.5	59 22.2	153 5.4	34.3	2.6	12	98	19	0.28	2.3	3.7	B
2 9 4	25.3	59 53.4	152 11.6	64.0	2.5	8	172	58	0.43	8.2	16.5	D
2 10 39	33.9	59 40.3	152 27.4	131.7	3.0	15	76	48	0.30	2.7	4.3	B
2 11 13	25.5	57 45.0	154 29.0	63.7	3.0	8	80	42	0.42	6.9	14.7	C
2 12 52	4.0	59 37.1	151 10.1	57.5	2.6	6	251	63	0.15	10.7	7.8	D
2 13 34	59.7	59 58.2	151 58.9	5.0	2.0	3	180	31	0.01	0.	0.	C
2 13 55	23.7	59 [illegible]	153 42.9	79.3	2.2	5	156	16	0.07	2.5	5.3	D
2 14 41	40.0	56 12.9	155 7.7	75.0	4.6	18	222	59	0.36	6.0	6.9	D
2 15 4	23.8	60 6.3	152 28.0	45.0	2.3	9	163	33	0.45	9.8	25.9	D
2 20 7	11.2	57 54.2	153 30.3	21.4	1.5	4	191	5	0.	0.	0.	C
2 21 7	35.6	60 3.4	152 58.9	134.0	2.5	11	137	41	0.31	5.5	7.8	D
2 21 23	11.5	58 1.3	154 38.4	5.0	1.6	3	267	59	0.17	0.	0.	C
2 22 33	39.0	57 53.6	154 28.4	19.7	1.4	5	183	4	0.	0.1	0.1	C
2 23 27	21.1	59 59.3	152 27.6	50.0	2.5	13	128	40	0.50	3.9	9.3	C
2 23 31	53.5	57 54.6	154 30.1	20.5	1.5	4	192	6	0.	0.	0.	C
2 23 39	47.5	57 57.5	154 3.8	50.0	1.9	5	188	18	0.44	19.3	21.6	D
2 23 45	34.3	57 53.2	154 29.3	19.7	1.5	4	187	4	0.	0.	0.	C
2 23 46	20.0	57 54.2	154 28.0	22.4	2.0	5	183	5	0.16	4.0	4.5	D
3 0 13	10.7	57 54.7	154 31.3	21.7	1.9	4	197	6	0.	0.	0.	C
3 0 13	33.5	57 54.4	154 31.3	21.0	1.9	4	196	5	0.	0.	0.	C
3 0 18	25.4	57 54.6	154 30.8	20.4	1.4	4	194	5	0.	0.	0.	C
3 [illegible] 42	1.4	56 40.5	152 24.8	4.0	2.0	4	234	48	0.56	0.	0.	D
3 5 19	36.2	57 54.9	154 31.7	20.0	1.6	4	199	6	0.	0.	0.	C
3 5 33	50.2	57 54.4	154 24.5	11.0	1.0	4	154	7	0.04	0.	0.	C
3 5 36	23.0	57 22.4	153 34.0	12.0	2.6	5	122	51	0.44	6.2	977.8	D
3 5 47	7.0	57 56.0	154 31.7	20.0	1.4	4	199	5	0.	0.	0.	C
3 5 50	0.1	57 20.5	155 46.9	63.0	2.3	7	227	50	0.24	7.3	8.5	D
3 10 23	41.0	59 44.4	153 17.4	14.0	1.6	5	194	81	0.10	2.1	4.0	C
3 11 20	4.2	57 4.4	153 43.5	36.0	2.5	5	131	40	0.01	0.1	0.1	C
3 12 14	19.0	57 54.2	155 30.1	21.0	1.8	4	191	13	0.	0.	0.	C
3 16 40	25.0	59 26.2	152 55.4	75.0	2.1	5	155	63	0.	0.	0.1	C
3 17 2	20.1	59 41.7	152 48.2	90.0	2.1	7	155	65	0.19	3.7	8.6	D
3 17 6	11.4	59 21.3	154 16.8	91.1	1.9	7	135	72	0.24	3.7	12.6	C
3 17 59	21.1	57 52.4	155 38.7	7.1	2.3	5	211	9	0.09	2.0	1.4	C
3 19 43	4.0	60 10.1	151 56.7	4.2	2.5	4	222	53	0.57	0.	0.	C
3 19 48	33.3	59 2.0	153 47.9	28.8	4.2	16	275	102	0.46	13.9	4.2	C
4 0 41	20.6	59 14.9	153 37.5	110.4	2.6	8	185	12	0.25	5.9	4.9	D
4 1 52	56.0	59 44.4	153 19.6	121.4	2.8	14	132	41	0.35	4.0	5.5	C
4 4 48	13.1	59 37.3	152 15.8	24.0	2.5	4	146	35	0.24	0.	0.	C
4 7 5	50.0	60 50.0	154 42.2	137.1	2.4	10	176	40	0.23	3.0	5.5	C
4 7 19	37.1	57 44.3	152 32.0	43.1	1.9	4	125	14	0.	0.	0.	C
4 8 20	20.7	59 59.7	153 46.9	33.4	2.0	5	282	71	0.10	11.9	1.5	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

	ORIGIN HR	MN	TIME SEC	LAT DEG	MIN	LONG DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
4	[illegible]	23	[illegible]	54	[illegible]	[illegible]	51.0	[illegible]	3.5	16	274	97	0.43	14.2	4.0	D
4	[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]	25.4	34.2	2.5	8	202	39	0.22	2.9	1.8	D
4	14	45	[illegible]	56	[illegible]	[illegible]	27.6	15.4	2.1	4	316	74	0.02	0.	0.	C
4	[illegible]	38	[illegible]	[illegible]	[illegible]	[illegible]	44.6	212.2	3.6	19	192	54	0.31	3.7	5.3	D
4	[illegible]	7	[illegible]	[illegible]	[illegible]	152	27.7	[illegible]	2.3	5	154	49	0.31	8.6	10.2	D
4	[illegible]	34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.4	3	133	56	0.	0.	0.	C
4	[illegible]	5	[illegible]	[illegible]	[illegible]	[illegible]	41.7	[illegible]	3.1	6	305	209	0.11	14.4	193.9	D
5	[illegible]	23	[illegible]	59	[illegible]	[illegible]	36.2	[illegible]	4.4	20	140	39	0.50	5.1	6.8	D
5	[illegible]	10	[illegible]	59	[illegible]	151	5.0	50.4	3.3	10	267	44	0.25	7.5	5.1	D
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	152	26.8	75.4	2.6	13	130	39	0.41	3.1	5.9	C
5	[illegible]	45	[illegible]	[illegible]	[illegible]	[illegible]	50.0	[illegible]	2.3	9	135	31	0.38	2.8	6.3	C
5	[illegible]	53	[illegible]	60	[illegible]	[illegible]	22.5	[illegible]	4.2	13	84	43	0.44	4.4	6.7	B
5	[illegible]	55	[illegible]	56	[illegible]	152	52.5	[illegible]	3.9	13	274	95	0.49	15.8	4.4	D
5	[illegible]	36	[illegible]	[illegible]	[illegible]	[illegible]	37.4	[illegible]	0.9	4	142	15	0.14	0.	0.	C
5	[illegible]	12	[illegible]	57	[illegible]	[illegible]	39.3	[illegible]	2.1	4	197	12	0.08	0.	0.	C
5	[illegible]	54	[illegible]	57	[illegible]	154	45.3	5.0	1.5	4	214	63	0.02	0.	0.	C
6	[illegible]	27	[illegible]	60	7.4	151	59.7	[illegible]	1.6	4	212	54	0.53	0.	0.	C
6	1	1	[illegible]	59	[illegible]	151	[illegible]	[illegible]	2.2	6	113	17	0.21	5.4	8.0	C
6	[illegible]	41	[illegible]	59	[illegible]	153	17.3	127.6	2.3	6	152	56	0.14	4.1	10.6	C
6	[illegible]	13	41.1	59	29.7	152	57.3	[illegible]	2.8	6	129	32	0.09	2.1	4.0	B
6	[illegible]	54	[illegible]	59	[illegible]	153	7.5	2.5	1.5	4	215	70	0.29	0.	0.	C
6	[illegible]	1	37.0	60	11.7	153	8.7	[illegible]	2.8	10	182	32	0.39	9.5	15.2	D
6	[illegible]	19	[illegible]	59	[illegible]	153	8.7	2.5	1.8	4	216	71	0.28	0.	0.	C
6	14	57	[illegible]	59	[illegible]	152	39.3	5.0	1.8	3	242	57	0.03	0.	0.	C
6	[illegible]	12	[illegible]	60	[illegible]	[illegible]	6.4	[illegible]	2.7	14	94	47	0.33	3.5	6.0	C
6	[illegible]	6	[illegible]	59	[illegible]	151	40.0	[illegible]	2.4	5	214	15	0.26	13.0	13.9	D
6	[illegible]	32	[illegible]	59	[illegible]	[illegible]	21.4	56.4	2.0	4	173	36	0.	0.	0.	C
6	[illegible]	47	[illegible]	59	[illegible]	154	18.0	[illegible]	4.9	18	83	17	0.28	1.8	3.3	B
6	21	35	[illegible]	59	[illegible]	151	[illegible]	[illegible]	2.4	5	218	15	0.03	2.6	3.7	D
7	[illegible]	21	[illegible]	57	[illegible]	[illegible]	45.0	[illegible]	2.7	7	165	43	0.43	5.4	4.5	D
7	[illegible]	57	[illegible]	56	[illegible]	154	6.8	[illegible]	1.6	4	162	3	0.23	0.	0.	C
7	[illegible]	38	[illegible]	[illegible]	[illegible]	[illegible]	18.1	[illegible]	3.0	8	146	62	0.35	3.9	12.0	C
7	[illegible]	53	[illegible]	59	[illegible]	[illegible]	42.8	[illegible]	3.8	15	94	49	0.34	2.7	4.3	C
7	[illegible]	24	[illegible]	59	[illegible]	[illegible]	49.8	105.4	2.1	7	109	25	0.08	2.0	1.7	B
7	[illegible]	11	[illegible]	[illegible]	[illegible]	151	14.9	[illegible]	2.8	6	245	67	0.26	8.0	3.3	D
7	[illegible]	19	[illegible]	59	[illegible]	152	54.1	[illegible]	2.4	9	181	33	0.13	4.2	3.3	D
7	[illegible]	44	[illegible]	60	[illegible]	151	17.4	[illegible]	2.2	5	260	54	0.25	5.7	4.6	D
7	[illegible]	39	[illegible]	57	[illegible]	[illegible]	12.7	[illegible]	1.4	6	129	34	0.46	5.9	32.2	D
7	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	8.2	[illegible]	3.0	11	107	74	0.68	3.6	955.8	D
7	21	50	[illegible]	56	[illegible]	[illegible]	56.0	[illegible]	3.1	7	262	75	0.69	29.4	6.2	D
8	[illegible]	17	[illegible]	60	[illegible]	152	[illegible]	109.1	3.2	7	166	40	0.08	2.4	4.5	C
8	[illegible]	35	[illegible]	56	[illegible]	[illegible]	[illegible]	[illegible]	3.1	5	236	93	0.36	277.1	55.5	D
8	[illegible]	46	[illegible]	59	[illegible]	[illegible]	20.9	[illegible]	3.1	4	161	35	0.	0.	0.	C
8	[illegible]	16	[illegible]	53	[illegible]	154	43.6	[illegible]	2.6	8	164	50	0.03	1.1	2.2	C
8	14	[illegible]	[illegible]	[illegible]	[illegible]	154	45.6	[illegible]	2.8	11	120	45	0.32	3.5	7.0	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
8	15	55	44.1	59	3.4	154	17.4	146.9	2.7	4	156	7	0.03	0.	0.	C
9	17	15	5.5	59	40.7	153	3.1	9.4	2.4	5	303	38	0.02	3.6	0.8	D
9	21	15	45.0	59	35.2	153	7.7	21.3	1.7	12	79	32	0.30	1.6	2.1	B
9	15	44	53.[illegible]	60	[illegible]	152	40.4	100.7	2.5	6	150	31	0.26	3.3	15.8	D
9	17	24	1[illegible].1	59	5[illegible].2	153	20.0	125.[illegible]	2.2	6	175	72	0.10	3.1	5.7	D
9	20	53	31.7	59	1[illegible].3	152	33.3	64.5	2.1	6	130	35	0.21	5.2	8.6	C
9	22	2	53.5	59	17.5	152	25.9	62.2	2.5	5	130	52	0.21	5.2	11.2	D
10	7	34	32.1	60	46.0	153	35.3	5.0	3.7	12	202	59	0.64	6.0	16.8	D
10	9	0	54.3	60	46.1	153	35.6	5.0	2.5	6	202	59	0.45	6.9	779.0	D
10	4	30	30.3	59	10.2	147	27.4	5.0	3.4	5	310	322	0.08	18.7	179.2	D
10	[illegible]	30	30.[illegible]	59	17.9	152	6.8	36.8	2.2	4	256	39	0.	0.	0.	C
10	11	53	11.[illegible]	59	5.3	154	48.7	99.2	2.8	13	84	71	0.25	1.7	4.6	B
10	11	55	5[illegible].[illegible]	59	52.9	152	17.2	87.5	3.5	15	149	43	0.36	4.1	5.8	C
10	12	13	11.3	59	52.4	151	57.1	5.0	2.0	4	226	75	1.43	0.	0.	D
10	14	9	44.6	56	32.1	157	20.8	59.6	2.7	5	217	33	0.07	3.1	2.8	D
10	17	9	57.3	59	55.5	152	15.8	153.9	2.2	4	198	61	0.22	0.	0.	C
10	19	10	5[illegible].3	57	49.3	154	1.8	5.6	1.5	5	156	17	0.03	0.5	0.7	C
10	19	32	34.1	59	43.8	152	1.5	5.0	1.8	4	217	87	0.46	0.	0.	D
10	22	33	5[illegible].1	59	17.6	154	2.6	134.1	2.6	7	215	47	0.25	9.4	7.8	D
11	[illegible]	43	[illegible].1	59	40.5	15[illegible]	52.0	0.5	2.6	5	268	134	0.36	26.1	104.5	D
11	5	21	30.0	59	43.1	152	30.9	0.7	2.3	4	173	13	0.08	0.	0.	D
11	4	9	2[illegible].5	58	[illegible].1	154	9.6	59.3	2.6	12	83	35	0.32	2.5	5.9	B
11	13	30	6.6	59	26.6	152	8.3	65.2	2.9	10	111	32	0.38	4.1	6.6	C
11	14	12	3[illegible].[illegible]	56	29.1	153	30.5	5.0	2.7	3	262	42	0.01	0.	0.	C
12	[illegible]	6	5[illegible].5	59	29.9	153	7.2	5.0	2.1	3	270	93	0.09	0.	0.	C
12	[illegible]	16	1[illegible].[illegible]	61	35.4	151	0.7	5.0	3.8	4	270	247	0.42	0.	0.	D
12	11	18	24.[illegible]	5[illegible]	[illegible].1	155	0.3	5.0	2.5	4	263	79	0.73	0.	0.	D
13	[illegible]	52	2[illegible].[illegible]	57	53.1	156	41.2	1.6	1.5	4	219	12	0.06	0.	0.	C
13	[illegible]	7	47.[illegible]	58	1.7	156	6.7	5.0	0.6	3	273	13	0.19	0.	0.	C
13	11	46	3[illegible].5	57	27.1	155	1.5	35.[illegible]	2.4	4	172	26	0.01	0.	0.	C
13	13	27	32.[illegible]	56	52.0	154	50.3	90.3	2.7	7	176	46	0.43	7.6	12.9	D
13	15	44	[illegible]	59	5[illegible].[illegible]	152	17.9	140.[illegible]	2.9	9	172	36	0.12	2.7	2.8	C
13	1[illegible]	8	1[illegible].6	57	22.[illegible]	153	29.9	35.[illegible]	2.7	4	190	42	0.03	0.	0.	C
13	2[illegible]	43	5[illegible].[illegible]	56	3[illegible].4	154	51.7	4[illegible].1	2.3	7	200	43	0.32	5.0	2.8	D
14	[illegible]	32	47.3	60	11.[illegible]	152	1.5	2.9	2.2	4	217	48	0.60	0.	0.	D
14	1[illegible]	21	27.[illegible]	57	53.4	154	32.6	5.0	1.4	3	255	4	0.	0.	0.	C
14	1[illegible]	37	5[illegible].[illegible]	60	45.3	153	33.7	5.0	3.1	3	202	57	0.01	0.	0.	C
14	1[illegible]	4	4[illegible].[illegible]	57	[illegible]	153	58.5	21.5	2.2	5	206	50	0.32	9.2	9.3	D
14	1[illegible]	27	1[illegible].[illegible]	59	5[illegible].[illegible]	152	49.0	110.3	2.6	10	119	43	0.33	5.0	7.8	C
15	[illegible]	5	31.[illegible]	56	44.5	154	45.6	5.0	2.4	3	243	43	0.04	0.	0.	C
15	[illegible]	2	4[illegible].4	60	13.[illegible]	152	27.9	119.5	2.7	4	181	27	0.22	0.	0.	C
15	[illegible]	52	4[illegible].5	57	34.[illegible]	155	45.8	53.[illegible]	2.2	6	141	33	0.30	14.9	29.6	D
15	13	9	5[illegible].4	59	14.4	152	38.3	82.4	2.9	3	156	41	0.16	2.6	4.3	C
15	14	41	1[illegible].1	57	4[illegible].3	15[illegible]	[illegible]0.4	5.0	1.1	3	155	10	0.	0.	0.	C
15	19	50	5[illegible].[illegible]	61	1[illegible].[illegible]	151	47.3	131.[illegible]	2.3	4	325	103	0.22	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM
15	10	2	21.5	58	58.9	152	18.7	78.9	1.9	7	146	39	0.11	1.7	2.8
16	7	6	35.5	57	21.0	155	24.0	83.3	3.0	7	213	58	0.19	5.3	9.2
16	10	13	14.5	58	9.7	155	19.8	1.3	2.2	6	195	60	0.40	4.5	20.0
16	15	21	40.9	57	34.6	154	32.5	2.5	2.1	5	130	27	0.35	39.8	84.3
16	19	28	25.6	59	55.4	152	26.0	5.0	1.5	3	160	53	0.	0.	0.
17	0	17	17.2	57	55.1	152	39.3	39.5	1.6	4	221	33	0.	0.	0.
17	6	59	30.7	60	5.3	152	38.1	94.9	2.9	9	249	73	0.22	6.7	7.5
17	7	4	55.7	59	4.9	150	27.7	21.7	2.3	5	274	125	0.47	29.9	13.9
17	7	14	43.6	58	50.1	152	49.1	60.2	2.7	5	129	35	0.16	4.0	5.7
17	9	30	50.9	57	40.9	153	18.0	5.0	1.4	3	152	26	0.	0.	0.
17	11	10	52.4	57	54.7	156	29.5	27.2	1.3	5	191	6	0.07	2.1	2.3
17	11	13	59.9	57	53.6	156	19.8	5.0	0.8	3	170	10	0.	0.	0.
17	11	31	14.4	57	53.8	156	28.0	24.3	2.0	5	182	4	0.17	4.3	4.9
17	11	55	23.1	57	53.0	156	19.5	5.0	0.6	3	173	10	0.	0.	0.
17	12	6	10.7	57	35.5	154	9.8	63.7	2.8	5	138	26	0.07	1.6	2.6
17	13	13	56.2	57	54.5	156	26.4	29.5	1.4	4	175	6	0.	0.	0.
17	13	34	31.0	57	53.7	156	19.6	5.0	0.6	3	172	10	0.	0.	0.
17	13	36	1.0	57	53.8	156	20.6	5.0	1.3	3	166	9	0.	0.	0.
17	13	39	16.2	57	53.9	156	22.1	5.0	0.6	3	157	3	0.	0.	0.
17	13	43	51.6	57	52.0	156	22.1	5.0	0.2	3	155	7	0.	0.	0.
17	13	49	9.6	57	54.4	156	29.5	21.3	1.8	5	189	5	0.14	3.4	3.7
17	13	59	25.3	57	53.7	156	30.7	18.0	1.8	4	191	4	0.	0.	0.
17	14	2	10.0	57	54.1	156	18.7	5.0	0.9	3	178	11	0.	0.	0.
17	14	4	45.7	57	54.3	156	29.1	22.3	2.0	5	188	5	0.08	2.0	2.2
17	14	9	51.9	57	54.1	156	28.4	21.4	2.0	5	184	5	0.17	4.0	4.5
17	14	20	12.8	57	54.0	156	28.7	21.0	2.4	5	195	4	0.08	1.8	2.0
17	14	27	3.7	57	54.0	156	43.9	32.3	1.9	4	283	15	0.	0.	0.
17	14	30	30.2	57	54.2	156	30.8	23.1	1.3	4	195	5	0.	0.	0.
17	14	31	2.7	57	53.0	156	29.3	21.5	1.7	4	187	4	0.	0.	0.
17	14	33	23.3	57	53.6	156	28.8	13.7	2.0	4	184	4	0.	0.	0.
17	14	56	55.1	57	54.2	156	29.4	22.5	1.8	5	198	5	0.12	3.1	3.3
17	15	23	50.2	59	40.6	152	39.0	5.0	1.9	3	231	59	0.	0.	0.
17	16	40	36.4	57	52.8	156	29.7	18.6	1.6	4	188	4	0.	0.	0.
17	19	34	45.3	57	57.6	157	40.6	27.6	2.3	4	332	71	0.08	0.	0.
17	19	52	20.0	57	53.8	156	30.6	15.0	1.8	4	191	4	0.	0.	0.
17	20	19	44.7	57	53.9	156	28.4	13.3	2.7	5	184	4	0.06	1.4	1.5
17	20	52	23.0	60	0.9	152	41.1	104.0	3.2	7	134	45	0.19	6.4	14.8
17	21	8	47.7	57	54.4	156	28.6	17.6	2.1	5	186	5	0.21	4.7	5.2
17	21	42	3.3	57	52.9	156	29.5	9.1	2.3	5	213	10	0.06	1.4	1.0
18	1	8	12.0	57	54.0	156	27.7	15.0	1.3	5	181	5	0.06	1.4	1.6
18	1	15	30.7	57	53.8	156	28.4	17.4	2.2	5	183	4	0.08	1.8	2.0
18	1	44	0.1	57	53.4	156	32.6	5.0	1.7	3	255	4	0.	0.	0.
18	2	21	21.1	57	56.3	154	22.9	5.0	0.9	3	152	3	0.	0.	0.
18	2	32	23.0	58	23.7	154	4.3	84.0	2.4	7	101	53	0.25	3.8	10.6
18	2	42	22.7	57	54.0	156	21.3	12.4	1.5	4	125	0	0.25	0.	0.

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
18	4	48	31.1	57	22.8	152	32.6	125.0	2.9	12	171	41	0.34	4.7	5.4	C
18	8	43	53.3	59	55.3	152	41.6	97.3	2.9	9	121	55	0.21	3.1	5.7	C
18	9	15	0.1	59	51.8	153	11.5	139.0	2.4	6	135	66	0.05	1.4	3.6	C
18	12	15	19.5	59	11.0	152	54.2	73.0	2.3	7	184	33	0.22	5.7	5.5	D
18	13	15	51.5	59	29.5	152	22.3	5.0	2.2	4	203	87	0.98	0.	0.	D
18	13	26	21.4	59	29.7	151	19.2	73.1	2.7	5	283	14	0.05	6.2	5.2	D
18	14	12	33.3	59	37.0	153	23.3	127.9	3.2	26	67	27	0.39	2.2	2.7	B
18	17	39	21.1	57	54.2	156	21.9	5.0	1.0	3	153	9	0.	0.	0.	C
18	22	4	51.5	57	54.2	156	21.9	5.0	0.9	3	159	9	0.01	0.	0.	C
19	0	21	19.3	59	29.0	152	5.2	29.0	2.1	4	222	101	0.11	0.	0.	C
19	6	22	51.2	59	23.1	152	17.6	70.0	3.4	13	107	41	0.40	3.4	6.0	C
19	7	13	1.9	59	0.4	152	48.1	69.0	2.5	9	131	42	0.26	2.9	5.6	C
19	10	54	34.3	59	43.3	152	46.3	5.0	1.9	3	248	64	0.02	0.	0.	C
19	19	3	37.6	59	20.4	154	6.1	141.4	2.7	4	249	38	0.01	0.	0.	C
19	20	8	9.9	59	1.2	154	52.6	37.6	2.8	5	257	77	0.03	3.3	4.1	D
19	21	1	1.2	56	53.0	153	21.0	5.0	2.8	3	205	33	0.01	0.	0.	C
20	0	54	53.6	57	5.3	153	46.4	9.7	2.7	4	219	42	0.22	0.	0.	C
20	2	44	45.7	57	30.6	153	32.2	35.4	2.7	4	124	31	0.	0.	0.	C
20	3	59	4.4	60	4.1	153	26.3	167.1	4.9	15	81	53	0.34	3.4	5.7	B
20	4	26	41.7	59	14.0	154	33.5	10.9	2.0	4	177	41	0.12	0.	0.	C
20	6	53	44.4	57	53.2	156	33.2	5.0	1.3	3	257	5	0.	0.	0.	C
20	8	15	37.1	59	47.8	153	14.2	144.9	4.3	29	70	47	0.44	2.1	3.0	B
20	9	29	53.7	59	55.2	152	41.7	56.6	2.5	6	160	48	0.22	5.3	11.7	D
20	10	27	47.6	59	20.3	152	28.0	77.0	2.4	3	101	52	0.17	2.1	3.9	B
20	14	58	10.3	59	17.3	154	31.1	9.5	2.0	4	160	41	0.37	0.	0.	D
20	16	57	50.5	59	8.3	153	12.5	45.0	2.3	7	122	11	0.17	2.6	3.3	C
20	18	10	54.2	59	22.9	152	30.0	77.5	2.3	7	95	52	0.24	3.4	8.5	C
20	20	11	50.0	59	10.6	155	18.9	0.5	2.4	7	106	61	0.32	2.4	17.9	D
20	21	15	59.0	57	31.0	155	10.6	41.0	2.2	4	166	38	0.10	0.	0.	C
21	3	4	51.0	59	15.7	150	40.6	39.0	2.0	4	310	55	0.	0.	0.	C
21	4	11	27.6	60	4.5	154	34.1	163.2	2.6	5	274	83	0.03	42.4	13.3	D
21	4	45	3.5	59	20.1	152	3.0	77.6	2.0	5	137	26	0.17	6.8	13.3	D
21	6	7	24.2	59	35.6	152	4.0	126.2	2.5	7	172	29	0.18	3.9	5.8	D
21	11	27	36.3	59	40.3	152	34.1	5.0	2.0	3	239	52	0.01	0.	0.	C
21	13	27	13.3	59	46.7	153	7.7	116.0	2.3	5	269	15	0.14	1.3	2.1	C
21	13	32	10.0	59	57.2	152	13.8	103.1	2.7	8	165	46	0.18	3.9	8.3	C
21	14	44	40.2	59	22.9	153	39.4	124.3	2.5	10	113	14	0.19	2.6	3.7	C
21	17	13	27.4	59	50.1	153	29.3	84.0	1.0	5	135	51	0.26	11.1	24.1	D
21	20	7	52.1	59	36.7	153	25.7	119.0	2.4	3	164	27	0.10	2.1	2.6	C
21	20	23	44.0	57	15.0	155	22.3	11.3	2.0	4	203	45	0.61	0.	0.	D
21	22	22	37.3	59	44.4	153	29.8	137.7	2.7	7	204	42	0.08	2.5	2.9	D
22	3	30	15.6	60	5.4	153	34.6	179.0	2.5	7	233	54	0.23	9.3	14.3	D
22	3	51	20.0	57	44.1	155	3.1	39.5	2.0	6	138	51	0.17	2.7	2.0	D
22	16	47	2.0	59	0.1	156	22.7	5.0	-0.1	3	183	5	0.01	0.	0.	D
22	17	55	13.0	57	2.0	153	41.3	52.0	2.1	4	152	12	0.	0.	0.	C

COOK INLET–WESTERN GULF OF ALASKA EARTHQUAKES

1978	ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM
MAR 22	10	1	3.7	59	42.9	152	55.6	39.0	2.3	4	113	77	0.10	0.	0.
22	19	25	40.3	57	6.4	155	18.4	73.4	3.2	13	104	47	0.20	2.1	4.5
23	1	6	55.0	57	53.1	156	40.3	0.0	1.5	4	216	11	0.04	0.	0.
23	4	26	50.0	60	46.4	153	37.6	1.1	2.8	6	201	61	0.61	3.0	41.1
23	6	33	27.0	59	19.3	151	49.2	80.5	3.4	23	148	22	0.36	1.9	2.5
23	17	47	0.1	59	12.0	153	31.3	109.8	2.3	6	153	15	0.14	4.1	3.6
23	19	54	4.6	59	55.0	152	53.2	5.0	0.8	3	242	56	0.29	0.	0.
23	21	31	51.3	59	23.2	151	59.0	92.7	2.2	4	174	24	0.14	0.	0.
24	3	33	11.1	59	45.7	152	56.4	5.0	2.2	4	168	68	0.47	0.	0.
24	4	38	57.3	58	3.0	154	13.4	242.7	3.2	4	181	43	0.76	0.	0.
24	4	43	31.6	57	44.3	152	40.5	391.6	3.5	6	231	43	1.96	123.4	351.7
24	5	34	33.9	57	56.5	156	16.1	145.6	3.3	12	146	16	0.26	3.1	5.5
24	6	44	30.6	57	45.0	155	10.5	1.0	3.0	7	138	56	0.16	1.2	5.6
24	7	8	53.1	57	43.5	155	11.4	1.4	3.1	10	92	54	0.30	1.8	11.6
24	13	4	33.3	59	26.4	152	38.3	5.0	1.9	3	269	60	0.09	0.	0.
24	14	1	40.9	57	29.8	153	48.9	59.5	2.7	4	120	29	0.	0.	0.
24	17	39	0.5	59	2.6	153	59.8	101.0	2.4	4	171	13	0.08	0.	0.
25	5	8	14.0	59	44.6	153	25.1	5.0	2.3	3	279	80	0.32	0.	0.
25	6	20	17.0	56	51.0	154	19.6	35.1	4.2	14	101	33	0.32	2.2	1.6
25	12	33	57.6	56	45.2	152	35.0	29.5	3.1	7	243	50	0.25	8.8	3.8
25	12	53	54.0	59	34.5	152	30.3	5.0	2.1	3	249	49	0.18	0.	0.
25	19	33	14.9	57	53.7	155	36.0	5.0	1.0	3	267	7	0.03	0.	0.
26	0	27	57.7	57	52.4	156	34.2	5.0	0.7	3	261	6	0.03	0.	0.
26	0	33	15.7	61	9.0	152	2.7	31.6	2.4	4	310	88	0.06	0.	0.
26	1	20	25.9	57	54.3	156	10.9	122.2	2.6	9	135	15	0.27	8.1	8.3
26	2	39	7.2	56	53.6	154	16.8	5.0	2.3	3	165	37	0.	0.	0.
26	5	2	10.7	58	53.9	154	25.9	123.3	2.5	9	101	26	0.30	3.9	6.4
26	17	42	27.5	58	47.1	154	5.2	5.0	2.6	3	315	97	0.25	0.	0.
26	19	47	21.5	57	30.3	155	11.9	85.0	3.4	11	140	67	0.28	3.1	6.9
27	4	9	49.7	59	55.0	152	53.2	5.0	1.8	3	242	56	0.29	0.	0.
27	7	6	17.0	55	7.2	155	29.1	31.5	3.3	4	298	228	0.10	0.	0.
27	20	6	15.5	58	32.3	154	29.1	5.0	1.8	5	173	63	0.45	9.0	9999.9
27	20	37	50.4	60	17.3	150	22.7	5.0	2.0	3	300	113	0.09	0.	0.
27	21	12	40.0	58	25.6	154	27.7	2.5	2.8	12	91	69	0.37	1.9	17.3
27	21	25	10.0	58	34.2	154	30.4	5.0	2.2	4	175	61	0.08	0.	0.
27	23	19	25.3	58	17.9	154	6.4	92.0	2.4	9	119	61	0.15	1.8	5.5
28	0	57	47.3	59	52.7	152	42.8	5.0	2.3	3	245	60	0.03	0.	0.
28	2	15	32.1	58	36.0	153	33.8	39.1	2.3	4	156	37	0.04	0.	0.
28	4	7	11.3	57	10.7	155	13.3	26.3	2.2	5	220	39	0.10	4.1	6.7
28	10	28	40.1	59	5.0	151	48.2	20.7	2.7	11	179	45	0.47	3.6	4.4
28	11	45	17.1	59	47.8	152	15.9	40.4	2.4	5	264	97	0.35	32.9	784.6
28	12	1	2.0	58	49.0	151	46.6	5.0	2.1	4	184	67	0.53	0.	0.
28	14	15	4.1	57	56.1	154	44.5	5.0	2.3	3	267	61	0.29	0.	0.
28	14	19	23.3	60	32.5	152	39.5	154.7	2.1	4	306	15	0.08	0.	0.
29	17	11	39.4	58	30.0	156	28.2	12.3	2.3	5	123	69	0.23	3.3	515.4

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DATE	ORIGIN HR MN	TIME SEC	LAT N DEG MIN	LONG W DEG MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
28	17 32	6.4	57 44.1	152 35.3	1.3	1.9	4	129	5	0.51	0.	0.	D
28	18 26	7.7	60 1.1	153 27.3	5.5	2.0	4	225	59	0.25	0.	0.	D
28	20 33	[illegible]	57 [illegible]	154 30.6	5.0	1.2	3	230	3	0.	0.	0.	D
28	22 23	37.1	57 [illegible]	156 2.9	74.2	2.3	4	245	43	0.03	0.	0.	D
28	22 42	[illegible]	59 [illegible]	153 25.3	143.4	3.0	13	145	22	0.47	6.7	8.3	D
28	23 31	37.1	59 [illegible]	152 16.6	73.3	3.3	13	165	50	0.23	2.7	4.3	D
29	[illegible] 6	44.5	55 47.3	155 14.9	12.5	3.2	10	160	70	0.32	2.5	4.0	D
29	1 31	44.3	59 [illegible]	153 32.6	5.0	1.9	4	200	85	1.03	0.	0.	D
29	[illegible] 56	21.0	57 [illegible]	156 29.4	27.3	1.6	5	132	1	0.04	1.0	1.2	C
29	[illegible] 11	52.4	59 55.4	153 2.3	7.0	1.5	4	193	57	0.26	0.	0.	C
29	10 49	[illegible]	58 7.4	15[illegible] 32.2	5.0	0.8	3	311	14	0.09	0.	0.	C
29	13 22	[illegible]	59 22.4	153 0.4	13.2	2.3	4	185	73	0.20	0.	0.	C
29	13 45	45.6	57 52.3	156 41.4	1.9	1.4	4	218	12	0.07	0.	0.	C
29	14 43	[illegible]	58 53.7	154 12.9	101.2	2.3	9	126	23	0.28	4.2	5.9	C
29	[illegible] 3	[illegible]	57 51.6	156 33.1	5.0	0.8	3	257	3	0.15	0.	0.	C
29	22 1	[illegible]	59 34.4	15[illegible] 12.5	5.0	2.1	4	307	169	0.19	0.	0.	C
29	23 36	21.3	59 34.6	152 24.3	68.1	2.6	5	114	47	0.13	4.0	8.0	D
30	[illegible] 4	59.4	58 47.6	153 58.0	5.7	1.7	6	139	31	0.11	1.2	1.6	C
30	3 10	[illegible]	57 29.3	153 41.9	39.2	2.2	6	122	32	0.13	1.6	1.7	B
30	[illegible] 11	[illegible]	60 5.1	152 50.2	122.1	2.5	9	129	37	0.15	3.1	5.2	C
30	[illegible] 36	[illegible]	56 51.5	152 45.2	0.7	1.7	4	305	39	0.07	0.	0.	C
30	[illegible] 26	[illegible]	53 27.6	15[illegible] 1.9	5.0	2.0	3	290	162	0.98	0.	0.	D
30	[illegible] 31	[illegible]	58 [illegible]	154 35.1	3.6	2.4	4	181	26	0.	0.	0.	C
30	[illegible] 12	[illegible]	59 43.3	153 32.7	96.4	2.4	6	161	26	0.07	3.9	4.2	C
30	[illegible] 22	[illegible]	59 35.5	154 32.1	5.0	2.2	5	196	59	0.46	10.7	9999.9	D
30	[illegible] 14	[illegible]	59 44.0	153 4.6	79.6	1.8	4	176	73	0.	0.	0.	C
30	14 46	[illegible]	58 [illegible]	153 9.9	5.0	2.3	4	179	65	0.11	0.	0.	C
30	14 54	[illegible]	59 49.7	152 53.5	5.0	1.9	3	243	66	0.45	0.	0.	D
30	15 40	[illegible]	57 12.5	153 54.3	33.7	3.3	8	103	47	0.38	8.5	7.4	C
30	[illegible] 41	[illegible]	59 42.2	152 34.7	5.0	2.0	3	238	52	0.05	0.	0.	C
30	21 55	[illegible]	56 54.5	156 12.4	2.5	2.2	5	199	67	0.18	3.6	410.9	D
30	23 9	[illegible]	59 54.2	152 51.6	5.0	2.1	3	160	57	0.	0.	0.	C
31	[illegible] 27	54.1	59 [illegible]	153 21.2	137.3	2.5	5	146	63	0.19	7.6	23.2	D
31	[illegible] 38	12.6	61 41.3	151 10.3	107.4	5.3	21	83	63	0.43	2.7	4.9	B
31	[illegible] 27	[illegible]	57 [illegible]	152 37.6	5.0	1.4	3	241	54	0.	0.	0.	C
31	[illegible] 38	27.5	57 [illegible]	152 34.3	12.7	0.3	5	196	17	0.09	4.3	15.3	D
31	[illegible] 11	47.4	[illegible]	154 21.0	[illegible]	2.2	6	110	49	0.35	3.7	25.1	C
31	[illegible] 45	[illegible]	58 [illegible]	15[illegible] 30.8	55.4	2.7	8	155	60	0.29	3.2	8.8	D
31	[illegible] 34	[illegible]	56 15.0	156 55.5	16.6	2.7	7	226	73	0.62	13.8	15.1	D
31	11 57	[illegible]	59 [illegible]	153 23.9	127.0	2.5	4	177	76	0.07	0.	0.	C
31	[illegible] 32	[illegible]	60 [illegible]	152 15.6	61.6	2.7	6	238	39	0.14	6.9	9.7	D
31	23 5	[illegible]	58 16.6	153 4.1	49.3	2.0	5	190	24	0.16	6.8	4.8	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DATE	ORIGIN HR	ORIGIN MN	TIME SEC	LAT DEG	LAT MIN	LONG DEG	LONG MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
1	[illegible]	30	31.5	57	[illegible]	153	50.8	44.2	1.8	4	120	29	0.	0.	0.	C
1	2	2	[illegible]	59	2.0	153	56.0	70.[illegible]	1.9	6	179	35	0.30	8.6	9.7	D
1	6	16	21.4	59	27.2	152	40.7	5.[illegible]	1.6	3	269	62	0.06	0.	0.	C
1	[illegible]	43	31.4	[illegible]	[illegible]	154	35.2	102.5	1.9	6	249	73	0.21	11.1	14.4	D
1	1[illegible]	11	17.5	57	[illegible]	154	9.9	3.6	1.0	4	222	25	0.	0.	0.	C
1	11	21	44.3	59	57.3	153	41.1	6.3	1.9	5	136	9	0.10	2.0	1.9	C
1	13	57	5[illegible].3	59	21.0	152	17.0	5.[illegible]	1.9	3	249	39	0.01	0.	0.	C
1	13	51	43.7	59	21.1	152	43.9	77.3	2.5	8	114	38	0.22	2.7	5.4	C
1	14	33	21.0	56	41.0	155	29.2	31.6	2.5	5	193	63	0.35	30.6	61.9	D
1	17	29	44.3	57	46.8	152	43.7	2.5	1.7	4	161	15	1.37	0.	0.	D
1	19	30	[illegible].0	57	59.2	154	38.6	53.0	2.2	4	265	57	0.	0.	0.	C
1	1[illegible]	55	57.4	59	6.2	152	27.7	33.0	1.4	5	171	39	0.06	5.3	3.8	D
1	22	14	[illegible].3	55	41.6	153	18.2	9.6	1.3	4	240	54	0.48	0.	0.	D
2	1	30	2[illegible].0	57	14.0	152	48.2	1[illegible].0	2.0	4	249	20	0.03	0.	0.	D
2	1	23	56.4	59	51.[illegible]	153	44.2	110.7	1.4	5	196	94	0.05	2.8	4.0	D
2	2	34	51.3	60	25.3	153	26.1	223.7	3.0	8	148	36	0.12	3.9	6.0	C
2	7	31	43.7	59	43.4	153	16.2	97.7	2.2	4	190	82	0.02	0.	0.	C
2	7	57	2[illegible].1	59	12.9	154	31.2	[illegible].9	1.5	4	176	43	0.	0.	0.	C
2	9	48	23.[illegible]	57	28.0	155	16.1	133.0	2.3	8	134	13	0.25	5.9	10.1	C
2	13	14	5[illegible].7	60	6.[illegible]	151	49.0	107.0	1.9	5	226	51	0.17	21.8	40.1	D
2	14	19	47.7	56	51.0	153	6.1	31.2	3.0	5	295	35	0.02	1.3	0.3	C
2	17	4	3[illegible].0	57	53.0	154	22.7	155.2	3.3	10	156	13	0.23	3.3	5.5	C
2	17	17	[illegible].3	59	43.4	153	53.4	103.0	2.5	6	151	47	0.17	4.0	6.0	C
2	22	22	5[illegible].4	58	1.2	154	23.7	10.0	2.6	5	175	47	0.11	2.0	241.2	D
2	22	44	4[illegible].3	58	1.0	154	24.2	[illegible]	2.2	6	115	48	0.17	1.7	292.2	C
2	22	51	3[illegible].3	56	27.4	154	10.3	34.5	2.1	5	304	11	0.10	4.9	1.7	D
3	0	4	41.6	53	1[illegible].2	155	51.3	[illegible].6	2.5	10	152	40	0.57	4.0	27.6	D
3	1	14	2[illegible].2	53	2[illegible].1	153	40.4	61.2	2.4	9	125	43	0.24	2.8	6.0	D
3	3	56	2[illegible].3	60	2.7	153	42.9	[illegible]	3.0	6	149	42	2.21	21.4	43.9	D
3	5	42	5[illegible].7	56	57.1	154	20.3	32.7	2.7	9	104	35	0.29	2.6	2.2	C
3	[illegible]	26	29.2	53	56.0	153	33.2	114.0	3.0	11	134	55	0.40	6.0	9.8	C
3	[illegible]	48	3[illegible].8	57	1[illegible].2	152	54.9	50.0	2.3	10	192	24	0.29	4.0	4.1	D
3	10	25	[illegible].6	57	3.3	154	35.8	40.7	1.3	5	203	31	0.16	5.7	2.2	D
3	13	24	[illegible].0	59	24.1	153	6.4	102.6	2.3	11	141	26	0.36	4.4	6.4	C
3	1[illegible]	47	2[illegible].9	59	44.[illegible]	153	10.6	10[illegible].0	2.7	10	92	43	0.30	3.3	4.8	C
3	13	15	[illegible].3	59	36.5	159	26.3	36.0	2.5	4	258	136	1.24	0.	0.	D
3	20	26	3[illegible].3	59	[illegible]	154	26.1	3.0	2.3	7	180	51	0.43	5.2	7.6	D
4	[illegible]	46	35.7	50	[illegible]	153	44.2	93.0	3.0	9	124	46	0.13	2.9	4.8	D
4	13	52	4[illegible]	50	55.3	155	24.8	151.7	3.1	6	134	31	0.07	1.9	3.9	B
4	1[illegible]	41	[illegible]	57	[illegible].3	155	32.3	5.0	2.0	3	222	58	0.	0.	0.	C
4	19	47	42.3	56	15.2	154	58.2	20.0	2.7	5	243	72	0.59	20.5	22.0	D
4	19	11	[illegible]	58	1[illegible].3	154	13.6	171.7	2.7	4	290	15	0.01	0.	0.	D
4	21	29	5[illegible].0	50	3[illegible].7	153	21.5	[illegible].5	2.3	4	166	77	0.47	0.	0.	D
5	[illegible]	55	34.1	53	5[illegible].3	151	50.9	93.[illegible]	2.5	5	206	35	0.10	9.3	17.9	D
5	[illegible]	19	5[illegible].7	57	5[illegible].3	154	36.2	[illegible].4	2.4	5	206	7	0.12	2.7	1.5	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DAY	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
5	[illegible]	35	[illegible]	[illegible]	[illegible]	[illegible]	37.0	[illegible]	2.3	4	[illegible]	64	0.44	0.	0.	D
5	7	1	[illegible]	[illegible]	[illegible]	[illegible]	21.4	[illegible]	2.4	6	109	49	0.33	7.2	22.4	D
5	[illegible]	56	[illegible]	59	[illegible]	153	4.2	[illegible]	2.0	3	272	81	0.01	0.	0.	D
5	12	29	[illegible]	57	[illegible]	[illegible]	[illegible]	[illegible]	1.2	3	255	4	0.	0.	0.	D
5	14	4	[illegible]	[illegible]	[illegible]	151	37.9	84.[illegible]	1.9	4	207	23	0.07	0.	0.	D
5	[illegible]	0	[illegible]	58	[illegible]	[illegible]	43.3	[illegible]	3.1	5	249	69	0.19	14.3	4.4	D
5	[illegible]	51	[illegible]	57	[illegible]	[illegible]	[illegible]	[illegible]	1.0	4	204	7	0.01	0.	0.	D
6	[illegible]	28	[illegible]	59	[illegible]	[illegible]	11.9	[illegible]	1.9	4	164	26	0.	0.	0.	D
6	4	51	[illegible]	59	[illegible]	[illegible]	40.5	[illegible]	1.9	3	241	58	0.10	0.	0.	D
6	[illegible]	4	[illegible]	59	[illegible]	152	40.8	[illegible]	1.6	3	272	62	0.12	0.	0.	D
6	11	5	[illegible]	[illegible]	25.3	[illegible]	5.3	[illegible]	1.4	4	222	100	0.63	0.	0.	D
6	11	16	[illegible]	[illegible]	[illegible]	[illegible]	14.7	[illegible]	2.3	3	232	19	0.23	0.	0.	D
6	12	17	[illegible]	[illegible]	[illegible]	153	7.4	[illegible]	2.9	9	108	23	0.33	2.6	4.3	D
6	12	54	[illegible]	[illegible]	54.1	[illegible]	39.4	[illegible]	1.5	3	139	9	0.	0.	0.	D
6	[illegible]	36	[illegible]	59	[illegible]	152	50.1	73.[illegible]	2.2	4	143	42	0.	0.	0.	D
6	[illegible]	19	[illegible]	[illegible]	32.1	152	32.6	[illegible]	2.6	3	169	44	0.	0.	0.	D
6	23	32	[illegible]	[illegible]	[illegible]	[illegible]	7.5	67.[illegible]	3.2	7	135	25	0.52	7.8	8.7	D
7	[illegible]	53	[illegible]	[illegible]	57.[illegible]	[illegible]	40.9	52.[illegible]	2.7	7	139	43	0.29	4.5	9.7	D
7	4	44	[illegible]	57	[illegible]	[illegible]	46.6	[illegible]	2.3	4	205	42	0.	0.	0.	D
7	[illegible]	12	[illegible]	59	52.1	152	27.1	[illegible]	2.3	6	150	72	0.14	6.3	18.0	D
8	[illegible]	48	[illegible]	58	[illegible]	154	5.4	77.1	2.3	8	96	65	0.13	1.5	3.4	D
8	2	42	[illegible]	57	58.4	[illegible]	41.7	[illegible]	1.9	4	229	14	0.	0.	0.	D
8	[illegible]	4	[illegible]	[illegible]	31.4	[illegible]	39.3	52.[illegible]	1.4	4	184	43	0.	0.	0.	D
8	[illegible]	9	[illegible]	[illegible]	[illegible]	[illegible]	20.6	[illegible]	3.6	20	96	48	0.63	3.1	13.0	D
8	4	58	[illegible]	59	[illegible]	153	29.8	36.4	2.0	4	136	53	0.47	0.	0.	D
8	[illegible]	46	[illegible]	57	55.7	154	7.6	124.[illegible]	2.4	6	141	13	0.30	15.0	25.0	D
8	[illegible]	30	[illegible]	[illegible]	[illegible]	151	[illegible]	[illegible]	2.2	3	223	87	0.	0.	0.	D
8	[illegible]	13	[illegible]	57	[illegible]	[illegible]	[illegible]	[illegible]	2.9	5	125	51	0.43	2.2	4.5	D
8	19	45	[illegible]	[illegible]	[illegible]	[illegible]	38.7	[illegible]	2.2	4	211	42	0.	0.	0.	D
8	[illegible]	18	[illegible]	[illegible]	[illegible]	[illegible]	58.5	[illegible]	1.2	3	246	29	0.03	0.	0.	D
8	[illegible]	43	[illegible]	[illegible]	[illegible]	[illegible]	26.1	[illegible]	2.7	5	215	60	0.09	5.3	9.6	D
9	[illegible]	47	[illegible]	57	[illegible]	[illegible]	[illegible]	[illegible]	1.8	3	185	36	0.01	0.	0.	D
9	11	22	[illegible]	[illegible]	[illegible]	[illegible]	50.6	[illegible]	1.5	4	123	57	0.93	0.	0.	D
9	12	41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.6	5	212	9	0.09	2.0	1.4	D
9	14	26	[illegible]	60	22.[illegible]	152	28.4	[illegible]	3.1	5	225	17	0.23	20.6	30.7	D
9	17	13	[illegible]	60	[illegible]	151	51.6	[illegible]	4.5	23	111	57	0.70	3.1	6.1	C
9	17	13	[illegible]	59	[illegible]	153	37.8	122.[illegible]	2.9	10	156	12	0.24	3.8	5.1	C
9	[illegible]	40	[illegible]	59	[illegible]	152	42.1	[illegible]	1.5	3	240	60	0.21	0.	0.	C
9	[illegible]	21	[illegible]	[illegible]	[illegible]	[illegible]	50.5	123.[illegible]	2.9	12	122	30	0.30	4.1	6.6	C
9	[illegible]	33	[illegible]	57	[illegible]	152	[illegible]	[illegible]	2.4	5	144	45	0.24	5.8	13.9	D
9	23	59	[illegible]	60	14.7	[illegible]	9.7	[illegible]	2.3	4	219	38	0.75	0.	0.	D
10	[illegible]	4	[illegible]	[illegible]	[illegible]	153	15.7	[illegible]	1.7	3	161	33	0.	0.	0.	D
10	[illegible]	52	[illegible]	[illegible]	[illegible]	[illegible]	28.5	24.[illegible]	1.2	4	152	1	0.	0.	0.	D
10	[illegible]	14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	47.1	2.6	6	135	12	0.20	6.0	6.7	D
10	1	0	[illegible]	59	[illegible]	[illegible]	43.2	[illegible]	1.3	3	149	60	0.	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DA	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
10	1	12	51.7	59	13.4	151	46.3	36.1	2.6	9	214	56	0.28	4.3	2.5	D
10	22	27	51.0	60	1.0	152	59.4	131.7	3.4	17	125	44	0.27	2.4	2.9	B
10	22	3	27.3	57	47.7	155	57.4	5.0	3.0	3	294	168	0.76	0.	0.	D
10	23	49	40.1	58	12.4	154	51.0	2.8	3.0	6	245	36	0.44	10.9	757.9	D
11	3	57	20.4	59	45.0	152	51.4	131.2	2.3	4	199	24	0.01	0.	0.	C
11	5	33	1.6	60	3.4	153	14.5	140.0	3.3	28	76	49	0.49	2.7	3.7	B
11	5	42	40.2	60	22.3	153	16.4	109.4	2.6	9	242	27	0.20	3.8	10.5	D
11	6	36	10.3	59	0.7	153	40.2	130.7	2.1	5	213	23	0.11	6.2	5.0	D
11	11	29	1.3	60	23.0	153	16.6	107.3	2.7	7	222	27	0.21	6.5	6.9	D
11	11	58	32.5	57	57.2	156	26.2	172.1	2.3	5	223	13	0.22	36.4	57.3	D
11	13	17	17.2	57	27.1	152	36.5	4.0	1.3	4	134	16	0.	0.	0.	C
11	14	56	57.4	59	33.3	153	19.3	17.2	2.1	5	193	90	0.17	3.6	6.2	D
11	16	1	37.0	59	55.3	152	15.6	72.1	2.5	6	144	40	0.24	8.7	15.1	D
11	1[illegible]	21	12.9	57	53.4	156	34.2	5.0	1.4	3	261	6	0.03	0.	0.	C
12	0	27	11.2	58	53.9	152	46.2	44.7	2.0	4	147	44	0.	0.	0.	C
12	1	11	31.6	60	7.4	153	18.3	160.3	2.9	10	169	44	0.52	11.2	17.9	D
12	1	50	27.1	57	4.0	153	12.1	50.7	2.6	8	172	44	0.34	4.5	9.9	C
12	3	42	3.3	56	20.7	152	37.3	30.5	5.8	20	252	95	0.47	7.7	3.0	D
12	4	5	3.0	56	33.0	152	47.6	31.4	3.4	11	271	87	0.61	19.9	5.0	D
12	4	9	47.2	56	3.0	152	33.3	21.5	3.1	9	289	117	0.51	34.7	13.2	D
12	4	16	2.6	56	21.3	152	27.4	14.4	4.6	16	266	98	0.78	17.1	6.7	D
12	4	19	3.1	55	25.9	152	48.1	21.1	3.4	9	267	83	0.58	17.5	6.2	D
12	4	20	32.1	54	51.6	152	9.1	31.6	2.3	4	340	234	0.26	0.	0.	C
12	4	24	23.5	57	50.0	152	16.4	13.3	2.8	5	239	16	0.17	2.5	2.3	D
12	4	26	57.7	56	44.5	152	10.2	0.1	4.3	15	226	43	1.29	14.4	17.2	D
12	4	36	53.4	56	44.1	153	5.2	0.7	2.6	4	253	47	1.46	0.	0.	D
12	4	39	54.6	57	10.5	152	52.4	22.5	2.9	6	213	12	0.43	9.7	5.2	D
12	4	43	15.5	54	27.6	152	25.5	24.3	3.5	8	324	89	0.31	65.9	11.7	D
12	4	47	17.5	56	26.3	152	44.8	33.4	5.1	16	249	84	0.44	7.7	2.8	D
12	5	4	55.5	57	11.0	153	28.2	5.0	2.3	5	153	23	1.14	1.7	2.3	D
12	5	9	23.0	56	47.3	152	57.9	5.0	1.5	3	265	50	0.10	0.	0.	C
12	5	10	27.6	55	13.4	152	36.3	25.4	3.6	10	281	104	0.47	20.4	5.9	D
12	5	22	1.2	56	31.4	151	54.0	33.0	3.3	8	259	71	0.39	13.8	3.3	D
12	5	27	1.6	54	24.0	152	23.8	23.3	3.1	7	319	77	0.27	40.5	8.7	D
12	5	32	20.0	57	11.0	153	18.3	1.3	2.3	4	133	13	0.56	0.	0.	D
12	5	37	21.1	56	33.2	152	39.5	25.9	3.3	7	323	72	0.27	44.5	6.8	D
12	5	38	57.5	55	34.3	152	58.7	29.4	3.4	9	255	65	0.42	11.6	3.8	D
12	5	44	55.3	56	23.1	152	27.5	32.0	2.8	5	325	91	0.33	9.2	2.2	D
12	5	47	10.1	57	25.9	152	25.9	23.0	2.4	5	186	10	0.02	1.2	0.7	C
12	6	0	43.0	54	29.3	152	39.0	27.0	3.2	6	265	91	1.19	54.9	16.1	D
12	6	4	27.6	59	17.0	151	57.0	41.3	3.6	9	334	319	0.24	104.1	326.3	D
12	6	39	51.7	58	12.0	154	35.4	5.0	2.6	6	236	39	0.35	8.0	603.6	D
12	7	11	17.3	56	26.6	153	48.9	32.0	3.5	14	231	32	0.53	19.4	6.0	D
12	7	19	31.0	56	47.4	152	23.4	23.4	2.9	7	306	53	0.27	19.2	5.1	D
12	7	22	3.0	56	30.3	152	54.6	33.3	3.8	14	268	32	0.47	11.7	3.1	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DAY	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
12	[illegible]	31	[illegible]	56	[illegible]	153	45.9	[illegible]	3.2	6	228	50	0.77	495.9	305.6	D
12	[illegible]	36	[illegible]	55	[illegible]	152	19.7	[illegible]	3.8	9	263	131	0.43	18.5	23.1	D
12	[illegible]	2	55.2	56	2.2	152	3.3	[illegible]	3.4	9	290	144	0.32	18.0	16.7	D
12	[illegible]	0	24.4	55	43.1	153	15.9	193.3	2.5	4	324	168	0.62	0.	0.	D
12	[illegible]	19	53.3	56	23.1	153	36.6	25.2	3.1	8	271	91	0.46	16.4	6.2	D
12	[illegible]	56	1[illegible]	56	15.3	153	32.9	26.[illegible]	3.6	11	272	106	0.43	15.0	5.0	D
12	[illegible]	12	[illegible]	57	[illegible]	153	30.0	33.7	2.3	4	319	39	0.04	0.	0.	C
12	[illegible]	22	4[illegible]	56	1[illegible]	152	27.5	24.4	3.7	13	275	114	0.41	14.8	5.1	D
12	[illegible]	33	3[illegible]	55	[illegible]	153	43.6	32.5	4.5	19	249	95	0.37	5.8	2.2	D
12	[illegible]	55	1[illegible].7	56	6.7	152	14.9	14.3	3.1	10	277	127	0.35	15.5	5.7	D
12	[illegible]	57	5[illegible]	56	[illegible]	152	55.3	32.4	3.5	13	267	81	0.51	14.0	3.6	D
12	1[illegible]	34	14.[illegible]	57	1[illegible]	157	22.2	5.0	2.2	3	211	39	0.51	0.	0.	D
12	1[illegible]	40	4[illegible].4	55	12.7	152	22.6	21.7	4.4	18	274	114	0.55	15.6	7.4	D
12	11	26	3[illegible]	56	[illegible]	152	56.4	32.4	3.2	8	312	20	0.37	10.7	2.5	D
12	1[illegible]	5	5[illegible]	55	2[illegible]	152	38.6	31.5	3.2	11	263	84	0.42	11.6	3.4	D
12	13	14	[illegible].1	57	36.7	155	34.4	133.0	2.6	4	296	42	0.	0.	0.	C
12	14	56	53.5	55	2[illegible].7	153	2.3	27.1	3.4	15	261	70	0.54	9.5	3.0	D
12	15	7	[illegible]	56	17.4	152	46.4	20.4	3.1	7	278	91	0.29	17.3	6.0	D
12	1[illegible]	20	25.[illegible]	56	11.4	152	17.7	15.0	3.3	9	285	118	0.33	23.5	9.1	D
12	17	10	34.2	56	17.4	152	18.0	13.7	3.8	7	326	108	0.32	77.3	23.4	D
12	17	20	2[illegible].4	56	31.2	152	31.2	26.7	3.4	7	324	79	0.34	82.1	13.4	D
12	17	31	57.4	56	26.2	153	23.6	5.0	1.2	3	220	47	0.08	0.	0.	C
12	17	47	27.2	56	[illegible]	152	41.4	28.1	3.5	13	269	95	0.76	22.3	7.8	D
12	1[illegible]	0	17.3	57	4.3	153	30.6	5.0	1.1	3	223	27	0.	0.	0.	C
12	1[illegible]	33	4[illegible]	56	2[illegible]	152	35.2	24.3	3.0	6	324	81	0.26	53.9	9.9	D
12	17	47	27.2	56	[illegible]	152	41.4	28.1	3.5	13	269	95	0.76	22.3	7.8	D
12	1[illegible]	0	17.3	57	4.3	153	30.6	5.0	1.1	3	223	27	0.	0.	0.	C
12	1[illegible]	33	43.3	56	[illegible]	152	35.2	25.2	3.0	6	324	91	0.26	53.9	9.9	D
12	1[illegible]	45	5[illegible]	56	[illegible]	152	23.6	25.5	2.4	6	322	55	0.21	46.4	7.3	D
12	2[illegible]	46	5[illegible]	56	37.[illegible]	153	57.3	23.2	3.2	11	265	75	0.55	12.7	4.8	D
12	21	7	13.7	56	5[illegible]	152	34.9	25.1	2.9	9	298	39	0.38	15.2	4.3	D
12	21	9	43.[illegible]	57	[illegible]	152	51.5	30.7	2.8	10	308	22	0.40	10.7	2.3	D
12	21	25	47.4	56	25.[illegible]	152	20.0	21.4	3.3	8	323	93	0.32	54.5	13.5	D
12	22	7	3[illegible]	60	17.[illegible]	151	8.2	5.0	2.0	3	277	91	0.30	0.	0.	D
12	23	10	5[illegible]	54	3[illegible]	153	3.3	23.2	3.5	15	257	62	0.52	8.6	2.8	D
12	23	45	[illegible].4	55	30.4	152	6.4	30.1	3.5	5	332	378	0.39	173.9	613.6	D
12	23	45	52.7	60	42.5	153	0.4	32.4	3.4	20	113	52	0.33	2.5	3.8	C
13	[illegible]	6	[illegible]	55	4[illegible].5	151	16.6	113.0	2.7	4	316	199	0.	0.	0.	C
13	[illegible]	51	54.[illegible]	56	[illegible]	152	40.7	25.4	3.5	8	308	116	0.52	53.5	16.4	D
13	[illegible]	1	1.7	55	[illegible]	152	19.9	2[illegible]	3.1	4	331	369	0.15	0.	0.	C
13	[illegible]	33	[illegible]	56	4[illegible]	152	31.2	25.7	3.1	6	307	50	0.40	30.9	7.8	D
13	[illegible]	37	4[illegible].4	56	2[illegible].2	155	58.6	27.7	2.8	7	264	74	0.58	19.6	6.7	D
13	4	50	1[illegible]	57	2[illegible].7	157	11.1	5.0	1.3	3	273	96	0.12	0.	0.	C
13	4	0	40.0	56	23.3	152	43.6	31.0	4.0	14	271	99	0.51	13.5	3.6	D
13	7	30	37.2	56	22.7	152	45.3	14.1	3.4	10	272	89	0.63	20.0	7.8	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DAY	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM
13	[illegible]	12	[illegible]	[illegible]	[illegible]	15[illegible]	14.9	[illegible]	2.8	4	270	25	0.11	0.	0.
13	[illegible]	51	[illegible]	59	[illegible]	15[illegible]	13.2	121.[illegible]	2.3	7	150	26	0.11	2.3	5.6
13	[illegible]	50	[illegible]	56	24.1	152	47.3	[illegible]	3.4	14	267	36	0.46	11.0	3.2
13	12	3	[illegible]	[illegible]	[illegible]	153	26.2	[illegible]	3.0	8	196	58	0.09	2.9	5.2
13	12	47	[illegible]	56	[illegible]	152	28.7	23.4	2.8	7	249	59	0.20	6.7	3.0
13	1[illegible]	59	[illegible]	56	[illegible]	15[illegible]	24.3	[illegible]	4.6	18	274	114	0.49	12.5	4.4
13	1[illegible]	23	[illegible]	55	[illegible]	152	41.4	25.[illegible]	4.1	14	261	75	0.38	11.3	4.5
13	1[illegible]	49	[illegible]	56	[illegible]	15[illegible]	35.5	[illegible]	3.1	7	323	71	0.34	73.1	9.5
13	17	44	[illegible]	59	[illegible]	152	2.9	[illegible]	2.2	3	275	80	0.04	0.	0.
13	1[illegible]	29	[illegible]	56	[illegible]	15[illegible]	34.8	25.[illegible]	3.6	8	278	93	0.36	27.3	7.9
13	2[illegible]	1	[illegible]	59	[illegible]	15[illegible]	45.5	104.4	2.7	7	158	50	0.20	6.0	12.3
13	2[illegible]	25	[illegible]	57	[illegible]	15[illegible]	0.8	6.4	1.6	4	143	18	0.	0.	0.
14	[illegible]	3	[illegible]	[illegible]	[illegible]	15[illegible]	39.5	[illegible]	2.0	3	212	20	0.07	0.	0.
14	[illegible]	23	[illegible]	56	[illegible]	15[illegible]	8.4	32.1	2.0	4	315	81	0.04	0.	0.
14	1[illegible]	59	[illegible]	55	[illegible]	15[illegible]	12.5	31.7	2.2	4	311	75	0.06	0.	0.
14	[illegible]	31	[illegible]	56	[illegible]	15[illegible]	37.9	5.0	2.1	3	179	46	0.01	0.	0.
14	[illegible]	35	[illegible]	59	[illegible]	15[illegible]	9.4	93.0	2.1	4	165	39	0.21	0.	0.
14	1[illegible]	55	[illegible]	56	[illegible]	15[illegible]	37.0	36.2	2.7	4	322	264	0.09	0.	0.
14	1[illegible]	8	2[illegible].2	56	[illegible]	15[illegible]	10.6	11.[illegible]	1.3	4	321	91	0.94	0.	0.
14	14	17	31.[illegible]	59	[illegible]	152	53.9	5.0	1.5	5	164	53	0.95	81.9	200.5
14	14	17	[illegible]	57	[illegible]	15[illegible]	49.0	[illegible]	1.9	6	121	19	0.10	2.6	4.2
14	1[illegible]	13	[illegible]	56	[illegible]	152	28.2	25.[illegible]	3.1	8	259	74	0.33	10.7	3.8
14	1[illegible]	27	[illegible]	56	[illegible]	152	58.5	32.6	3.3	13	281	81	0.41	14.7	3.0
14	1[illegible]	29	[illegible]	56	14.[illegible]	152	59.3	34.1	3.3	10	285	91	0.38	19.6	3.1
14	1[illegible]	1	5[illegible].1	55	[illegible]	15[illegible]	38.2	41.7	2.9	8	184	58	0.41	5.1	581.8
14	2[illegible]	25	1[illegible].1	5[illegible]	[illegible]	15[illegible]	53.1	[illegible]	2.0	6	158	32	0.13	2.4	3.9
14	2[illegible]	29	[illegible]	56	[illegible].7	15[illegible]	35.4	27.[illegible]	2.3	7	310	47	0.26	19.7	3.3
14	2[illegible]	35	[illegible]	5[illegible]	[illegible].1	152	19.5	[illegible].1	3.4	7	276	123	0.32	17.2	34.1
15	1	54	1[illegible]	57	[illegible]	15[illegible]	12.6	[illegible]	2.4	3	172	52	0.	0.	0.
15	[illegible]	5	[illegible]	59	[illegible].1	15[illegible]	21.6	12[illegible]	2.2	6	193	61	0.17	4.8	10.1
15	[illegible]	8	4[illegible]	5[illegible]	[illegible]	151	24.8	64.4	3.0	26	130	75	0.57	2.6	6.4
15	[illegible]	35	1[illegible]	5[illegible]	[illegible]	15[illegible]	23.0	21.[illegible]	3.1	6	245	21	0.93	164.3	51.1
15	1[illegible]	14	1[illegible]	5[illegible]	[illegible]	15[illegible]	47.2	10[illegible]	2.9	6	120	24	0.09	3.1	5.3
15	17	40	4[illegible]	56	[illegible].1	152	39.5	23.1	2.3	5	304	37	0.24	19.8	4.8
15	17	55	[illegible]	57	[illegible].7	152	16.3	26.[illegible]	2.2	6	255	19	0.14	5.0	1.8
15	1[illegible]	43	1[illegible]	56	[illegible]	152	11.6	1[illegible]	3.3	8	235	124	0.25	12.8	12.2
15	1[illegible]	43	4[illegible]	5[illegible]	41.6	152	10.6	27.[illegible]	4.2	5	331	372	0.22	71.6	262.8
15	21	25	15.[illegible]	5[illegible]	4.[illegible]	15[illegible]	13.6	96.[illegible]	2.9	9	154	41	0.20	2.4	4.8
15	2[illegible]	21	[illegible]	56	[illegible]	15[illegible]	18.9	2[illegible]	3.5	6	324	97	0.17	41.0	10.7
15	2[illegible]	3	3[illegible]	56	11.[illegible]	15[illegible]	25.8	21.4	3.9	9	233	115	0.33	16.5	5.8
15	23	39	[illegible].7	5[illegible]	2[illegible]	15[illegible]	51.7	7[illegible]	2.7	4	184	62	0.01	0.	0.
15	[illegible]	16	1[illegible]	5[illegible]	[illegible]	15[illegible]	48.7	3[illegible]	3.1	7	130	13	0.05	3.1	2.2
16	[illegible]	49	1[illegible]	5[illegible]	[illegible].7	152	44.0	7[illegible]	4.2	28	85	37	0.44	2.0	2.7
16	[illegible]	50	51.[illegible]	56	[illegible].4	15[illegible]	50.9	26.4	4.6	18	243	71	0.59	8.9	3.2
16	1[illegible]	37	3[illegible]	56	1[illegible].7	15[illegible]	32.0	2.7	3.3	9	295	99	0.55	33.8	36.0

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DAY	ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
16	10	50	53.[illegible]	55	3[illegible].[illegible]	152	23.3	21.[illegible]	3.2	6	322	83	0.15	33.0	8.0	D
16	11	2	57.1	54	[illegible].4	152	33.3	99.[illegible]	2.4	4	233	76	0.04	0.	0.	C
16	11	11	23.[illegible]	56	15.[illegible]	152	41.7	22.7	3.4	8	271	103	0.37	15.8	6.0	D
16	12	23	1[illegible].[illegible]	57	12.2	152	47.0	35.5	2.1	7	240	18	0.43	10.5	3.6	D
16	1[illegible]	19	29.4	59	45.[illegible]	153	15.0	6.[illegible]	2.6	4	201	78	0.24	0.	0.	C
16	23	55	5[illegible].[illegible]	58	[illegible].4	153	44.7	91.1	1.7	6	133	35	0.18	3.9	6.0	C
17	1	20	1[illegible].[illegible]	59	4[illegible].[illegible]	152	44.1	5.[illegible]	1.5	3	245	62	0.08	0.	0.	C
17	[illegible]	50	4[illegible].4	59	4[illegible].6	153	24.1	152.6	2.8	7	251	50	0.15	13.2	16.3	D
17	4	55	37.[illegible]	59	52.[illegible]	153	17.8	149.5	2.9	14	79	56	0.37	3.8	6.3	B
17	[illegible]	50	34.[illegible]	59	[illegible].6	152	26.8	5.[illegible]	2.2	4	124	45	0.43	0.	0.	D
17	[illegible]	38	5[illegible].[illegible]	57	11.4	152	27.8	5.[illegible]	3.2	5	186	23	1.13	4.7	6.3	D
17	[illegible]	6	[illegible].1	57	1[illegible].3	153	24.2	5.[illegible]	0.9	3	144	25	0.	0.	0.	C
17	[illegible]	30	1[illegible].[illegible]	59	[illegible].[illegible]	152	21.5	34.[illegible]	2.6	7	171	42	0.07	1.4	0.7	C
17	1[illegible]	14	[illegible].[illegible]	54	1[illegible].3	152	49.1	33.1	3.4	8	277	38	0.36	15.5	3.8	D
17	1[illegible]	47	[illegible].[illegible]	56	16.5	152	32.3	20.[illegible]	3.4	7	272	104	0.31	17.9	7.4	D
17	1[illegible]	20	2[illegible].[illegible]	59	47.6	152	59.1	5.[illegible]	1.5	3	255	70	0.50	0.	0.	D
17	1[illegible]	54	44.[illegible]	55	43.6	153	37.0	16.3	2.9	5	323	162	0.17	67.9	22.5	D
17	1[illegible]	35	41.3	60	11.[illegible]	153	2.3	143.7	2.9	4	157	23	0.	0.	0.	C
17	2[illegible]	15	47.[illegible]	56	5[illegible].4	154	37.8	5.[illegible]	2.2	3	283	41	0.39	0.	0.	D
17	2[illegible]	40	3[illegible].4	56	[illegible].7	152	42.2	24.[illegible]	4.8	16	262	76	0.57	10.2	3.8	D
17	21	15	41.[illegible]	56	54.[illegible]	152	28.3	21.5	2.8	5	304	44	0.31	145.7	33.4	D
17	22	25	5[illegible].[illegible]	55	57.7	154	37.3	75.7	2.5	5	167	49	0.16	7.6	16.5	D
17	22	49	3[illegible].[illegible]	59	2[illegible].[illegible]	152	25.0	30.1	2.9	9	102	43	0.22	1.7	1.9	B
17	22	51	1[illegible].[illegible]	59	3[illegible].[illegible]	152	25.8	9.[illegible]	2.2	4	126	44	0.24	0.	0.	C
17	2[illegible]	4	1[illegible].[illegible]	59	3[illegible].[illegible]	152	26.8	5.[illegible]	2.3	4	123	45	0.41	0.	0.	D
17	23	9	[illegible].[illegible]	55	1.1	154	4.9	30.[illegible]	2.7	4	239	247	0.21	0.	0.	C
18	[illegible]	6	4[illegible].[illegible]	56	44.[illegible]	152	43.7	32.1	3.2	6	334	52	0.27	176.5	12.1	D
18	[illegible]	13	[illegible].[illegible]	56	14.[illegible]	152	52.1	31.1	4.1	17	247	97	0.61	13.1	4.0	D
18	[illegible]	23	4[illegible].[illegible]	57	53.[illegible]	152	42.3	4.[illegible]	1.7	4	221	13	0.	0.	0.	C
18	[illegible]	28	4[illegible].2	59	[illegible].[illegible]	152	25.3	29.[illegible]	2.9	8	102	43	0.25	2.1	2.4	B
18	4	41	5[illegible].[illegible]	59	[illegible].1	152	54.5	92.5	2.6	5	160	77	0.02	0.6	1.2	C
18	4	44	35.4	57	5[illegible].[illegible]	152	32.1	5.[illegible]	1.2	3	248	4	0.	0.	0.	C
18	[illegible]	8	3[illegible].[illegible]	57	21.5	152	25.7	56.5	1.0	5	130	47	0.19	6.4	12.0	D
18	1[illegible]	23	[illegible].4	59	3[illegible].3	151	23.2	66.[illegible]	2.8	5	252	14	1.17	128.4	117.5	D
18	1[illegible]	32	4[illegible].[illegible]	56	25.[illegible]	152	43.5	30.[illegible]	3.4	10	266	82	0.49	16.3	4.3	D
18	1[illegible]	34	32.[illegible]	57	23.1	153	0.2	5.[illegible]	1.2	3	239	25	0.	0.	0.	C
18	2[illegible]	42	22.[illegible]	59	41.[illegible]	152	26.3	[illegible].[illegible]	2.0	4	96	16	0.	0.	0.	C
18	21	5	2[illegible].[illegible]	59	3[illegible].4	152	34.4	13[illegible].[illegible]	2.8	4	210	36	0.10	0.	0.	C
18	2[illegible]	27	5[illegible].1	57	[illegible].[illegible]	154	50.4	27.1	2.4	6	107	29	0.46	9.2	11.3	C
18	[illegible]	47	[illegible].1	56	5[illegible].4	152	36.3	5.[illegible]	1.4	3	157	37	0.	0.	0.	C
19	[illegible]	49	[illegible].1	60	[illegible].1	153	27.1	122.5	4.8	35	81	55	0.45	2.2	3.2	B
19	[illegible]	1	4[illegible].[illegible]	59	[illegible].[illegible]	151	27.7	2.4	2.8	6	271	63	0.40	25.4	690.7	D
19	4	37	5[illegible].[illegible]	55	2[illegible].[illegible]	156	10.3	31.7	2.8	4	312	74	0.03	0.	0.	C
19	[illegible]	17	1[illegible].[illegible]	5[illegible]	14.4	153	15.0	55.1	2.2	9	106	22	0.29	3.2	5.3	C
19	4	23	2[illegible].[illegible]	56	[illegible].1	152	59.7	25.5	3.5	11	265	74	0.55	12.9	4.4	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DAY	ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
19	[illegible]	36	[illegible]	[illegible]	[illegible]	[illegible]	0.3	[illegible]	3.2	9	243	138	0.61	15.3	48.7	D
19	[illegible]	51	[illegible]	59	[illegible]	[illegible]	26.5	[illegible]	2.4	6	109	44	0.37	3.9	643.3	C
19	11	13	[illegible]	[illegible]	57.3	[illegible]	42.0	[illegible]	2.5	8	313	136	0.67	94.6	953.6	D
19	[illegible]	55	[illegible]	55	[illegible]	[illegible]	42.1	[illegible]	3.1	8	319	171	0.69	115.9	961.0	D
19	[illegible]	39	11.3	59	[illegible]	[illegible]	3.4	123.1	1.9	4	182	56	0.30	0.	0.	D
19	15	47	[illegible]	57	[illegible]	157	33.7	[illegible]	2.1	4	203	57	0.35	0.	0.	D
19	22	30	17.4	60	[illegible]	151	49.0	1.5	2.3	4	253	53	0.50	0.	0.	D
19	[illegible]	23	17.4	[illegible]	[illegible]	153	36.0	25.4	2.3	7	305	42	0.36	19.7	5.2	D
20	[illegible]	42	54.6	56	22.0	153	41.9	34.5	2.2	4	279	91	0.	0.	0.	C
20	4	15	[illegible]	56	[illegible]	156	55.2	26.4	2.9	8	238	53	0.34	9.0	8.2	D
20	4	27	[illegible]	59	55.2	152	48.6	5.6	1.8	4	154	55	0.19	0.	0.	C
20	5	45	[illegible]	56	[illegible]	153	59.7	34.5	2.8	6	280	73	0.28	21.0	2.9	D
20	[illegible]	49	57.2	60	[illegible]	152	57.4	131.7	3.0	9	143	31	0.19	5.0	10.5	D
20	[illegible]	44	[illegible]	[illegible]	[illegible]	151	29.4	[illegible]	2.2	4	315	115	0.33	0.	0.	D
20	[illegible]	42	51.2	59	[illegible]	152	59.8	[illegible]	2.4	6	153	38	0.18	5.0	7.3	D
20	[illegible]	40	27.3	57	35.1	155	12.6	0.0	1.9	4	154	44	0.15	0.	0.	C
20	[illegible]	13	[illegible]	56	[illegible]	153	53.4	[illegible]	2.7	7	315	120	0.47	67.6	17.7	D
20	14	34	23.3	59	41.6	153	29.6	94.2	2.3	6	176	53	0.10	2.2	4.0	C
20	[illegible]	37	[illegible]	59	37.7	153	56.0	5.0	1.7	3	263	72	0.23	0.	0.	C
20	17	35	[illegible]	57	52.6	156	42.4	[illegible]	1.7	4	220	13	0.02	0.	0.	C
20	17	50	23.5	60	11.6	151	35.9	5.0	2.4	3	287	69	0.40	0.	0.	D
20	23	2	41.7	56	[illegible]	153	37.2	[illegible]	3.2	7	325	85	0.54	138.6	26.0	D
20	23	8	45.3	59	34.4	151	1.5	5.0	2.4	5	262	133	0.44	19.9	984.1	D
21	[illegible]	3	[illegible]	57	13.3	155	25.6	5.0	2.9	6	173	21	1.05	10.7	15.7	D
21	[illegible]	25	[illegible]	56	23.7	155	11.1	[illegible]	2.9	6	261	109	0.06	3.3	1.6	D
21	[illegible]	45	47.0	59	[illegible]	154	23.7	136.4	2.5	7	170	18	0.13	2.6	3.5	C
21	[illegible]	16	[illegible]	59	40.6	154	49.6	[illegible]	2.8	4	233	109	0.06	0.	0.	C
21	[illegible]	32	[illegible]	[illegible]	35.7	[illegible]	16.3	5.0	1.4	3	166	42	0.	0.	0.	C
21	[illegible]	9	[illegible]	55	31.0	[illegible]	28.0	4.5	2.7	5	327	197	0.16	68.3	63.2	D
21	[illegible]	25	44.4	56	56.7	[illegible]	56.5	34.7	2.5	4	314	25	0.23	0.	0.	C
21	4	48	[illegible]	[illegible]	[illegible]	154	32.9	123.4	2.6	13	109	35	0.36	3.5	7.1	C
21	[illegible]	59	[illegible]	56	[illegible]	[illegible]	5.2	91.4	3.1	9	177	41	0.24	4.5	5.5	C
21	[illegible]	1	[illegible]	60	[illegible]	151	53.7	[illegible]	[illegible]	29	103	44	0.39	1.7	2.6	C
21	[illegible]	30	[illegible]	55	[illegible]	[illegible]	3.2	35.2	2.3	6	239	130	0.40	18.1	686.9	D
21	[illegible]	9	[illegible]	[illegible]	[illegible]	152	19.2	[illegible]	2.7	22	76	49	0.42	2.3	3.5	B
21	[illegible]	32	36.1	59	11.5	[illegible]	24.3	5.0	2.3	3	252	60	0.15	0.	0.	C
21	21	34	[illegible]	57	[illegible]	153	55.3	[illegible]	1.3	3	210	49	0.01	0.	0.	C
22	4	29	[illegible]	55	[illegible]	[illegible]	51.9	[illegible]	2.5	4	243	102	0.	0.	0.	C
22	5	6	[illegible]	60	34.3	154	13.2	2.5	2.6	4	259	91	0.12	0.	0.	C
22	7	19	51.5	[illegible]	[illegible]	[illegible]	50.9	[illegible]	2.0	4	139	31	0.	0.	0.	C
22	[illegible]	1	[illegible]	59	[illegible]	[illegible]	53.3	[illegible]	1.5	3	240	49	0.29	0.	0.	C
22	[illegible]	14	54.2	[illegible]	[illegible]	153	27.4	[illegible]	1.9	5	153	31	0.29	5.2	9.8	D
22	[illegible]	21	[illegible]	56	[illegible]	153	19.1	[illegible]	1.7	4	247	53	0.51	0.	0.	D
22	12	36	31.5	55	[illegible]	154	17.8	87.7	2.2	11	80	68	0.21	1.7	5.8	B
22	13	24	[illegible]	56	11.4	152	49.2	30.4	3.5	17	254	93	0.49	9.2	3.6	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DA	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
22	13	39	40.4	56	55.6	153	56.0	21.3	3.3	13	268	78	0.63	14.0	5.4	D
22	13	42	24.0	56	5.7	153	42.4	1.1	3.1	3	301	130	0.44	40.6	68.7	D
22	13	58	51.0	57	13.2	153	43.6	35.0	2.4	4	239	22	0.	0.	0.	D
22	14	0	20.9	56	13.0	153	45.7	27.0	3.1	8	283	35	0.26	19.5	5.9	D
22	14	6	40.7	56	15.0	153	44.5	29.6	2.3	8	296	102	0.41	30.3	9.0	D
22	14	11	2.6	56	10.0	152	49.7	5.0	3.0	7	308	110	0.57	53.3	53.9	D
22	15	12	17.7	60	35.2	155	40.9	4.6	2.8	5	241	5	0.53	600.7	423.5	D
22	15	17	24.7	53	35.5	153	49.2	17.0	2.1	5	213	109	0.25	1.8	2.5	D
22	15	36	3.7	54	37.0	153	10.3	33.7	3.0	5	259	61	0.04	1.7	0.6	D
22	21	10	11.1	57	53.6	154	19.2	5.0	0.9	3	174	10	0.	0.	0.	C
22	21	10	40.0	57	54.0	154	30.5	24.0	1.1	4	191	5	0.	0.	0.	C
22	21	14	40.4	57	53.5	154	17.3	5.0	0.7	3	183	12	0.	0.	0.	C
22	21	41	55.1	57	54.0	154	24.9	34.0	1.3	4	162	7	0.	0.	0.	C
23	3	57	10.0	56	50.2	153	51.3	33.0	1.8	4	313	25	0.23	0.	0.	C
23	4	15	27.7	54	52.4	153	18.0	34.4	2.5	4	264	24	0.63	0.	0.	D
23	11	59	47.1	57	54.0	154	30.7	23.0	1.3	4	195	18	0.	0.	0.	C
23	12	7	27.1	57	55.6	154	29.6	23.5	2.0	4	194	16	0.	0.	0.	C
23	12	23	41.0	57	53.0	154	39.3	5.0	1.5	3	216	25	0.	0.	0.	C
23	12	29	51.1	57	55.3	154	31.7	26.3	2.0	5	200	7	0.04	1.1	1.2	C
23	12	51	37.0	57	52.4	153	9.5	5.0	0.9	3	177	20	0.	0.	0.	C
23	17	55	10.2	56	13.6	153	38.2	31.3	1.5	4	288	102	0.04	0.	0.	C
23	23	36	30.4	57	29.5	153	4.2	32.0	2.0	5	130	36	0.06	1.4	5.3	C
24	7	17	14.1	57	42.5	153	28.2	5.0	-0.2	3	133	18	0.	0.	0.	C
24	11	13	5.7	55	53.6	153	55.0	34.6	2.5	4	313	22	0.21	0.	0.	C
24	11	21	55.5	55	37.2	153	59.9	27.4	3.0	9	265	73	0.50	13.7	4.2	D
24	13	39	54.0	59	46.2	152	49.8	14.6	1.9	5	246	68	0.06	2.3	1.7	C
24	13	59	15.0	56	2.7	153	56.1	24.0	3.3	6	313	123	0.43	62.0	18.7	C
25	0	21	20.0	53	13.4	155	9.2	3.1	2.9	8	135	54	0.28	2.3	4.7	C
25	2	23	33.7	56	20.0	153	29.4	13.0	3.2	6	259	43	0.68	12.2	102.5	D
25	5	21	30.0	57	29.1	154	10.2	45.6	2.0	4	124	31	0.	0.	0.	C
25	5	43	3.5	57	3.6	153	56.1	23.4	1.3	4	207	47	0.	0.	0.	C
25	6	20	56.5	57	22.0	154	52.9	5.0	0.8	3	191	15	0.	0.	0.	C
25	6	50	27.0	59	55.0	152	49.6	96.0	2.3	8	245	60	0.40	21.5	21.7	C
25	7	36	5.6	60	2.4	152	27.7	181.0	4.3	31	98	74	0.48	2.4	4.0	C
25	12	46	54.4	56	54.0	154	40.3	5.0	1.7	5	170	46	0.17	2.7	3.0	D
25	15	5	41.5	59	46.0	153	1.3	183.1	2.5	4	144	73	0.08	0.	0.	C
25	23	45	34.5	57	1.7	158	4.4	2.3	2.2	4	183	43	0.01	0.	0.	C
26	2	22	14.4	59	21.1	153	22.5	124.4	3.4	8	115	45	0.20	2.9	4.0	C
26	5	59	7.4	57	47.7	153	41.6	33.3	1.7	4	133	12	0.01	0.	0.	C
26	7	7	20.4	57	4.4	153	29.3	5.0	1.0	3	215	25	0.	0.	0.	C
26	14	49	47.3	59	34.3	152	26.7	5.0	1.3	3	170	44	0.	0.	0.	C
26	21	6	1.0	59	22.5	152	27.7	97.4	2.7	5	136	47	0.21	11.4	30.2	C
27	1	41	15.4	56	23.2	153	40.1	32.5	4.6	19	242	39	0.48	8.1	3.0	C
27	3	21	3.4	57	52.5	154	41.3	1.0	1.4	4	218	12	0.03	0.	0.	C
27	4	39	10.3	54	45.0	156	44.5	5.0	2.2	3	262	51	0.23	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DY	ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
27	[illegible]	35	13.1	57	[illegible]	15[illegible]	45.8	[illegible]	1.7	4	142	42	0.35	0.	0.	D
27	7	38	4[illegible]	5[illegible]	[illegible].4	15[illegible]	21.5	11[illegible].7	3.3	10	154	19	0.26	4.5	6.0	C
27	8	29	2[illegible]	5[illegible]	[illegible].1	15[illegible]	36.0	[illegible]	2.4	4	242	43	0.	0.	0.	C
27	[illegible]	42	3[illegible]	59	40.1	152	53.9	110.5	2.6	5	239	26	0.12	13.5	19.2	D
27	19	20	47.7	59	[illegible].0	15[illegible]	22.6	32.7	3.2	5	187	42	0.03	1.5	3.8	C
27	19	56	6.5	59	23.2	15[illegible]	29.9	64.1	2.7	6	112	51	0.27	7.6	19.0	C
27	2[illegible]	30	[illegible].7	55	51.4	15[illegible]	26.2	5.[illegible]	2.3	4	222	105	0.02	0.	0.	C
27	21	27	1[illegible]	56	40.5	15[illegible]	32.0	5.[illegible]	2.9	3	197	46	0.43	0.	0.	D
27	2[illegible]	55	55.1	57	[illegible].2	15[illegible]	39.6	[illegible].1	0.9	4	215	10	0.	0.	0.	C
28	1	53	57.[illegible]	59	21.5	152	59.3	85.1	2.8	6	138	19	0.08	3.4	5.3	C
28	[illegible]	47	57.2	57	[illegible].4	15[illegible]	56.8	2[illegible]	1.8	4	220	51	0.	0.	0.	C
28	[illegible]	52	43.2	55	[illegible]	15[illegible]	53.0	26.[illegible]	3.9	13	265	90	0.54	11.8	3.6	D
28	[illegible]	14	2[illegible]	53	23.6	15[illegible]	38.1	30.5	3.0	6	131	44	0.06	1.5	2.5	B
28	[illegible]	59	59.4	60	21.0	152	24.2	113.[illegible]	3.1	7	295	88	0.23	33.6	30.3	D
28	13	47	57.[illegible]	56	57.[illegible]	152	34.2	32.[illegible]	2.7	4	303	39	0.60	0.	0.	D
28	14	29	4.2	60	4.9	153	10.4	163.5	3.0	6	279	47	0.04	5.7	6.6	D
29	[illegible]	41	43.4	57	43.9	154	50.1	2.1	2.0	4	156	46	0.03	0.	0.	C
29	3	34	12.6	58	16.6	15[illegible]	51.8	47.[illegible]	2.6	6	122	29	0.17	2.5	4.7	C
29	[illegible]	23	1.5	57	1[illegible]	15[illegible]	2.8	5.[illegible]	1.5	4	203	39	0.	0.	0.	C
29	11	5	2[illegible]	59	55.5	153	0.5	100.7	2.8	7	159	82	0.36	7.3	16.5	D
30	7	30	37.0	58	23.0	15[illegible]	18.9	135.1	2.7	5	249	70	0.16	26.4	32.4	D
30	15	41	44.3	56	45.0	153	45.0	6.6	1.9	5	190	33	0.73	55.3	88.1	D
30	15	7	33.6	59	16.0	152	25.4	3.[illegible]	1.9	4	152	62	0.16	0.	0.	C
30	16	40	44.7	56	46.5	153	36.2	15.2	2.3	5	200	42	0.12	3.1	2.7	D
30	1[illegible]	19	1[illegible]	57	54.4	15[illegible]	8.1	5.[illegible]	1.9	4	190	70	1.07	0.	0.	D
30	2[illegible]	58	37.4	59	35.2	15[illegible]	31.6	11.3	1.3	4	160	40	0.19	0.	0.	C
30	22	6	31.[illegible]	59	[illegible]	15[illegible]	31.4	5.[illegible]	1.8	3	160	53	0.	0.	0.	C
1	[illegible]	28	4[illegible].5	58	[illegible].6	154	47.4	65.5	2.3	4	226	50	0.	0.	0.	C
1	[illegible]	48	1[illegible]	56	45.0	15[illegible]	19.4	1[illegible]	0.	5	306	65	0.05	6.7	2.2	D
1	[illegible]	12	47.[illegible]	5[illegible]	26.6	15[illegible]	18.2	3[illegible].4	2.4	9	163	70	0.62	7.3	5.8	D
1	[illegible]	53	3[illegible]	53	[illegible].6	15[illegible]	41.5	5.[illegible]	1.9	3	294	20	0.22	0.	0.	C
1	1[illegible]	52	4[illegible].7	57	[illegible].7	155	0.9	3[illegible]	1.9	4	259	29	0.	0.	0.	C
1	14	33	1[illegible]	5[illegible]	[illegible].4	15[illegible]	11.6	[illegible].1	2.4	7	121	70	0.19	3.0	8.1	C
1	2[illegible]	13	[illegible]	50	[illegible].7	15[illegible]	51.6	105.0	2.2	4	216	77	0.	0.	0.	C
2	1	34	2[illegible]	5[illegible]	44.2	154	23.5	100.6	2.9	7	151	42	0.06	1.5	3.6	C
2	2	24	24.1	5[illegible]	5.1	154	[illegible]9.2	95.[illegible]	2.7	12	137	61	0.17	1.6	3.4	C
2	[illegible]	4	56.5	57	58.7	15[illegible]	34.4	5.[illegible]	1.3	3	265	15	0.06	0.	0.	C
2	[illegible]	57	41.[illegible]	61	27.5	151	25.3	5.[illegible]	3.6	5	241	231	0.15	6.5	332.6	D
2	[illegible]	10	[illegible].2	55	20.4	15[illegible]	46.4	23.[illegible]	3.1	3	263	77	0.66	19.3	6.9	D
2	[illegible]	35	[illegible].4	58	[illegible]	154	2.5	110.[illegible]	2.9	9	129	16	0.26	3.5	13.7	C
2	[illegible]	38	32.1	59	53.6	15[illegible]	15.3	165.5	2.7	8	261	105	0.30	11.9	13.9	D
2	1[illegible]	49	3[illegible]	57	17.3	155	4.5	7[illegible]	2.3	4	303	60	0.02	0.	0.	C
2	11	40	[illegible]	59	[illegible]	15[illegible]	4.2	5.[illegible]	0.	3	226	24	0.	0.	0.	C
3	1[illegible]	52	5[illegible]	50	[illegible]	15[illegible]	0.2	1[illegible].3	2.6	5	212	20	0.57	31.2	74.5	D
3	1[illegible]	2	5[illegible]	59	44.1	151	59.3	33.2	2.8	6	231	21	0.1[illegible]	7.9	3.0	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

DY	ORIGIN HR	MN	TIME SEC	LAT DEG	MIN	LONG DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
4	[illegible]	35	35.[illegible]	59	16.4	152	46.0	92.4	2.7	7	234	35	0.29	13.6	16.6	D
4	[illegible]	0	14.1	57	45.6	154	23.3	127.0	3.4	12	152	10	0.25	3.4	4.9	C
4	[illegible]	26	24.3	61	27.4	150	57.6	5.0	3.3	6	247	223	0.12	4.6	207.1	D
4	8	36	50.4	59	40.4	153	12.4	69.4	2.3	8	212	31	0.31	12.2	17.5	D
4	[illegible]	23	42.0	60	12.0	152	22.0	110.6	3.1	7	295	72	0.19	25.4	23.6	D
4	14	55	41.6	59	29.0	152	29.9	50.5	2.3	6	200	50	0.58	3.0	5.5	D
4	19	49	5[illegible].4	57	53.4	155	32.6	5.0	1.2	3	255	4	0.	0.	0.	D
4	21	6	54.3	58	14.4	154	49.7	102.0	1.8	5	226	66	0.16	9.9	14.0	D
4	23	35	47.7	59	44.3	153	51.6	45.7	2.0	6	254	69	0.42	19.2	70.8	D
5	5	32	45.9	58	2.9	155	55.0	5.0	0.	4	278	259	0.21	0.	0.	C
5	4	46	4[illegible].0	57	52.9	156	40.9	1.1	1.6	4	217	11	0.02	0.	0.	C
5	5	56	15.5	57	5[illegible].0	156	40.8	2.2	1.5	4	217	11	0.10	0.	0.	C
5	[illegible]	53	17.7	57	5[illegible].0	15[illegible]	41.7	[illegible]	1.6	4	219	12	0.06	0.	0.	C
5	9	40	1[illegible].2	59	41.5	150	59.3	99.5	2.3	5	252	75	0.55	22.7	32.8	D
5	14	26	46.4	57	4.0	153	20.8	[illegible].4	2.3	4	235	19	0.06	0.	0.	C
5	15	35	58.0	59	2[illegible].4	152	39.4	5.0	2.4	6	162	36	0.35	5.1	4.8	D
5	18	12	31.0	57	53.2	154	39.6	[illegible].5	2.6	5	215	10	0.02	0.5	0.3	D
5	19	6	32.9	58	12.0	155	10.4	[illegible].4	2.2	5	203	53	0.04	0.8	81.4	D
5	21	0	51.1	59	46.9	152	42.2	75.5	3.1	8	250	72	0.27	9.0	11.2	D
5	22	40	[illegible].4	57	30.8	154	31.4	[illegible].6	1.5	4	140	21	0.35	0.	0.	D
5	22	45	3.4	57	53.3	154	34.0	5.0	0.9	3	260	5	0.04	0.	0.	C
6	4	43	[illegible].4	57	23.[illegible]	155	10.0	78.0	3.1	9	144	32	0.34	3.8	6.2	C
6	16	50	34.9	60	14.3	153	15.1	5.0	2.5	3	186	125	0.	0.	0.	C
7	11	13	44.4	57	52.3	156	40.5	5.0	1.8	3	214	29	0.	0.	0.	C
[illegible]	[illegible]	9	43.5	59	17.2	151	28.9	23.5	2.9	6	214	21	0.34	13.8	11.1	D
8	4	38	53.1	60	46.7	151	15.5	36.5	3.4	4	331	345	0.26	0.	0.	C
8	5	28	23.2	59	44.1	155	24.7	5.0	2.3	3	206	49	0.	0.	0.	C
8	9	36	5[illegible].0	57	[illegible].0	155	18.1	5.0	1.7	3	245	19	0.	0.	0.	C
8	17	23	44.7	59	4.0	152	56.8	6[illegible].3	2.8	4	200	35	0.	0.	0.	C
9	4	54	4[illegible].1	57	[illegible].1	158	45.1	99.4	2.5	4	201	69	0.	0.	0.	C
9	17	12	4[illegible].1	58	[illegible].7	155	26.3	37.2	2.4	4	192	53	0.92	0.	0.	D
9	11	4	14.[illegible]	53	1.5	155	25.8	37.4	1.4	4	194	53	0.80	0.	0.	D
9	17	43	5[illegible].5	59	36.4	155	46.0	74.[illegible]	2.9	4	183	26	0.02	0.	0.	D
9	21	12	24.[illegible]	58	33.2	153	44.9	40.7	2.6	8	150	56	0.29	3.5	3.0	D
10	14	29	[illegible].1	59	33.1	152	36.1	5.0	1.6	3	171	37	0.	0.	0.	C
10	2[illegible]	1	3[illegible].7	59	[illegible].5	153	4.3	96.1	3.0	8	101	16	0.25	5.9	7.7	C
11	[illegible]	37	4[illegible]	59	45.1	158	47.7	233.2	3.3	4	329	84	0.04	0.	0.	C
11	4	11	5[illegible].0	59	[illegible].5	152	18.5	5.0	2.3	3	164	41	0.	0.	0.	C
11	17	52	[illegible].0	57	47.4	151	16.2	3[illegible].0	3.0	5	158	29	1.16	35.2	19.3	D
11	15	51	2[illegible].3	59	53.3	152	2.0	3[illegible].1	2.3	5	263	53	0.09	8.8	1.8	D
11	17	10	3[illegible].7	59	17.7	153	27.2	67.0	2.4	5	173	62	0.05	1.7	2.9	C
12	[illegible]	55	37.[illegible]	57	[illegible]	154	43.8	40.0	1.1	4	132	13	0.	0.	0.	C
12	4	46	4[illegible]	57	17.6	155	47.7	5.0	1.5	3	244	22	0.01	0.	0.	C
12	8	50	4[illegible]	59	22.2	153	1.0	93.0	1.4	4	329	72	0.05	0.	0.	C
12	19	59	3[illegible]	[illegible]	1[illegible]	151	13.4	[illegible]	3.4	4	233	89	0.91	0.	0.	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

	ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
12	14	1	[illegible]	57	[illegible]	[illegible]	53.9	5.4	2.6	4	185	24	0.	0.	0.	C
12	15	0	[illegible]	57	[illegible]	152	54.6	54.7	2.7	5	132	32	0.21	7.3	11.0	D
12	17	13	[illegible]	57	[illegible]	153	55.5	5.0	1.0	3	216	40	0.	0.	0.	C
12	21	59	[illegible]	[illegible]	27.3	153	38.2	57.5	3.0	6	161	56	0.28	7.0	11.7	D
12	22	4	7.3	58	14.7	152	40.9	34.6	3.3	4	237	99	0.	0.	0.	C
13	4	3	[illegible]	57	11.2	[illegible]	47.7	[illegible]	3.7	6	139	24	0.37	16.3	24.9	D
13	11	41	[illegible]	57	[illegible]	[illegible]	1.1	[illegible]	1.5	3	256	69	0.	0.	0.	C
13	12	13	29.7	60	4.0	152	29.0	43.5	2.9	5	166	40	0.57	55.0	191.3	D
14	[illegible]	4	21.7	57	54.4	155	60.0	94.7	2.1	5	222	26	0.13	22.1	9.9	D
14	6	32	[illegible]	56	[illegible]	[illegible]	42.2	20.2	2.7	10	295	100	0.40	18.1	4.4	D
14	6	35	[illegible]	[illegible]	[illegible]	151	11.3	217.4	2.8	7	229	68	1.40	61.7	92.2	D
14	[illegible]	42	[illegible]	59	[illegible]	151	32.9	73.5	2.6	4	224	13	0.	0.	0.	C
14	[illegible]	59	[illegible]	59	1.1	154	48.5	91.1	2.4	5	210	50	0.06	2.8	6.0	D
14	10	4	[illegible]	55	17.4	155	54.2	34.5	2.3	5	233	118	0.20	8.9	452.0	D
14	12	42	[illegible]	57	[illegible]	[illegible]	41.4	1.0	1.6	4	213	12	0.07	0.	0.	C
14	12	43	[illegible]	57	1.2	153	58.6	35.3	1.3	4	238	52	0.	0.	0.	C
14	12	52	47.6	56	[illegible]	152	53.9	34.0	2.9	8	276	83	0.29	12.2	2.7	D
14	[illegible]	49	[illegible]	58	37.2	155	55.4	116.7	3.2	13	97	37	0.34	3.4	4.8	C
15	4	3	3.2	57	14.1	155	8.3	14.0	1.5	5	214	32	0.13	4.1	14.7	D
15	[illegible]	19	27.2	60	13.4	152	16.4	33.8	2.2	4	207	35	0.05	0.	0.	C
15	6	29	35.2	58	10.7	151	20.6	32.4	1.7	5	224	96	0.20	9.4	6.4	D
15	8	13	[illegible]	59	14.8	155	22.8	67.3	2.2	7	114	50	0.29	4.5	7.2	C
15	10	51	37.5	58	21.3	155	48.4	150.0	3.0	6	257	46	0.23	17.3	25.3	D
15	14	51	27.4	[illegible]	14.2	152	0.7	32.2	3.0	7	195	43	0.24	4.6	1.8	D
16	7	59	45.4	59	44.2	152	35.3	91.5	2.9	7	126	59	0.20	3.5	5.4	C
16	11	36	[illegible]	59	40.1	153	16.6	165.8	2.0	6	166	48	0.31	9.7	14.5	D
16	12	12	[illegible]	57	53.2	154	39.3	3.3	2.0	5	215	10	0.08	1.9	1.3	C
16	13	39	[illegible]	56	53.7	154	3.0	5.0	2.2	6	200	74	1.00	14.1	0.	D
16	20	26	[illegible]	58	24.2	153	57.4	38.0	2.1	4	237	72	0.01	0.	0.	C
17	[illegible]	18	15.4	56	[illegible]	154	43.2	39.4	2.1	4	195	33	0.	0.	0.	C
17	11	26	[illegible]	59	51.4	153	10.6	11.1	1.3	5	191	66	0.21	4.4	22.8	D
17	23	32	[illegible]	57	[illegible]	155	11.2	[illegible]	2.8	5	114	4	0.02	0.3	0.3	C
18	1	35	[illegible]	59	3.5	152	47.0	70.4	3.1	7	99	47	0.15	2.3	4.4	B
18	6	45	[illegible]	[illegible]	[illegible]	152	23.8	33.7	2.7	4	237	45	0.	0.	0.	C
18	9	25	[illegible]	59	27.5	153	3.7	[illegible]	3.0	11	96	10	0.42	4.5	5.8	C
18	14	45	54.7	56	25.7	152	38.5	30.4	3.4	4	270	68	0.	0.	0.	C
18	17	55	7.1	60	26.0	151	46.7	5.0	2.5	3	268	54	0.15	0.	0.	C
18	[illegible]	1	[illegible]	60	4.0	153	6.8	163.4	3.6	14	102	42	0.37	5.2	6.6	C
18	[illegible]	58	21.3	59	55.3	152	29.6	5.0	2.1	3	151	51	0.	0.	0.	C
18	21	33	31.7	56	[illegible]	153	15.9	33.0	3.5	9	294	72	0.52	30.4	4.8	D
19	[illegible]	43	[illegible]	55	[illegible]	153	5.1	20.7	2.3	6	318	123	0.27	90.3	17.2	D
19	8	40	47.1	60	[illegible]	153	16.8	103.7	2.7	11	222	29	0.15	2.6	2.3	D
19	11	58	[illegible]	57	[illegible]	155	23.3	30.3	1.7	6	124	26	0.21	5.7	7.3	C
19	14	41	51.4	59	[illegible]	151	40.7	20.0	2.2	5	239	96	0.57	24.1	21.0	D
19	15	13	[illegible]	59	[illegible]	151	12.1	5.0	2.1	4	261	48	0.38	0.	0.	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

[illegible]	ORIGIN HR	MN	TIME SEC	LAT DEG	MIN	LONG DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
19	14	42	[illegible]	57	[illegible]	153	18.2	5.0	0.4	3	153	29	0.	0.	0.	C
20	[illegible]	44	3[illegible]	60	1[illegible]	153	21.0	147.[illegible]	2.4	5	208	41	0.29	6.6	17.5	D
20	1	36	[illegible].7	59	45.[illegible]	152	46.5	99.4	2.7	7	132	54	0.20	3.7	6.0	C
20	2	24	2[illegible]	57	37.[illegible]	152	26.9	5.0	2.0	3	152	34	0.	0.	0.	C
20	4	53	5[illegible].4	57	21.[illegible]	155	42.7	106.[illegible]	2.8	4	320	68	0.	0.	0.	C
20	[illegible]	26	45.4	59	[illegible].2	154	25.5	[illegible]	2.8	9	140	67	0.39	2.7	527.6	D
21	[illegible]	19	55.[illegible]	57	52.[illegible]	154	35.8	4.1	2.6	6	157	61	2.06	26.0	0.	D
21	[illegible]	37	33.7	55	57.3	155	17.4	[illegible]	3.5	10	187	65	0.29	2.5	378.1	D
21	14	55	27.4	56	[illegible].7	152	20.7	1[illegible].5	4.3	12	273	127	0.61	21.7	8.6	D
21	1[illegible]	43	2[illegible].3	60	11.4	152	23.5	112.4	2.9	9	190	33	0.06	1.7	2.4	C
21	23	24	24.3	57	30.9	154	57.0	5.0	2.6	3	275	39	0.29	0.	0.	C
21	2	46	33.2	59	[illegible].1	155	20.7	10.[illegible]	1.5	5	216	43	0.45	8.5	782.8	D
21	[illegible]	6	17.1	57	35.[illegible]	155	4.5	46.[illegible]	2.3	4	145	39	0.04	0.	0.	C
22	11	14	37.2	60	[illegible]	152	52.7	110.2	2.2	8	151	41	0.28	6.6	11.1	D
22	13	26	32.3	59	52.[illegible]	152	20.5	87.0	2.9	10	144	46	0.31	4.4	7.0	C
22	14	57	27.[illegible]	59	23.[illegible]	153	54.4	37.4	2.9	5	218	38	0.12	6.3	2.1	D
22	15	16	42.1	57	[illegible].6	153	16.2	15.[illegible]	2.4	4	260	20	0.12	0.	0.	C
22	15	39	59.[illegible]	57	20.4	153	37.9	32.7	2.9	7	167	13	0.21	3.0	1.7	C
22	17	22	37.4	59	27.5	153	55.7	26.1	2.2	6	190	31	0.03	0.4	0.4	C
22	19	5	3[illegible]	57	21.2	155	56.5	[illegible]	2.3	11	153	28	0.17	2.1	2.4	C
22	23	21	5[illegible].7	59	[illegible]	154	51.6	110.4	2.4	5	232	56	0.13	9.4	19.1	D
23	[illegible]	3	[illegible]	56	40.3	156	51.8	40.7	2.5	6	210	46	0.47	36.9	30.7	D
23	1	56	1[illegible]	59	[illegible].7	152	10.8	80.1	2.2	5	216	23	0.	0.2	0.3	C
23	2	25	[illegible]	57	47.7	15[illegible]	12.3	127.4	3.6	19	71	9	0.26	2.0	2.8	D
23	[illegible]	54	[illegible]	60	2.[illegible]	152	25.4	5.0	2.3	5	169	45	1.26	41.3	101.9	D
23	11	50	14.[illegible]	55	31.2	155	47.6	40.[illegible]	3.0	6	220	114	0.25	7.3	437.9	D
23	1[illegible]	59	54.[illegible]	60	[illegible]	152	17.2	5.0	0.	3	137	44	0.01	0.	0.	C
23	2[illegible]	23	2[illegible]	60	1[illegible]	152	8.3	5.0	0.	3	231	37	0.07	0.	0.	C
24	[illegible]	7	2[illegible]	57	36.1	155	28.5	82.4	3.2	7	115	19	0.14	3.5	3.6	C
24	[illegible]	56	4[illegible]	59	29.4	152	53.7	39.4	3.0	5	111	26	0.02	0.4	0.6	C
24	[illegible]	29	5[illegible].1	53	[illegible]	15[illegible]	2.8	34.5	4.0	8	266	140	0.19	9.0	266.6	D
24	[illegible]	31	17.[illegible]	5[illegible]	7.[illegible]	153	12.0	4.[illegible]	4.1	8	312	172	0.27	44.6	14.3	D
24	13	12	14.4	59	5[illegible]	153	19.5	167.[illegible]	3.2	4	214	35	0.	0.	0.	C
24	13	35	4[illegible].7	59	[illegible].4	152	22.1	30.[illegible]	2.7	4	149	35	1.47	0.	0.	C
24	1[illegible]	27	3[illegible]	59	40.4	152	41.5	102.[illegible]	2.6	4	192	30	0.01	0.	0.	C
25	[illegible]	51	4[illegible].5	59	12.4	152	53.2	129.5	2.5	4	313	129	0.11	0.	0.	C
25	[illegible]	14	51.[illegible]	57	4.4	155	3.1	5.0	1.5	3	269	82	0.	0.	0.	C
25	14	49	2[illegible]	55	[illegible].6	15[illegible]	17.4	17.4	3.3	13	280	134	0.46	21.6	8.3	D
25	1[illegible]	23	2[illegible]	5[illegible]	27.[illegible]	151	37.3	4.[illegible]	2.1	4	188	3	0.07	0.	0.	C
25	1[illegible]	50	3[illegible].7	57	4.[illegible]	15[illegible]	57.0	32.[illegible]	2.6	9	217	48	0.33	4.8	2.1	D
25	2[illegible]	17	1[illegible]	57	24.7	15[illegible]	0.7	5.0	1.9	3	183	24	0.06	0.	0.	C
25	22	29	3[illegible]	59	47.[illegible]	153	9.7	117.4	2.4	4	181	15	0.01	0.	0.	C
25	2[illegible]	55	5[illegible]	55	57.[illegible]	15[illegible]	11.6	[illegible]	2.4	5	175	63	0.27	5.0	608.6	D
26	[illegible]	1	4[illegible]	59	11.5	151	35.4	77.[illegible]	2.7	9	200	31	0.22	3.5	5.1	D
26	[illegible]	45	1[illegible]	59	5[illegible]	151	49.9	97.4	2.2	4	263	81	0.01	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

[illegible]	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
26	17	15	[illegible]	57	[illegible]	154	3.1	131.[illegible]	2.9	7	140	20	0.21	3.3	11.5	D
26	1[illegible]	43	21.1	53	4.6	152	14.5	32.[illegible]	3.1	10	133	39	0.32	3.7	2.4	D
26	19	7	37.3	53	1[illegible].5	154	47.3	5.0	2.0	4	165	73	0.07	0.	0.	C
26	20	39	44.5	59	34.[illegible]	151	41.4	57.6	2.3	8	182	12	0.18	3.3	3.9	D
26	22	8	34.3	60	[illegible].1	152	51.7	134.1	3.3	12	153	37	0.33	6.6	8.8	D
26	22	13	2[illegible].3	59	16.3	15[illegible]	24.9	4.4	1.8	4	270	23	0.	0.	0.	C
26	22	46	4[illegible].3	59	[illegible].7	153	4.6	147.1	2.9	9	171	40	0.10	2.5	3.1	C
[illegible]	[illegible]	52	1.7	53	[illegible].5	151	0.7	5.0	2.3	4	292	119	0.21	0.	0.	C
[illegible]	7	23	[illegible].5	53	17.9	151	16.7	33.5	3.0	8	228	94	0.27	5.8	384.9	D
27	[illegible]	30	13.9	57	49.0	154	11.4	51.9	2.1	7	160	25	0.29	4.0	6.0	C
27	[illegible]	2	2[illegible].3	59	44.4	153	13.7	140.7	3.4	16	155	9	0.22	3.1	3.4	C
27	1[illegible]	15	5[illegible].1	59	51.0	151	46.2	5.0	1.5	3	208	45	0.01	0.	0.	C
27	12	24	53.0	60	2.1	152	59.7	12[illegible].9	2.2	4	179	44	0.	0.	0.	C
27	14	12	2[illegible].5	57	44.6	155	1.2	32.6	2.0	5	156	29	0.08	3.2	5.8	D
27	14	29	31.5	59	31.0	154	25.4	5.0	1.3	4	189	71	0.06	0.	0.	C
27	14	49	5[illegible].0	61	7.0	149	6.8	34.5	3.9	11	319	214	0.23	33.4	289.2	D
27	1[illegible]	2	5[illegible].3	58	24.[illegible]	156	10.5	195.7	3.4	10	233	60	0.24	8.1	15.2	D
27	15	39	12.5	5[illegible]	[illegible].4	153	52.9	53.2	2.1	4	194	32	0.	0.	0.	C
27	2[illegible]	4	54.1	57	54.5	152	2.7	5[illegible].1	2.1	4	223	23	0.	0.	0.	C
28	[illegible]	11	5[illegible].5	59	4[illegible].1	153	6.9	53.8	2.2	5	169	47	0.06	1.9	6.8	D
28	7	5	25.5	58	54.0	155	2.9	5.0	1.7	3	301	106	0.	0.	0.	C
28	[illegible]	28	7.3	57	13.2	153	28.7	5.[illegible]	2.3	3	261	37	0.06	0.	0.	C
28	[illegible]	9	37.5	59	5[illegible].5	152	44.5	101.[illegible]	2.5	9	132	39	0.24	4.2	6.0	C
28	13	34	[illegible].4	56	4.7	152	46.1	25.2	3.6	9	310	122	0.49	48.3	14.6	D
28	2[illegible]	2	2[illegible].1	55	5[illegible].6	154	29.1	3.0	2.3	4	189	40	0.58	0.	0.	D
29	22	3	[illegible].6	57	26.1	154	17.0	74.4	2.6	6	132	59	0.19	3.9	7.6	C
29	[illegible]	38	[illegible].3	56	45.7	155	59.4	33.0	2.7	10	102	36	0.19	2.1	4.2	B
29	[illegible]	24	4[illegible].4	60	[illegible].3	153	16.6	1[illegible].3	3.3	21	92	44	0.36	4.3	5.7	C
29	[illegible]	42	3[illegible].5	60	3[illegible].7	153	23.4	5.0	1.3	4	329	15	0.34	0.	0.	D
29	[illegible]	42	[illegible].3	57	47.0	156	11.4	107.2	2.5	8	113	10	0.20	5.0	7.0	C
30	1[illegible]	3	2[illegible]	56	36.2	154	19.8	38.8	3.1	10	199	80	0.30	3.7	3.4	D
30	13	40	39.4	59	14.5	151	57.1	54.0	2.1	8	157	33	0.39	5.0	9.8	D
30	13	42	1.[illegible]	59	22.7	151	50.7	7[illegible].3	2.2	5	195	17	0.06	3.1	4.8	D
30	1[illegible]	43	1[illegible]	60	1[illegible].6	152	0.4	71.[illegible]	2.3	4	240	43	0.	0.	0.	C
30	17	22	[illegible].5	59	21.5	154	11.5	1.4	1.3	5	224	54	0.06	0.1	0.5	C
30	1[illegible]	9	44.7	59	23.0	154	8.2	80.7	3.5	12	104	79	0.17	1.4	3.8	B
31	[illegible]	25	5[illegible].3	56	4[illegible].1	157	2.5	71.6	2.9	6	189	35	0.40	10.6	14.0	D
31	11	23	5[illegible].7	60	6.6	15[illegible]	50.0	39.[illegible]	4.2	8	269	67	0.17	8.2	3.9	D
31	14	22	42.3	5[illegible]	4[illegible].3	15[illegible]	2.6	6[illegible]	2.4	4	170	33	0.	0.	0.	D
31	17	43	[illegible].1	60	33.5	151	21.0	5.0	0.	3	237	79	0.23	0.	0.	C
31	1[illegible]	33	5[illegible].4	59	[illegible].0	152	46.8	8[illegible].9	3.3	12	97	32	0.30	3.0	4.4	C
31	2[illegible]	39	[illegible].3	53	5[illegible]	155	30.2	5.0	2.2	3	315	120	0.	0.	0.	C

Appendix 2

Epicenter Location Maps

March 1978 through May 1978

This appendix shows plots of epicenters for January 1978 and February 1978. Triangles with three-letter codes show the locations of seismic stations. The one-letter code shows the epicenter location with the following depth code:

A	0 ≤ 25
B	26 ≤ 50
C	51 ≤ 100
D	101 ≤ 125
E	126 ≤ 150
F	151 ≤ 175
G	176 ≤ 200
etc.	

The size of the letters is proportional to the magnitude of the event.

The following is a list of figures:

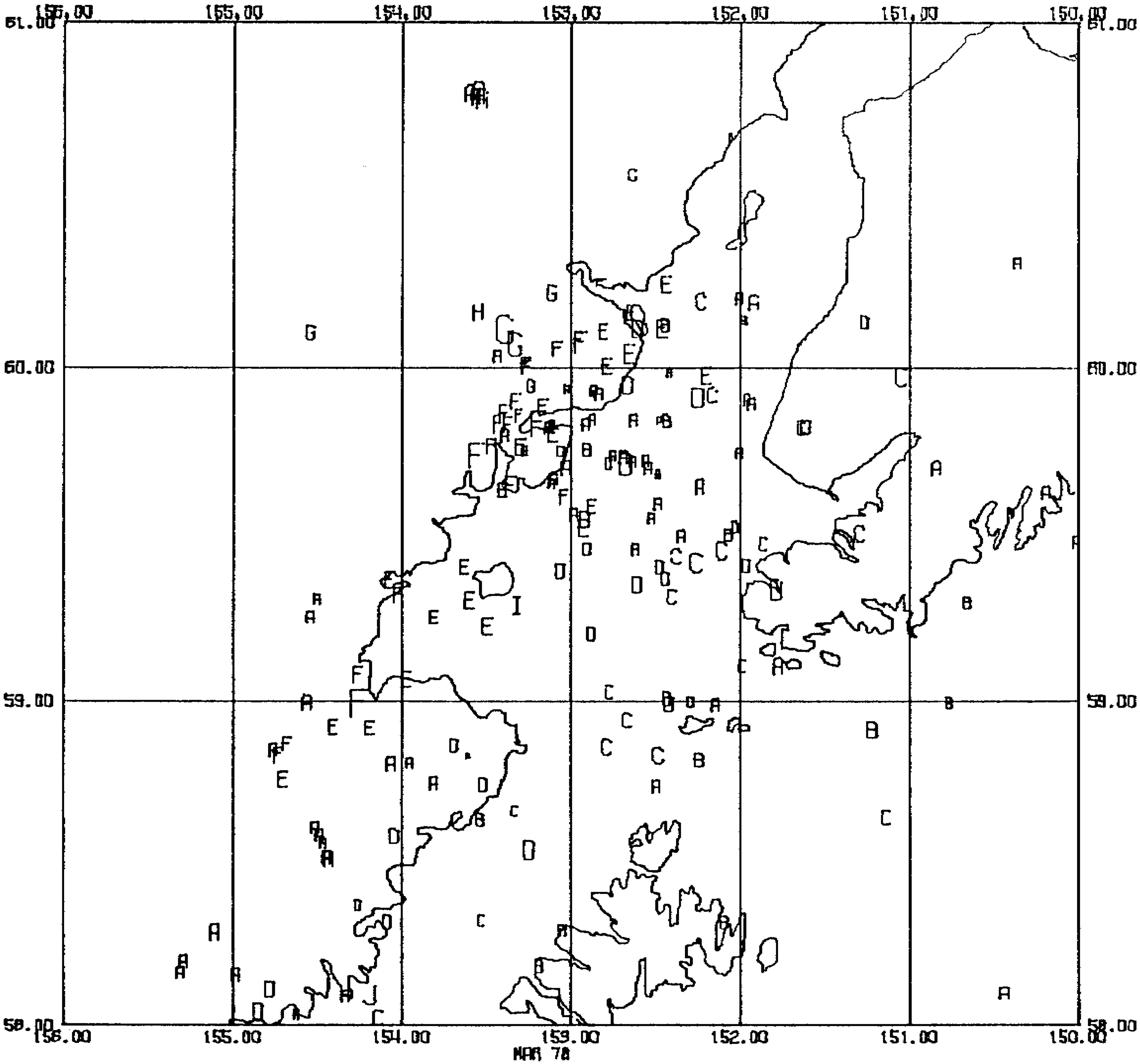
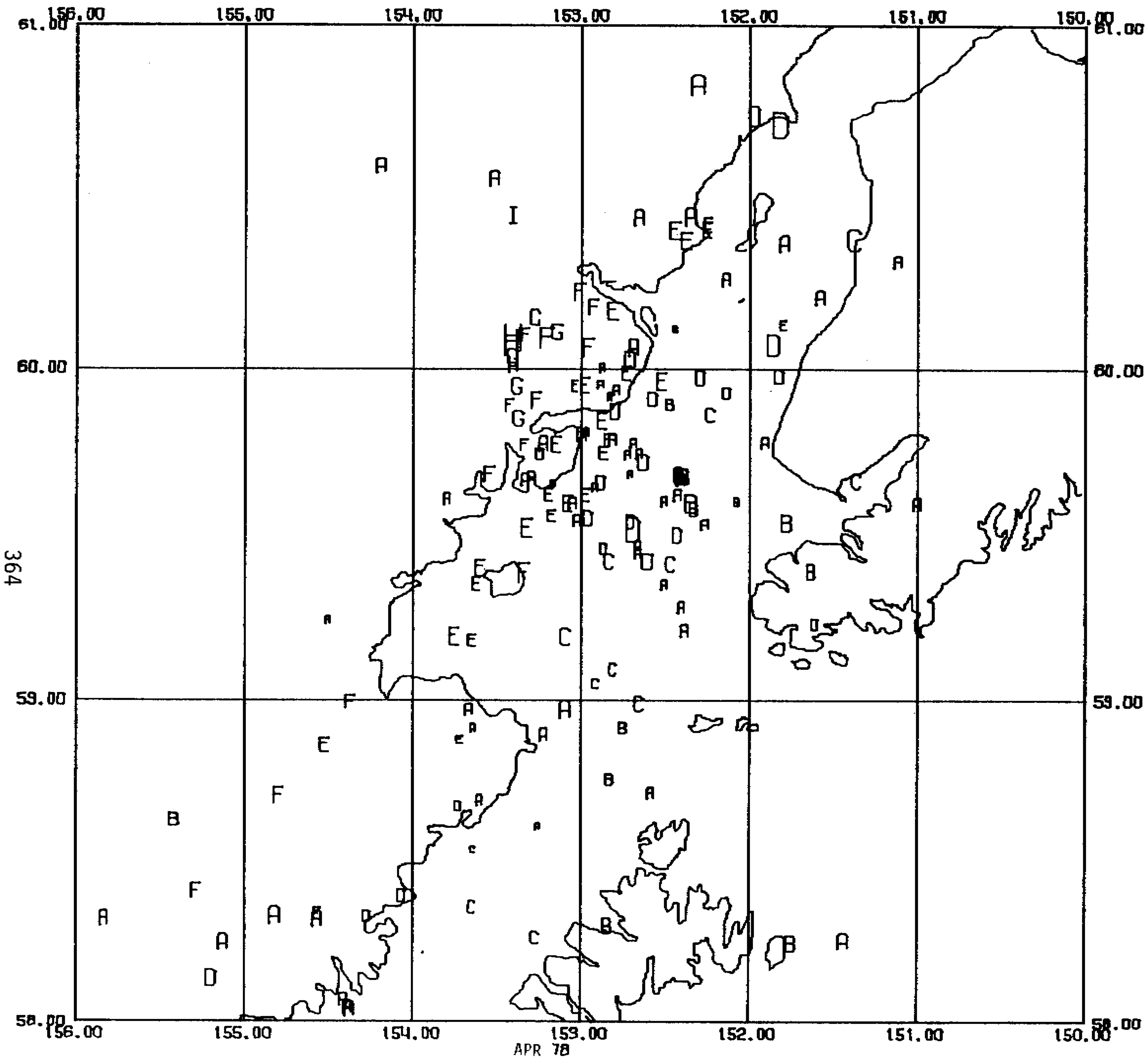

156.00
155.00
154.00
153.00
152.00
151.00
150.00
61.00
60.00
59.00
58.00
MAR 78

Figure A2-1



156.00
155.00
154.00
153.00
152.00
151.00
150.00
61.00
60.00
59.00
58.00
APR 78

Figure A2-2

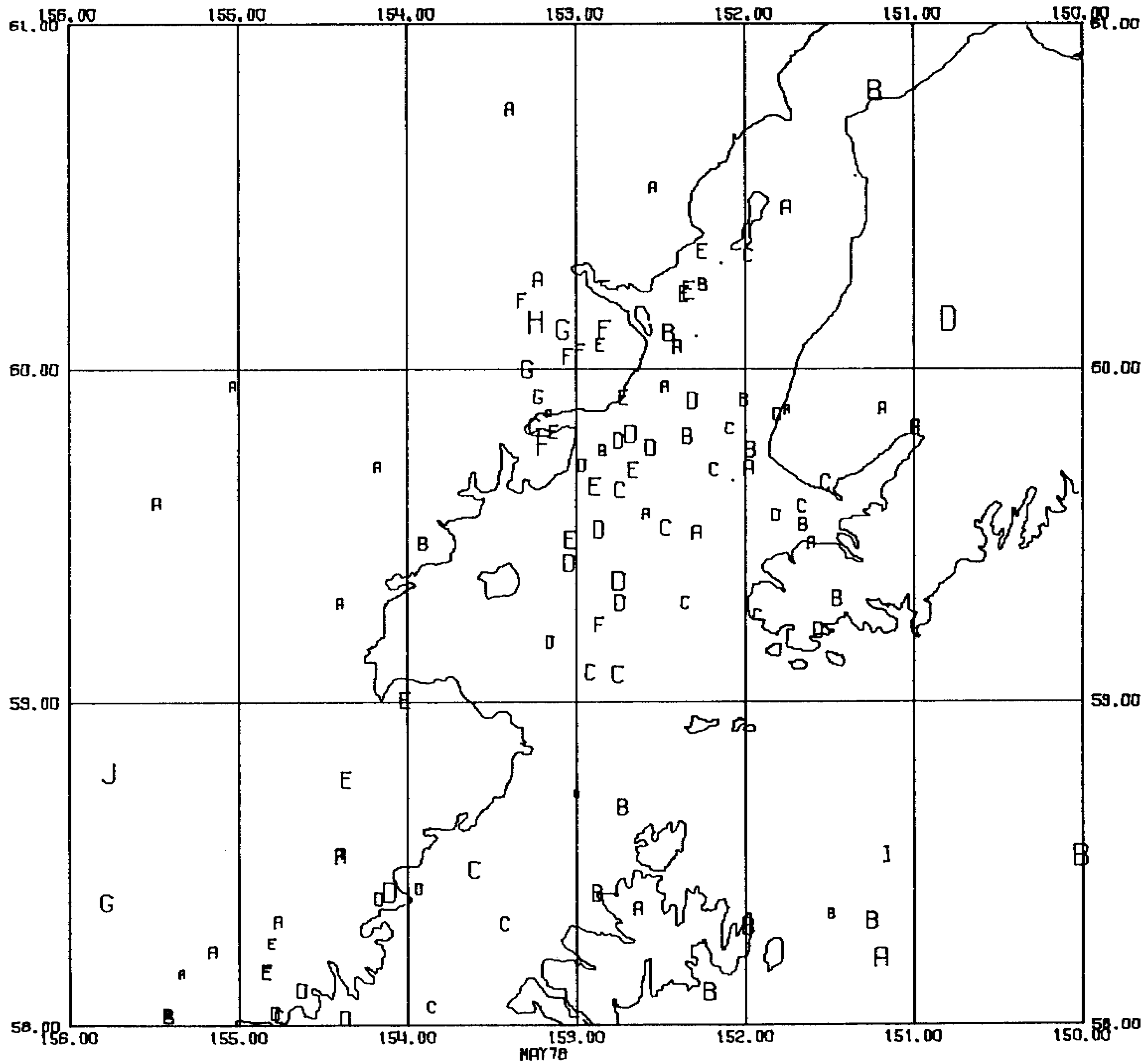
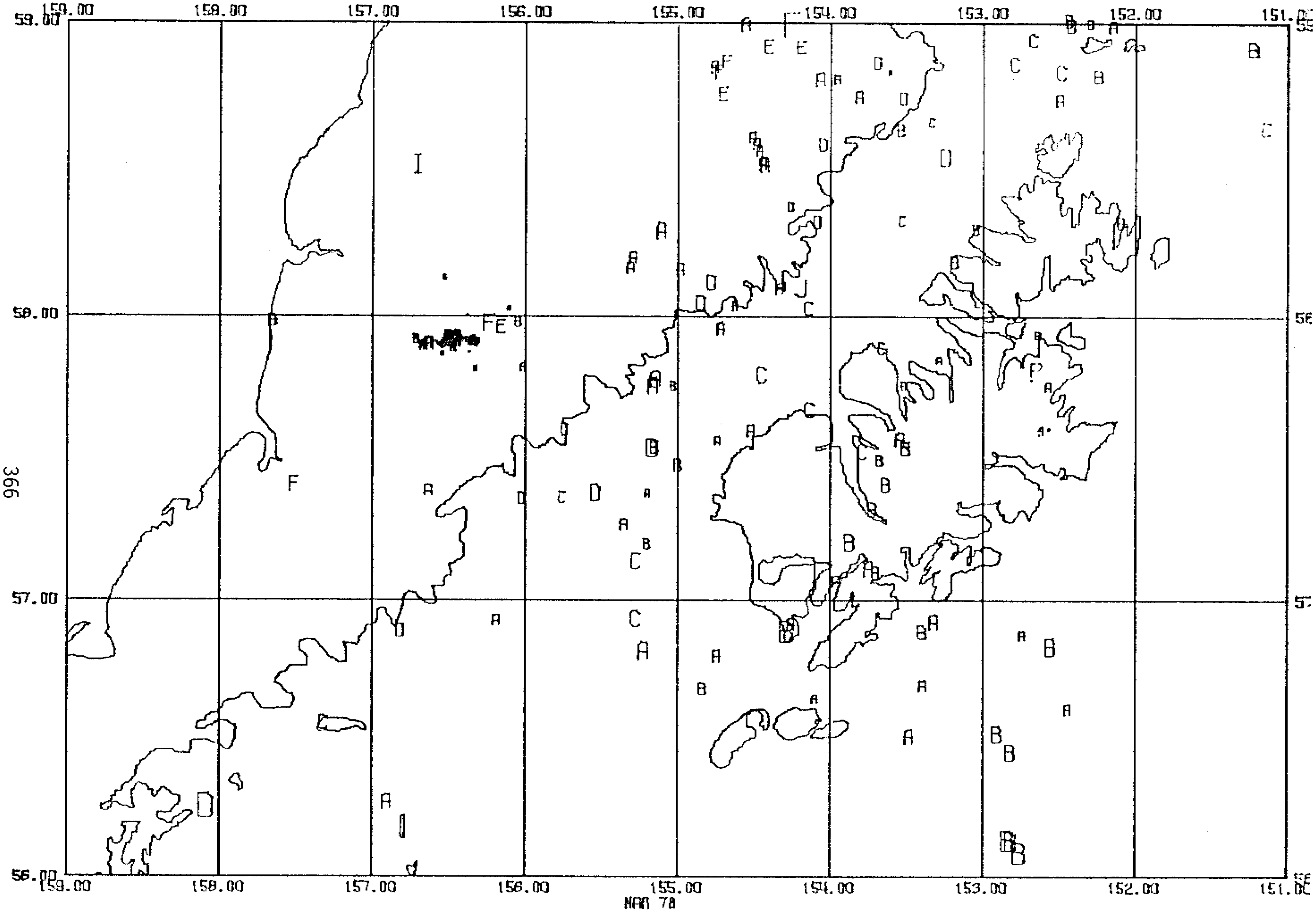

156.00
155.00
154.00
153.00
152.00
151.00
150.00
61.00
60.00
59.00
58.00
MAY78

Figure A2-3



159.00
158.00
157.00
156.00
155.00
154.00
153.00
152.00
59.00
58.00
57.00
56.00
MAR 78

Figure A2-4

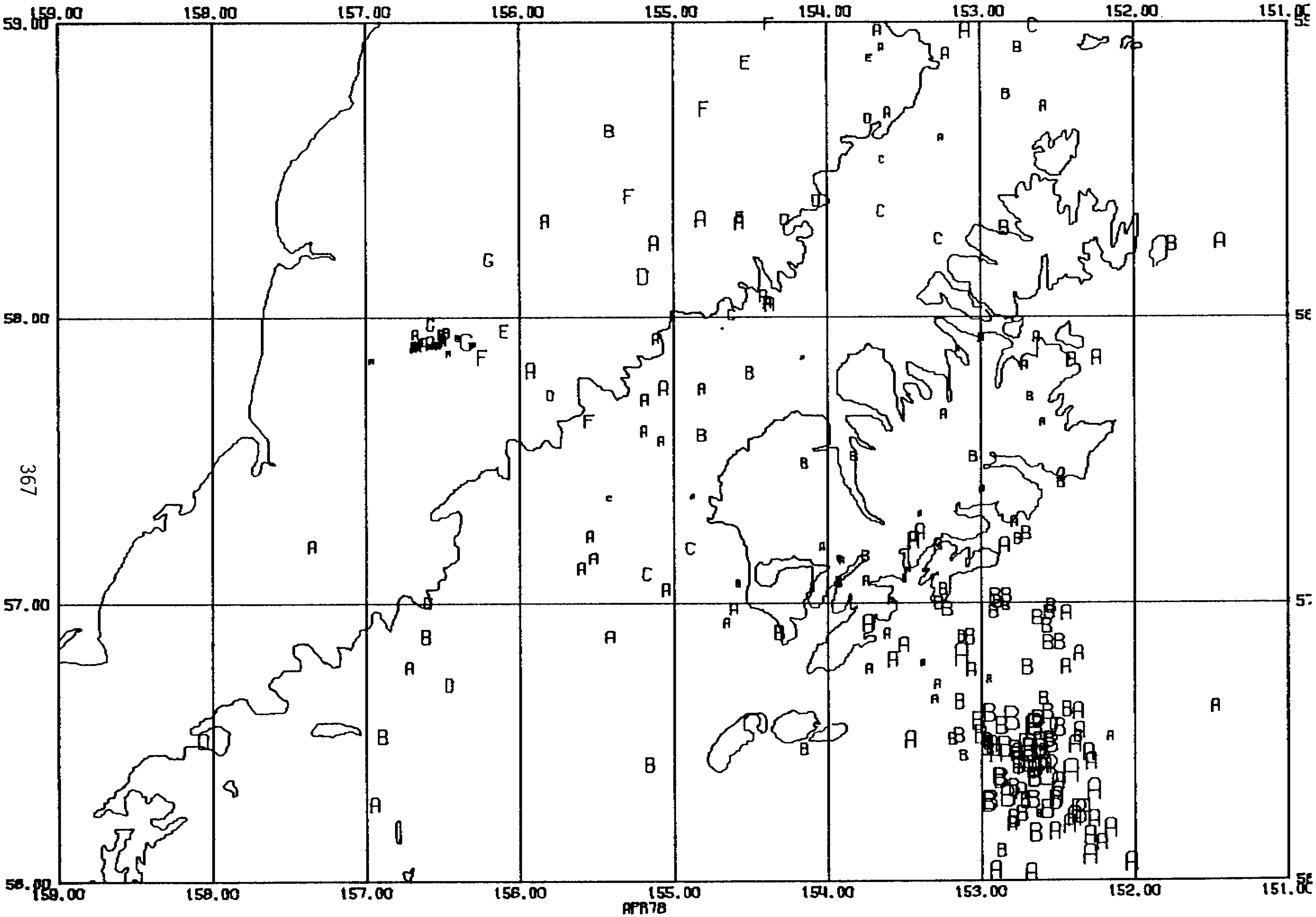

159.00
158.00
157.00
156.00
155.00
154.00
153.00
152.00
59.00
58.00
57.00
56.00
APR78

Figure A2-5

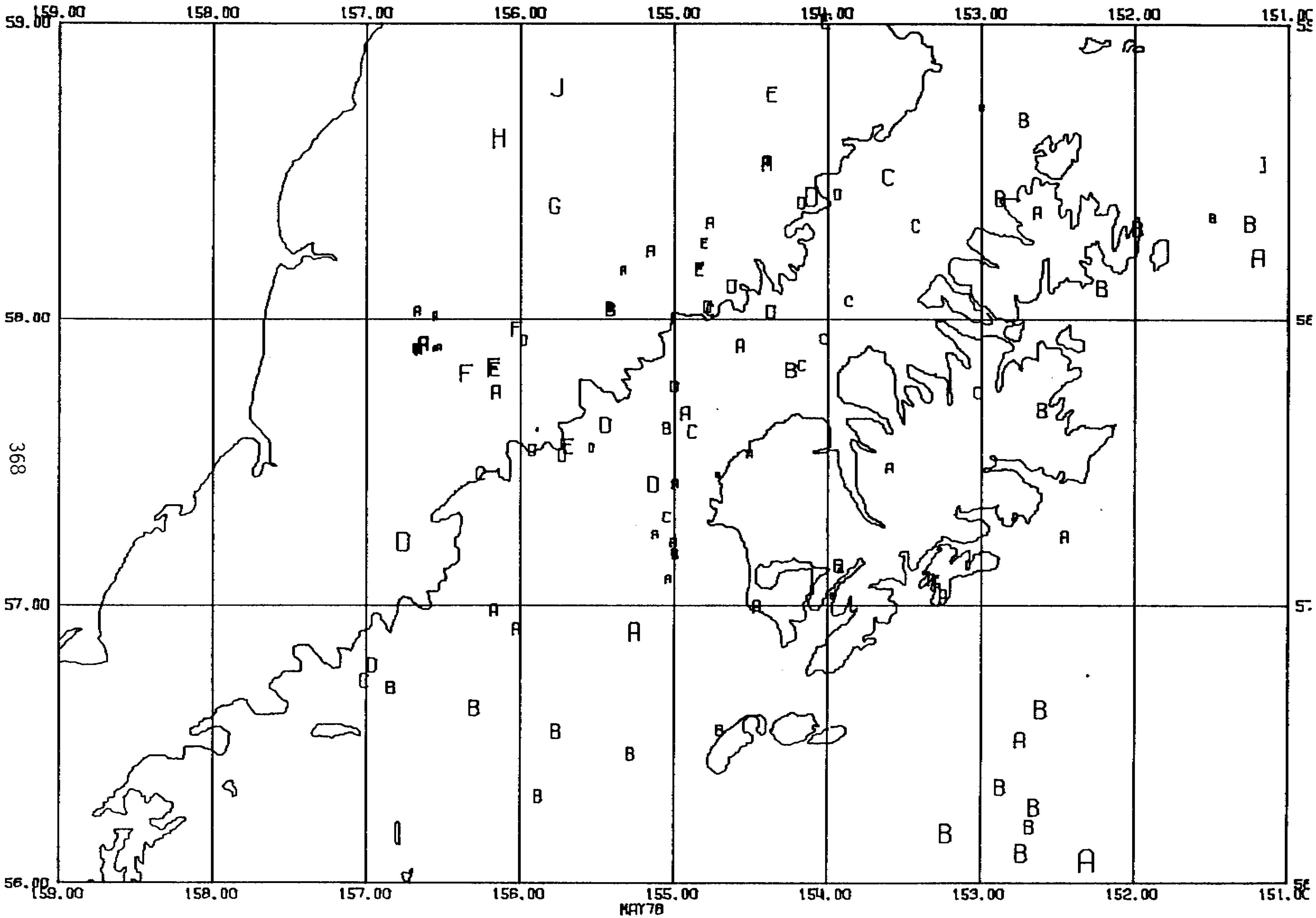

159.00
158.00
157.00
156.00
155.00
154.00
153.00
152.00
151.00
59.00
58.00
57.00
56.00
MAY78

Figure A2-6

QUARTERLY REPORT

Contract # 03-5-022-55
Research Unit #253
Task Order #1
Reporting Period: 4/1/78 - 6/30/78
Number of Pages: 2

SUBSEA PERMAFROST
PROBING, THERMAL REGIME AND DATA ANALYSIS

T. E. Osterkamp
W. D. Harrison
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

June 1978

OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Period Ending June 30, 1978

Project Title:	Subsea Permafrost: Probing, Thermal Regime and Data Analysis
Contract Number:	03-5-022-55
Task Order Number:	1
Principal Investigators:	T. E. Osterkamp and W. D. Harrison

I. Task Objectives:

To determine the subsea permafrost regime in selected near-shore areas in the Beaufort Sea using lightweight probing techniques and appropriate data and analysis (D-9).

II. Field and Laboratory Work:

This period was spent preparing for our field season and conducting our field work. We spent about 125 man-days in the field during April and May. The majority of the work was done at Prudhoe Bay with some additional work in Elson Lagoon. We have obtained additional temperature profiles, salinity profiles, hydraulic conductivity measurements, lithological information etc., at these sites. These data are being analyzed and will be presented in our future quarterly reports. One notable discovery was of ice-bonded permafrost within 8 m of the sea bed at a site 4 1/2 miles north of Reindeer Island where the water depth was ≈ 17 m. The sediments were compact clays. This discovery implies that ice-bonded permafrost, with its attendant problems for development, may be found near the sea bed in association with these compact clays even in relatively deep water.

III. & IV. Results and Interpretation:

In progress

V. Problems:

None

VI. Funds Expended:

$265,369.48 as of May 31, 1978.

QUARTERLY REPORT

Contract No. 03-5-022-55
Research Unit 257/258
Task Order No. 8
Reporting Pd. 4/1/78-6/30/78
Number of Pages 3

Morphology of Beaufort, Chukchi and Bering Sea Nearshore Ice Conditions by Means of Satellite and Aerial Remote Sensing

W. J. Stringer
S. A. Barrett
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

June 1978

OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Period Ending June 30, 1978

Project Title: Morphology of Beaufort, Chukchi and Bering Sea Nearshore Ice Conditions by Means of Satellite and Aerial Remote Sensing

Contract Number: 03-5-022-55

Research Unit: 257/258

Task Order Number: 8

I. Task Objectives:

The objective of this study is to develop a comprehensive morphology of nearshore ice conditions in the Beaufort Sea. This morphology will include a synoptic picture of the development and decay of fast ice and related features along the Beaufort Sea coast, and in the absence of fast ice, the nature of other ice (pack ice, ice islands, hummock fields, etc.) which may occasion the nearshore areas in other seasons. Special emphasis will be given to consideration of potential hazards to offshore facilities and operations created by nearshore ice dynamics. A historical perspective of nearshore ice dynamics will be developed to aid in determining the statistical rate of occurrence of ice hazards.

II. Field and Laboratory Work:

An aerial reconnaissance by light plane was made of the Beaufort and Chukchi Sea coasts. While past reconniassance flights were made to provide ground truth for analysis of Landsat imagery, these flights were made largely to photograph specific features occurring within the nearshore zone. The secondary purpose for this set of flights was to look for ice conditions contrary to the general picture being developed by this research unit prior to completion of our final report.

III. Results:

The aerial reconnaissance yielded photographs of several ice features observed to occur from year to year on Landsat imagery. These photographs will now serve as documentation supporting image interpretation. No ice conditions were observed which contrasted greatly with results from previous years.

IV. Interpretation:

These results support our earlier conclusions that ice conditions in the nearshore areas are generally similar from year to year. Our statistical work based largely on Landsat imagery has the objective of placing limits on the degree of uniformity from year to year. During this quarter we have been putting these statistical results into final report form. This activity will continue through the following quarter.

V. Problems:

At this time it appears that this research unit will require a small amount of supplemental funding in order to finish our final report.

VI. Funds Expended:

$178,000

Quarterly Report

Contract #03-5-022-55
Research Unit #265
Task Order #6
Reporting Period: 4/1/78-6/30/78
Number of Pages: 6

IN-SITU MEASUREMENTS OF THE MECHANICAL PROPERTIES OF SEA ICE

Lewis H. Shapiro

Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

June 30, 1978

OCS CORDINATION OFFICE

University of Alaska

Quarterly Report for Quarter Ending June 30, 1978

Project Title: In-Situ measurements of the Mechanical Properties of Sea Ice.

Contract Number: 03-5-022-55

Task Order Number: 6

Principal Investigator: Lewis H. Shapiro

I. Task Objectives:

To develop hardware and procedures for conducting in-situ measurements of the mechanical properties of sea ice.

II. Schedule

Field work and data reduction.

III. Results and Interpretation.

A. Introduction

The field program was completed in early May. A total of 119 test specimens were prepared. One broke during set-up, 3 were used in calibration experiments, and one was improperly set-up and gave meaningless results. The remainder all yielded useful data, although not all to the same degree of completeness. The test series consisted of 69 tests at constant loading rate to failure, 29 creep-rupture tests, 21 creep tests, and 6 tests using variable loading programs. This totals 125 sets of results, because some of the specimens used for creep tests were later taken to failure as either constant loading rate or creep-rupture tests. Of these tests, 113 were conducted on specimens set up as described below, while variations of this procedure were used on the remaining tests as indicated.

To date, the strain data has not been worked up, so that it is not certain that at least some of the creep tests did not approach failure and should be classified as creep-rupture tests.

B. Procedures

Samples were prepared as described in the last annual report of this project. Briefly, test blocks 30 X 30 X 60 cm were removed from the ice, the bottom of the hole lined with a double layer of plastic sheeting, and the block replaced. A 30 X 30 cm flatjack was then installed at each end of the block, and both the block and the flatjacks frozen back into the ice sheet. Just prior to testing, the blocks were cut free along the sides, giving a rectangular prism unconfined on three sides, and resting on the double layer of plastic sheeting. The purpose of the plastic sheeting is to eliminate any shear stress across the base of the block, so that the only stress across this face is that due to the weight of the block, which is negligible compared to the magnitude of the axial load.

Strain was calculated from linear potentiometer measurements of the change in distance between two 1.3 cm diameter aluminum pegs frozen into the test specimen as shown in Figure 1. The potentiometers were calibrated to sense absolute displacements of 2.5×10^{-5} cm which, over a 20 cm gauge length, provides strain measurements as small as 1.3×10^{-6}. By measuring the displacement at two heights, rotation of the pegs can be accounted for, and the results used to calculate the strain at any depth in the specimen.

Immediately prior to testing, each block was loaded quickly (ie, in 1-2 seconds to a pressure of 94 psi. The load was held for about 10 seconds, and then released to zero, again in 1-2 seconds. The specimen was then permitted to recover for a few minutes and then the cycle was repeated twice more. This repeated loading serves two purposes. First, the initial load causes tensile failure of any ice connecting the test specimen to the ice sheet across the plane of the jack. A thin layer of ice is usually left in this position when the relief slots are cut along the sides of the test specimen. Second, the additional loading cycles provide data from which Young's modules can be calculated.

In many of the tests, a layer of plastic sheeting was wrapped around the flatjacks prior to the test in order to reduce friction between the flatjacks and the ice. However, there is no indication that this had any effect on the strength of the samples.

The load was applied to the flatjacks by nitrogen gas with the rate or magnitude controlled by hand manipulation of a pressure regulator or of a quick release valve when very high loading rates were desired. The loading curves were recorded either by a strip chart recorder, recording oscilliscope, or at one second intervals on punch tape and tape printout on a Vishay 220 Data logging system.

When under internal load, the pressure in the flatjack is transmitted to the ice generating a stress field, and the efficiency with which this is done has been determined using the method shown in Figure 2. A block of ice 30 X 30 X 60 cm was prepared as described above with a double layer of plastic film at its base, and a 30 X 30 cm steel flatjack at each end. A 35 X 35 cm copper flatjack was then installed in a chain saw cut parallel to, and midway between the steel flatjacks, with its top edge at the surface of the ice. Chain saw cuts were then made along a line connecting the ends of the steel flatjacks up the face of the copper flatjack. These form two 30 X 30 cm cubes, each with a steel flatjack along one face, and both in contact with the copper flatjack. The copper flatjack was then expanded with diesel fuel, allowed to relax, and sealed, with a pressure transducer on one nipple. Finally the steel flatjacks were loaded at rates of about 2 psi/sec and the change in internal pressure of the copper flatjack was recorded. The results are shown in Figure 3, in which the data points were acquired at ten second intervals so that the loading rates can be determined.

Over the linear portions of the curves the slopes average 0.63. At the end of each loading cycle, the pressure in the steel flatjacks was held constant, during which time the pressure in the copper flatjack drifted down. This was probably in response to the creep of the ice around that part of the copper flatjack which was not confined in the loaded block. Similarly, the departure of the loading curve from linearity in the curve which reached the highest pressure probably reflects a combination of rapid creep of the ice in this same region, a decrease in loading rate of the steel flatjacks, and possible tensile failure of the ice around the ends of the copper flatjacks.

The efficiency 'e' of the steel flatjacks was determined from the equation $ePA_{steel} = .63\ PA_{cu}$ where P is the pressure in the steel flatjacks, and A is the area of the flatjack indicated by the subscript.

The results show that the copper flatjack sensed about 86% of the pressure in the steel flatjacks and this is taken as the efficiency of the steel flatjacks for the size used. This indicates that the edge weld reduces the effective loading area of the steel flatjacks by approximately 1 cm along each welded edge. Note that the value of 85% for flatjack efficiency is in agreement with the determinations based on theoretical considerations.

Ice temperature was monitored continuously by thermisters placed at depths of 0, 10, 20, and 30 cm in the ice sheet at a central location in the test site. Samples were collected adjacent to each test specimen for salinity measurements. These were made for each 5 cm interval from the surface to the 30 cm depth of the base of the block. In addition, one sample test block was cut into 5 X 5 cm cubes, to determine the small-scale salinity variations. These were sufficiently large that almost all of the salinity profiles determined from the individual test specimens fell within the range of profiles measured from the test block. Exceptions to this occurred at the end of the test program when brine drainage away from the surface was in progress and the salinity of the surface ice had dropped to about 2 ppt below the winter average. For purposes of preliminary an average salinity of 6.5 ppt appears reasonable.

The ice at the test site included a layer of slush ice which ranged up to 10-15 cm thick, with dispersed silt in the depth range between 6 and 12 cm at various locations. Where silt was particulary dense, the tests indicated strength increase of up to 10%, but small amounts of silt appear to have had no effect. Grain diameters in the slush ice were a few mm. Below this layer the normal columnar ice was present with grain sizes of about 1 cm, which is usual for this depth in the ice sheet.

All of the test specimens were cut so that their long axes were parallel to the shoreline. A sample was collected from the base of each block from which a thin section was prepared and photographed to document the degree of orientation of the c-axes, and the grain size. In all cases, the c-axes were tending to align parallel to the long axes of the specimens, although the degree of orientation (in the sense of percent of c-axes aligne in a particular direction) has yet to be determined. Thus, with the excepti noted below, fabric and texture of the ice were not considered as variables in this study.

Preliminary results of all of the tests are given in Table 1. The strengths indicated for the constant loading rate tests and the loads for the creep and creep-rupture tests include the correction for flatjack efficiency described above, as well as for deviations in the cross-sectional area of the test specimens prior to loading. Variations in the precision with which the test times were recorded reflect differences in the precision of the timing systems used. A total of five timing methods were available, and the one selected for any particular test was dependent upon the anticipated duration of that test.

C. Discussion

In general, tests at low loading rates failed in a ductile manner by the gradual development of pervasive horizontal cracks. These were largely confined to the columnar ice in the lower two-thirds of the specimen. In the last stages of failure the surface of the specimens bulged upwards and extension cracks formed along the center line. These indicate rapid deterioration of the specimen, and their formation was followed in a few seconds by explosive failure unless the pressure in the flatjacks was released. On those tests when pressure could be released, lateral expansion of the specimens was also apparent.

At high loading rates failure occurred along a narrow shear zone which connected opposite ends of the flatjack pair and was therefore oriented at about 30° to the compressive stress direction. No horizontal cracks formed when failure occurred in this mode, and neither vertical nor horizontal expansion of the specimen was evident.

Tests were run to evaluate the effect of the aluminum pegs on the properties of the test specimens. These showed that if the bottom of the pegs were at depths less than half the thickness of the specimen, the measured strength was the same as if the pegs were absent. When set deeper than that, they tended to increase the strength of the specimens. However, this may also reflect the properties of the ice at the test site or the bond strength between the ice and the pegs, rather than simply being a geometric effect of the pegs which could be expected to apply in general.

As noted, tests at low loading rates ultimately failed by the formation of extension cracks oriented vertically along the axis of the block. When pegs were installed in the block, the cracks naturally tended to run through these. However, similar cracks formed even in the absence of the pegs. The shear cracks that formed at higher rates passed between the pegs, so that again, the pegs did not appear to influence the failure mechanism. However, in most tests small cracks were present around the base of the pegs after failure, so that some local stress concentration effects did occur.

Two types of tests were run to investigate the effect of the vertical gradient in properties of the ice on the test results. In the first, three blocks were removed from the ice and rotated 90° about the long axis before being replaced and the flatjacks installed. Thus, the gradient in properties of the ice was set horizontal with respect to the surface and the temperature gradient. The first of these blocks was tested in creep-rupture, and examination of the failed block showed that the pattern of cracks was probably controlled by the ice structure rather than the temperature gradient or loading geometry. That is, most of the longer cracks were confined to the columnar ice section of the specimen, and the strong horizontal crack pattern which typically developed in normally set blocks was not present. Instead, the cracks were vertical. The remaining two blocks were tested in constant load rate and failed at approximately the same strength as normal blocks. The firs of these was examined after failure at a load rate of 0.77 psi/sec and, as in the case of the creep rupture test, most of the cracking was confined to the columnar ice section. The second block was loaded at a rate of 3.88 psi/sec, and was completely shattered on failure and exploded out of the hole. As a result, it was not possible to determine the crack distribution.

The second test series used to evaluate the gradient effect consisted of the preparation of four composite blocks. Two of these were prepared by freezing together the top halves of four normal sample blocks, while the remaining two were made of the bottom halves of the same blocks. This gave two blocks representing the slush ice layer, and two of the columnar ice layer. All were tested at rates of 0.77 psi/sec at approximately the same temperatures. The top layer blocks failed at loads of 359 and 374 psi, while the columnar ice blocks failed at 295 and 304 psi. These results clearly indicate the difference in strength between the two ice types. Note that the temperatures at the time of the tests ranged from about -10 to -11° C at the surface to -9.0° C at the base of the blocks. Examination of the blocks after failure showed that the slush layer blocks had few long cracks in them, but instead, there was an apparently pervasive development of short cracks, probably along grain boundaries. In contrast, the columnar ice blocks had fewer, but longer cracks. In both cases, failure was probably ductile when viewed on the scale of the entire blocks.

Taken in combination, the two test series show that the strengths of the ice over the thickness range studied, was largely carried by the upper slush layer. It is therefore likely that a vertical stress gradient was developed in the test blocks during the experiments. However, failure of the lower columnar ice blocks occurred at stresses which were approximately the same as those of normal blocks at comparable loading rates and temperatures which may contradict the conclusion above regarding the stress gradient. The problem may be resolved when the strain data for these tests are availabl for study.

Two tests were conducted in which the sides of the tests specimens were loade with a confining pressure of 94 psi. The tests were run by first loading the confining pressure flatjacks, then rapidly loading the end jacks to an equal pressure. The load in the end jacks was then increased at rates 0.86 and 0.80 psi/sec until failure occurred. In both cases, failure was ductile, represented by overexpansion and failure of the flatjacks without the formation of major cracks in the blocks. Differential stresses at failure were 366 and 352 psi corresponding to the loading rates above. These values represent strengths 15 to 20% greater than those from uniaxial tests at comparable load rates and temperatures.

Finally, two uniaxial tests were run on blocks collected from the interval between 90 and 120 cm in the ice sheet. These were brought to the surface of the ice and emplaced in the manner described above. Loading was done in the direction parallel to the dominant c-axis orientation. The temperature gradients at the time the tests were run were slightly reversed with the surface temperature at -7.5 to -8° C, and those at 10, 20, and 30 cm at -8.5, -8.0, and -7.0° C respectively.

The first block was loaded at a rate of 0.77 psi/sec to a peak load of 385 psi when one flatjack overexpanded and failed. At that time, long vertical cracks, typical of the last stages of ductile failure of the surface blocks, were present on the surface, and the center of the specimen had bulged noticeably but was still intact. Accordingly, the failed flatjack was removed from the loading system, and the remaining flatjack was loaded at a rate of 6.81 psi/sec. A peak load of 479 psi was reached before the second flatjack failed. The block, however, did not fail catastraphically, bu the ice surrounding the test was fractured. In view of the above results, the second block was loaded at a rate of 4.70 psi/sec for the first loading. It reached a peak stress of 728 psi before fracture of the block occurred. In this case, the test specimen clearly failed.

These results show that the stength of the deeper ice in this orientation is clearly greater than that of the surface ice. For the low loading rate, the strength increase is about 1.4, while for the higher rate it is about 1.8 times the strength of surface ice at comparable loading rates and temperatures

As noted above, these descriptions and discussions are preliminary, pending the analysis of the strain data, and refinement of the time data. However, they indicate the scope of the work accomplished during the fields season and show the applicability of the techniques to a variety of test types.

IV Problems Encountered

None.

TABLE I

A. CONSTANT LOAD RATE (UNCONFINED)

Test Number	Strength	Load Rate (psi/sec)	Time To Failure (sec)	TEMPERATURE (-°C) Surface	-4"	-8"	-12"	Set-Up (See note below)	Comments
1	589	23.6	25	17.0	15.5	14.0	13.0	1	
2	337	241	1.4	6.0	7.0	6.5	6.0	1	
8	344	0.83	420	10.5	10.0	10.0	9.0	1	
10	539	8.2	65	10.0	10.0	9.0	9.0	1	
15	323	0.83	390	13.0	12.0	11.0	10.0	1	
16	549	220	25	11.0	10.0	9.5	9.0	1	
17	549	183	3.0	11.0	10.0	9.5	9.0	1	
18	448	0.78	575	13.0	12.0	11.0	10.0	1	
20	534	205	2.6	11.5	10.5	10.0	9.0	1	
21	550	80.9	6.8	11.5	10.5	10.0	9.0	1	
22	550	6.6	83	11.5	10.5	9.0	9.0	1	
23	463	4.0	116	11.5	10.5	9.0	9.0	1	
24	510	23.4	21.8	11.5	10.5	10.0	9.0	1	
25	271	0.065	4200	12.5	11.0	10.0	9.0	1	
26	545	85.2	6.4	13.0	12.0	11.0	10.0	1	
27	510	20.6	248	11.5	10.5	10.0	9.0	1	
28	585	585	1.0	13.0	12.0	11.5	10.5	1	
29	453	6292	0.072	14.5	13.5	13.0	11.5	1	
30	468	1170	0.4	13.5	13.0	12.0	11.0	1	
31	625	83.3	7.5	13.0	12.0	11.0	10.0	1	
32	636	1325	0.48	14.5	13.5	13.0	11.5	1	
33	566	5145	0.11	14.5	13.5	13.0	11.5	1	
34	518	3453	0.15	17.5	14.5	13.0	11.0	1	
36	597	27.3	21.9	23.0	21.0	19.0	16.0	2	3rd loading after early flatjack failure
37	454	0.79	578	23.0	21.0	19.0	16.0	2	
39	745	4139	0.18	21.0	20.0	19.0	17.5	2	
40	589	4207	0.14	21.0	20.0	19.0	17.5	2	
43	683	4269	0.16	22.0	20.0	18.5	16.0	6	
47	535	0.79	677	21.0	17.5	15.0	13.0	6	Followed creep test at 89 psi for 24 hrs
48	360	0.066	5476	20.0	20.0	19.0	17.0	6	Followed creep test at 90 psi for 18 hrs
50	688	3.7	184	22.0	20.0	18.0	16.5	6	Followed creep test at 118 psi for 20 hrs
55	303	0.78	387	6.5	7.0	8.0	8.0	6	
61	397	0.77	514	17.5	20.0	19.0	17.0	6	
62	273	0.76	360	6.0	7.0	6.5	6.0	4	Rotated test block
63	289	0.77	374	6.5	7.0	8.0	8.0	4	
64	396	3.88	102	6.0	7.0	6.5	6.0	4	Rotated test block
65	295	0.77	385	6.5	7.0	8.0	8.0	4	
68	304	0.75	405	11.5	11.0	10.5	9.0	6	Composite block-lower halves
69	359	0.78	463	10.0	10.5	10.0	9.0	6	Composite block-upper halves
70	377	0.77	489	10.0	10.0	10.0	9.0	6	Composite block-upper halves

TABLE 1.

A. CONSTANT LOAD RATE (UNCONFINED)

Test Number	Strength	Load Rate (psi/sec)	Time To Failure (sec)	TEMPERATURE (-°C) Surface	-4"	-8"	-12"	Set-Up (See note below)	Comments
71	295	0.77	385	10.5	10.0	10.0	9.0	6	Composite block-lower halves
77	229	0.076	3033	10.0	10.0	9.0	8.0	6	
79	298	0.76	390	10.5	9.0	8.0	7.5	6	
86	358	0.77	463	9.0	9.0	8.0	7.5	5	Silt layer, 3"-9"
87	290	0.77	376	9.0	8.5	8.0	7.5	5	
88	288	0.77	373	8.5	8.5	8.0	7.5	5	
90	297	0.77	385	9.0	9.0	8.0	7.0	6	
91	388	7.95	48.8	8.0	8.5	8.0	7.0	6	
93	323	0.77	418	8.5	8.5	8.0	7.5	6	
94	329	0.78	424	9.0	9.0	8.0	7.5	6	Silt layer, 2"-8"
95	300	0.78	384	8.5	8.5	8.0	7.5	6	
98	286	0.77	372	7.0	7.0	7.0	7.0	6	Tested 3 min after unloading 15 hr creep test at 47 psi
103	367	7.65	48.0	5.5	6.0	6.0	6.0	6	
104	330	21.6	15.3	5.0	6.0	6.0	6.0	6	
108	294	0.78	378	8.0	8.0	7.2	6.5	6	
109	378	25.2	15.0	8.0	6.5	6.5	6.1	6	
110	439	87.8	5	7.5	8.0	7.0	6.5	6	
111	392	112.0	3.5	7.0	7.5	7.0	6.5	6	
112	350	4.12	85	7.0	7.5	7.0	6.0	6	
113	358	239	1.5	7.0	7.5	7.0	6.5	6	
114	314	209	1.5	7.0	7.5	7.0	6.5	6	
115	416	297	1.4	6.5	7.0	7.0	6.5	6	
116	361	258	1.4	6.0	6.5	6.5	6.5	6	
117	345	76.7	4.5	7.5	8.0	7.0	6.0	6	
118-1	385	0.77	500	7.5	8.5	8.0	7.0	6	Sample from 3'-4' depth, 1st loading (see text)
118-2	579	6.81	85	7.5	8.5	8.0	7.0	6	2nd loading in sample 118
119	728	6.68	109	8.0	8.5	8.0	7.0	6	Sample from 3'-4' depth

B. CONSTANT LOAD RATE (CONFINING PRESSURE, 94psi)

Test Number	Strength	Load Rate (psi/sec)	Time To Failure (sec)	Surface	-4"	-8"	-12"	Set-Up	Comments
84	366	.86	424	6.5	7.5	7.0	6.5	6	$\sigma_1-\sigma_2=366$, rate from $\sigma_1=94$ to peak
89	352	.80	439	9.0	8.0	7.5	7.0	6	$\sigma_1-\sigma_2=352$, rate from $\sigma_1=94$ to peak

C. CREEP RUPTURE (UNCONFINED)

Test Number	Load (psi)	Time To Rupture (sec)	TEMPERATURE (-°C) Surface	-4"	-8"	-12"	Set-Up (See note below)	Comments
5	184	590	11.5	10.5	10.0	9.5	1	
9	338	40	10.5	10.0	10.0	9.0	1	
11	502	3.7	10.0	10.0	9.3	9.0	1	Silt layer 2"-6"
19	298	1620	13.0	12.0	11.0	10.0	1	Time (?)
38	235	820	18.0	18.0	17.0	16.0	2	
44	445	54.6	20.0	20.0	19.0	17.0	6	Speciman surface very rough
51	454	156	22.5	22.0	20.0	17.5	6	Silt layer 4"-9", followed 15 hr creep test at 44 psi, 24 hr recovery period.
52	204	1170	23.0	21.0	19.0	17.0	6	Time(?)
53	196	6960	23.0	20.0	19.0	17.0	6	Followed creep test, 18 hrs at 19.6 psi
58	250	318	15.0	17.0	17.0	17.0	3	
59	361	439	21.0	20.0	18.0	16.5	6	Rotated speciman, followed creep test 7.5 hrs at 118 psi
60	400	73	16.0	20.0	19.0	17.0	3	
66	350	87	7.0	8.0	8.0	7.5	6	
67	275	60	7.0	7.0	8.0	7.5	6	
72	235	130	6.5	7.0	7.5	7.5	6	
73	235	123	6.5	7.0	7.5	7.5	6	
76	221	263	10.0	9.5	9.0	8.0	6	
78	259	168	10.0	9.0	8.5	8.0	6	
82	200	683	12.0	11.0	10.5	9.5	6	
83	220	306	8.0	8.0	7.5	7.0	6	
92	178	716	7.0	7.0	7.0	8.0	6	
96	314	40.6	4.0	5.5	6.0	6.5	6	
97	260	174	6.5	7.5	7.0	7.0	6	
99	150	3065	6.5	7.0	7.0	7.0	6	
100	294	49	5.0	7.0	7.0	7.0	6	
102	315	15	4.0	6.0	6.5	6.5	6	Time (?)
105	317	13	4.0	6.0	6.0	6.0	6	
106	194	493	4.0	6.0	6.0	6.0	6	
107	302	57	5.0	7.0	7.0	6.5	6	

D. CREEP (UNCONFINED)

Test Number	Load (psi)	Duration (sec)	TEMPERATURE (-°C) Surface start	end	-4" start	end	-8" start	end	-12" start	end	Set-Up (See note below)	Comments
3	79	66,600	14.0	13.0	14.0	12.5	13.0	12.0	13.0	11.0	1	
6	141	16,800	11.0	11.0	11.0	10.5	10.0	10.0	10.0	9.0	1	
35	39	70,380	10.0	12.0	10.0	10.0	9.5	10.0	9.0	9.5	2	
41	118	61,920	11.5	11.5	11.0	11.0	10.5	10.5	10.0	10.0	6	
46	157	16,140	20.0	20.0	17.0	17.5	15.0	15.0	13.0	14.0	6	
47	89	86,400	18.0	19.0	14.5	16.0	13.0	14.0	11.5	12.5	6	
48	90	57,540	20.0	20.0	19.5	20.0	18.0	19.0	16.5	17.0	6	
49	159	45,360	21.0	18.5	19.0	18.5	17.5	16.5	16.0	16.0	6	
50	118	72,000	19.5	20.0	19.0	20.0	17.5	18.5	16.0	17.5	6	
51	44	53,640	22.0	23.0	20.0	22.0	18.0	20.0	16.5	17.5	6	
53	20	56,880	23.0	21.0	20.5	20.0	19.0	18.0	17.0	17.0	6	
54	59	36,000	22.5	20.0	20.0	20.0	18.5	18.0	17.0	16.5	6	
57	80	89,880	12.0	11.0	13.0	11.0	13.5	12.0	13.0	12.0	6	
59	118	27,000	21.0	21.0	19.0	20.0	17.0	18.0	15.5	16.5	6	Rotated speciman
74	21	76,800	13.0	11.5	11.0	11.0	9.0	10.0	8.5	9.0	6	
75	60	89,640	10.0	12.0	9.5	11.0	9.0	10.0	8.0	9.0	6	
80	118	36,000	13.0	13.0	11.0	13.0	10.0	11.0	9.0	9.5	6	
98	49	55,800	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6	
108	59	58,800	4.5	8.0	5.5	8.0	6.0	7.0	6.0	6.5	6	

Set-up notes:

1. No plastic sheeting on flatjacks, wood pegs (1.3 cm diam.) 20 cm deep
2. Plastic sheeting on flatjacks, wood pegs 10 cm deep
3. Plastic sheeting on flatjacks, aluminum pegs (1.3 cm diam.) 20 cm. deep
4. Plastic sheeting on flatjacks, no pegs
5. No plastic sheeting on flatjacks, aluminum pegs 12 cm deep
6. Plastic sheeting on flatjacks, aluminum pegs 12 cm deep

Figure Captions

Figure 1. Test set-up (dimensions in cm)

Figure 2. Flatjack calibration installation (dimensions in cm)

Figure 3. Results of calibration experiment. Flatjack #1 is the steel flatjack pair; flatjack #2 is the copper flatjack.

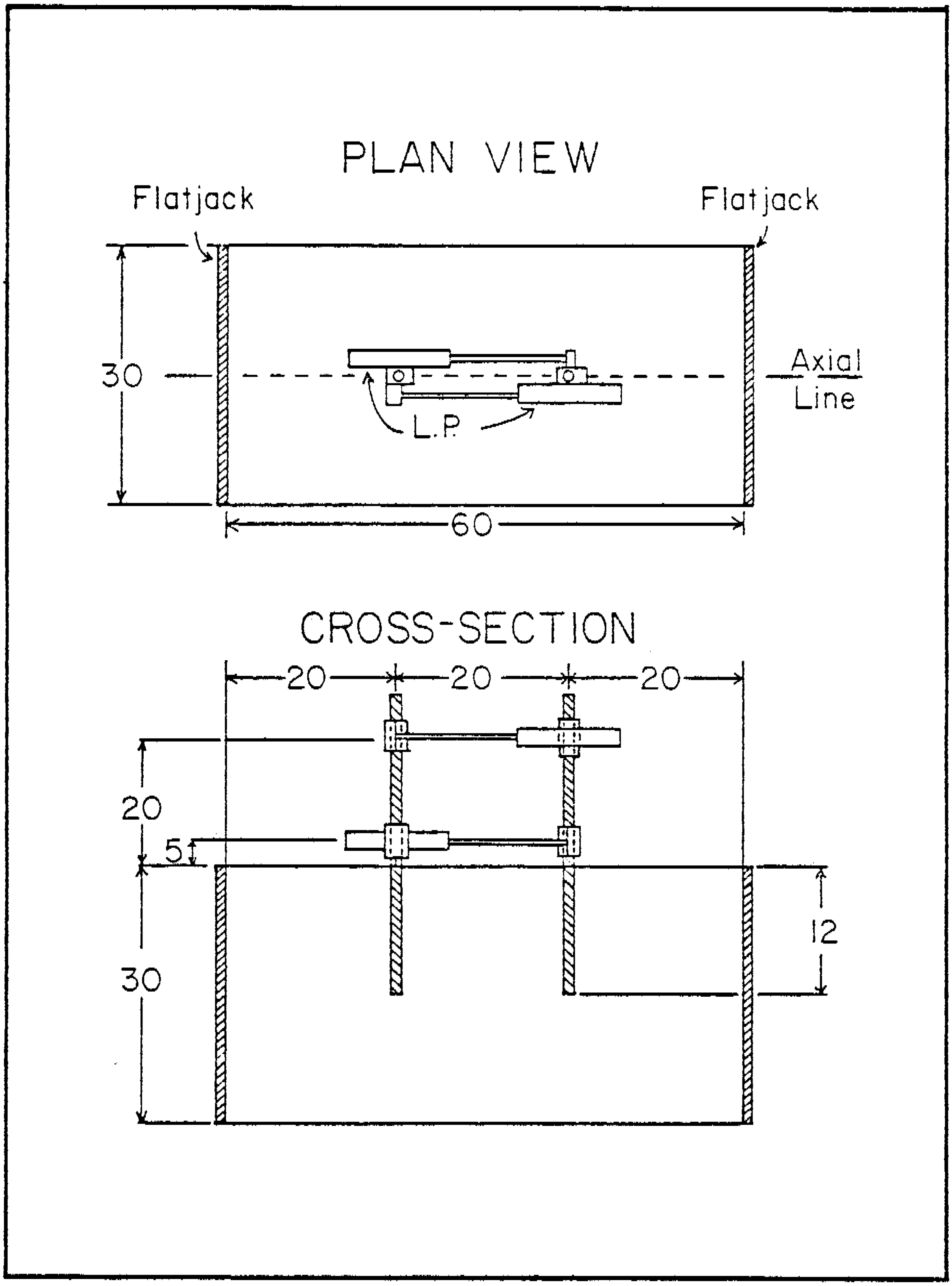

PLAN VIEW
Flatjack
Flatjack
30
Axial Line
L.P.
60
CROSS-SECTION
20
20
20
20
5
30
12

FIGURE 1

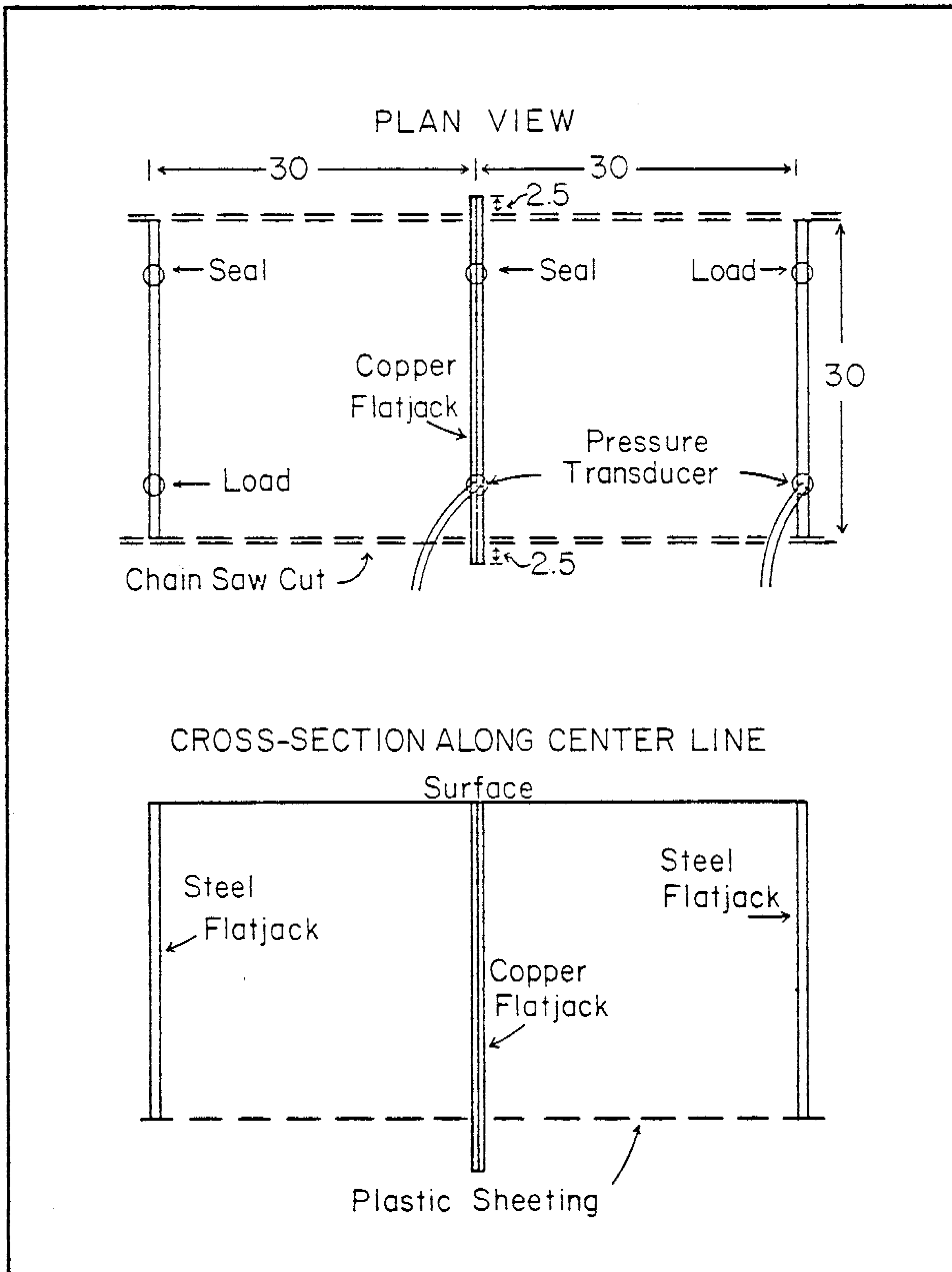

PLAN VIEW
30
30
2.5
Seal
Seal
Load
Copper
Flatjack
30
Pressure
Transducer
Load
Chain Saw Cut
2.5
CROSS-SECTION ALONG CENTER LINE
Surface
Steel
Flatjack
Steel
Flatjack
Copper
Flatjack
Plastic Sheeting

FIGURE 2

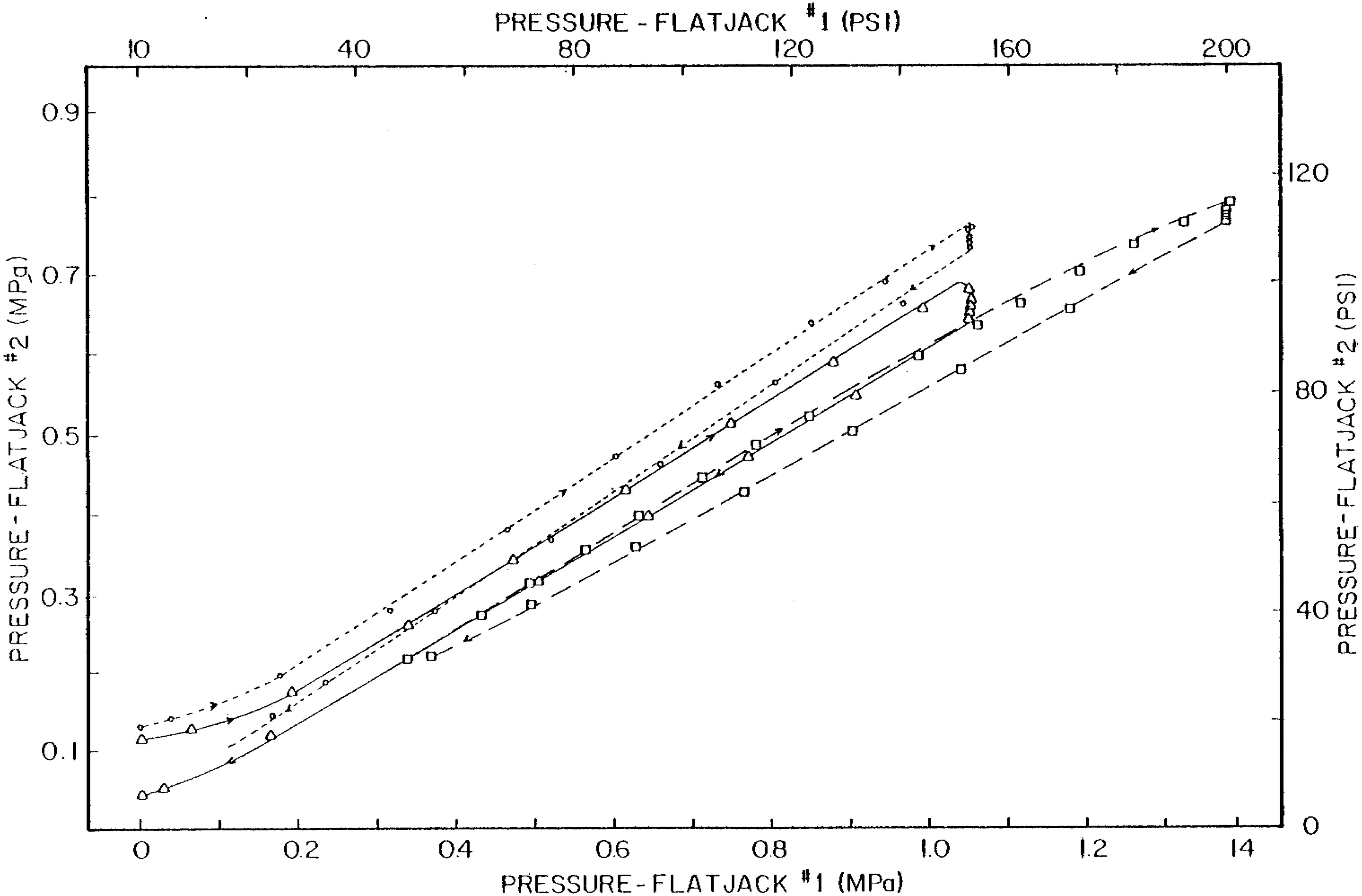

PRESSURE - FLATJACK #1 (PSI)
10
40
80
120
160
200
0.9
0.7
0.5
0.3
0.1
PRESSURE - FLATJACK #2 (MPa)
120
80
40
0
PRESSURE - FLATJACK #2 (PSI)
0
0.2
0.4
0.6
0.8
1.0
1.2
14
PRESSURE - FLATJACK #1 (MPa)

FIGURE 3

Q U A R T E R L Y   R E P O R T

Contract #03-5-022-55, Task 10
Research Unit #267
Reporting Period: April 1, 1978
to June 30, 1978
Number of Pages: 4

OPERATION OF AN ALASKAN FACILITY
FOR APPLICATIONS OF REMOTE-SENSING DATA TO OCS STUDIES

Albert E. Belon
Geophysical Institute
University of Alaska

June 30, 1978

OPERATION OF AN ALASKAN FACILITY

FOR APPLICATIONS OF REMOTE-SENSING DATA TO OCS STUDIES

Principal Investigator: Albert E. Belon
Affiliation: Geophysical Institute, University of Alaska
Contract: NOAA #03-5-022-55, Task 10
Research Unit: #267
Reporting Period: April 1 to June 30, 1978

I. TASK OBJECTIVES

The primary objective of the project is to assemble available remote-sensing data of the Alaskan Outer Continental Shelf and to assist other OCS investigators in the analysis and interpretation of these data to provide a comprehensive assessment of the development and decay of fast ice, coastal geomorphology, sediment plumes and offshore suspended sediment patterns along the Alaskan coast from Yakutat to Demarcation Bay.

II. LABORATORY ACTIVITIES

A. Operation of the Remote-Sensing Data Library

We continued to search periodically for new Landsat imagery of the Alaskan coastal zone entered into the EROS Data Center (EDC) data base. As a result fifty Landsat scenes were selected and ordered from EDC at a total cost of $800. These data products, which are gradually received from EDC, complete our files of Landsat data from the launch of the first satellite, July 26, 1972. This imagery is ordered in the following formats:

-70mm positive transparency of MSS, spectral band 5

-9 inch print of MSS, spectral band 7

Other formats are ordered on a case-by-case basis and at the request of individual OCS investigators.

The unusually small number of Landsat scenes selected and received from EDC during the spring quarter is caused by two factors, 1) owing to winter darkness in Alaska, Landsat data acquisition did not resume until late April, 2) owing to processing backlogs at EDC caused by a gradual transfer to an all-digital processing system and the launch of Landsat 3 in late March, the delay between data acquisition by the satellites and availability to users has increased temporarily to nearly three months. We are now starting to receive March data and have not yet received any of the high resolution RBV Landsat-3 data. We expect EDC to catch up during the summer quarter with a consequent large increase in data receipts and costs.

We continued to receive and catalog daily copies of NOAA satellite imagery of Alaska in both the visible and infrared spectral bands under a standing order with the NOAA/NESS Fairbanks Satellite Data Acquisition Station. 273 NOAA scenes at a total cost of $3112 were acquired in 10" positive transparency format during the reporting period.

B. Operation and maintenance of data processing facilities

This quarter Mr. Steve Leonard, programmer analyst, joined our data processing staff. He has reviewed our digital image processing programs and has started a consolidation of programs which will facilitate special processing functions for small areas ($1000 Km^2$), which sould have applications for site specific lease area considerations.

C. Development of Data Analysis and Interpretation Techniques

In response to the upcoming Beaufort lease sale a report was prepared in cooperation with RU258 (Stringer) using historical Landsat imagery of the Beaufort lease area in conjunction with sea-ice maps to provide input to the tract selection process. That report is being disseminated through the Arctic Project Bulletin.

D. Assistance to OCS Investigators

Eighteen OCS investigators utilized our facilities during this reporting period, many of them repeatedly. Additionally several visitors, though not formal OCSEAP investigators, used our facility for OCSEAP-related activities. Approximately 30 people made extensive use of our services for either OCSEAP or OCSEAP-related projects. Some of these users and their activities are:

Peter Reinhardt and Miles Hayes (RU59) called from the University of South Carolina and asked for appropriate summer and winter Landsat imagery of Kodiak Island. A selection was made and enlargements ordered for them.

Frank Fay (RU194) looked at NOAA imagery of the Bering Sea prior to his departure for the area. He also ordered several images that he could take along on his cruise in the Bering Sea.

Kristina Ahlnas (Royer, RU289) studies the NOAA imagery weekly in her work involving mapping of sea-surface temperatures.

Austin Kovacs (RU88) inquired as to the status of current SLAR imagery.

Bill Stringer (RU258) looked at the latest Beaufort Sea Landsat imagery and worked on the joint report he prepared with RU267.

Wilford Weeks (RU88) visited to check on the latest imagery available for his study area.

Dr. Naidu (RU529) looked at and ordered some Landsat imagery showing sediment and circulation patterns in the Beaufort Sea.

Max Puhl, Polar Research Institute, called to ask the availability of NOAA imagery and how much imagery we had on hand.

Jan Cannon (RU530, RU99) visits on a regular basis to keep current on data available.

John Burns (RU248) spent a day looking at both Landsat and NOAA imagery and ordered copies of each.

Juergen Kienle (RU251) searched through Landsat and NOAA imagery.

Teri McClung (Shapiro RU250) used our equipment and light tables in her work for Shapiro.

Steve Barrett (Stringer RU258) searched through the files for sea-ice imagery.

Mike McGUire, Cities Service Oil Company in Tulsa, visited our facility and looked at imagery available. He expressed surprise at finding such a complete compilation of remote-sensing data for the state.

David Yesner, University of Maine, asked for flight line maps of the Port Heiden area.

John Hall, USF&WS, Sacramento, ordered U-2 and Landsat imagery of the Prince Williams Sound area.

Jim Lockings, graduate student working for Peter Mikkelson, used the Zoom Transfer Scope to transfer information from current photos to maps in their study of the Copper River Delta.

Bob Gleason, Sohio of Anchorage, called to ask for imagery of the Prudhoe Bay area which shows smoke plumes. He is conducting a study of the changes which might occur if more power were generated in the Prudhoe area.

G. Carleton Ray, John Hopkins University, looked at latest NOAA imagery.

Fred Sorenson, USF&WS, is working with tracking polar bears in the Chukchi Sea and is interested in using Landsat and NOAA imagery to aid in this work. He spent considerable time in our facility becoming familiar with the operation of it and how he could best use our services.

Kris Tommos asked for a data search in the Bristol Bay area to help correlate marine sediment data to surface circulation. Several Landsat images were ordered for her.

Jack Mellor used our light table to view aircraft imagery of the northern sea coast.

Ron Metzner viewed all the SLAR imagery we have of the Beaufort Sea area.

Jim Scudd, USGS, ordered NOS aerial photography of proposed drilling sites in the Barrow, Cape Simpson area.

As a special service to Dr. Frank Fay (RU194), we received daily NOAA imagery of the Bering Sea and forwarded them to him for pickup at Savoonga. These current NOAA images aided him in determining where the RV Surveyor should proceed and thereby eliminated a considerable amount of waste time searching for the edge of the pack ice.

Niren Biswas (RU483) looked at NOAA imagery and also Landsat which might be useful in the evaluation of earthquake activities in the Norton and Kotzebue Sound areas. A standing order for Landsat imagery for the area for a specific time period was placed for him.

III. RESULTS

As mentioned in Section II-C, a report was prepared combining historical Landsat imagery with sea ice maps (Stringer RU258) of the proposed Beaufort lease area. This report, contained in Arctic Project Bulletin #20, uses imagery and maps to show the annual development of sea ice conditions in the lease area which may have bearing on future development.

Work is proceeding on a catalog of all remote-sensing data acquired during winter and spring 1978. This catalog will be up-dated through June 30, 1978 and will be distributed to all OCS investigators in late July/early August.

IV. PRELIMINARY INTERPRETATION OF RESULTS

The project's function is to provide remote-sensing data and technical support to the other OCSEAP projects. Therefore disciplinary data interpretations are normally reported by the individual user projects.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES

No significant problems were encountered this reporting period.

VI. ESTIMATE OF FUNDS EXPENDED

The estimated expenses of the project during the reporting period were approximately $21,200, a relatively low sum due to a backlog of data orders at EDC which will probably be rectified during the next quarter.

Quarterly Report

Contract #03-5-022-55
Research Unit #271
Report Period: 13th Quarter
Ending June 30
Number of Pages: 3

BEAUFORT SEACOAST PERMAFROST STUDIES

James C. Rogers
John L. Morack
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
(907) 272-5522

June 13, 1978

I. Task objectives: The objectives of this study are to develop an understanding of the nature and distribution of offshore permafrost along the Alaskan Beaufort Seacoast. Also of interest is the distribution of permafrost beneath the barrier islands. Emphasis is placed upon seismic methods but close cooperation with others using thermal, chemical, and geological methods is an important part of the work.

II. Field work: This quarter has been spent in preparation for the upcoming field season. In order to give the investigations a greater flexibility in the locations surveyed and an increased time in the field, a 21' Boston Whaler has been purchased. This boat will be shared with Carter Broad, et al. (RU 356) and is currently being outfitted for both groups.

Because this boat is much smaller than the USGS "Karluk," several components of the experimental apparatus have been modified. A new high pressure air handling system for the airguns has been designed and is under construction. The 3000 psi air compressor used to charge the airguns is presently being converted from electric to gasoline power. A pair of booms to support the airguns on the boat have been designed and will be constructed when the boat arrives in Fairbanks. The seismic hydrophone line is currently being modified by Mark Products of Houston, Texas. The modifications include shortening the line to 230 meters and relocating several of the hydrophones. The modifications were required in order that the line may be handled by hand on the smaller boat instead of by the electric cable reel used on the "Karluk." Also repairs have been made to the electronic components of the seismic systems used in the experiments.

A tentative schedule for the summer field season has been set up. This includes a week in late June in the Fairbanks area to shake down the boat and new systems, a week in the Prudhoe Bay area in late July and then after a week or so to examine the preliminary data, another ten days to two weeks will be spent in the field in middle August. This is approximately twice as much field time as have been spent in previous years and it is anticipated that this increase in field time will be beneficial to the investigations.

As in past years, two types of seismic investigations are planned for the summer field season. Refraction work will be carried out on the new boat in the near shore area in Gwydyr Bay and offshore from the Return Islands to the west of Prudhoe Bay.

III. Results: Information has been gathered in the Prudhoe Bay area on offshore permafrost and on permafrost underlying several of the offshore islands. These results have been synthesized with the work of other investigators ahd have been presented in the annual report of this project (Annual Report of RU 271, April 1, 1978).

IV. Preliminary Interpretation of Results: The interpretation of results is also summarized in the annual report of this project.

V. Problems encountered/recommended changes: Continued efforts are being expended to diversify the seismic investigations. The purchase of the 21' Boston Whaler for the project will eliminate the scheduling problems encountered with the use of the "Karluk" in past years and will allow a greater time in the field.

VI. Estimate of Funds Expended to Date: Approximately $154,000.

QUARTERLY REPORT

Contract #03-5-022-56
Research Unit #275
Task Order #5
L April - 30 June, 1978

HYDROCARBONS: NATURAL DISTRIBUTIONS AND DYNAMICS ON THE ALASKA OUTER CONTINENTAL SHELF

D. G. Shaw
Principal Investigator
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1978

Quarterly Report
Period April 1 - June 30, 1978
Research Unit 275
Principal Investigator: D. G. Shaw
Project Title: Hydrocarbons: Natural Distributions and Dynamics on the Alaska Outer Continental Shelf

I. Field Activities

A collection of water, particulate matter and zooplankton was carried out in Cook Inlet from the NOAA ship Discoveror in early May. During this cruise this project had proposed to occupy time series stations in both lower and upper Cook Inlet in order to compare the hydrocarbon contents of environments both near and far from present offshore oil production in the upper Inlet. Unfortunately, OCSEAP was unable to provide logistic support for the upper Inlet time series and a second lower Inlet series was substituted. The scientific consequences of this are discussed under results below.

Planning and preparation for Beaufort Sea field work in August is underway.

II. Laboratory Activities

One minor change has been made in Laboratory procedure. In the column chromatography clean-up step 20% CH_2Cl_2 in hexane instead of 40% benzene in hexane is now used for elution of the unsaturated fraction. This is preferable because the more volatile CH_2Cl_2 is more easily removed allowing better recovery of the low end of the hydrocarbons being determined.

III. Results

The analyses of filtered seawater collected during time series stations in Kachemak and Redoubt Bays of lower Cook Inlet contained no detectable hydrocarbons. The zooplankton samples showed considerable species variability and in some cases contained large numbers of phytoplankton. Pristane was the only identifiable compound in these samples. No clear trend appeared in the samples taken at 12 hourly intervals. This may be a result of the facts that the stations were occupied before the strong zooplankton bloom and that the area (60°N) lacks a good light-dark cycle so near the summer solstice.

Three surface water samples obtained by small boat from upper Cook Inlet have also been filtered and analysed. Each of these showed a steady series of normal alkanes characteristic of petroleum. For two of the stations chain lengths from 17 to 33 were recognizable and pristane and phytane were tentatively identified. Further analysis of these samples including their unsaturated fractions is planned using gc-ms.

QUARTERLY REPORT

Contract: #03-5-022-56
Research Unit: #289
Task Order: #19
Reporting Period: 4/1/78-6/30/78
Number of Pages: 4

CIRCULATION AND WATER MASSES IN THE GULF OF ALASKA

Thomas C. Royer
Principal Investigator
Associate Professor of Marine Science

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

NO RESULTS WERE PRESENTED

June 1978

Quarterly Report

Contract 03-5-022-56
Task Order #3
Reporting Period 4/1/78-6/30/78
RU# 290

GRAIN SIZE ANALYSIS OF SEDIMENT FROM ALASKAN CONTINENTAL SHELVES

Prepared by:

Charles Hoskins &
Kris Tommos
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

June 30, 1978

We are proceeding with the study of physical parameters and mineral composition of surface sediments from the southeastern Bering Sea Continental Shelf in order to determine the sedimentation processes operating in this region.

1. Grain-size Analysis

Granulometric analyses have been completed and statistical parameters such as mean grain size, sorting, skewness, kurtosis, percentage gravel, percentage sand, percentage silt, percentage clay, sand/mud ratio, and size class have been generated from the size analysis. Factor analyses on the sediment textural data have yet to be run.

2. Petrographic Analysis

Thin-sections have been made from each sand fraction allowing impregnation with artificial resin. These are being examined by petrographic microscope. Point counting has yet to be completed.

3. Heavy Mineral Analysis

Since heavy minerals (those with a specific gravity greater than 2.85) are of value in studying provenance (and transportation and weathering history) of a sediment and in correlation and petrographic studies, heavy mineral separation by gravity settling in bromoform has been completed (for the 2Ø-3Ø and 3Ø-4Ø size fractions) for all samples.

X-ray Diffraction Analysis (of heavy minerals)

It has been found that x-ray diffraction analysis can be used as a routine, rapid, and supplementary method for analyzing large numbers of heavy mineral samples. Therefore, in order to characterize the heavy mineral samples, group them, and then select representative samples for detailed petrographic analysis, x-ray diffraction analysis of the heavy minerals is currently in progress. Before the samples were analyzed by x-ray diffraction, however, each was subsampled; the most magnetically susceptible minerals were then removed with a magnetic separator; the samples then were boiled in concentrated HCl (to remove carbonate, organic material, and free iron oxides) and washed, dried, and ground to a uniform size of less than 4μ. The powder was mounted on a glass slide with Duco-cement.

4. Satellite Imagery

Satellite imagery will be used to provide data regarding sediment plumes from land drainage systems and surface suspended sediment distribution in order to aid in delineating major pathways of suspended sediment transport. Prints from images taken during the August 1975 sampling period have been ordered from LANDSAT.

5. Physical Oceanography

By correlating the results of these sedimentological studies with data obtained from physical oceanographic reports, principle water masses and circulation patterns that influence mineral transport will be determined.

6. Clay Mineralogy and Chemical Composition

Clay mineral data and chemical composition data (trace element analysis) from previous research carried out by Dr. A. S. Naidu and Dr. G. D. Sharma, respectively will be correlated with this study.

7. Biological Studies

Relationships have been sought between sediment and the benthos (Dr. C. M. Hoskin, Benthos-Sedimentary Substrate Interactions, Summary Report, January 1978). The problem of biological correlation with sediment type will be considered further.

8. Correlation with Terrestrial Geology

This investigation of the sediments of the southeastern Bering Sea will help to define the character, trends, and variations of the surface sediments, and will indicate source areas by, for example, comparing the gelogy of the catchment areas of drainage systems and the various mineral assemblages of the sediments. By interpreting texture and minerology influences of environmental forces on sediment distribution will be delineated and various energy regimes will be defined.

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

April 1 to June 30, 1978

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

ABSTRACT

Personnel of RU 332 are participating in field activities in the Northern Gulf of Alaska (NGOA), Kodiak Island near-shore studies, in cooperation with the Alaska Department of Fish and Game (ADFG) (RU 552). Three fish pathologists, one person at a time, from RU 332 were on the RV YANKEE CLIPPER between May 1 and June 14, 1978. Three pathological conditions were detected in fish from Kalsin Bay, including skin tumors (epidermal papillomas) and epidermal cysts of rock sole (Lepidopsetta bilineata), and skin tumors of flathead sole (Hippoglossoides elassodon). In Izhut Bay, the three above-mentioned conditions, plus pseudobranchial tumors and skin ulcers of Pacific cod (Gadus macrocephalus) were found. The same two conditions reported above in rock sole were also observed in this species in Kayugnak Bay, as were the Pacific cod tumors. Sampling in these bays will resume in August 1978.

OBJECTIVES

Determine the frequency, geographical distribution, and pathological characteristics of diseases of marine fish and macroinvertebrates in the Bering and Beaufort Seas, and the Gulf of Alaska.

FIELD OR LABORATORY ACTIVITIES

A. SHIP SCHEDULE

Dates: May 1 to June 14, 1978

Vessel: RV YANKEE CLIPPER

(Chartered by ADFG, RU 552, with OCSEAP support)

Dates: May 11, 23, 24, and June 12 and 13, 1978

Vessel: RV COMMANDO (Chartered by ADFG with OCSEAP support)

B. 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
Jolly Hibbits, MS	Laboratory technician, under the supervision of Dr. Sparks
Mark S. Myers	Performs histopathological analyses of tissue specimens and participates in field activities and data processing
Kenneth V. Pierce, MS	Histopathologist

C. METHODS

Fish were sorted according to species, and the total sample or subsamples were examined for externally visible pathological conditions and, when feasible, for readily recognizable internal disorders. The following information was recorded for each haul in the Species Catch Record: haul number, date, number of animals examined of each species, sex, the type of pathological condition observed, and the number of animals with each type of condition for each species and each sex. Animals with abnormal conditions were processed while still alive or freshly dead. Each animal was assigned a specimen number and the following information was recorded on the Individual Data Sheet: species, sex, length, weight, method of age determination (otolith or scale), condition, and location, and size of the condition(s). Photographs were taken of representative and unusual conditions. Tissue samples were preserved in appropriate fixatives.

D. SAMPLE COLLECTION LOCALITIES

Four bays on or near Kodiak Island are being sampled: Kalsin, Izhut, Kayugnak, and Ailinda Bays.

E. DATA COLLECTED AND/OR ANALYZED

1. Number and types of samples

Approximately 3,000 fish representing at least 40 species were examined; 185 had pathological conditions.

2. Number and type of analyses

Approximately 800 tissue specimens were collected and preserved from 100 individual animals for light microscopy. Two specimens from two fish were preserved for electron microscopy.

RESULTS

Most of the fish examined for abnormalities were captured with an otter trawl at depths of 11 and 90 m. The data from three of the bays sampled have so far been analyzed. The pathological condition, species affected, and the frequency of each condition in Kalsin, Izhut, and Kayugnak Bays, respectively, were as follows: skin tumors, rock sole, 12,4,8%; flathead sole, 6,3,0%. Epidermal cysts, rock sole, 4,3,12%. Pseudobranchial tumors, Pacific cod, 0,18,8%. Skin ulcers, Pacific cod, 0,1,0%.

The pathological condition which was most prevalent and widespread in the three bays studied so far in the Kodiak area was skin tumors of rock sole. Juvenile rock sole (less than 200 mm long) had tumor frequencies up to 7.3 times higher than did adult rock sole (greater than 200 mm). The greatest number of tumor-bearing rock sole were found in hauls which had the greatest number of juveniles.

Another condition of rock sole found in all three bays is tentatively called "epidermal cysts" until a histological study is made and a more definitive classification can be given. This condition affected both juvenile and adults, and affected fish had from two to more than 50 cysts visible on the nonpigmented or "blind" side. The cysts varied in size from 1 to 5 mm in diameter.

PRELIMINARY INTERPRETATION OF RESULTS

Although epidermal papillomas have been found on adult rock sole in other areas of the Gulf of Alaska (GOA) and the Bering Sea, the tumor-bearing juvenile rock sole found during this cruise were the youngest tumor-bearing rock sole found by us in Alaskan waters. As a result, the earliest form of the tumor was observed, the angioepithelial nodule, and will be further characterized histologically. This information will help establish the age at which rock sole develop these tumors.

Pseudobranchial tumors of Pacific cod have also been observed in other areas of the GOA and Bering Sea. The prevalence of this condition appears to be higher in the Kodiak area than in the offshore waters of the GOA. In 1977 we detected a tumor frequency of 3% in the offshore waters, as compared to approximately 18 and 8% for Izhut and Kayugnak Bays, respectively. This condition was not detected in Kalsin Bay because no adult Pacific cod were captured.

The absence of tumor-bearing flathead sole in Kayugnak Bay is of special interest since both the other bays had flathead sole with skin tumors. If further observations in this bay substantiate these preliminary data, then a pronounced variation in the geographical distribution of this condition may be indicated.

AUXILIARY MATERIAL

A. BIBLIOGRAPHY OF REFERENCES - None

B. PAPERS IN PREPARATION OR IN PRINT

WELLINGS, S.R., C.E. ALPERS, B.B. McCAIN, and M.S. MYERS (1977) Fish diseases in the Bering Sea. Annals N.Y. Acad. Sci. 298:290-304.

ALPERS, C.E., B.B. McCAIN, M. MYERS, S.R. WELLINGS, M. POORE, J. BAGSHAW, and C.J. DAWE (1977) Pathologic anatomy of pseudobranch tumors in Pacific cod, Gadus macrocephalus. J. Nat'l. Cancer Inst. 59:377-98.

McCAIN, B.B., S.R. WELLINGS, C.E. ALPERS, M.S. MYERS, and W.D. GRONLUND (1977) The frequency, distribution, and pathology of three diseases of demersal fishes in the Bering Sea. J. Fish. Biol. 12:267-76.

HODGINS, H.O., B.B. McCAIN, and J.W. HAWKES (1977) Marine fish and invertebrate diseases, host disease resistance, and pathological effects of petroleum. IN: Effects of Petroleum on Arctic and Subarctic Marine Environments and Organisms (D.C. Malins, ed.), Vol. II, 95-173. Academic Press, New York.

ALPERS, C.E., B.B. McCAIN, M.S. MYERS, and S.R. WELLINGS (1977) Lymphocystis disease in yellowfin sole (Limanda aspera) in the Bering Sea. J. Fish. Res. Board Can. 34:611-6.

McCAIN, B.B., W.D. GRONLUND, M.S. MYERS, and S.R. WELLINGS (1978) Tumors and microbial diseases of marine fishes in Alaskan waters. (Submitted).

C. ORAL PRESENTATIONS

The frequency, geographical distribution, and pathology of marine fish diseases in the Bering Sea and Gulf of Alaska. An oral report given at an OCSEAP Program Review, April 18, 1978, in Santa Cruz, California.

PROBLEMS ENCOUNTERED AND RECOMMENDED CHANGES - None

ESTIMATE OF FUNDS EXPENDED - 43.5 K

QUARTERLY REPORT

Contract: 01-5-022-2538
Research Unit: RU-337
Reporting Period: April 1, 1978 to
June 30, 1978

SEASONAL DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS IN ALASKAN WATERS

Calvin Lensink
PRINCIPAL INVESTIGATOR

Patrick Gould
PROJECT LEADER

U. S. Fish and Wildlife Service
Office of Biological Services - Coastal Ecosystems
1011 E. Tudor Road
Anchorage, Alaska 99503

July 1, 1978

SEASONAL DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS IN ALASKAN WATERS

I. ABSTRACT

This quarterly work period was devoted to data management and analysis, the development of software programs for data synthesis, and a literature review in anticipation of preparing the final report on RU337.

II. TASK OBJECTIVES

The overall objective of RU337 is to describe the seasonal distribution and abundance of birds in Alaskan marine environments. Major task objectives for this quarter were the editing and verification of digital data collected to date and the development of software programs for the computer analysis of that data.

III. ACTIVITIES

A. Ship or Field Trip Schedule: There were no field trips undertaken during this period. Some pelagic surveys, however, were conducted within the integrated Kodiak project under RU341.

B. Scientific Party: The personnel involved in this quarters work and their activities were: Patrick Gould (data analysis, literature review, and computer program development), Calvin Lensink (coordination and supervision), Douglas Forsell (data editing and verification), Robert Blancett (computer program development), and Claudia Voss (data synthesis).

C. Methods: No special techniques were employed in this months activities.

D. Sample Locations: There were no sample locations.

E. Data collected or analyzed: No data were collected. Distribution and abundance data were analyzed for the southeast Alaska and Kodiak areas.

IV. RESULTS

None of the tasks were completed during this work period but major headway was made in all areas, especially in computer program development. Our software programs now include 1) determinations of the range, mean, standard deviation, and standard error of seabird density indices with data broken down into geographical areas and into selected habitats such as bays, continental shelf, shelfbreak and oceanic waters, and 2) computer mapping of cruise tracks and of species ranges by transect densities.

The analysis of Kodiak data was presented in the 1978 annual report on RU337. The analysis of Southeast Alaska data is appended to the end of this report.

V. PRELIMINARY INTERPRETATION OF RESULTS

For the preliminary interpretation of data analysis please refer to the RU337 annual report for 1978 and to the appended manuscript on Southeast Alaska.

VI. AUXILIARY MATERIAL

There is no auxiliary material for this quarters work.

VII. PROBLEMS ENCOUNTERED

Data verification continues to be a slow process. A few problems have been encountered in the conversion of formats by Hal Peterson but these problems are being solved by telephone and letter between Dr. Peterson and Patrick Gould. The development of computer software programs is becoming quite expensive and we anticipate a major problem in being able to complete all of the multivariate programs that we had originally intended.

SEABIRDS IN MARINE HABITATS OF SOUTHEAST ALASKA

Patrick J. Gould
Claudia Voss
AUTHORS

Calvin Lensink
PRINCIPAL INVESTIGATOR

U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska

July 1, 1978

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

FORWARD

This report provides a preliminary review of progress in field or laboratory activities and is prepared for administrative use within the Fish and Wildlife Service. The interpretations and conclusions presented herein are frequently based on fragmentary data and partial analysis, and are subject to change. For these reasons, information contained in this report should be used or quoted with caution.

ACKNOWLEDGMENTS

This study was supported by the Bureau of Land Management through interagency agreement with the National Oceanic and Atmospheric Administration, under which a multi-year program responding to needs op petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office.

Data used in this paper were collected by the following people: Judith Benson, Todd Eberhardt, David A. Frazer, Juan Guzman, Colleen M. Handel, David M. Hardy, Scott A. Hatch, Karen Henderson, M. E. "Pete" Isleib, Matthew Kirchhoff, David R. Nysewander, Margaret Peterson, Mark Phillips, Mark J. Rauzon, Jerry Ruehle, Gerry A. Sanger, Ted Schad, Rebecca S. Timson, and Irving M. Warner.

SEABIRDS IN MARINE HABITATS OF SOUTHEAST ALASKA

The United States Fish and Wildlife Service, Office of Biological Services-Coastal Ecosystems has been conducting shipboard surveys of seabirds in Alaskan waters under Research Unit 337 as part of the Outer Continental Shelf Environmental Assessment Program. The area covered by this report includes all marine waters of Southeast Alaska bounded by 54N, 59N, 130W, and 140W. Marine habitats within this area have been grouped into four catagories: Oceanic Waters (depth greater than 1,800 meters), Shelfbreak Waters (depth from 180 to 1,799 meters), Continental Shelf Waters (depth less than 180 meters), and Inland Passage Waters including bays and fyords (Figure 1). A preliminary analysis of these data is presented in the following report.

METHODS

Data were obtained from 16 cruises in marine waters between January 31, 1975, and February 19, 1977 (Table 1). Strip censuses (transects) were employed based on a 10-15 minute (temporal) cruising time with the ship moving along a straight path at a constant speed (5-16 knots). The observer counted all birds observed forward of mid-ship to the projected end of the transect and laterally, on one side, to 300 meters. Only those birds observed within the transect boundaries during the actual time of the transect were counted. Ship following birds were recorded separately and not included in density estimates. Distances were determined where possible by a range finder using the design developed by Dennis Heinemann under RU 108 (Wiens et. al, 1977 and 1978). In bay situations, distances were estimated by observers who had been using the range finder under good conditions and had verified their estimating ability.

RESULTS

Oceanic Waters

Six families, 15 species and 674 individual seabirds were recorded during the months of January, February, May, June, and August within oceanic waters (Table 2). Alcidae was the most abundant family due to one flock of 312 Cassin's Auklets encountered in June. This also made Cassin's Auklets the most abundant species within the area. The highest monthly total bird density was recorded in June (23.4 birds/Km2). The densities for the remaining four months were very uniform ranging from 1.5 to 3.3 birds/Km2.

BLACK-FOOTED ALBATROSS (Diomedea nigripes): This species was recorded only in February and August but probably occurs throughout the summer. Two to four birds followed the ship on February 19, 1977, in the southwest part of the study area (ca. 54N x 137W). This represents one of our few winter records for the Gulf of Alaska.

NORTHERN FULMAR (Fulmarus glacialis): Fulmars were found in January, February and June with highest density recorded in February. This was the third most abundant species within oceanic waters.

SOOTY/SHORT-TAILED SHEARWATER (Puffinus griseus/P. tenuirostris): These non-breeding summer residents were recorded only in May and June. The populations in this arrea appear to be much lower than has been found in other parts of the Gulf of Alaska.

FORK-TAILED STORM PETREL (Oceanodroma furcata): These birds were found in all months surveyed except January. Densities appear to remain uniform ranging from a low of 0.2 birds/Km2 in August to a high of 1.0 birds/Km2 in June.

LEACH'S STORM PETREL (Oceanodroma leucorhoa): This species was found only in oceanic waters where it appears to be one of the most abundant summer residents.

JAEGER (Stercorarius sp.): One unidentified jaeger was seen in June and another in August.

GLAUCOUS-WINGED GULL (Larus glaucescens): This species was recorded in oceanic waters only in January and February.

HERRING GULL (Larus argentatus): Like the Glaucous-winged Gull, this species occurs in oceanic waters only during the winter. Our only records are of a few birds following the ship in February.

KITTIWAKE (Rissa sp.): All records for this area probably refer to Black-legged Kittiwakes. We recorded these birds in small numbers only in January and February. As with Glaucous-winged and Herring Gulls, these birds move into more coastal waters during the summer breeding season.

SABINE'S GULL (Xema sabini): Six birds were recorded on June 15, 1976, at 54° 30'N x 131° 29'W.

MURRE (Uria sp.): Murres were found in January and June indicating that small numbers are probably present in oceanic waters throughout the year.

ANCIENT MURRELET (Synthliboramphus antiquus): Four birds were seen on June 13, 1976, at 54° 14'N x 134° 41'W.

CASSIN'S AUKLET (Ptychoramphus aleutica): One bird was seen on January 31, 1975, and 321 were found on June 13, 1977. This latter concentration occurred at 54 28'N x 134 59'W and was the reason for this sepcies being the most abundant bird occurring in oceanic waters.

RHINOCEROS AUKLET (Cerorhinca monocerata): We recorded this species in oceanic waters only in May and June.

TUFTED PUFFIN (Lunda cirrhata): Small numbers were found throughout oceanic waters in all months except August.

Shelfbreak Waters

Six families, 11 species, and 224 individual seabirds were recorded from shelfbreak waters in March and September (Table 3). Total bird density was highest in March but the September data are too few for adequate comparison. The family Laridae dominated the avifauna both in terms of species and number of individuals. Kittiwakes far outnumbered all other species.

BLACK-FOOTED ALBATROSS (Diomedea nigripes): Four birds followed the ship on September 12, 1975, at 58°28'N x 139°43'W.

NORTHERN FULMAR (Fulmarus glacialis): This was the second most abundant species in this area and was found in both months surveyed.

SOOTY/SHORT-TAILED SHEARWATER (Puffinus griseus/P. tenniurostris): A few birds tentatively identified as Sooties were observed during the September survey.

FORK-TAILED STORM PETREL (Oceanodroma furcata): None were found in March, but large numbers were present in September.

JAEGER (Stercorarius sp.): One unidentified jaeger was seen on September 12, 1975.

GLAUCOUS-WINGED GULL (Larus glaucescens): This species was common in shelfbreak waters in March. The lack of sightings in September was probably due to the small number of transects taken during that month.

HERRING GULL (Larus argentatus): One bird was observed on March 19, 1976, and another on September 12, 1975.

KITTIWAKE (Rissa sp.): Most of these birds were identified as Black-legged Kittiwakes. This was the most abundant species observed in shelfbreak waters although only one bird was found in September.

ARCTIC TERN (Sterna paradisaea): One bird was found on September 12, 1975, at 58°27'N x 139°33'W.

MURRE (Uria sp.): One murre was found on March 19, 1976, at 58°06'N x 139°14'W.

TUFTED PUFFIN (Lunda cirrhata): Small numbers were seen throughout the area during both months surveyed.

Continental Shelf Waters

Seven families, 17 species and 649 individual seabirds were recorded in continental shelf waters during February, March, April, May, September, and November (Table 4). Northern Fulmars were the dominant members of this avifauna although Pintails, Sooty/Short-tailed Shearwaters, Herring Gulls and Kittiwakes reached high local densities. Total bird density was highest in April and May (21.6 and 22.1 birds/Km2 respectively). Densities in the remaining months ranged from 3.5 to 8.4 birds/Km2.

LOON (Gavia sp.): One loon was observed on February 19, 1976, and another on April 28, 1976. Both were in the area of 58N x 138W.

BLACK-FOOTED ALBATROSS (Diomedea nigripes): On bird was seen on March 19, 1976, at 58°07'N x 138°36'W, and another on April 28, 1976, at 58°20'N x 138°32'W.

NORTHERN FULMAR (Fulmarus glacialis): Recorded from September through March with densities ranging from 1.4 to 4.1 birds/Km2.

SOOTY/SHORT-TAILED SHEARWATER (Puffinus griseus/P. tennuirostris): Birds seen in April, May and September with largest numbers found in May.

BLACK BRANT (Branta nigricans): A flock of 15 birds was seen on April 28, 1976, at 58°29'N x 138°49'W.

PINTAIL (Anas acuta): Two groups numbering 68 and 101 individuals were observed on April 28, 1976, in the area of 58°25'N x 138°30'W.

PECTORAL SANDPIPER (Calidris melanotos): A flock of 25 birds was found on April 28, 1976, at 58°37'N x 138°04'W.

GLAUCOUS-WINGED GULL (Larus glaucescens): This species was found only during the months of February, March and April. Densities ranged from 0.2 to 1.1 birds/Km2).

HERRING GULL (Larus argentatus): We recorded this species from February through May with largest numbers (6.9 birds/Km2) occurring during the latter month.

KITTIWAKE (Rissa sp.): Most of these birds were identified as Black-legged Kittiwakes. They were present during all months surveyed. Densities ranged from 0.4 to 5.2 birds/Km2.

ARCTIC TERN (Sterna paradisaea): Three birds were found on May 11 1975, at 58°58'N x 139°50'W.

MURRE (Uria sp.): Sixteen birds were identified as Thick-billed Murres in February, 1976. The remaining birds found in February, April and November were not identified to species. Highest density occurred during the winter months.

MARBLED MURRELET (Brachyramphus marmoratum): Ten birds were observed on April 28, 1976, at 58°24'N x 138°36'W.

KITTLITZ'S MURRELET (Brachyramphus brevirostris): Two were seen on April 28, 1976, at 58°29'N x 138°42'W.

CASSIN'S AUKLET (Ptychoramphus aleutica): Twenty-six birds were found in April in the area of 58°25'N x 138°40'W.

HORNED PUFFIN (Fratercula corniculata): A single bird was observed on February 19, 1976 at ca. 58N x 138W.

Inland Passage Waters

Nine families, 27 species and over 1,600 individual seabirds were recorded during the months of February, March, April, May, August, October, and December in inland passage waters. Alcids dominated the avifauna with Larids a close second. Murres were the most abundant species within the area although Glaucous-winged Gulls, Mew Gulls, Kittiwakes, and Marbled Murrelets reached high local densities. Total bird densities ranged from a low of 1.4 birds/ Km2 in August to a high of 25.7 birds/Km2 in February.

COMMON LOON (Gavia immer): Single birds were seen on February 18, 1976, and May 20, 1976.

ARCTIC LOON (Gavia arctica): One bird was recorded on September 16, 1975.

NORTHERN FULMAR (Fulmarus glacialis): A single bird was encountered on March 18, 1976 at 56°13'N x 134°23'W.

FORK-TAILED STORM PETREL (Oceanodroma furcata): Four birds were seen on March 19, 1976 and six were found on September 16, 1975.

PELAGIC CORMORANT (Phalacrocorax pelagicus): This species was recorded in small numbers from September through March. None were observed in waters outside of the passage area.

EMPEROR GOOSE (Philacte canagica): One bird was observed on February 18, 1976, at 56°22'N x 133°42'W.

OLDSQUAW (*Clangula hyemalis*): Three birds were seen on October 23.

EIDER (*Somateria* sp.): One unidentified eider was found on December 1 at 56°20'N x 133°43'W.

WHITE-WINGED SCOTER (*Melanitta deglandi*): One bird was observed on October 23 at 58°16'N x 134°42'W.

SURF SCOTER (*Melanitta perspicillata*): Twelve birds were noted on October 23 and a few in April. All sightings were in the area of *ca*. 58°20'N x 134°45'W.

COMMON MERGANSER (*Mergus merganser*): Three birds were seen on February 18 at 56°15'N x 132°56'W.

RED-BREASTED MERGANSER (*Mergus serrator*): Two birds were observed on February 18 in the same area as the Common Mergansers.

BALD EAGLE (*Haliaeetus leucocephalus*): This species was observed on February 18, 1976, at 56°23'N x 133°33'W.

PHALAROPE (Genus?): Several unidentified phalaropes were observed in April.

GLAUCOUS-WINGED GULL (*Larus glaucescens*): This species appears to be present in relatively high numbers throughout the year. The lack of birds in April and August may have been the result of small sample size. Densities ranged from 0.4 to 3.3 birds/Km2 with greatest abundance in October.

HERRING GULL (*Larus argentatus*): Recorded from September through March with relatively uniform densities throughout that period (0.2 to 1.0 birds/Km2).

MEW GULL (*Larus canus*): These gulls were found from September through April with low densities in the fall and high densities in late winter.

BONAPARTE'S GULL (*Larus philadelphia*): Several birds were seen in April.

KITTIWAKE (*Rissa* sp.): All of these birds were identified as Black-legged Kittiwakes. They were observed only in September and October with most birds recorded from the latter month.

ARCTIC TERN (*Sterna paradisaea*): Several birds were seen in April.

MURRE (*Uria* sp.): Ninety-one percent of those murres identified to species were Common Murres. Murres were the most abundant species in this region. They were found in all seasons except summer with highest density in late winter (13.1 and 7.5 birds/Km2 in February and March respectively).

MARBLED MURRELET (*Brachyramphus marmoratum*): This species was recorded in relatively high numbers in May and September, but they were not observed during the other survey periods.

KITTLITZ'S MURRELET (*Brachyramphus brevirostris*): One bird was identified on May 30, 1976, at $58^{\circ}42'$N x $136^{\circ}05'$W.

ANCIENT MURRELET (*Synthliboramphus antiquus*): Three birds were found on February 18, and one bird was found on March 18.

CASSIN'S AUKLET (*Ptychoramphus aleutica*): Six birds were seen on February 18 and a few were found on March 18.

TUFTED PUFFIN (*Lunda cirrhata*): Two birds were recorded on February 18 at $56^{\circ}11'$N x $133^{\circ}54'$W. This species is apparently absent from the inner parts of the inside passage area.

SUMMARY

Members of 10 different families were observed within the four regions of the study area, including 35 species and 3,165 individual birds. Representatives of seven families were seen in both the Inside Passage region and the Coastal Shelf region. The Oceanic and Shelfbreak regions each included sightings of six families. The largest number of birds were observed within the Inside Passage region, and the least number of birds were seen in the in the Shelfbreak region. These two areas coinsided with the regions of the greatest and fewest transects, however, so this relationship may simply be a function of the number of transects conducted in each area. Th most numerous individual species seen within a region was Cassin's Auklet.

Three families; Procellariidae, Laridae, and Alcidae, were represented in all four regions by one or more species. Black-footed Albatross were observed in all areas except the Inside Passage region. Loons, ducks and geese were seen only within the Coastal Shelf and Inside Passage regions, while the Storm Petrels and Jaegers were present only within the Oceanic and Shelfbreak regions. The Inside Passage region was the only area where Cormorants and Bald Eagles were observed.

LITERATURE CITED

Wiens, J. A., W. Hoffman, D. Heinemann. 1977. Community Structure, Distribution, and Interrelationships of Marine Birds in the Gulf of Alaska. In Environmental Assessment of the Alaskan Continental Shelf. Receptors - Birds, II:383-401. U. S. Department of Commerce and U. S. Department of the Interior.

Wiens, J. A., W. Hoffman, D. Heinemann. 1978. Community Structure, Distribution, and Interrelationships of Marine Birds in the Gulf of Alaska. Final Report of RU 108 - Phase I, August 1975-October 1977, submitted to NOAA, OCSEA Program, Juneau, Alaska.

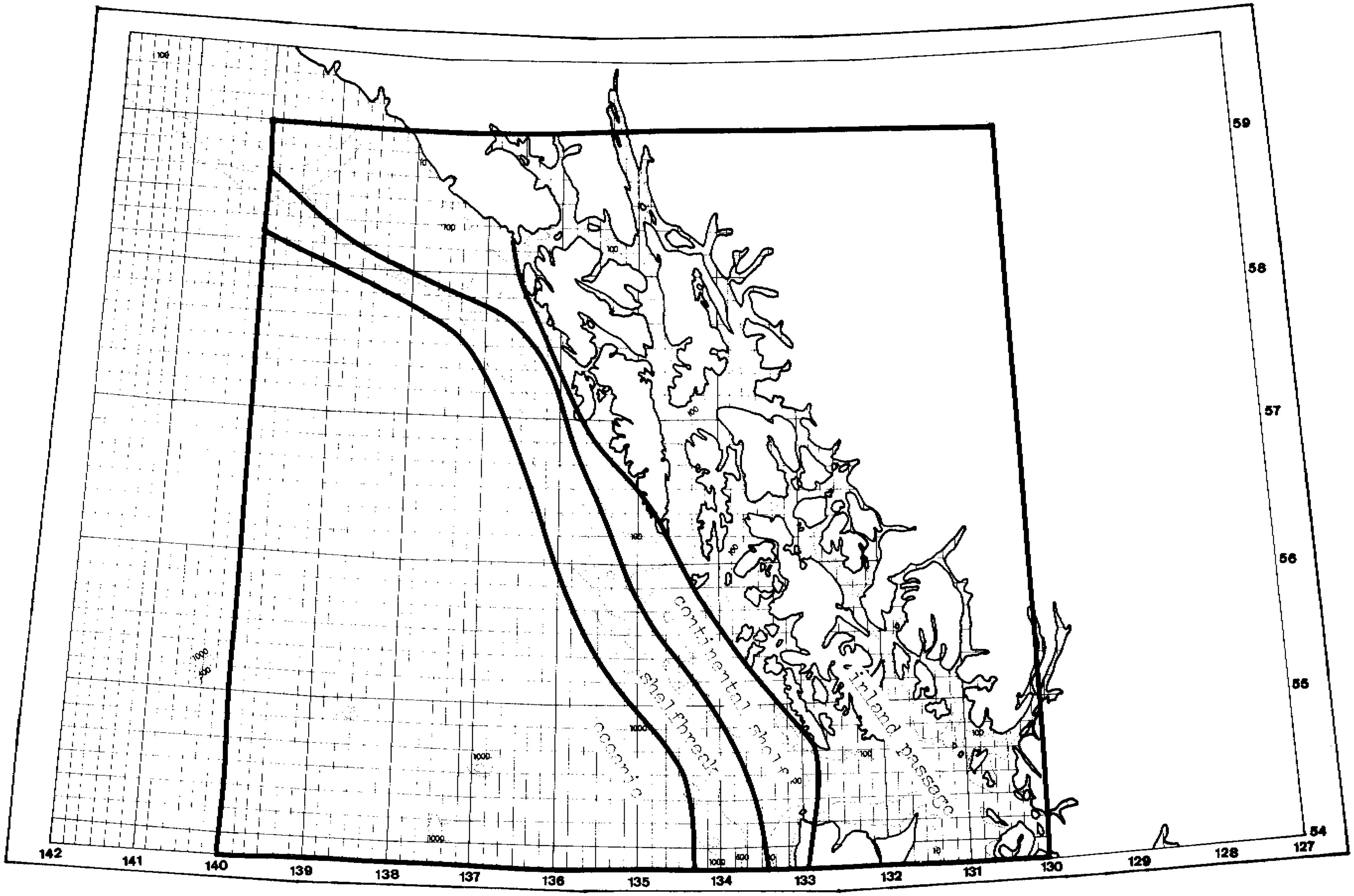


Figure 1. Southeast Alaska study area.

Table 1. Schedule of field operations within marine habitats of Southeast Alaska.

OPERATION NUMBER*	MARINE HABITATS			
	OCEANIC	SHELFBREAK	CONTINENTAL SHELF	INLAND PASSAGE
FW5002	1/31**	-	-	-
FW5004	6/12-13	-	5/11	-
"	-	-	4/21	-
FW5005	5/10	-	-	-
"	6/21	-	-	-
FW5015	8/7	-	-	-
FW5016	-	9/12	9/12	-
FW5020	-	-	-	8/31
FW5024	-	-	-	9/16
FW5025	-	-	-	10/23
FW5031	-	-	-	10/28
FW5033	-	-	11/30	12/1
FW6022	-	-	2/19	2/18
FW6005	2/26	-	-	-
FW6010	-	3/19	3/19	3/18-19
FW6018	-	-	4/28-29	4/30
FW6068	6/14-15	-	-	5/30
FW7027	2/19	-	-	-

* : FW5 = 1975, FW6 = 1976, FW7 = 1977
** : Month/Day

Table 2. Seabird abundance in oceanic waters of Southeast Alaska.

SPECIES	NUMBER OF BIRDS	RELATIVE ABUNDANCE (%)	$\bar{X}$ TRANSECT DENSITY (BIRDS/KM2)	RANGE OF TRANSECT DENSITIES
JANUARY (8 transects, 18.9 Km2 covered)				
Northern Fulmar	10	36	0.6	0.0-2.4
Glaucous-winged Gull	7	25	0.3	0.0-0.8
Kittiwake	4	14	0.2	0.0-0.5
Murre	2	7	0.1	0.0-0.8
Cassin's Auklet	1	4	0.1	0.0-0.4
Tufted Puffin	4	14	0.2	0.0-0.8
Total Birds	28	-	1.5	0.0-2.6
FEBRUARY (25 transects, 33.1 Km2 covered)				
Black-footed Albatross	4	4	0.1	0.0-0.1
Northern Fulmar	38	35	1.1	0.0-4.3
Fork-tailed Petrel	13	12	0.4	0.0-3.1
Unid. Storm Petrel	3	3	0.1	0.0-0.8
Glaucous-winged Gull	1	1	0.1	0.0-0.8
Herring Gull	+	+	+	+
Unid. Gull	3	3	0.1	0.0-0.8
Kittiwake	41	38	1.2	0.0-8.6
Tufted Puffin	5	5	0.1	0.0-1.5
Total Birds	108	-	3.3	0.0-11.4
MAY (2 transects, 2.7 Km2 covered)				
Shearwater	3	38	0.8	0.7-0.9
Fork-tailed Petrel	1	12	0.3	0.0-0.7
Rhinoceros Auklet	1	12	0.3	0.0-0.7
Tufted Puffin	2	25	0.4	0.0-0.9
Unid. Alcid	1	12	0.3	0.0-0.7
Total Birds	8	-	2.2	1.8-2.7
JUNE (12 transects, 20.0 Km2 covered)				
Northern Fulmar	10	2	0.5	0.0-1.7
Shearwater	26	5	1.2	0.0-2.6
Fork-tailed Petrel	20	4	1.0	0.0-4.2
Leach's Petrel	83	16	4.0	0.0-14.2
Unid. Storm Petrel	21	4	0.8	0.0-5.3
Unid. Jaeger	1	1	0.1	0.0-0.4
Sabine's Gull	6	1	0.1	0.0-1.8
Murre	1	1	0.1	0.0-0.5
Ancient Murrelet	4	1	0.2	0.0-2.1
Cassin's Auklet	321	62	14.1	0.0-164.2
Rhinoceros Auklet	4	1	0.2	0.0-1.1
Tufted Puffin	9	1	0.4	0.0-2.2
Unid. Alcid	7	1	0.3	0.0-3.7
Total Birds	513	-	23.4	1.0-186.3

Table 2 (continued).

SPECIES	NUMBER OF BIRDS	RELATIVE ABUNDANCE (%)	$\bar{X}$ TRANSECT DENSITY (BIRDS/KM2)	RANGE OF TRANSECT DENSITIES
AUGUST (2 transects, 4.4 Km2 covered).				
Black-footed Albatross	2	12	0.4	0.0-0.4
Fork-tailed Petrel	1	6	0.2	0.0-0.4
Leach's Petrel	10	59	2.2	0.9-3.6
Unid. Storm Petrel	3	17	0.7	0.0-0.9
Unid. Jaeger	1	6	0.2	0.0-0.4
Total Birds	17	-	3.8	1.8-5.9

TABLE 3. Seabird abundance in Shelfbreak waters of Southeast Alaska.

SPECIES	NUMBER OF BIRDS	RELATIVE ABUNDANCE (%)	$\bar{X}$ TRANSECT DENSITY (BIRDS/KM2)	RANGE OF TRANSECT DENSITIES
MARCH (16 transects, 14.4 Km2 covered)				
Northern Fulmar	31	16	2.2	0.0-7.5
Glaucous-winged Gull	14	7	1.0	0.0-6.3
Herring Gull	1	1	0.1	0.0-1.1
Kittiwake	119	62	7.8	0.0-55.5
Unid. Gull	10	5	0.7	0.0-5.5
Murre	1	1	0.[illegible]	0.0-1.1
Tufted Puffin	3	2	0.2	0.0-1.1
Unid. Alcid	7	3	0.5	0.0-2.5
Unid. Bird	4	2	0.3	0.0-4.4
Total Birds	190	-	13.3	1.1-65.5
SEPTEMBER (2 transects, 5.7 Km2 covered)				
Black-footed Albatross	4	12	0.5	0.0-1.1
Northern Fulmar	6	17	1.0	0.9-1.1
Shearwater	4	12	1.0	0.0-1.9
Fork-tailed Petrel	14	41	2.0	0.0-3.9
Unid. Jaeger	1	3	0.2	0.0-0.5
Herring Gull	1	3	0.2	0.0-0.5
Kittiwake	1	3	0.2	0.0-0.5
Arctic Tern	1	3	0.2	0.0-0.5
Hybrid Gull	1	3	0.2	0.0-0.5
Tufted Puffin	1	3	0.2	0.0-0.5
Total Birds	34	-	5.9	5.7-6.1

Table 4. Seabird abundance in continental shelf waters of Southeast Alaska

SPECIES	NUMBER OF BIRDS	RELATIVE ABUNDANCE (%)	$\bar{X}$ TRANSECT DENSITY (BIRDS/KM2)	RANGE OF TRANSECT DENSITIES
FEBRUARY (12 transects, 32.8 Km2 covered)				
Unid. Loon	1	1	0.1	0.0-0.3
Northern Fulmar	131	51	4.1	0.3-23.2
Glaucous-winged Gull	17	6	0.5	0.0-1.6
Herring Gull	4	2	0.1	0.0-0.8
Hybrid Gull	1	1	0.1	0.0-0.3
Kittiwake	36	14	1.1	0.0-2.4
Unid. Gull	3	1	0.1	0.0-0.4
Murre	52	20	0.8	0.0-6.4
Horned Puffin	1	1	0.1	0.0-0.3
Unid. Alcid	4	2	0.1	0.0-0.8
Unid. Bird	2	1	0.1	0.0-0.4
Total Birds	252	-	7.8	1.1-25.7
MARCH (8 transects, 6.6 Km2 covered)				
Black-footed Albatross	1	2	0.2	0.0-1.3
Northern Fulmar	24	43	3.7	0.0-11.3
Glaucous-winged Gull	1	2	0.2	0.0-1.3
Herring Gull	2	4	0.3	0.0-1.1
Kittiwake	18	33	2.6	0.0-7.5
Unid. Gull	6	11	0.9	0.0-3.7
Unid. Alcid	3	5	0.4	0.0-2.2
Total Birds	55	-	8.4	4.4-12.5
APRIL (16 transects, 9.0 Km2 covered)				
Unid. Loon	1	1	0.1	0.0-1.7
Black-footed Albatross	+	+	+	+
Shearwater	8	3	0.7	0.0-6.7
Black Brant	15	5	1.2	0.0-18.7
Pintail	169	57	11.6	0.0-101.0
Pectoral Sandpiper	25	8	2.6	0.0-41.7
Glaucous-winged Gull	11	4	1.1	0.0-11.7
Herring Gull	3	1	0.2	0.0-1.3
Kittiwake	5	2	0.4	0.0-6.3
Unid. Gull	1	1	0.0	0.0-1.7
Murre	4	1	0.3	0.0-2.5
Marbled Murrelet	10	3	0.6	0.0-10.0
Kittlitz's Murrelet	2	1	0.1	0.0-2.0
Cassin's Auklet	26	9	1.6	0.0-23.0
Unid. Alcid	13	4	0.9	0.0-7.5
Total Birds	293	-	21.6	0.0-126.0

Table 4 (continued)

SPECIES	NUMBER OF BIRDS	RELATIVE ABUNDANCE (%)	$\bar{X}$ TRANSECT DENSITY (BIRDS/KM2)	RANGE OF TRANSECT DENSITIES
MAY (2 transects, 0.7 Km2 covered)				
Shearwater	10	35	7.5	5.0-10.0
Herring Gull	9	31	6.9	6.7-7.1
Kittiwake	7	24	5.2	3.3-7.1
Arctic Tern	3	10	2.5	0.0-5.0
Total Birds	29	-	22.1	20.0-24.3
SEPTEMBER (1 transect, 1.8 Km2 covered)				
Northern Fulmar	3	20	1.7	-
Shearwater	9	60	4.9	-
Kittiwake	2	13	1.1	-
Unid. Murrelet	1	7	0.5	-
Total Birds	15	-	8.3	-
NOVEMBER (1 transect, 1.4 Km2 covered)				
Northern Fulmar	2	40	1.4	-
Kittiwake	1	20	0.7	-
Murre	2	40	1.4	-
Total Birds	5	-	3.5	-

Table 5. Seabird abundance in inside passage waters of Southeast Alaska.

SPECIES	NUMBER OF BIRDS	RELATIVE ABUNDANCE (%)	$\bar{X}$ TRANSECT DENSITY (BIRDS/KM2)	RANGE OF TRANSECT DENSITIES
FEBRUARY (18 transects, 44.7 Km2 covered)				
Common Loon	1	1	0.1	0.0-0.3
Unid. Loon	2	1	0.1	0.0-0.9
Pelagic Cormorant	3	1	0.1	0.0-1.1
Unid. Cormorant	18	2	0.5	0.0-3.6
Emperor Goose	1	1	0.1	0.0-0.3
Common Merganser	3	1	0.1	0.0-0.7
Red-breasted Merganser	2	1	0.1	0.0-0.7
Unid. Merganser	3	1	0.1	0.0-1.1
Unid. Duck	2	1	0.1	0.0-0.3
Bald Eagle	1	1	0.1	0.0-0.9
Glaucous-winged Gull	61	6	1.2	0.0-16.1
Herring Gull	33	3	0.7	0.0-3.2
Mew Gull	175	17	3.5	0.0-23.2
Und. Gull	181	17	3.7	0.0-55.0

Table 5 (continued)

SPECIES	NUMBER OF BIRDS	RELATIVE ABUNDANCE (%)	$\overline{X}$ TRANSECT DENSITY (BIRDS/KM2)	RANGE OF TRANSECT DENSITIES
Murre	422	41	13.1	0.0-95.5
Marbled Murrelet	33	3	0.7	0.0-6.1
Ancient Murrelet	3	1	0.1	0.0-1.1
Cassin's Auklet	6	1	0.1	0.0-2.1
Tufted Puffin	2	1	0.1	0.0-0.7
Unid. Alcid	67	7	1.6	0.0-10.7
Unid. Bird	2	1	0.1	0.0-0.7
Total Birds	1021	-	25.7	1.1-125.5
MARCH (19 transects, 24.0 Km2 covered)				
Northern Fulmar	1	1	0.1	0.0-0.8
Fork-tailed Petrel	4	1	0.1	0.0-1.5
Pelagic Cormorant	3	1	0.1	0.0-2.1
Glaucous-winged Gull	11	4	0.5	0.0-3.3
Herring Gull	26	9	1.0	0.0-10.7
Mew Gull	51	17	2.2	0.0-18.3
Unid. Gull	4	1	0.1	0.0-1.0
Murre	181	61	7.5	0.0-89.3
Ancient Murrelet	1	1	0.[illegible]	0.0-0.8
Cassin's Auklet	+	+	+	+
Unid. Alcid	11	4	0.5	0.0-4.0
Total Birds	293	-	13.1	0.0-90.8
APRIL (0 transects, 2 periods of general observations)				
Surf Scoter	+	+	+	+
Unid. Phalarope	+	+	+	+
Mew Gull	+	+	+	+
Bonaparte's Gull	+	+	+	+
Unid. Gull	+	+	+	+
Arctic Tern	+	+	+	+
Unid. Alcid	+	+	+	+
MAY (1 transect, 1.1 Km2 covered)				
Common Loon	1	14	0.9	-
Glaucous-winged Gull	1	14	0.9	-
Marbled Murrelet	4	58	3.6	-
Kittlitz's Murrelet	1	14	0.9	-
Total Birds	7	-	6.4	-
AUGUST (3 transects, 4.4 Km2 covered)				
Unid. Gull	1	17	0.2	0.0-0.7
Murre	5	83	1.2	0.0-3.6
Total Birds	6	-	1.4	0.0-3.6

Table 5 (continued).

SPECIES	NUMBER OF BIRDS	RELATIVE ABUNDANCE (%)	$\overline{X}$ TRANSECT DENSITY (BIRDS/KM2)	RANGE OF TRANSECT DENSITIES
SEPTEMBER (5 transects, 9.7 Km2 covered)				
Arctic Loon	1	1	0.1	0.0-0.5
Unid. Loon	1	1	0.0	0.0-0.5
Fork-tailed Petrel	6	7	0.7	0.0-2.8
Pelagic Cormorant	2	3	0.2	0.0-1.1
Unid. Cormorant	1	1	0.1	0.0-0.5
Unid. Scoters	9	10	0.9	0.0-4.2
Unid. Ducks	3	4	0.3	0.0-1.7
Glaucous-winged Gull	17	19	1.7	0.0-3.3
Herring Gull	5	6	0.5	0.0-1.4
Mew Gull	2	2	0.2	0.0-0.5
Kittiwake	8	9	0.9	0.0-1.7
Unid. Gull	1	1	0.1	0.0-0.5
Murre	23	26	2.4	0.0-9.5
Marbled Murrelet	9	10	1.0	0.0-5.0
Total Birds	88	-	9.2	3.1-15.3
OCTOBER (4 transects, 10.1 Km2 covered)				
Glaucous-winged Gull	50	47	3.3	0.0-10.0
Herring Gull	1	1	0.2	0.0-0.5
Mew Gull	1	1	0.2	0.0-0.3
Kittiwake	16	15	2.2	0.0-5.0
Oldsquaw	3	3	0.5	0.0-1.5
White-winged Scoter	1	1	0.2	0.0-0.5
Surf Scoter	12	11	2.0	0.0-2.6
Murre	23	21	2.7	0.0-5.0
Total Birds	107	-	11.5	4.7-10.0
DECEMBER (7 transects, 14.7 Km2 covered)				
Unid. Loon	1	1	0.1	0.0-0.5
Unid. Cormorant	1	1	0.1	0.0-0.5
Unid. Eider	1	1	0.1	0.0-0.5
Glaucous-winged Gull	6	7	0.4	0.0-1.4
Herring Gull	9	10	0.2	0.0-2.4
Unid. Murrelet	72	80	4.9	0.0-33.3
Total Birds	90	-	6.1	0.0-36.2

Contract: 01-5-022-2538
Research Unit: 341
Period: April 1 - June 30, 1978
Principal Investigator: Calvin J. Lensink

QUARTERLY REPORT

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

By

Gerald A. Sanger and Patrick J. Gould
Study Leaders

RU 341 Study Leaders

P. J. Gould
Seabirds and Seabird Habitat

R. E. Gill, Jr.
Shorebirds, Waterfowl and Estuarine Habitat

G. A. Sanger
Feeding Ecology and Trophic Relationships

R. D. Jones, Jr.
Habitat Effects and Special Studies

U. S. Fish and Wildlife Service
Office of Biological Services - Coastal Ecosystems
1011 E. Tudor Rd.
Anchorage, Alaska 99503

I. ABSTRACT OR HIGHLIGHTS OF QUARTERS ACCOMPLISHMENTS

Field camps have been established at Chisik Island, Sitkalidak Island, Middleton Island and Chiniak Bay. Breeding biology studies have begun at these camps and will continue through the summer field season. Preparation of the CATALOG OF ALASKAN SEABIRD COLONIES continues with a projected completion date of October, 1978.

In the studies of feeding ecology, the final collection of birds wintering in Lower Cook Inlet (Kachemak Bay) was obtained in early April. We participated in six of the first seven cruises aboard the charter vessel Commando as part of the integrated Kodiak Food Web Project.

Laboratory analyses of all stomachs from the winter study in Lower Cook Inlet were completed during the quarter, except for verification of the identity of a few prey species. Analysis of our winter stomach samples from Kodiak (Chiniak Bay) was completed, as were collections from the Kodiak Food Web Project through cruise four of the Commando. Analyses of stomach samples from a diminishing backlog of pre-1977 "minor species" was continued.

The computer format for "Marine Bird Specimen and Feeding Studies" was brought near final approval by NODC, and after delays in keypunching contract arrangements, we began getting our considerable backlog of bird feeding habits data keypunched.

II. TASK OBJECTIVES

A. Colony Studies

The colony work is directed toward obtaining baseline data on the breeding biology of important seabird species. The most important data being collected includes: colony size, breeding chronology, clutch size, productivity, growth rates, food habits, and habitat use. The major species being studied at each camp include: Black-legged Kittiwake (all colonies), Tufted Puffin (Chiniak and Sitkalidak), Horned Puffin (Chisik), Pelagic Cormorant (Middleton and Chiniak), Red-faced Cormorant (Chiniak), Glaucous-winged Gull (all colonies). Other species being investigated under lower priority status include: Mew Gull, Arctic Tern, Aleutian Tern, Common Murre, Pigeon Guillemot, Common Eider, Rhinoceros Auklet, Black Oystercatcher.

B. Colony Catalog

The colony catalog is being completed by Arthur Sowls and will be printed at Fort Richardson, the equivalent of the U. S. Government Printing Office in Alaska.

C. Feeding Ecology and Trophic Relationships

The major objectives during this quarter for the feeding studies were to analyze stomach samples, implement an internal data management and analysis plan, to finish field work for our winter study of the feeding ecology of birds in Lower Cook Inlet, to conduct field work in the Kodiak Food Web Project, and to begin to integrate and analyze past feeding data from the colony and pelagic studies.

III. FIELD AND LABORATORY ACTIVITIES

A. Field Trip Schedules and Scientific Parties

All scientific personnel engaged in the colony and shipboard studies are permanent or temporary employees of the U. S. Fish and Wildlife Service, Office of Biological Services - Coastal Ecosystems. The field camps were occupied as follows:

Sitkalidak Island, 8 May: Patricia Baird (work leader), Martha Hatch (field assistant). Additional short-term work was conducted by Douglas Forsell, Valerie Hironaka and Art Sowls.
Chisik Island, 15 May: Robert Jones (work leader), Margaret Petersen (co-leader).
Chiniak Bay, 15 May; David Nysewander (work leader), Bruce Barbour (field assistant). Additional short-term work was conducted by Anthony DeGange.
Middleton Island, 28 April: Scott Hatch (work leader), Tom Pearson (field assistant). Short-term work was conducted by Patrick Gould.

Logistics support in setting up the Sitkalidak camp was provided by the R/V Commando. Table 1 indicates the dates, personnel and summarized activities in the shipboard field work. We made one collecting trip to Kachemak Bay early in the quarter and participated in six of the seven cruises on the charter vessel Commando in the Kodiak Food Web Study. In the Kachemak Bay study, we utilized a FWS, 22' MonArk skiff for collecting. As in the preceding quarter, this project took four days to complete, including two days driving between Anchorage and Homer and two days of actual collection.

Table 1. --Dates, scientific parties and activities of shipboard field operations, quarter ending 30 June 1978.

Field Operation and Cruise Numbers	Dates	Personnel	Activities[1] and Area
FW8-005 April Kachemak Bay. MonArk Skiff	4-5 April	Robert Jones (Work Leader), David Nysewander (Assistant)	C; FB. Kachemak Bay, Lower Cook Inlet
FW8-006 *Commando* Cruise 1	3-8 April	Gerald A. Sanger (Work Leader), David Wiswar (Assistant)	C;FB; T. Kiliuda Bay, Kodiak Area
FW8-007 Commando Cruise 3	20-27 April	Gerald A. Sanger (Work Leader), Douglas J. Forsell (Assistant)	C; FB; T. Izhut & Kiliuda Bays, Kodiak
FW8-008 Commando Cruise 4a	28 April-18 May	Douglas J. Forsell (Work Leader), Valerie F. Hironaka (Assistant)	C; FB; T; FC. Izhut & Kiliuda Bays, Kodiak. Includes collecting in Sitkalidak area after cruise.
FW8-014 Commando Cruises 4b & 5	23 May-11 June	Gerald A. Sanger (Work Leader), Lynne D. Krasnow (Assistant)	C; FB; T; FC. Kiliuda, Izhut, Kiliuda.
FW8-015 Commando Cruises 6 & 7a	12 June-July 3	Douglas J. Forsell (Work Leader), David Wiswar (Assistant)	C; FB; T; FC. Izhut, Kiliuda, Izhut

[1] C = collecting; FB = observations of feeding/foraging behavior and areas; T = transect counts; FC = observations of feeding/foraging cycles (see methods).

B. Methods

Field methods on the colonies are the same as those used in previous years (see RU341 annual reports for 1976-1977). In general this field work is conducted by establishing study plots and marking individual nests and birds. Basic data on each aspect of the birds' breeding biology is checked at least every five days and frequently every two days depending on the specific requirements of each species and each chronological event.

Our work aboard the Commando was a part of the Kodiak Food Web Project. It included, in descending order of priority: intensive collections of birds in Izhut Bay and Kiliuda Bay for feeding habits data; observing and documenting foraging behavior and areas; and, conducting transect counts to determine distribution and abundance in relation to distribution and abundance of prey. Field methods generally followed those described in earlier reports.

In addition, after cruise 4 of the Commando and following each subsequent cruise, personnel disembarked the vessel at the Sitkalidak Island field camp to conduct foraging cycle studies in the Sitkalidak-Kiliuda area. This project was designed to determine the feeding and other activity cycles of Black-legged Kittiwakes and Tufted Puffins.

Outer Right Cape at the northern entrance to Sitkalidak Strait is uniquely situated to monitor puffin and kittiwake movements. From a point on the south side of the cape there is a clear view of the open ocean for an arc of 120°; the site lies two miles from, and nearly in direct sight of the Boulder Bay kittiwake colony, and it also has a clear view across the north entrance of Sitkalidak Strait (Figure 1). The Boulder Bay kittiwake colony (ca. 50-100,000 birds) is the largest in the Kodiak area, but it has received virtually no study beyond sporadic counts of the numbers of birds on the cliffs.

From Outer Right Cape the timing and direction of kittiwake movements toward and away from the colony can be monitored by observing the birds through a spotting scope aimed across the bay. Similarly, the movements of kittiwakes and Tufted Puffins in the mouth of Sitkalidak Strait can be observed from the same site by aiming the scope toward Cape Barnabas on the far side of the strait. These latter birds probably originate on one of several colonies in Kiliuda Bay. Thus, from the same site, movements of the two most abundant species of marine birds breeding in the Kodiak area, and from two major colony areas may be monitored.

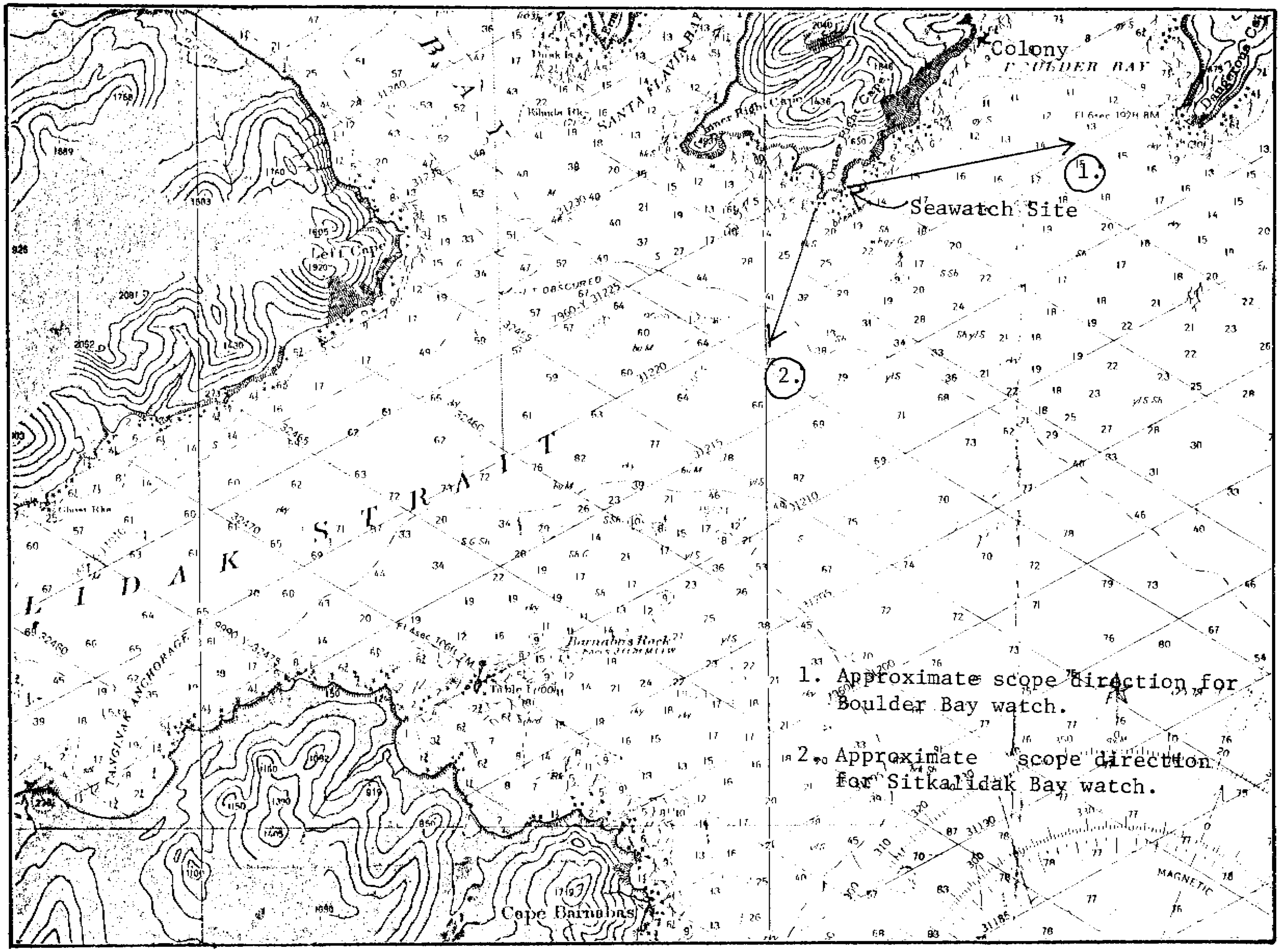


Figure 1.—Location of special seawatch project at Outer Right Cape, Sitkalidak Strait, to monitor foraging and other activity cycles of Black-legged Kittiwakes and Tufted Puffins.

The methods were straightforward: for a/48-hour period, the numbers of kittiwakes flying toward and away from the Boulder Bay colony, as seen through a 20-power spotting scope aimed toward Dangerous Cape, were counted for ten minutes each hour from dawn until dusk. The counts were divided along an imaginary line running seaward from the colony to distinguish birds flying north-south and east-west. Immediately afterward, a similar count of kittiwakes and Tufted Puffins was made by aiming the spotting scope toward Cape Barnabas.

Numbers of birds were tallied by species and direction of flight (i.e., "in" or "out") as they were observed on a five-place laboratory counter.

The data will be used to monitor the timing of diurnal movements toward and away from the colonies, to generally locate foraging areas (inferred from Boulder Bay kittiwakes by flight direction), and they will be used to estimate total numbers of birds leaving and arriving at a colony in each 24-hour period. By comparing this information with similar data gathered in Sitkalidak Strait near Cathedral Island by FWS personnel from the Sitkalidak field camp (Pat Baird), we will be able tc determine if synchrony in bird movements exists in two different parts of the study area.

Laboratory methods generally followed those described in previous reports.

C. Sample Locations

The locations of our colony study camps is noted in Figure 2. Our collecting work aboard the Commando was concentrated in Izhut and Kiliuda Bays, but we conducted transect counts in all areas that the vessel worked, i.e., between Izhut Bay and Kaiugnak Bay, depending on cruise.

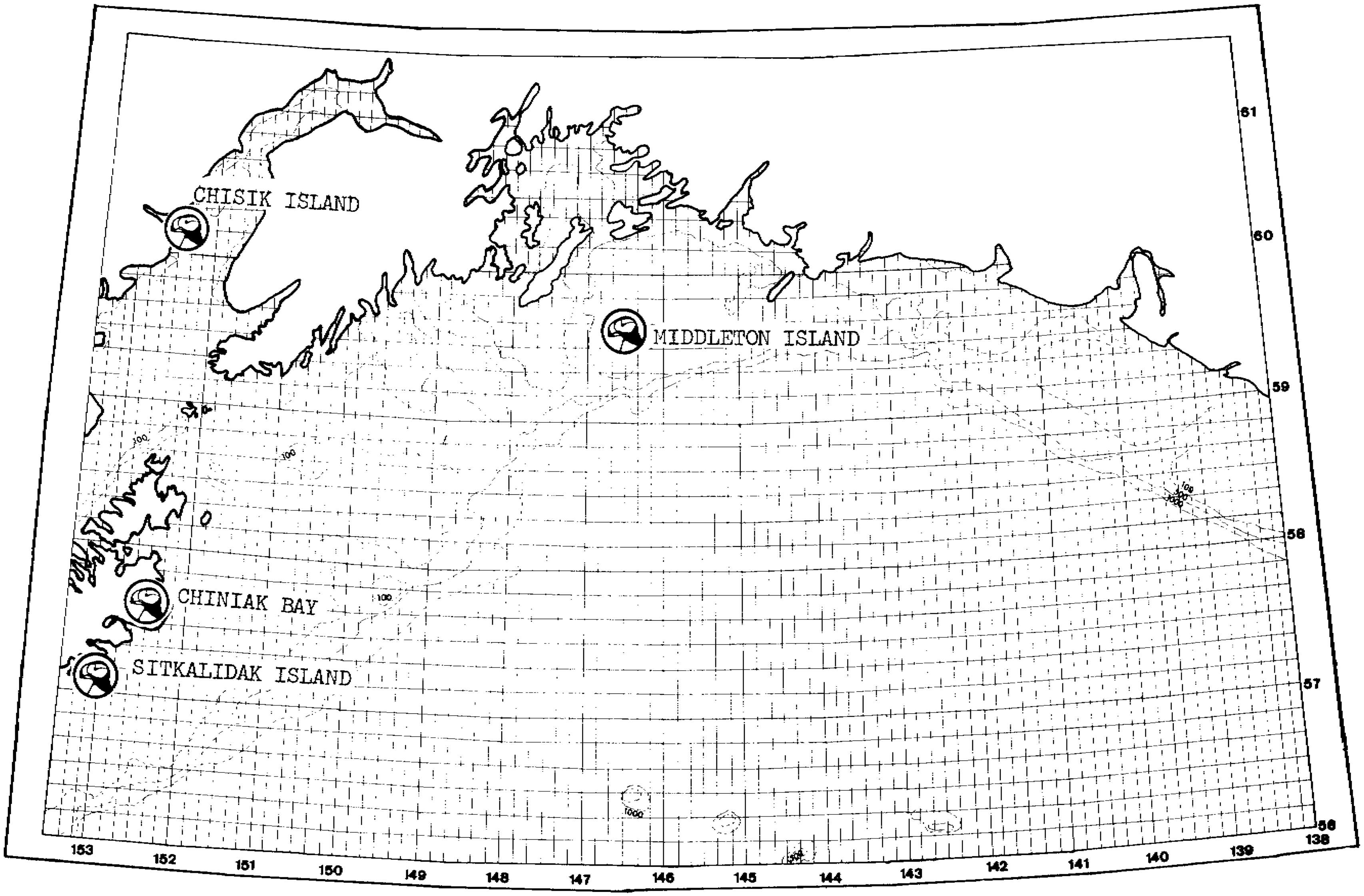


Figure 2. Locations of the four field camps established for colony studies in 1978.

D. Data Collected and Analyzed

During the quarter, stomach samples were analyzed as follows:

Cruise or Study Area	Number of Stomachs
Kachemak Bay, Winter	127
Kodiak (Chiniak Bay), Winter	58
Commando Cruise 1	15
Commando Cruise 3	32
Commando Cruise 4a	32
Yankee Clipper (1977), "minor species"	40

Work was accomplished by Valerie Hironaka, Alan Fukuyama and David Wiswar. A limited amount of work in the lab was done by Clara Lopez (special work program through the Municipality of Anchorage at no cost to the OCSEAP) and Sanger (amphipod identification).

During the April collecting trip in Kachemak Bay noted above, these birds were collected:

Common Murre	5	White-winged Scoter	5
Marbled Murrelet	5	Black Scoter	1
Pigeon Guillemot	1	Surf Scoter	2
		Oldsquaw	2

Birds collected during the Commando cruises are noted by area and date in Table 2.

E. Data Management

Working with Marcy Butcher of the Juneau Project Office, Sanger spent considerable time bringing the Marine Bird Specimen and Feeding Studies data format (File Type 031) in shape for final approval by NODC. Getting a working format in operation has been a continuing concern, since analyses of our growing amount data depends on a working ADP system.

We plan on doing all or most of our computerized analysis of feeding ecology data in-house. Our existing data is on two separate, but similar, formats. Translation programs will be written for these for submission of our data in the NODC-approved format.

IV. RESULTS

Results of the feeding studies will not be available until laboratory

Table 2. --Birds collected for feeding habits studies in the Kodiak Food Web Project aboard the R/V Commando April-June 1978. The U. S. Fish and Wildlife Service did not participate in cruise 2.

Bird Species	Cruise 1	Cruise 3		Cruise 4		Cruise 5			Cruise 6		Cruise 7a	TOTALS
	Kiliuda 4-6 April	Izhut 21-22 April	Kiliuda 23-25 April	Izhut 3-4 May	Kiliuda 14-19 May	Kiliuda 24-27 May	Izhut 1-2 June	Kiliuda 4-5 June	Izhut 12-16 June	Kiliuda 19-21 June	Izhut 27-28 June	
Black-legged Kittiwake	1	1	1			6	7	6	12	9	13	56
Tufted Puffin			2	13	6	13	6	4	11	11	9	75
Common Murre	7	4	1		7	10	7	4		5	6	51
Sooty Shearwater							12	5	17	8	10	52
Short-tailed Shearwater						5			1			6
Marbled Murrelet		3		3	5	1	7	6	6	5	2	38
Pigeon Guillemot		7	6	4			3		2	1	2	25
Pelagic Cormorant		3	1	1			1					6
Red-faced Cormorant				1								1
Oldsquaw	5	2										7
White-winged Scoter			1	2								3
Black Scoter	1											1
Horned Grebe	1											1
Northern Fulmar							1					1
Glaucous-winged Gull						2						2
Aleutian Tern										1		1
Rhinoceros Auklet									1			1
Kittlitz's Murrelet						2						2
TOTALS	15	20	12	24	18	39	44	25	50	40	42	329

analysis of stomach contents are completed. However, it is possible to make a few general comments on the birds in the Kodiak area based on our direct observations in the field.

During the first two cruises aboard the Commando in April, the avifauna was still largely of a winter species composition. Scoters, particularly White-winged Scoters, Oldsquaw and Common Murres were abundant in Kiliuda Bay, Sitkalidak Strait, southern Marmot Bay and in shallow areas of Izhut Bay. The large breeding populations of Tufted Puffins and Black-legged Kittiwakes were not evident in numbers until late April in Kiliuda Bay and in early May in Izhut Bay. By then, all but a few of the wintering scoters and oldsquaw had departed.

Based on a few stomachs opened in the field for preliminary examination, most of the birds in the Kiliuda area from May through mid June were feeding on euphausiids; these included kittiwakes, Glaucous-winged Gulls, and to a lesser extent, Tufted Puffins. Common Murres contained Capelin, but not euphausiids. Puffins and murres also foraged on capelin, but kittiwakes ate only euphausiids. However, in late June kittiwakes in Izhut Bay were eating capelin and/or sandlance, but these prey still were not evident in kittiwakes from Kiliuda then.

There has been a marked contrast in the occurrence of shearwaters compared to last year. Only once this year (late May) have Short-tailed Shearwaters been abundant. A flock of several tens of thousands occurred off Cape Barnabas in the Sitkalidak area. They were feeding heavily, and all five of the birds collected from this flock contained euphausiids. A few days later, Sooty Shearwaters were abundant in the Izhut area, but there were no Short-tails. Two days after this, in the same area we had seen and collected the Short-tailed Shearwaters, Sooties were abundant, but there were no short-tails present. Capelin were present in the sooties taken from both areas. Curiously, in an early morning collection of sooties in Izhut, following mid-day and evening collections of birds containing nothing but Capelin, they were full of euphausiids but had no Capelin.

Sooties remained abundant in the Kodiak area through the end of June. Of several hundred individual birds seen at very close range (within 20-30 feet) while collecting from the skiff, none were identified as short-tails through late June, and even then only a few were seen among the thousands of "sooties". Through this time last year, the situation was reversed, with Short-tails being very much the dominant species of the two shearwaters.

While euphausiids were a major food source in May and early June, it appeared that by mid June they had become unavailable to the birds. Last year Capelin became prominent in the birds' diets in June. This year, it seems that capelin became abundant in Izhut bay in June with unusually large flocks of kittiwakes, Tufted Puffins and Sooty Shearwaters feeding on them. In Kiluida Bay there seemed to be relatively few capelin available, especially to the surface feeding kittiwakes. This suggests the capelin may be staying below the surface 1-2 meters out of range of surface plungers, or perhaps are in very low densities throughout the area. Further analysis of stomachs and data from the other investigators should explain this phenomenon.

We have been monitoring a possible pioneering colony of Common Murres at Inner Right Cape, Sitkalidak Strait. In our reconnaisance surveys of the Kiliuda-Sitkalidak area in 1976, Common Murres were very rare. The few we did see were all single birds off the outer coast. Last year, Common Murres were the third most abundant species seen during transect counts in the bays. Up to 10 to 20 birds were noted roosting on ledges at Inner Right Cape, and generally staying in the proximity to the kittiwake colony there. This year, 300-400 Common Murres have been in evidence rafting on the water below the cliffs at Inner Right Cape each time we have gone by, or they have been circling in front of the cliffs, occasionally approaching the ledges as if to land. None were actually seen landing, however, and the most seen roosting at any one time was about eight.

A phenomenon perhaps related to this, is the greater proportion of adult birds in the Common Murres collected this year. Forty-four of the 45 Common Murres collected last year were sub-adults, while the proportion this year has been nearly equally divided between adults and sub-adults. Presumably, sub-adult birds are more inclined to pioneer a new area than adults.

We will continue to monitor the presence and behavior of the Common Murres at Inner Right Cape each time we are in the area. Any evidence of the ability of this species to colonize or re-colonize suitable habitat will be of significance for evaluating the potential recovery of populations following losses due to oil spills or other anthropogenic or natural causes.

V. AUXILIARY MATERIAL

None.

VI. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES

There have been no major problems and we have changes to recommend at this time.

Aboard the Commando, an early problem with an inadequate collecting skiff was alleviated when the Juneau Project Office secured a 14' Boston Whaler for our use. Although the Whaler has posed some minor problems when towed behind the Commando, between bays, it has proven to be outstandingly stable, maneuverable and seaworthy. It has been ideal as a collecting skiff. The minor problem has stemmed from the fact that Whalers are not made for extended towing behind a larger vessel, and the flimsy rub rail cannot withstand even minor banging against the Commando without damage. However, this situation has been remedied by our placing a heavy duty automobile tire around the vulnerable bow of the Whaler, and by the vessel and scientific crews becoming more aware of the special precautions necessary to avoid damage. This has included placing more hull bumpers around the Commando than "normal", and having someone standing by when maneuvering, starting or stopping the Commando.

The interdisciplinary work aboard the Commando has generally gone well, and we have experienced good cooperation and rapport with the FRI zooplankton people and the vessel crew. In particular, Mr. Biff Bermingham, the Party Chief, has been outstandingly cooperative and helpful during the cruises.

If the interdisciplinary approach can be faulted from the standpoint of the bird work, it would be in not having enough time to do as much as we would like. Due to bad weather and scarcity of birds on some of the cruises, we have sometimes had to settle with fewer birds in our collections than we would have liked. With more time to spend in a given bay, say twice what we have been spending, we likely could have secured adequate collections by spending more time hunting for the scarce birds and by waiting out bad weather before moving to the next bay. There has been a necessary emphasis on collecting due to the limited time in each bay, sometimes only one and a half to two days. As a result, the general observations of foraging behavior made concurrently with collecting from the skiff, and the transect counts from the Commando within and between bays, have suffered in some instances.

We mention this not in complaint, but as our assessment of the interdisciplinary approach to field work from the same platform. We recognize the need for sticking to a schedule and the concurrent give and take necessary in such an interdisciplinary operation. However, if such a program is to be repeated next year, we would recommend that the collections of birds be made from shore-based skiffs. We would lose the transect data from the ship with such an approach, but aerial censuses or even counts from the skiff would provide adequate data on populations and the quantity and quality of the collections and observations of foraging would be more than make up for any loss in precision of estimates of populations. The interdisciplinary approach could be maintained by conducting the skiff operations as close as possible in time to the zooplankton/fisheries work from the larger vessel.

Contract 03-5-022-81
Research Unit 356
April 1 to June 30, 1978
2 pages

QUARTERLY REPORT

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

By

A. C. Broad et. al

NO RESULTS PRESENTED

June 29, 1978

QUARTERLY REPORT

Contract #: 03-78-B01-6
Research Unit #: 359
Reporting Period: 1 Apr-30 Jun 1978
Number of Pages: 88

Beaufort Sea Plankton Studies

Rita A. Horner

1 July 1978

I. Abstract-Highlights

Analysis of zooplankton and phytoplankton standing stock and plant pigment samples collected during the 1977 icebreaker cruise has been completed. Annual primary productivity for 1977 was somewhat higher than in 1976, being *ca.* 14 g C m^{-2} yr^{-1} vs. 9 g C m^{-2} yr^{-1} for the Beaufort Sea and 28 g C m^{-2} yr^{-1} vs 18 g C m^{-2} yr^{-1} for the northeastern Chukchi Sea. The same phytoplankton species were present both years with the exception of *Leptocylindrus minimus* Gran that was present in Bering Sea water in 1976.

Between year comparisons of zooplankton species and abundances is difficult because we used different collecting gear due to ice conditions. The 1977 samples support our separation of the zooplankton into categories based on hydrography and life cycle stages.

II. Task Objectives

The objectives of this study are to assess the density distribution and environmental requirements of zooplankton and ichythoplankton in an array of samples of opportunity, and to make index measurements of phytoplankton activity.

III. Field or Laboratory Activities

A. There were no field activities this quarter.

B. Laboratory analysis of zooplankton and phytoplankton samples collected during the 1977 icebreaker cruise (Fig. 1) has been completed. Data analysis and formating are underway. Table 1 lists the number and kinds of samples collected and analyzed.

Table 1. Number and kinds of samples collected and analyzed.

Parameter	Number Collected	Number Analyzed
Temperature	331	331
Salinity	334	334
Primary Productivity	186	186
Chlorophyll *a*, Phaeopigments	334	334
Standing Stock		
Phytoplankton	334	193
Zooplankton		
Bong net	37	37
English umbrella net	8	6

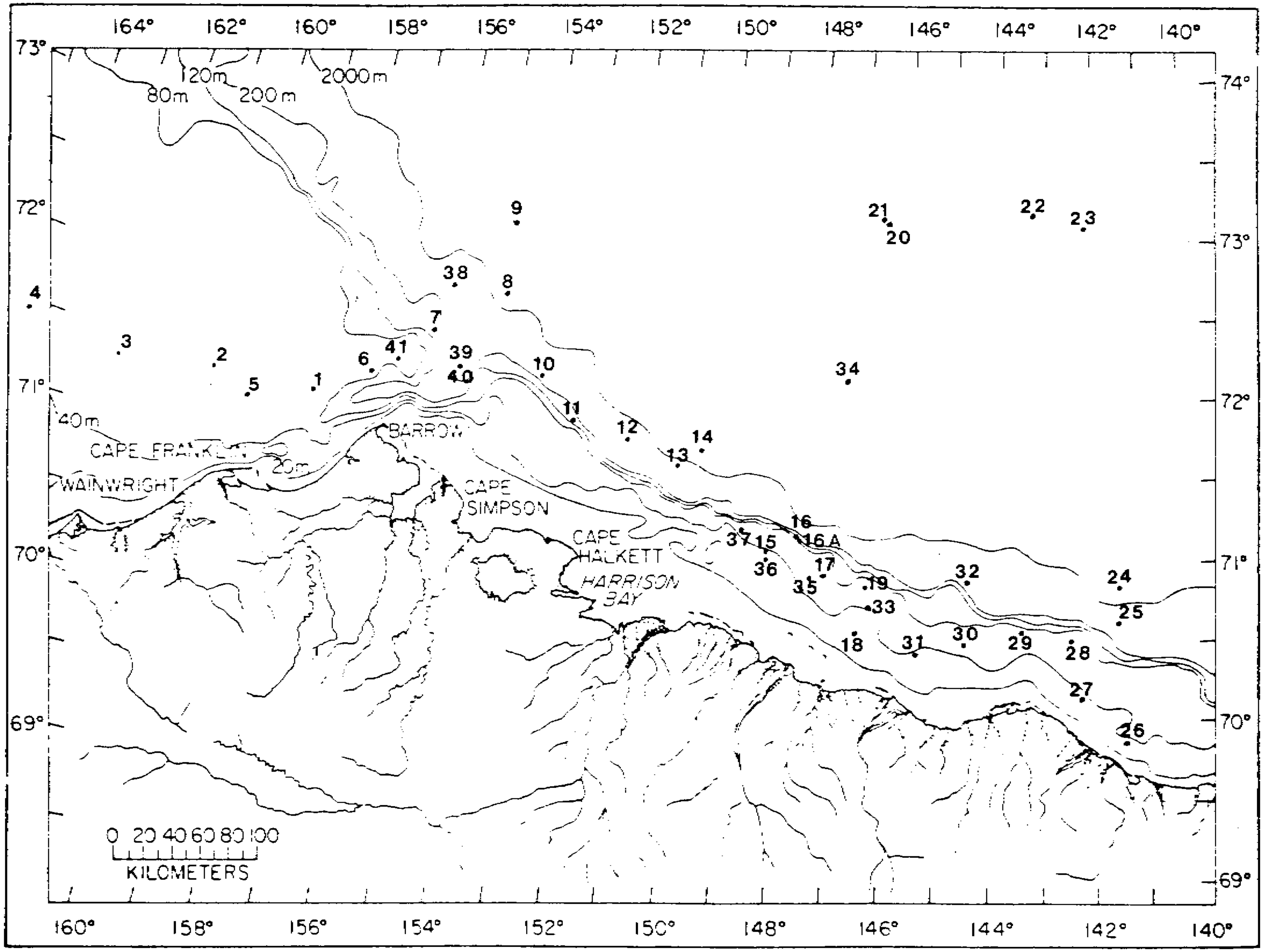


Fig. 1. Study area and station locations, USCGC *Glacier*, 01 Aug to 07 Sep 1977.

C. Methods

Zooplankton samples were first sorted for all specimens of amphipods, shrimps, euphausids, mysids, and fish eggs and larvae. Each sample was then split in a Folsom plankton splitter until a subsample containing about 100 specimens of the most abundant remaining species was obtained. The organisms in the subsample plus all amphipods, shrimps, euphausids, mysids, and fish eggs and larvae were identified and counted using a dissecting microscope. Copepods were not identified to species, but only as numbers of adults and juveniles.

Phytoplankton standing stock samples were analyzed using a Zeiss phase-contrast inverted microscope. Rare and large organisms (> 75 μm) were counted at 125 X magnification in 50 ml chambers, while abundant, small (< 75 μm) organisms were counted at 312 X magnification in 5 ml chambers. The portion of the sample to be counted was determined for each chamber depending on the number of cells present, but usually 1/5 of the 50 ml chamber and 1/8 or 1/10 of the 5 ml chamber was counted.

Chlorophyll *a* and phaeopigment determinations were done using a fluorometer technique (Strickland and Parsons 1968).

D. Milestone Chart and Data Submission Schedule

See p. 4.

E. Acknowledgements

Tom Kaperak assisted with the field work and analyzed the zooplankton samples with help from Marc Weinstein and Melanie Tyler. Dave Murphy identified the shrimp and Leanne Stahl identified the fish eggs and larvae. Melanie Tyler also helped with the pigment analyses. Jerry Hornof did the data processing, including Figs. 2 and 3. Chris White helped with figures and typing.

IV. Results

A. Hydrography

Hydrographic data for stations taken in the Chukchi and Beaufort seas are listed in Table 2; vertical profiles of temperature and salinity are given in Fig. 2. Bering Sea water, indicated by warmer, more saline water was apparently present in the Beaufort Sea only at stations 9, 10, and 11, or to about 153°W.

B. Phytoplankton standing stock

Standing stock samples have been counted for all stations where primary productivity measurements were made. Seventy-six categories from five phyla, including 58 species and 18 other categories including unidentified species and groups of species were present. All the categories have been reported previously from the Chukchi and Beaufort seas (Bursa 1963, 0 - Planned Completion Date

X - Actual Completion Date

RU # 359 PI: Rita A. Horner

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
Reports: Quarterly	X			X						X			0		
Annual							X								
Sample Analysis: Plant pigments	0					X	X	X							
Primary Productivity	0	0			X	X									
Zooplankton									0 X						
Phytoplankton									0 X						
Data Processing: Plant pigments			0						X	X					
Primary productivity				0		X			X	X					
Zooplankton									0 X	0 X					
Phytoplankton									0 X	0 X					
Data Submission: All data submitted													0		
FY 78 Field Effort											X	X			

Table 2. Summary of station locations, hydrography, ice cover, chlorophyll *a* and phaeopigment concentrations, and primary productivity, USCGC *Glacier*, 01 Aug to 07 Sep 1977.

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/∘∘	Chl *a* (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
01	02 Aug	71°91'	157°59'		2	000	5.08	30.24			
						005	4.43	31.66			
						010	4.21	32.09	0.04	0.14	
						015	1.92	32.18	0.22	0.02	
						020	-1.31	32.67	0.13		
						025	-1.46	32.95	4.26		
						030	-1.20	32.89	3.63		
						045	-0.93	33.01	4.74		
02	02 Aug	71°22'	160°04'		0	000	1.77	30.20	0.31	0.02	0.06
						004	1.54				
						007	-0.62	30.90	0.25	0.02	0.05
						011	-1.15	31.29	0.12		0.08
						022	-1.41	32.27	0.43	0.12	0.31
						027	-1.48	32.40	1.82	0.25	1.58
						035	-1.66	32.80	3.06	0.17	1.44
						045	-1.72	33.64	3.72	1.45	1.15
03	03 Aug	71°24'	162°00'	10	0	000	-0.17	28.09	0.26	0.12	0.11
						004	2.10	30.12	0.09	0.13	0.06
						008	2.28	30.30	0.12	0.05	0.10
						014	4.25	31.60	0.08	0.04	0.11
						020	-1.51	32.57	0.45	0.34	0.19
						027	-1.71	33.09	3.82	0.05	2.20
						035	-1.71	33.16	2.80	0.05	0.88
						045	-1.72	33.17	2.89	0.22	0.98

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
04	04 Aug	71°25'	164°00'	8	1	000	-0.14	27.14	0.15	0.04	0.11
						005	1.36	30.50	0.11	0.21	0.09
						010	-0.47	31.77	0.40	0.15	0.29
						015	-1.43	32.32	0.10	0.35	0.06
						020	-1.53	32.49	7.58		4.52
						025	-1.70	32.82	22.94		7.96
						030	-1.70	33.18	9.08	0.22	1.84
						045	-1.74	33.45	0.69	0.16	0.49
05	06 Aug	71°12'	158°22'	9	1	000	1.20	24.26	0.27	0.03	0.08
						010	3.89	31.32	0.10	0.22	0.09
						020	-0.09	31.97	0.34	0.13	0.34
						030	-1.63	32.78	18.80		3.08
						045	-1.62	32.92	15.45		4.20
						060	-1.64	32.86	14.34	0.19	3.63
						075	-1.65	32.87	15.17	0.48	3.79
						100	-1.70	32.92			3.75
06	06 Aug	71°25'	156°56'	11	1	000	2.81	29.38	0.22	0.02	0.16
						010	2.83	30.64	0.20	0.09	0.21
						020	0.13	32.36	0.61	0.27	0.48
						030	-0.21	32.46	0.94	0.25	0.51
						045	1.69	32.47	1.53	0.43	0.55
						060	-0.60	32.49	1.37	0.39	0.56
						075	-0.72	32.51	1.85	0.27	0.68
						100	-1.38	32.69	3.80	0.61	1.25
07	07 Aug	71°46'	155°51'	16	1	000	0.27	27.94	0.22	0.18	0.05
						010	-0.79	30.85	0.15	0.02	0.08
						020	-0.97	31.19	0.11	0.04	0.02
						030	-1.41	31.55	0.74		0.24

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/∘∘	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
						045	-1.29	32.04	1.48	0.20	1.02
						060	-1.26	32.44	1.85	0.01	0.59
						075	-1.08	32.95	1.78	0.20	0.63
						100	-1.61	33.20	1.04	0.19	0.32
08	09 Aug	71°57'	154°33'	15	1	000	1.12	28.22	0.16	0.10	0.09
						010	1.12	29.27	0.18	0.02	0.11
						020	-0.33	30.27	0.25	0.08	0.25
						030	0.85	31.58	0.33	0.12	0.30
						045	-0.50	32.54	0.42	0.47	0.66
						060	-1.24	33.01	0.98	0.20	0.36
						075	-1.29	33.13	0.10	0.04	0.41
						100	-1.66	33.43	0.45	0.14	0.15
						125	-1.50	33.77	0.24	0.15	0.23
						150	-0.95	34.20	0.09	0.69	
						175	0.05	34.70	0.22	0.15	0.12
09	10 Aug	72°24'	154°37'		8	000	-0.73	25.20	0.17	0.13	0.14
						010	-0.63				
						020	0.95	31.80	0.14	0.19	0.23
						030	-1.38	32.29	0.10	0.04	0.04
						045	3.34	32.90	0.19	0.09	0.13
						060	2.34	32.86	0.19	0.16	0.16
						075	1.68	32.92	0.08	0.31	0.18
						100	0.16	33.01	0.24	0.16	0.22
10	10 Aug	71°35'	153°29'		1	000	1.24	29.45	0.19	0.29	0.25
						010	1.02	29.58	0.14	0.48	0.32
						020	3.90	31.95	0.59		0.56
						025	5.19	32.24	0.50	0.03	0.50
						030	5.06	32.33	0.75	0.05	0.63

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl *a* (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
						035	4.81	32.48	0.62	0.02	0.46
						040	5.02	32.58	0.43	0.03	0.36
						045	3.39	32.62	0.19	0.11	0.26
11	11 Aug	71°18'	152°43'		0	000	1.39	29.39	2.12	0.03	0.74
						010	1.35	29.41	0.83	1.25	0.85
						015	1.33	29.45	1.85	0.04	1.37
						020	0.77	30.68	0.12	0.01	2.26
						025	0.83	31.99	1.35	0.05	0.82
						035	1.77	32.57	0.23	0.20	0.24
						045	2.57	32.77	0.18	0.16	0.08
						050	1.15	32.78	0.70	0.24	0.34
12	12 Aug	71°10'	151°30'		0	000	-0.71	28.80	2.42	0.28	1.89
						005	-0.81	29.35	3.75	0.01	1.75
						010	-1.23	31.18	4.40	0.09	2.65
						015	-1.30	32.84	1.70	0.36	1.03
						020	-1.28	32.87	2.02	0.47	1.07
13	13 Aug	71°05'	150°23'		1	000	-1.00	30.29	1.78	0.25	0.99
						005	-1.06	30.35	1.85	0.24	1.20
						010	-1.03	30.31	1.77	0.20	1.37
						015	-1.48	32.67	0.55	0.10	0.56
						020	-1.29	32.81	0.42	0.26	0.28
						025	-1.40	32.82	0.45	0.16	0.29
14	14 Aug	71°10'	150°04'	7	4	000	-0.85	30.95	1.66	0.39	1.22
						005	-1.00	31.32	3.12	0.14	1.83
						010	-0.97	31.71	2.15		3.21
						015	-1.13	31.96	1.99		1.78
						020	-1.45	32.24	0.61	0.10	0.41

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
						025	-1.49	32.33	0.16	0.16	0.11
						030	-1.49	32.54	0.21	0.06	0.07
						040	-1.53	32.86	0.28	0.10	0.20
15	15 Aug	70°38'	148°28'		0-1	000	0.05	31.25	2.59	1.34	2.75
						003	-0.69	31.80	3.50	0.11	2.97
						006	-0.74	31.83	4.14		4.12
						009	-0.94	31.90	5.29		3.81
						012	-0.84	32.13	2.12	1.14	2.57
						015	-1.23	32.13	2.29	1.76	1.51
						018	-1.24	32.13	2.71		1.43
16	17 Aug	70°42'	147°59'		3	000	0.19	31.03	3.49	0.16	
						005	-0.47	31.97	9.99		
						010	-0.98	32.31	1.17	0.13	
						015	-1.12	32.42	1.19	0.16	
						020	-0.98	32.47	1.41	0.11	
						025	-1.21	32.46	1.38	0.02	
16A	17 Aug	70°40'	147°48'	4	2	000	-0.39	30.44	3.40	0.35	
						005	-0.43	32.18	7.77	0.08	
						010	-0.65	32.39	3.19	0.50	
						015	-1.02	32.41	2.44	0.08	
						020	-1.09	32.43	1.83	0.35	
						025	-1.12	32.42	2.25	0.02	
						030	-1.17	32.42	1.83	0.15	
17	18 Aug	70°33'	147°24'	4	2-3	000	-0.15	31.48	7.26	0.18	4.13
						003	-0.16	31.51	8.74		3.94
						006	-0.28	31.55	7.26		5.82
						009	-0.47	31.61	6.32	0.41	4.99

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl *a* (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
						012	-0.50	31.65	6.12	1.22	7.08
						015	-0.64	31.85	7.52		7.35
						020	-0.78	31.98	4.66		6.42
						025	-0.97	32.09	5.00		5.12
18	18 Aug	70°25'	146°41'		0	000	0.90	32.06	2.96	0.39	2.19
						003	0.86	32.06	4.27	0.68	2.06
						006	0.88	32.06	2.45	0.55	2.18
						009	0.82	32.06	3.91	1.13	2.54
						012	0.90	32.06	3.06	0.51	2.57
						015	1.02	32.06	2.70	0.85	1.85
						020	-0.72	32.38	4.69	0.20	3.65
						025	-0.74	32.40	7.57	5.64	3.45
19	19 Aug	70°32'	146°30'	30	0	000	-0.97	26.66	0.14	0.13	
						010	-0.94	28.10	0.05	0.05	
						020	-1.24	30.98	0.07	0.05	
						030	-1.45	31.63	0.10	0.07	
						045	-1.33	31.91	0.05	0.32	
						060	-0.79	32.24	0.06	0.11	
						075	-1.42	32.52	0.05	0.05	
						100	-1.50	32.83	0.02	0.04	
						200	-0.77	34.27	0.02	0.03	
						400	0.47	34.88	0.02	0.02	
						500	0.45	34.90	0.02	0.04	
						600	-0.29	34.91	0.04	0.04	
						700	-0.23	34.91		0.09	
						800	0.03	34.92	0.01	0.02	
						900	-0.04	34.92	0.02	0.03	
						1000	-0.15	34.93	0.01	0.01	

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
20	21 Aug	72°46'	146°23'	42	8	000	1.35	05.02	0.08	0.02	
						010	-0.85	29.76	0.04	0.01	
						020	-1.19	30.71	0.04	0.02	
						030	-1.43	31.45	0.06	0.04	
						045	-1.35	31.74	0.15	0.08	
						060	-1.48	32.10	0.08	0.11	
						075	-1.44	32.44	0.05	0.05	
						100	-1.47	32.76	0.01	0.03	
21	22 Aug	72°47'	146°34'	14	1	000	1.41	24.42	0.11	0.05	
						010	2.15	26.30	0.10	0.06	
						020	-1.14	30.60	0.05	0.03	
						030	-1.42	31.54	0.08	0.03	
						045	-1.50	31.88	0.10	0.10	
						060	-1.44	32.18	0.09	0.06	
						075	-1.42	32.37	0.03	0.04	
						100	-1.50	32.81	0.01	0.03	
22	23 Aug	72°57'	143°20'	21	4	000	2.13	17.72	0.23	0.11	
						010	-0.48	27.01	0.06	0.04	
						020	-0.87	30.93	0.08	0.03	
						030	-1.26	31.82	0.07	0.03	
						045	-1.17	31.82	0.09	0.05	
						060	-1.48	32.17	0.05	0.10	
						075	-1.47	32.42	0.03	0.04	
						100	-1.45	32.78	0.02	0.02	
23	23 Aug	72°54'	142°08'	21	5	000	3.34	21.22	0.17	0.13	
						010	1.16	29.20	0.06	0.01	
						020	-0.65	31.17	0.05	0.07	
						035	-1.45	31.71	0.05	0.06	

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/°°	Chl *a* (mg m^3)	Phaeo (mg m^3)	Prim Prod (mg C m^{-3} hr^{-1})
						050	-1.59	31.95	0.04	0.09	
						075	-1.59	32.43	0.03	0.06	
						100	-1.46	32.76	0.01	0.04	
						3400	-0.28	34.98			
24	25 Aug	70°45'	141°28'	12	0	000	2.59	30.50	0.09	0.06	
						010	2.39	30.54	0.07	0.08	
						020	-1.10	31.65	0.21	0.08	
						030	-1.49	31.92	1.48	0.09	
						045	-1.59	32.18	0.54	0.25	
						060	-1.56	32.43	0.11	0.10	
						075	-1.51	32.63	0.12	0.07	
						100	-1.50	32.95	0.05	0.05	
25	25 Aug	70°32'	141°32'	20	0	000	2.02	30.92	0.25	0.07	
						010	-0.14	31.44	0.50		
						020	-0.73	31.96	5.74	1.20	
						030	-1.04	32.15	2.42	0.23	
						045	-0.85	32.40	1.34	0.11	
						060	-1.43	32.72	0.94	0.19	
						075	-1.48	32.81	0.80	0.21	
						100	-1.49	32.86	0.84	0.19	
26	26 Aug	69°49'	141°31'	5	0	000	2.38	32.52	10.40		8.20
						003	2.36	32.53	8.72		9.72
						006	2.41	32.52	13.59		10.35
						009	2.37	32.53	10.40		8.56
						012	2.33	32.52	18.84		8.30
						015	2.36	32.53	12.76		8.59
						020	0.36	32.76	3.06	0.06	1.71
						025	-0.18	32.79	1.55	0.36	1.40

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl *a* (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
27	26 Aug	70°04'	142°14'	4	0	000	1.27	32.24	5.06	0.21	2.82
						003	1.23	32.34	6.08		2.10
						006	1.26	32.34	4.59		2.93
						009	1.20	32.34	5.82		2.17
						012	1.19	32.34	7.00		2.53
						015	1.21	32.34	4.62		1.86
						020	0.20	32.45	6.84		1.98
						030	-0.33	32.50	8.90	0.68	1.85
28	27 Aug	70°19'	142°32'	13	0	000	1.47	31.22	0.57	0.03	
						005	1.45	31.21	0.44	0.05	
						010	1.47	31.21	0.41		
						015	0.93	32.09	1.58	0.25	
						020	0.55	32.35	4.93		
						025	-1.03	32.56	2.09		
						030	-1.08	32.56	4.24	0.34	
						045	-1.20	32.59	4.43	2.03	
29	28 Aug	70°21'	143°29'		0	000	1.47	31.71	0.76	0.10	0.25
						005	1.45	31.76	0.74		0.25
						010	1.38	32.03	1.26	0.01	0.80
						015	1.61	32.16	1.44		0.53
						020	1.15	32.19	2.39	0.06	1.05
						025	-0.64	32.46	11.03	2.21	5.17
						030	-0.61	32.46	10.40	3.64	4.52
						035	-0.62	32.46	4.77	2.24	4.58
30	28 Aug	70°14'	144°28'	11	0	000	1.37	32.13	0.32	0.23	0.19
						003	1.36	32.13	0.30	0.20	0.36
						006	1.42	32.14	0.37	0.23	0.17
						009	1.36	32.14	0.48	0.05	0.25

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl *a* (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
						012	1.33	32.21	0.30	0.16	0.22
						015	1.35	32.14	0.29	0.19	0.18
						020	-0.76	32.37	4.82	1.75	4.86
						025	-0.80	32.38	13.08	1.47	3.94
31	29 Aug	70°10'	145°32'	5	0	000	1.04	31.39	0.64	0.17	0.31
						003	1.07	31.39	0.45	0.23	0.26
						006	1.09	31.42	0.51	0.13	0.28
						009	1.09	31.52	0.46	0.15	1.44
						012	1.07	31.61	0.29	0.22	0.25
						015	1.30	31.68	0.30	0.30	0.25
						018	1.36	31.71	0.35	0.31	0.37
32	30 Aug	70°39'	145°34'	10	0	000	2.08	29.62	0.10	0.06	
						005	2.08	29.62	0.06	0.09	
						010	2.08	29.65	0.11	0.03	
						015	1.28	31.67	0.21	0.01	
						020	0.56	31.89	0.26	0.13	
						025	-0.84	32.14	5.74		
						030	-0.83	32.29	8.31		
						045	-1.45	32.59	4.20	1.34	
33	30 Aug	70°23'	146°26'		2	000	-0.20	29.82	0.96	0.01	
						003	0.12	30.24	1.02		
						006	0.12	30.86	0.81	0.34	
						009	-0.07	31.40	1.53	0.38	
						012	-0.21	31.40	2.30	0.31	
						015	-0.46	31.55	3.06	1.33	
						020	-0.69	31.63	5.17	0.55	
						025	-0.73	31.64	7.34	1.19	

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl *a* (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
34	31 Aug	71°46'	147°02'	24	0	000	1.04	28.02	0.36	0.08	
						005	1.75	28.99	0.17	0.05	
						010	0.70	29.90	0.20	0.03	
						015	0.59	29.91	0.17	0.05	
						020	0.19	30.54	0.29	0.03	
						025	-1.08	31.46	0.23	0.06	
						030	-1.19	31.55	0.30	0.02	
						045	0.12	32.24	0.55	0.46	
35	01 Sep	70°32'	147°35'	5	3-4	000	0.55	29.89	0.81	0.17	
						003	0.75	30.00	0.49	0.05	
						006	0.53	30.17	1.31	0.40	
						009	0.27	30.23	1.59	0.24	
						012	0.15	32.67	2.35	0.61	
						015	0.04	30.99	3.25	1.03	
36	01 Sep	70°36'	148°26'		1	000	0.66	28.78	0.60	0.04	0.15
						003	1.17	28.87	0.78		
						006	0.90	28.91	0.40	0.03	0.18
						009	0.40	30.07	0.61		0.20
						012	0.21	30.81	0.72	0.22	0.35
						015	-0.26	31.22	3.98	0.17	1.73
						018	-0.27	31.22	3.28	1.22	2.21
37	02 Sep	70°45'	149°03'	11	3	000	0.67	28.45	0.17	0.42	
						003	0.36	28.78	0.48	0.06	
						006	-0.13	29.79	0.21	0.19	
						009	-0.15	30.04	0.33	0.18	
						012	-0.50	30.47	0.40	0.14	
						015	-1.06	31.29	1.29	0.14	
						018	-1.43	31.83	14.54	1.38	

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
38	04 Sep	71°58'	155°43'		0	000	5.96	29.17	0.21	0.29	
						010	6.21	29.23	0.21	0.14	
						020	-1.16	31.70	0.16	0.24	
						030	-1.38	31.93	0.04	0.11	
						040	-1.40	32.10	0.05	0.08	
						050	-1.10	32.27	0.02	0.23	
						075	-1.06	32.68	0.09	0.17	
						100	-1.46	32.98	0.23	0.21	
39	04 Sep	71°30'	155°12'	9	0	000	7.97	29.62	0.73	0.30	
						003	8.07	28.63	0.76	0.27	
						006	8.47	28.98	1.02	0.15	
						009	8.54	28.97	0.73	0.23	
						012	8.37	29.03	0.58	0.32	
						015	8.42	29.15	0.75	0.26	
						018	8.35	29.21	0.52	0.23	
						021	7.83	29.37	0.69	0.21	
40	04 Sep	71°30'	155°13'	6	0	000	8.57	29.03	1.18	0.20	
						003	8.58	29.13	1.17	0.29	
						006	8.59	29.02	1.11	0.16	
						009	8.57	29.02	0.86	0.28	
						012	8.50	29.04	0.64	0.28	
						015	8.48	29.13	0.85	0.21	
						018	8.50	29.18	0.62	0.31	
						021	8.51	29.21	0.73	0.24	
41	05 Sep	71°32'	156°30'	9	0	000	3.56	27.67	0.19	0.13	
						010	4.39	31.26	0.35	0.18	
						020	3.01	31.52	0.15	0.30	
						030	1.22	31.98	0.28	0.20	

Table 2. (continued)

Sta	Date (1977) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/∘∘	Chl *a* (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
						040	0.83	32.06	0.25	0.15	
						050	0.63	32.10	0.10	0.35	
						075	0.51	32.13	0.30	0.16	
						100	-0.16	32.38	0.40	0.19	

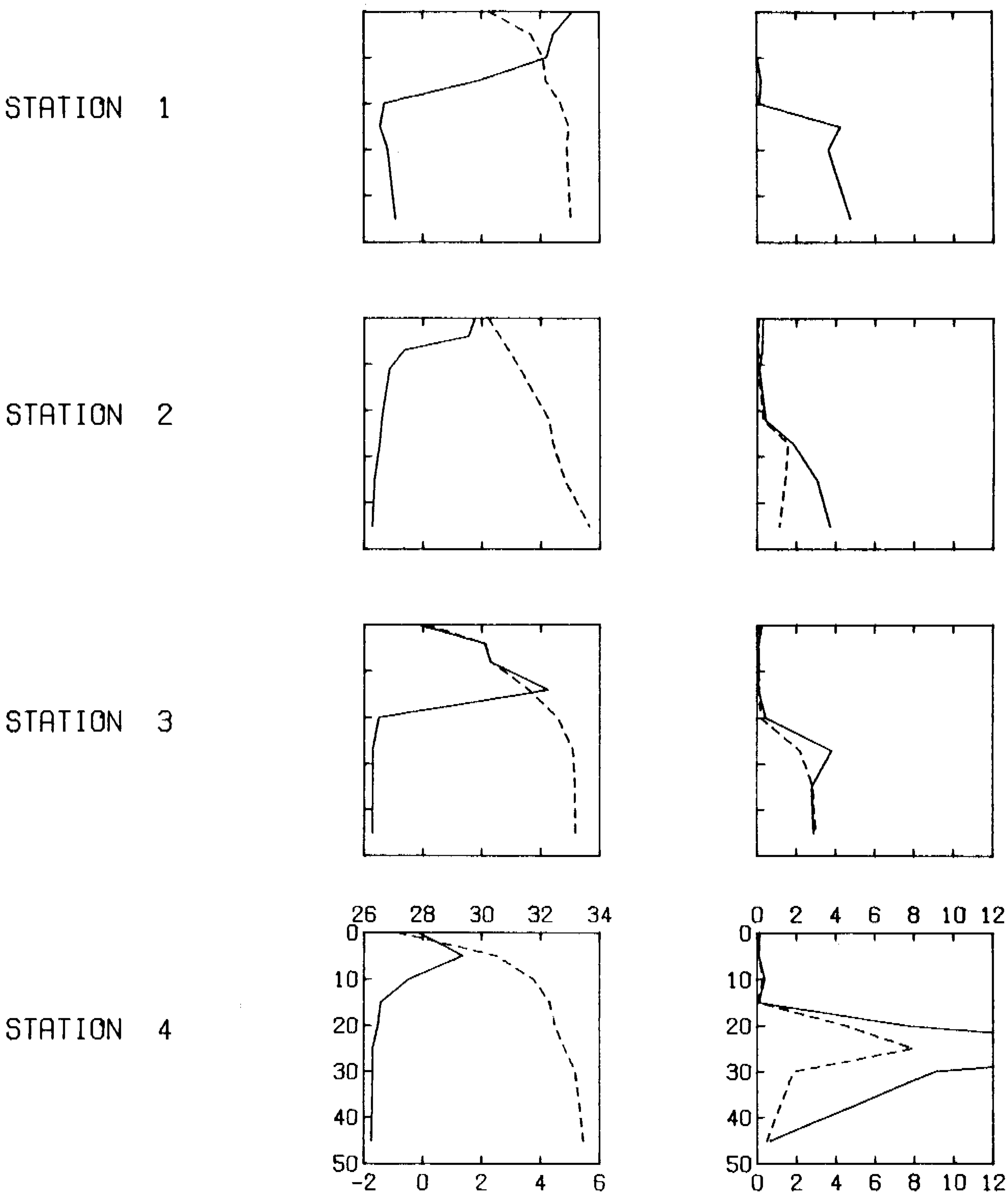


Fig. 2. Depth profiles of temperature - salinity and chlorophyll *a* - ^{14}C assimilation in the Chukchi and Beaufort seas, Aug - Sep 1977. Salinity (°/₀₀) ---; temperature (°C) ——; ^{14}C assimilation (mg C m^{-3} hr^{-1}) ---; chlorophyll *a* (mg m^{-3}) ——

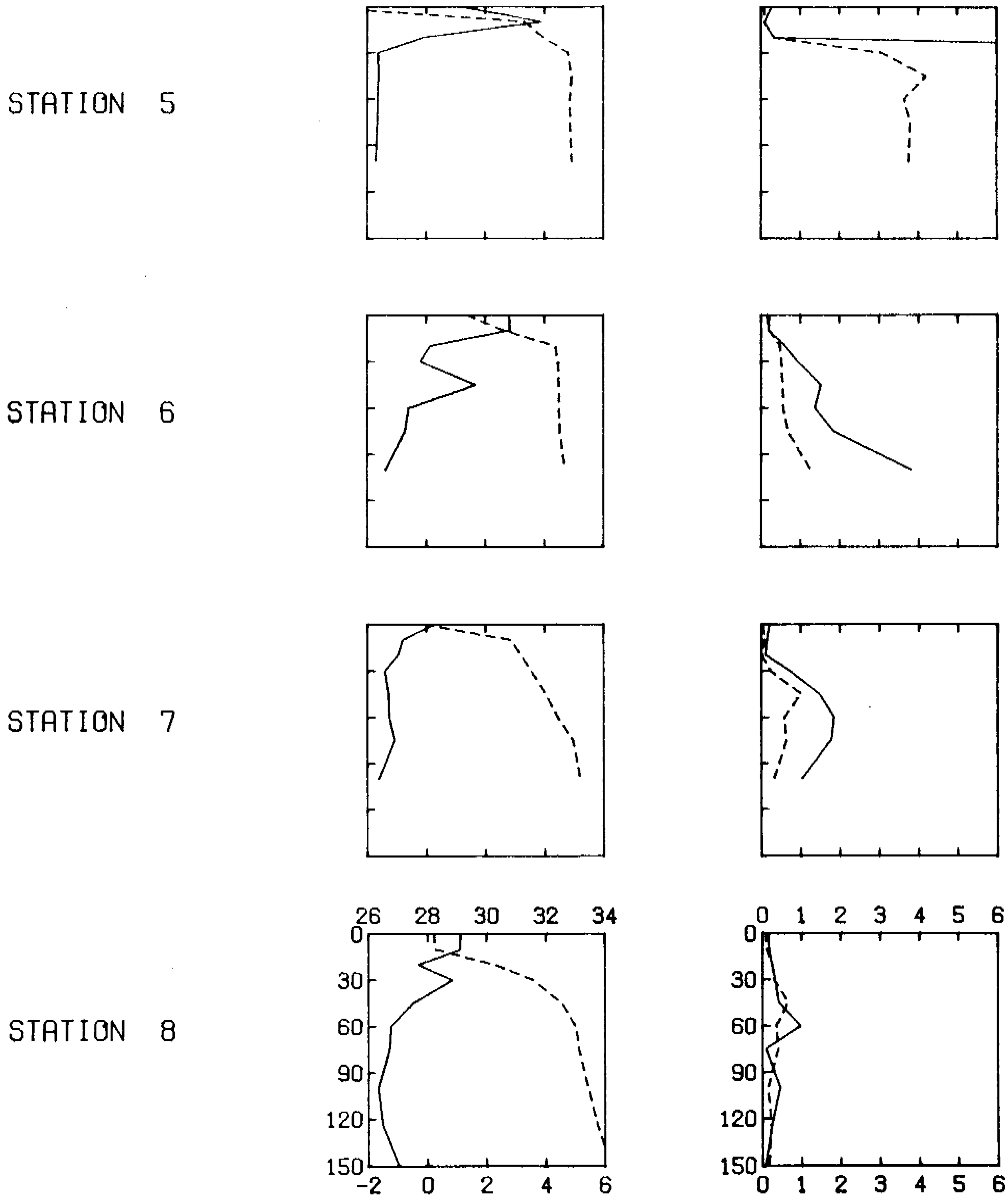


Fig. 2. (continued)

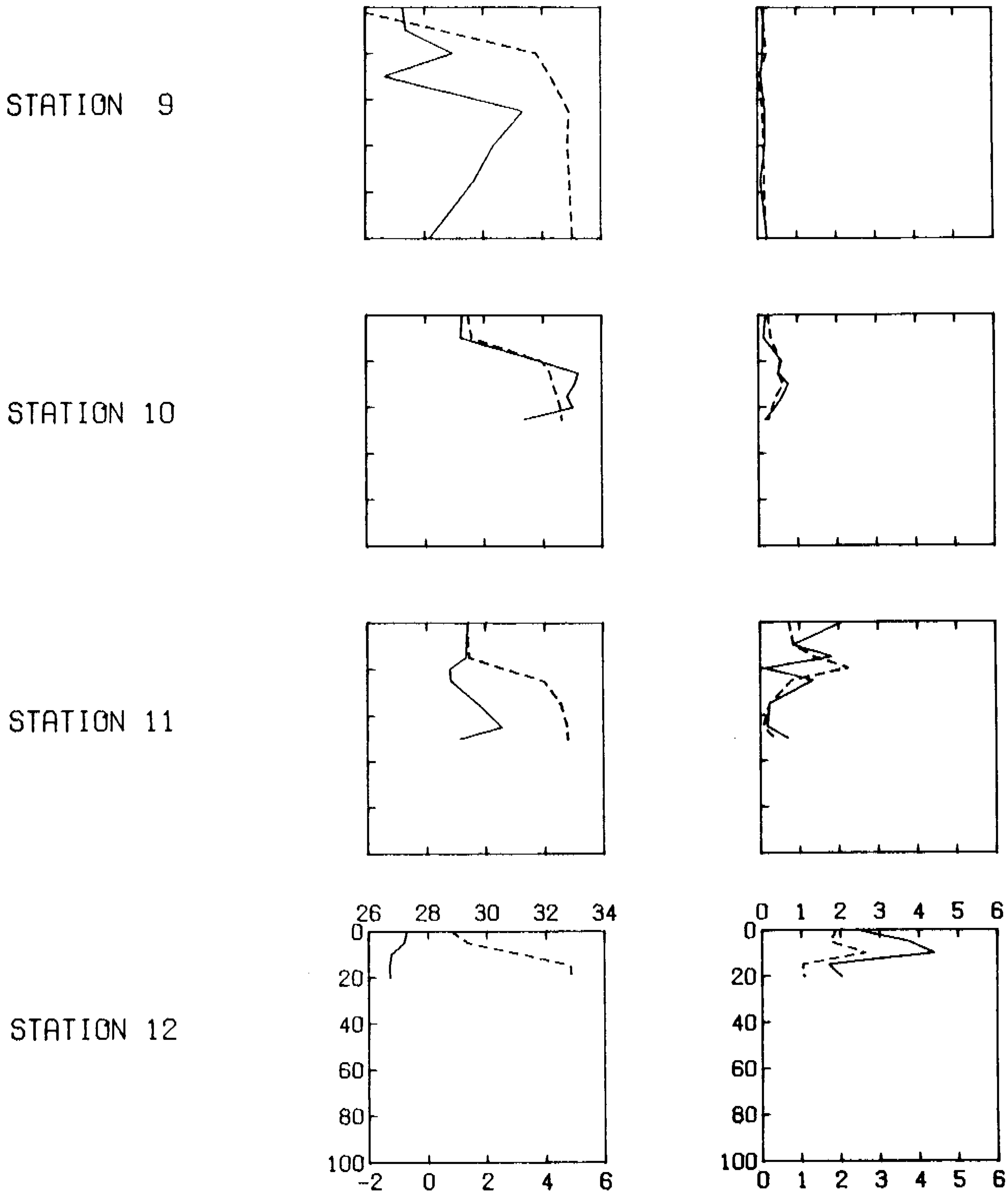


Fig. 2. (continued)

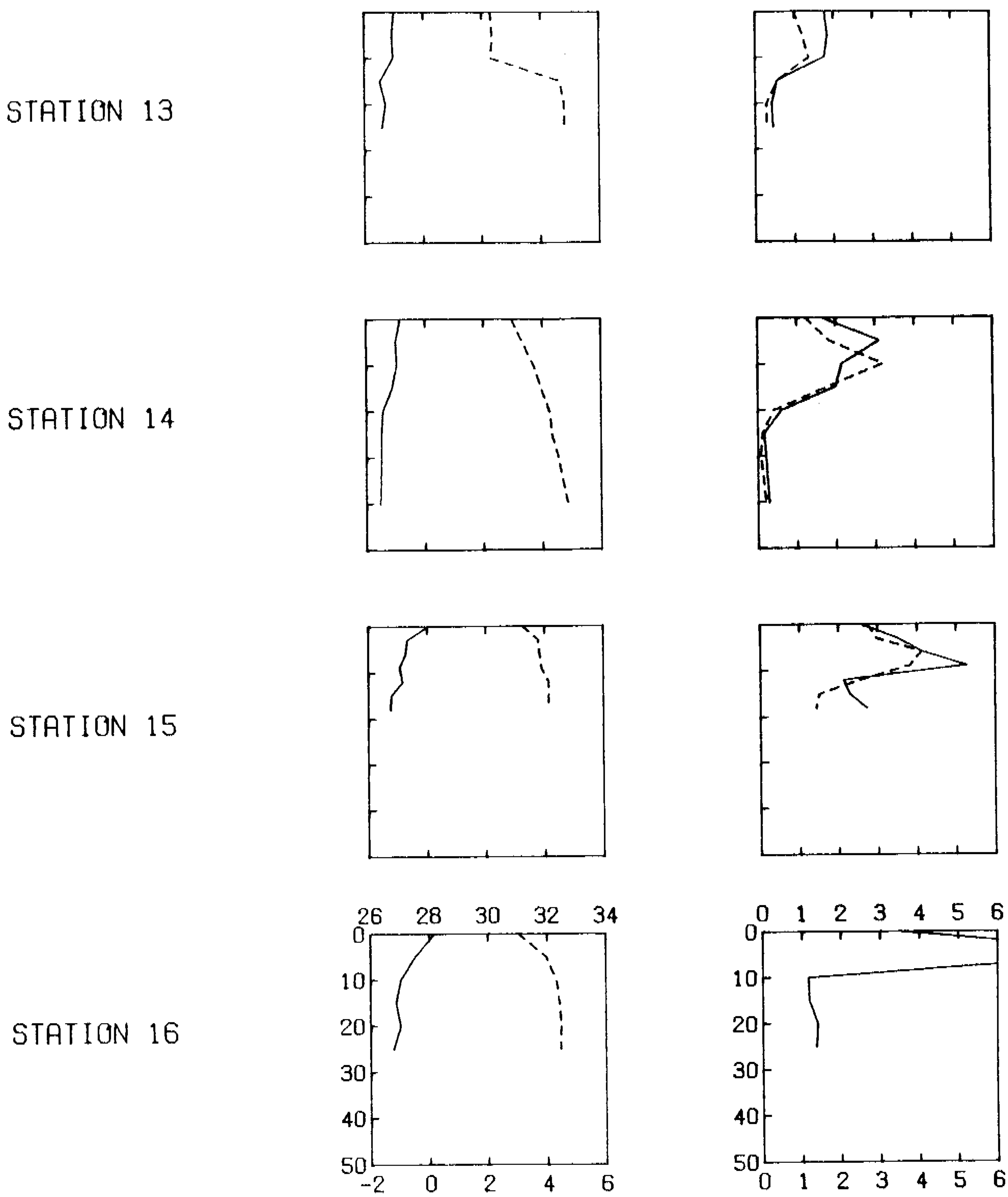


Fig. 2. (continued)

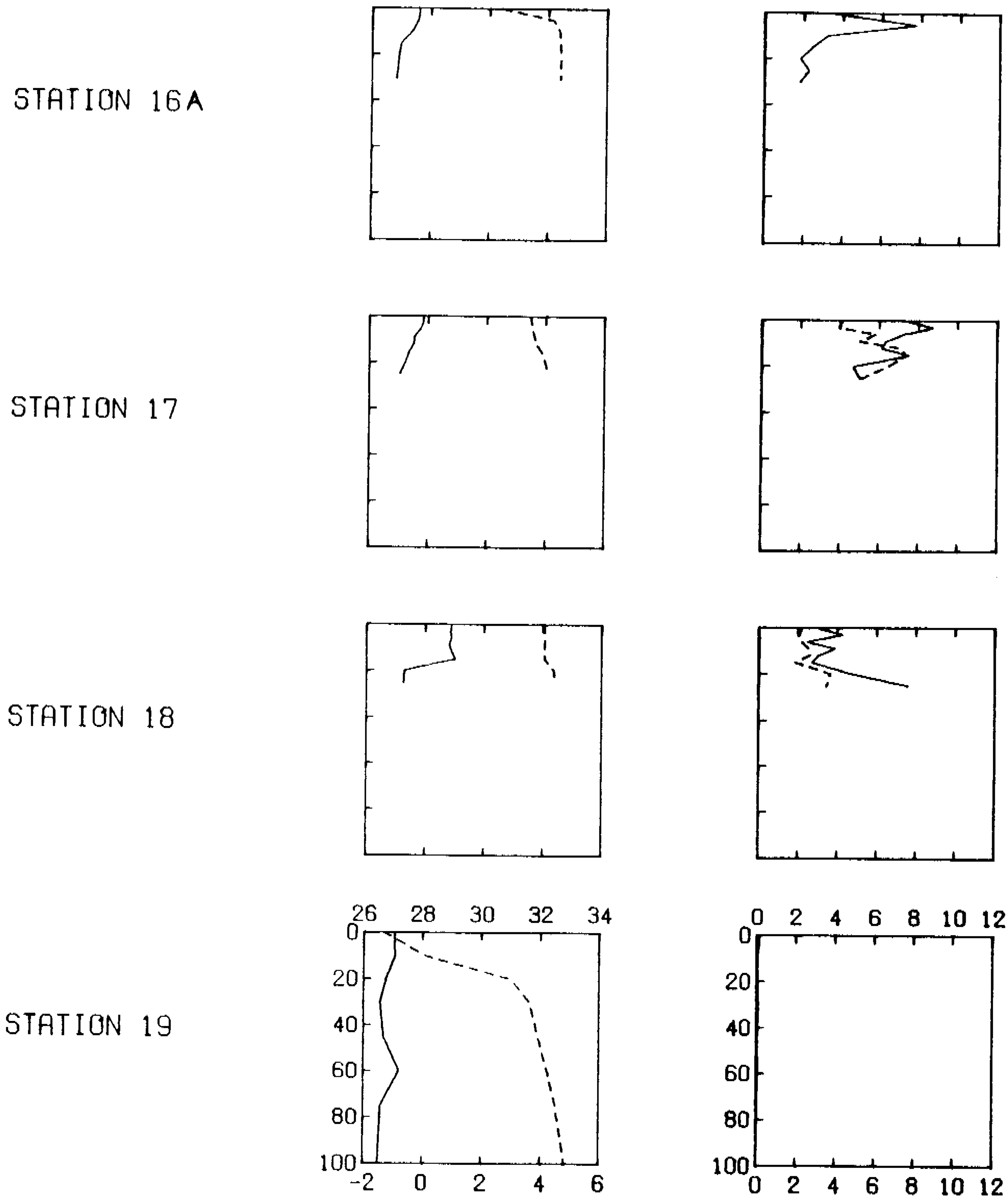


Fig. 2. (continued)

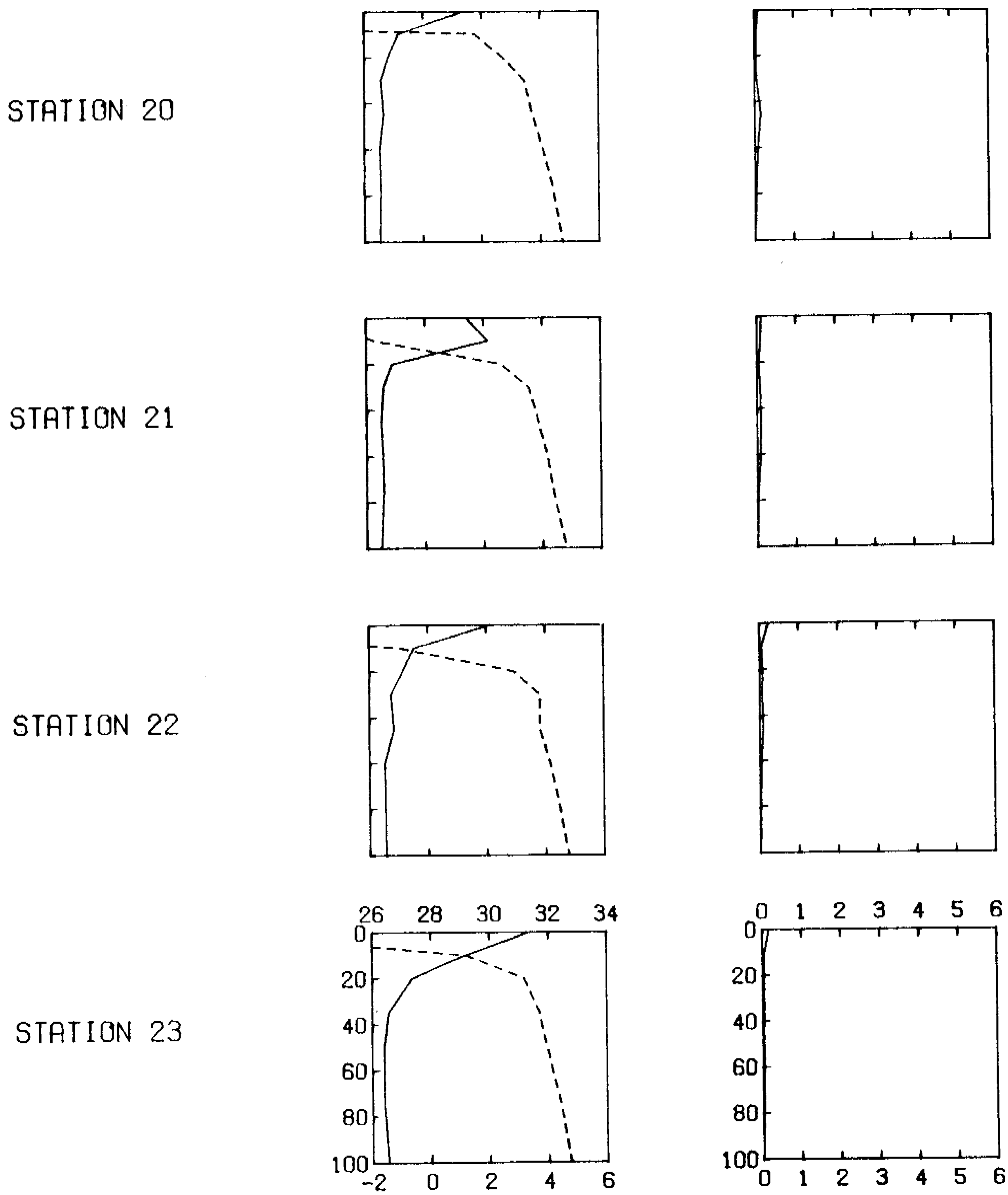


Fig. 2. (continued)

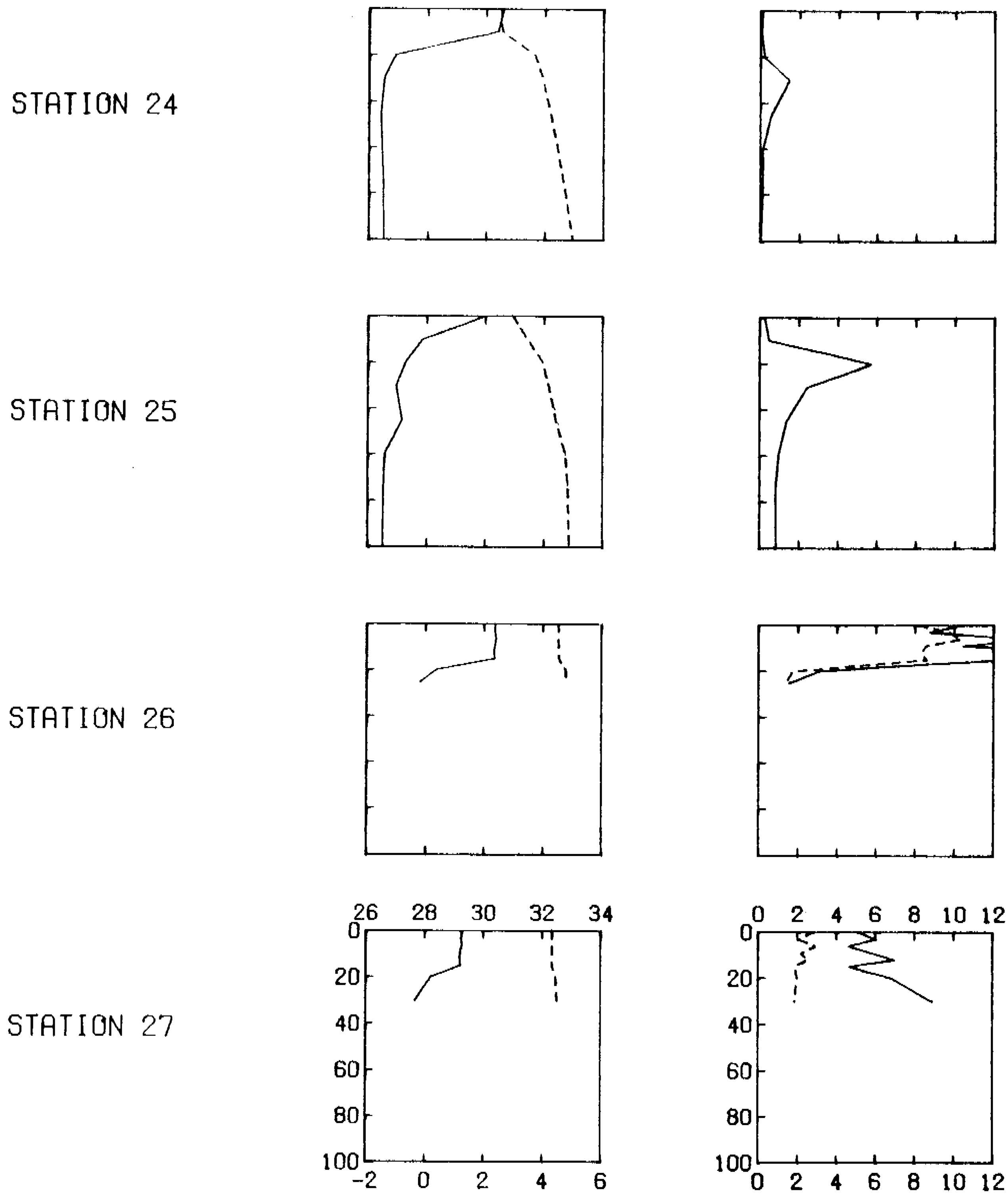


Fig. 2. (continued)

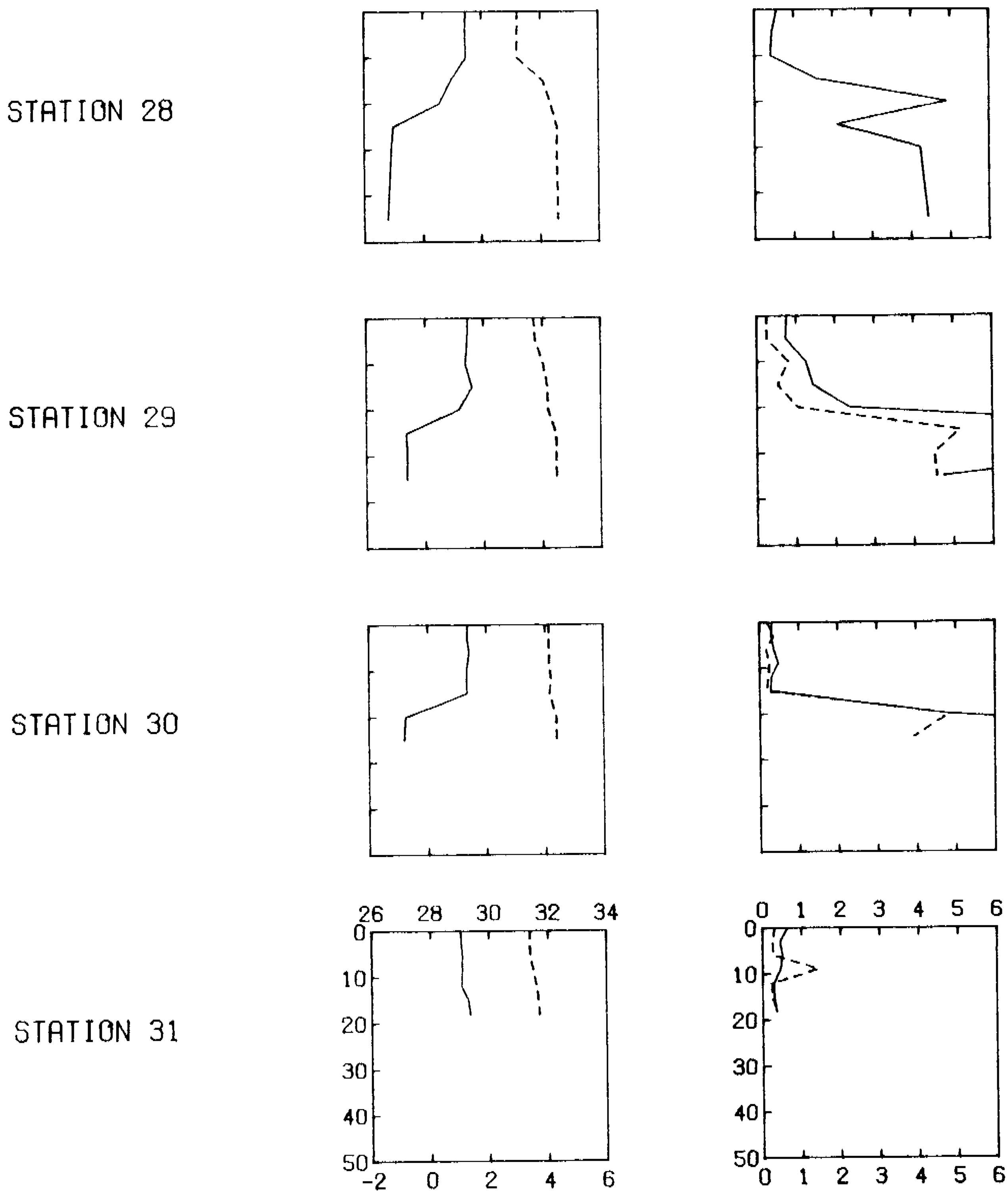


Fig. 2. (continued)

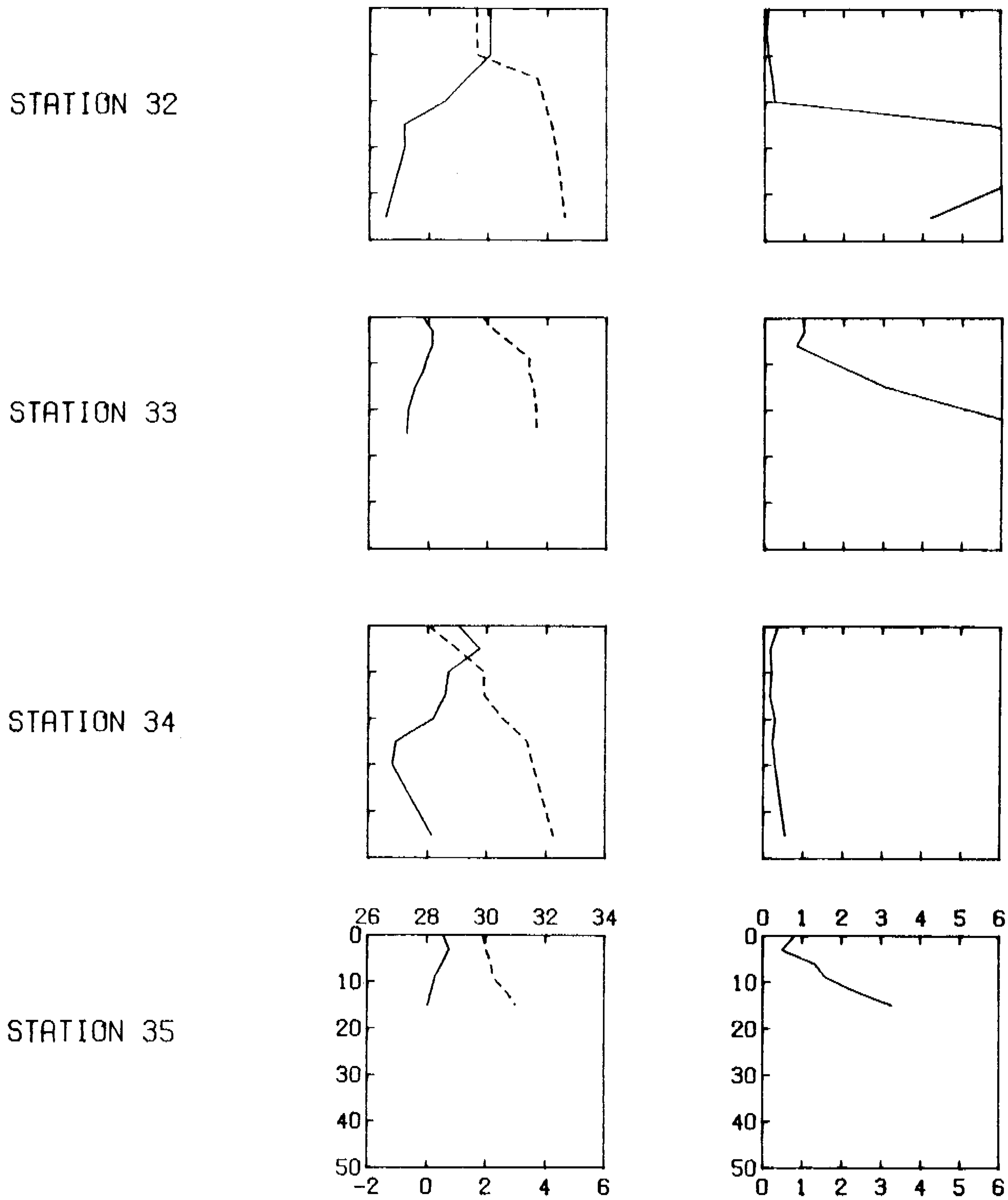


Fig. 2. (continued)

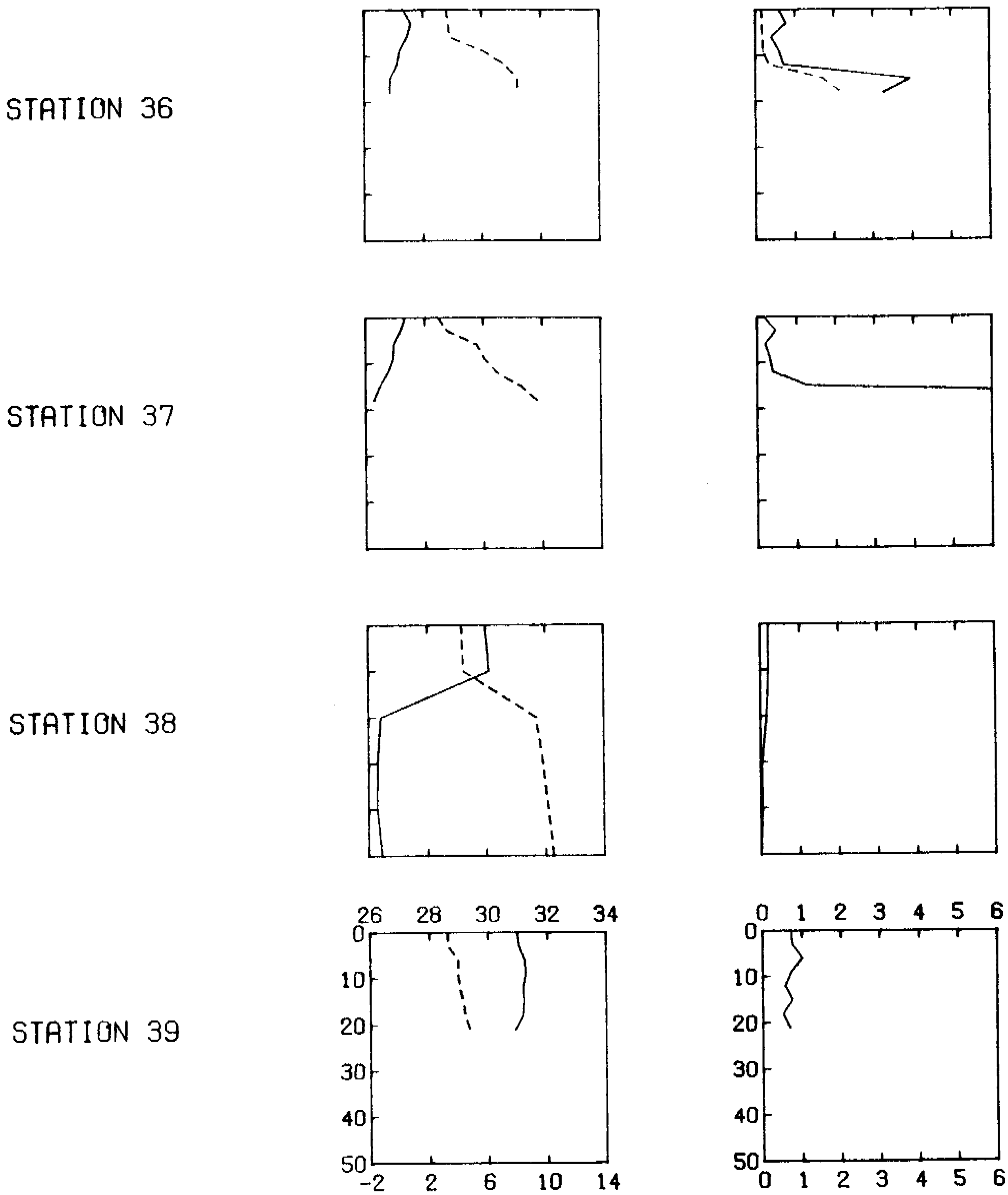


Fig. 2. (continued)

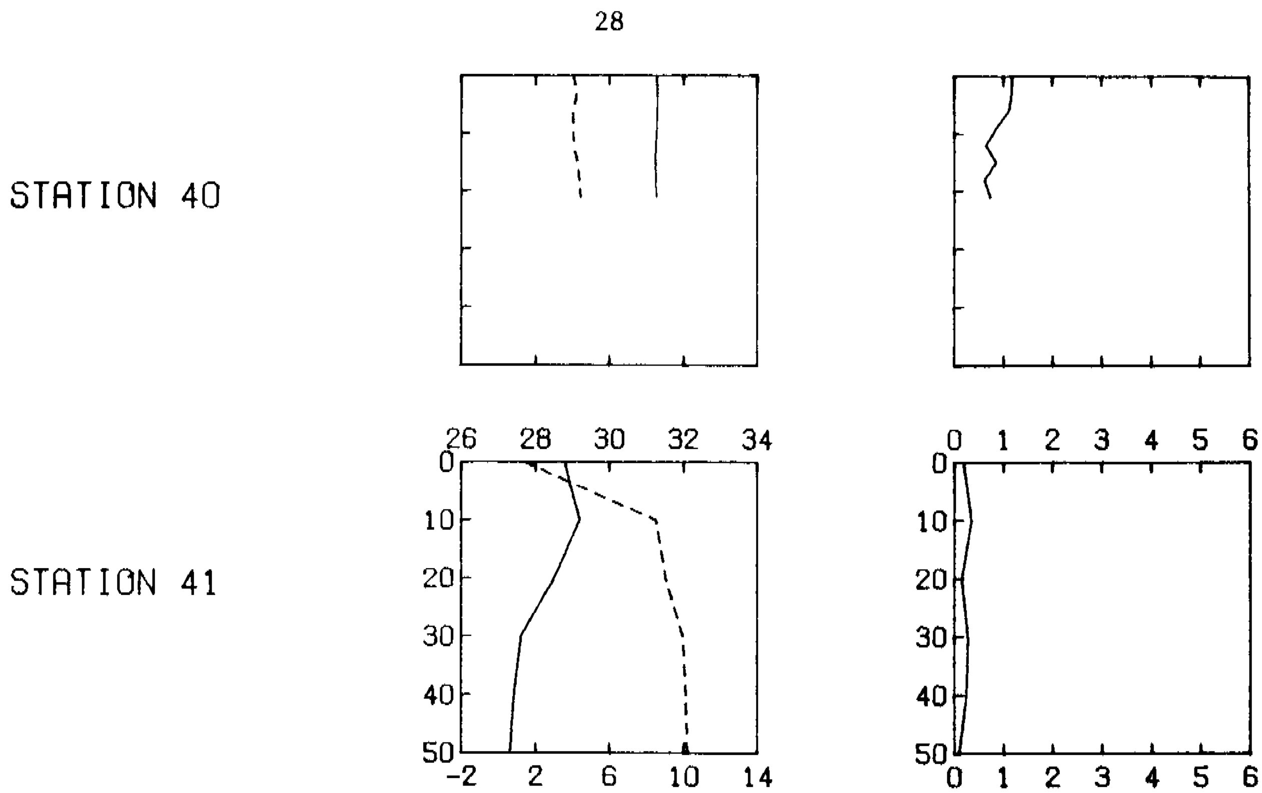


Fig. 2. (continued)

Horner 1969, Hsiao 1975, English and Horner 1977).

The phytoplankton have been grouped into four major categories based on taxonomic group or morphological similarities, such as presence of flagella. The percentage of phytoplankton and the number of cells by major category are given in Table 3 and Fig. 3. The number of cells ranged from $< 1 \times 10^5$ to $> 12 \times 10^6$ cells per liter, with the highest numbers occurring at stations 29 and 30 located northwest of Barter Island, probably in the upwelling area reported by Hufford (1974).

Species of the genus *Chaetoceros*, usually about 6 µm along the apical axis, were the most abundant organisms at nearly all depths and stations. They accounted for 97 to 98% of the total number of cells at depths with the highest cell numbers. Sixteen species of *Chaetoceros* were identified with certainty, other cells were not identified to species, but were grouped as *Chaetoceros* spp. Other abundant diatoms species were *Bacterosira fragilis* Gran, *Nitzschia grunowii* Hasle, and *Thalassiosira* spp., including *T. antarctica* Comber, *T. gravida* Cleve, and *T. nordenskioeldii* Cleve. *Leptocylindrus minimus* Gran, reported from Bering Sea water in the Beaufort Sea in 1976, was tentatively identified at two stations in the Chukchi Sea and one station in the Beaufort Sea, but only a few cells were found at each station.

Small flagellates, that were not identified, were not as abundant as in 1976 except at station 19 where, in the upper 30 m, they comprised almost 100% of the organisms. At most stations and depths east of Prudhoe Bay, flagellates comprised less than 20%, usually closer to 5%, of the total number of organisms.

Dinoflagellates were always present, but never in large numbers, usually occurring as 1% or less of the total number of cells.

C. Primary productivity and plant pigment concentrations

Primary productivity and chlorophyll *a* and phaeopigment concentrations are listed in Table 2; vertical profiles are shown in Fig. 2. Integrated values for carbon assimilation and chlorophyll *a* are given in Figs. 4 and 5.

Primary productivity ranged from 0.02 to 10.35 mg C m^{-3} hr^{-1} with integrated productivity ranging from 8.46 mg C m^{-2} hr^{-1} at station 31 to 283.32 mg C m^{-2} hr^{-1} at station 5. *Chaetoceros* spp. were the most abundant organisms at both stations, but station 5 had many more cells in all categories.

Chlorophyll *a* ranged from 0.01 to 22.94 mg m^{-3}; integrated chlorophyll *a* ranged from 4.50 mg m^{-2} at station 23 to 801.37 mg m^{-2} at station 5. The four stations, including station 23, with the lowest integrated chlorophyll concentrations were in deep water where ice concentrations ranged from 1 to 8 oktas.

High chlorophyll concentrations generally were found at the same depths as high productivity and diatoms were the most abundant organisms. At

Table 3. Number of cells per liter and percentage of phytoplankton by major category by depth at each station. Where no number is given, the sample has not been counted; - indicates no cells found in the sample.

Sta	Depth (m)	*Chaetoceros* Number	*Chaetoceros* %	Other diatoms Number	Other diatoms %	Flagellates Number	Flagellates %	Dinoflagellates Number	Dinoflagellates %	Total Number of Cells
1	00									
	05	290000	61	126000	27	50000	11	6000	1	472000
	10	185000	53	104000	30	55000	16	2000	1	346000
	15	362000	72	80000	16	55000	11	4000	1	501000
	20	1516000	81	233000	13	102000	5	12000	1	1863000
	25	2531000	87	285000	10	59000	2	23000	1	2898000
	30	2899000	90	172000	5	105000	3	28000	1	3204000
	45	7866000	94	396000	5	110000	1	17000	< 1	8389000
2	00	1456000	88	28000	2	174000	10	6000	< 1	1664000
	07	1955200	93	48000	2	86400	4	6400	< 1	2096000
	11	2400000	93	59200	2	110400	4	6400	< 1	2576000
	22	636800	72	91200	10	145600	16	11200	1	884800
	27	2238400	78	507200	18	110400	4	3200	< 1	2859200
	35	1171200	54	971200	45	14400	1	22400	1	2179200
	45	2147200	60	1198400	34	209600	6	6400	< 1	3561600
3	00	408000	47	202000	23	260000	30	-	-	870000
	04	299200	51	136000	23	14400	2	3200	1	582400
	08	265600	49	49600	9	220000	41	3200	1	538400
	14	262400	34	372800	48	126400	16	14400	2	776000
	20	235200	37	188800	29	212800	33	6400	1	643200
	27	158400	21	523200	69	65600	9	9600	1	756800
	35	147200	23	403200	62	73600	11	22400	3	646400
	45	177600	22	497600	63	83200	10	35200	4	793600

Table 3. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
4	00	240000	21	574000	51	308000	27	4000	< 1	1126000
	05	204800	25	504000	62	83200	10	17600	2	809000
	10	464000	46	384000	38	139200	14	12800	1	1000000
	15	152000	48	81600	26	80000	25	6400	2	320000
	20	675200	43	550400	35	328000	21	12800	1	1566400
	25	593600	20	2038400	67	360000	12	32000	1	3024000
	30	192000	20	622400	64	139200	14	19200	2	972800
	45	67200	16	193600	47	131200	32	17600	4	409600
5	00	234000	29	246000	30	338000	41	2000	< 1	820000
	10	196800	22	184000	21	496000	56	3200	< 1	880000
	20	542400	51	336000	31	182400	17	8000	1	1068800
	30	5572800	85	288000	4	681600	10	12800	< 1	6555200
	45	7350000	88	628000	8	354000	4	22000	< 1	8354000
	60	7094000	92	412000	5	112000	1	24000	< 1	7642000
	75	8318000	93	518000	6	116000	1	32000	< 1	8984000
	100	7224000	94	358000	5	104000	1	34000	< 1	7720000
6	00	524000	48	310000	28	256000	23	6000	1	1096000
	10	401600	58	214400	31	68800	10	4800	1	689600
	20	355200	42	419200	49	75200	9	4800	1	854400
	30	502400	50	417600	41	75200	7	11200	1	1006400
	45	672000	57	419200	36	73600	6	6400	1	1171200
	60	782400	62	387200	31	76800	6	17600	1	1264000
	75	942400	63	456000	31	76800	5	9600	1	1484800
	100	2502400	82	392000	13	144000	5	20800	1	3059200
7	00	336000	73	14000	3	112000	24	–	–	462000
	10	320000	79	35200	9	33600	8	16000	4	404800
	20	41600	44	6400	7	36800	39	9600	10	94400
	30	353600	69	54400	11	102400	20	1600	< 1	512000
	45	2036800	83	284800	12	118400	5	–	–	2440000

Table 3. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
7	60	2600000	89	204800	7	124800	4	3200	< 1	2932800
	75	2931200	91	201600	6	91200	3	1600	< 1	3225600
	100	640000	71	184000	20	70400	8	8000	1	902400
8	00	326000	60	40000	7	180000	33	-	-	546000
	10	344000	70	27200	6	118400	24	3200	1	492800
	20	387200	77	40000	8	72000	14	1600	< 1	500800
	30	827200	76	49600	5	212800	19	4800	< 1	1094400
	45	1561600	68	32000	1	683200	30	3200	< 1	2280000
	60	768000	82	59200	6	107200	11	-	-	934400
	75	681600	74	96000	10	124800	14	19200	2	921600
	100	627200	73	136000	16	84800	10	16000	2	864000
	125	992000	81	160000	13	67200	6	1600	< 1	1220800
	150	545600	91	17600	3	27200	5	8000	1	598400
	175	401600	90	22400	5	19200	4	4800	1	448000
9	00	294000	64	8000	2	154000	34	-	-	456000
	10	No sample - bottle didn't trip								
	20	308800	29	68800	6	688000	65	-	-	1065600
	30	38400	51	1600	2	32000	43	3200	4	75200
	45	99200	44	11200	5	112000	50	3200	1	225600
	60	251200	50	36800	7	217600	43	1600	< 1	507200
	75	270400	55	49600	10	174400	35	1600	< 1	496000
	100	334400	51	57600	9	267200	41	-	-	659200
10	00	196000	57	64000	19	82000	24	-	-	342000
	10	472000	70	67200	10	126400	19	4800	< 1	670400
	20	692800	81	27200	3	137600	16	-	-	857600
	25	513600	73	36800	5	153600	22	3200	< 1	707200
	30	392000	72	40000	7	107200	20	1600	< 1	540800
	35	521600	79	33600	5	104000	16	1600	< 1	660800

Table 3. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
10	40	336000	68	32000	6	123200	25	3200	1	494400
	45	249600	76	11200	3	67200	20	1600	< 1	329600
11	00	882000	58	456000	30	186000	12	6000	< 1	1530000
	10	1059200	73	192000	13	187200	13	12800	1	1451200
	15	1073600	71	225600	15	219200	14	3200	< 1	1521600
	20	1603200	73	424000	19	156800	7	6400	< 1	2190400
	25	609600	68	62400	7	214400	24	4800	1	891200
	35	257600	43	41600	7	304000	50	1600	< 1	604800
	45	233600	57	32000	8	144000	35	1600	< 1	411200
	50	798400	62	158400	12	323200	25	8000	1	1288000
12	00	2210000	82	364000	14	104000	4	4000	< 1	2682000
	05	2244800	80	475200	17	84800	3	3200	< 1	2808000
	10	1171200	61	624000	33	116800	6	1600	< 1	1913600
	15	584000	61	312000	33	52800	6	9600	1	958400
	20	483200	54	348800	39	43200	5	14400	2	889600
13	00	790000	68	178000	15	186000	16	4000	< 1	1158000
	05	1118400	81	118400	9	136000	10	6400	< 1	1379200
	10	1017600	73	236800	17	124800	9	8000	1	1387200
	15	208000	62	80000	24	44800	13	1600	< 1	334400
	20	129600	60	68800	32	14400	7	4800	2	217600
	25	177600	73	28800	12	38400	16	–	–	244800
14	00	1730000	81	250000	12	154000	7	6000	< 1	2140000
	05	1347200	67	592000	29	65600	3	3200	< 1	2008000
	10	1649600	65	828800	33	48000	2	6400	< 1	2532800
	15	1052800	72	345600	24	64000	4	6400	< 1	1468800
	20	107200	58	35200	19	32000	17	9600	5	184000
	25	3200	6	14400	28	25600	50	8000	16	51200
	30	22400	44	8000	16	20800	41	–	–	51200
	40	80000	30	150400	57	27200	10	6400	2	264000

Table 3. (continued)

Sta	Depth (m)	*Chaetoceros* Number	*Chaetoceros* %	Other diatoms Number	Other diatoms %	Flagellates Number	Flagellates %	Dinoflagellates Number	Dinoflagellates %	Total Number of Cells
15	00	2072000	67	822000	27	174000	6	4000	< 1	3072000
	03	1891200	63	992000	33	123200	4	1600	< 1	3008000
	06	2072000	69	846400	28	70400	2	4800	< 1	2993600
	09	1884800	66	876800	31	107200	4	1600	< 1	2870400
	12	1592000	71	516800	24	80000	4	1600	< 1	2190400
	15	1091200	79	241600	17	43200	3	4800	< 1	1380800
	18	1057600	72	352000	24	49600	3	–	–	1459200
16	00	2402000	62	1412000	37	42000	1	6000	< 1	3862000
	05	3150400	82	636800	17	56000	1	8000	< 1	3851200
	10	620800	72	190400	22	46400	5	3200	< 1	860800
	15	889600	75	257600	22	43200	4	–	–	1190400
	20	848000	79	198400	19	20800	2	–	–	1067200
	25	772800	73	249600	24	36800	3	–	–	1059200
16A	00	3048000	86	436000	12	40000	1	2000	< 1	3526000
	05	7081600	86	1130400	14	59200	1	4800	< 1	8276000
	10	1625600	81	377600	19	6400	< 1	3200	< 1	2012800
	15	1798400	82	369600	17	19200	1	–	–	2187200
	20	1516800	86	219200	12	17600	1	3200	< 1	1756800
	25	1654400	84	292800	15	28800	1	1600	< 1	1977600
	30	1520000	83	283200	16	14400	< 1	4800	< 1	1822400
17	00	5036800	81	1121600	18	81600	1	4800	< 1	6244800
	03	4620800	76	1345600	22	80000	1	3200	< 1	6049600
	06	5270400	77	1512000	22	65600	1	–	–	6848000
	09	5225600	74	1785600	25	68800	1	4800	< 1	7084800
	12	5982000	80	1410000	19	64000	1	12000	< 1	7468000
	15	4876000	69	2089000	30	72000	1	8000	< 1	7045000
	20	3904000	74	1366000	26	32000	1	2000	< 1	5304000
	25	2272000	67	1076000	32	52000	2	6000	< 1	3406000

Table 3. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
18	00	4254000	92	340000	7	34000	1	–	–	4628000
	03	3954000	93	240000	6	50000	1	14000	< 1	4258000
	06	4236000	95	194000	4	34000	1	12000	< 1	4476000
	09	3310000	90	304000	8	74000	2	10000	< 1	3698000
	12	3714000	89	390000	9	52000	1	2000	< 1	4158000
	15	3036000	92	208000	6	60000	2	12000	< 1	3316000
	20	4174000	90	404000	9	30000	1	6000	< 1	4614000
	25	6584000	86	1042000	14	34000	< 1	2000	< 1	7662000
19	00	–	–	4000	1	566000	99	4000	1	574000
	10	–	–	–	–	206000	100	–	–	206000
	20	–	–	4000	5	80000	91	4000	5	88000
	30	–	–	–	–	88000	100	–	–	88000
	45									
	60									
	75									
	100									
	200									
	400									
	500									
	600									
	700									
	800									
	900									
	1000									
26	00	6682000	83	890000	11	436000	5	4000	< 1	8012000
	03	6676000	83	948000	12	432000	5	36000	< 1	8092000
	06	6884000	84	916000	11	376000	5	38000	< 1	8214000
	09	7188000	84	1006000	12	340000	4	38000	< 1	8572000
	12	7818000	86	786000	9	418000	5	44000	< 1	9066000
	15	5610000	81	846000	12	490000	7	22000	< 1	6968000

Table 3. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
26	20	2230000	88	136000	5	136000	5	24000	1	2526000
	25	1902000	92	50000	2	94000	5	18000	1	2064000
27	00	1342000	57	771000	33	210000	9	16000	1	2339000
	03	996000	47	818000	39	296000	14	14000	1	2124000
	06	1574000	55	866000	30	416000	14	18000	1	2874000
	09	1540000	59	704000	27	342000	13	8000	< 1	2594000
	12	1494000	55	918000	34	284000	10	16000	1	2712000
	15	1440000	59	668000	27	308000	13	14000	1	2430000
	20	1800000	72	556000	22	140000	6	14000	1	2510000
	30	2782000	73	850000	22	172000	5	10000	< 1	3814000
29	00	454000	76	64000	11	78000	13	4000	1	600000
	05	820000	76	114000	11	146000	13	4000	< 1	1084000
	10	782000	73	128000	12	158000	15	6000	1	1074000
	15	626000	63	196000	20	160000	16	8000	1	990000
	20	1274000	74	314000	18	134000	8	2000	< 1	1724000
	25	12028000	97	256000	2	140000	1	14000	< 1	12438000
	30	12030000	97	174000	1	158000	1	8000	< 1	12370000
	35	12232000	97	188000	1	114000	1	14000	< 1	12548000
30	00	800000	80	94000	9	104000	10	2000	< 1	1000000
	03	684000	81	66000	8	90000	11	2000	< 1	842000
	06	788000	85	68000	7	62000	7	4000	< 1	922000
	09	592000	73	178000	22	32000	4	4000	< 1	806000
	12	12526000	97	264000	2	146000	1	2000	< 1	12938000
	15	756000	91	14000	2	60000	7	–	–	830000
	20	648000	91	18000	3	44000	6	2000	< 1	712000
	25	12142000	98	170000	1	102000	< 1	2000	< 1	12416000

Table 3. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
31	00	1140000	94	52000	4	14000	1	4000	< 1	1210000
	03	1010000	87	140000	12	14000	1	2000	< 1	1166000
	06	1050000	87	116000	10	40000	3	4000	< 1	1210000
	09	1072000	93	46000	4	30000	3	2000	< 1	1150000
	12	1072000	87	50000	4	108000	9	2000	< 1	1232000
	15	1122000	94	46000	4	18000	2	2000	< 1	1188000
	18	1208000	90	106000	8	28000	2	4000	< 1	1346000
36	00	802000	73	44000	4	246000	22	14000	1	1106000
	03	766000	77	30000	3	194000	19	6000	< 1	996000
	06	698000	83	48000	6	88000	11	2000	< 1	836000
	09	1146000	86	62000	5	110000	8	8000	< 1	1326000
	12	868000	74	84000	7	212000	18	6000	< 1	1170000
	15	3898000	86	254000	6	350000	8	14000	< 1	4516000
	18	5310000	89	344000	6	264000	4	26000	< 1	5944000

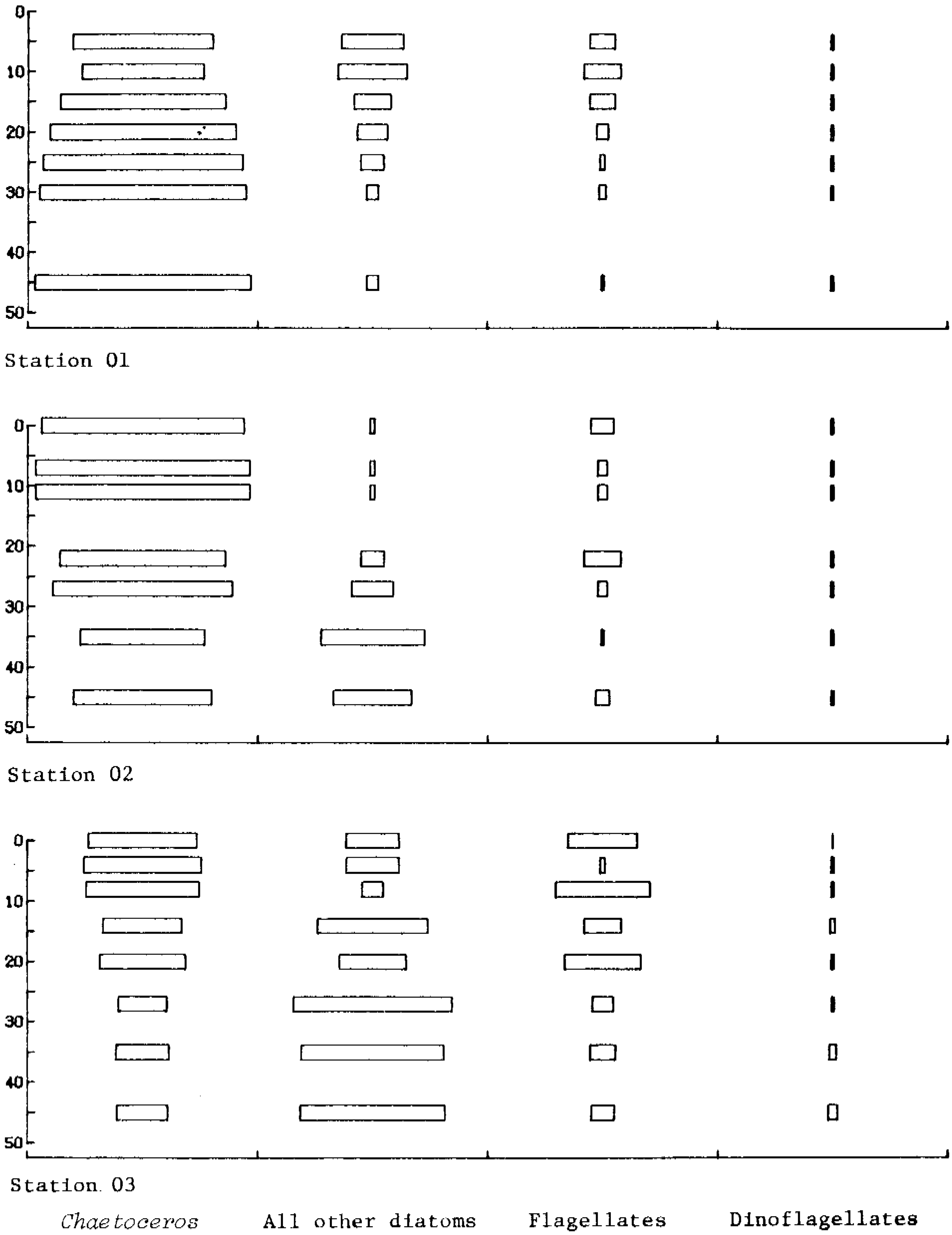


Fig. 3. Percentage of phytoplankton by major category by depth for each station. Blanks indicate depths where samples were not taken. Percentages add up to 100% running from left to right across the diagram.

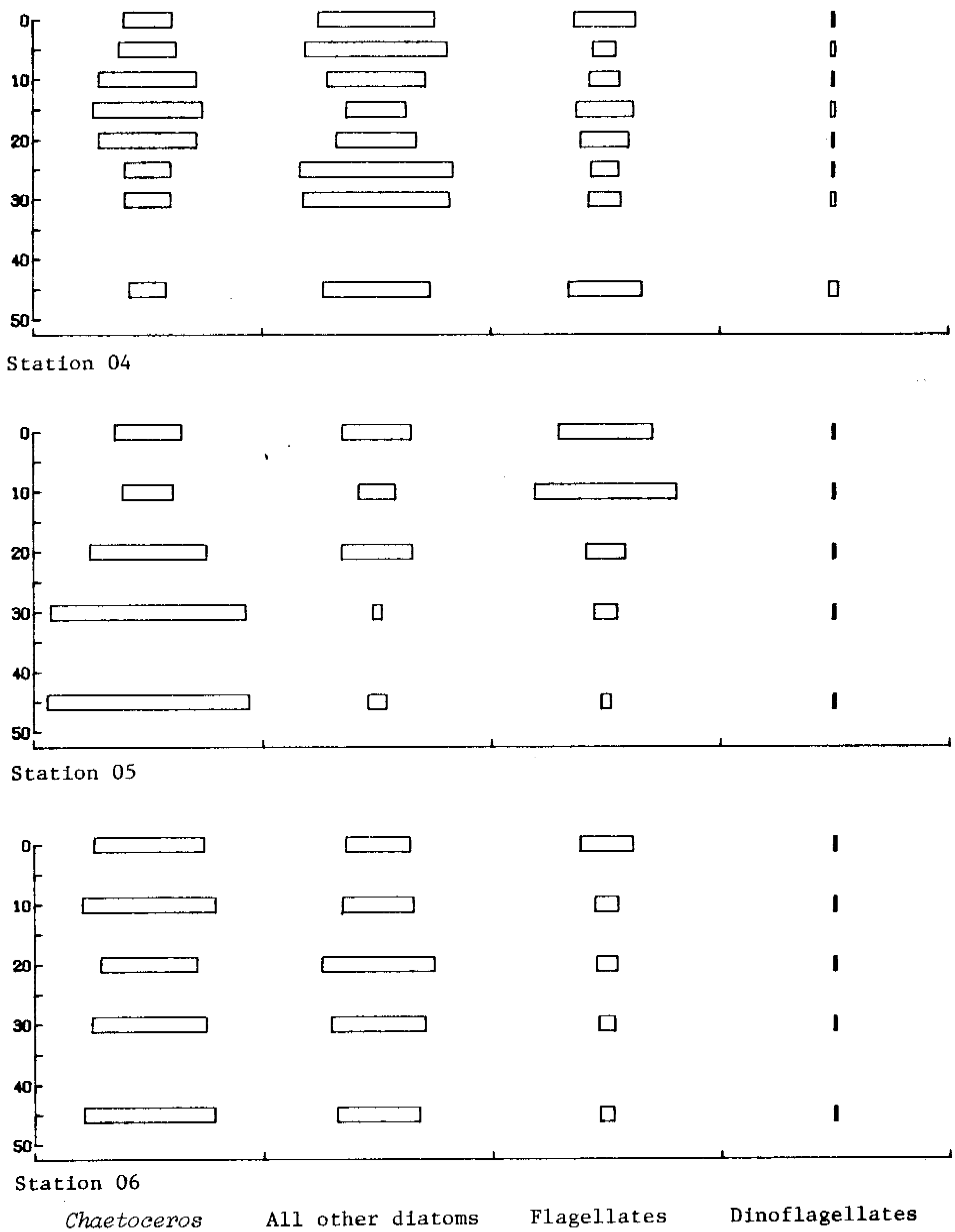


Fig. 3. (continued)

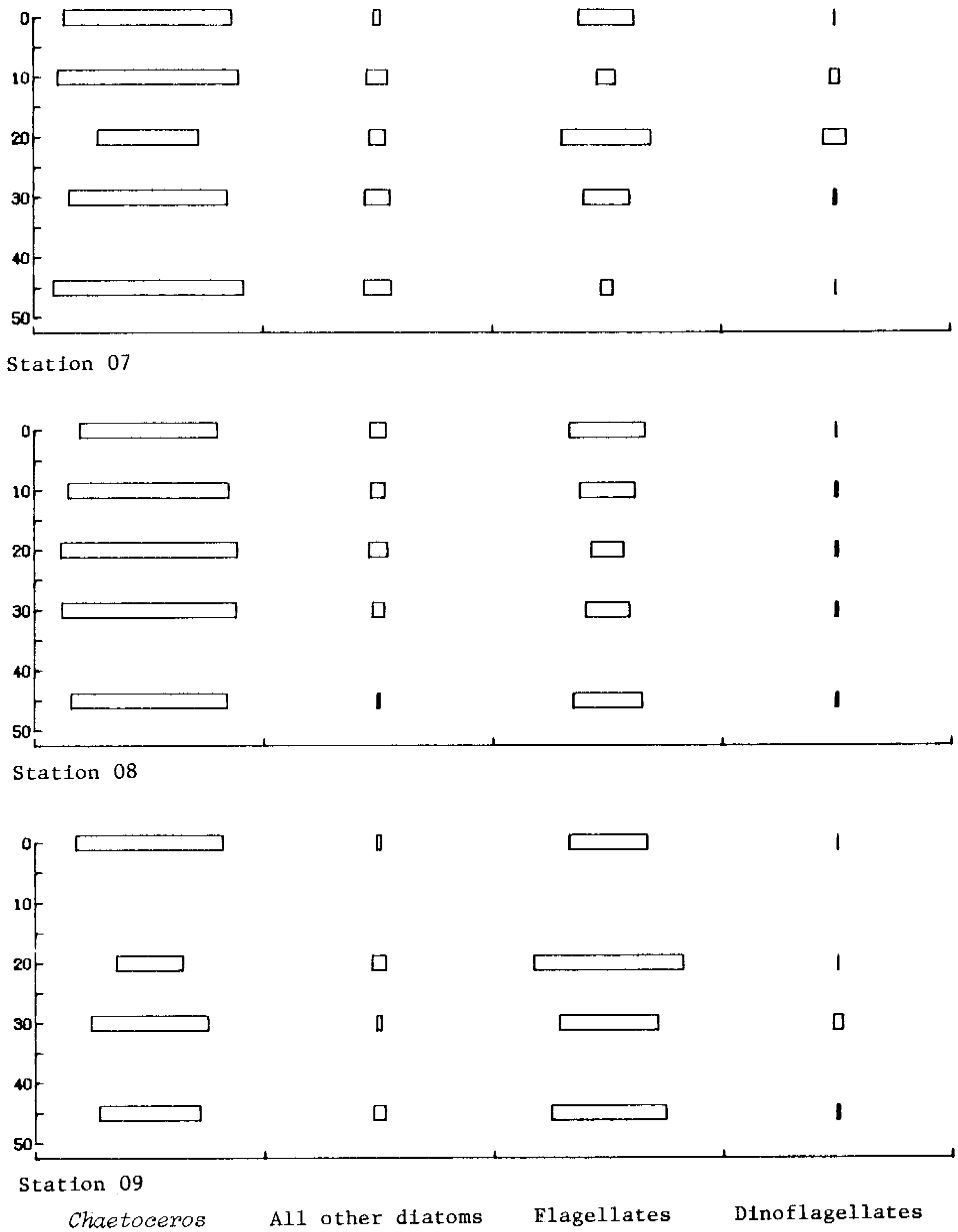


Fig. 3. (continued)

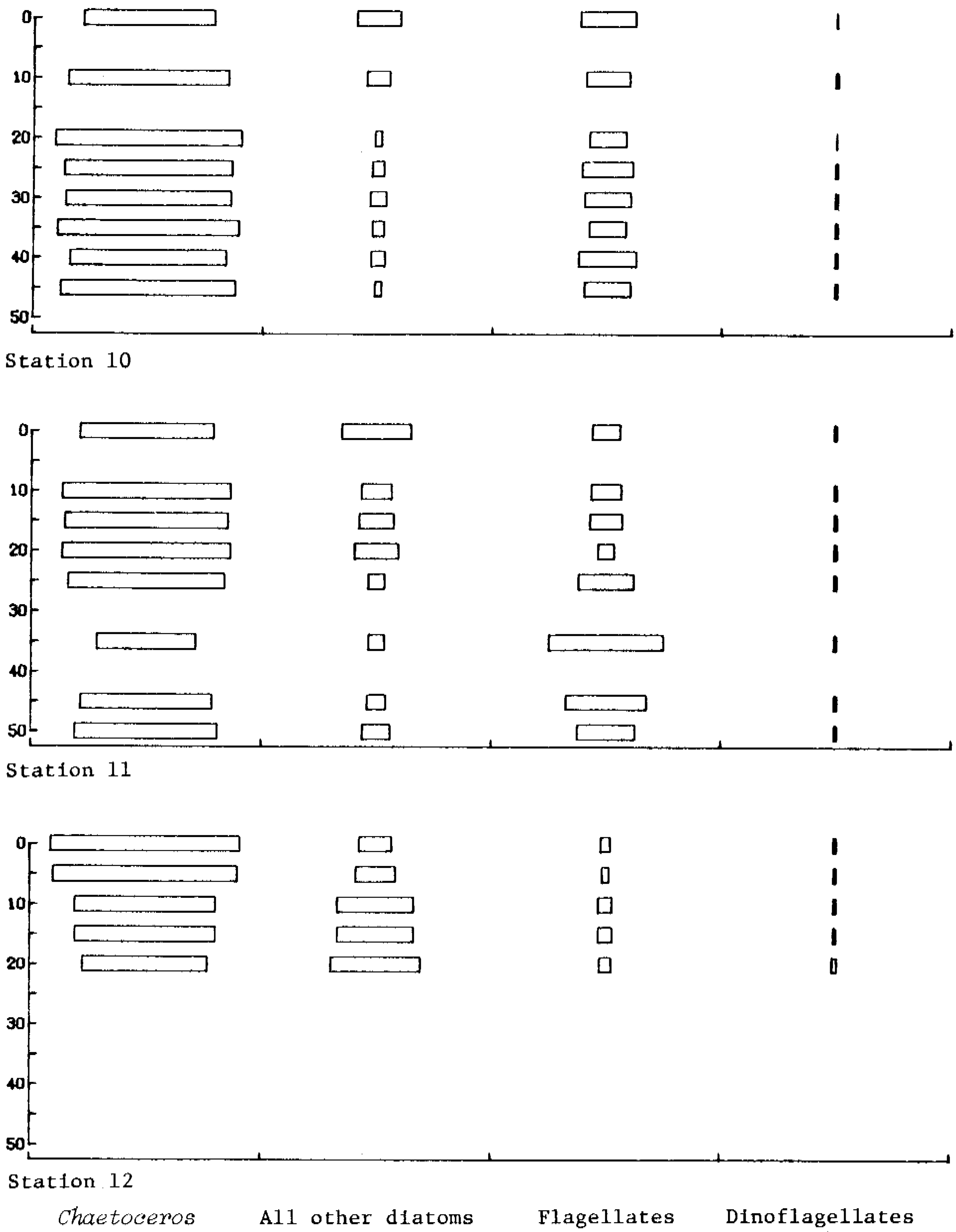


Fig. 3. (continued)

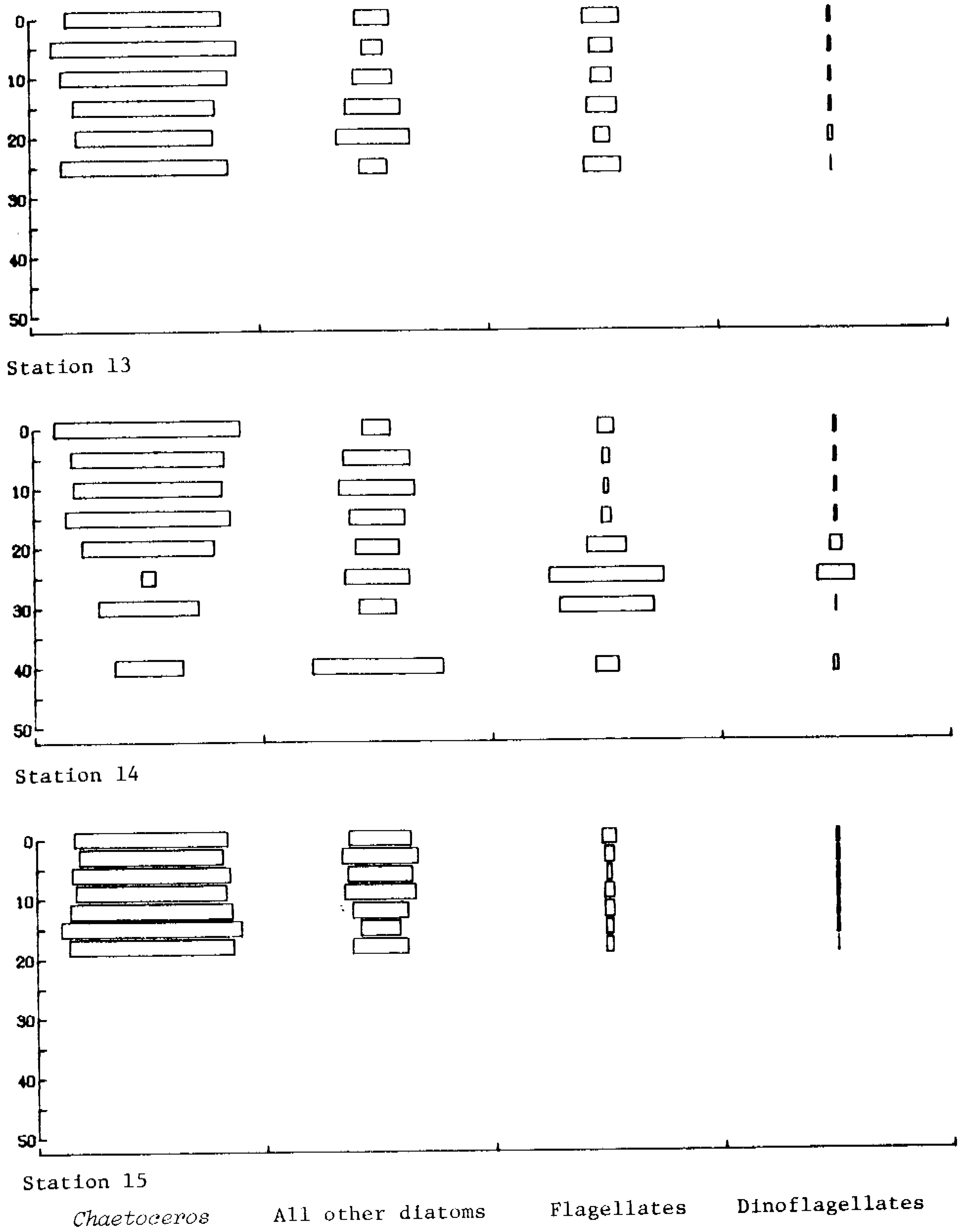


Fig. 3. (continued)

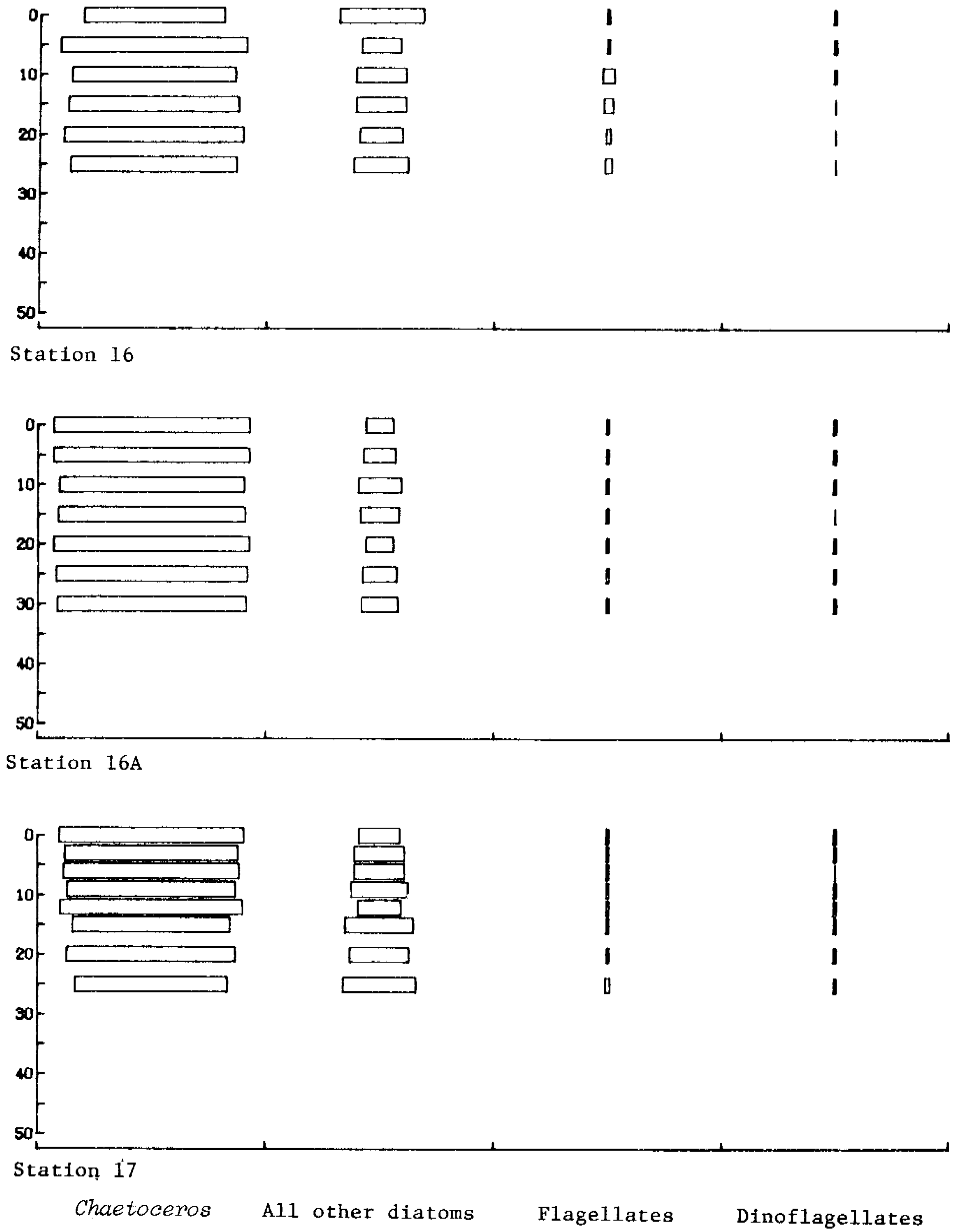
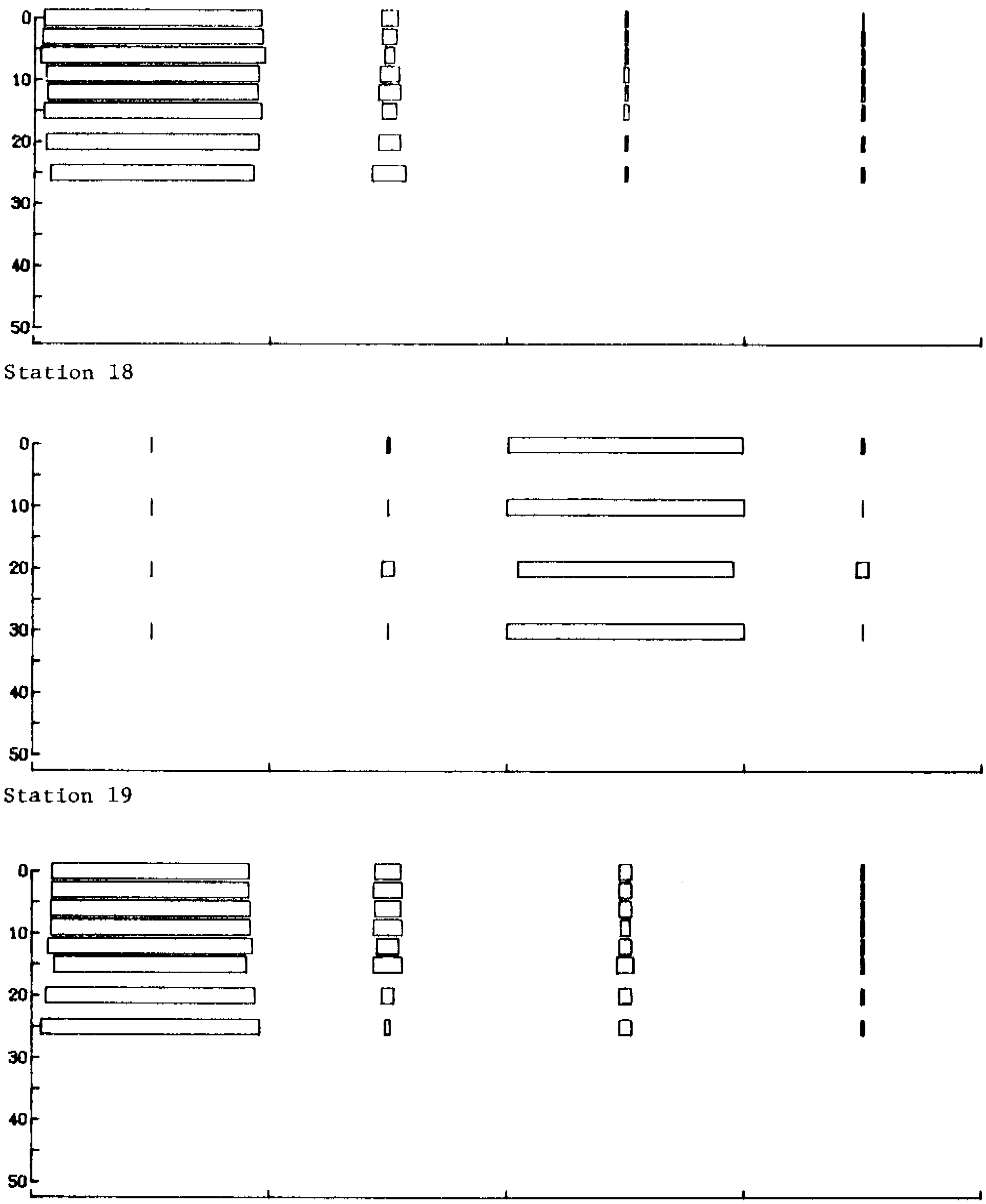


Fig. 3. (continued)



Station 26

Chaetoceros All other diatoms Flagellates Dinoflagellates

Fig. 3. (continued)

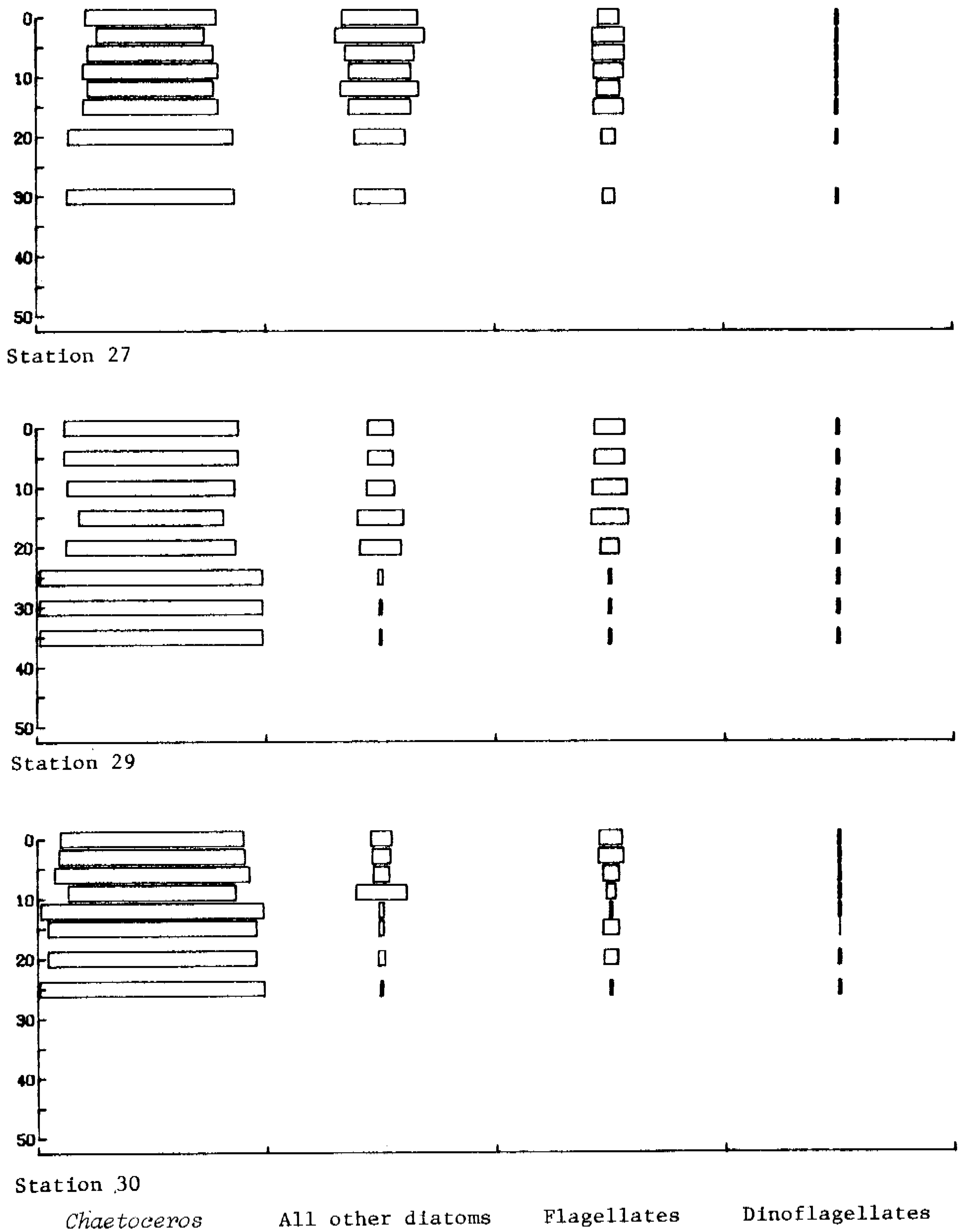


Fig. 3. (continued)

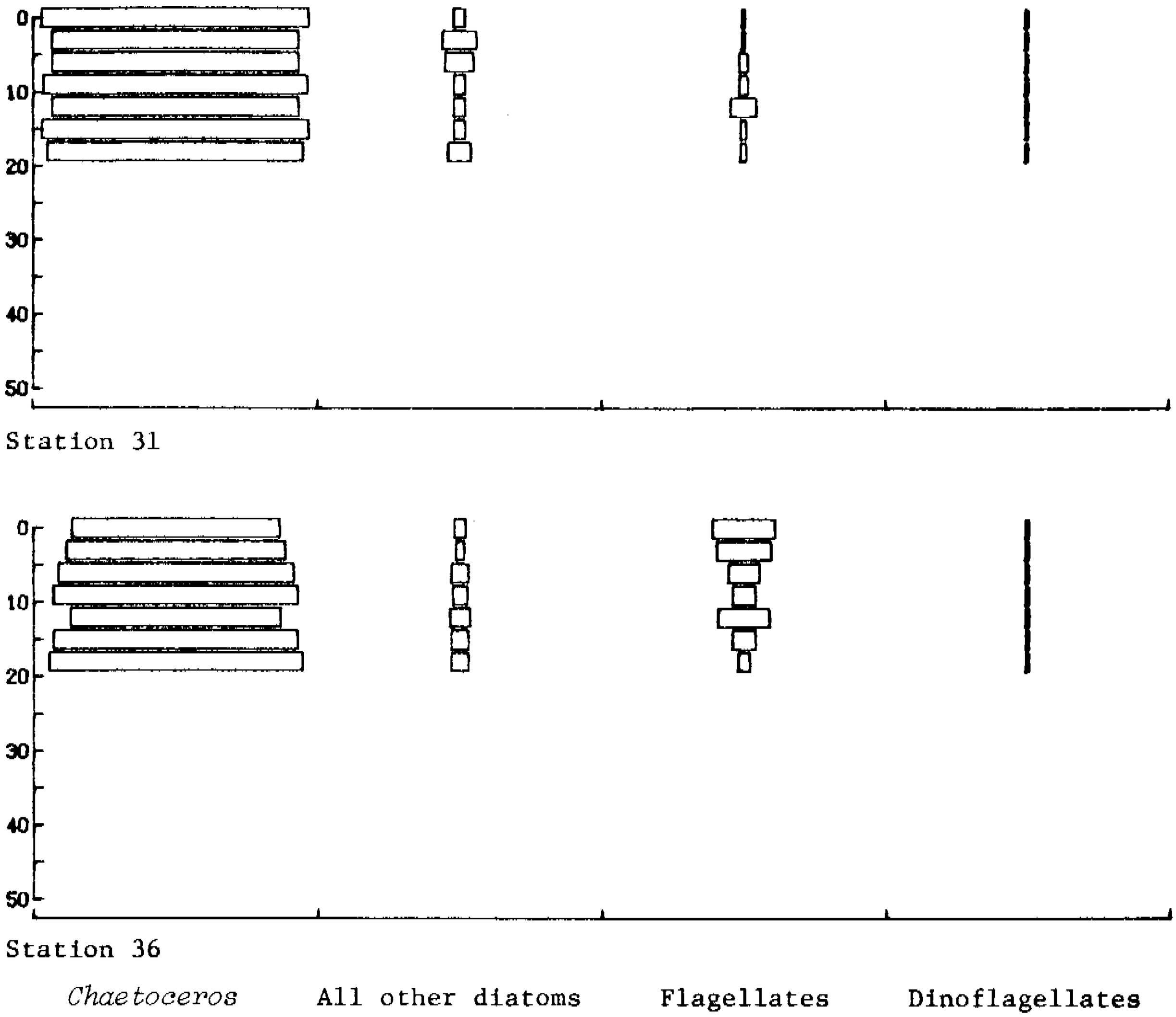


Fig. 3. (continued)

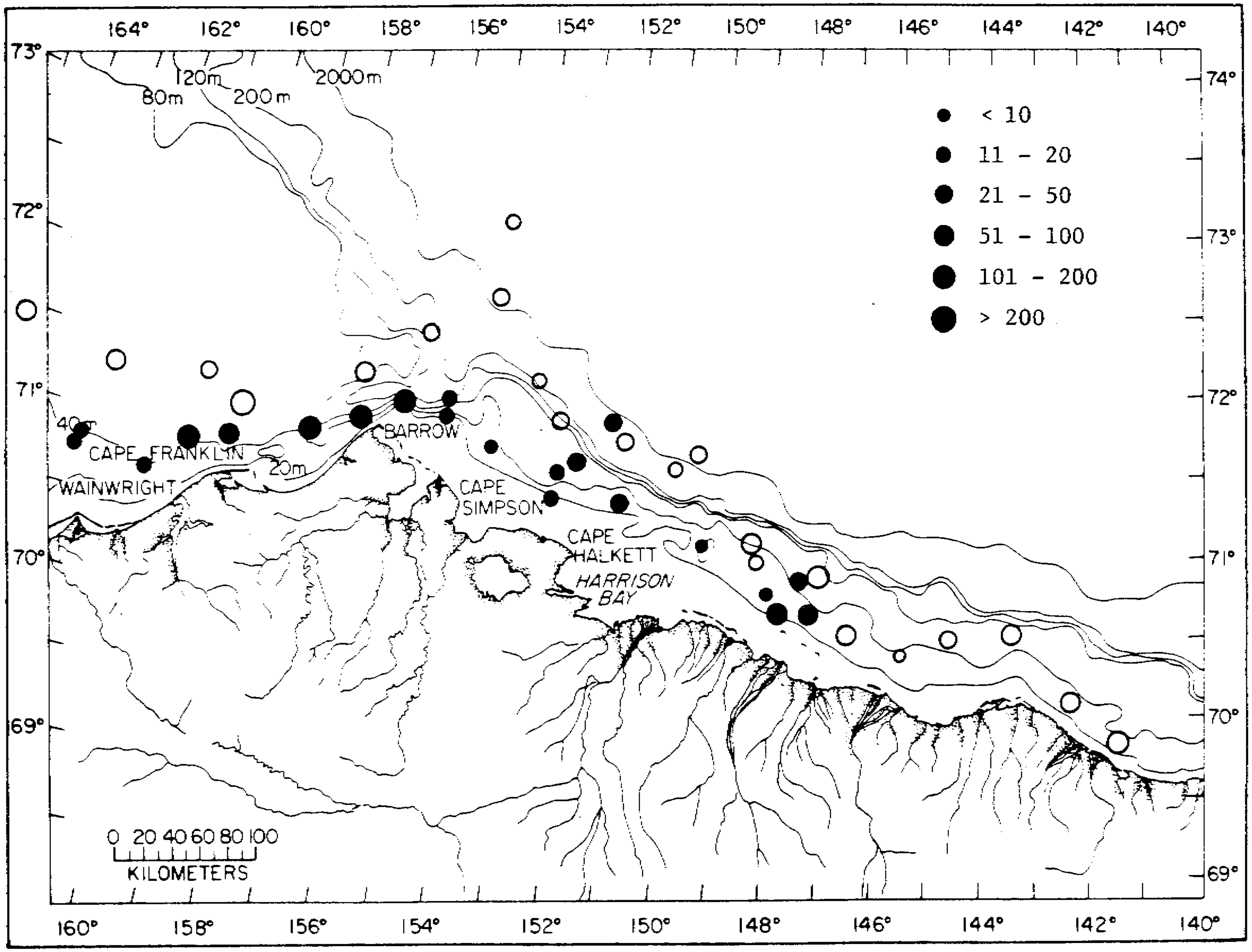


Fig. 4. Integrated ^{14}C assimilation (mg C m^{-2} hr^{-1}) for all stations in the Chukchi and Beaufort seas, Aug - Sep 1976, 1977. ● = 1976, ○ = 1977.

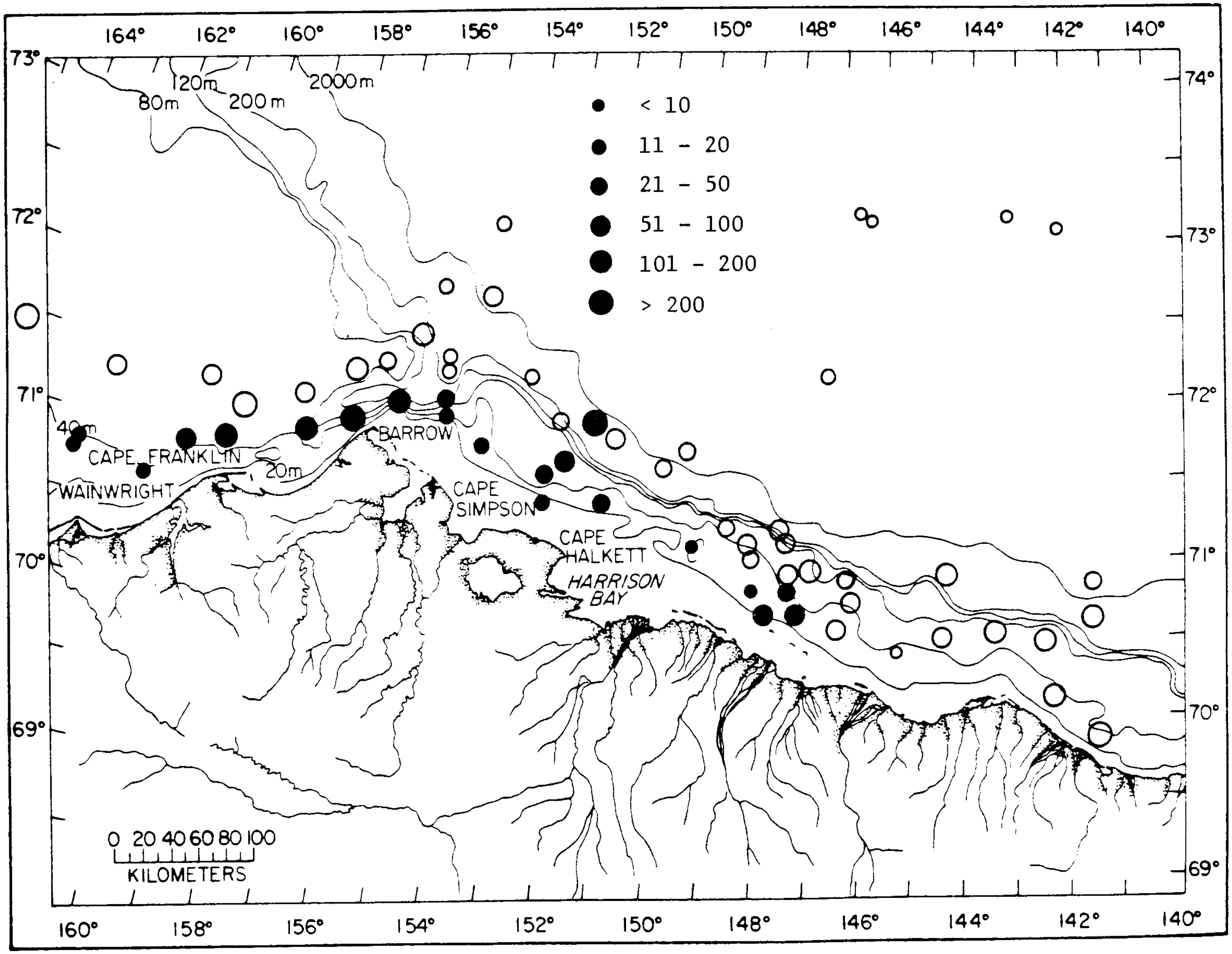


Fig. 5. Integrated chlorophyll *a* (mg m^{-2}) for all stations in the Chukchi and Beaufort seas, Aug - Sep 1976, 1977. ● = 1976, ○ = 1977.

stations and depths where productivity and chlorophyll *a* were low, flagellates comprised more than 50% of the population. At nearly all stations, small, unidentified *Chaetoceros* spp. were the most abundant taxonomic group at the depth of greatest carbon uptake, regardless of total number of cells. The diatoms *Thalassiosira gravida* and *T. nordenskioeldii* were the most abundant organisms at station 4, comprising 34% of the population. At station 9, the flagellate *Parvicorbicula socialis* (Meunier) Deflandre was dominant, comprising 46% of the population. At station 4, productivity at 25 m was 7.96 mg C m^{-3} hr^{-1} and the chlorophyll *a* concentration was 22.94 mg m^{-3}, the highest found during the cruise. At station 9, highest productivity occurred at 20 m and was only 0.23 mg C m^{-3} hr^{-1}; the chlorophyll *a* was 0.14 mg m^{-3}.

D. Zooplankton

Eighty-five categories of zooplankton have been identified from 43 net hauls in the Chukchi and Beaufort seas, including 42 species and 43 other categories such as larval stages and categories where identification was made to some taxonomic rank higher than species (Tables 4 to 8). Greatest emphasis has been placed on species and species groups known to be important prey species for birds and mammals, including amphipods, euphausids, mysids, shrimps, and fish eggs and larvae. Copepods have been identified and counted only as adults and juveniles; they were not identified to species.

Amphipoda

Amphipods have been separated into Gammaridea and Hyperiidae, with the hyperiids further identified to species. *Apherusa glacialis* and *Onisimus glacialis* were identified at some stations near the east end of Harrison Bay, but have not been separated in the tables (Tables 4 to 8). Gammarid amphipods (Fig. 6) occurred at nearly all stations, including those near 73°N, often in large numbers. Hyperiid amphipods (Fig. 7) were present at most stations, especially in the Beaufort Sea, with *Parathemisto* spp. (Fig. 8) being the most numerous.

Euphausiacea

Three species of the genus *Thysanoëssa, T. inermis, T. longipes,* and *T. raschii* were collected throughout the sampling area, but were never very abundant (Fig. 9). Largest numbers occurred at station 39 off Barrow, stations 18 and 33 about 147°W, and station 26 off Demarcation Pt. Large numbers of unidentified furcilia were found at station 41 off Barrow. Few euphausids were found at the deep stations near 73°N.

Decapoda

The decapods have been divided into Anomura, Brachyura, and Caridea, with the Caridea further divided into families. Some specimens have been identified to species, but most have been listed as unidentified larvae. Most larvae belonged to the family Hippolytidae. Larvae were present at nearly all stations, except near 73°N, and were often relatively abundant (Fig. 10).

Table 4. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from the Beaufort Sea. All samples were collected with bongo nets, mesh size 505 μm. Where no number is present, no animals were found.

Taxon	Station Numbers						
	1	2	3	4	4A	5	6
Coelenterata							
Hydrozoa							
Aeginopsis laurentii		90		20			
Aglantha digitale		180	160	20	110	110	50
Calycopsis birulai							
Corymorpha flammea							
Perigonimus vesicarius							
Perigonimus yoldia-arcticae							
Perigonimus spp.							
Plotocnide borealis		90					
Rathkea sp.							
unidentified hydrozoans		180	30				
Scyphozoa - unidentified							
Siphonophora - unidentified							
Ctenophora							
Beroë cucumis			30			40	100
Pleurobrachia pileus cf.							
Polychaeta - unidentified adults and larvae	210	360	740	170	40	150	190
Mollusca							
Gastropoda - Pteropoda							
Clione limacina		550	50	20		40	
Spiratella helicina	410	2910	270	200	220	400	140
unidentified mollusc larvae							

Table 4. (continued)

Taxon	Station Numbers						
	1	2	3	4	4A	5	6
Crustacea							
Ostracoda							
Conchoecia borealis maxima							
Philomedes globosus cf.							
unidentified ostracods			30				
Copepoda							
Calanoida (adults and juveniles)	71380	74730	16000	26540	98070	40690	14150
Calanoida - adults							
Calanoida - juveniles							
Harpacticoida						40	
unidentified nauplii			50			150	50
Cirripedia							
unidentified nauplii	620	1270	30		740	470	290
unidentified cyprids	410						
Mysidacea							
Mysis litoralis							
Mysis oculata							
Mysis relicta cf.							
Mysis spp.		60					2
unidentified *Mysis* larvae							
Cumacea							
unidentified cumaceans					20		
Amphipoda							
Gammaridea - unidentified	720		150	60		590	150

Table 4. (continued)

Taxon	Station Numbers						
	1	2	3	4	4A	5	6
Hyperiidea							
Hyperia galba		10					
Hyperia medusarum							
Hyperoche medusarum							
Parathemisto abyssorum							
Parathemisto libellula		90			220	5	3
Parathemisto sp.		10				5	
Other Hyperiidea							
Euphausiacea							
Thysanoëssa inermis	30				40	10	2
Thysanoëssa longipes		20					2
Thysanoëssa raschii	10	10		10			4
unidentified, unstaged furcilia							2
Decapoda							
Anomura - unidentified		50		60	20	20	10
Brachyura - unidentified		820	40	10	150	130	8
Caridea - unidentified							
Crangonidae							
Sclerocrangon boreas							2
unidentified crangonid larvae						5	
Hippolytidae							
Eualus gaimardii							
Eualus stoneyi							
Hippolyte spp.							
Spirontocaris spp.							
unidentified hippolytid larvae	20	170	50	20	110	5	80

Table 4. (continued)

Taxon	Station Numbers 1	2	3	4	4A	5	6
Oplophoridae							
Hymenodora glacialis							
Pandalidae							
Pandalus borealis							
Pandalus danae	6						
unidentified pandalid larvae	6						
Echinodermata							
unidentified adults & larvae							50
Appendicularia (Larvacea)							
Fritillaria borealis		3270				330	
Fritillaria haplostoma							
Fritillaria spp.		2360	30			470	
Oikopleura labradoriensis		270					
Oikopleura vanhöffeni	1030						290
Oikopleura spp.	2670	5910				180	670
Chaetognatha							
Eukrohnia hamata							
Sagitta elegans	9440	10270	4490	3830	4520	15350	7960
Sagitta maxima cf.	210						
Sagitta spp.		4000		70	520		
unidentified chaetognaths	1440		160	200	300	760	
Pisces							
Eggs - unidentified							
Pleuronectidae							
Hippoglossoides robustus		10				5	

Table 4. (continued)

Taxon	Station Numbers						
	1	2	3	4	4A	5	6
Larvae - unidentified							
Cottidae							
Myoxocephalus quadricornis							
Cyclopteridae							
Liparis sp.							
Gadidae - unidentified	30	120			150	20	2
Boreogadus saida							
Stichaeidae							
Lumpenus fabricii cf.		10					2
Other organisms							
Foraminifera - unidentified							
Nematoda - unidentified			140	60			
Unknown organisms		180		10	70	40	530

Table 5. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from the Beaufort Sea. All samples were collected with bongo nets, mesh size 505 μm. Where no number is present, no animals were found.

	Station Numbers											
Taxon	7	8†	9	10†	11†	12	13	14	38	39	40	41
Coelenterata												
Hydrozoa												
Aeginopsis laurentii	80				120	260	110					
Aglantha digitale	320	20	140	1180	240	260	3090		570	300970	47180	
Calycopsis birulai												
Corymorpha flammea		1		40			40					
Perigonimus vesicarius		1	90		150	260	140					
Perigonimus yoldia-arcticae							40					
Perigonimus spp.		1				110	140					
Plotocnide borealis	160		50		120							
Rathkea sp.	3											
unidentified hydrozoans				80		50	280		2		100	
Scyphozoa - unidentified										10		
Siphonophora - unidentified												
Ctenophora												
Beröe cucumis									70			
Pleurobrachia pileus cf.				40								
Polychaeta - unidentified adults and larvae	320	180	140	470	150		40		220			220
Mollusca												
Gastropoda - Pteropoda												
Clione limacina		40		40		160	70	130		3030	210	140
Spiratella helicina	1090	280	500	1450	2050	5530	2770	4950				330
unidentified mollusc larvae				40		50						

† Volume of water filtered has been estimated for these tows using ship speed x duration of haul x mouth area of the net.

Table 5. (continued)

Taxon	Station Numbers 7	8†	9	10‡	11†	12	13	14	38	39	40	41
Crustacea												
Ostracoda												
Conchoecia borealis maxima		240	50			110	210					
Philomedes globosus cf.		20		40								
unidentified ostracods				40	60							
Copepoda												
Calanoida (adults & juveniles)								36320	17510			
Calanoida - adults	1710	2710	3990	9600	3910	4050	7370					4330
Calanoida - juveniles	32000	15640	17510	64460	57530	15580	24070				360	52590
Harpacticoida		20	230	40								
unidentified nauplii	240	40	280	300	90							290
Cirripedia												
unidentified nauplii	47790	3410	3480	3730	8760		40		70			5310
unidentified cyprids	850	120	550	460								
Mysidacea												
Mysis litoralis					8	160	50	80				
Mysis oculata						80	20	30				
Mysis relicta cf.				10		30						
Mysis spp.		1		10	8	90	40	30				
unidentified *Mysis* larvae												
Cumacea												
unidentified cumaceans				80								
Amphipoda												
Gammaridea - unidentified	80	170	340	430	720	2680	210	870	40	10		90

Table 5. (continued

Taxon	Station Numbers											
	7	8†	9	10†	11†	12	13	14	38	39	40	41
Hyperiidea												
Hyperia galba	3				20	40	20	20		30		
Hyperia medusarum												
Hyperoche medusarum		1										
Parathemisto abyssorum	160	40	50	10	8	260	1230	950	10	10		
Parathemisto libellula	40	60	160	100	150	750	1160	1220	110	510		210
Parathemisto sp.	3	6	20		20	240	370	140	2	30		
Other Hyperiidea					8					30		
Euphausiacea												
Thysanoëssa inermis	3	10							7	40		2
Thysanoëssa longipes							20					10
Thysanoëssa raschii	20	3		10		10		20		120		2
unidentified, unstaged furcilia				80	8				2		10	210
Decapoda												
Anomura - unidentified	110		140	40		10	20		70			40
Brachyura - unidentified	90	40		40							100	
Caridea - unidentified								20				
Crangonidae												
Sclerocrangon boreas												
unidentified crangonid larvae												
Hippolytidae												
Eualus gaimardii												
Eualus stoneyi												
Hippolyte spp.						10						
Spirontocaris spp.			3			30						
unidentified hippolytid larvae	30	4	3	110	60	80	90	170	90			210

Table 5. (continued)

Taxon	7	8[†]	9	10[†]	11[†]	12	13	14	38	39	40	41
	Station Numbers											
Oplophoridae												
Hymenodora glacialis												
Pandalidae												
Pandalus borealis											10	20
Pandalus danae												
unidentified pandalid larvae						10						
Echinodermata												
unidentified adults & larvae		20		60								
Appendicularia (Larvacea)												
Fritillaria borealis				10	120							
Fritillaria haplostoma												
Fritillaria spp.	20050	2340	1330	460	370	210			70			330
Oikopleura labradoriensis	240		50		150		70	510				
Oikopleura vanhöffeni	3680	200	1100	2820	5500	110		1400	430			250
Oikopleura spp.	11090	2870	6370	28380	9500	4530	1720	5210	3090			5020
Chaetognatha												
Eukrohnia hamata	240	100	280		30	160	390	130	70			
Sagitta elegans	6880	2020	4860	3120	2200	890	6040	1140	9540			12280
Sagitta maxima cf.												
Sagitta spp.								130				
unidentified chaetognaths		60	410	950	90	50						3070
Pisces												
Eggs												
Pleuronectidae												
Hippoglossoides robustus	3											

Table 5. (continued)

Taxon	Station Numbers 7	8†	9	10†	11†	12	13	14	38	39	40	41
Larvae - unidentified										10		2
Agonidae												
Aspidophoroides olriki												
Cottidae - unidentified												
Myoxocephalus quadricornis				10								
Cyclopteridae												
Liparis spp.				10			20					
Gadidae - unidentified				20	8	10	40			30		5
Boreogadus saida									2			10
Stichaeidae												
Lumpenus fabricii cf.	3											5
Other organisms												
Foraminifera - unidentified					210	50						
Nematoda - unidentified							40				50	
Unknown organisms	50	80		440			70					40
Unknown invertebrate egg												

Table 6. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from the Beaufort Sea. All samples were collected with bongo nets, mesh size 505 μm, unless otherwise indicated. Where no number is present, no animals were found.

	Station Numbers									
Taxon	15E*	16E*	16AE*	17†	18	19	24	25	26†	27
Coelenterata										
Hydrozoa										
Aeginopsis laurentii		30	40	20		6	4			
Aglantha digitale	280	100	300	400	2200	190	500	560	160	1440
Calycopsis birulai										
Corymorpha flammea		20			30					
Perigonimus vesicarius		30	130		20					10
Perigonimus yoldia-arcticae										
Perigonimus spp.										
Plotocnide borealis		9								30
Rathkea sp.										
unidentified hydrozoans	10									
Scyphozoa - unidentified										
Siphonophora - unidentified							20	60		
Ctenophora										
Beroë cucumis						6				30
Pleurobrachia pileus cf.	30		40	20				6	8	10
Polychaeta - unidentified adults and larvae					20	6		6		
Mollusca										
Gastropoda - Pteropoda										
Clione limacina	60	30	90		70	6	4	10		
Spiratella helicina	2640	2880	6170	2970	3040	530	50	270	8	10
unidentified mollusc larvae								6		

* E indicates the sample was collected with the English umbrella net, mesh size *ca.* 220 μm.
† Volume of water filtered has been estimated for these tows using speed x duration x mouth area of the net.

Table 6. (continued)

	Station Numbers									
	15E*	16E*	16AE*	17†	18	19	24	25	26†	27
Crustacea										
Ostracoda										
Conchoecia borealis maxima	10	30	40	130	170	160	190	220	20	
Philomedes globosus cf.										
unidentified ostracods										
Copepoda										
Calanoida (adults and juveniles)	8780									
Calanoida - adults		4560	7170	42970	9290	6980	3890	3320	23820	10700
Calanoida - juveniles		3960	5090	14400	25120	15460	17940	13600	33220	12130
Harpacticoida								6		
unidentified nauplii										
Cirripedia										
unidentified nauplii	10	40								
unidentified cyrids										
Mysidacea										
Mysis litoralis	10			40	8				30	10
Mysis oculata		9		10					20	10
Mysis relicta cf.										
Mysis spp.		40		40	40			2	100	
unidentified *Mysis* larvae										
Cumacea										
unidentified cumaceans					8					
Amphipoda										
Gammaridea - unidentified	110	100	80	380	320	10	6	20	20	10

Table 6. (continued)

Taxon	Station Numbers 15E*	16E*	16AE*	17[†]	18	19	24	25	26[†]	27
Hyperiidea										
Hyperia galba										
Hyperia medusarum										
Hyperoche medusarum										
Parathemisto abyssorum			10			60	210	680		30
Parathemisto libellula				30	30	150	60	90	8	30
Parathemisto sp.						7	6	20		10
Other Hyperiidea										
Euphausiacea										
Thysanoëssa inermis					8			3	20	
Thysanoëssa longipes								3		
Thysanoëssa raschii		9		10	110		1		510	40
unidentified, unstaged furcilia								2		
Decapoda										
Anomura - unidentified										
Brachyura - unidentified										
Caridea - unidentified										
Crangonidae										
Sclerocrangon boreas										
unidentified crangonid larvae										
Hippolytidae										
Eualus gaimardii										
Eualus stoneyi										
Hippolyte spp.										20
Spirontocaris spp.										
unidentified hippolytid larvae	100	80	150	300	100			2		

Table 6. (continued)

Taxon	Station Numbers									
	15E*	16E*	16AE*	17 †	18	19	24	25	26 †	27
Oplophoridae										
Hymenodora glacialis										
Pandalidae										
Pandalus borealis										
Pandalus danae										
unidentified pandalid larvae										
Echinodermata										
unidentified adults & larvae										
Appendicularia (Larvacea)										
Fritillaria borealis				40				30		
Fritillaria haplostoma										
Fritillaria spp.		140		60				10		
Oikopleura labradoriensis	180	70	90					20		20
Oikopleura vanhöffeni	150	1280	1430	60	30	170	80	140		400
Oikopleura spp.	210	810	960	690	1090	1040	1080	2570		1330
Chaetognatha										
Eukrohnia hamata		20			20	900	510	1150	100	110
Sagitta elegans	430	370	300	530	170	30	40	40	140	180
Sagitta maxima cf.										
Sagitta spp.										
unidentified chaetognaths		9			20			6		
Pisces										
Eggs										
Pleuronectidae										
Hippoglossoides robustus										

Table 6. (continued)

Taxon	Station Numbers									
	15E*	16E*	16AE*	17†	18	19	24	25	26†	27
Larvae - unidentified										
Agonidae										
Aspidophoroides olriki										
Cottidae - unidentified										
Myoxocephalus quadricornis										
Cyclopteridae										
Liparis spp.					8					
Gadidae - unidentified	30	20		50	20					
Boreogadus saida										
Stichaeidae										
Lumpenus fabricii cf.										
Other organisms										
Foraminifera - unidentified										
Nematoda - unidentified										
Unknown organisms										
Unknown invertebrate egg										

Table 7. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from the Beaufort Sea. All samples were collected with bongo nets, mesh size 505 μm, unless otherwise indicated. Where no number is present, no animals were found.

Taxon	Station Numbers									
	28	29	30	31†	32	33	35E*	36	37E*	37
Coelenterata										
Hydrozoa										
Aeginopsis laurentii	10	20	20		240	20	70	90	340	210
Aglantha digitale	480	920	1080	270	550	270	430	150	210	70
Calycopsis birulai							20	30		
Corymorpha flammea					60	8	140			10
Perigonimus vesicarius			30			20	180		90	
Perigonimus yoldia-arcticae								30	180	
Perigonimus spp.							140			50
Plotocnide borealis		8					50			
Rathkea sp.										
unidentified hydrozoans										10
Scyphozoa - unidentified										
Siphonophora - unidentified	4									
Ctenophora										
Beroë cucumis		20	20		60		110			
Pleurobrachia pileus cf.		30								
Polychaeta - unidentified adults and larvae	4				8	20	70			
Mollusca										
Gastropoda - Pteropoda										
Clione limacina	8	50	220	120		100		50	130	170
Spiratella helicina	310	890	2220	7440	6910	3620	5610	3830	8650	1390
unidentified mollusc larvae	10	20								

* E indicates the sample was collected with the English umbrella net, mesh size *ca.* 220 μm.
† Volume of water filtered has been estimated for these tows using speed x duration x mouth area of the net.

Table 7. (continued)

Taxon	Station Numbers 28	29	30	31†	32	33	35E*	36	37E*	37
Crustacea										
Ostracoda										
Conchoecia borealis maxima		8	90		60	50	180	20		20
Philomedes globosus cf.										
unidentified ostracods										
Copepoda										
Calanoida (adults and juveniles)							115640	16590	71290	96170
Calanoida - adults	6520	4890	27950	9420	5940	4870				
Calanoida - juveniles	10360	8990	23170	3690	44610	7070				
Harpacticoida										
unidentified nauplii					850					
Cirripedia										
unidentified nauplii	4						40	20	90	
unidentified cyprids										
Mysidaceae										
Mysis litoralis		20	20			8	20	120	90	40
Mysis oculata		40	20				20	30		80
Mysis relicta cf.		20		20						
Mysis spp.	4	30	10			20		20		
unidentified *Mysis* larvae							120			
Cumacea										
unidentified cumaceans										
Amphipoda										
Gammaridea - unidentified	20	130	330	1880	110	1040	380	260	820	460

Table 7. (continued)

Taxon	Station Numbers 28	29	30	31†	32	33	35E*	36	37E*	37
Hyperiidea										
Hyperia galba		20			8	8		30	30	40
Hyperia medusarum									10	
Hyperoche medusarum			10							10
Parathemisto abyssorum	40	20	10		670	30		110	370	260
Parathemisto libellula	390	120	70	20	3190	180		420	10	7970
Parathemisto sp.	110	60			50	80				500
Other Hyperiidea										20
Euphausiacea										
Thysanoëssa inermis	4	20	20			20		50		10
Thysanoëssa longipes										
Thysanoëssa raschii	8	40	70	20	8	250		50		40
unidentified, unstaged furcilia										
Decapoda										
Anomura - unidentified										
Brachyura - unidentified										
Caridea - unidentified										
Crangonidae										
Sclerocrangon boreas										
unidentified crangonid larvae										
Hippolytidae										
Eualus gaimardii		8								
Eualus stoneyi		8								
Hippolyte spp.										
Spirontocaris spp.										
unidentified hippolytid larvae	60	390	20	20	80	80	340	50	100	80

Table 7. (continued)

Taxon	Station Numbers									
	28	29	30	31†	32	33	35E*	36	37E*	37
Oplophoridae										
Hymenodora glacialis										
Pandalidae										
Pandalus borealis										
Pandalus danae										
unidentified pandalid larvae										
Echinodermata										
unidentified adults & larvae		8								
Appendicularia (Larvacea)										
Fritillaria borealis	10				300		960			
Fritillaria haplostoma								60		
Fritillaria spp.	4		50	20		330	2930	150	590	
Oikopleura labradoriensis		20				70	250	30	8000	520
Oikopleura vanhöffeni	70	790	80	60	10970	1650	640	120	6240	4520
Oikopleura spp.	2060	3310	1630	810	39150	7230	570	850	13760	15300
Chaetognatha										
Eukrohnia hamata	300	140	30		550	20	40	50	10	
Sagitta elegans	10	170	90	80	240	730	1320	210	100	1040
Sagitta maxima cf.										
Sagitta spp.										700
unidentified chaetognaths	4							30		170
Pisces										
Eggs										
Pleuronectidae										
Hippoglossoides robustus										

Table 7. (continued)

Taxon	Station Numbers									
	28	29	30	31[†]	32	33	35E*	36	37E*	37
Larvae - unidentified					40					
Agonidae										
Aspidophoroides olriki										
Cottidae - unidentified	8									
Myoxocephalus quadricornis								20		20
Cyclopteridae										
Liparis spp.	4	8								
Gadidae - unidentified							20	20		10
Boreogadus saida								20		10
Stichaeidae										
Lumpenus fabricii cf.										
Other organisms										
Foraminifera - unidentified					60					
Nematoda - unidentified										
Unknown organisms	8	8					40			
Unknown invertebrate egg							20			

Table 8. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from the Beaufort Sea. All samples were collected with bongo nets, mesh size 505 μm, unless otherwise indicated. Where no number is present, no animals were found.

Taxon	Station Numbers				
	20E*	21	22	23§	34
Coelenterata					
Hydrozoa					
Aeginopsis laurentii					20
Aglantha digitale	180	90	5		180
Calycopsis birulai					
Corymorpha flammea					
Perigonimus vesicarius					
Perigonimus yoldia-arcticae					
Perigonimus spp.					
Plotocnide borealis					
Rathkea sp.					
unidentified hydrozoan medusae					
Scyphozoa - unidentified medusae					
Siphonophora - unidentified	40	100	80		
Ctenophora					
Beröe cucumis			5		
Pleurobrachia pileus cf.					50
Polychaeta - unidentified polychaetes (adults and larvae)			20		30
Mollusca					
Gastropoda - Pteropoda					
Clione limacina		70			50
Spiratella helicina	100	710	380		1460
unidentified mollusc larvae					

* E indicates the sample was collected with the English umbrella net, mesh size *ca.* 220 μm.
§ Net lost, no sample taken.

Table 8. (continued)

Taxon	Station Numbers				
	20E*	21	22	23	34
Crustacea					
Ostracoda					
Conchoecia borealis maxima	20	740	480		
Philomedes globosus cf.					
unidentified ostracods					20
Copepoda					
Calanoida					
Calanoida - adults	1880	3310	1730		6860
Calanoida - juveniles	7940	14930	11010		21040
Harpacticoida			10		
unidentified nauplii					
Cirripedia					
unidentified nauplii					100
unidentified cyprids					
Mysidacea					
Mysis litoralis					
Mysis oculata					
Mysis relicta cf.					
Mysis spp.		1	1		
unidentified *Mysis* larvae					
Cumacea					
unidentified cumaceans					
Amphipoda					
Gammaridea - unidentified	20	20	10		60

Table 8. (continued)

Taxon	Station Numbers 20E*	21	22	23	34
Hyperiidea					
Hyperia galba					
Hyperia medusarum					
Hyperoche medusarum					
Parathemisto abyssorum	30	70	90		30
Parathemisto libellula	8	140	230		500
Parathemisto sp.		4	10		20
Other Hyperiidea					
Euphausiacea					
Thysanoëssa inermis					
Thysanoëssa longipes			1		
Thysanoëssa raschii					
unidentified, unstaged furcilia					
Decapoda					
Anomura - unidentified					
Brachyura - unidentified					
Caridea - unidentified					
Crangonidae					
Sclerocrangon boreas					
unidentified crangonid larvae					
Hippolytidae					
Eualus gaimardii					
Eualus stoneyi					
Hippolyte sp.					
Spirontocaris spp.					
unidentified hippolytid larvae					30
Oplophoridae					
Hymenodora glacialis			1		

Table 8. (continued)

Taxon	Station Numbers 20E*	21	22	23	34
Pandalidae					
Pandalus borealis					
Pandalus danae					
unidentified pandalid larvae					
Echinodermata					
unidentified adults and larvae					20
Appendicularia (Larvacea)					
Fritillaria borealis					170
Fritillaria haplostoma					
Fritillaria spp.		40	30		
Oikopleura labradoriensis	60				
Oikopleura vanhöffeni	2060	260	140		490
Oikopleura spp.	310	2200	2230		3530
Chaetognatha					
Eukrohnia hamata	2220	1200	1240		390
Sagitta elegans			5		2740
Sagitta maxima cf.					
Sagitta spp.					
unidentified chaetognaths					220

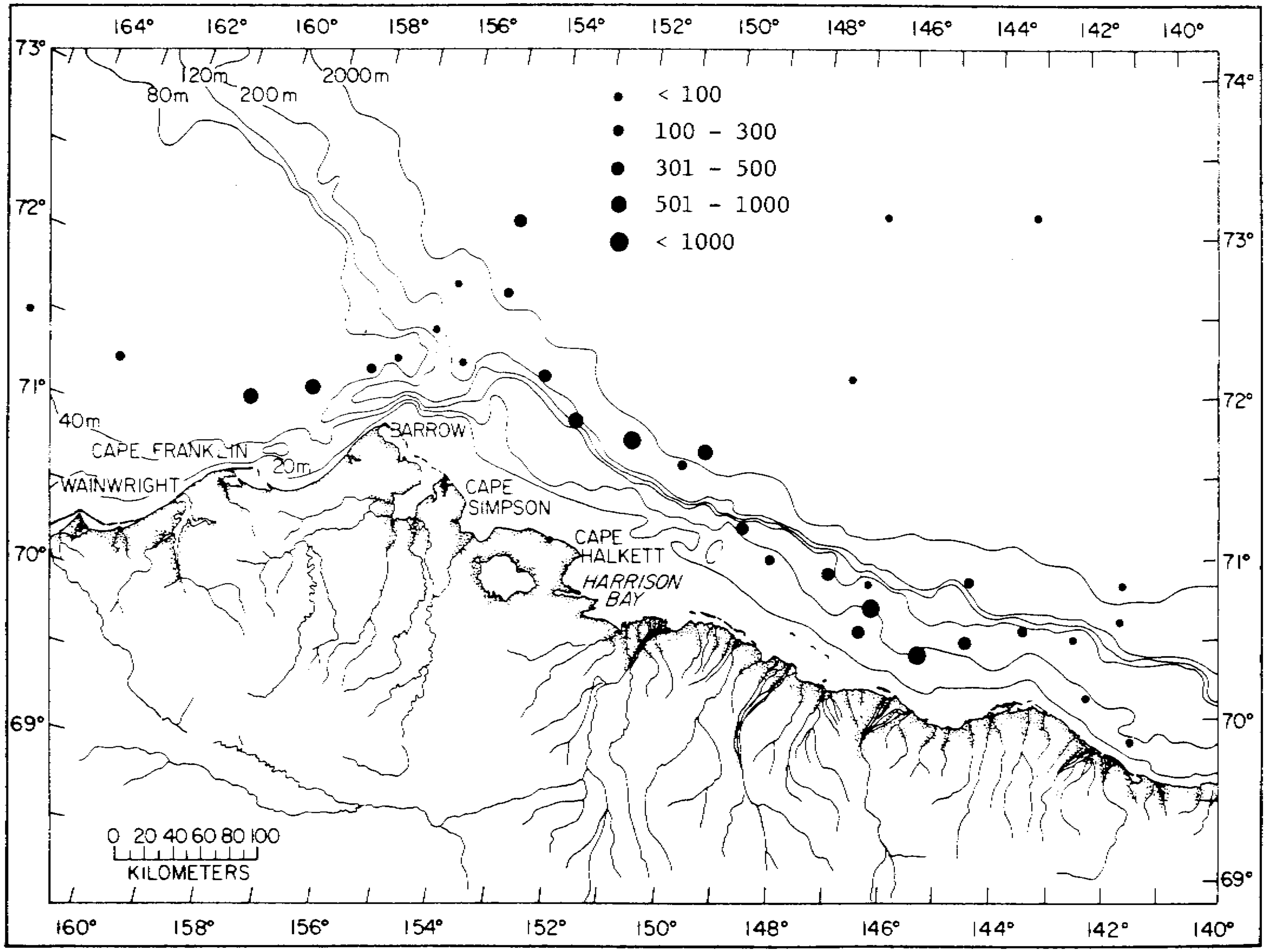


Fig. 6. Abundance (number per 1000 m^3) of gammarid amphipods at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

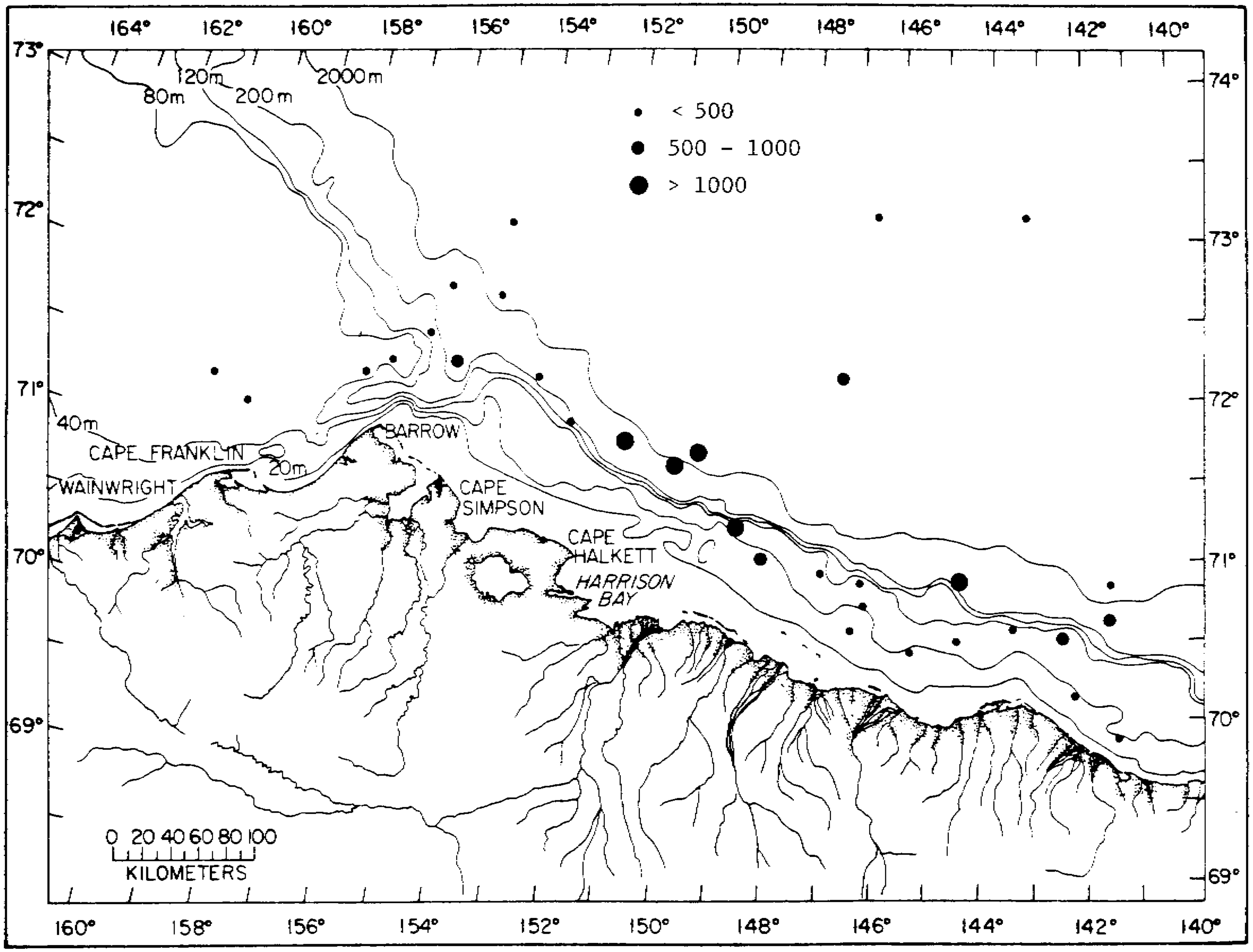


Fig. 7. Abundance (number per 1000 m^3) of hyperiid amphipods at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

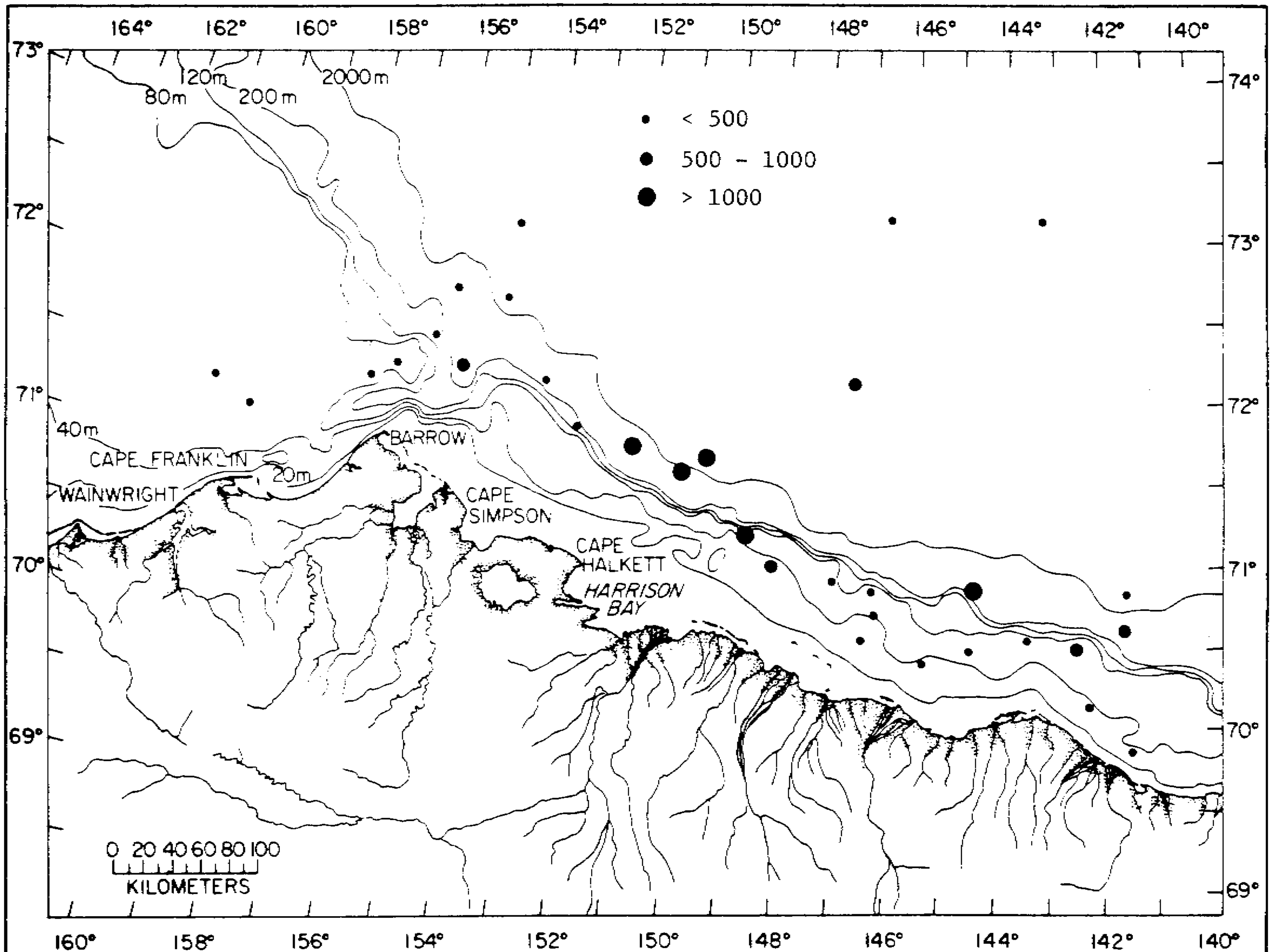


Fig. 8. Abundance (number per 1000 m^3) of *Parathemisto* spp. at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

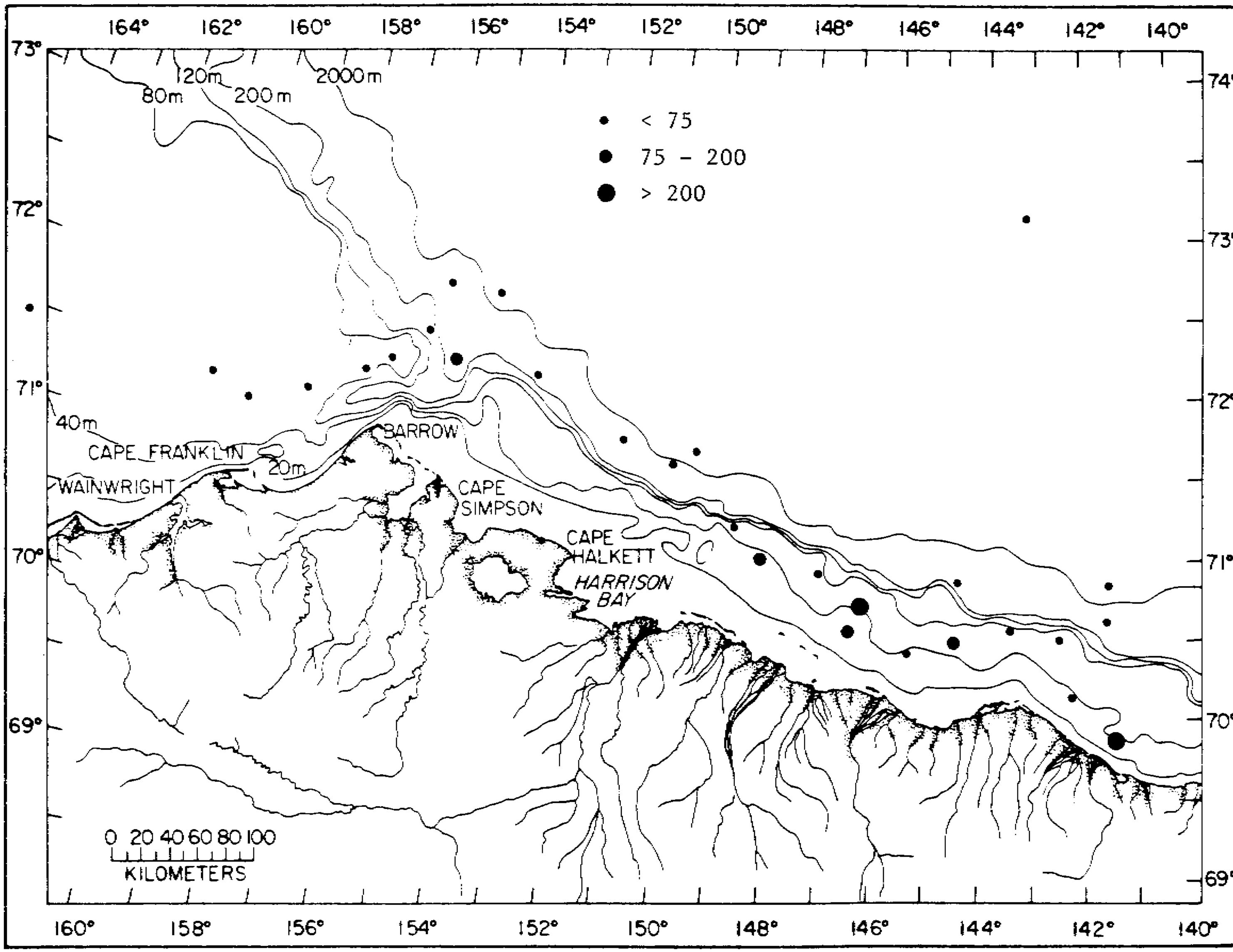


Fig. 9. Abundance (number per 1000 m^3) of *Thysanoëssa* spp. at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

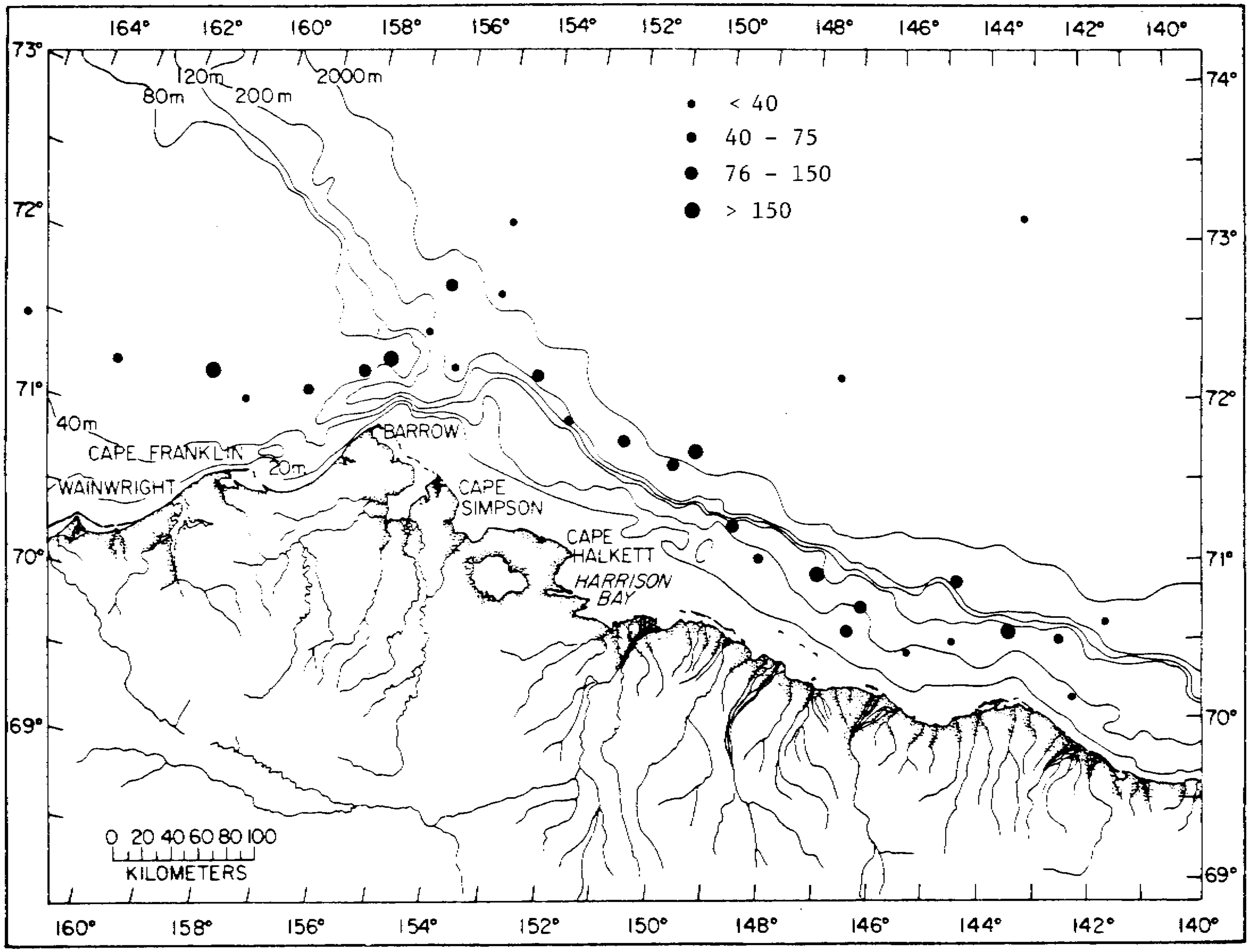


Fig. 10. Abundance (number per 1000 m^3) of shrimp at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

Mysidacea

Mysids were present at most Beaufort Sea stations, but only two Chukchi Sea stations (Fig. 11). They were most numerous at stations off Harrison Bay.

Pisces

Few fish eggs and larvae were collected. A few *Hippoglossoides robustus* eggs were found at stations 2 and 5 off Pt. Franklin (*ca.* 159°W) and at station 7 off Barrow.

Fish larvae were collected at some stations (Fig. 12), but not in large numbers. Unidentified gadid larvae were the most numerous. These larvae were generally too small to be identified to species, but were probably arctic cod, *Boreogadus saida.* All gadid larvae that could be identified with certainty were arctic cod. Other larvae identified to species were *Aspidophoroides olriki* from station 34, *Myoxocephalus quadricornis* from stations 10, 36, and 37, and *Lumpenus fabricii cf.* from stations 2, 6, 7, and 41. Unidentified *Liparis* species were collected at stations 10, 13,18, 28, and 29.

Coelenterata

Hydrozoan medusae were collected at all stations except 1, 14, and 41. The most common species, *Aglantha digitale*, occurred at all stations, often in large numbers. It was especially abundant at stations 39 and 40 off Barrow. Six other species of hydrozoans were also identified.

Siphonophora

Unidentified siphonophores were present at stations 20, 21, and 22 near 73°N and at stations 24, 25, and 28 near 71°30'N off Demarcation Pt.

Ctenophora

Beroë cucumis and *Pleurobrachia pileus cf.* were the only ctenopores identified. They were present at stations throughout the sampling area, but were never very abundant.

Polychaeta

Unidentified polychaete larvae were present throughout the area, but were most abundant at stations west of Cape Halkett.

Mollusca

The pteropods *Clione limacina* and *Spiratella helicina* were common throughout the sampling area (Fig. 13). *Spiratella* was the most abundant, occurring at all stations except 38, 39, and 40 off Barrow.

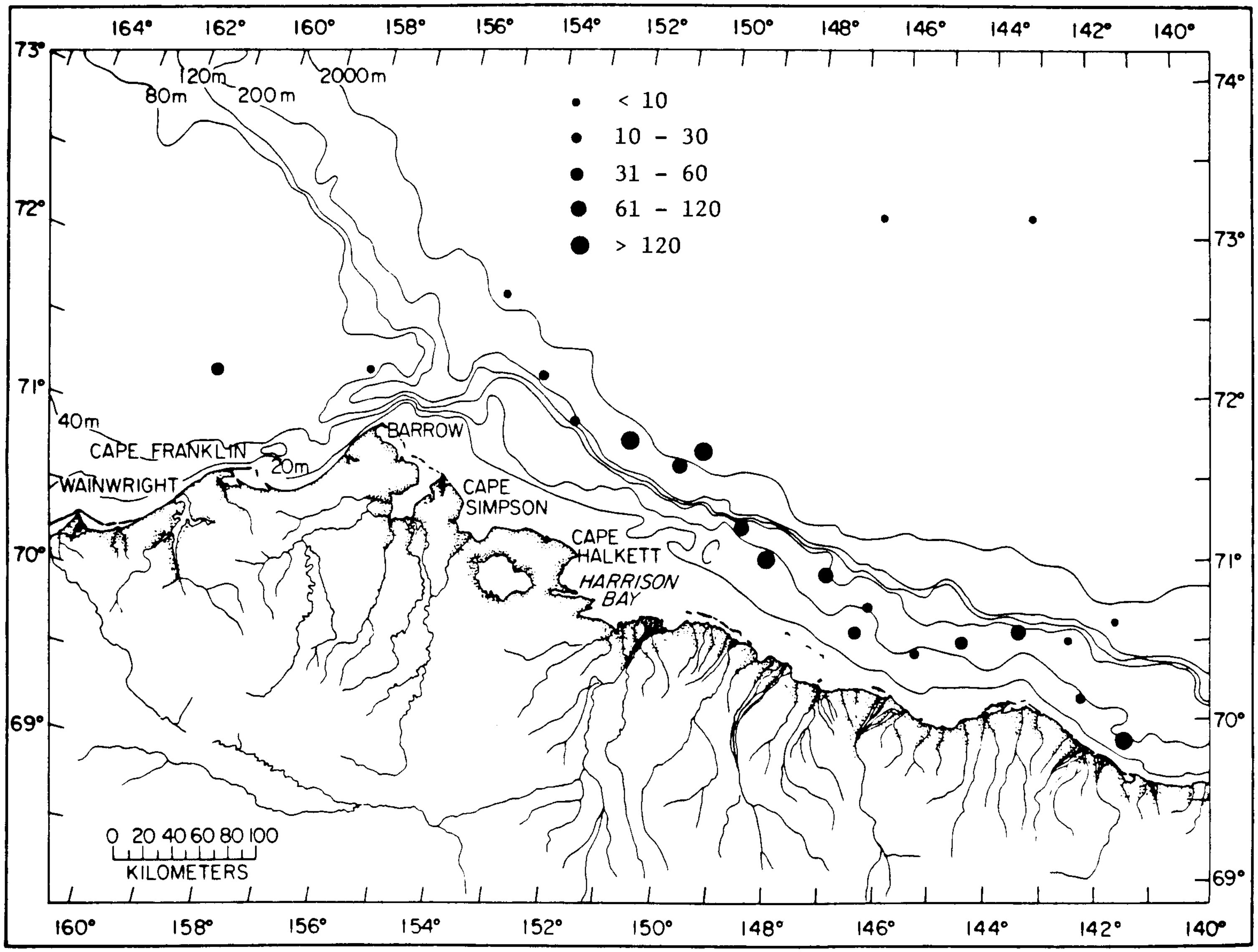


Fig. 11. Abundance (number per 1000^3) of mysids at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

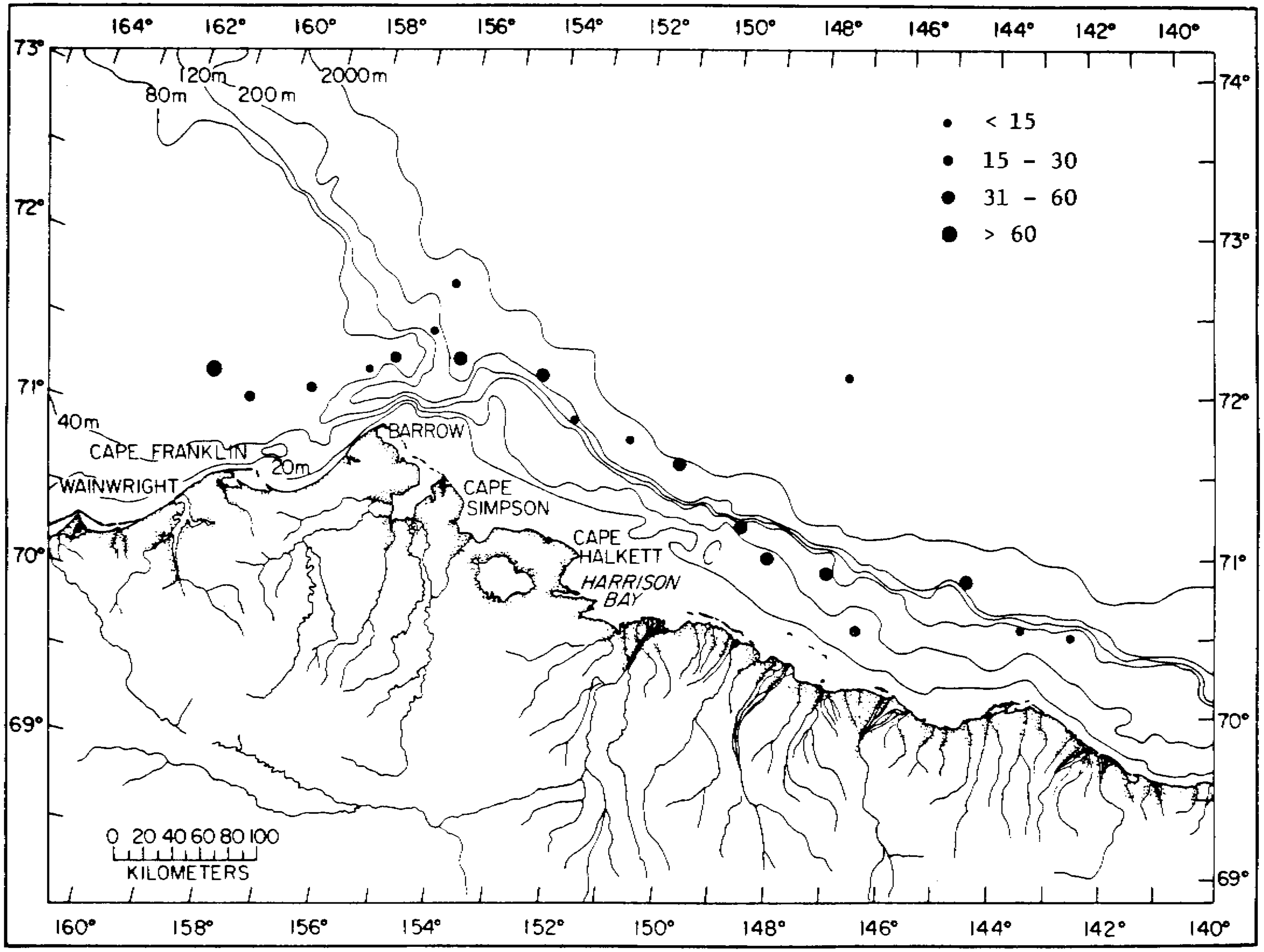


Fig. 12. Abundance (number per 1000 m^3) of fish larvae at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

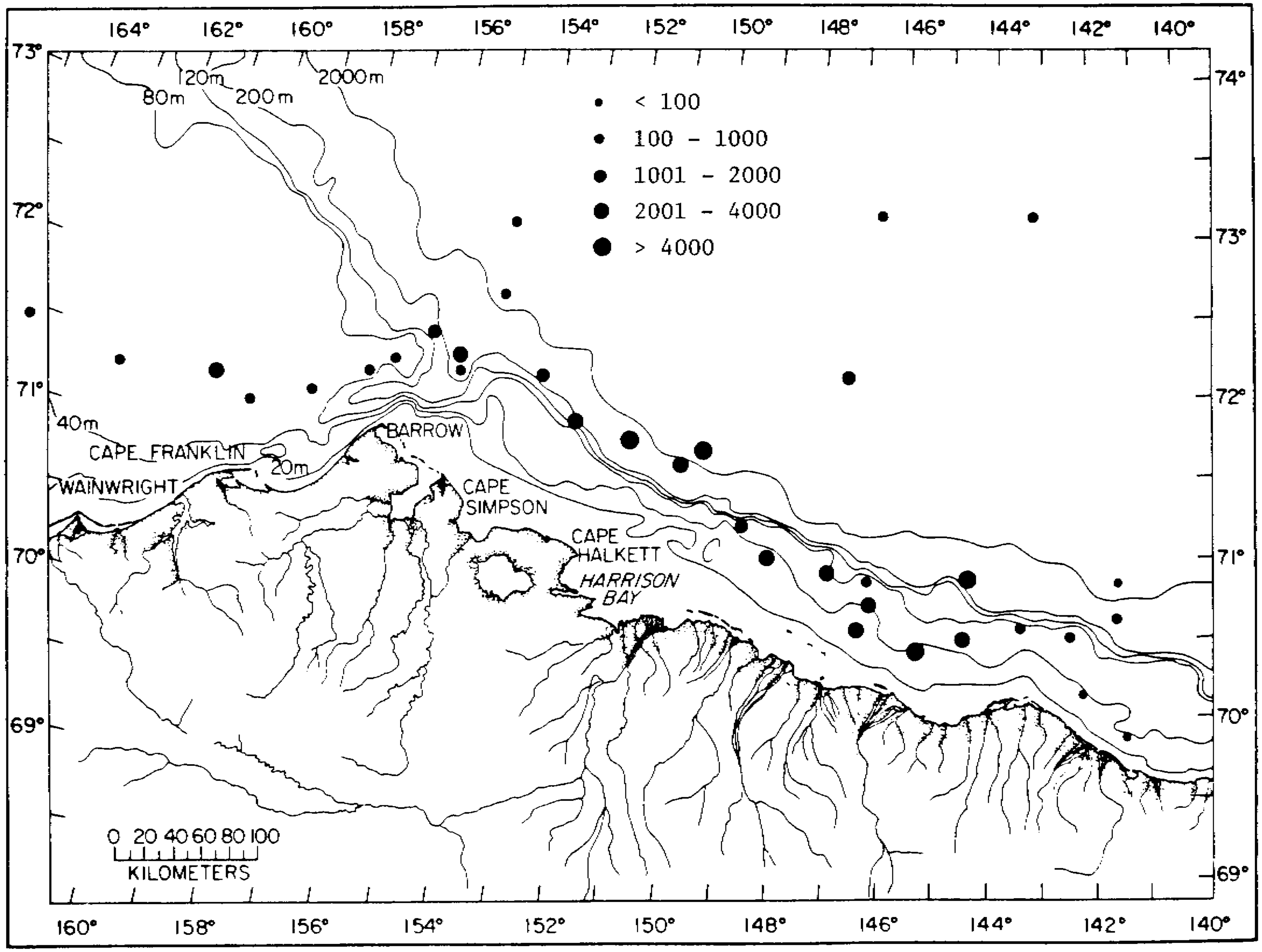


Fig. 13. Abundance (number per 1000 m^3) of pteropods at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

Copepoda

Calanoid copepods, identified only as adults and juveniles, were abundant at all stations except 39 and 40. Harpacticoid copepods were found only at stations 5 and 22. Distribution of all copepods is given in Fig. 14.

Cirripedia

Barnacle larvae were most abundant at stations in the Chukchi Sea and west of Cape Halkett.

Ostracoda

Ostracods were found at most stations in the Beaufort Sea, but only one station in the Chukchi Sea. *Conchoecia borealis maxima* was the most common species found.

Cumacea

Unidentified cumaceans were found at stations 4A, 10, and 18.

Echinodermata

Unidentified echinoderm larvae were found at stations 6, 8, 10, 29, and 34.

Appendicularia

Appendicularians were present and relatively abundant at nearly all stations, but were more numerous in the Beaufort Sea than in the Chukchi Sea.

Chaetognatha

Chaetognaths (Fig. 15) were widespread and abundant throughout the sampling area, except at stations 39 and 40 off Pt. Barrow. They were most numerous at Chukchi Sea stations. *Eukrohnia hamata* and *Sagitta elegans* were the most abundant species, although *Eukrohnia* was not found in the Chukchi Sea samples.

V. Preliminary Interpretation of Results

Hufford (1973) has reported Bering Sea water in the Beaufort Sea as far east as 138°15'W. In 1976, Bering Sea water was found near 151°19'W, while in 1977, it was found to 152°43'W. Expatriate copepod species, including *Calanus cristatus* and *Eucalanus bungii bungii*, and the diatom *Leptocylindrus minimus* were found in Bering Sea water in 1976. Copepods were not identified to species in the 1977 samples, but few cells of *Leptocylindrus* were found.

All of the phytoplankton species found in the 1977 *Glacier* samples have been reported previously in the Chukchi and Beaufort seas (Bursa 1963,

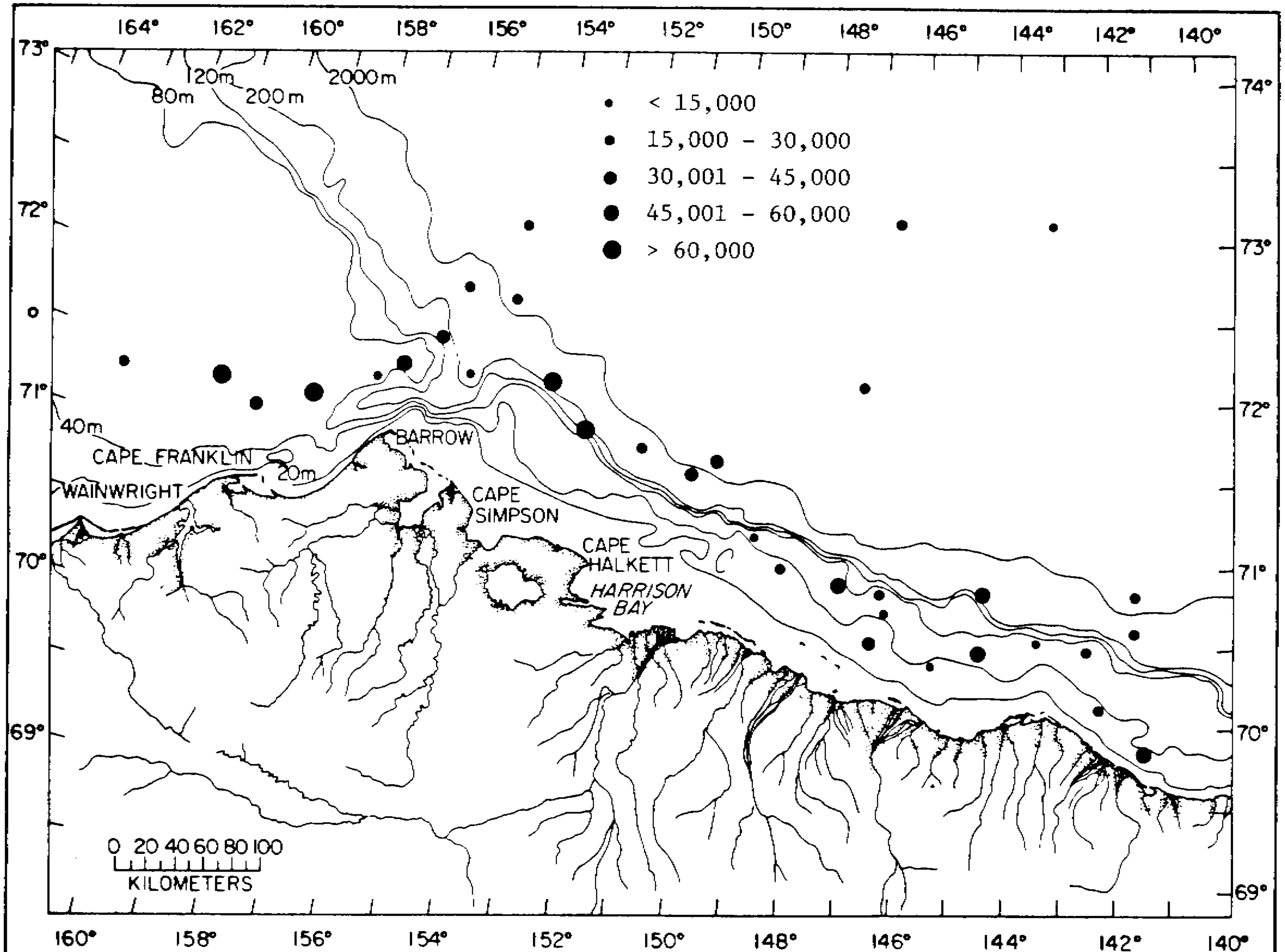


Fig. 14. Abundance (number per 1000 m^3) of copepods at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

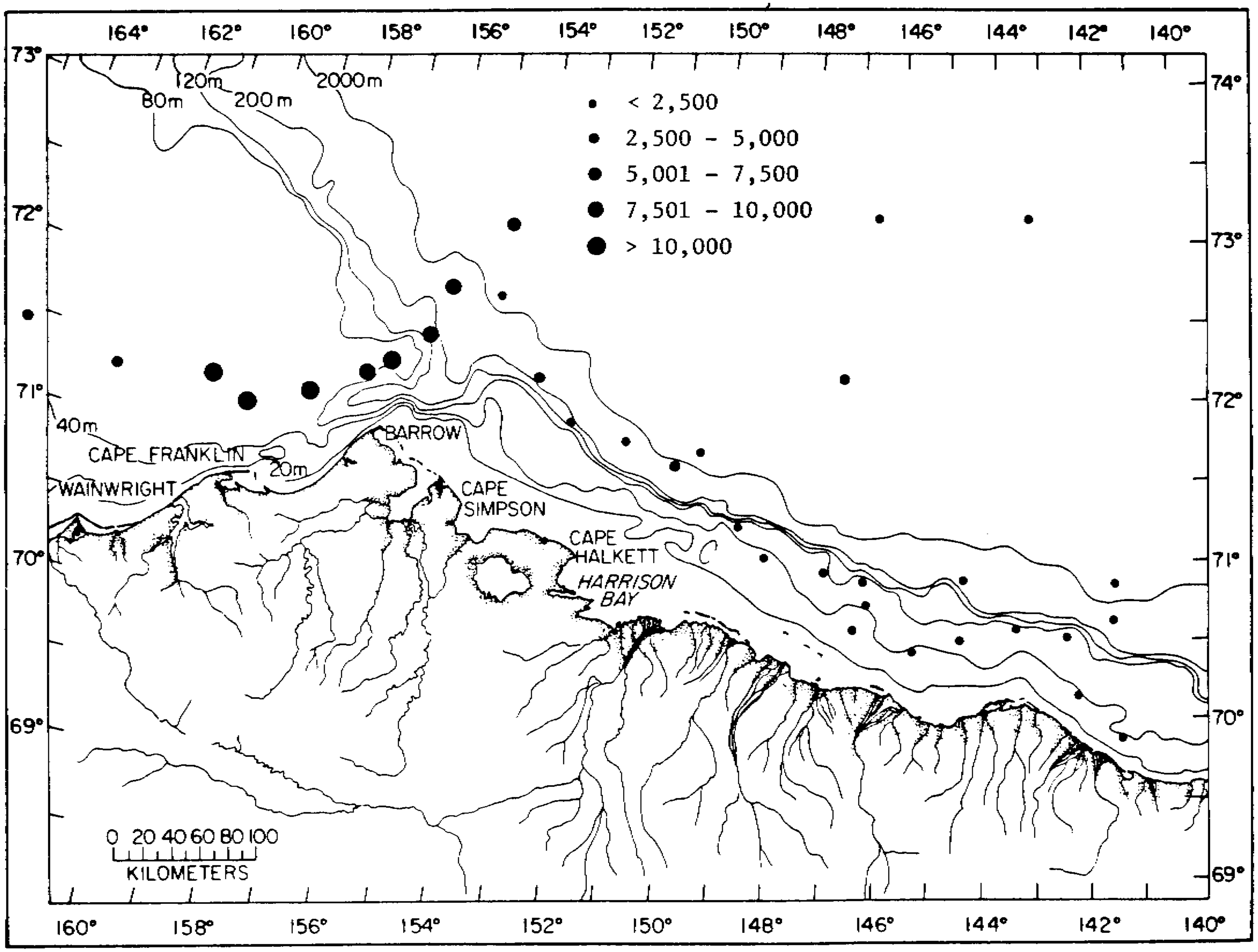


Fig. 15. Abundance (number per 1000 m^3) of chaetognaths at stations in the Chukchi and Beaufort seas in Aug - Sep 1977.

Horner 1969, Coyle 1974, Horner *et al.* 1974, Hsiao 1975, and English and Horner 1977). *Chaetoceros* spp. or small, unidentified flagellates are nearly always the most abundant groups of organisms. Flagellates were more abundant in 1976 when more ice was present in the sampling area; *Chaetoceros* spp. were more abundant in 1977 when there was more open water.

Most of the species are common and widespread occurring throughout the Beaufort Sea, although a few species are apparently somewhat more restricted or patchy in distribution and some species are more abundant some years than others. The silicoflagellate *Dictyocha speculum* Ehrenberg is not usually found close to shore in the Beaufort Sea, although it is very abundant in offshore areas (Tibbs 1967). It was relatively common at stations 14, 27, and 29 in 1977. The diatom *Thalassiosira antarctica* was found only from about 144°W to 153°W in 1977, and near 148°W in 1976.

Primary production is apparently higher in the northeastern Chukchi Sea than in most areas of the Beaufort Sea. However, sampling has been done in early August in the Chukchi Sea when light and nutrient conditions would be optimal. Sampling has been later in August in the Beaufort Sea, when light levels and nutrient concentrations may not have been optimal. It is also possible that although cells numbers were high, cells were becoming senescent later in August and were not as productive.

Estimates of annual production for the northeastern Chukchi Sea and western Beaufort Sea were reported for 1976 *Glacier* data (English and Horner 1977). The calculations assumed 24 hr days in June and July, 20 hr days in August, and 15 hr days in September. It was also assumed that twice as much production occurs during the spring bloom in June as occurs later in the summer, and that essentially no production occurs at other times of the year. Ice algae and benthic microalgal production were not included in the estimates. For the 1976 data, annual production was estimated to be *ca.* 18 g C m^{-2} yr^{-1} in the northeastern Chukchi Sea and *ca.* 9 g C m^{-2} yr^{-1} in the western Beaufort Sea. Using the same assumptions, annual production in 1977 was estimated to be *ca.* 28 g C m^{-2} yr^{-1} in the Chukchi Sea and *ca.* 14 g C m^{-2} yr^{-1} in the western Beaufort Sea. The higher estimates for 1977 probably reflect the lighter ice conditions of 1977.

Our use of a constant light incubator, while practical for the conditions under which we were working, gives relative production. The average light value used here, *ca.* 2100 lux, is somewhat lower than the light levels reported by Alexander *et al.* (1974) for 6 m near Barrow when no ice was present. Carbon assimilation values reported here may therefore, be slightly low, but annual production values are similar to the 10 to 15 g C m^{-2} yr^{-1} reported by Alexander (1974) for Simpson Lagoon and Harrison Bay.

It is difficult to compare 1976 and 1977 zooplankton data because of differences in the gear used and groups of organisms identified to species. Based on the 1976 samples, the zooplankton were separated into four major categories based on hydrography and life cycle stage (English and Horner 1977). The 1977 samples tend to support this scheme, but copepods, the major group of animals used to document the system, were not identifed to species for the 1977 samples.

The four major categories include:

1. Species that are expatriates from the Bering and Chukchi seas and are found in Bering Sea water in the Beaufort Sea. Species in this group include the copepods *Calanus cristatus* and *Eucalanus bungii bungii* (Johnson 1956) and perhaps the cladocerans *Evadne nordmanni* and *Podon leuckarti* (Redburn 1974). None of these species was identified in 1977 samples that were analyzed, although *Calanus cristatus* was identified in a sample from the Chukchi Sea (Wyman pers comm).

2. Species that occur throughout the Arctic Basin. Non-copepod species in this category that were found in samples from both 1976 and 1977 include *Thysanoëssa* spp., *Fritillaria borealis, Oikopleura* spp., *Sagitta elegans,* and *Boreogadus saida.*

3. Species that are usually found in neritic, less saline areas such as *Mysis litoralis* and *Onisimus glacialis.*

4. Species that contribute meroplanktonic life history stages. Meroplanktonic larvae of barnacles, polychaetes, and echinoderms were most abundant at stations in the Chukchi Sea and near Pt. Barrow in the Beaufort Sea both years. Johnson (1956) has suggested that meroplanktonic larvae are more numerous in these areas than in the eastern Beaufort Sea because of the wide continental shelf and shallow water.

Copepods were the most abundant zooplankters at nearly all stations. They were absent or rare only at stations 39 and 40 just east of Pt. Barrow in an area where currents converged and the water temperature was *ca.* 8°C and the salinity was *ca.* 29°/₀₀ throughout the water column. The most abundant animal at these stations was the medusa *Aglantha digitale*. Birds were also numerous at these stations, but stomachs of birds collected were empty (Divoky pers comm). Stations 38 and 41, north and west of the convergence area, had slightly higher salinities and lower temperatures except near the surface. Fewer *Aglantha* and many more copepods, chaetognaths, and appendicularians occurred at these stations.

Appendicularians, pteropods, and chaetognaths were numerous at nearly all stations. Perhaps these organisms are used as food by birds and mammals when their preferred prey species are not available.

VI. Auxiliary Materials - Literature Cited

Alexander, V. 1974. Primary productivity regimes of the nearshore Beaufort Sea, with reference to potential roles of ice biota, pp. 609-632. In J. C. Reed and J. E. Sater, eds., The Coast and Shelf of the Beaufort Sea. Arctic Institute of North America, Arlington, Va.

Alexander, V., R. Horner, and R. C. Clasby. 1974. Metabolism of Arctic sea ice organisms. Univ. Alaska, Inst. Mar. Sci. Rep. R74-4. 120 pp.

Bursa, A. 1963. Phytoplankton in the coastal waters of the Arctic Ocean at Point Barrow, Alaska. Arctic 16:239-262.

Coyle, K. O. 1974. The ecology of the phytoplankton of Prudhoe Bay, Alaska, and the surrounding waters. M.S. Thesis, Univ. Alaska, Fairbanks. 265 pp.

English, T. S.; and R. A. Horner. 1977. Beaufort Sea plankton studies. Final report to BLM/NOAA for Contract # 03-5-022-67-TA2 #4. 340 pp.

Horner, R. 1969. Phytoplankton studies in the coastal waters near Barrow, Alaska. Ph.D. Thesis, Univ. Washington, Seattle. 261 pp.

Horner, R., K. O. Coyle, and D. R. Redburn. 1974. Ecology of the plankton of Prudhoe Bay, Alaska. Univ. Alaska, Inst. Mar. Sci. Rep. R74-2, Sea Grant Rep. 73-15. 78 pp.

Hsiao, S. I. C. 1976. Biological productivity of the Southern Beaufort Sea: phytoplankton and seaweed studies. Dept. Environment, Beaufort Sea Project Tech. Rep. 12c. Victoria, B. C. 99 pp.

Hufford, G. L. 1973. Warm water advection in the Southern Beaufort Sea August-September 1971. J. Geophys. Res. 78:2702-2707.

Hufford, G. L. 1974. On apparent upwelling in the southern Beaufort Sea. J. Geophys. Res. 79:1305-1306.

Johnson, M. W. 1956. The plankton of the Beaufort and Chukchi Sea areas of the Arctic and its relation to the hydrography. Arctic Inst. North America Tech. Paper No. 1. 32 pp.

Redburn, D. R. 1974. The ecology of the inshore marine zooplankton of the Chukchi Sea near Point Barrow, Alaska. M.S. Thesis, Univ. Alaska, Fairbanks. 172 pp.

Strickland, J. D. H., and T. R. Parsons. 1968. A Practical Handbook of Seawater Analysis. Bull. Fish. Res. Bd Can. 167. 311 pp.

Tibbs, J. F. 1967. On some planktonic Protozoa taken from the track of Drifting Station ARLIS I, 1960-61. Arctic 20:247-254.

VII. Problems

There have been no problems this quarter.

VIII. Estimate of Funds Expended

Approximately 70% of the funds have been expended as of 30 June 1978.

QUARTERLY REPORT

Research Unit 362

Quarter Ending - 15 June 1978

OCSEAP DATA BASE MANAGEMENT

SUPPORT

Submitted by : John J. Audet
Principal Investigator
National Oceanographic Data Center
Environmental Data Service
National Oceanic and Atmospheric Administration

July 1, 1978

DIGITAL DATA

A total of 52 data sets (excluding resubmissions) were received by NODC and NGSDC this quarter. A total of 182 data sets were 'final processed' during the quarter. Data sets in hold have increased from 58 the past quarter to 126 as a result of decisions to convert all Bird Colony data (035) to the revised 135 format, the review of a large number of NMFS mammal data (027) by NMFS before processing continues, modification to other 027 data sets for RU 481, and the need for additional codes and corrections required of investigators for marine bird data (file types 033 and 040).

The distribution and status of all OCSEAP digital data sets received to date is as follows:

	Received	Finaled	In Hold	In Processing
Biological	874	568	112	194
Physical	231	157	11	63
Chemical	35	12	0	23
Geological	6	3	3	0

Data sets received for each file type during this quarter and distribution by lease areas are shown below.

TABLE 1. Distribution of Data Sets received between March 16 and June 15, 1978.

File Type/Format	Total	Lease Area Code*								
		1	2	3	4	5	6	7	8	9
015 - Current Meters	16	9	-	-	3	-	7	-	-	-
017 - Pressure Gauge	1	1	-	-	-	-	-	-	-	-
021 - Trace Metals	3	-	3	2	-	-	-	-	-	-
022 - STD/CTD	6	3	2	2	3	-	2	-	-	-
023 - Fish Resource	7	-	2	-	-	-	-	5	-	-
024 - Zooplankton	4	-	-	-	4	-	3	-	-	-
028 - Phytoplankton	3	-	-	-	3	-	2	-	-	-
029 - Primary Productivity	3	-	-	-	3	-	3	-	-	-
030 - Intertidal	2	-	2	-	-	-	-	-	-	-
035 - Bird Colony	1	-	-	-	-	-	-	-	-	1
040 - Bird Habitat	3	2	3	2	-	-	-	-	-	-
057 - Herring Spawning	2	-	-	-	1	-	1	1	-	1
	52									

* Lease Area Code

1 - NEGOA
2 - Lower Cook
3 - Kodiak
4 - St. George
5 - Beaufort
6 - Bristol Bay
7 - Norton Sound
8 - Aleutians
9 - Chukchi

DATA REPORTS

A total of 23 data reports were received through the Project Offices this quarter. Details of each report are entered in the tracking system which includes the appropriate lease areas for each report. The distribution of reports by discipline is shown in TABLE 2.

TABLE 2. Distribution of Data Reports received between March 16 and June 15, 1978.

Discipline		
Mammals	2	
Birds	1	(1)
Fish/Plankton/Intertidal	6	(4)
Chemistry/Microbiology/Effects	1	(1)
Phy. Oceanography/Meteorology	3	
Geology/Geophysics	10	(6)

( ) - Reports indicated by the JPO that contain relevant data to be considered part of the OCSEAP data base but not within the digital data bank - copies of these reports will be retained by the Project Office.

ROSCOPS

A total of 59 ROSCOPs were received this quarter. A total of 460 have been received to date for OCSEAP cruises and surveys. ROSCOPs received this quarter were from the following:

NMFS (NWAFC)	27
USFWS	3
PMEL	4
USGS	1
ADF&G	12
Univ. Alaska	6
Univ. Washington	3
Univ. California	1
Dames and Moore	2

DATA REQUESTS

The following is a list of the major requests received and/or being processed this quarter. Requests for the Data Catalog, new taxonomic codes and other routine information such as copies of data formats are not included in this list.

Date Received	Data Completed	Requestor/Description
1/24/78	Partial	Program Office/SAI - Products for the annual summary report - shipments of physical, chemical and biological products for five highest priority lease areas already forwarded - remainder to follow - more details under 'Product Development'.
2/13/78	Partial	Finch (Program Office) - Dist. of birds for Pribilof and Middleton Is. Unable to complete request until data distribution and other data problems resolved.
2/27/78	4/13/78	Arneson (ADF&G RU 003) - Plots of selected species for Lower Cook on UTM projection.
3/2/78	3/23/78	Swanner (JPO) - Sea surface temperature values from selected OCSEAP data sets in Lower Cook.
3/6/78	3/15/78	Cava (JPO) - Draft versions and explanations of Parts II and III of the Data Catalog.
3/14/78	6/1/78	Harrison (Geo. Inst. Univ. Alaska) - Annotated bottom temperature plots for Chukchi - first plots forwarded 4/19 - revised plots and listing needed to identify cruises, station numbers, etc.
3/22/78	4/20/78	Cava (JPO) - Copies of 'WALLCHART' with sort by RU-alphabetical sort forwarded earlier.
3/28/78	4/7/78	Cava (JPO) - Inventory of all check program results forwarded to JPO to date.
3/28/78	4/15/78	Cava (JPO) - List of data reports received by NODC and listed in DTS - request for non-quarterly and annual reports not able to be answered except by visual check because no code is available for these particular reports.
4/17/78	4/19/78	Hadley (Univ. Alaska - IMS) - Listings of 1976 non-OCSEAP STD/CTD data for NEGOA-requested through Dean Dale.

4/21/78	4/25/78	Robertson (Corps of Engineers - Anchorage) - Environmental data for NEGOA/Lower Cook and Kodiak - Revised Data Catalog to be forwarded - Mike Crane indicated as Anchorage contact for future requests.
4/21/78	5/8/78	Pelto (JPO) - February sea surface temperature map and listings for Lower Cook - insufficient data for map (9 data points) - requested through Mike Crane.
4/24/78	5/5/78	Crane - Inventory and selected species plots for Arneson data set (FG7803) - copies forwarded to Arneson and Swope (JPO).
5/8/78	5/12/78	Cava (JPO) - request for selected RU data tracking updates.
5/15/78	5/23/78	National Park Service (Fairbanks) - Environmental data near Glacier Bay - Ocean station data and BT data forwarded by Data Services - three OCSEAP file types (023/027/029) identified with stations in area - inventory plots forwarded.
-	5/23/78	Royer (Univ. Alaska-IMS - RU 289) - U.S. Coast Guard data for 4 recent cruises in the Gulf of Alaska - forwarded as part of continuing request for USCG data in OCSEAP areas.
5/22/78	Partial	Pease (PMEL - RU 541) - Tape copies of IMS STD/CTD data for NEGOA with station plots for each cruise - 23 data sets - tape copy sent 6/8 - plots to follow.
6/6/78	______	Craig (LGL - RU 467) - Copy of Bendock (RU 233) fish data collected near Prudhoe Bay - one potential data set identified - requested through Toni Johnson.
6/7/78	______	Cava (JPO) - Summary of all OCSEAP digital data received to date - sorted by lease area.
6/7/78	______	Lowry (ADF&G) - Copy of Feder (RU 005 and 502) benthic organism data (032) collected in Bering and Chukchi sea for selected species.

6/8/78	______	Thibodeaux (LSU) - STD data listing for Beaufort Sea area - relevant OCSEAP data sets identified - request to Data Services for completion.
6/13/78	______	Cava (JPO) - List of all temperature values submitted with RU 78 - file type 030 data (5 file IDs).

A data request form was developed and copies forwarded to Program and Project Office personnel for their comments and recommendation. A modified version will be distributed at the Asilomar meetings. Copies also will be forwarded with any investigator request for submission with future requests.

PRODUCT DEVELOPMENT

Additional plot products for the annual summary report have been forwarded to Boulder for Program Office and SAI review and include the following:

Shipment 4. - Seasonal dynamic height contour plots for Kodiak, NEGOA and Lower Cook - sent 4/20.

Shipment 5. - Seasonal dynamic height contour plots for the Beaufort, primary productivity contour charts for 4 of the 5 highest priority areas (all but Norton), and seasonal current transport plots for NEGOA - sent 5/5.

Shipment 6. - Supplementary primary productivity information and seasonal transport plots for Kodiak - sent 5/17.

Shipment 7. - All biological products requested where data are available for any of the five lease areas - consisted of the following plots sent 6/16:

- Location of walrus rookeries and hauling out grounds
- Seasonal presence of shearwaters
- Location of gull and kittiwake breeding and nesting sites
- Seasonal presence of Mallard and Pintail ducks.
- Seasonal distribution of selected ground fish species where catch is greater than 100lb/hr. - included halibut, flounder, perch, pollock, sole and cod.
- Seasonal abundance of benthic species - king crab and pandalus shrimp where catches exceed 1000 lb/hr.

A review of the status of the summary product development was held on May 3 in Mr. Ochinero's office. It was determined that a major obstacle in retrieving biological taxonomic-coded data had been resolved and that all products for the five highest priority lease areas would be completed by June. It was also decided that more complete and detailed explanations for each product and comments concerning improvements that NODC personnel felt should be made to any product will accompany each shipment.

Samples of page-size plots of available products using OCSEAP data were forwarded to Project Offices and the Seattle and Anchorage Liaison Offices. A more formal version of this sample is planned for discussion at the data management meeting in Asilomar in July.

FORMAT DEVELOPMENT

The current status including distribution lists for all OCSEAP formats was forwarded to the Program Office (Overstreet). This was followed by the distribution on May 8 of the most recent version of each format (25 format total) to both data management personnel and to selected investigators as indicated by the Juneau Project Office.

Copies of 'FACT' sheets were distributed on March 16 and on June 1 and included modifications for file types 025, 030, 033 and 100, modified codes, and some earlier material not included with the May 8 format distribution.

The final draft of the new Bird Colony format (135) was completed and was reviewed during an April visit to NODC by Wayne Fischer. The modified final draft was received from John Murphy on May 8 and will be distributed by NODC following receipt of parameter definitions and any additional codes.

The final draft of the new Marine Bird Specimen format (031) was received from Marcy Butcher on June 2. The formal version with codes and format layout will be distributed by NODC by the end of June.

DATA PROCESSING

An improved data checking program allowing for more specific and comphehensive range checking, parameter statistics, and taxonomic code results has been completed by Chris Noe and will be used for all future data checking.

Check program results continue to be provided to the Project Offices (and Mike Crane where applicable). The response to my memo of May 25 which identified the highest priority data sets based on information from John Murphy and Juneau Project Office needs has been excellent. Over 150 high priority data sets for about 30 data submissions have been run through the check programs by Elaine Collins' and Phil Hadsell's processing personnel within the last three weeks. However, other priorities including work on the Data Catalog, Parts I, II and III, the FY 79 proposal, summary products for the Program Office, new bird formats, updating of the quarterly distribution of the tracking system and file type summary and preparation for the forthcoming Asilomar meeting have prevented the completion of the necessary memos needed to accompany most of the check runs.

Master tapes (crunch tapes) have been completed to date for file types 015, 022, 028, 029, 043, 056 and 101. Original tapes for these data sets have been returned to the investigators or appropriate data processors. Efforts to complete similar work for file type 024 and 032 are now underway. This effort has resulted in a total of 450 data sets (1,236,000 records) being upgraded.

A coding form for file type 044 (Heavy Hydrocarbons) was requested by John Calder and has been completed in draft form by Phil Hadsell's group. The draft was forwarded to NOAA offices in Rockville for final drafting and printing of coding pads and should be available within two weeks.

As mentioned elsewhere, all Marine Bird Colony data (file type 035) that has been received or that is to be received will be placed in a 'hold status' once the date are checked for tape compatability and agreement with DDFs. These data should be evaluated in the near future with Project and Program Office and investigator assistance for conversion to the revised colony format, file type 135.

DATA CATALOGS AND INVENTORIES

Part I (revised) of the Data Catalog has been submitted to the printers and is to be delivered to NODC no later than June 30. Distribution will follow in July.

Part II will include the actual number of stations per data set for each lease area environmental region and the actual time period that the observations took place. Environmental regions were established working with Program Office personnel to provide a more complete assignment of stations to one of the nine lease areas. A computer program was written by Mike McCann of the Data Index Branch to search all data inventories and determine the number of stations and inclusive dates per area. Part II was completed and submitted to the printers on June 16 and should be available for review at the Asilomar meeting.

Part III, the description of each file type and related codes, is approximately 50% completed. The section describing each format will be completed in draft form for the Asilomar meeting. A digital copy of all codes has been completed by Mike Crane's office and will be incorporated into Part III after additions and modifications are finished. The parameter index and format layouts will not be completed until August or September. All file types and codes are being digitized and entered on the 'WYLBUR' system for eventual on-line retrieval of the most current version of each format and the associated codes.

TAXONOMIC CODES

The second edition of the NODC taxonomic codes, dated May 30, 1978, is now completed and copies of the revised edition with 'Newsnote #6' are being distributed this month to all personnel on the current distribution list.

A problem with the use of species group codes has been tentatively resolved by updating the existing code distributed by NODC and incorporating the updated version in the digital version of OCSEAP codes. It is hoped that all investigators using species groups (primarily marine bird investigators) have used the same codes for species identified beyond the standard 12-byte code. Codes have been received in data sets which were not on the NODC distribution. The next 'Newsnote' will address this problem and include a list of all known (to NODC) group codes.

Another problem becoming more evident as requests are answered and products developed is the inability to retrieve selected species level (10 bytes) because of coding by investigators to only to 4, 6 or 8 bytes. Crabs can be identified with 8 byte codes but king crabs require 10 bytes. Coded at the family or genus level, some of the species requested may very well be included but positive identification to species cannot be assumed and cannot be included in retrieval and products at the species level. If an organism is not coded to 10 bytes, it is not possible to retrieve species as is often requested.

ADMINISTRATIVE

Meetings with BLM-Anchorage personnel Jan Arbegast and Byron Morris were held at NODC in April to describe NODC's role in data management and data processing. John Murphy attended most of the meetings.

Joe Dygas, also of BLM-Anchorage, was briefed in April by NGSDC personnel on the contents of the NOS files held at NGSDC.

Toni Johnson met with NODC personnel during her visit to Washington the week of June 5 and was briefed on NODC activities concerning data processing, data requests and products, taxonomic codes, the mini-computer facility, the status of a NOAA OCSEAP services brochure and the NODC/EDS role in other multidisciplinary data projects.

A meeting was held on June 12 at NIH to discuss the microbiology data base and the research units and personnel involved with its management and data retrieval capabilities, Mike Krichevsky (RU 371), Ron Atlas (RU 29/30, Lois Killowich (JPO) and myself attended the meeting. A demonstration of data retrieval using NIH terminals was included in this very informative meeting.

The replacement of the IBM computer with the new UNIVAC is beginning to show an effect on OCSEAP, as individuals associated with OCSEAP tasks are scheduled for a variety of training courses and other activities related to the conversion.

QUARTERLY REPORT

Contract No. R7120848
RU: 367
Reporting Period:
1 April - 30 June 1978
Number pages: 2

COASTAL METEOROLOGY

R. Michael Reynolds

Pacific Marine Environmental Laboratory

30 June 1978

Task Title: Coastal Meteorology

PI: R. Michael Reynolds
NOAA/PMEL
3711 15th Ave. N. E.
Seattle, Washington 98105

Reporting period: 1 April - 30 June 1978

I. Task Objectives

A. To characterize the regional wind field in three areas, Albatross Banks, Lower Cook Inlet, and Hichinbrook Entrance. To make measurements as necessary and analyze data sufficient to define mean seasonal circulations. Priority and emphasis will be placed on Lower Cook Inlet.

B. To relate observed over-water winds to winds computed by the meteorological model adapted from Lavoie under R.U. 140.

II. Field and Laboratory Activities

A. Cruises: None

B. Field Experiments:

1. Two meteorological stations were installed in the Lower Cook Inlet region on 27 April - 1 May. The stations were placed on the southwest side of Augustine Island and on Contact Point on the west side of the Inlet. The purpose of the stations is to better define the flow of winds through the Aleutian Mountain Range at that point.

2. On 20-21 June, Mr. Walter serviced the meteorological stations in Lower Cook Inlet. The stations were recovered, and all sensors were in good working order. The unit at Contact Point was not functioning on recovery, but the unit on Augustine Island was working well and subsequent analysis indicates that this is an excellent data set. Both stations were redeployed and will continue to be used until next April.

C. Laboratory Activities:

1. Mr. Reynolds and Mr. Macklin attended an OCSEAP workshop on Physical Oceanography and Meteorology at Rosario Inn from 2 May to 4 May 1978.

2. Mr. Walter visited AEIDC in Anchorage on 22 June to investigate the possibility of our obtaining data which has been taken by the oil companies. We were able to get some of that data, and continue the discussions about some form of requirement for the oil companies to make environmental data available in a more timely fashion.

III. Results:

A. Coastal Wind Forecasting Techniques: Appended to this report is an additional empiracal forecast procedure developed by the NWS Anchorage Office (see Annual Report for 1978, Sec. 5). This procedure describes the method for predicting katabatic flow from Whittier Glacier. The prediction mechanism employed relates warm air advection at the 850 mb level to subsequent cooling over the glacier.

B. The pressure field algorithm adapted from Davis* is working well. This algorithm is described in the April 1978 annual report. The purpose of the algorithm is to compare the gradient wind field produced from real data with the wind field calculated from a synoptic scale numerical model which incorporates smoothing on a large scale. A typical product of the pressure algorithm is given in Fig. 1. The pressure points in the interior of the figure are real measurements and model pressures on the borders and exterior to the region shown preserve stability.

C. Meteorological measurements and for the month of January the western Gulf of Alaska have been digitized. The stations which have been utilized are discussed in the April 1978 annual report. In addition, AMOS data and marine data will be included in this set. The pressure fields resulting from this net will be analyzed with the pressure algorithm described above and compared with LFN derived winds for the month.

* Davis, John C., (1973) Statistics and Data Analysis in Geology. John Wiley and Sons, New York, 322-337.

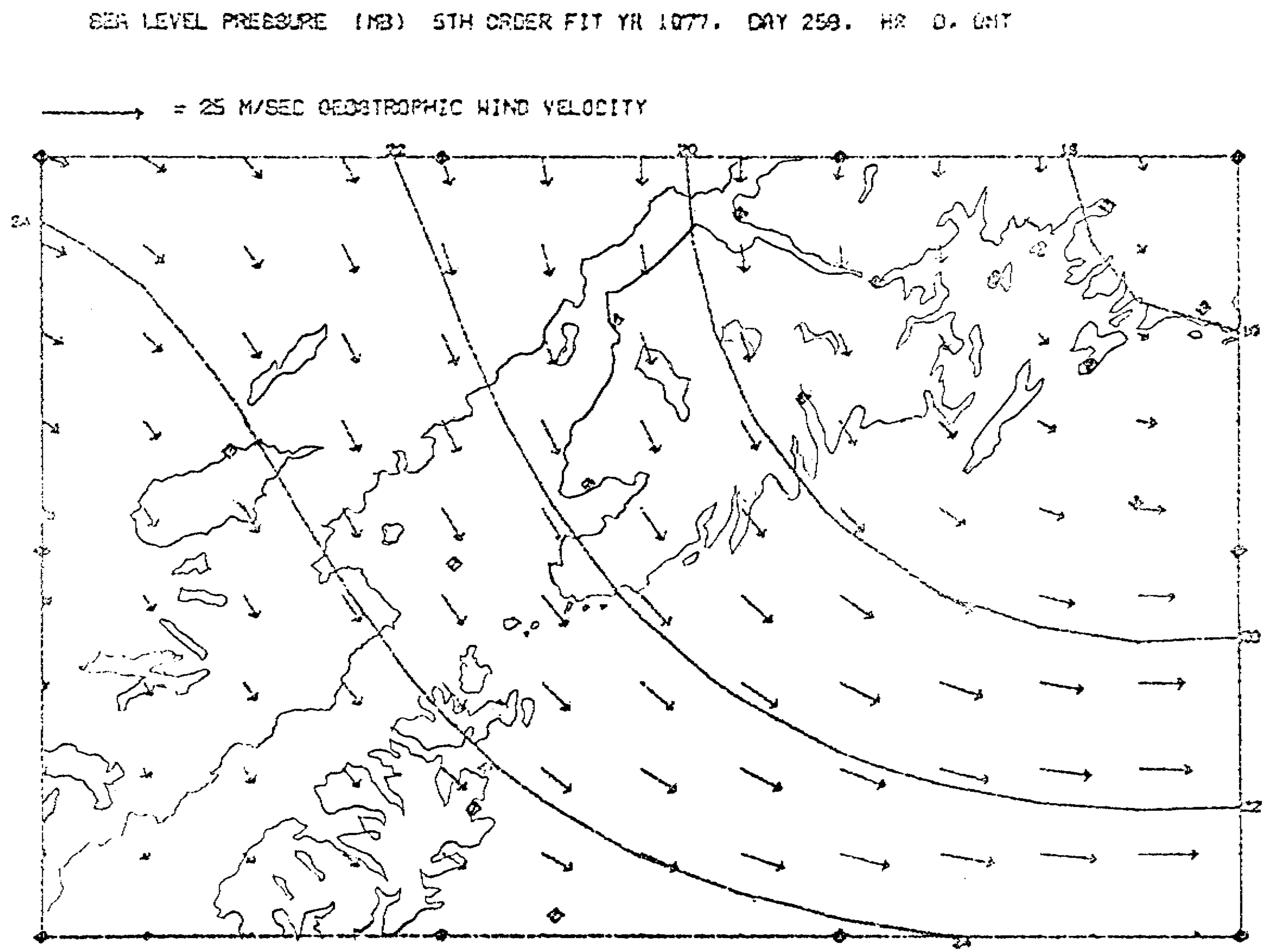


Figure 1. Typical windfield map from the mesoscale pressure algorithm.
Symbols marked by ◇ are the input pressure points.

AN AID FOR FORECASTING GUSTY SOUTHWEST SURFACE WINDS AT WHITTIER, ALASKA

Ruben "SG" Schulz
01 March 1978

Gusty southwest surface winds frequently occur at Whittier that are not substantiated by the pressure gradient. Normally, the surface winds in Passage Canal are determined by the pressure difference in millibars between Anchorage and Cordova times a factor of five. The winds through Passage Canal generally blow from the east or the west. However, at times the surface winds at Whittier are gusty to near 35 knots from the southwest with very little pressure gradient between Anchorage and Cordova. It is the experience of the Harbor Master at Whittier that these gusty winds extend two to three miles eastward from the Whittier docks before they diminish.

The 850 millibar chart is a very useful tool in forecasting the onset and the end of periodic gusty southwest winds at Whittier. Any flow pattern from the east through north on the 850 mb chart, accompanied by warm air advection over Prince William Sound, will trigger super gradient gusty southwest winds in the Whittier area. This situation can occur at any time of the year but is most frequent in the Spring and Fall. Apparently the mechanics of a gusty southwest wind situation at Whittier goes something like this ... if relatively warmer air is advected over Prince William Sound at the 850 mb level and the flow at that level is from the east through the north ... then this air over the Whittier Glacier will be cooled and gravity feeds into the Whittier area as a gusty southwest wind. The winds will cease when the flow pattern at 850 millibars over Prince William Sound changes from east through north to any other direction. This in effect cuts off the warm air advection to the Whittier Glacier and the gravity flow ceases.

Forty-one cases of gusty southwest wind situations occurred at Whittier between January and September 1977. There were probably more as indicated by the 850 millibar charts but observations from Whittier were frequently missing during this time frame.

Comparing the gusty surface wind periods with the associated 850 mb charts ... it was found that if the wind flow pattern over Prince William Sound ranged anywhere from east through north, and that warm air was being advected, then gusty southwest winds occurred at Whittier. Ninety-five percent of the cases occurred with warm air advection and 5 percent with cold air advection. Eighty-eight percent of the time, the surface winds ranged between 200-240 degrees, and twelve percent of the time between 160-190 degrees. Available surface observation temperatures at Whittier ranged from a low of 20 degrees, to a high of 70 degrees, and the temperatures at the 850 mb level ranged from -14 C to 17 C ... there is no apparent temperature correlation with wind speed. Wind reports were very uniform with each case. Wind direction was predominately southwest ... sustained wind speed 20 - 25 knots ... and gusts ranged between 25 - 35 knots. Unofficial reports have been received in the past of gusts 40 to 50 knots but it is not known if these were estimated or measured. It is hard to tell just how long it takes for the winds to start up after the 850 mb flow pattern and warm air advection is right since observations at Whittier are limited and the first one in the morning is usually at 1600 GMT. At least we know that if the 850 mb chart indicates gusty winds and the 1600 GMT observation has gusty winds then one knows that it takes less than 4 hours. Many of the 41 cases had this situation.

The wind speeds at the 850 mb level for the 41 cases ranged from 5 - 30 knots with the mean speed about 10 knots. Here again there is no apparent correlation with the surface wind speed.

Mostly fair weather accompanies the gravity feed or down slope winds. The following is a breakdown of the weather that occurred during the gusty winds:

Clear ... 27 percent, ... 20 - 50 scattered ... 24 percent ...
60-100 scattered ... 20 percent, ... 60 - 100 broken . . . 12 percent,...
20 - 50 broken ... 10 percent, ... 15 - 30 overcast ... 5 percent, ...
110 - 150 scattered ... 2 percent.

By using the 850 mb technique, a Passage Canal marine forecast could be refined by incorporating the periodic gusty southwest winds in the Whittier area.

Ruben "SG" Schulz

Meteorologist

Influence of Petroleum on Egg Formation and Embryonic Development in Seabirds

By

D.G. Ainley[1], C.R. Grau[2] and S.H. Morrell[1], Principal Investigators and T.E. Roudybush[2], H.R. Huber[1] and Craig Strong[1]

Submitted as the Quarterly Report for Research Unit 423
Outer Continental Shelf Environmental Assessment Program

Sponsored by
U.S. Department of Interior
Bureau of Land Management
through the U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Bering Sea Gulf of Alaska Project Office
P.O. Box 1808, Juneau, Alaska 99802

June 30, 1978

1. Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970.

2. Department of Avian Sciences, University of California, Davis, CA 95616

I. Abstract or Highlights of Quarter's Accomplishments

Cassin's auklets on Southeast Farallon Island occupied nest boxes put in place last year as well as natural burrows. Egg laying and dosing began on April 13th, dosing was completed in early May. Egg laying is now essentially complete, and hatching has begun. Eggs collected and incubated artifically for an embryo series have been incubated, and the series is now complete.

Methods for identifying eggs from birds which have ingested oil are being improved. Fluorescence in both visible and ultraviolet regions, after excitation at 290 nm, is different between treated extracts of eggs from oil-fed and control ducks and chickens. Petroleum ether extracts of yolks that have been frozen and fixed in formalin are chromatographed on thin layer plates. After three separations, extracts are examined by ultraviolet spectrofluorometry, and differences at 365 nm determined.

Ultraviolet absorption of extract is also being used to identify eggs from oil-fed birds.

II. Task objectives

The task objectives during this quarter were to:

1. Establish or locate nest boxes and natural burrows with pairs of auklets to total 400 pairs of auklets.

2. Measure beaks and thereby establish the sex of as many of the auklets as possible.

3. Dose as many female members of the pairs as possible with 4g euphausiids plus either 1g Bunker C oil or 1g Prudhoe Bay crude oil.

4. Obtain egg production data on these birds and compare their egg production to that of undistributed groups of auklets.

5. Obtain unincubated eggs for artificial incubation to provide a normal embryo series of Cassin's auklets.

6. Improve methods of identifying eggs from birds fed oil and identify oil components in eggs.

III. Field activities

A. Ship or Field Trip Schedule.

1. March 25 - June 30, 1978. Work on Southeast Farallon Island.

B. Scientific Party

1. Thomas Roudybush and C.R. Grau - Department of Avian Sciences, University of California at Davis. Check burrows for egg laying. Sex and band auklets. Set up and maintain data collection. Dose auklets. Collect eggs for analysis or incubation.

2. Craig Strong, Steve Morrell and Harriet Huber - Point Reyes Bird Observatory. Check control group for egg laying. Continue checking of control and experimental groups for egg laying and hatching after departure of Roudybush on May 6, 1978.

C. Methods

Burrow checking is done simply by reaching into the burrow or box and feeling for an egg, chick or adult.

Auklets were sexed and banded by capturing both members of a pair in their burrow at night. Beak depths and lengths were measured. The bird with the largest depth X length product was the male and was banded with a numbered metal band on the right leg. Females were banded on the left leg.

Dosing was accomplished by pushing wet No. 3 gelatin capsules containing oil down the esophagus of the auklet with a match stick. Pieces and whole bodies of Euphausia spp. were fed in the same manner. The oil totaled one gram of either Bunker C oil or Prudhoe Bay crude oil. The euphausiids weighed about 4 grams. The oil and euphausiids were fed in the order which appeared to cause the least distress and excitement in each individual bird.

Some auklets laid eggs before they could be dosed with oil. These eggs were removed upon discovery for transport to Davis for incubation. The parents of these eggs were then divided into three groups, a control group, an oil-dosed group and a smeared group. The control group birds were allowed to relay without disturbance. The oil dosed group was dosed with Bunker C oil and euphausiids in the same manner and amount as the birds which were dosed before egg laying. These birds were first dosed about one week after their egg was removed. If another egg was not laid within one week after dosing they were dosed again and left undisturbed except for daily checking until an egg was found. The smeared group was treated in the same manner as the oil dosed group except that about 100 mg of Buncker C oil was smeared on one brood patch. The opposite brood patch was used if the bird was resmeared.

III. Laboratory Activities

A. April 1 - June 30th, Department of Avian Sciences, University of California at Davis.

B. Scientific Party.

Thomas A. Wootton, Department of Avian Sciences, University of California at Davis.

Chemical analysis of oil components in yolk.

C.R. Grau, Department of Avian Sciences, University of California at Davis - Direct Research.

C. Methods

Auklet eggs sent to Davis were incubated in a bench top incubator at 37°C. Eggs were removed at 3 day intervals, and the embryos were placed in bottles in 10% formalin for storage.

Mallard duck eggs (courtesy of W.N. Holmes, U.C. Santa Barbara) and chicken eggs have been used as material for perfection of techniques for detection of oil components in yolk. Yolks were extracted in petroleum ether, and the extract was concentrated and spotted on silica gel thin layer plates. The plates were developed in petroleum ether:isopropanol (100:2). The fluorescent front was then scraped off and the oil components eluted with petroleum ether. The eluate was then spotted as before. The fluorescent front was scraped off and eluted with spectro grade isopentane. An ultraviolet absorption scan was run from 325 nm to 210 nm.

In a similar but simpler experiment whole eggs were frozen at -20°, fixed in 4% formalin for 16 hours at 65°, and sliced into 3 mm thick sections. Pieces containing 2 g wet yolk were dried 1 hour in a vacuum oven at 60°, broken up with a glass rod, and extracted 3 times with 26 ml portions petroleum ether. The extract was filtered, concentrated by evaporation at room temperature to a few microliters applied to a silica-gel thin layer glass plate, developed with isopentane:isopropanol:chloroform (100:0.5:0.1) and visualized by ultraviolet light (254 nm). In this study, groups of Mallards (Anas platyrhynchos) were fed 4 different crude oils at 1% or 3% of the diet for several months. The crude oils were South Louisiana, Prudhoe Bay, California Platform A, and California Platform Holly. The eggs laid were identified only by number at Santa Barbara, and analyzed at Davis.

D. Sample Locations

Duck eggs for laboratory analysis were obtained through the courtesy of W.N. Holms, University of California, Santa Barbara. Chicken and quail eggs were obtained at the Department of Avian Sciences, University of California, Davis. All other samples were obtained on Southeast Farallon Island.

E. Data Collected or Analyzed

Daily observations of all experimental burrows and nest boxes and every other day observations of control burrows and nest boxes were taken until egg laying occurred in each burrow.

Observations and photographs of thin layer plates and UV scans have been taken as development of procedures for analysis of oil components in eggs has progressed.

Embryos from artifically incubated auklet eggs have been stored for future study.

IV. Results

Results from field activities are nearing completion but final tabulation of data awaits the final egg laying dates which remain to be observed. However, the results are complete enough to demonstrate that auklets laid substantial numbers of eggs in spite of the treatments we have given them.

Laboratory results from UV scans of purified extract of yolks from birds fed oil show a broad shoulder at 258 nm. Observation of UV fluorescence of thin layer plates after a single development of duck yolk extract in isopentane: isopropanol:chloroform (100:0.5:0.1) show that characteristic fluorescence patterns exist in extracts of yolks of birds fed oil. Of the 48 yolks submitted to analysis, all 36 of the oil yolks were successfully identified while none of the 12 controls were identified as containing oil.

V. Preliminary Interpretation of Results

The most fundamental and significant observation from this quarter's work is that egg laying in Cassin's auklets is not eliminated by ingestion of 1 gram of either Prudhoe Bay crude oil or Bunker C oil. This, however, may have little influence on eventual reproductive success in oiled seabirds if oil ingestion with a meal during egg formation causes eggs not to hatch. More information will be available on this problem next quarter.

Apparently oil ingestion by a bird during yolk formation causes changes in the yolk which can be identified by chemical and physical methods. Eggs from ducks fed 4 different crude oils were all identified as eggs from birds which had ingested oil by examining spots of extract of yolk on thin layer plates under UV light. UV spectrophotometric scans of similar but more purified extracts shows a shoulder at 258 nm. These data indicate that fluorescent, UV absorbing compounds are present in yolks of birds fed oil. Levy (1970) has stated that absorbance at 256 nm should be considered evidence of the presence of petroleum compounds. If this is true it appears likely that the UV absorbing fluorescent compound(s) found in oil yolks are of oil origin and not biogenic or induced compounds found after oil ingestion.

VI. Auxiliary Material

A. Bibliography of References

Levy, E.M. 1970. A shipboard method for the estimation of Bunker C in seawater. Paper presented at Symposium on Marine Sciences. Chemical Institute of Canada, Charlottetown P.E.I. August 16-18 as cited in Petroleum in the Marine Environment pg. 27. National Academy of Sciences 1975.

B. Paper in Preparation or in Print

Grau, C.R., T.A. Wootton, T.E. Roudybush, W.N. Holmes and D.G. Ainley 1978. Detection of eggs from oil-fed birds by ultraviolet fluorescence of yolk extracts. To be presented to meeting of Society of Petroleum Industry Biologists, Los Angeles, August 22-23, 1978.

C. Oral Presentations

None

VII. Estimate of funds expended

As of 30 June the following amounts have been expended:

Salaries		$ 27,773
Travel		3,667
Commodities & supplies		48
Equipment		7,319
	Total expenditures	$ 38,807
	Overhead	13,290
	TOTAL	$ 52,097

QUARTERLY REPORT

Contract # 03-5-022-67-TA8 #4
Research Unit # 424
Reporting Period: 1 Apr 78 - 30 Jun 78
Number of Pages: 9

Lower Cook Inlet Meroplankton

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

30 June 1978

Departmental Concurrence: G. C. Anderson
George C. Anderson
Associate Chairman for Research

REF:

I. Task Objectives

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 Activities

A. Ship Cruises

1. 19 May 1978, *Humdinger*
2. 28 May 1978, *Humdinger*
3. 4 June 1978, *Humdinger*
4. 8 June 1978, *Humdinger*
5. 9 June 1978, *Humdinger*
6. 25-29 June 1978, scheduled sampling

B. Scientific Party

1. Kendra Daly, Cruise Leader, University of Washington.
   Marc Weinstein, Oceanographer, University of Washington.
   On cruises 1 and 2.

2. Kendra Daly, Cruise Leader, University of Washington.
   Gordy Vernon, undergraduate, Antioch College.
   On cruises 3, 4 and 5.

C. Methods

All stations were located in Lower Cook Inlet between Kamishak and Kachemak Bay (Fig. 1, Table 1). On the 19th of May 1978, the East Inshore stations 1, 2 and 3 were occupied. Stations 4 and 5 were not occupied due to a winch malfunction. An average of 30 minutes was spent on each station. The weather was overcast with prevailing 12-knot winds. The whaler stations were not sampled again because the whaler and winch on order had not arrived.

The East Diurnal station 6 was taken on 28 May 1978. Bongo net tows from 10 m above the bottom to the surface were taken at noon and midnight, standard time. The weather was overcast with 6-12 knot winds.

On June 4, during the 1° Transect across Lower Cook Inlet, stations 13, 14, 15 and 16 were sampled. Stations 17 and 18 were abandoned due to adverse sea conditions. An average of 20 to 30 minutes was spent on station. The weather was overcast and cool, with wind increasing to 25 knots and waves to 5 feet.

On June 8, all stations were sampled on the West Trackline including station 18 from the 1° Transect. The stations were occupied for an average of 20 minutes each. The weather was partly cloudy, with increasing wind to 26 knots and waves to 5 feet.

On the 9th of June, all stations on the 2° Transect across Lower Cook Inlet were occupied. Station 31 was taken at 59° 31.0'N and 152° 02.0'W due to bridge navigational error. Twenty to 30 minutes were spent on each station. The weather was clearing, with wind and waves decreasing from 14 knots and 4 feet seas to calm.

The West Inshore whaler stations 25, 26 and 27 were not occupied as had been planned because a winch for the whaler was not available.

We understand that, for the remaining sampling period, we will take the East Inshore stations 1, 2 and 3 between the noon and midnight tows of the East Diurnal station. The East Inshore stations 4 and 5 will be taken on the scheduled East Inshore days, using a smaller set of bongos off a whaler, whenever the whaler and the bongo nets become available. West Inshore stations 25, 26 and 27 will be taken by whaler with the smaller set of bongos. When the neuston net is available we will take one bongo tow and one neuston tow at every station.

We have received station prioritizations for the East Trackline, 1° Transect, West Trackline and 2° Transect stations.

In the sampling schedule we have been given a day on both the *Humdinger* and the whaler on the 25th of August. We assume that we should be sampling the East Inshore by whaler on the 22nd of August and use the *Humdinger* on the 25th as per the calendar schedule.

It is understood that an additional day of boat time on the *Humdinger* has been scheduled for August 31 to sample the East Inshore stations 1, 2 and 3. However, this is in conflict with a previously scheduled whaler day for East Inshore work at stations 4 and 5. Which boat would you like us to use on August 31 and where would you like us to sample?

Zooplankton and ichthyoplankton were sampled during all the cruises with a bongo net in a double oblique tow. The bongo net consisted of a double-mouthed frame (each mouth with an inside diameter of 60 cm and a mouth area of 0.2827 m^2) made of fiberglass and weighing 95 lbs. A 50 lb cannonball weight was attached to the bottom of the frame. A 505 μm mesh net with an open area ratio (OAR) of 8:1 and a 333 μm mesh net, 8:1 OAR, were attached to the frame. A Hydro-Products winch was used to deploy the bongo net. The winch did not have a power-out capability, so the MARMAP-required deployment of 50 m/min was estimated. There was a 30 sec sinking time and a retrieval rate of approximately 40 m/min, the slowest speed the winch was capable of. A towing speed of about 2-3 kts was typical. Ship speed was adjusted to keep a 45° wire angle during sinking and retrieval. Sampling depth was generally within 10 m above the bottom to the surface. The fishing depth of the net was determined by the product of the cosine of the wire angle at depth and the amount of wire out. Exact volumes of water filtered are unknown as the flowmeters had not yet been received. The salt-water hose was not working, so nets were washed down with buckets of water. Samples were preserved with formaldehyde, propylene phenoxetol and propylene glycol.

Navigation was accomplished nearshore by 16-mile radar and by bridge reckoning offshore, pending Loran C installation.

D. Sample localities and tracklines. For sample locations and ship trackline see Fig. 1.

E. Data collected or analyzed.

1. The number and kinds of net hauls are given in Table 2.

2. Shrimp, crab and fish larvae and fish eggs are being sorted from the 505 μm bongo net samples. They will also be sorted from the neuston net samples. Sorting is now in progress at the Kasitsna Bay laboratory and at the University of Washington. Samples are not being sorted at the Cottonwood Bay field camp.

In processing digital data, original haul sheets and count sheet numbers are transferred to IBM 80-column entry sheets, keypunched and listed. These listings are proofread from the original haul and count sheets. Corrections are made, then new listings are made of the corrected deck. These corrections are then proofread again from the originals. Deck listings are checked two more times for correct spacing and field placement.

3. Miles of Trackline.

523 km.

F. Milestone Chart and Data Submission Schedules

The revised milestone chart is attached. The time of submission of spring data has been slipped because of the unanticipated loss of sorting time lost when away from the base camp.

III. Results

No new results.

IV. Preliminary Interpretation of Results.

None.

V. Problems Encountered

The usual problems associated with the start of a large field program have been encountered and solved by the Project Office. The present lack of problems is remarkable.

VI. Estimate of Funds Expended

Our estimate is that 77.4% of funds will have been expended through 30 June 1978.

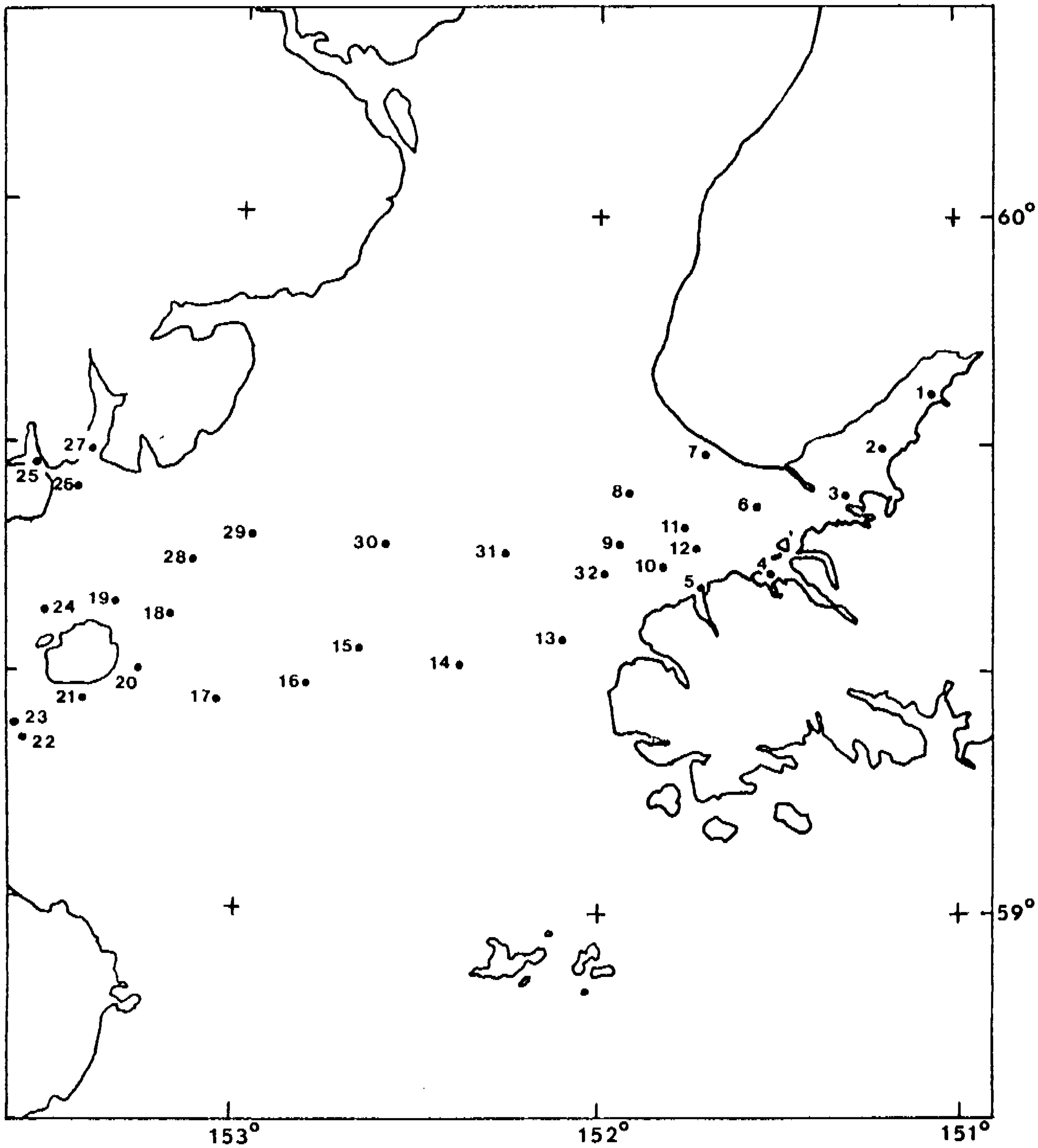


Figure 1. Station locations, Lower Cook Inlet.

Table 1. Station Locations

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	59° 44.0'	151° 04.0'	36	Inner Kachemak Bay
2	59° 40.0'	151° 12.0'	64	Inner Kachemak Bay
3	59° 36.0'	151° 18.0'	82	Inner Kachemak Bay
4	59° 28.7'	151° 31.8'	29	Jakalof Bay
5	59° 27.5'	151° 43.5'	9	Seldovia
6	59° 34.0'	151° 32.5'	76	Outer Kachemak Bay
7	59° 39.0'	151° 48.0'	31	Outer Kachemak Bay
8	59° 37.0'	151° 52.0'	30	Outer Kachemak Bay
9	59° 33.0'	151° 55.0'	35	Outer Kachemak Bay
10	59° 29.0'	151° 51.0'	65	Outer Kachemak Bay
11	59° 34.0'	151° 44.0'	72	Outer Kachemak Bay
12	59° 31.0'	151° 45.0'	82	Outer Kachemak Bay
13	59° 23.0'	152° 06.0'	53	Lower Cook Inlet
14	59° 20.0'	152° 22.0'	82	Lower Cook Inlet
15	59° 22.5'	152° 40.0'	58	Lower Cook Inlet
16	59° 16.3'	152° 49.5'	88	Lower Cook Inlet
17	59° 15.9'	153° 08.5'	51	Lower Cook Inlet
18	59° 26.0'	153° 14.0'	38	Lower Cook Inlet
19	59° 27.5'	153° 22.0'	28	Kamishak Bay
20	59° 20.0'	153° 14.0'	48	Kamishak Bay
21	59° 17.0'	153° 26.0'	22	Kamishak Bay
22	59° 14.0'	153° 40.0'	30	Kamishak Bay
23	59° 15.9'	153° 41.0'	27	Kamishak Bay
24	59° 27.0'	153° 34.0'	25	Kamishak Bay
25	59° 38.0'	153° 35.0'	9	Cottonwood Bay
26	59° 36.0'	153° 29.0'	11	Kamishak Bay
27	59° 39.0'	153° 26.0'	5	Iniskin Bay
28	59° 30.0'	153° 10.0'	35	Lower Cook Inlet
29	59° 32.0'	152° 58.0'	42	Lower Cook Inlet
30	59° 31.0'	152° 36.0'	58	Lower Cook Inlet
31	59° 33.0'	152° 14.0'	48	Lower Cook Inlet
32	59° 28.0'	151° 58.0'	64	Lower Cook Inlet

Table 2. Haul Summary Sheet, 19 May - 9 June 1978

Bongo Tows

Date (1978) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Sampling Depth (m)	Mesh Size (μm) 505	333
19 May	2159	1	1	59° 44.0'	151° 04.0'	46	1	1
19 May	2359	2	1	59° 40.0'	151° 12.0'	47	1	1
20 May	0049	3	1	59° 36.0'	151° 18.0'	52	1	1
28 May	2111	6	1	59° 34.0'	151° 32.5'	66	1	1
29 May	0914	6	1	59° 34.0'	151° 32.5'	72	1	1
1 June	2018	12	1	59° 31.0'	151° 45.0'	65	1	1
1 June	2103	10	1	59° 29.0'	151° 51.0'	66	1	1
1 June	2154	9	1	59° 33.0'	151° 55.0'	26	1	1
1 June	2234	8	1	59° 37.0'	151° 52.0'	18	1	1
1 June	2311	7	1	59° 39.0'	151° 48.0'	24	1	1
2 June	0002	11	1	59° 34.0'	151° 44.0'	70	1	1
2 June	0101	6	1	59° 34.0'	151° 32.5'	67	1	1
4 June	2057	13	1	59° 23.0'	152° 06.0'	35	1	1
4 June	2207	14	1	59° 20.0'	152° 22.0'	86	1	1
4 June	2354	15	1	59° 22.5'	152° 40.0'	48	1	1
5 June	0114	16	1	59° 16.3'	152° 49.5'	76	1	1
8 June	2054	24	1	59° 27.3'	153° 34.0'	6	1	1
8 June	2128	23	1	59° 15.9'	153° 41.0'	8	1	1

Table 2. (continued)

Date (1978) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Sampling Depth (m)	Mesh Size (μm) 505	333
8 June	2203	22	1	59° 14.0'	153° 40.0'	19	1	1
8 June	2327	21	1	59° 17.0'	153° 26.0'	10	1	1
9 June	0032	20	1	59° 20.0'	153° 14.0'	38	1	1
9 June	0125	18	1	59° 26.0'	153° 14.0'	29	1	1
9 June	0209	19	1	59° 27.5'	153° 22.0'	20	1	1
9 June	1625	28	1	59° 30.0'	153° 10.0'	23	1	1
9 June	1734	29	1	59° 32.0'	152° 58.0'	33	1	1
9 June	1924	30	1	59° 31.0'	152° 36.0'	41	1	1
9 June	2140	31	1	59° 31.0'	152° 02.0'	38	1	1
9 June	2214	32	1	59° 28.0'	151° 58.0'	71	1	1

MILESTONE CHART

RU #: 424 PI: T. Saunders English

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

MAJOR MILESTONES	1977			1978												1979			
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
Plan - Coordinate for Field Program	—	—	—	—	—	—	—	—											
Analysis - Interpretation of 1976-77 Data	—	—	—	—	—	—													
Quarterly Report			▲																
Annual Report						▲													
Spring Data Collection Period (55 bongo hauls)								—	—										
Quarterly Report									△										
Spring Data Processing										—	—	—	—	—	—	—	—	—	
Summer Data Collection Period (173 bongo + 173 neuston)										—	—	—							
Quarterly Report												△							
Summer Data Processing													—	—	—	—	—	—	—
Quarterly Report															△				
Submit Spring Data																		△	
Program Review							▲												
Final Report (if RU is terminated)																			△
Synthesis Meeting					▲														

△ Planned Completion Date ▲ Actual Completion Date

QUARTERLY REPORT

Contract: #03-5-022-56
Research Unit: #427
Task Order: #1
Reporting Period: 4/1/78 - 6/30/78
Number of Pages: 3

ICE EDGE ECOSYSTEM
BERING SEA

Dr. Vera Alexander
Dr. R. T. Cooney
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99708

July 1, 1978

Quarterly Report for Quarter Ending June 30, 1978

Project Title: Phytoplankton Studies in the Bering Sea

Contract Number: 03-5-022-56

Task Order Number: 1

Principal Investigator: Dr. Vera Alexander
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99708

I. Task Objectives

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-related production to the Bering Sea ecosystem, to estimate its importance in comparison with summer production on the shelf, with production in the shelf-break area and in the vicinity of the Alaskan penninsula and the Aleutians. The algae growing on the underside of the sea ice were included in the study. The vulneribility of the phytoplankton community to perturbation and the potential impact on the Bering Sea ecosystem were the significant questions.

II. Field Activities

None

Laboratory activities

Final compilation of all tabular data and information from the Bering Sea cruises is complete. Some plotting is still underway for under-ice chlorophyll levels from the spring helicopter work and from the *in situ* fluorometer work along the ice edge.

Major activities during the quarter have included:

1. Cluster analysis of the phytoplankton population composition, with special attention to the ice edge communities versus open water and seasonal changes.

2. Examination of physical oceanographic data, especially for the ice edge, to analyze and to determine the factors contributing to the intense spring ice edge primary production. In particular, the hypothesis of increased water-column stability is being examined with a view to critical assesement of the interrelationship between potential pollutant transport and the physical conditions during the spring bloom.

3. A presentation was made at Santa Cruz for the program review.

4. The model is being examined critically.

5. Confirmation of some of the phytoplankton species identifications was continued.

QUARTERLY REPORT

Contract RK-6-6074
Research Unit: 430
Reporting Period:
1 Apr 1978 -
30 June 1978

A. Bottom and Near-Bottom Sediment Dynamics in Norton Basin

B. Bottom and Near-Bottom Sediment Dynamics in Lower Cook Inlet

C. Sediment Transport during Wintertime Conditions, Northern Bering Sea

David A. Cacchione
David E. Drake

Pacific-Arctic Branch of Marine Geology
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025

June 30, 1978

A. Bottom and Near-Bottom Sediment Dynamics in Norton Basin

I. Task Objectives

A. Development of quantitative relationships between bottom velocity shear and induced sediment entrainment for specific sites in Norton Sound.

B. Estimation of near-bottom sediment flux at various locations in Norton Sound, with particular attention to the movements of Yukon River materials.

C. Comparison of bottom sediment movements during quiescent and stormy periods at specific sites in Norton Sound.

D. Monitoring of bottom currents and light scattering/transmission (within two meters of the sea floor) to enable prediction of sediment and pollutant flux vectors at future times.

E. Measurement of near-surface and near-bottom suspended sediment distribution in Norton Basin.

II. Field and Laboratory Activities

A. No ship cruises or field trips were made during this quarter.

B. Scienitific Party: not applicable.

C. Methods:

1. Laboratory analysis of data collected during calendar year 1977 on R/V SEA SOUNDER and with the GEOPROBE tripod are continuing. Two scientific journal articles are currently in preparation that describe (1) the suspended sediment transport system in the eastern portion of the Northern Bering Sea; and (2) storm-generated bottom transport in Norton Sound, respectively.

D. Sample locations - Detailed sample location and trackline charts were shown in the annual report for RU 430 (1 April 1978).

E. Data Collected and Analyzed - A complete list of data are given in the annual report (1 April 1978).

III. Results

No new results are available since the submission of the annual report other than a recalibration of electromagnetic flow sensors. A complete technical report of the calibration procedures and results will be included in the final report.

IV. Preliminary Interpretation of Results

The latest calibration of electromagnetic current sensors indicates that they are performing as before: the accuracy is about $\pm$ 2 cm/sec; drift is negligible, and response is adequate to record surface gravity water waves.

V. Problems - None.

VI. Estimate of Funds Expended: 90%

B. Bottom and Near-Bottom Sediment Dynamics in Lower Cook Inlet

I. Task Objectives

This study addresses the overall objective of evaluating geologic hazards associated with erosion and deposition on the seafloor and of characterizing bottom sediment dynamics. Specific objectives in Lower Cook Inlet are:

1. To provide a spatial and temporal description of bottom sediment transport.

2. To develop estimates of bottom sediment flux related to high energy events such as storms and tides.

3. To relate the magnitude of bedshear to the initiation of bottom sediment movement for each sedimentary environment.

4. To provide detailed descriptions of seafloor physiography and surface sediment characteristics in selected areas of observation.

5. To describe changes in the surface character of the seafloor over relatively long duration (at least one month).

II. Field and Laboratory Activities

Most of the activities to date have been planning, construction, and other preparations for the field experiment scheduled in July 1978. As discussed in the proposal we intend to deploy two GEOPROBE tripods in the area of large sand waves (Bouma and Hampton, RU 327) in Lower Cook Inlet. These two tripods will record oceanographic and sedimentological data at 7.5 min intervals over a 3-4 day period to obtain information on the short period transport.

One of the two GEOPROBE systems will be reset and redeployed in an area of smaller bed forms for a longer time period (until Oct. 1978). These data will provide information on longer term bottom transport.

III. Results: None

IV. Preliminary Interpretation of Results: None

V. Problems Encountered: None

VI. Estimate of funds expended: $58,000, principally used to construct one GEOPROBE tripod.

C. Sediment Transport during Wintertime Conditions, Northern Bering Sea

I. Task Objectives

To determine the quantity and composition of suspended matter in Norton Sound during the winter season and use this information to assess annual rates of sediment transport.

II. Field and Laboratory Activities

A. Field work was completed in February-March 1978. Work during the past quarter has focused on the distribution of suspended matter in the sound and analyses of the texture and composition of the particulate matter recovered from ice and water samples.

B. Methods - Combustion analysis, polarizing and scanning electron microscopy, x-ray diffraction.

C. See Annual report RU 430, April 1978 and Cruise Report prepared by Clarke H. Darnall for helicopter cruise W-29.

D. 39 stations for suspended sediment sampling in Norton Sound and along the southwestern coast of Seward Peninsula; 94 ice and water samples.

III. Results

1. Transmissometer profiles and suspended matter concentrations show that there is little or no vertical stratification of the water column in Norton Sound during the winter season. This well-mixed condition is in marked contrast to the strong density stratification present in the summer.

2. Concentrations of suspended matter in the winter are essentially the same as during non-storm periods in the summer months, despite the fact that terrigenous sediment supply is negligible in the winter.

3. The distribution of suspended matter in February-March 1978 (Fig.1) reveals the same pattern of advective transport that has been found during the summers of 1976 and 1977 (Cacchione and Drake, annual report, Apr 1978).

4. Concentrations of sediment within the seasonal pack-ice ranged from 3 mg/l to nearly 2 g/l. The highest concentration was present approximately 50 km north of the Yukon Delta.

5. Ice movement occurs continuously and sometimes very rapidly in Norton Sound. Large leads were formed overnight in response to increased winds or a shift in wind direction.

6. In general, ice formed in the eastern part of Norton Sound is blown westward by prevailing winter winds. Ice which is blown out of Norton Sound probably turns north toward Bering Strait.

IV. Preliminary Interpretation of Results

Particulate matter in suspension during the winter is predominantly fine-grained terrigenous silt and clay which must come from resuspension of bottom sediment. The necessary currents are most likely produced by the astronomical tides which are relatively uneffected by the ice cover. In addition, the distribution of suspended matter shows that transport across the mouth of Norton Sound toward Bering Strait is significant in the winter.

The presence of exceptionally high concentrations of sediment in some portions of the pack ice suggests the importance of storms during the winter. An analysis of sediment transport by ice has been started.

V. Problems Encountered: None

VI. Funds expended: 90% of available funds.

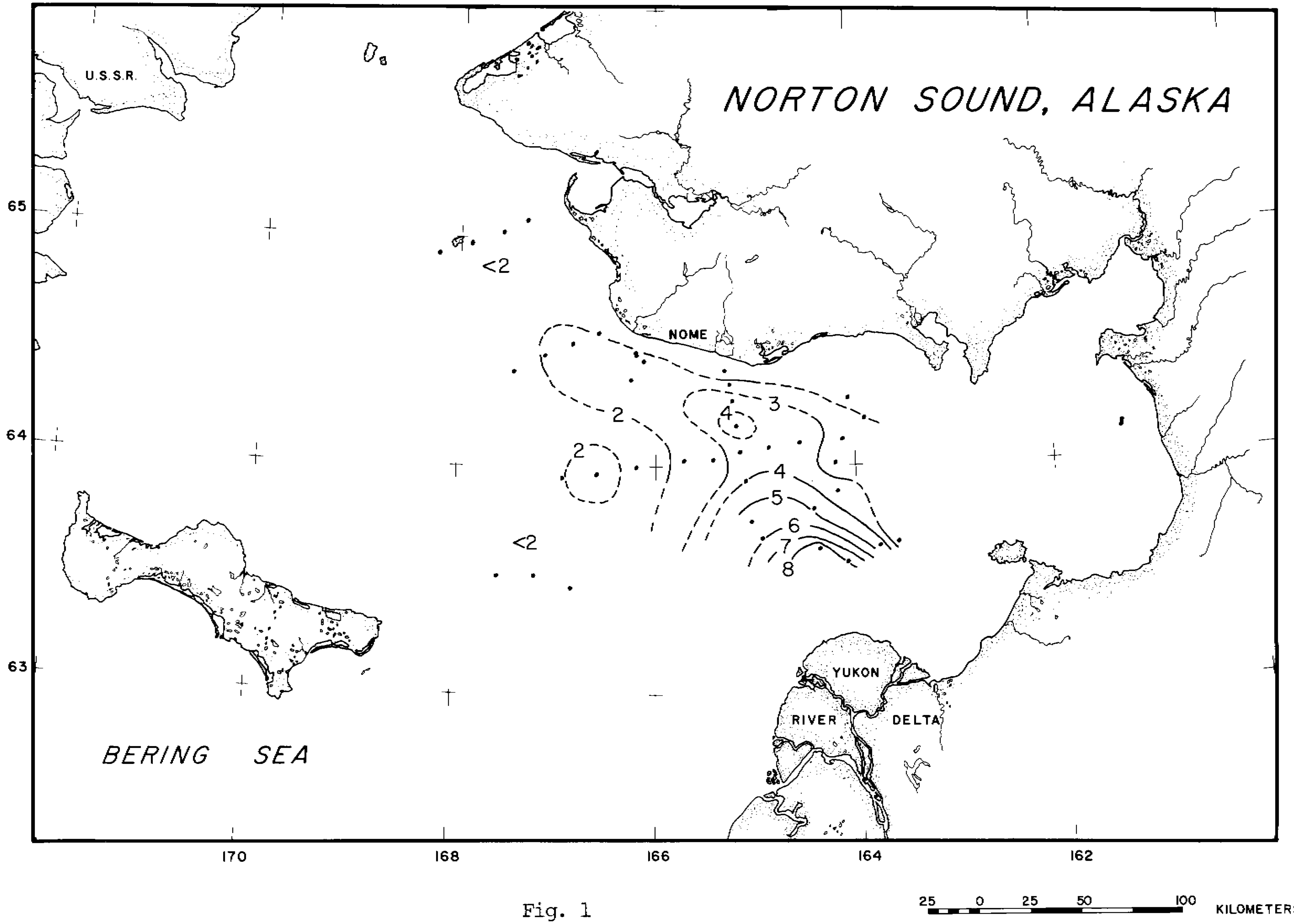

NORTON SOUND, ALASKA
U.S.S.R.
NOME
BERING SEA
YUKON
RIVER
DELTA
<2
<2
2
2
3
4
4
5
6
7
8
65
64
63
170
168
166
164
162
25 0 25 50 100 KILOMETERS

Fig. 1

Research Unit #435
1 April - 30 June

Quarterly Report

MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA

By

J. J. Leendertse
S. K. Liu

Rand Corporation
Santa Monica, California 90496

Progress Report

MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA (RU 435)

National Oceanic and Atmospheric Administration

April 1, 1978 - June 30, 1978

J. J. Leendertse and S. K. Liu

Rand Corporation, Santa Monica, CA 90496

During the reporting period the emphasis of our study has been centered around the final adjustments of the three-dimensional model of Bristol Bay and St. George Basin. The open boundaries of the model had been rearranged earlier this year to take full advantage of the data collected by the Pacific Marine Environmental Laboratory for the adjustment and verification of the model. Copies of the pressure and current data analyzed by PMEL have recently been obtained by Rand's modeling team. To coordinate this task, two trips were made by one of the co-principal investigators from Rand. At the present time all 15 important tidal constituents analyzed from the pressure data are utilized by the model at the open boundaries as forcing functions. Weather data collected by the research ship Moana Wave are also incorporated in the modeling effort. The model verification process is presently underway. The computed water level, currents, temperature and salinity field are being compared against the observed data for the verification period, using only the environmental factors and predicted tidal information prescribed at the model's open boundary by the model itself for that particular period. Because of the volume of simulation output data which has to be compared with the observed data in the interior of the model area, the process is quite laborious. Preliminary analyses show excellent agreement in the hydrodynamic field.

During the reporting period, interaction between PMEL's Physical Oceanographic Study Group and Rand's modeling team has been extensive. Both investigators also participated in the Physical Oceanography Workshop in May 1978. At the meeting results of this study were presented and aspects of investigator data management interaction were discussed.

QUARTERLY REPORT

Contract #03-5-022-56
Research Unit #441
Task Order #27
1 April - 30 June 1978

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

P. G. Mickelson
Principal Investigator
Institute of Arctic Biology

Report Prepared By:
Anne Seguin

30 June 1978

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 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

Since March we have been processing, summarizing, and coding data. All data from waterfowl plots 1 and 2 for 1976 and 1977, in addition to the eider colony (waterfowl plot 3) for 1977, has been turned into the Sea Grant office for keypunching.

All plant specimens from 1976 and 1977 have been identified. A list of taxa and flowering dates will appear in the final report. In addition gull regurgitation pellets, intertidal samples, and fox scats are being analysed.

IV. PRELIMINARY DISCUSSION OF RESULTS

There is no additional discussion at this time.

QUARTERLY REPORT
ON RESEARCH UNIT 454

RESEARCH TO DETERMINE THE ACCUMULATION OF ORGANIC CONSTITUENTS AND HEAVY METALS FROM PETROLEUM-IMPACTED SEDIMENTS BY MARINE DETRITIVORES OF THE ALASKAN OUTER CONTINENTAL SHELF

by

J. W. Anderson, J. M. Augenfeld,
E. A. Crecelius and R. Riley

BATTELLE
Pacific Northwest Division
Marine Research Laboratory
Route 5, Box 1000
Sequim, Washington 98382
U.S.A.

THIRD QUARTER OF FY1978

National Oceanic & Atmospheric Administration
OCSEAP Office
P. O. Box 1808
Juneau, Alaska

Contract No. 2311102778

July, 1978

Purity and Purification of ^{14}C-Substrates

Reverse phase high-pressure liquid chromatography has previously been used in a method to characterize impurities associated with benzo(a)pyrene degradation (Clarke, 1976). We have recently used this technique to determine the radio-purity of all three substrates used in these studies. Phenanthrene and chrysene undergo no significant chemical degradation under prolonged storage, however, benzo(a)pyrene showed the presence of about 10% impurities and, therefore, had to be purified by silica gel chromatography prior to the 60-day exposure experiment to assure that no degradative chemical artifacts were introduced to invalidate radioactivity analysis. The purification on silica gel was as follows: benzo(a)pyrene (60.7 mCi/mmol, 200 μCi in 1 ml benzene) was chromatographed over 10 grams of silica gel (Grace Davison Chemical Co., 100/200 mesh-heated overnight at 120°C) using benzene as the eluent. Ten milliliter fractions were collected and pure benzo(a)pyrene eluted from the column in the second 10 ml fraction. The column and collection were wrapped in aluminum foil to minimize the exposure of the benzo(a)pyrene to light. The benzene was removed under a stream of purified nitrogen and the crystalline benzo(a)pyrene was stored at -20° until use the next day.

Distribution and Metabolism of ^{14}C-Hydrocarbons in Oil-Impacted Sediment and Detritivores

Exposure System

We are conducting an experiment to determine the fate of specific hydrocarbons in oil-impacted sediments, in terms of their distribution in association with sediment particles, in interstitial and surface water, and in detritivorous organisms, as well as their chemical alteration into polar metabolites. For this purpose, 190 *Macoma inquinata*, a detritus-feeding clam, and 100 kg sediment were collected from the low intertidal zone in an area of coarse sand mixed with fine gravel. The sediment was passed through a 6 mm mesh sieve, and it and the clams were stored in the laboratory under flowing sea water at approximately 10°C and 30°/oo salinity. Detritus was collected from the laboratory seawater head tanks, filtered through #42 Whatman filter paper, and refrigerated. ^{14}C-labelled phenanthrene, chrysene, and benzo(a)pyrene were purchased from Amersham-Searle. The benzo(a)pyrene was separated from contaminating polar compounds one day before its use by passage through a column of silica gel and eluted with benzene.

The labelled compounds were individually dissolved in solvent together with Prudhoe Bay crude oil, mixed with detritus, and incorporated into sieved sediment in a fiberglass-lined cement mixer. The final mixtures contained approximately 80g detritus, 40 ppm PBC, and between 4.5 and 6.8 μCi labelled compound per kg. Final concentration of chrysene was 232 μg/kg, of phenanthrene 79 μg/kg, and of benzo(a)pyrene 18 μg/kg. These mixtures were poured to a depth of 8 cm into mesh-bottomed trays divided into three compartments each. The trays were placed on cement blocks in fiberglass tanks at a depth which permitted 5 cm of water to stand above the sediment surface but which did not permit water to rise above the edge of the trays. At 12 hour intervals, water was pumped out of the fiberglass tanks for one hour, allowing the water in the trays to drain out through the mesh bottom and to be replaced by fresh volumes of water after the pumping stopped.

After two flushings, a sediment core was taken from each compartment and replaced by a 12 mm standpipe to facilitate future drainage. At this time, ten *M. inquinata* were placed in each compartment. The cores from the center compartment of each tray were divided into upper, middle, and lower sections. The radioactivity in replicate samples from each section was measured, and the results indicated that the labelled compounds were evenly distributed throughout the sediment. Eighty percent of the calculated radioactivity added was recovered in the chrysene and benzo(a)pyrene exposures and 67% in the phenanthrene.

At intervals of one, three, seven, fifteen, thirty, and sixty days after the clams were initially exposed, a sample of the surface water overlying the sediment was removed from one compartment and passed through a 0.45 μ Millipore filter. The water level was then lowered, the clams were removed and placed in a mesh basket in clean running sea water for 24 hours depuration, after which they were rinsed with distilled water and frozen. Part of the sediment was also frozen immediately. The remaining sediment was placed in a Wildco CR^{TM} Core Squeezer, in 100 cc batches, and the interstitial water was forced out with compressed air at 50 psi, passing through several layers of Whatman #42 filter paper within the squeezer. This filtrate was then passed through a syringe fitted with a Swinnex-47 Filter Holder (Millipore Corporation) containing a pre-filter and a 0.45 μ filter. Glassware containing benzo(a)-pyrene in water was protected from light by aluminum foil wrappings. All water was kept in ice and protected from evaporation wherever possible.

Tissue, sediment, and water samples are being prepared for analysis of parent and metabolite compounds by reverse phase HPLC. The total concentration of labelled compounds in interstitial and filtered surface water at several time intervals have been measured.

The results summarized in Table 1 indicate that the solubility of heavier hydrocarbons in interstitial water is inversely related to their molecular weight. The interstitial concentration of phenenthrene rises to a peak after 15 days at a level equivalent to 7.2% of the initial measured sediment concentration. In later measurements it declined to about one third of this value. The concentration in the surface water overlying the sediment was an order of magnitude less than that in the interstitial water, but it increased and decreased in step with the latter.

The interstitial concentration of chrysene was an order of magnitude less than that of phenanthrene, but rose steadily over the exposure period, reaching a peak of 0.38% of the initial concentration after 58 days. The concentration in the surface water was close to that in the interstitial water.

Little benzo(a)pyrene was dissolved in interstitial water over the first three weeks of exposure. The level was about 0.08% of the initial sediment concentration, and showed no tendency to change with time. The concentration in the surface water was almost immeasurably low.

Further interpretation of these data will follow the completion of the HPLC analyses, described next.

Table 1. Total ^{14}C-Hydrocarbon Concentration in Surface and Interstitial Water

Days	Phenanthrene				Chrysene				Benzo(a)pyrene			
	IW		SW		IW		SW		IW		SW	
	1	2	1	2	1	2	1	2	1	2	1	2
1	1630	3.22	138	.26	64	.034	29	.016	5.8	.041	1	.0071
3	1285	2.45	44	.084	62	.033	23	.012	9.1	.064	.4	.0003
7	2390	4.56	432	.82	43	.023	51	.027	10.7	.076	50	.35
15	3760	7.2	461	.88	76	.042	77	.042	10.7	0.76	2	.00015
24			177	.34								
30	1113	2.12	205	.39	500	.27	208	.11				
37			124	.24			483	.26				
44			67	.13			488	.262				
51			71	.14			313	.17				
58					704	.38	380	.21				

1 = picogram/ml

2 = % of initial sediment concentration

Chemical Analyses

In the previous quarterly report, an analytical method was described for monitoring the uptake and fate of ^{14}C-aromatic hydrocarbons in marine organisms. In this report we wish to describe the method and its application to monitoring the uptake and fate of ^{14}C-phenanthrene, ^{14}C-chrysene and ^{14}C-benzo(a)pyrene in the intertidal detritivore, *Macoma inquinata*. The method is also designed in such a manner as to account for the formation of degradative products. The overall scheme is outlined in Fig. 1. Conventional tissue digestion techniques such as that described by Warner (1976) cannot be used in the method because the potential chemical destruction of degradation products that might be formed during the experiments. Therefore, initial preparation includes homogenization of tissue samples in an organic solvent. We decided to use ethylacetate/acetone: 2/1 for extracting the tissue. This extraction technique has previously been applied to a study of the metabolism of 7, 12-dimethylbenz(a)anthracene in mouse skin homogenates (DiGiovanni *et al.*, 1977) and it produced very high recoveries of original substrate and metabolites. A modification of the technique has been used in a study of benzo(a)pyrene phenols formed by the metabolism of benzo(a)-pyrene by rat liver microsomes (Selkirk *et al.*, 1974).

To test the efficiency of recovery employing the above techniques, tissue samples were spiked with known amounts of ^{14}C-phenanthrene, ^{14}C-chrysene, and ^{14}C-benzo(a)pyrene and extracted (Tekmar homogenizer) with 3 ml of ethylacetate acetone (2/1), followed by a second extraction with 2 ml of ethylacetate acetone (2/1) with the addition of 1 ml saturated sodium chloride. The results of the recovery experiment are shown in Table 2. Recovery of all three hydrocarbons was greater than 90%. Only about 80% of the radioactivity could be recovered in the first extraction of hydrocarbon, but the second extraction was satisfactory.

Figure 1. Scheme for the Isolation and Analysis of ^{14}C-Aromatic Hydrocarbon from Clam Tissue.

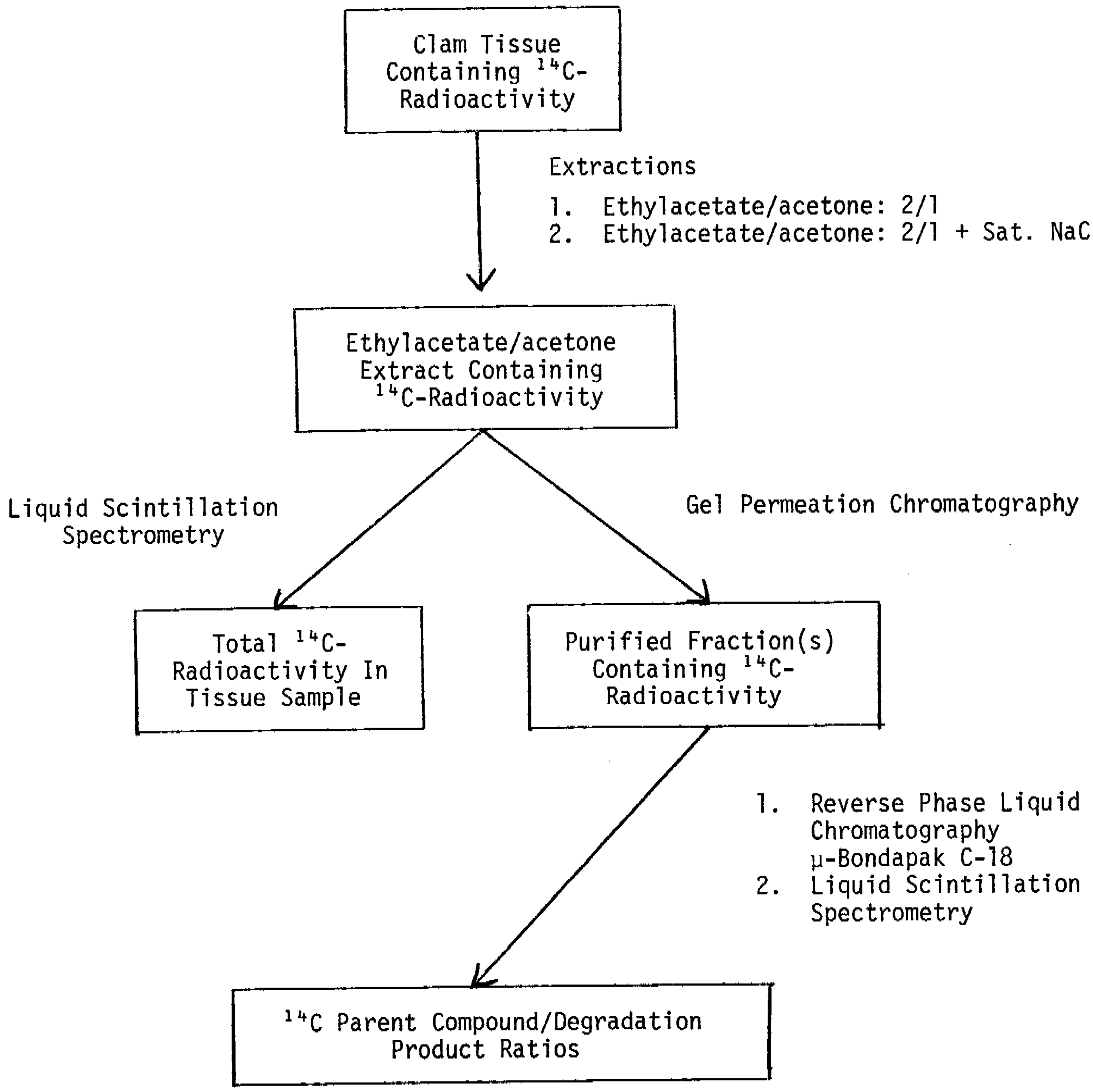


Table 2. Recovery of ^{14}C-Aromatic Hydrocarbons from Clam Tissue

Compound	DPM Added	DPM Recovered		% Recovered	
Phenanthrene	32,185	10,410	1272	94.5	3.9
Chrysene	21,898	21,081	853	96.3	3.9
Benzo(a)pyrene	34,586	31,703	1854	91.7	5.3

The next step in the isolation sequence involved the use of high-pressure gel permeation chromatography (GPC) to remove high molecular weight components which have the potential for interfering with the final detailed analysis of individual ^{14}C-labelled degradation products during analysis by reverse phase high-pressure liquid chromatography (RPLC). Initial attempts to use a modified version of a method described by Kuehl *et al.* (1978) failed, and therefore, a GPC technique was developed using three series coupled y-styrogel columns with pore sizes of 1000, 500 and 100 Angstoms, respectively. To test the separation capability of the GPC system, model compounds with structural types equal to or similar to the compounds of interest were analyzed on the system using UV detection at 254 nm and the results are shown in Table 3. Those compounds with equal or similar structural types to the substrates used in the uptake studies (benzene, naphthalene, phenanthrene and chrysene) were tested for their retention volumes. The retention volume of chrysene differed from the other three compounds by 0.2 ml. 1-naphthol, a compound which simulates a compound type that might be formed as a result of degradation of the parent compound has larger retention volume compared to the non-polar compounds previously described, therefore, recognition of degradation products could be observed by this method. Components extracted from the tissue with molecular weight greater than 1000 are also easily separated from these compounds as shown by the retention volumes for polystyrene (MW 2,400 and 15,000). Therefore, recognition of the formation of conjugates is also possible at this time. Samples of tissue extract containing ^{14}C-phenanthrene when subjected to the above separation produced a ^{14}C-phenanthrene fraction almost completely devoid of extraneous tissue components as determined by mass balance. This GPC technique, therefore, provides a means of reducing separation interaction and minimizing quenching effects as a result

Table 3. Separation of Aromatic Hydrocarbons by Gel Permeation Chromatography

Compound	Molecular Weight	Retention Volume (ml)
Benzene	78	31.7
Naphthalene	128	31.7
Phenanthrene	178	31.7
Chrysene	228	31.9
1-naphthol	144	35.7
Polystyrene	2,900	20.6
Polystyrene	15,000	17.4

of the presence of high molecular weight components (biogenic) in the tissue extract. It will provide initial information on the presence of low molecular weight polar degradation products or higher molecular weight conjugates as a result of organism metabolism or other degradative processes associated with the experimental system.

The techniques described above are currently being applied to the analysis of tissue derived from *Macoma inquinata* exposed to detritus-sediment mixtures containing ^{14}C-phenanthrene, ^{14}C-chrysene and ^{14}C-benzo(a)pyrene.

Total ^{14}C-uptake in the tissue of *Macoma inquinata* has been determined at 1, 3, 7 and 15 day time intervals of a 60-day exposure to ^{14}C-chrysene. These results are reported in Table 4. The rate of uptake of ^{14}C in clams exposed to chrysene appears to be decreasing with time after an initial rapid rise in the first 3-day time period. These data appear to be consistent with data previously reported on the uptake by *Macoma inquinata* exposed to ^{14}C-chrysene (Roesijadi *et al.*, 1978). To determine whether any chemical alteration of the chrysene had occurred after 15 days, triplicate tissue extracts were analyzed by GPC and by a reverse phase high-pressure liquid chromatographic technique similar to that reported by Selkirk *et al.* (1974) for the separation of benzo-(a)pyrene from its metabolites. Based on the results of the two analyses, all of the radioactivity was associated with chrysene, thus the data reported in Table 4 represents the total uptake by clams during the first 15 days of the 60-day exposure.

Future research will be directed toward examination of tissue of *Macoma* exposed for 30 to 60 days to ^{14}C-chrysene using the above methodology. The above techniques will also be applied to samples of *Macoma* exposed to ^{14}C-phenanthrene and benzo(a)pyrene. Samples of tissue from the 60-day time period of each

Table 4. Total Radioactivity Uptake (Original Substrate + Degradation Products) by *Macoma inquinata* Exposed to ^{14}C-chrysene.

Compound	Time (days)	^{14}C-Uptake (DPM/gram tissue)
Chrysene	1	8,567 ± 1,160
	3	19,436 ± 4,534
	7	25,612 ± 10,479
	15	51,343 ± 23,568

exposure will be analyzed for the presence of degradation products. The chemical data will provide information on the degree of availability of these compound types to *Macoma* based on chemical structure and route of entry (sediment, interstitial water). Information will also be provided on the potential for the formation of ^{14}C-substrate degradation products which will provide a means of evaluating whether such effects need to be considered with respect to their toxicological impact on marine ecosystems.

Field Experiment

Task 3 concerning the long-term field exposure of *Macoma, Protothaca,* and *Phascolosoma* with oiled sediment (1237 ± 112 ppm PBC) containing the three species were placed in the field in early March. The length of exposure was 54 days. At termination, the control trays contained live specimens of all three species. The exposed trays contained live *Macoma* and *Protothaca,* but no *Phascolosoma* (Table 5).

Tasks 4 and 5 regard the analysis of the above mentioned field exposure. The analysis of condition index on 64 control *Protothaca* and 59 exposed animals has been completed. In conjunction with this, from 5 to 15 specimens of each species recovered were frozen for analysis of amino acid and hydrocarbon content. At the present time, the tissue preparation and extraction has been completed for all initial control samples taken at the time of installation. The remaining exposed and control samples for amino acid and hydrocarbon analysis are being prepared at the present time and results are expected shortly.

Table 5. 54 Day Field Exposure.

	Control			Exposed		
	Protothaca	*Macoma*	*Phascolosoma*	*Protothaca*	*Macoma*	*Phascolosoma*
Field exposure initiated # organisms added	90	20	30	90	30	30
Field exposure terminated # live organisms recovered	82	20	11	77	5	0
Percent live recovered	91%	100%	37%	85%	17%	0%
Analysis of Samples for:						
1. Condition Index	Analysis completed	-	-	Analysis completed	-	-
2. Amino Acid						
Initial controls	[10]Analysis completed	[10]Analysis incomplete	[10]Analysis incomplete	-	-	-
54 day samples	[10]In preparation	[15]In preparation	[11]In preparation	[10]In preparation	Not enough survived	No survivors
3. Hydrocarbons	[5]Frozen for later analysis	[5]Frozen for later analysis	-	[5]Frozen for later analysis	[5]Frozen for later analysis	-

REFERENCES

Clarke, P. A. 1976. Benzo(a)pyrene Metabolite Identification - An Example of NMR as an Analytical Technique. Carcinogenesis Vol. 1, Polynuclear Aromatic Hydrocarbons: Chemistry, Metabolism, and Carcinogenesis. R. I. Freudenthal and P. W. Jones, Ed., Raven Press, New York.

DiGiovanni, J., T. J. Slaga, D. L. Berry and M. R. Juchau. 1977. Metabolism of 7, 12-Dimethylbenz(a)anthracene in Mouse Skin Homogenates Analyzed with High-Pressure Liquid Chromatography. Drug Metabolism and Disposition 5: 295-301.

Kuehl, D. W. and E. N. Leonard. 1978. Isolation of Xenobiotic Chemicals from Tissue Samples by Gel Permeation Chromatography. Anal. Chem. 50: 182-185.

Roesijadi, G., J. W. Anderson and J. W. Blaylock. 1978. Uptake of Hydrocarbons from Marine Sediments Contaminated with Prudhoe Bay Crude Oil: Influence of Feeding Type of Test Species and Availability of Polycyclic Aromatic Hydrocarbons. J. Fish. Res. Bd. Can. 35:608-614.

Selkirk, J. K., R. G. Croy and H. V. Gelboin. 1974. Benzo(a)pyrene Metabolites: Efficient and Rapid Separation by High Pressure Liquid Chromatography. Science 184:169-175.

Selkirk, J. K., R. G. Croy and H. V. Gelboin. 1976. High Pressure Liquid Chromatographic Separation of 10 Benzo(a)pyrene Phenol and Identification of 1-Phenol and 7-Phenol as New Metabolites. Cancer Research 36:922-926.

Warner, J. S. 1976. Determination of Aliphatic and Aromatic Hydrocarbons in Marine Organisms. Anal. Chem. 48:578-583.

QUARTERLY REPORT

Contract No.: 03-6-022-35210
Research Unit: 460
Reporting Period: 1 April-
30 June 1978
Number of Pages: 1

ECOLOGICAL STUDIES OF COLONIAL SEABIRDS AT CAPE THOMPSON AND CAPE LISBURNE, ALASKA

Principal Investigators

Alan M. Springer
David G. Roseneau

Renewable Resources Consulting Services, Ltd.
3529 College Rd.
Fairbanks, Alaska 99701

1 July 1978

I. Task Objectives

The objective of this study is to provide information on the ecology of seabirds which breed in the eastern Chukchi Sea. By broadening the data base, effects of resource developments in the Hope Basin may be more accurately measured.

II. Field and Laboratory Activities

A. Field Activities

Final arrangements and scheduling was completed with Bill Drury and Don Olson to fly aerial transects over the waters near Capes Thompson and Lisburne. Unfortunately landing papers for the civilian aircraft at the Cape Lisburne Air Force Site were not filed during June and the surveys have been postponed until early July.

Scheduling for the Natchik has been initiated, however, beginning dates will be contingent upon open water between Barrow and Cape Lisburne.

B. Laboratory Activities

None

III. Results

None

IV. Problems Encountered

None

V. Estimate of Funds Expended

CPF-1	$1790.00
CPF-2	475.00
CPF-3	200.00
TOTAL	$2465.00

QUARTERLY REPORT

Contract No. - 03-78-B01-31

Research Unit No. - 467

Reporting Period - 1 April to 30 June 1978

Number of Pages - 8

Project Director	Joe C. Truett, Ph.D. LGL Limited - U.S., Inc. 103-A Pleasant Street BRYAN, Texas U.S.A. 77801
PI, Aquatic Ecology	Peter C. Craig, Ph.D. LGL Limited 53 Howard Avenue NANAIMO, British Columbia V9R 3P9
PI, Avian Ecology	Stephen R. Johnson LGL Limited 10110 - 124 Street EDMONTON, Alberta T5N 1P6

BEAUFORT SEA BARRIER ISLAND-LAGOON ECOLOGICAL PROCESS STUDIES

I. Highlights

Initial field sampling efforts began in early April; at this time sampling of the over wintering fish population was initiated by using gill nets set beneath the ice near the Colville River delta west of the study area. In late April a research planning and modeling workshop was held at the University of British Columbia in Vancouver. Program Investigators at the workshop planned in detail research for the forthcoming field season; additionally the workshop hosted a scientific review panel. Following this workshop, researchers assembled field equipment, completed research plans for the field season, and planned logistics and camp support for the research effort. Field research began in early June; activities in June included sampling of under-ice and ice-edge habitats for fish and benthic invertebrates, measuring water quality at sampling sites, surveying island and mainland habitats for nesting birds, and maintaining daily watch for birds to determine their local movements and habitat use patterns.

II. Task Objectives

This program was originated 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 program's broad objectives are to:

(1) Identify and analyze the importance of selected ecosystem components and processes contributing importantly to the structure and productivity of nearshore ecosystems.

(2) Evaluate the feasibility of detecting and quantifying temporal change in those ecosystem components and processes identified as important.

(3) 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 the research efforts of OCSEAP Research Units No. 526, 527, 529, 530, and 531, (nutrient dynamics, oceanography, geomorphology, and sedimentology). It is the responsibility of LGL Limited to conduct studies in aquatic ecology and ornithology, to administer the integration of the above Research Units into the entire barrier island-lagoon program, 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 modeling 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. Specific task objectives of RU 467 are as follows:

(1) To clarify the food web and energy flow processes (to include all trophic levels from the ultimate food base to the key bird and fish species) which support important vertebrates in the barrier island-lagoon system.

(2) To assess food sources and feeding dependencies of fishes and invertebrates in lagoon and nearshore marine waters.

(3) To document movements and residency behaviour of fish and invertebrates in the lagoon habitat.

(4) To characterize the manner in which selected bird species utilize the barrier island-lagoon system for feeding, resting, nesting and/or molting.

(5) To describe the feeding and habitat dependencies of the bird and fish species studied as these dependencies may be disrupted by OCS-related development.

(6) To evaluate the importance of microhabitat features (which may potentially be altered by petroleum development activities) to the breeding and feeding activities of birds and fish.

(7) To determine locations and mechanisms of over-wintering (as opposed to annual recolonization) by fish and invertebrates.

(8) To evaluate feeding dependencies and habitat use by arctic foxes as these relate to other elements of the biological community.

(9) To document the dependencies of biotic communities on coastal dynamics, geochemical processes, and nearshore circulation patterns through active coordination with Research Units No. 526, 527, 529, 530, and 531.

III. Activities

A. Field Work, Laboratory Analyses, Workshops

Sampling activities began in late winter (April) when gill nets were set beneath the ice in the lower Colville River delta west of Simpson Lagoon. (The able assistance of Jim Helmericks of Colville Village in this effort is acknowledged.) Approximately 300 fish, including some of the common species found in Simpson Lagoon in the summer of 1977, were taken before the nets were removed in May. These fish were sexed and measured, and their stomachs were removed for analysis of contents.

The fourth semi-annual modeling/synthesis workshop of this program was held at the University of British Columbia in Vancouver, 24 - 26 April. Dr. Carl Walters and his associates at the University's Institute of Resource Ecology hosted the three-day event. Principal workshop participants in addition to the modelers were investigators for Research Units No. 526, 527, 529, 530, 531, and 467, and representatives from NOAA and BLM. Also attending was an invited review panel of four prominent scientists (ecologists and oceanographers). (These scientists subsequently submitted written reviews of the program). During the course of the workshop, the objectives, current findings, and future research plans of the program were reviewed, the use of modeling was explained, submodels were refined, and the scheduling and locations of research activities planned for the forthcoming field season were discussed.

During May, investigators of this Research Unit (No. 467) finalized equipment purchases, travel arrangements, and logistics support plans for the field season's activities. The Arctic Project Office personnel in Fairbanks and Barrow arranged for the moving of research buildings from a storage site on the Colville delta to this year's research camp site at Milne Point on Simpson Lagoon. They also assisted the project to obtain the necessary air support for the summer's operations.

Summer field work commenced on 2 June, when an investigator (Griffiths) and two technicians moved into the Milne Point camp on the south side of Simpson Lagoon to prepare the camp and begin the summer's research effort. By the end of June, an additional investigator (Johnson) and two additional technicians occupied the camp. During June the following types of research activities were performed:

(1) Samples of epibenthic invertebrates were taken in open leads near the mainland, on landward and seaward sides of the barrier island chain, and under the ice in mid-lagoon. Gill nets were maintained for fish at these same stations, and station water temperatures and salinities were recorded. Samples of water were also taken periodically at these stations for subsequent nutrient analysis by Don Schell of RU 527.

(2) Invertebrate samples taken were examined to determine their general composition then preserved for more thorough analysis at a later date. These initial gross examinations of samples were made to look for major changes in the composition of the epibenthic community through time relative to the disintegration of the sea ice and associated freshening of lagoon waters. All fish caught were measured, their otoliths were excised for subsequent aging of the fish, and the fish stomachs were removed and preserved for later analysis. Detailed laboratory analyses of samples of invertebrates and fish stomachs will commence next quarter.

(3) Rectangular plots were established on the barrier islands and on the nearshore mainland; investigators periodically searched for nesting birds on these plots so that bird nesting densities by habitat type could be estimated. Daily watches were made for birds moving through or into the area to help evaluate the extent to which migrating and feeding birds used the lagoon and adjacent land areas.

B. Scientific Party

The scientists involved in this program and their roles and affiliations are listed below.

Name	Affiliation	Project Role
Joe Truett, Ph.D.	LGL Limited-U.S., Inc.*	Project Director
Peter Craig	LGL Limited**	PI, Aquatic Ecology (fish)
William Griffiths	LGL Limited***	Aquatic Ecology (invertebrates)
Lewis Haldorson	LGL Limited-U.S., Inc.*	Aquatic Ecology (fish and invertebrates)
Stephen Johnson	LGL Limited***	PI, Avian Ecology
Robert Dillinger	LGL Limited***	Laboratory Analysis (invertebrates)

* 103-A Pleasant Street, Bryan, Texas 77801

** 53 Howard Avenue, Nanaimo, British Columbia V9R 3P9

*** 10110-124 Street, Edmonton, Alberta T5N 1P6

C. Methods

General methods used for the several areas of research this quarter are presented below:

Research Activity	Method
Collecting epibenthic invertebrates under the ice	Baited invertebrate traps
Collecting fish under the ice	Gill nets
Sampling epibenthos in open water leads	Baited invertebrate traps; tow nets and dredges
Sampling fish populations in open water leads	Gill nets
Measuring water temperature and salinity profiles	Hydro-lab
Collecting water samples for nutrient analysis	Messenger-activated water sampling bottle; freezing of samples for storage

C. Methods (cont'd)

Research Activity	Method
Estimating nesting bird densities	Searches of permanent rectangular plots
Evaluating local bird movement and habitat use	Standardized watches with binoculars and telescope; opportunistic observations
Research integration among investigators	Workshop sessions, modeling
Process sensitivity analysis, generation of critical hypotheses for subsequent testing	" " "

D. Sample Localities

All aquatic samples were collected in or immediately to the seaward side of Simpson Lagoon, with the exception of fish taken under the ice in April near the Colville River delta. Bird surveys were made in the vicinity of Simpson Lagoon in the nearshore waters, on the barrier islands, and on the nearshore mainland.

E. Data Analyzed

Data collected in 1978 have not been analyzed to date; commencement of analysis is expected to occur near the end of next quarter.

IV. Results

Results from the 1978 sampling program are preliminary and should at this point be viewed as unsubstantiated by critical analysis. Important hypotheses proposed as a consequence of the sampling efforts performed to date, and which will be tested as data are analyzed, include the following:

(1) A few of the principal amphipod species found to occupy the low-salinity waters of the lagoon during the open-water season last year (1977) were also abundant this year on the lagoon bottom (and in some cases on the subsurface of the ice) in the high-salinity environments of the lagoon under the ice in winter (April).

(2) Mysids, which were abundant in the epibenthic regions of the lagoon in summer, 1977, were extremely scarce or absent in winter and spring under the lagoon ice, but were

extremely abundant in shallow waters near the lagoon entrances after shore leads had formed; at this time the remaining ice cover on the lagoon was essentially complete (June). Mysids appeared near the mainland shore soon after alongshore currents developed in the narrow leads formed there.

(3) Gill net catches in brackish water in the lower Colville River delta in winter (April) indicated that populations of certain anadromous fish (Arctic and least cisco) may overwinter there instead of in fresh water as was formerly thought.

(4) Gill net catches indicated that fish were scarce or absent throughout June beneath the ice in the central portion of Simpson Lagoon. The first fish to be caught in the lagoon (late June) were in narrow shore leads on the marine side of the barrier islands and in shore leads adjacent to the mainland.

(5) Nesting densities of most birds, as well as diversity of bird species, appeared to be higher on the mainland tundra adjacent to the lagoon than they were on the tundra-covered islands. Exceptions to this trend were the high densities of glaucous gulls found on a few of the islands bordering Simpson Lagoon. (Glaucous gulls were not found nesting on the mainland.)

(6) Preliminary examinations of the stomachs of anadromous fish and of oldsquaw ducks indicated that the diets of these animals were similar to diets of individuals of the same species caught in 1977.

(7) The period of peak fresh water discharge into the lagoon system (largely over the lagoon ice and thence downward through *strudel* in the ice) coincided closely in time with the peak discharge in 1977. Breakup of the ice cover on the lagoon, however, appeared to be later by more than a week than was the ice breakup in 1977.

V. Preliminary Interpretation of Results

Interpretation of the results of this quarter's research in more detail than is given in IV above is not possible at this time.

VI. Auxiliary Material

None submitted.

VII. Problems Encountered/Recommended Changes

No major problems have been encountered. There are no recommended major changes in research objectives.

VIII. An estimated 25% of 1978 project funds has been expended.

Research Unit #473
April 1 - June 30

Quarterly Report

SHORELINE HISTORY OF CHUKCHI AND BEAUFORT SEAS AS AN AID TO PREDICTING OFFSHORE PERMAFROST CONDITIONS

By

D. M. Hopkins
R. W. Hartz

United States Geological Survey
345 Middlefield Road
Menlo Park, California 94025

Research Unit 473: Quarterly Report, April-May-June 1978

SHORELINE HISTORY OF CHUKCHI AND BEAUFORT SEAS AS AN AID TO PREDICTING OFFSHORE PERMAFROST CONDITIONS

I. Abstract of highlights:

In April we began a study of recently acquired low-level sequential aerial photography of the Beaufort and Chukchi Sea coasts, in order to establish rates of erosion and shoreline change over the past 28 years. Hopkins and Hartz completed the revision for publication of a manuscript on coastal erosion, coastal morphology, and barrier islands of the Beaufort Sea coast.

II. Task objectives: D-9

III. Field or laboratory activities:

A) No field activities
B) Scientific party:
  D. M. Hopkins, geologist and Principal Investigator
  R. W. Hartz, geologist and Co-Investigator
C) Methods of analysis:
  Study of maps and air photos
  Synthesis of field observations
D) Sample localities: No new ones
E) Data collected or analyzed:
  Newly acquired, 1977, NOS/OCSEAP sequential aerial photography of the Chukchi Sea and Beaufort Sea coasts.

IV. Results:

As noted by previous investigators (Lewellen, 1970; Harper, 1978), it is relatively easy to locate a common point of reference, such as a distinct polygon, which permits comparison of long-term sequential aerial photography. Utilizing this method we have undertaken a comparison of recently acquired, 1977, 1:20,000 and 1:40,000 scale aerial photography with photos taken in 1949 and 1955. The comparison has resulted in the location of approximately 300 new data stations along the Beaufort Sea and Chukchi Sea coasts.

Since this study is still in its infancy, no results are available at this time. The results of this study will be presented in our quarterly report for Oct.-Nov.-Dec. 1978.

Hopkins and Hartz completed and submitted for publication a manuscript entitled Coastal Morphology, Coastal Erosion, and Barrier Islands of the Beaufort Sea, Alaska.

References cited

Lewellen, R. I., 1970, Permafrost erosion along the Beaufort Sea coast (published by author, P.O. Box 2435, Littleton, Colorado 80161), 25 p.

Harper, J., 1978, Coastal erosion rates along the Chukchi Sea coast near Barrow, Alaska (in press).

V. Interpretation:

Nothing new to report.

VI. Problems encountered and recommended changes:

No problems encountered. Fieldwork will be conducted between August 15 and September 30 on the Beaufort Sea coast. The mainland coast will be examined between Kogru River and Beechey Point. We also plan to examine Pingok, Bodfish, and Bertoncini Islands.

VII. Estimate of funds expended to date: $29,320.00

Unexpended: $7,500. (Remaining funds will be expended on salaries, travel, and expenses during Aug. 15-Sept. 30 fieldwork)

Total: $36,820.00

QUARTERLY REPORT

to

U.S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

April 1, 1978 to June 30, 1978

RESEARCH UNIT #480

CHARACTERIZATION OF ORGANIC MATTER IN SEDIMENTS FROM NORTON SOUND, KODIAK SHELF AND BEAUFORT SEA

Contract No. 03-6-022-35250, R.V. No. 480

I.R. Kaplan
S. Brenner
M. Venkatesan
J. Bonilla

Institute of Geophysics and Planetary Physics
University of California
Los Angles, California 90024

June 30, 1978

FIELD ACTIVITY

Mr. Dave Winter from our group participated in the April/May, 1978 cruise of the R.V. DISCOVERER in Lower Cook Inlet. Eighteen samples for gas and hydrocarbon analysis were collected from the western part of the inlet.

LABORATORY ACTIVITY

1. The analysis of all the samples collected in 1976 and 1977 have been completed including the GC of the aliphatic and aromatic fractions. GC-MS analysis of some selected samples will be performed in the next few months. Data reduction of the GC results is now in progress.

2. Maps and tables are enclosed summarizing the recent results.

Table 1. State of Analysis of OCSEAP Sediment Samples as of June 30, 1978

	Cook Inlet 1976	Cook Inlet 1977	Norton Sound 1976	Beaufort Sea	Kodiak	Norton Sound 1977
Original No. of Samples	23[a]	9	20	11	20	12
No. Worked	23	9	20	11	20	12
No. Extracted	23	9	20	11	16	12
No. Saponified	23	9	20	11	16	12
No. Chromatographed (Column)	23	9	20	11	16	12
No. of GC runs (aliphatic)	20	9	18	11	16	12
No. of GC runs (aromatic)	20	9	18	11	16	12
No. of GC-MS	11		-	-	-	-
No. lost or Contaminated	3[b]	-	-	-	1[b]	-
No. of Total C & Org. C	23	9	20	11	20	12
No. of S (Elemental)	23	9	20	11	20	-

(a) Three bulk samples were only analyzed for total C and Org. C.
(b) Those samples were freeze dried.

Table 2. Norton Sound Sediment Samples (1976 Cruises).

Station[1]	Lat (N)	Long (W)	Depth (m)	Rating[2]	Total Carbon %	Organic Carbon %	Weight[3] (gr)	Non Saponi-[4] fiable Fr. (ppm)	Aliphatic Fr. (ppm)	Aromatic Fr. (ppm)
47	64°25'	165°29.90'	15	3	1.02	0.93	104.42	77.95	9.644	7.470
49	63°27.77'	163°52.57'	10	3	1.40	1.12	84.74	199.91	24.782	4.130
70	65°6.13'	167°40.40'	31	4	0.37	0.31	153.58	8.47	2.207	6.186
88B	65°46.01'	168°05.51'	9	1	0.84	0.53	70.58	119.58	3.953	5.682
105	64°49.00'	166°44.00'	15	2	1.29	0.93	124.13	18.05	1.845	0.886
121	63°52.99'	163°01.34'	20	0	1.37	1.18	-	-	-	-
125	64°00.12'	162°24.60'	18	3	0.98	0.55	127.95	51.97	0.141	2.438
131	64°23.60'	161°49.27'	17	4	0.96	0.44	97.07	135.47	9.035	2.988
137	63°40.89'	161°13.29'	14	3	-	-	72.61	221.32	17.766	4.531
147	63°47.00'	163°41.50'	17	2	0.87	0.33	111.23	104.38	6.779	2.293
152	64°05.00'	164°26.50'	22	2	0.50	0.35	-	-	-	-
154	63°45.08'	164°37.43'	18	2	1.25	0.99	86.08	209.69	16.264	4.182
156	63°28.39'	165°19.28'	17	3	1.40	1.30	97.63	104.89	7.119	5.511
157S	63°18.11'	165°03.26'	8	1	1.16	0.82	-	-	-	-
160S	62°54.50'	165°08.15'	10	1	2.40	0.70	-	-	-	-
162	63°02.80'	165°53.99'	21	3	1.26	0.92	120.88	45.09	2.316	2.316
166S	63°14.62'	167°02.21'	26	1	1.54	1.16	161.30	39.99	1.097	0.756
168S	63°26.25'	166°29.64'	28	1	1.33	1.10	150.44	57.03	3.191	2.180
169S	63°34.79'	166°05.53'	27	1	1.09	0.33	137.47	117.12	2.619	4.001
170S	63°41.72'	165°45.81'	25	2	0.87	0.52	128.86	62.86	4.439	2.208
172S	64°00.10'	165°29.25'	20	1	1.36	0.87	115.55	80.14	10.904	3.773
174S	64°21.15'	165°00.40'	36	2	1.48	0.82	160.13	53.21	3.872	2.005

1. Samples are 0-2 cm except B- Bulk and S- Surface.
2. Quality of sample recovery based on a subjective scale of 5 (excellent) to 1 (poor).
3. Extracted (salt free) dry sediment.
4. No elemental sulfur was detected in this group of samples.

Table 3. Norton Sound Sediment Samples (1977 Cruises).

Station[1]	Latitude (N)	Longitude (W)	Depth (m)	Rating[2]	Total C(%)	Org. C (%)	Weight[3] (gr)	Non-Saponi-[4] fiable Fr. (ppm)	Aliphatic Fraction (ppm)	Aromatic Fraction (ppm)
34 0-2cm	64°52.30'	167°39.65'	32	3	0.35	0.12	160.71	4.72	0.809	0.678
35 0-2cm	65°14.90'	167°45.70'	52	3	0.67	0.59	121.01	100.74	2.248	1.132
39 surf.	64°07.09'	171°18.00'	34	2	1.54	0.38	174.11	7.98	0.643	0.247
41 surf.	64°02.75'	171°36.10'	27	2	0.91	0.44	171.15	50.83	2.466	0.847
42 surf.	63°58.40'	169°22.65'	39	3	1.76	0.32	114.48	114.26	4.444	1.922
43 0-2cm	63°57.85'	167°48.03'	35	4	0.63	0.60	156.38	23.42	1.010	1.714
44 0-2cm	63'45.40'	167°00.50'	31	4	0.66	0.52	128.89	34.06	2.072	0.900
48 surf.	62°58.20'	165°16.25'	10	2	9.08	4.23	95.38	83.16	5.829	5.012
14 IK 0-3cm	64°14.80'	165°25.50'	18	-	1.12	0.28	86.41	67.93	5.360	1.296
17 SV 0-3cm	64°05.10'	165°28.62'	19	-	1.09	0.86	121.21	68.48	14.066	2.228
17 0-3cm	64°05.10'	165°28.62'	19	-	0.31	0.24	99.74	49.43	5.494	2.667
17 IK160cm	64°05.10'	165°28.62'	19	-	0.64	0.50	111.12	17.19	3.150	0.855

[1] Samples 14-17 belong to a different program

[2] Quality of sample recovery based on a subjective scale of 5 (excellent) to 1 (poor).

[3] Extracted (salt free) dry sediment.

[4] Small amounts of elemental sulfur were detected in samples: 39, 41, 42, 44 and 14 IK.

Table 4. Beaufort Sea Samples (1976 Cruises).

Station[1]	Lat (N)	Long (W)	Depth (m)	Rating[2]	Total Carbon %	Organic Carbon %	Weight[3] (gr)	Non Saponi-fiable Fr.[4] (ppm)	Aliphatic Fr. (ppm)	Aromatic Fr. (ppm)
1 (R)	70°32'	147°33'	27	3	3.20	0.89	124.57	113.11	14.313	9.424
2 (11)	70°39'	147°37'	26	2	2.68	0.74	98.66	130.55	24.883	15.488
3	70.47'	148°02'	25	3	3.05	0.91	52.76	183.66	41.016	18.707
4	70°57'	149°33'	25	3	2.45	0.63	69.97	152.78	36.301	14.106
5	71°08'	151°19'	23	2	2.11	0.83	104.05	163.96	28.429	13.993
6	71°43'	151°47'	1750	3	2.75	1.01	37.35	231.59	19.866	12.557
7	71°22'	152°20'	60	3	2.52	0.79	84.96	132.06	12.830	8.463
8	71°19'	152°32'	50	2	2.13	0.39	110.85	147.86	16.460	12.648
9	71°08'	152°57'	22	3	2.49	0.68	75.73	201.37	23.729	9.402
10	71°23'	154°21'	29	3	2.58	0.63	54.01	220.52	34.531	14.590
11B	71°36'	155°32'	197	2	2.63	0.51	179.18	110.28	22.436	12.150

1. All are surface samples. 11B is bulk.
2. Quality of sample recovery based on a subjective scale of 5 (excellent) to 1 (poor).
3. Extracted (salt free) dry sediment.
4. Elemental sulfur was detected in only one sample (No. 11).

Table 5. Kodiak Shelf Sediment Samples (1976 Cruises)

Station[1]	Lat (N)	Long (N)	Depth (m)	Rating[2]	Total Carbon %	Organic Carbon %	Weight[3] (gr)	Non Saponi-fiable Fr.[4] (ppm)	Aliphatic Fr. (ppm)	Aromatic Fr. (ppm)
52	58°24.42'	151°13.80'	52	4	5.13	0.34	125.65	42.22	1.202	2.149
57	57°50.94'	150°03.74'	194	3	0.67	0.36	130.01	28.31	1.438	1.415
60	57°45.96'	149°37.41'	444	4	0.68	0.31	150.64	37.71	2.151	2.835
68	57°28.10'	151°28.7'	154	3	0.86	0.60	87.53	69.46	2.285	1.428
72	57°24.2'	151°05.1'	92	2	0.71	0.23	131.97	22.28	1.569	0.887
75	57°45.80'	151°08.05'	70	3	3.91	0.33	106.87	33.22	2.059	0.356
80	58°01.50'	151°21.90'	81	4	2.29	0.35	173.98	12.99	0.506	0.466
80'	58°01.50'	151°21.90'	81	4			174.43	24.94	0.699	0.585
81	58°05.21'	151°14.55'	143	4	1.13	0.50	72.83	71.13	2.650	2.856
87	57°36.50'	151°47.65'	132	4	0.90	0.45	87.35	29.19	0.790	1.534
92	56°56.5'	152°33.0'	167	2.5	1.91	1.17	64.94	130.89	5.128	6.637
93	56°53.45'	152°40.90'	128	5	1.33	1.01	82.92	26.05	1.869	2.267
97	56°40.10'	153°10.02'	147	4	2.95	2.45	57.02	98.74	4.209	5.156
98	56°38.00'	153°16.00'	145	3	3.10	2.15	61.39	205.08	7.786	10.881
130	58°42.35'	149°03.38'	149	2	1.25	0.91	170.33	36.63	1.867	2.971

1. Samples are 0-2 cm except 80' which is 2-4 cm.
2. Quality of sample recovery based on a subjective scale of 5 (excellent) to 1 (poor).
3. Extracted (salt free) dry sediment.
4. Elemental sulfur was detected in only one sample (No. 92).

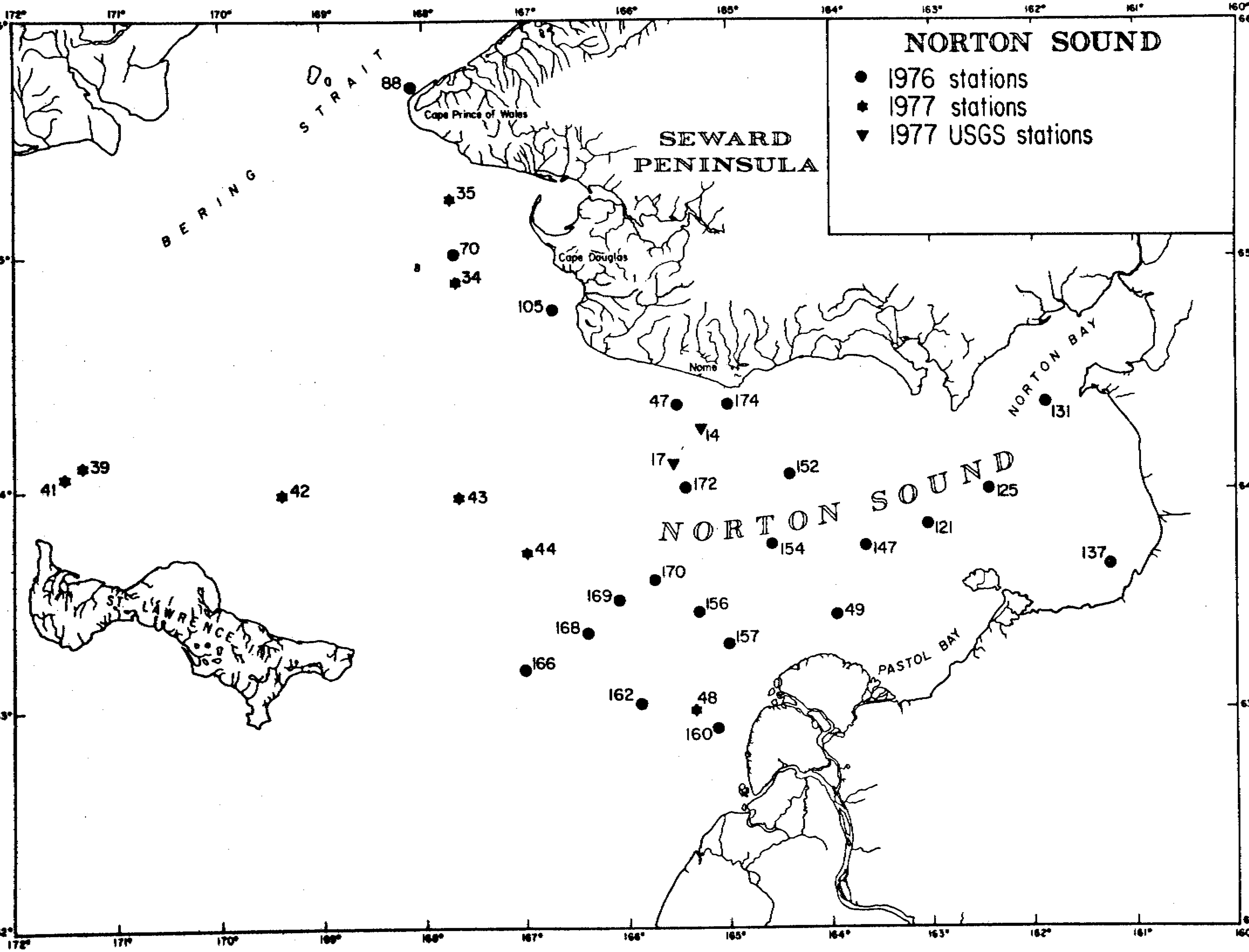
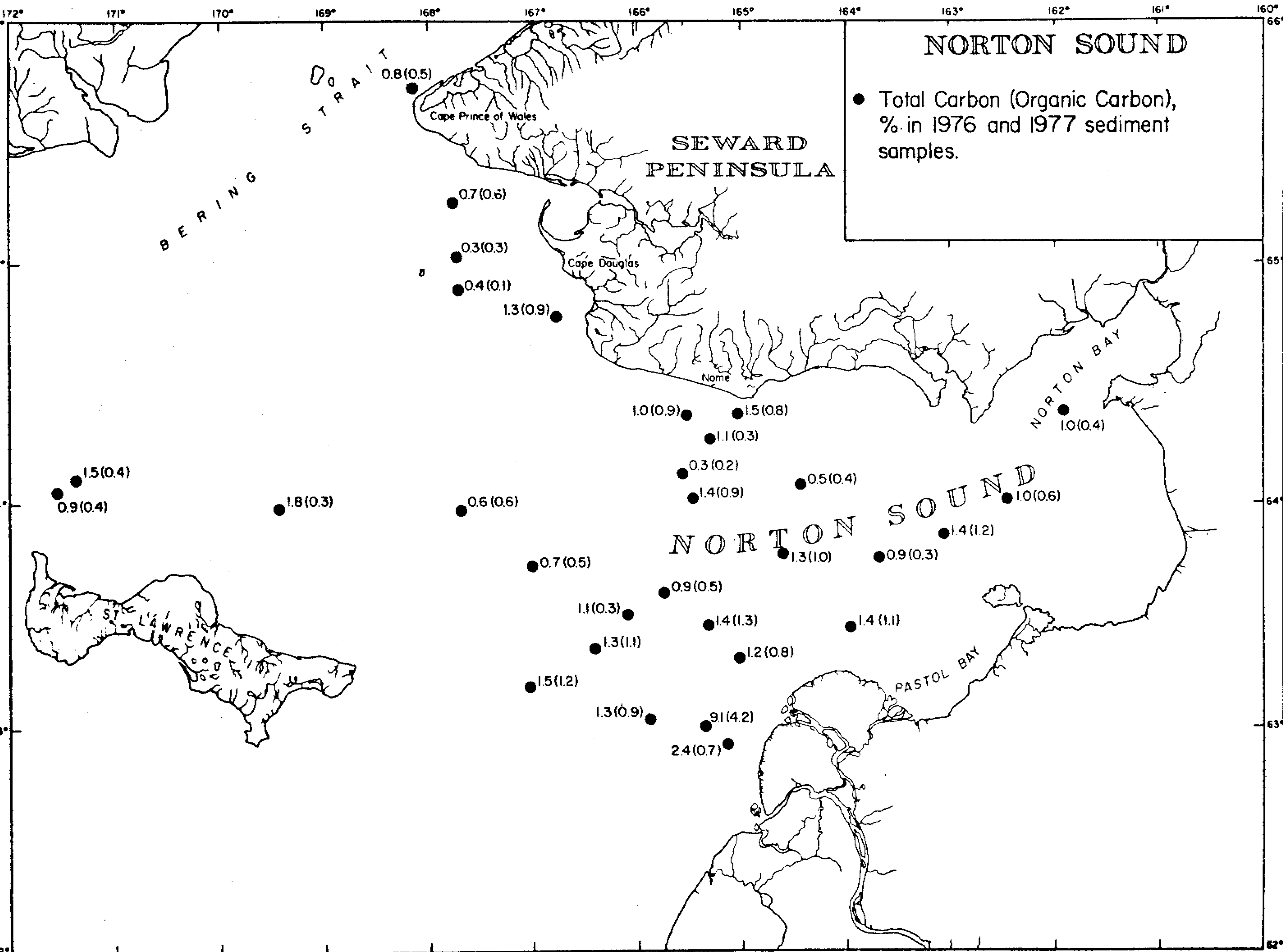

NORTON SOUND
1976 stations
1977 stations
1977 USGS stations
SEWARD PENINSULA
BERING STRAIT
Cape Prince of Wales
Cape Douglas
Nome
NORTON BAY
NORTON SOUND
PASTOL BAY
ST. LAWRENCE I.
88
35
70
34
105
47
174
14
17
152
172
125
131
121
137
147
154
170
169
156
49
168
157
166
162
48
160
39
41
42
43
44

Fig 1



NORTON SOUND
Total Carbon (Organic Carbon), % in 1976 and 1977 sediment samples.
SEWARD PENINSULA
BERING STRAIT
Cape Prince of Wales
Cape Douglas
Nome
NORTON BAY
NORTON SOUND
PASTOL BAY
ST. LAWRENCE IS.
172° 171° 170° 169° 168° 167° 166° 165° 164° 163° 162° 161° 160°
66° 65° 64° 63° 62°
0.8 (0.5)
0.7 (0.6)
0.3 (0.3)
0.4 (0.1)
1.3 (0.9)
1.0 (0.9)
1.5 (0.8)
1.1 (0.3)
1.0 (0.4)
0.3 (0.2)
1.4 (0.9)
0.5 (0.4)
1.0 (0.6)
1.5 (0.4)
0.9 (0.4)
1.8 (0.3)
0.6 (0.6)
1.4 (1.2)
1.3 (1.0)
0.9 (0.3)
0.7 (0.5)
0.9 (0.5)
1.1 (0.3)
1.4 (1.3)
1.4 (1.1)
1.3 (1.1)
1.2 (0.8)
1.5 (1.2)
1.3 (0.9)
9.1 (4.2)
2.4 (0.7)

Fig 2

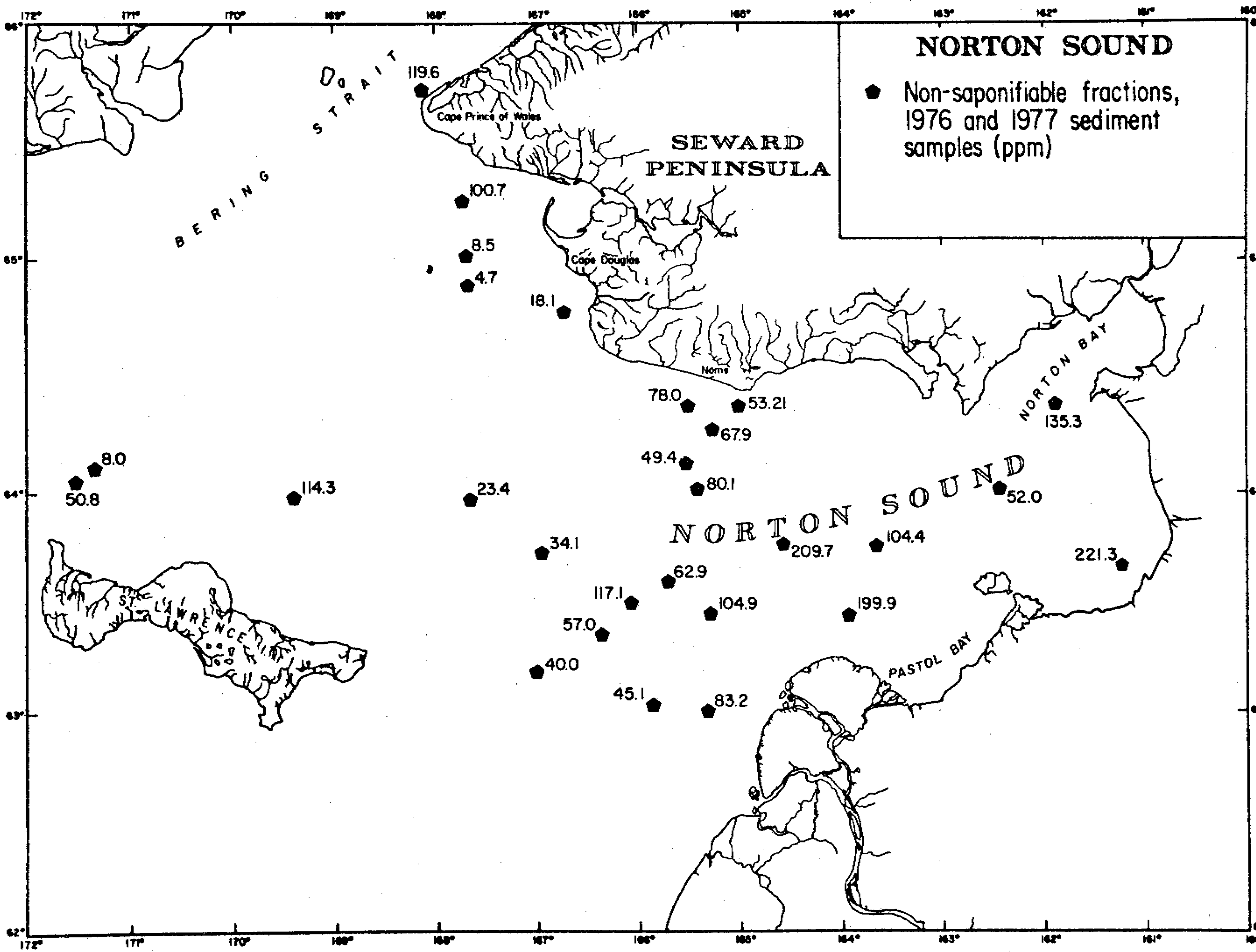

NORTON SOUND
Non-saponifiable fractions, 1976 and 1977 sediment samples (ppm)
SEWARD PENINSULA
BERING STRAIT
Cape Prince of Wales
Cape Douglas
Nome
NORTON BAY
NORTON SOUND
ST. LAWRENCE ISL.
PASTOL BAY
119.6
100.7
8.5
4.7
18.1
78.0
53.21
67.9
135.3
49.4
80.1
8.0
50.8
114.3
23.4
52.0
34.1
209.7
104.4
221.3
62.9
117.1
104.9
199.9
57.0
40.0
45.1
83.2

Fig 3

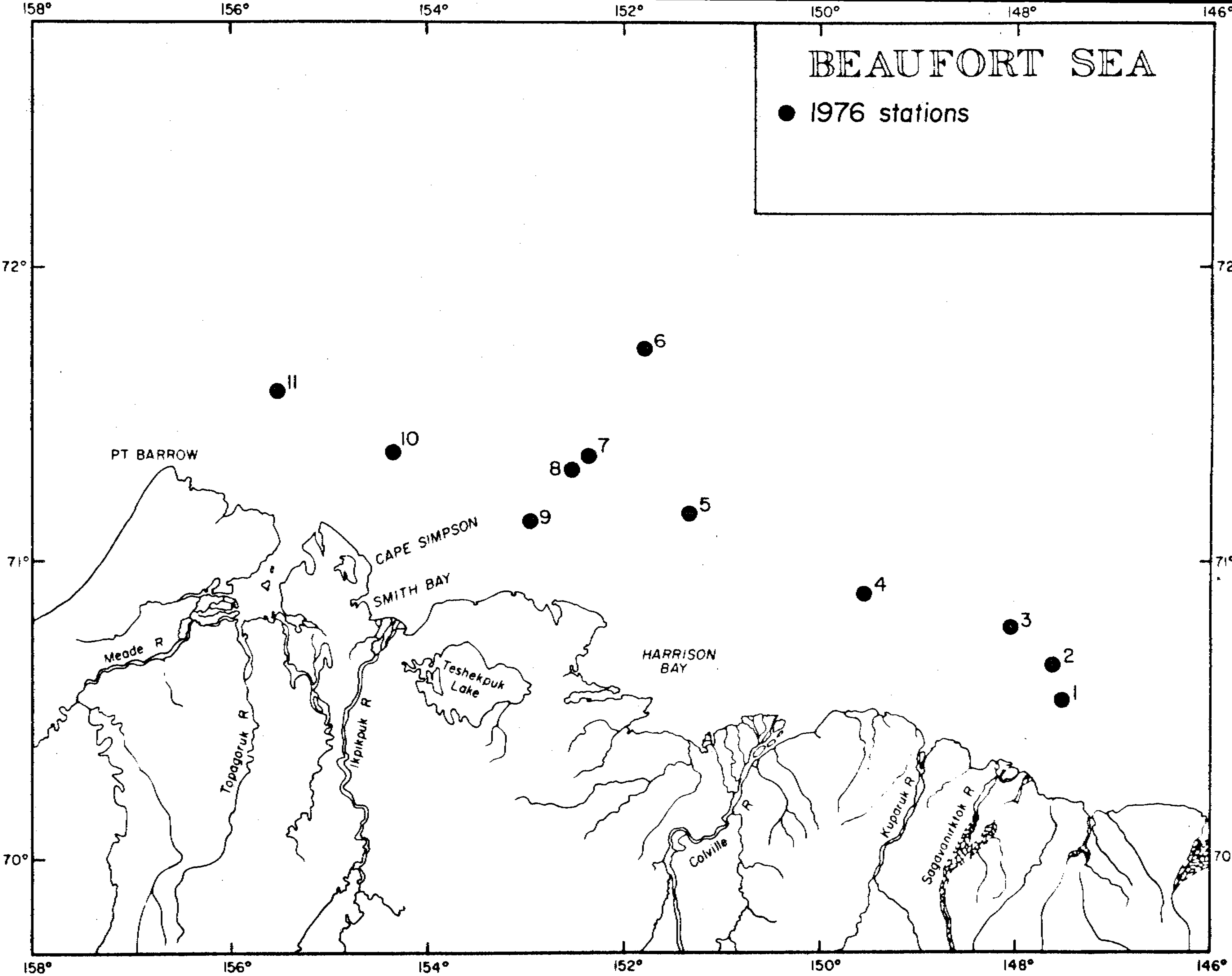

BEAUFORT SEA
1976 stations
158°
156°
154°
152°
150°
148°
146°
72°
71°
70°
1
2
3
4
5
6
7
8
9
10
11
PT BARROW
CAPE SIMPSON
SMITH BAY
HARRISON BAY
Teshekpuk Lake
Meade R
Topagoruk R
Ikpikpuk R
Colville R
Kuparuk R
Sagavanirktok R

Fig. 4

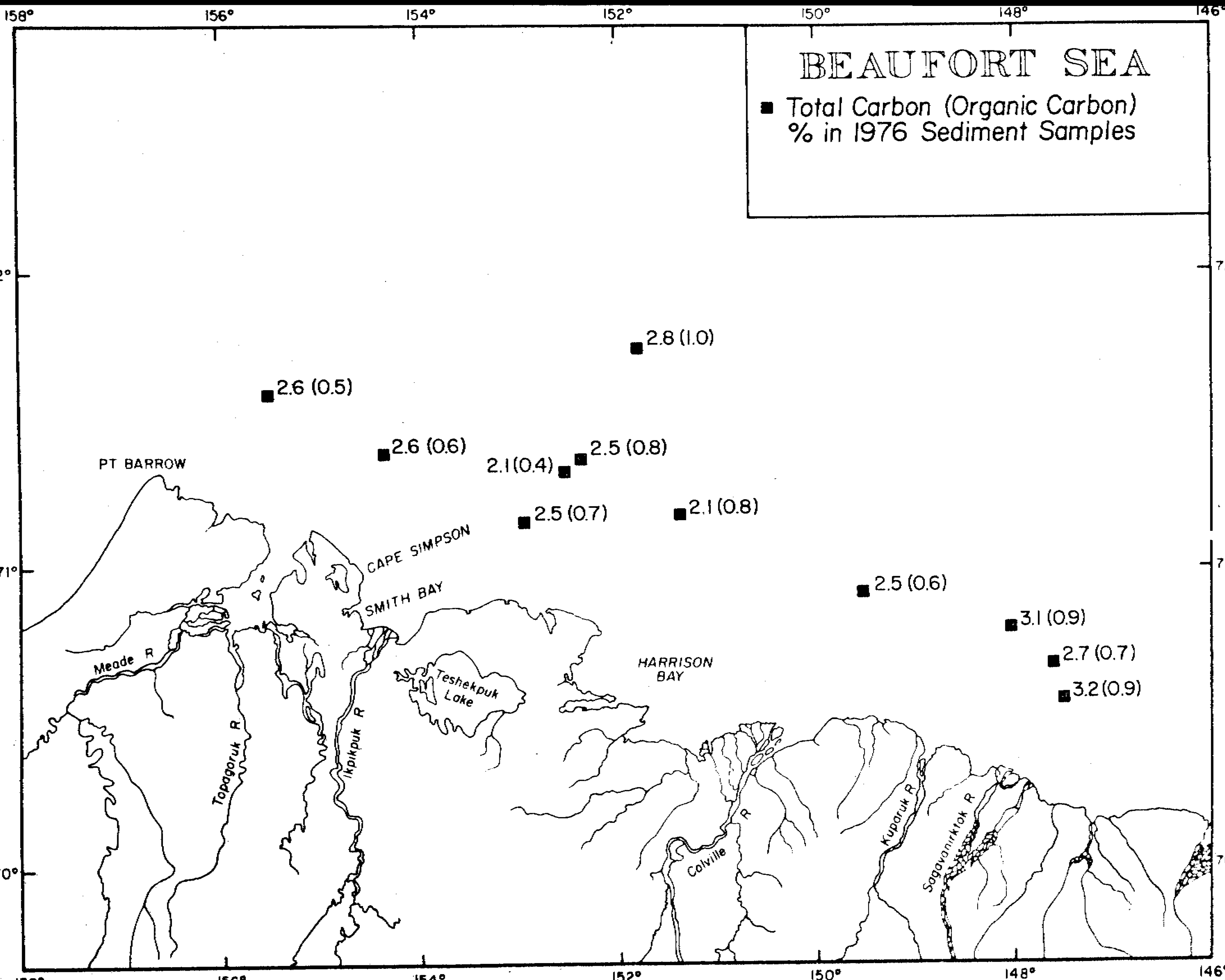
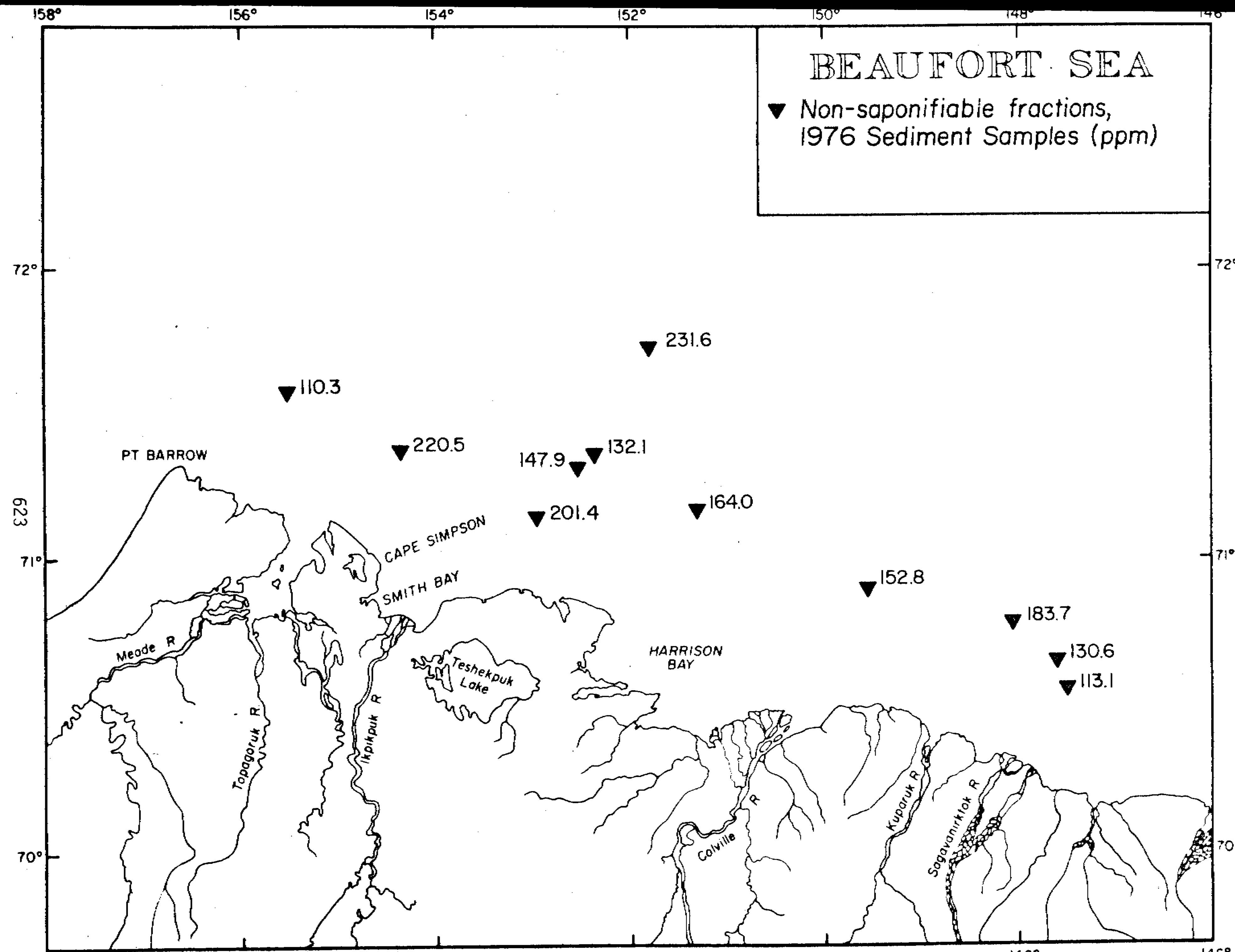

BEAUFORT SEA
Total Carbon (Organic Carbon) % in 1976 Sediment Samples
2.8 (1.0)
2.6 (0.5)
2.6 (0.6)
2.1 (0.4)
2.5 (0.8)
2.5 (0.7)
2.1 (0.8)
2.5 (0.6)
3.1 (0.9)
2.7 (0.7)
3.2 (0.9)
PT BARROW
CAPE SIMPSON
SMITH BAY
HARRISON BAY
Teshekpuk Lake
Meade R
Topagoruk R
Ikpikpuk R
Colville R
Kuparuk R
Sagavanirktok R
158°
156°
154°
152°
150°
148°
146°
72°
71°
70°

Fig 5



BEAUFORT SEA
▼ Non-saponifiable fractions,
1976 Sediment Samples (ppm)
158°
156°
154°
152°
150°
148°
146°
72°
71°
70°
231.6
110.3
220.5
147.9
132.1
201.4
164.0
152.8
183.7
130.6
113.1
PT BARROW
CAPE SIMPSON
SMITH BAY
HARRISON BAY
Meade R
Topagoruk R
Ikpikpuk R
Teshekpuk Lake
Colville R
Kuparuk R
Sagavanirktok R

Fig 6

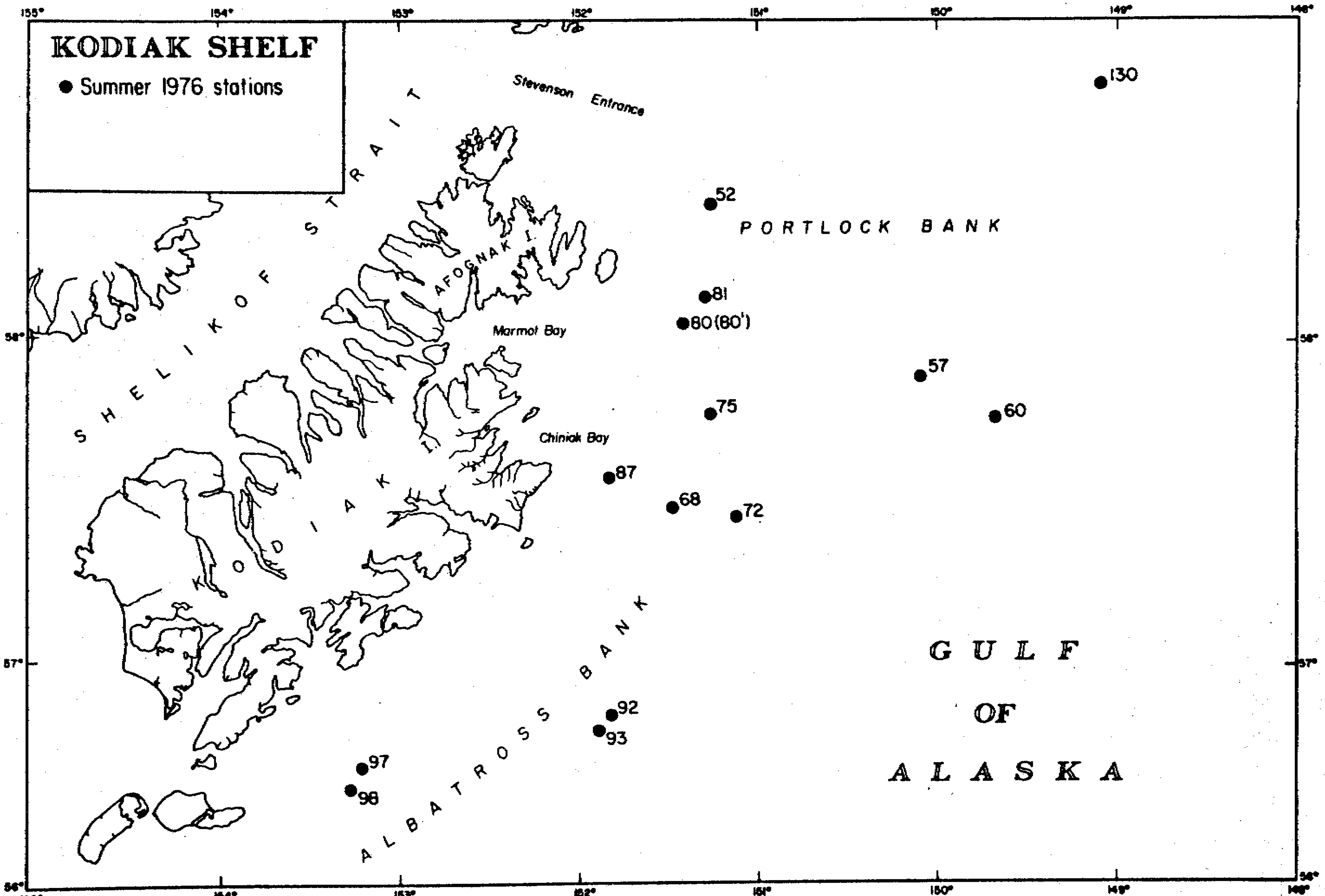

KODIAK SHELF
Summer 1976 stations
SHELIKOF STRAIT
Stevenson Entrance
AFOGNAK I.
PORTLOCK BANK
Marmot Bay
Chiniak Bay
KODIAK I.D
ALBATROSS BANK
GULF OF ALASKA
130
52
81
80(80')
57
60
75
87
68
72
92
93
97
98
155°
154°
153°
152°
151°
150°
149°
148°
58°
57°
56°

Fig 7

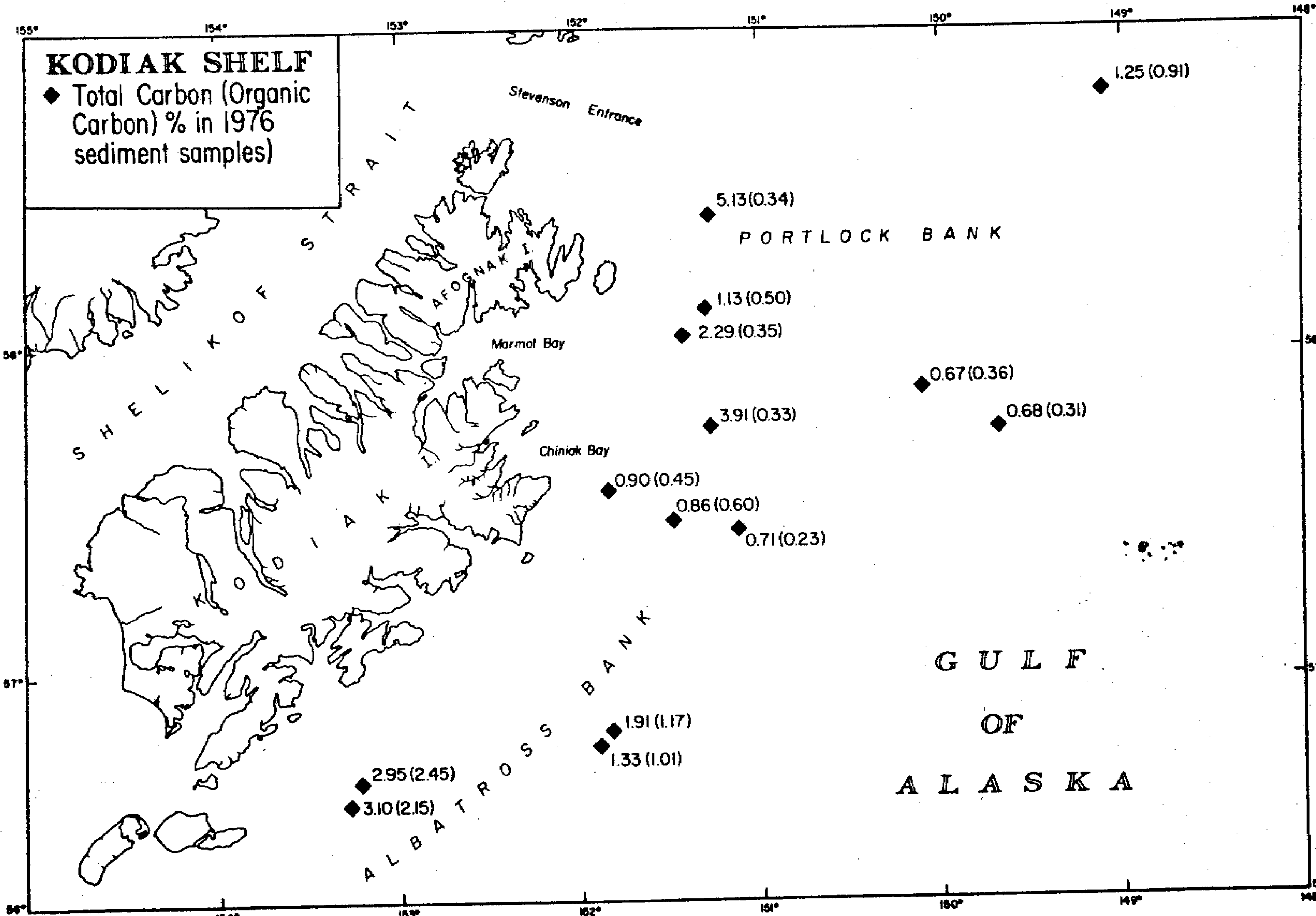
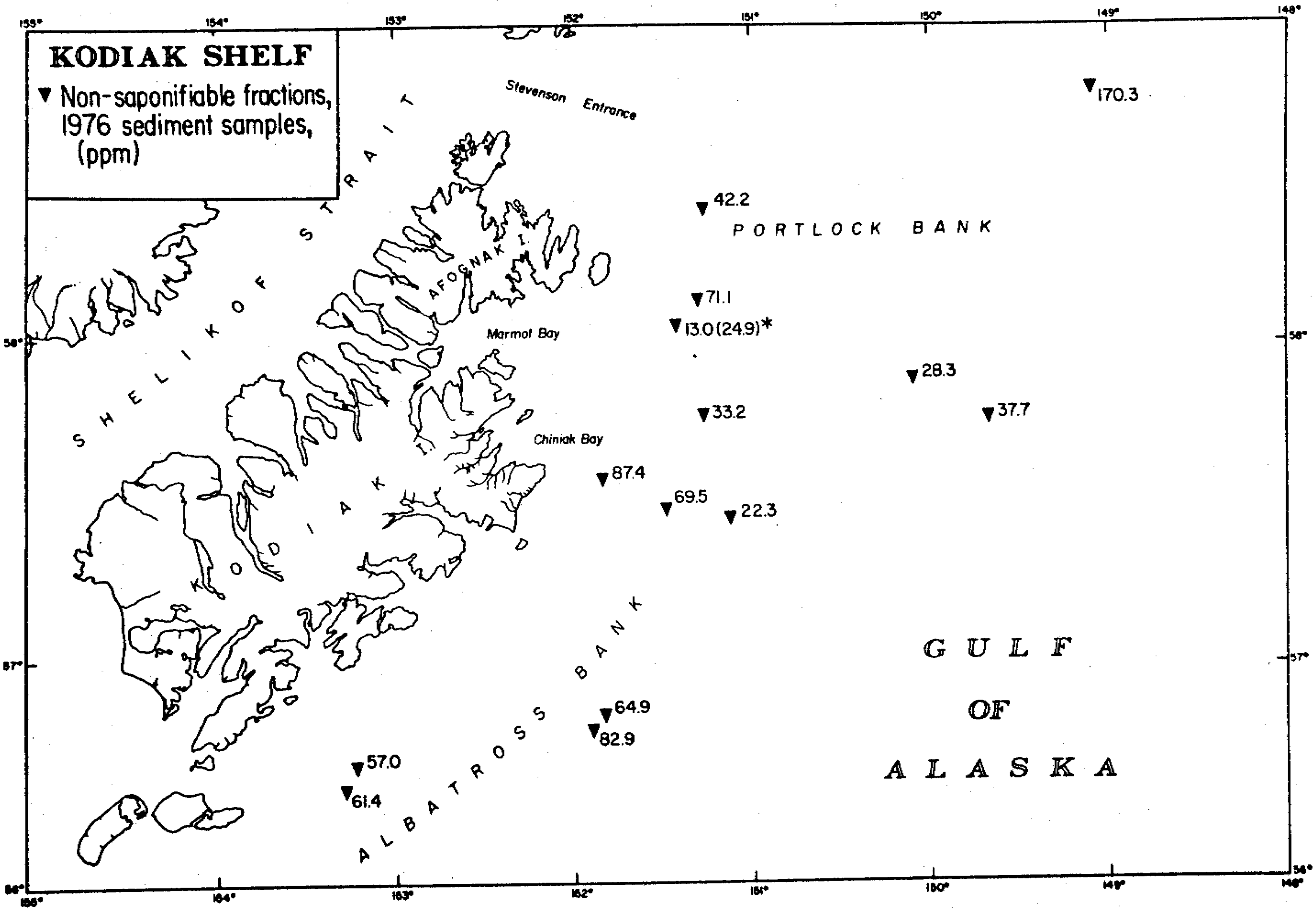

KODIAK SHELF
◆ Total Carbon (Organic Carbon) % in 1976 sediment samples)
SHELIKOF STRAIT
Stevenson Entrance
AFOGNAK I.
Marmot Bay
Chiniak Bay
KODIAK I.
PORTLOCK BANK
ALBATROSS BANK
GULF OF ALASKA
1.25 (0.91)
5.13 (0.34)
1.13 (0.50)
2.29 (0.35)
0.67 (0.36)
0.68 (0.31)
3.91 (0.33)
0.90 (0.45)
0.86 (0.60)
0.71 (0.23)
1.91 (1.17)
1.33 (1.01)
2.95 (2.45)
3.10 (2.15)
155°
154°
153°
152°
151°
150°
149°
148°
58°
57°
56°

Fig 8



* This sample 2-4 cm.

Fig 9

QUARTERLY REPORT

Contract #03-05-022-55
Research Unit # 483
Task Order # 12
Reporting Period: 04/1/78-
06/30/78

EVALUATION OF EARTHQUAKE ACTIVITY AROUND NORTON AND KOTZEBUE SOUNDS

N. N. Biswas
L. Gedney
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

June 30, 1978

OCS COORDINATION OFFICE
University of Alaska

Quarterly Report for Quarter Ending June 30, 1978

Project Title: Evaluation of Earthquake Activity Around Norton and Kotzebue Sounds

Contract Number: 03-05-022-55

Task Order Number: 12

Principal Investigators: N. N. Biswas and L. Gedney

I. Task Objectives:

1. Complete the laboratory and field tests for a new type of seismometer (Geotech S-500) for the Kotzebue seismographic station.

2. Relocate the North River seismographic station at a nearby site.

3. Scale seismic data for the Tatalina (TTA) seismographic station operated by NOAA in western Alaska.

4. Digitize geologic structural trends in offshore and onshore arcas of western Alaska.

5. Routine scaling of daily seismic data gathered by the western Alaska seismographic network.

II. Field and Laboratory Activities

1. The horizontal component seismometers installed at Kotzebue during the field season of 1977 went off level with ground freeze-up. To rectify this, a new type of seismometer (Geotech S-500) was acquired and tested by operating over a period in the laboratory and in the field in the vertical and horizontal modes. The system proved adequate for our purposes, and we intend to install them at Kotzebue during the field season of 1978 for icequake studies.

2. The North River seismographic station was located at the White Alice site. This facility was terminated during the early part of 1978 by RCA and the communication system has been switched to satellite. Accordingly, the North River station of our network has been moved to a new site to link with the new communication system. After installing instruments at the new site, the system has been calibrated and reset to the original operating gain.

3. The seismographic station at Tatalina is operated by NOAA. This station provides seismic coverage to the southwestern side of the study area. However, the daily data for this station is recorded at Plamer Observatory. Arrangements to acquire the original data for the above station were completed; we are in the process of scaling the data. It is anticiapted that incorporation of arrival time data for this station in the computer program will improve the locations of the events in the study area.

4. The most recent geologic structural maps prepared by U. S. Geological Survey for western Alaska have been acquired. The digitization of the trends of important structures is in progress. The digitized data are intended to be used to study the relationships between active faults and clustering of seismicity for the area of interest on a unified computer generated plot.

5. The scaling of the daily data from the network is the study area has been maintained up-to-date. The computer processing of these data is continuing routinely.

III. Results: None

IV. Preliminary Interpretation: None

V. Problems Encountered: The Alascom of RCA was granted an intrastate telephone rate increase by 87% of the prevaling rate since mid-May, 1978.

In order to achieve the objectives of this program under the existing constraints, a number of cost-effective alternatives for the data telemetry were examined. We have concluded that the most logical approach would be to record the data on magnetic tape at Nome.

VI. Estimate of the Funds Expended: $60,000.

Quarterly Report

RU Contract No.

497 ----------

370 03-5-022-56

Reporting Period 1 April 78
30 June 78

Pages 12

OCSEAP Alaskan Data Processing Facility

Michael L. Crane

David M. Hickok

30 June 1978

I. Introduction

The Outer Continental Shelf Environmental Assessment Program has established a data processing facility to service the needs of management, data base and investigators. The relative concentration of effort has shifted periodically from one area to another and the data processing activities have reflected these changes. Because the requirements of each element influences the procedures and capabilities of the others, the Anchorage Data Processing Center has anticipated many of these shifts and contributed in part to the dynamic enhancements in OCSEAP's data management activities. This quarter marked the beginning of another phase.

The transition from an input/source-document phase was completed this quarter, and the initiation of a control/checking phase has begun. The significant changes are the emphasis of data content as delivered to the OCSEAP, displaying potential errors and inconsistencies, compiling detailed inventories, preparing compatible media for the data base, and translating codes to meaningful descriptions. Data are received and replace the manuscripts in the previous phase. Control of errors have shifted from a "preventive" mode to a "testing" mode. The basic goals and assumptions are different, and the investigators are considered independent in the data processing flow. In the previous phase, the intent was a cooperative effort by keyentry and originator to minimize problems. Now, the management has assumed the responsibility of maintaining efficient keyentry procedures with the investigators. The assumptions now - any error is possible and no data control has been initiated by the originator. Data checking standards as a result are very rigorous by the Anchorage Data Processing Center. The corresponding requirements of quality data by the data base and contract compliance by the management determine the level of effort to insure adequate standards.

The level of effort in time requires computer assistance to make each test according to the established standards. Programs must be written and data media converted so that computer assistance is implemented smoothly in an administrative sense. Keyentry equipment was replaced by a data checking minicomputer and editing equipment. The tasks shifted from generation of digital data to the review of existing digital data. The Outer Continental Shelf Environmental Assessment Program has lost the capability of controlling the schedule of data generation, returning the capability (and responsibility) to the investigator.

The following sections describe the methods and status of implementing a data control phase at the Anchorage Data Processing Center.

II. Methods

The steps in data control are adapted to the specific requirements and limitations imposed by the Outer Continental Shelf Environmental Assessment Program. The same professional standards established by the OCSEAP data base are incorporated in rigorous data checking guidelines. The foundations of all data checking procedures are good record keeping, direct communication, and adequate guidance. Because the source documents have not been controlled for adequate content, the data checking procedures must substitute for the review stages plus institute the proper data checking tests for syntax and cataloging errors.

The consequences are exhaustive checking programs that include both direct errors, eg. syntax, coding, and range errors, and indirect errors, eg. relational, conditional and contractual errors. The level of effort must match the scale of errors anticipated, and many times these checking procedures are the only consistent, extensive control of data. The types of checking are determined by standards established by the OCSEAP Data Base and by quidance from OCSEAP Management.

These checking procedures have been implemented in part for Marine Mammal Specimen Data, file type 025. The design of checking programs followed general guidelines from discussions with investigators, management, and data base. The data were tested to meet the following criteria:

1. Are all cataloguing requirements to store and retrieve digital data satisfactorily entered?
2. Are parameters logically coded?
3. Are taxonomics properly entered?
4. Are ranges of parameters within selected limits?
5. Are relationships between and among data parameters proper and consistent?
6. Are all required fields properly entered for contract compliance?
7. Are defined values used in coded fields?
8. Is consistent internal coding handled properly?

The design incorporates unique properties of the format style and specific guidance. A series of both chained and independent check programs have been developed to address the requirements of data checking.

The check programs were divided into specific categories. The main checking program for Data Base requirements is named ID025 (criteria items 1, part of 2, part of 3, part of 4, and part of 6). The ranges for lat/long and date/time plus file parameters are entered from a program named "START". One begins with the START program which loads ID025. The taxonomic relationship is determined in a program named PR025 which isolates the unique predator/prey relationships. PR025 is chained to ID025 for the taxonomic tables and completes criteria item 3. The Alaskan taxonomic code can be converted to the NODC taxonomic code in program TX025.

The sequence numbers for file type 025 require special attention and program SQ025 was designed to assure proper coding for retrieval. This program addresses criteria item 2.

The relational/range checks were designed for two programs, ID025 and RL025. Scientific information is concentrated within program RL025 and addresses criteria items 5, part of 2,4, part of 6 and part of 8. Direct control of conditional fields and required fields for contract compliance have been entered in the design of RL025. Contract supervisor input was the principal guideline for ranges and relationships.

The entries of coded fields can be checked in program CD025 and addresses criteria item 7. This program has a preliminary design and will be completed in July 1978.

Check programs require complementary programs and general utilities to maintain the power and efficiency of each computer program. A utility to list the fields on a discette provides access to all data contained within a single volume (i.e., a single discette). A utility named LIST CAT lists the contents of the index tract or catalogue. Another utility named PFILE lists the contents of a catalogued data set.

The indirect errors must be isolated so that the checking procedures can detect them. A program named SL025 was designed to capture a given category of data and generate a special subset. This program addresses criteria items part of 5 and 8.

These programs are assembled in a sequence and the output from each of these programs are reviewed. Preliminary editing is completed and the sequence of programs are run again. The intermediate results are forwarded to OCSEAP management and a copy is sent to the investigator.

When all items from the criteria have been answered, the data are prepared for transmittal to the OCSEAP Data Base. The media are converted and documentation organized. Secure copies of both data and documentation are made and filed.

The time elements are divided among preparation, execution, distribution, and transmittal of data. The preparation phase includes initial conversion of media for checking, receiving documentation, and compiling information required for checking. Execution phase is running the check programs and completing preliminary edits and running the checking sequence again. The distribution phase is the delivery of checking results to management and originator. The transmittal phase includes the final editing and running of the check programs. The media and documentation are copied and transmittal forms completed. All inventory logs are updated. The entire package is forwarded to the Data Base. The time requirements are outlined below.

I.	Preparation phase	3 days/data set
II.	Execution phase	2 days/data set
III.	Distribution phase	3 days/data set
IV.	Transmittal phase	4 days/data set
	Total	12 days/data set

The same approach for program development will be adopted in check programs for all other file types required by the Outer Continental Shelf Environmental Assessment Program.

III. Achievements

The following check programs have been written this quarter:

START - menu for main check program
ID025 - checks NODC requirements
PR025 - predator/prey program
TX025 - converts Ak code to NODC code
RL025 - relational/range program
SQ025 - sequence number validation program
SL025 - selection program
PFILE - lists data file
LIST CAT - lists contents of index track
CDLIST - lists contents of OCSEAP codes
PAKTAK - prints taxonomic codes used in validation

The last program to be written will be CD025.

To support the programming effort, additional activities have been planned, executed and completed. A summary of data processing activities and supporting activities for the OCSEAP Data Base will be presented in this section.

Data processing activities are grouped into two catagories -- keyentry and data control. Within the keyentry category, two data sets were received, one was completed and mailed and one was mailed. The table below summarized the keyentry activities.

RU	NAME	FILE TYPE	PROCESSED
172	Conners	034	1
240	Schneider	026	1

Data control is the review of the data for format compliance, consistency, and correction of machine readable media. Data check programs now enable some data to be checked by machine. Within data control, 44 data sets were received, 4 were completed and mailed. The remaining 40 are in hold as they may require additional processing. The table below summarized the data review activity.

RU	NAME	FILE TYPE	REVIEWED
230	Burns	025	30*
337	Lensink	033	1*
196	Divoky	033	3
003	Arneson	040	1
196	Divoky	033	9*

*In hold, may require additional processing.

The supporting activities for the OCSEAP Data Base have been fivefold: assistance to RU 003 Arneson in checking his data, inserting genera in the taxonomic code listing, digitizing the OCSEAP codes, updating the formats and digitized codes with 8 May 1978 revisions, and digitizing the resubmission of RU 240 Schneider.

The data set of RU 003 Arneson, file type 040 was received in disk form. As an assistance, a more efficient checking procedure was developed to replace the one he currently used. The original, Method 1, would have taken the total time of 6 hours for this data set. It involved: listing the material from diskette, printing cards, sorting by taxonomic code and taxonomic - habitat code, and comparing the diskette listing to the actual coding forms. Method 1 required 2 people to complete. Method 2 took a total time of 3 hours 55 minutes. If entailed: listing the material from diskette, printing card, sorting by taxonomic code and taxonomic habitat code, and list record type 1, 2, and 5 separately. The sort listings and record type listing were checked for placement, spelling, discrepencies and feasibility of data. The total disk listing was used to compare values to actual coding forms in the areas of header information, record type 1,2,5 and portions of 4. These were scanned as the majority of checking was accomplished by sort and record type listings. Method 2 required 1 person, increased efficiently by 30% and increased accuracy due to less human error.

The Alaska version and the NODC version of the Taxonomic Codes did not contain a genera listing. All genera, minus birds, were incorporated into the codes as an assistance to a check program being completed. These were inserted onto disks containing both Alaska and NODC versions of the codes. The completed 10 disks were then copied and sorted to give two equal sets. One set is in Alaska Taxonomic Code order and the remaining set in NODC Taxonomic Code order.

The OCSEAP codes were digitized to give a total of 217 codes. The most current updates, prior to 3 April 1978, of file type descriptions and code sheets were used. Six codes do not have record type 1 complete and one does not have a record type 2. All codes in the format book were digitized, given a four-digit number and a unique name. The name was created to best describe the code and limit the possibilities of confusion when one code had a similar or same name as another. The four digit number preceeding the name was assigned in a consecutive manner with code 1 on disk 1 equaling 0001. One of the problems encountered was, codes without record type 2 sheets, but with record type 2 information. These were listed under the Use and Meaning section of the file type description sheets. Other problems were, codes with more than one name and the 20 character limit on length of name.

The 8 May 1978 mailing of revised file type descriptions and code sheets were incorporated into the format books and the disks of digitized codes. A total of 26 revised formats were processed. The format books were matched to the master copy. The record type 1's of the digitized codes were checked; resulting in 31 additions, 2 corrections and 6 delections. The record type 2's were also checked; resulting in 38 additions, 44 corrections and 2 deletions. Two new codes were added, (Morbidity/Mortality and Sex 001). The revised formats contained 12 code sheets with changes or additions and 1 new code sheet (Equipment). The new code sheet was for a code that had previously only been listed under the Use and Meaning section of the file type description sheets. Codes 001, 034, 035, 036, and 037 did not have revisions in the 8 May mailing but the changed code sheets were inserted where applicable.

Data set RU 240 Schneider, file type 026 was digitized from field notes. It was a resubmission of File I.D. OIKS76, survey dates 30, 31, July 1976. The survey consisted of front seat observations with track width of 0.1 nm and rear seat observations of unlimited track width. Included was a survey of Bechevin Bay. The survey was digitized using file type 026 and record types 1,2,4, and 6. The front and rear seats were digitized seaparately and noted with a "F" and "R" preceding the sequence number. Bechevin Bay was treated as an isolated sighting and noted with a "B" preceding the sequence number. The visibility code used was not tile type 026, but 040 so visibility conditions were noted in the text. The data set was put on disk, checked and converted to tape.

IV. System Description

To implement rigorous data checking procedures, access to adequate data processing equipment is essential. The data checking equipment must be effective, efficient, and managable. The programing language must handle string character manipulations and the programming code should be easy to maintain. The media must be compatible to editing and conversion processing. Computation speed, disk access time, and output speed should be balanced. Equipment service should be available.

Our current configuration includes the following hardware:

Wang 2200VP, 80 X 20 character screen, ASCII keyboard Model 2270A diskette drive, 3 each IBM compatible, communication controller for synchronous communication, Model 222]W printer - 200 CPS Serial, matrix.

Because the system is "printer bound", another printer has been ordered, a 240 line-per-minute printer. Additional enhancements have been contemplated. A schedule of enhancements will depend on Data Base tape characteristics.

The editing requirements are accomplished with a diskette work station. Keyboard control of all functions allows rapid editing functions such as character changes, additions, and deletions. Records can be deleted or inserted. Copies of diskettes can be made efficiently. Batch communicators are available. To implement this editing power, an IBM 374] Model II with a decal diskette drive, printer, and record insert feature is installed. Automated files for inventions are maintained and printed with this system. Effective search capability is attractive in maintaining digital code files such as the OCSEAP codes or the taxonomic codes. The BLM Predator-Prey Matrix file can be maintained by this system.

Access to the Data Tracking System is provided with an interactive portable terminal. An asynchronous, alpha numeric ASCII terminal with an acoustic coupler is adequate to query the data files. A model TI735 is leased and a model TI745 will be purchased and will replace the leased terminal. OASIS searches can be initiated from Alaska with this terminal.

V. Assessment of Problems

There are many items which automated procedures cannot check. These are centered on the scientific content of the data. These are as follows:

1. Are the parameters adequate to address the problems of oil and gas development in marine environments?

2. Do the entries within the data fields reflect the natural environment observed?

3. Can the observations from one discipline be compared to other disciplines?

4. Are interpretations of data fields among investigators consistent with management's plan for the investigators?

Milestone Chart

	1 July	1 August	1 Sept.	1 October
Submit Renewal Proposal	X			
Complete 025 check programs		X		
Design 023 check programs			X	
Plan BLM data processing support			X	
File quarterly report				X

QUARTERLY REPORTS
(Covering the period of January 1 to June 30, 1978)

on

ACTIVITY-DIRECTED FRACTIONATION OF PETROLEUM SAMPLES

to

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

September 6, 1978

by

J. S. Warner and J. W. Anderson

RU# 500

BATTELLE
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

QUARTERLY REPORTS
(Covering the period of January 1 to June 30, 1978)

on

ACTIVITY-DIRECTED FRACTIONATION ON PETROLEUM SAMPLES

to

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

from

BATTELLE
Columbus Laboratories

September 6, 1978

INTRODUCTION

Studies on the biological effects of petroleum and associated chemical analyses have concentrated primarily on the hydrocarbon content that can be readily analyzed by gas chromatography. The aromatic hydrocarbons, mainly the benzenes, naphthalenes, and phenanthrenes, have been shown to have very significant toxic effects. The higher polycyclic aromatic hydrocarbons are known to be mutagenic and carcinogenic. However, little information is available concerning the biological effects of the nonhydrocarbon portions of crude oils, especially those of weathered crude oils that remain after an oil spill. The hydrocarbons that can be analyzed by gas chromatography frequently represent considerably less than half of a weathered crude oil.

This research program is an effort to determine the potential environmental hazard of the nonhydrocarbon portions of weathered oil that have thus far been neglected. The program involves fractionation of both fresh and weathered Prudhoe Bay crude oil, subfractionation of primarily nonhydrocarbon fractions, biological screening of fractions to assess their toxicity and mutagenicity, and chemical characterization of any highly active fractions.

SUMMARY

Additional solvent studies have indicated that cyclopentanone and cyclopentanol are solvents of choice for completely dissolving crude oil and permitting it to be dispersed in water with a minimum of toxicity contributed by the solvent. The Ames mutagenicity assay, prescreen confluency assay for mammalian cell toxicity, and *in vivo* bioassays using brine shrimp and mysids were used to screen cyclopentanone solutions of reference compounds, crude oil, and crude oil fractions. Although the reference compounds were active, the design of the assays to accommodate highly insoluble components prevented much biological activity from crude oil and its fractions. One fraction, expected to contain heterocyclic compounds, exhibited marginal activity.

Future work will include efforts to remove interfering highly insoluble components.

EXPERIMENTAL WORK

Solvent Studies

As discussed previously, a major problem in the program is that many of the petroleum fractions of interest are not soluble or readily dispersible in acetone or dimethyl sulfoxide (DMSO), the main solvent other than water suitable in bioassay systems. Our work in studying alternative solvent systems showed that tetrahydrofuran (THF) is a good solvent but also quite toxic. The use of THF with a dispersant appeared feasible for the Ames mutagenicity assay provided no more than 20 μl of THF was used per plate. THF, even in the absence of a dispersant, could not be tolerated in the mammalian cell toxicity assay.

Further studies with THF during the current reporting period have shown that it is not satifactory for chromatographic studies when residue weights are of interest. Relatively high residue weights were obtained for blank THF samples concentrated 100-fold. The problem is caused by the ease with which THF forms peroxides and lactones. Phenolic antioxidants can be used but these would seriously interfere with our studies. The THF can be obtained relatively peroxide-free or purified to remove peroxides but unless special precautions are taken to exclude air from all operations the peroxide content becomes a problem again within a day or so. The problem is particularly apparent when Soxhlet extraction is used. Another concern associated with THF peroxides is their possible reactivity with petroleum components. We want to avoid any chemical modification of petroleum components throughout the fractionation and bioassay program.

Because of the toxicity and peroxide problem associated with THF, other solvents were sought. From a chromatographic standpoint methylene chloride was considered best since it is an excellent solvent for oil, can be obtained in a high-purity grade, is chemically stable, is low-boiling and readily concentrated, and can be mixed with small amounts of methanol and/or acetic acid to increase its polarity. Methylene chloride can not be used as a solvent for oil fractions to be added to bioassay media because it is quite toxic and not very water-soluble. The ideal solvent would (1) dissolve oil completely, (2) be miscible in water, (3) be low-boiling, (4) be chemically stable, and (5) be nontoxic. THF is one of the few common solvents that meets the first three criteria. Unfortunately, it does not meet the last two criteria. Therefore, numerous replacement solvents were evaluated, including alcohols, esters, and ketones. The most promising solvents found were cyclopentanol, cyclopentanone, and pyridine. Cyclopentanol exhibited about the same toxicity as THF in the Ames assay, cyclopentanone was somewhat less toxic and pyridine was somewhat more toxic. None of the solvents were mutagenic. Both cyclopentanol and cyclopentanone were used in subsequent *in vitro* biological studies. Cyclopentanol was preferred on the basis of chemical stability and cyclopentanone was preferred on the basis of toxicity.

In Vitro Biological Screening Studies

Various reference compounds known or expected to be present in fresh or weathered crude oil as well as various crude oil fractions obtained by silica gel chromatography were screened by *in vitro* biological assays. Since the value of dispersants was found to be very questionable, no dispersant was used. This change permitted mammalian cell toxicity studies (prescreen confluency assays) to be run in addition to the Ames *Salmonella* mutagenicity assay. The results of the studies are given in Table 1. Only one of the crude oil fractions exhibited a slight toxicity. This was a fraction that would be expected to contain some of the heterocyclic oxygen and nitrogen compounds. None of the samples exhibited any mutagenicity.

It is apparent that the concentrations of components such as 1-methylpyrene and benz(a)pyrene in the oil fractions studied are too low to give any toxicity or mutagenicity, respectively. A greater degree of fractionation and/or the addition of greater amounts to the assay media will be required. Both of these approaches will be studied during the next quarter.

One of the original objectives of the program was the determination of toxicity and mutagenicity of *all* fractions obtained from crude oil. Our studies to date have indicated that the highly insoluble components interfere with the study of more soluble components. The highly insoluble components prevent the use of dimethyl sulfoxide for preparing homogeneous solutions, prevent the preparation of homogeneous dispersions in water,

TABLE 1. IN VITRO BIOLOGICAL SCREENING STUDIES

No.	Sample Description[a]	Concentration,[b] mg/100 μl	Biological Activity[c] in Given Assay: Salmonella Toxicity[d]	Biological Activity[c] in Given Assay: Salmonella Mutagenicity[d]	Biological Activity[c] in Given Assay: Mammalian Cell Toxicity[e]
1.	Vacuum-stripped PB crude oil	0.40	0	--	--
2.	Vacuum-stripped PB crude oil	2.00	0	0	--
3.	Volatiles from PB crude oil	2.00	+++	--	--
4.	Benzene	2.00	+	0	--
5.	Benzene	1.00	0	0	0
6.	Benz(a)pyrene	0.02	0	++	--
7.	1,2,4-Trimethylbenzene	1.00	++	--	++
8.	Naphthalene	1.00	++	--	+
9.	2-Methylnaphthalene	1.00	+++	--	++
10.	Phenanthrene	1.00	++	--	0
11.	2-Naphthol	1.00	+	0	++
12.	4,4'-Methylbiphenyl	1.00	+	0	+
13.	1-Methylpyrene	1.00	++	--	+++
14.	4-Methylphenol	1.00	0	0	0
15.	Carbazole	1.00	0	0	0
16.	Fresh PB fr. 1-20% CH_2Cl_2/pet. ether	1.00	+	0	0
17.	Fresh PB fr. 2-20% CH_2Cl_2/pet. ether	1.00	+	0	0
18.	Fresh PB fr. 3-20% CH_2Cl_2/pet. ether	1.00	+	0	0
19.	Fresh PB fr. 4-CH_2Cl_2	1.00	+	0	+
20.	Fresh PB fr. 5-CH_2Cl_2	1.00	0	0	0
21.	Fresh PB fr. 6- CH_2Cl_2 (Soxhlet)	1.00	+	0	0
22.	Weathered PB fr. 1-20% CH_2Cl_2/pet ether	1.00	0	0	0
23.	Weathered PB fr. 2-20% CH_2Cl_2/pet ether	1.00	+	0	0
24.	Weathered PB fr. 3-20% CH_2Cl_2/pet ether	1.00	+	0	0
25.	Weathered PB fr. 4-CH_2Cl_2	1.00	0	0	0
26.	Weathered PB fr. 5-CH_2Cl_2	1.00	+	0	0
27.	Weathered PB fr. 6 - CH_2Cl_2 (Soxhlet)	1.00	+	0	0
28.	Control	--	0	0	0

a. PB (Prudhoe Bay crude oil) fractions were obtained by column chromatography using activated silica gel followed by Soxhlet extraction of the silica gel.

b. The samples were dissolved in cyclopentanone and diluted with dimethyl sulfoxide to give 20% cyclopentanone.

c. Inactive (0), slightly active (+), moderately active (++), or highly active (+++) under the conditions used.

d. 100 μl of sample solution was added to each plate

e. The sample solution was added to the assay media at levels of 0.2, 0.4, 1, 2, 4, and 10 μl/ml. Toxicity was observed only at the 10 μl/ml level except for 1-methylpyrene which also exhibited toxicity at the 4 μl/ml level.

and seriously decrease the concentrations of fractions that can be studied. The desirability of studying the highly insoluble components should, therefore, be reconsidered. One can rationalize, with considerable justification, that if a material is insoluble in dimethyl sulfoxide or acetone (solvent suitable for the Ames test) and completely insoluble in water, it is unlikely that the material can be absorbed into a biological system and exert an effect. The main mechanism by which such an intractable material might affect an organism would involve chemical modification resulting from extracellular enzyme systems.

In the interest of channeling our efforts into those areas which are most apt to yield valuable data, we will concentrate our future studies on obtaining fractions that are less likely to be highly insoluble. Our initial studies in this direction, involving selective solvents and gel-permeation chromatography, have been very encouraging. We will separate out the high-molecular-weight and highly-insoluble material prior to subfractionation.

In Vivo Biological Screening Studies
(Performed by Jack Anderson, Battelle Pacific Northwest Laboratories)

Preliminary bioassays were conducted to determine the most effective solvent and test animal for evaluating the toxicity of oil fractions. Whole crude oil and phenanthrene were used as reference materials in this initial study.

Brine shrimp *Artemia salina* (L.), and mysids *Neomysis awatschensis* were used. After initial hatching, *Artemia* were maintained in two 5-gallon aquaria at room temperature with gentle aeration. The algae *Monochrysis* was used as a food source. Adult animals selected were approximately five millimeters in length. Mysids were collected by trawl in Sequim Bay and maintained in large flow-through tanks. They were acclimatized for at least one day prior to testing and fed a diet of *Artemia nauplii*.

All bioassays ran for 40 hours with the exception of the initial 72-hr phenanthrene test. Animals were placed in five 6-quart static aquaria containing four liters of filtered seawater with gentle aeration. Ambient temperature (10°C) was maintained by water bath and the salinity and temperature of each aquarium was monitored daily.

Brine shrimp were transferred from culture tank to test aquaria using a fine mesh net. This allowed for slow draining of algal culture water with a minimum of animal stress. Mysids were captured by the use of hollow glass tubes. These tubes utilized suction to draw the animal and seawater into its chamber without direct handling. Mysids were placed in an intermediate beaker in groups of ten. The seawater and detritus were drained and the beaker contents submerged in the bioassay aquarium.

Phenanthrene was used as a standard toxicant to provide an index of the general health status of the animals. A 10,000 mg/l phenanthrene stock solution was prepared by mixing one gram of phenanthrene with 100 ml of acetone in a volumetric flask and refrigerating until use. For the first bioassay, mysids were placed in aquaria containing phenanthrene at concentrations of 0.05, 0.1, 0.2 and 0.5 mg/l. Due to the insolubility of phenanthrene in water, aliquots of a 1:10 dilution of the stock solution were mixed with seawater by blender in two 1-liter increments. Aliquots were delivered by microliter pipets. The phenanthrene bioassay using brine shrimp was conducted in the same manner with the following exceptions: Concentrations used were 0.025, 0.05, 0.1, 0.2 mg/l and aliquots of the stock solution were added directly to seawater without blending or diluting.

Cyclopentanone and tetrahydrofuran were bioassayed using mysids. Concentrations were 10, 100, 500, and 1000 μl/l and solvents were added directly via microliter pipets or syringe and mixed with seawater by hand in aquaria already containing mysids.

The last bioassay used Prudhoe Bay crude oil dissolved in cyclopentanone. One ml of "fresh" PBC oil was mixed with 9 ml of cyclopentanone in a volumetric flask and refrigerated. Aliquots were taken via microliter pipet or syringe and added to 500 ml of filtered seawater and blended to a dispersion. This was stirred into 3500 ml of filtered seawater in an aquarium already containing mysids. The final concentrations of crude oil were 0.5, 1, 5, and 10 μl/l. The final concentrations of cyclopentanone associated with the crude oil were 4.5, 9. 45, and 90 μl/l.

The results of the above bioassays are given in Table 2. Mysids were found to be considerably more sensitive than brine shrimp to exposure to phenanthrene. Mysids are also a much more realistic

TABLE 2

Concn, ppm	No. of Animals	No. of Test Animals Surviving After Given Exposure Time				LC_{50}, ppm, for Given Exposure Time	
		24 hr		48 hr		24 hr	48 hr
		Phenanthrene/Mysids					
0.050	30	25	83%	23	77%		
0.100	30	14	47%	8	27%	0.096	0.076
0.200	30	1	3%	0	0%		
0.500	30	1	3%	0	0%		
Control	30	27	90%	18	60%		
		Phenanthrene/Brine Shrimp					
0.025	20	20	100%	18	90%	>0.200	>0.200
0.050	20	19	95%	17	85%		
0.100	20	20	100%	17	85%		
0.200	20	20	100%	18	90%		
Control	20	20	100%	19	95%		
		Cyclopentanone/Mysids					
10	20	20	100%	20	100%	800	420
100	20	20	100%	17	85%		
500	20	14	70	9	45%		
1000	20	9	45%	2	10%		
Control	0	19	95%	19	95%		
		THF/Mysids					
10	20	20	100%	20	100%	570	240
100	20	20	100%	18	90%		
500	20	12	60%	3	15%		
1000	20	1	05%	0	0%		
Control	20	20	100%	19	95%		
		Prudhoe Bay Crude Oil in Cyclopentanone/Mysids					
0.5	20	20	100%	20	100%	>10	>10
1.0	20	20	100%	19	95%		
5.0	20	19	95%	19	95%		
10.0	20	19	95%	16	80%		
Control	20	19	95%	18	90%		

indicator species than brine shrimp. For these reasons, mysids will be used for future in vivo bioassays.

Cyclopentanone was less toxic than THF by a factor of about two and could be used at a concentration of 100 μl/l with little effect on mysids. A solution of 1 ml of Prudhoe Bay crude oil in 9 ml of cyclopentanone, prepared to aid dispersion and as a model for future studies of petroleum fractions, could therefore be used in the bioassay to give crude oil levels up to 10 μl/l without interference by the cyclopentanone. At this maximum level, no significant toxic effects of the crude oil were observed. Phenanthrene was at least 100 times more toxic than Prudhoe Bay crude oil in the mysids assay. This indicates that all of the different components in the crude oil that have toxicities as great as phenanthrene comprise altogether no more than one percent of the total unless there are also protective components present. Therefore, in order to provide toxic fractions, the fractionation process used must provide fractions that represent less than one percent of the total oil.

FUTURE WORK PLANS

Our efforts during the next report period will include:

(1) Fractionation to remove interfering highly insoluble components prior to subfractionation
- (a) By gel permeation chromatography, e.g. using Bio Beads or Sephadex LH-20
- (b) By selective solvents, e.g. acetone, dimethyl sulfoxide, or acetonitrile

(2) In vitro bioassay of selected fractions
- (a) Using Ames mutagenicity assay
- (b) Using prescreen confluency assay for mammalian cell toxicity

(3) In vivo bioassay of selected fractions using mysids.

Contract # 03-5-022-69
Research Unit # 512
Reporting Period April 1, 1978-
June 30, 1978
Number of Pages: 8

Quarterly Report

Pelagic and Demersal Fish Assessment in the Lower Cook Inlet Estuary System

James E. Blackburn

Alaska Department of Fish & Game
P.O. Box 686
Kodiak, Alaska 99615

June 30, 1978

I. Abstract or Highlings of Quarter's Accomplishments

During this quarter a field crew was assembled, field sampling was conducted in Kachemak Bay in April, Kamishak Bay in May and June and food habits analysis was begun. Through the end of June 157 hauls of all gear types were completed and the contents of 416 fish stomachs were examined.

II. Task Objectives

The objectives of this sutdy are intended to develop an understanding of seasonal changes in composition and feeding habits of predominant marine organisms. Specifically, these objectives are:

1. Determine feeding habits of principal life stages of predominant marine organisms and provide an initial description of the food web.

2. Describe the temporal dynamics of marine organisms at specific sites.

3. Evaluate the timing and use of specific areas by critical life stages of marine organisms.

III. Field or Laboratory Activities

A. Ship or Field Trip Schedule

1. 17' skiff - 10 through 30 April, 1978. Kachemak Bay

2. 17' skiff plus 21' skiff - 1 May through 30 June, 1978. Kamishak Bay

3. M/V HUMDINGER, an OCSEAP chartered vessel.

   a. Scheduled sampling days: April 22, May 5-6, 12-13, 24-25, June 4-7, 24-25, plus some time during 12-16 June as vessel is available.

   b. Sampling days realized: April 22, May 25, June 6-7, 15-16, 21-22, 24.

B. Scientific Party - All are Alaska Department of Fish and Game Personnel

1. Jim Blackburn, Principal Investigator, RU512. Accompanied field crew during part of April and most of May.

2. Jay Field, Crew Leader

3. Robert Sanderlin, Fishery Biologist

4. Daniel Locke, Fishery Biologist

5. Jim Sicina, Fishery Technician

6. Karen Anderson, Fishery Biologist. She has remained at the Kodiak laboratory and conducted food habits analyses.

C. Methods

1. Sampling Methods

a.	Beach Seine	Require skiff
b.	Trammal Net	Require skiff
c.	Gill Net	Require skiff
d.	Surface Tow Net	Require chartered vessel and skiff
e.	Try Net (20' bottom trawl)	Require chartered vessel

2. Fish Collections

Fish catches are sorted by species; the number and weight are recorded by species and life history stage when possible; length frequencies are taken and virtually all species are being preserved for food habits analysis. Large catches are subsampled. The stomachs of large specimens are removed but small specimens are preserved intact. Stomachs are not taken from gill net or trammal net catches.

3. Food Habits Analysis

The data sheets and samples are sent to the Kodiak lab where the catches are tallied by species within each cruise (one half month). The following priority list is used to select fish for analysis until all the available analysis time for a cruise has been expended.

Table 1. Priority list for selection of specimens for food habits analysis.

PRIORITY	SPECIES	MAXIMUM
1	Sandlance	25
2	Herring	25
3	Dolly Varden	25
4	Chum Salmon Fry	25
5	Chinook Salmon Fry	15
6	Red Salmon Fry	15
7	Coho Salmon Fry	15
8	Pink Salmon Fry	15
9	Whitespotted Greenling Juvenile	15

Table 1. Priority list for selection of specimens for food habits analysis. (cont.)

PRIORITY	SPECIMEN	MAXIMUM
10	Whitespotted Greenling Adult	10
11	Masked Greenling Juvenile	15
12	Masked Greenling Adult	10
13	Capelin	20
14	Eulachon	5
15	Longfin Smelt	10
16	Great Sculpin	20
17	Yellow Fin Sole	10
18	Starry Flounder	10
19	Rock Sole	10
20	Staghorn Sculpin	10
21	Pollock	10
22	Pacific Cod	10

D. Sample Locations

Figures 1 and 2 depict locations sampled.

E. Data Collected

Table 2. Number of samples by gear type and cruise

		GEAR				
Cruise	Dates	Beach Seine	Tow Net	Gill Net	Trammal Net	Try Net
1	10-30 April	10	0	0	0	1
2	1-15 May	6	0	0	1	0
3	16-31 May	32	4	2	7	1
4	1-15 June	16	17	3	6	3
5	16-30 June	26	12	0	3	7

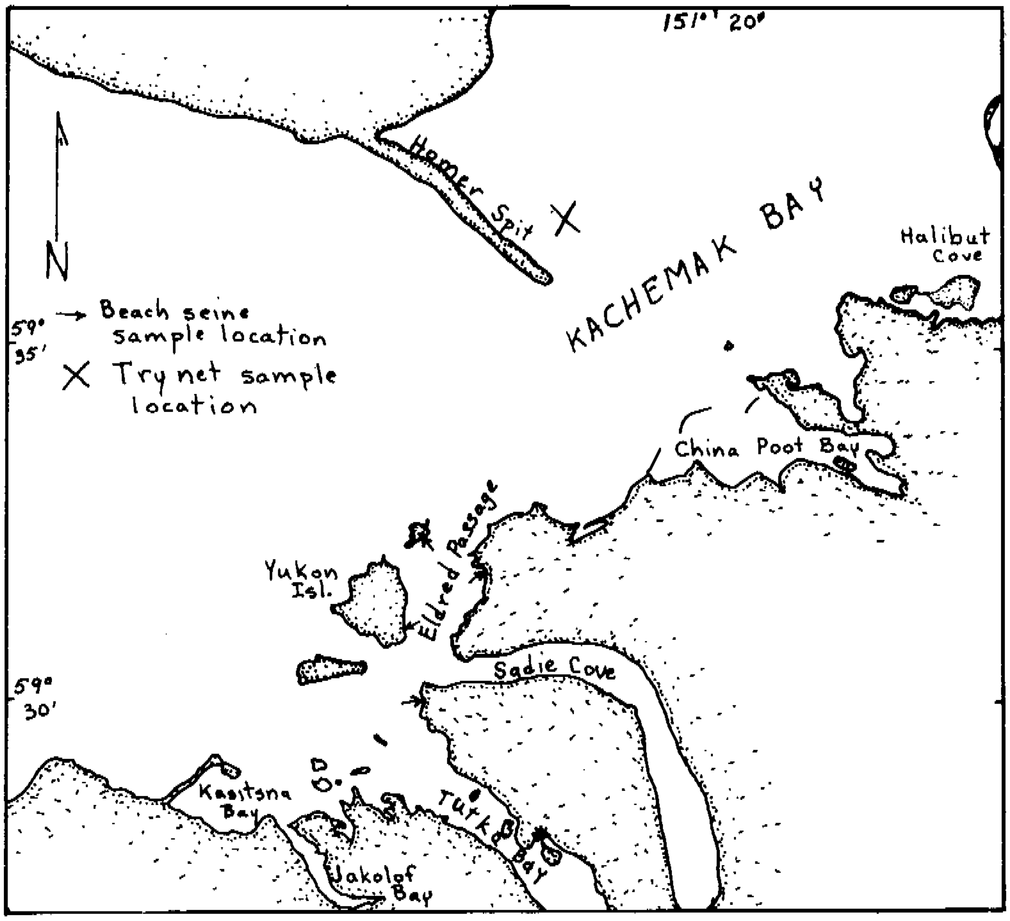


Figure 1. Locations sampled in Kachemak Bay during April 1978, by gear type. One additional location was sampled by beach seine on the west side of Tutka Bay just off the map.

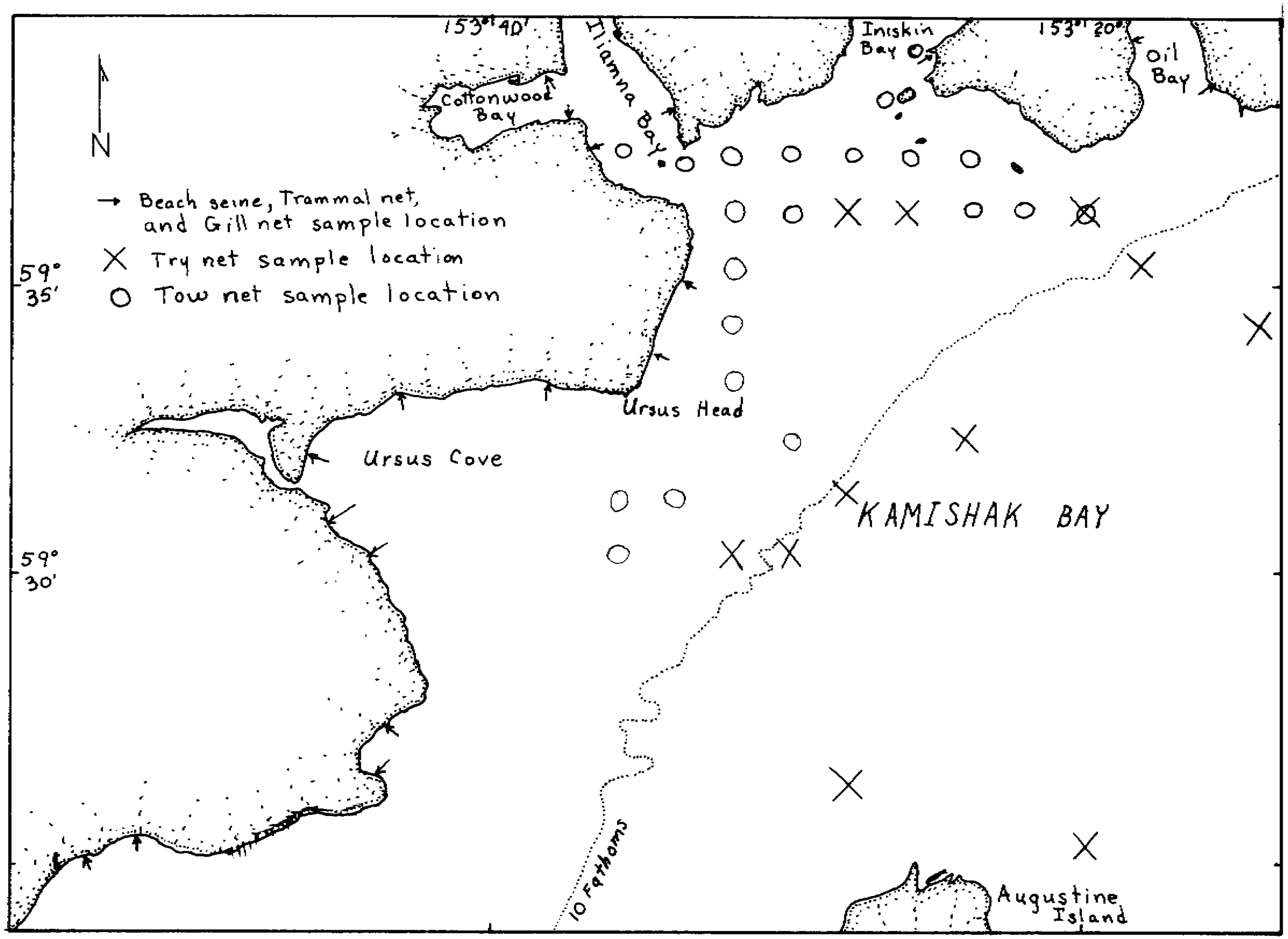


Figure 2. Locations sampled in Kamishak Bay during May and June 1978, by gear type. One additional location was sampled by tow net in Iniskin Bay just off the map.

Table 3. Number of fish stomaches analysed for food content by species and time period.

SPECIES	NUMBER BY TIME PERIOD April 10-May 15	May 16-31
Sandlance	9	11
Dolly Varden		20
Herring		9
Chum Fry	25	19
Pink Fry	35	
Whitespotted Greenling Juvenile	4	3
Pollock		9
Staghorn Sculpin	3	2
Great Sculpin	13	17
Rock Sole	1	6
Starry Flounder		7
Yellowfin Sole		2
Longfin Smelt		15
Surf Smelt		1
Capelin		6
TOTAL	90	127

The food habits analysis effort was initiated before the field season to ensure that problems were worked out early. Library research was conducted and food habits of fish collected in 1976 was examined. A total of 100 sandlance and 99 longfin smelt stomaches were examined. The large nuber of pink salmon fry examined in the first time period were a part of the gearing up effort. Thus, a total of 416 fish stomachs have been examined to date.

Results

During the period of April 18 to May 10 sampling with the beach seine yielded one year old great sculpin, small catches of sandlance, pink salmon fry (in Kachemak Bay but chum salmon fry in Cottonwood) and one larval greenling. Other species did not appear in beach seine catches until mid-May.

From four try net hauls in Kamishak Bay the abundance of juvenile snow crab is conspicuous. The mean catch was 52 crabs per haul (range 4 to 108) and the mean weight was quite small, 37 gms. (range 20 to 73 gms). The predominant fish in 4 try net hauls was yellowfin sole.

Further catch analysis has not been conducted.

V. Preliminary Interpretation of Results

Interpretation of results must await further data analysis and manuscript review.

VI. Auxiliary Material

A. Bibliography of References

No citations made.

B. Papers in Preparation or in Print

Blackburn, J. E. 1978. Pelagic and Demersal Fish Assessment in the Lower Cook Inlet Estuary System. Alaska Dept. of Fish and Game. Outer Continental Shelf Environmental Assessment Project. Research Unit 512, Final Report for work in 1976-77. This report has been completed as of June 30, 1978.

C. Oral Presentations.

Brief review by J. Blackburn of R.U. 512 at OCSEAP Hydrobiology Meeting in Santa Cruz, California during mid-April, 1978.

VII. Problems Encountered and Recommended Changes.

1. Severe weather in Kamishak Bay has precluded operation on several occasions and caused a reduction in scope (distance traveled) on other occasions. The only alternative seems to be operation in Kachemak Bay during periods when bad weather may be anticipated.

2. The use of one charter vessel on both the east and west side of the inlet has severely restricted our activity. Frequently the vessel cannot cross the inlet and we have lost sampling days.

   A solution to this problem is not obvious. Little latitude for change is available at this point in the study. More efficient use could be made of charter vessel time in Kachemak Bay but the area of concern is Kamishak Bay. If all operations were moved to Kamishak Bay then efficiently obtaining fuel and supplies for the charter vessel would be a problem although more efficient use of sampling time could occur since the vessel would save days crossing the inlet.

   The only recommendation is that operations be moved to Kachemak Bay by the end of August.

3. Communication with the field camp is a problem. The radio has been out of operation from about May 25 through the present. Communication via the Marine Operator with the M/V HUMDINGER is possible, but usually unsuccessful.

   When the radio was operational its use conflicted with sampling. A routine radio check will be set up for evening hours once the radio is operational again.

4. Transportation to and support of the Cottonwood field camp would be much easier for this project if the charter flights were between Kodiak and Cottonwood as opposed to the current arrangement between Homer and Cottonwood. I realize that there is value in using one location to support all the projects and the current arrangement may well be the best compromise possible.

5. One problem that persists and is often overlooked is the need for a pictorial key to fishes of Alaska. The quality of field data would be considerably improved by such a volume. The Pacific Fishes of Canada, by J.L. Hart, (1973 Fish Res. Bd. Canada, Bull. 180) is quite good but the fishes are sufficiently different here that the use of it by field crews tends to result in misidentifications. There are books in the process of being compiled by National Marine Fisheries Service personnel that will probably fill much of the gap and may be sufficient.

VIII. Estimate of Funds Expended

Personnel Services[1]	$56,852
Travel	2,231
Contractural Services[2,3]	1,557
Commodities	10,547
Equipment	1,873
Overhead	14,020
TOTAL	$87,080

[1]Projects salaries of permanent employees thru 9/30/78.

[2]An additional 20,000 committed to scuba surveys.

[3]Foregut analysis is being conducted in-house, thus $11,200 budgeted for contracts is being expended for personnel services.

Research Unit #516
March-June, 1978

Quarterly Report

A GEOGRAPHIC BASED DATA MANAGEMENT SYSTEM FOR PERMAFROST IN THE BEAUFORT AND CHUKCHI SEAS

by

M. Vigdorchik

INSTAAR
University of Colorado
Boulder, Colorado 80303

QUARTERLY PROGRESS REPORT - March-June, 1978 - R.U. 516

A geographic based data management system for permafrost in the Beaufort and Chukchi seas

M. Vigdorchik, INSTAAR, University of Colorado

I. Task Objectives: The first principal objective is to develop a computerized system which will aid in predicting the distribution and characteristics of off-shore permafrost. The second objective is to undertake a comprehensive review and analysis of past and current Soviet literature on subsea permafrost and related natural processes.

II. Summary of Results: According to the first objective, we have continued to compile computerized maps in the scale of 1:000,000. These maps include bottom deposit grain size for the Beaufort Sea ($69^{o}30'$ - $73^{o}30'$ north latitude and 141-147^{o} west longitude). We have also compared maps produced for the Canadian part of the Beaufort Sea Shelf by our system with earlier published maps of permafrost prediction (Hunter et al, 1976). This has been done to check the efficiency of our systems for permafrost prediction with the Canadian results. According to this comparison the areas of sea water seasonally supercooling are good indicators of submarine permafrost, lying not only right under the sea bottom, but to a considerable depth below it, and at the areas with bathimetry ranging from 7 to 100 m and some places with much more water depth (north-western part of the Canadian Beaufort Sea). The absence of the ice bonded permafrost below the sea bottom when it exists at greater depths could be explained by higher salinities in the upper layers of the deposits. The data about the delicate balances of the moistness, salt concentration in the pore water, grain size and freezing temperature of the bottom deposits in the Arctic seas were summarized during the analysis "Submarine Permafrost on Arctic Shelf of Eurasia," based on the recent Russian investigations and will be placed in the Final Report.

III. Financial Status: Amount dispersed since the beginning of the work . $85,867

Amount dispersed Second Quarter (March-June, 1978) $17,010

QUARTERLY REPORT

Contract: 03-5-022-67 TO 13
Research Unit: 519
Reporting Period: 1 April - 30 June 1978
Number of Pages: 2

COASTAL METEOROLOGY OF THE ALASKAN ARCTIC COAST

Eric Leavitt
Research Scientist

Polar Science Center
Division of Marine Resources
University of Washington
Seattle, Washington 98195

1 July 1978

I. Task Objectives

The objectives of this program are to measure and model mesoscale processes in the surface winds of the Beaufort Sea Coast. Any attempt to understand oceanic circulation and resultant pollutant trajectories must include a description of air stress forcing by the surface winds.

II. Field and Laboratory Activities

Preparations are underway for a field trip to be taken during July and August 1978 in the Deadhorse-Simpson Lagoon area. Measurements will be coordinated to provide meteorological input for the oceanographic studies of Mathews (RU 526) and Mungall (RU 531).

III. Results

1. Atmospheric data from both sample periods of the 1977 field season have been reduced and submitted to the OCSEAP data bank.

2. Sea breeze process modeling is continuing.

IV. Preliminary Interpretation of Results

1. The strong correlation between surface winds measured at widely separated points along the coast suggest that only a few measurement points would be needed to provide a data set for current trajectory studies near the coast.

2. Implementation of a working, non-linear, time-dependent, perturbation model of the thermal forcing at the coastline with an imposed synoptic wind field has resulted in a reasonable matching of the 1977 pilot balloon (wind velocity) profiles taken during sea breeze events. Recently analyzed wind direction data obtained at Pingok Island, Tolaktovut Point, Cross Island, and Narwhal Island show a change in modal wind direction from 45-60° True in spring (limited thermal contrast across the coastline) to 75-90° True in summer (large thermal contrast across the coastline). Spectral analysis of the same data (wind direction and speed) show a greater peak in the variance at the diurnal period for summer than for spring.

V. Problems Encountered and Recommended Changes

None

VI. Estimate of Funds Expended

As of 1 July 1978, expenditures under this contract will come to $22,310.00 out of an allocation of $51,914.00

QUARTERLY REPORT

Contract #03-5-022-55
Research Unit #526-77
Task Order #13
Reporting Period: 4/1/78 - 6/30/78
Number of pages: 5

CHARACTERIZATION OF THE NEARSHORE HYDRODYNAMICS OF AN ARCTIC BARRIER ISLAND-LAGOON SYSTEM

J. B. Matthews
Associate Professor of Marine Science
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

June 30, 1978

OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Quarter ending June 30, 1978

Project Title: Characterization of the Nearshore Hydrodynamics of an Arctic Barrier Island-Lagoon System

Contract Number: 03-5-022-55

Task Order Number: 13

Principal Investigator: J. B. Matthews

I. Task Objectives:

A. To review estuarine lagoon hydrodynamics

B. Summarize knowledge of Simpson Lagoon.

C. Produce numerical predictions of Simpson Lagoon circulation under various environmental conditions.

D. Plan and execute a field program to verify the numerical model computations.

E. Produce circulation, flow and water quality estimates for use by ecological modeling group.

II. Field or Laboratory Activities:

A. Ship or Field Schedule:

1. 12 May 1978 - 15 May 1978 Prudhoe Bay
2. 25 May 1978 - 28 May 1978 Prudhoe Bay

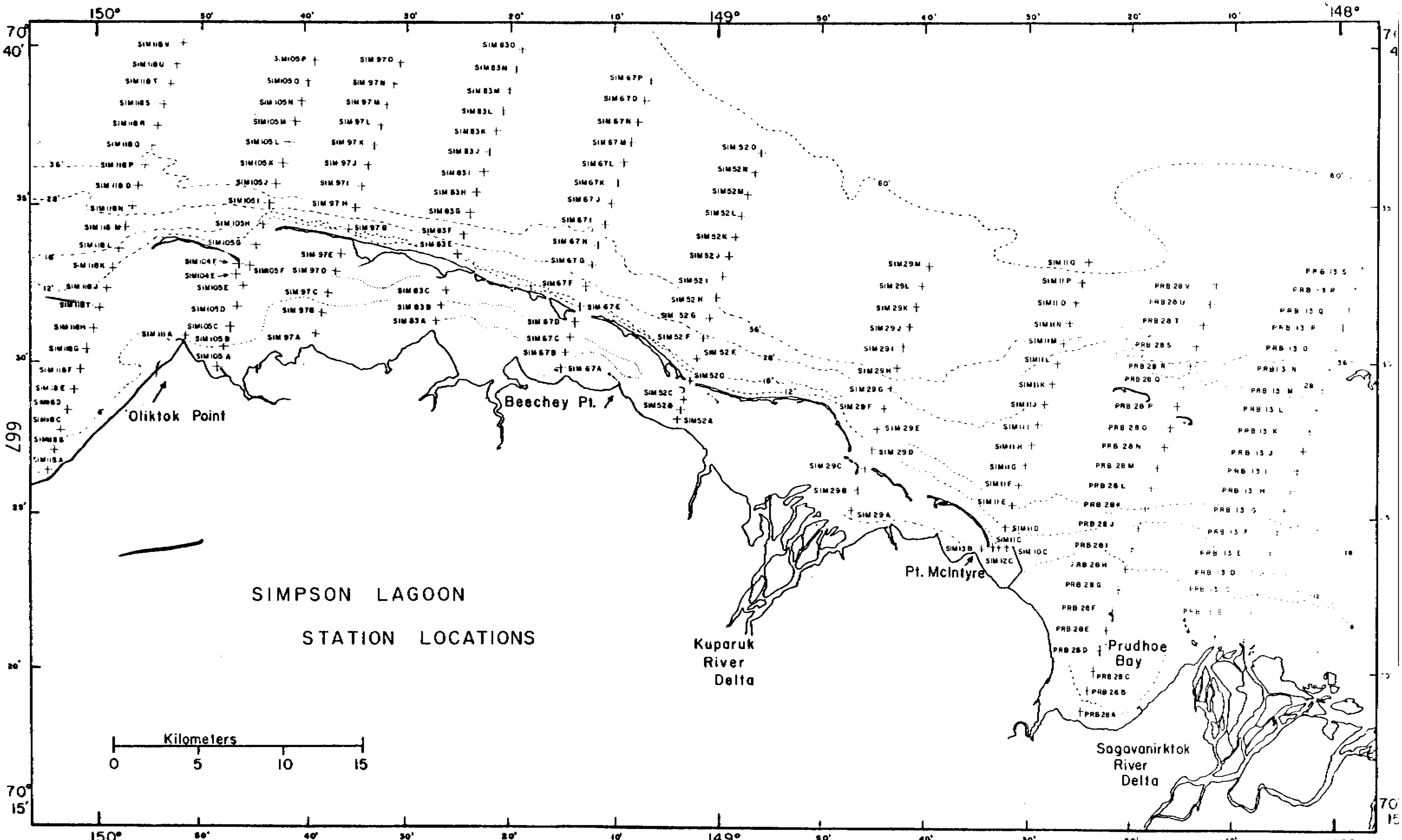
B. Scientific Party:

1. Kee Soo Nam
Stuart Rawlinson
Garry Meltvedt

2. J. B. Matthews
Bill Kopplin
Garry Meltvedt
Stuart Rawlinson

C. Methods:

The field expeditions were designed to test the diver-emplacement of under-ice bottom-mounted recording oceanographic equipment. Transportation between field camp and sample location was by helicopter.


SIMPSON LAGOON
STATION LOCATIONS
Oliktok Point
Beechey Pt.
Kuparuk River Delta
Pt. McIntyre
Prudhoe Bay
Sagavanirktok River Delta
Kilometers
0
5
10
15
150°
149°
148°
70° 40'
70° 15'

Use was made of the diving holes and crossing trenches dug by Drs. Barnes and Reimnitz through the 1.8 m thick ice. Instruments were lowered through the ice on pipe frames tested in prior field seasons. Divers then descended to the instrument array and serviced the instruments. In the second field trip a tide gauge and recording current meter were recovered and replaced before the onset of river runoff rendered the ice unsafe.

D. Sample Localities:

The instrument array was set in the Egg island channel at Station SIM 29C (Fig. 1), 70° 26.6N latitude and 148° 45.6W longitude.

E. Data Collected or Analyzed:

Current meter and tide guage data were recovered from station SIM 29C (Fig. 1) for the period 13 May - 26 May 1978.

III. Results:

Translations from Aanderaa serial format to 9-track binary data has been performed for the tide gauge TG 196 and current meter RCM4#3421. Preliminary analysis and editing has been carried out and a plot of data made in engineering limits.

Salinity appears to fall slowly from about 43.5°/oo to 42.5°/oo while temperature is very steady at -1.8°C from 13 May to 26 May 1978. Currents oscillate in and out of the channel at mean velocities of about 6 cm/sec at periods of about 50 minutes. There is some evidence of a semi-diurnal tidal oscillation superimposed on the short period oscillation. The uncorrected tidal record shows a strong semi-diurnal signal. These are small short period oscillations. Range of the tidal signal is about 20 cm. The water was turbid with visibility down to 10 cm and the ice was sediment laden for 1 m depth.

IV. Preliminary Interpretation of Results:

Brine from the formation of ice in Gwydyr Bay appears to be passing through the Egg Island channel where dilution with coastal water is occurring. The slow oscillations of the water in the channel could lead to mixing of the brine with coastal water. Measurements by other workers have shown salinities of at least 50°/oo inside the barrier islands in the lagoon and about 34°/oo just offshore of the islands. Our observations of salinities 42.5 - 43.5°/oo support the flow of brine seaward.

The turbid water and ice does not appear to be caused by the currents observed under the ice. It is speculated that the particles may be floating in the very dense (sigmat range 34-35) cold brine and in this way appear suspended in the water column and become frozen in the ice.

V. Problems Encountered/Recommended Changes:

The use of helicopter-borne divers proved highly successful. It is recommended that use of helicopters for instrument recovery and emplacement be made during the open-water season.

VI. Estimate of Funds Expended:

Approximately $21,000 remains unexpended.

Quarterly Report

Contract Number: 03-7-022-35139
Research Unit Number: 527
Reporting Period: 4/1/78-6/30/78

OCSEAP Data Processing Services

Harold Petersen Jr.
Data Projects Group
Pastore Laboratory
University of Rhode Island
Kingston, Rhode Island
02881

1 July 1978

Background and Objectives

The OCSEA Program encompasses a wide variety of investigations dealing with monitoring and assessing environmental parameters. One requirement of this program involves the submission of data collected in this fashion to national archiving centers. Much of this data flow is monitored by the Juneau Project Office (JPO).

As part of the task of monitoring data flow, JPO seeks assurance of data quality through data validation and data product development. It is in this framework that data processing services are provided by this research unit.

In order to carry out these procedures, use is made of an information management system known as the MARMAP Information System (MIS).

Past Work

This work began in March 1977 with the establishment of procedures necessary for code and data field validations, and subsequent format conversion of File Type 033 data which was initially collected in a format internal to the U.S. Fish and Wildlife Service (FWS) into that acceptable to the OCSEA Program (the "NODC" format). Later, data was collected in NODC format, obviating the need for most of the format conversion steps. There still remains, however, the need to perform code and data validations as well as some tailoring of data fields to remove or insert leading or trailing zeros, etc., on data in NODC format prior to its acceptance by the Program. A summary of the status of this continuing work is given below.

Current Work

Activities pursued during the quarter ending 30 June 1978 include the following:

1. Program Adoption of New Codes

Two new codes which apply to 033 data have been adopted by the Program during this quarter. The first of these is the addition of a code "3" to the Angle of View code field (NODC format column 74, record type 1) to mean "90 degrees either side of ship." The second is the addition of a code "7" to the Outside Zone code field (NODC format column 83, record type 5) to mean "Bird on horizon."

2. Additions to "OCSEAP Data Validation Procedures for File Type 033"

The product CODEPULL has now been modified to list the taxonomic codes found in each field operation data set coded in NODC format. No code verification is carried out, however the listing of such codes is of value to and has been requested by RU's.

An addition to the cverall procedures applies to NODC coded data. Such data received by this RU for validation do not require extensive reformatting, however it has been found that several changes are still desirable in order that the data conform as closely as possible to NODC specifications. This "tailoring" consists of such changes as deletion of all trailing doublet zeros from taxonomic codes, padding station number field with leading zeros, and so forth. A complete list is found in the latest version of the Procedures, which is included as part of this report. New additions are indicated by the appearance of an asterisk (*) to the left of each addition.

Several additional checks made by LOGLIST have been instituted during this quarter. They are included in a copy of the latest release of the Procedures.

Primarily as a result of these changes, but at times for other reasons as well, reruns of the validation products often detect "new" errors in data previously edited after receipt of earlier editions of validation products. In these cases, second deliveries of the products are needed, unless error resolution can be made over the telephone. Again, the reason for these second deliveries stems from new checks added to the validation products after initial runs are made and products delivered to the RU's. The frequency of occurrence of this extra step will subside as fewer new error checks are added to the validation programs.

3. Change to FOSREPT

The Field Operation Status Report has, in the summary section, previously counted as "Total Cruises Edited by RU 527" all those cruises (field operations) for which validation products have been returned to RU 527, data edited, and the column "EDITLOG Complete" filled in. However, in light of the second delivery of the products referenced above, these field operations are not actually completely edited. The report now lists as "Field Operations Which Passed Final Check" only those for which the "Final Check" column has been filled in. This column is filled in only if all editing has been completed and the data are ready for the next step in processing (submission to NODC if in that format, or conversion if in FWS format).

4. Receipt of New Data and Generation of Validation Products

Three tapes of data were received during this quarter. The first of these was received on 30 March, and was a resubmission of data from RU 239. As referenced in an earlier report, the tape which was initially received did not contain all the data indicated on its accompanying DDF. The resubmission tape was easily read, however, and validation products generated from the NODC-formatted data for field operations 01UC75, 02UC75, 03UC75, 01UC76, 02UC76, 03UC76, 04UC76, and 05UC76 were sent to the RU for error resolution. Upon return of these products, the data were edited, and the process repeated for resolution of some additional error citations. A tape of the validated data and a DDF were sent to NODC. Final copies of the validation products and a tape copy of the data were sent to the RU.

The second tape was received on 10 April, and contained data from field operation UCI602, carried out by RU 083. The data were coded in NODC format. They have been edited, and presently await tailoring of some data fields prior to submission to NODC and return to the RU. The operations collectively referred to as "tailoring" are described above.

The third tape, recently received on 13 June, was also prepared by RU 083, and contained data coded in NODC format for field operations UCI501, UCI701, UCI702, UCI703, and UCI704. Data for field operation UCI501 were originally submitted in FWS format in October 1977, and this receipt constitutes a resubmission of the data. Initial runs of validation products are now being prepared on data from this tape.

5. Submission of Data to NODC

During this quarter, two data submissions have been made. The first of these consisted of data from RU 239 as described above. The second consisted of data for a set of twelve field operations carried out by RU 108. These field operations, with sub-file id's indicated by parentheses, are the following: 0522(0), 0522(1), 0531(0), 0531(1), 0532(0,5), 0621(1), 0622(1,3), 1614(0), 1615(0), 1616(1), 2614(0), and 3607(0,4,6). A few comments are necessary concerning the latter submission.

As indicated in an earlier report, certain extensions were made by RU 108 to three fields, two of them data fields, and the third one a code field. The extensions to the Distance to Bird data field, a code of 999 to indicate "bird on the horizon," has been deleted and a code of 7 placed in the Outside Zone code field in its stead. Use of this code, which has Program authorization, has been made only in data sent to NODC. The data sent to RU 108 are coded as originally submitted. The extensions to the Weather Code field and the Light Level data field consisted of letters to indicate the effect of these parameters on the ability of the observer to identify birds (both fields), and an entry of 999 in the Light Level field to indicate off-scale data magnitude. Neither extension received Program approval, and were deleted from the data submitted to NODC, but retained in the version of the data returned to the RU.

Final data tailoring was made on both data submitted to NODC and returned to the RU. No DDF accompanied the submission to NODC, as none was received from RU 108.

6. Editing of Other Data Sets

In addition to those data sets submitted to NODC or just recently received from RU 083, several others require commentary.

Data for nine field operations in FWS format have been completely verified (received "Final Check"), and are now ready for conversion to NODC format, bringing the total of such data sets to twenty-four. The new ones are FW5034, FW5036, FW5037, FW6001, FW6015, FW6025, FW6026, FW6028, and FW6029.

Data for a total of forty-one additional field operations have been edited, and second deliveries of validation products mailed to RU 337 for resolution. They were sent in three mailings. The first set was mailed on 26 April, and contained products for FW5011, FW5012, FW5020, FW5031, FW6018, FW6019, FW6027, FW6050, FW6051, FW6067, FW6068, FW6088, and FW6094. The second set was mailed on 6 June, and contained products for FW5015, FW5025, FW6002, FW6007, FW6009, FW6021, FW6057, FW6070, and FW6095. The third mailing was made on 27 June and contained products for FW5022, FW5029, FW5038 FW6004, FW6005, FW6010, FW011, FW6012, FW6013 FW6016, FW6052, FW6077, FW6078, FW6082 FW6084, FW6085, FW6087 FW6092, and FW7026. During March 1978, second mailings were made for eight other field operations. Those sent in March and on 6 June were received by this RU on 26 June.

7. Reformatting File Type 038 Data (Migratory Bird Sea Watch)

During this quarter, work has begun on the procedures necessary for the validation and conversion of this data, recorded in a format internal to the FWS, to Program-acceptable NODC format. A draft layout of the tentative procedures was sent to RU 337 through JPO for guidance prior to the actual set-up of the procedures.

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/30/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

COLUMN HEADING DEFINITIONS:

TAPE NUMBER -	IDENTIFYING NUMBER ASSIGNED TO THE TAPE AS IT IS RECEIVED BY RU 527.
RESEARCH UNIT -	RESEARCH UNIT NUMBER OF THE PRINCIPAL INVESTIGATOR.
DATE RECEIVED -	DATE THE TAPE WAS RECEIVED BY RU 527.
FILE FORMAT -	FORMAT IN WHICH THE DATA ON THE TAPE HAVE BEEN CODED.
FIELD OPER. -	NAME ASSIGNED TO THE FIELD OPERATION BY THE PRINCIPAL INVESTIGATOR. "FW" FIELD OPS. FROM DR. CALVIN LENSINK; "UCI" FIELD OPS. FROM DR. GEORGE HUNT; "W" FIELD OPS. FROM DR. JOHN WIENS; "UC" FIELD OPS. FROM DR. JUAN GUZMAN.
CODEPULL MAILED -	DATE THE OUTPUT FROM THE QUALITY CONTROL PROGRAM "CODEPULL" WAS MAILED TO THE PRINCIPAL INVESTIGATOR FOR CORRECTIONS.
LOGLIST MAILED -	DATE THE OUTPUT FROM THE QUALITY CONTROL PROGRAM "LOGLIST" WAS MAILED TO THE PRINCIPAL INVESTIGATOR FOR CORRECTIONS.
CODEPULL RETURNED -	DATE THE CORRECTED OUTPUT FROM "CODEPULL" WAS RECEIVED BY RU 527.
LOGLIST RETURNED -	DATE THE CORRECTED OUTPUT FROM "LOGLIST" WAS RECEIVED BY RU 527.
EDITLOG COMPLETE -	DATE THE CORRECTIONS WERE MADE TO THE FIELD OP. AT RU 527, THROUGH THE USE OF AN INTERACTIVE PROGRAM "EDITLOG".
FINAL CHECK -	DATE THE FIELD OP. WAS READY FOR CONVERSION OR TRANSFORMATION. OCCASIONALLY ADDITIONAL PROBLEMS ARISE WHEN "CODEPULL" AND "LOGLIST" ARE RERUN AFTER EDITING. IF THESE CANNOT BE RESOLVED OVER THE TELEPHONE THE LISTINGS ARE SENT BACK TO THE PI FOR FURTHER CORRECTIONS. THIS FIELD IS NOT FILLED IN UNTIL ALL CORRECTIONS HAVE BEEN MADE.
CONVERT TO NODC -	DATE THE FIELD OP. WAS CONVERTED FROM FWS FORMAT TO NODC FORMAT. AN "NA" (NOT APPLICABLE) IS ENTERED HERE FOR FIELD OPS. RECEIVED IN NODC FORMAT.
MAIL TO NODC -	DATE THE FIELD OP. IN FINAL FORM WAS SUBMITTED TO NODC.
ENDNOTES -	REFERENCE NUMBER TO ADDITIONAL COMMENTS FOLLOWING THE TABLE.

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/30/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	FIELD OPER.	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
ALASKA1	337	03/12/77	FWS	FW5004	07/12/77	08/16/77	08/29/77	10/06/77	02/15/78	02/15/78			1A
ALASKA2	337	03/12/77	FWS	FW5009	07/12/77	08/16/77	10/06/77	10/06/77	01/26/78	01/30/78			1A
				FW5013	07/12/77	08/16/77	08/29/77	10/06/77	01/24/78	01/26/78			1A
				FW5018	07/12/77	08/16/77	08/29/77	10/06/77	01/30/78	02/01/78			1A
				FW5023	07/12/77	08/16/77	08/29/77	10/06/77	02/06/78	02/14/78			1A
				FW5024	07/12/77	08/16/77	08/29/77	10/06/77	02/14/78	02/15/78			1A
				FW5030	07/12/77	08/16/77	08/29/77	10/06/77	12/01/77	12/05/77	02/28/78		6
				FW5032	07/12/77	08/16/77	08/29/77	10/06/77	12/01/77	12/05/77	02/28/78		6
ALASKA3	337	05/27/77	FWS	FW5008	07/14/77	08/16/77	09/06/77	09/06/77	12/09/77	12/09/77			
				FW5016	07/14/77	08/16/77	09/06/77	09/06/77	01/26/78				1A
				FW5021	07/14/77	08/16/77	09/06/77	09/06/77	12/19/77				1B
				FW5026	07/14/77	08/16/77	09/06/77	09/06/77	01/31/78	02/01/78			
				FW5027	07/14/77	08/16/77	09/06/77	09/06/77	02/03/78	02/06/78			
				FW5033	07/14/77	08/16/77	09/06/77	09/06/77	01/30/78				1B
				FW5035	07/14/77	08/16/77	09/06/77	09/06/77	01/30/78	02/01/78			
				FW6008	12/12/77	12/12/77	01/10/78	01/10/78	02/06/78				1B
				FW6027	07/14/77	08/16/77	09/06/77	09/06/77	03/20/78				1C
				FW6050	07/14/77	08/16/77	09/06/77	09/06/77	03/22/78				1C
				FW6051	07/14/77	08/16/77	09/06/77	09/06/77	03/28/78				1C
				FW6074	07/14/77	08/16/77	09/06/77	09/06/77	03/02/78				1B
				FW6083	07/14/77	08/16/77	09/06/77	09/06/77	03/13/78				1B
ALASKA4	337	06/24/77	FWS	FW5011	08/16/77	08/16/77	11/01/77	11/01/77	03/20/78				1C
				FW5012	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78				1C
				FW5020	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78				1C
				FW5031	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78				1C
				FW5034	08/16/77	08/16/77	11/01/77	11/01/77	04/17/78	04/19/78			
				FW6015	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78	04/18/78			
				FW6016	08/16/77	08/16/77	11/01/77	11/01/77	04/12/78				1C
				FW6039	08/16/77	08/16/77	11/01/77	11/01/77	04/18/78				1C
				FW6067	08/16/77	08/16/77	11/01/77	11/01/77	04/12/78				1C
				FW6068	08/16/77	08/16/77	11/01/77	11/01/77	04/12/78				1C
				FW6088	09/29/77	09/29/77	10/20/77	10/20/77	04/17/78				1C
				FW6089	08/16/77	08/16/77	11/01/77	11/01/77	02/28/78				1B
				FW6094	08/16/77	08/16/77	11/01/77	11/01/77	03/01/78				1C
ALASKA5	337	07/01/77	FWS	FW5015	09/29/77	09/29/77	10/20/77	10/20/77	04/24/78				1E

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/30/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	FIELD OPER.	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
ALASKA5	337	07/01/77	FWS	FW5025	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78				1E
				FW6001	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78	04/28/78			
				FW6002	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78				1E
				FW6007	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78				1E
				FW6009	09/29/77	09/29/77	10/20/77	10/20/77	04/24/78				1E
				FW6021	10/28/77	10/28/77	11/30/77	11/30/77	04/25/78				1E
				FW6026	09/29/77	09/29/77	10/20/77	10/20/77	04/26/78	04/28/78			
				FW6029	09/29/77	09/29/77	10/20/77	10/20/77	04/26/78	05/08/78			
				FW6057	09/29/77	09/29/77	10/20/77	10/20/77	05/31/78				1E
				FW6064	09/29/77	09/29/77	10/20/77	10/20/77	02/20/78				1B
				FW6066	09/29/77	09/29/77	10/20/77	10/20/77	02/22/78	02/24/78			
				FW6070	09/29/77	09/29/77	10/20/77	10/20/77	04/25/78				1E
				FW6095	09/29/77	09/29/77	10/20/77	10/20/77	05/09/78				1E
ALASKA6	337	07/07/77	FWS	FW5014	10/21/77	10/21/77	11/14/77	11/14/77	02/17/78	02/22/78			
				FW5022	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				1F
				FW5029	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				1F
				FW5036	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78	06/07/78			
				FW5037	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78	06/07/78			
				FW6004	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				1F
				FW6005	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				1F
				FW6010	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				1F
				FW6011	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				1F
				FW6012	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				1F
				FW6016	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				1F
				FW6028	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78	06/08/78			
				FW6052	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				1F
				FW6077	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				1F
				FW6078	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				1F
				FW6084	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				1F
				FW6085	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				1F
				FW6092	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				1F
				FW7026	10/21/77	10/21/77	11/14/77	11/14/77	06/16/78				1F
				FW7027	10/21/77	10/21/77	11/14/77	11/14/77					
ALASKA7	063	07/07/77	FWS	UCI501	10/07/77	10/07/77							7
				UCI601	10/07/77	10/07/77							
ALASKA8	337	07/28/77	FWS	FW5038	10/28/77	10/28/77	11/30/77	11/30/77	06/16/78				1F
				FW6013	10/28/77	10/28/77	11/30/77	11/30/77	06/16/78				1F
				FW6025	10/28/77	10/28/77	11/30/77	11/30/77	06/15/78	06/19/78			

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/30/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	FIELD OPER.	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
ALASKA8	337	07/28/77	FWS	FW6082	10/28/77	10/28/77	11/30/77	11/30/77	06/16/78				1F
				FW6087	10/28/77	10/28/77	11/30/77	11/30/77	06/16/78				1F
ALASKA9	337	06/03/77	FWS	FW5003	10/28/77	10/28/77	11/30/77	11/30/77					2
				FW5006	10/28/77	10/28/77	11/30/77	11/30/77					
				FW5010	10/28/77	10/28/77	11/30/77	11/30/77					
				FW6006	10/28/77	10/28/77	11/30/77	11/30/77					
				FW6014	10/28/77	10/28/77	11/30/77	11/30/77					
ALASKA10	337	09/06/77	NODC	FW7032	10/07/77	10/07/77	11/03/77	11/03/77	11/22/77	11/30/77	/NA/	12/12/77	
				FW7033	10/07/77	10/07/77	11/03/77	11/03/77	11/22/77	11/30/77	/NA/	12/12/77	
ALASKA11	337	11/16/77	NODC	FW7034	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/10/78	/NA/	02/28/78	
				FW7035	11/30/77	11/30/77	01/04/78	01/04/78	01/06/78	01/17/78	/NA/	02/28/78	
				FW7042	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/16/78	/NA/	02/28/78	
				FW7046	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/16/78	/NA/	02/28/78	
ALASKA12	337	01/10/78	NODC	FW7028	01/18/78	01/18/78	01/30/78	01/30/78	01/31/78	02/01/78	/NA/	02/28/78	
				FW7031	01/18/78	01/18/78	01/30/78	01/30/78	02/01/78	02/02/78	/NA/	02/28/78	
				FW7036	01/18/78	01/18/78	01/30/78	01/30/78	01/31/78	02/01/78	/NA/	02/28/78	
				FW7045	01/18/78	01/15/78	01/30/78	01/30/78	02/01/78	02/01/78	/NA/	02/28/78	
ALASKA13	337	01/10/78	FWS	FW6086	01/18/78	01/18/78	01/30/78	01/30/78	02/17/78				1B
				FW6186	01/18/78	01/18/78	01/30/78	01/30/78	02/17/78	02/17/78			5
ALASKA14	063	04/10/78	NODC	UCI602	04/14/78	04/14/78	04/25/78	04/25/78	06/02/78	06/06/78	/NA/		
ALASKA15	063	06/13/78	NODC	UCI501									
				UCI701									
				UCI702									
				UCI703									
				UCI704									
OREGON1	108	05/25/77	NODC	W05220	10/26/77	10/26/77	01/03/78	01/03/78	05/05/78	05/17/78	/NA/	05/24/78	3B
				W05221	10/26/77	10/26/77	01/03/78	01/03/78	05/05/78	05/17/78	/NA/	05/24/78	3B
				W05310	10/26/77	10/26/77	01/03/78	01/03/78	05/08/78	05/17/78	/NA/	05/24/78	3B

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/30/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	FIELD OPER.	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
OREGON1	106	05/25/77	NODC	W05311	10/26/77	10/26/77	01/03/78	01/03/78	05/09/78	05/17/78	/NA/	05/24/78	
				W05325	10/26/77	10/26/77	01/03/78	01/03/78	05/10/78	05/17/78	/NA/	05/24/78	3B
				W06211	10/26/77	10/26/77	01/03/78	01/03/78	05/10/78	05/17/73	/NA/	05/24/78	3A
				W06221	10/26/77	10/26/77	01/03/78	01/03/78	05/12/78	05/17/78	/NA/	05/24/78	3A,3B
				W16140	10/26/77	10/26/77	01/03/78	01/03/78	05/12/78	05/17/78	/NA/	05/24/78	3B
				W16150	10/26/77	10/26/77	01/03/78	01/03/78	05/02/78	05/17/78	/NA/	05/24/78	3B
				W16161	10/26/77	10/26/77	01/03/78	01/03/78	05/12/78	05/17/78	/NA/	05/24/78	3A,3B
				W26140	10/26/77	10/26/77	01/03/78	01/03/78	05/05/78	05/17/78	/NA/	05/24/78	3B
				W36070	10/26/77	10/26/77	01/03/78	01/03/78	05/04/78	05/17/78	/NA/	05/24/78	3B
CANADA1	239	03/30/78	NODC	01UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/11/78	05/15/78	/NA/	06/12/78	4
				02UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/12/78	05/15/78	/NA/	06/12/78	4
				03UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	05/16/78	/NA/	06/12/78	4
				01UC76	04/17/78	04/17/78	05/08/78	05/08/78	06/09/78	06/09/78	/NA/	06/12/78	4,1D
				02UC76	04/17/78	04/17/78	05/08/78	05/08/78	06/09/78	06/09/78	/NA/	06/12/78	4,1D
				03UC76	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	05/16/78	/NA/	06/12/78	4.
				04UC76	04/17/78	04/17/78	05/08/78	05/08/78	06/09/78	06/09/78	/NA/	06/12/78	4,1D
				05UC76	04/17/78	04/17/78	05/08/78	05/08/78	06/09/78	06/09/78	/NA/	06/12/78	4,1D

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/30/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

ENDNOTES:

1. A. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (12/12/77), RETURNED TO RU 527 (01/10/78).
   B. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (03/16/78), RETURNED TO RU 527 (06/26/78).
   C. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (04/26/78).
   D. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (05/18/78), RETURNED TO RU 527 (06/08/78).
   E. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (06/06/78), RETURNED TO RU 527 (06/26/78).
   F. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (06/27/78).

2. TAPE WAS UNREADABLE, SENT BACK TO PI TO BE RE-GENERATED (08/31/77), RETURNED TO RU 527 (10/21/77).

3. A. UNAUTHORIZED LIGHT LEVEL AND WEATHER CODES USED BY PI, THESE WILL NOT BE INCLUDED IN SUBMISSION TO NODC.
   B. UNAUTHORIZED DISTANCE TO BIRDS ENTRY REPLACED BY OUTSIDE ZONE CODE FOR SUBMISSION TO NODC.

4. TAPE RETURNED TO PI BECAUSE SEVEN OF THE EIGHT EXPECTED FIELD OPS. COULD NOT BE FOUND (01/03/78).
   NEW TAPE WITH EIGHT FIELD OPS. RECEIVED (03/30/78).

5. FIELD OP. FW6186 IS A CONTINUATION OF FIELD OP. FW6086 BECAUSE FW6086 NEEDED MORE THAN 999 STATIONS.

6. ONE OF FIRST FIELD OPS. CONVERTED (02/23/78). FWS AND NODC FORMATS SENT TO PI FOR REVIEW.

7. DATA FOR THIS FIELD OP. RECODED BY ORIGINATOR IN NODC FORMAT AND RECEIVED ON TAPE ALASKA 15.

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/30/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

SUMMARY:

TOTAL FIELD OPS. RECEIVED BY RU 527	118
CODEPULLS MAILED TO INVESTIGATOR	113
LOGLISTS MAILED TO INVESTIGATOR	113
CODEPULLS RETURNED TO RU 527	111
LOGLISTS RETURNED TO RU 527	111
TOTAL FIELD OPS. BEING EDITED AT RU 527	56
FIELD OPS. WHICH PASSED FINAL CHECK	55
FIELD OPS. CONVERTED TO NODC	2
FIELD OPS. MAILED TO NODC	30

OCSEAP DATA VALIDATION PROCEDURES
For File Type 033
(Release 4: June 30, 1978)

In order to provide data validation for the File Type 033 data from the OCSEAP Project, four areas need consideration. These include card type validation, data range and relational parameter checking, and format, code, or unit conversion. Since this is a multi-card type file, the card type designation must first be verified (an incorrect value would lead to the improper interpretation of remaining fields on that card), along with the occurrence and sequencing of card types. Second, codes used in each code field (ex. - a two digit weather code) must be compared against all valid codes for that field for verification. Next, range checks must be carried out on all appropriate fields (ex. - sea surface temperature should be between certain upper and lower limits), and relational checks on interrelated fields (ex. - wet bulb temperature readings should be less than or equal to corresponding dry bulb temperature readings). Lastly, if the data are not coded in NODC format, the necessary format changes must be carried out.

Card type designation and sequencing, and valid code field contents are checked in a program called CODEPULL. First the card type is verified. This must be between one and five, and certain other fields are also checked for further verification (ex. - a type five card must have a taxonomic code and a sequence number). Extra cards and missing cards are detected with the sequencing routine. This checks that the cards are in order, that each station has a unique one card followed by a unique two card, and that there are no duplicated or skipped sequence numbers. Then the appropriate code tables are called, and each code of each code field is compared with the appropriate table containing all valid codes for that field.

The output from CODEPULL is a listing of the file in order by station number. Any errors detected are flagged by a brief descriptive message, including a record count for ease in correcting, and, in the case of a bad code, a string of asterisks under the field. Following the file listing is a summary of all the codes used for each code field and their definitions. For a bad code, the record in which it appeared replaces the definition. Figure 1 is a list of the code groups checked and Figure 2 is a portion of a CODEPULL listing.

Data range and relatonal checking are done in a program called LOGLIST. This verifies the data coded as raw numbers, rather than as codes. The contents of the data fields are first checked for numerics, signs, and leading zeros and then compared to upper and lower limits appropriate to each field. In some cases the value of one field is dependent on the value of another field and these relational checks are also made.

LOGLIST prints a columnar listing for each card type. The columns are identified by a three character field code defined prior to the data listing. The record number is listed on the left and any errors detected are flagged in the diagnostics section on the right. A totally blank field is indicated by a row of dots and embedded blanks by an asterisk. Figure 3 is a list of the limit and relational checks made and Figure 4 is a portion of a LOGLIST listing.

These outputs are sent to the Principal Investigator for correcting. He checks the diagnostic messages and the data and marks any necessary corrections directly on the listing. These are returned to us and the updates made to the file with an interactive program called EDITLOG. Then CODEPULL and LOGLIST are rerun for final verification.

Finally the data are converted to NODC format (if they were coded in another format) and submitted to NODC. Format conversion is done with a program called CONVPROG. Many different operations are carried out at this point. For example, data fields are moved from one place to another on a given card, or onto a different card; units are converted and rounded or truncated, or converted to codes; and codes are converted to those equivalent codes acceptable to NODC. Figure 5 is a list of the conversion routines carried out.
* Data collected in NODC format is also run through the conversion program. This is necessary in order to standardize certain fields since coding varies between investigators, and includes providing leading zeros or blanks, and checking for signs. Figure 6 is a list of transformation routines required.

All of these programs form part of the MARMAP Information System. Their operation is directed by a Master System Table (MST). The MST has an entry for each field of each card type in a file. This contains all the information needed for processing, including field code, data type, position, upper limit, lower limit, relational checking and conversion routines. The programs therefore are data independent and readily adaptable to any file type.

NOTE: An * denotes a change in this entry since the previous report.

FIGURE 1: CODE GROUPS VALIDATED

	Code Field	FWS Columns	NODC Columns
	CARD TYPE 1		
	Platform Type	67-68	69
	Ship Activity	70	71
	Sampling Technique	69	70
	Collection Code	-	72
	Zone Scheme	-	73
	Angle of View	-	74
	Observation Conditions	-	75
	Speed Type	60	-
	O.B.S. Region	28-30	-
	Observer Location	74	-
	CARD TYPE 2		
	Wind Direction	-	45-46
	Swell Direction	-	50-51
	Sea State	-	49
	Weather	16-17	55-56
	Cloud Type	-	57
	Cloud Amount	-	58
	Water Color	-	59
	Visibility	18	61
	Sun Direction	-	62
	Glare Intensity	61	63
	Glare Area	62	64
	Moon Phase	-	68
	Tide Height	-	69
	Debris	-	80
	Observation Conditions	19	-
	Turbidity	-	63
	CARD TYPE 3		
*	Ice Cover	16,23,35	16,22,51
	Ice Pattern/Description	17,24	32
	Ice Type	18,25	17,23
*	Ice Form	19,26,34	18,24,50
	Ice Relief	20,27	19,25
	Ice Thickness	21,28	20,26
	Ice Melting Stage	22,29	21,27
	Open Water Type	30	28
	Ice Direction	31,36	29,33
*	Distance	32,37	30,34
*	Lead/Polyna Width	33,39,40	31,43,44
*	Ship in Lead/Polyna Location	38	42
	Collection Code	41,42,43	35,36,37
	Mammal Trace	44,45	38,39
	Pond Size	-	49
*	Ice Pattern	-	40,41

Code Field	FWS Columns	NODC Columns
CARD TYPE 4		
No Code Groups Appear Here.		
CARD TYPE 5		
Age Class	50	32
Sex	51	33
Color Phase	52	34
Plumage	53	35
Molt	54	36
Counting Method	-	42
Reliability	-	43
Distance Measurement Type	-	44
Association Type	55-56	50
Behavior	46-47	56-57
Special Marks	62	58
Bird Condition	63	59
Food Source Association	-	60
Debris	74	71
Oil	-	72
Habitat	-	76,77
Substrate Type	-	81
Cover Code	-	82
Outside Zone	-	83
Text Flag	77	-

NOTE: An * denotes a change to this entry since the previous report.

FIGURE 2: SAMPLE CODEPULL LISTING

CODEPULL consists of two major sections.

Figure 2A is a page from the first section showing how the file is listed. It is sorted by Station, Card Type and Sequence Number and has dotted lines dividing the stations. The errors flagged are "Bad Card Type" because the card type 4 has no sequence number; "Bad Sequence Number" because the sequence number field is not numeric; and "Bad Code" because the code entered is invalid.

Figure 2B is a portion of the second section. This first gives a summary of the number of each type of record found in the file, then a list of the codes used and their definitions. For an invalid code the definition is replaced by the record number in which it appeared. This can be seen for the Weather Code on card type 2.

***** CODEPULL *****

Figure 2A

FOR CRUISE FW7032

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

*** CODEPULL - CRUISE FW7032

```
------------------------------------------------------------------------------------------------------------------------------
                            033FW70321 1073595250N1492600W7705232105                 10+09 1119  6      4        30
                            033FW70322 1073 260                              2      03
RECORD #     3
TYPE 4 #     1  BAD CARD TYPE -->
                            033FW70324 1073 WAY UP BACK SIDE. SEE FIELD NOTES.

RECORD #     4
TYPE 5 #     2  BAD SEQUENCE# -->
                            033FW70324 1073 KIWH ALL 3 VERY GREY BACKS ONE FEMALE WITH NOTCH IN DORSAL HALF
                            033FW70325 1073  91290106              1                                      001  0
                            033FW70325 1073  9128020301            1                                      002  0
                            033FW70325 1073  9129010502            2                                      003  2
                            033FW70325 1073  9218021601     1      1          001                         004  0
                            033FW70325 1073  9218021601     2      4          001                         005  0
------------------------------------------------------------------------------------------------------------------------------
                            033FW70321 1173595130N1492615W7705232115                 10+09 1120  6      4        30
RECORD #    11
TYPE 2 #     2  BAD CODE -->   033FW70322 1173 256   + 81                    2      03
                                                                                    **
                            033FW70325 1173  9129011302            2      10        20                    001  0
                            033FW70325 1173  9128020301            1                20                    002  0
                            033FW70325 1173  9129010301            4      10        20                    003  0
                            033FW70325 1173  91290106              2      10        20                    004  0
------------------------------------------------------------------------------------------------------------------------------
                            033FW70321 1273595000N1492730W7705232125                 10+09 1118  6      4        30
                            033FW70322 1273 256   + 84                       2      03
                            033FW70325 1273  9128020103            1      09        20                    001  0
                            033FW70325 1273  9129010301            8      09        20                    002  0
                            033FW70325 1273  9127070301            3                20                    003  0
                            033FW70325 1273  9109030201            2                61                    004  0
                            033FW70325 1273  91290106              2                20                    005  0
------------------------------------------------------------------------------------------------------------------------------
                            033FW70321 1373594800N1492715W7705232135                 10+09 1118  6      3        30
RECORD #    24
TYPE 2 #     4  BAD CODE -->   033FW70322 1373 265                           3      03
                                                                                    **
                            033FW70325 1373  9128020103            4      09        20                    001  0
                            033FW70325 1373  9129011401            2      09        20                    002  0
                            033FW70325 1373  9129011302            2                03                    003  0
                            033FW70325 1373  91290103              3      10        20                    004  0
                            033FW70325 1373  9129010601            2                03                    005  0
------------------------------------------------------------------------------------------------------------------------------
                            033FW70321 1473594600N1492715W7705232145                 10+09 1118  6      3        30
                            033FW70322 1473 220                              3      03
                            033FW70325 1473  9129011401            1                20                    001  0
                            033FW70325 1473  9128020301            1                20                    002  0
                            033FW70325 1473  912901                5                20                    003  0
                            033FW70325 1473  9128020103            1                20                    004  0
                            033FW70325 1473  91290103              2                20                    005  0
------------------------------------------------------------------------------------------------------------------------------
                            033FW70321 1573594430N1492715W7705232155                 10+09 1118  6      3        30
                            033FW70322 1573  91   + 78                       3      03
                            033FW70325 1573  9129011401            5      09        20                    001  0
                            033FW70325 1573  9129011401            9                01                    002  0
                            033FW70325 1573  9218022001            1                                      003  2
                            033FW70325 1573  9128020103            1                20                    004  0
                            033FW70325 1573  9129011302            2      09        20                    005  0
```

Figure 2B

***** SUMMARY *****

FOR CRUISE FW7032

2219 TOTAL RECORDS

277 TYPE 1 RECORDS
277 TYPE 2 RECORDS
0 TYPE 3 RECORDS
6 TYPE 4 RECORDS
1659 TYPE 5 RECORDS

0 RECORDS WITH AN INVALID TYPE

RECORD TYPE 1

CODE FIELD: PLATFORM TYPE - NODC(1:69)

CODES	COMMENT
BLANK	-

CODE FIELD: SAMPLING TECHNIQUE - NODC(1:70) - FWS(1:69)

CODES	COMMENT
BLANK	-

CODE FIELD: SHIP ACTIVITY - NODC(1:71)

CODES	COMMENT
BLANK	-

CODE FIELD: COLLECTION CODE (PHOTOS TAKEN) - NODC(1:72)

CODES	COMMENT
BLANK	-

CODE FIELD: ZONE SCHEME (TRANSECT WIDTH) - NODC(1:73)

CODES	COMMENT
BLANK	-

CODE FIELD: ANGLE OF VIEW - NODC(1:74)

CODES	COMMENT
BLANK	-

CODE FIELD: OBSERVATION CONDITIONS - NODC(1:75)

CODES	COMMENT
4	AVERAGE
3	POOR
2	MARGINAL
7	EXCELLENT
6	GOOD
5	FINE
BLANK	-

Figure 2B (cont.)

RECORD TYPE 2

CODE FIELD: WIND & SWELL DIRECTION - NODC(2:45-46)(2:50-51)

CODES	COMMENT
BLANK	-
31	305-314 DEG.
14	135-144 DEG.

CODE FIELD: SEA STATE - NODC(2:49)

CODES	COMMENT
2	SMOOTH-WAVELET
3	SLIGHT
4	MODERATE
1	CALM-RIPPLED
0	CALM-GLASSY
BLANK	-

CODE FIELD: WIND & SWELL DIRECTION - NODC(2:45-46)(2:50-51)

CODES	COMMENT
BLANK	-

CODE FIELD: WEATHER - NODC(2:55-56) - FWS(2:16-17)

CODES	COMMENT
03	CLOUDS GENERALLY FORMING OR DEVELOPING
0	*** 000011 000024 000045 000051 000690 000721
68	RAIN OR DRIZZLE AND SNOW, SLIGHT
00	CLOUD DEVELOPMENT NOT OBSERVED OR NOT OBSERVABLE
71	CONTINUOUS FALL OF SNOW FLAKES, SLIGHT
61	RAIN, NOT FREEZING, CONTINUOUS, SLIGHT
41	FOG OR ICE FOG IN PATCHES
43	FOG OR ICE FOG, SKY INVISIBLE, THINNING DURING LAST HOUR

CODE FIELD: CLOUD TYPE - NODC(2:57)

CODES	COMMENT
BLANK	-
3	ALTOCUMULUS

CODE FIELD: CLOUD AMOUNT - NODC(2:58)

CODES	COMMENT
BLANK	-

CODE FIELD: WATER COLOR - NODC(2:59)

CODES	COMMENT
BLANK	-

CODE FIELD: VISIBILITY - NODC(2:61) - FWS(2:18)

CODES	COMMENT
BLANK	-

CODE FIELD: COMPASS DIRECTION (SUN) - NODC(2:62)

CODES	COMMENT
BLANK	-

CODE FIELD: GLARE INTENSITY - NODC(2:63) - FWS(2:61)

CODES	COMMENT
BLANK	-

CODE FIELD: GLARE AREA - NODC(2:64) - FWS(2:62)

CODES	COMMENT
BLANK	-

FIGURE 3: LIMITS AND RELATIONAL CHECKS

Field	Format	Ranges		Relations
ALL CARD TYPES				
File Type		-		Must be 033
File ID		-		Must match that of first record on file
* Unused Columns		-		Must be blank
CARD TYPE 1				
Start/End Latitude	F	40-70	degrees	-
		0-599	minutes/tenths	
	N	40-70	degrees	-
		0-59	minutes	
		0-59	seconds	
		N	hemisphere	
Start/End Longitude	F	120-180	degrees	-
		0-599	minutes/tenths	
		W	hemisphere	
	N	120-180	degrees	-
		0-59	minutes	
		0-59	seconds	
		W	hemisphere	
Date		1-31	days	-
		1-12	months	
Time		0-23	hours	-
		1-59	minutes	
Elapsed time		0-30	minutes	-
Ships heading	F	0-359	degrees	-
	N	0-35	degrees/tens	
Ships speed	F	0-15	knots	When platform is ship
		> 5	knots	When transect type is 71
CARD TYPE 2				
Wind Direction	F	0-360	degrees	(NODC uses a code)
Wind Speed		0-50	knots	-
Swell Height		0-25	feet	-

Field	Format	Ranges	Relations
Sea Surface Temp		-2°C to +10°C	Check signs & numerics
Wet/Dry Bulb Temperature		-10°C to +70°C	Wet bulb <= Dry bulb Check signs & numerics
* Barometric Pressure		.9600-1.0300 bars	-
Barometric Trend		+, -, 0, or blank	Must be blank when Baro Pressure is blank
Salinity		20 o/oo to 34 o/oo	-
Thermocline Depth		0-100 meters	-

CARD TYPE 3

Field	Format	Ranges	Relations
Excess Sediment	F	-	Must be blank
Ice Algae	F	-	Must be blank
Other Features	F	-	Must be blank

CARD TYPE 4

No processing required

CARD TYPE 5

Field	Format	Ranges	Relations
Taxonomic Code		88-92 class	-
Direction of Flight	F N	1-12 o'clock 0-35 degrees/tens	-
Begin/End Zone	F	0-30 0-60	When transect 71 or 78 When transect 70 or 77 (unless BZN coded 97-99) Begin must be < End zone
Number of Individuals		-	Must be numeric

NOTES:

In the format field, F=FWS, N=NODC, and Blank=Both formats.
An * denotes a change to this entry since the previous report.

FIGURE 4: SAMPLE LOGLIST LISTING

LOGLIST lists the data for each card type individually in columnar form. Fields in each record are keyed by acronym codes.

Figure 4A shows the header page and the list of acronym definitions.

Figure 4B is a page from the data listing of card type 1. Blank data fields are depicted by a series of dots as in the LTD and LNG fields, while leading or embedded blanks appear as asterisks as in the SPD and HGT fields. Here the HED field is flagged as "outside" because it should be between 00 and 35 degrees.

Figure 4A

***** LOGLIST *****

FOR CRUISE FW7032

CALL FILE ********

CARD TYPE 1

THE MARMAP INFORMATION SYSTEM   OCSEAP -- GULF OF ALASKA PROJECT

Figure 4A (cont.)

*** LOGLIST - CRUISE FW7032 - CALL FILE ******** - CARD TYPE 1

ACRONYM DEFINITIONS

STA	STATION
LAT	START LATITUDE
LON	START LONGITUDE
DEG	DEGREES (SUBFIELD OF LON)
DAT	DATE - YYMMDD
DAY	DAY (SUBFIELD OF DAT)
MON	MONTH (SUBFIELD OF DAT)
TIM	TIME - HHMM
HOR	HOUR (SUBFIELD OF TIM)
MIN	MINUTES (SUBFIELD OF TIM)
LTD	END LATITUDE
LNG	END LONGITUDE
ELT	ELAPSED TIME
TZS	TIME ZONE SIGN
TZN	TIME ZONE NUMBER
SPD	SPEED MADE GOOD
HED	COURSE MADE GOOD
HGT	HEIGHT OF OBS. EYES (ABOVE SEA)
PLT	PLATFORM TYPE
SMP	SAMPLING TECHNIQUE
ACT	SHIP ACTIVITY
PHO	PHOTOS TAKEN
TRW	TRANSECT WIDTH
ANG	ANGLE OF VIEW
OBC	OBSERVATION CONDITIONS
DIS	DISTANCE MADE GOOD

ACRONYM DEFINITIONS

WTP	WATCH TYPE
TRN	TRANSECT WIDTH

SPECIAL CHARACTERS

-	INDICATES A CODE FIELD
*	INDICATES A BLANK CHARACTER IN A FIELD
.	INDICATES A TOTALLY BLANK FIELD
/	FIELD IS LISTED IN THE DIAGNOSTICS IF NON-BLANK (DATA WOULD OTHERWISE NOT FIT ON ONE LINE)

Figure 4B

*** LOGLIST - CFLISE FW7022 - CALL FILE ******** - CARD TYPE 1

	STA	LAT	LON	DAT	TIM	LTD	LNG	ELT	TZS	TZN	SPD	HED	HGT	PLT	SMP	ACT	PHO	TPW	ANG	OBC	DIS	WTP	TRN	DIAGNOSTICS
52	*7279	565358N	1523630W	770528	1950	....	....	10	+	09	**9	36	**8	.	.	.	.	.	.	6	....	.	*30	* HED FIELD OUTSIDE *
53	*7379	565408N	1523518W	770528	2000	....	....	10	+	09	**9	36	**8	.	.	.	.	.	.	6	....	.	*30	* HED FIELD OUTSIDE *
54	*7478	565537N	1523458W	770528	2010	....	....	10	+	09	**9	36	**8	.	.	.	.	.	.	7	....	.	*30	* HED FIELD OUTSIDE *
55	*7578	565712N	1523446W	770528	2020	....	....	10	+	09	**9	35	**8	.	.	.	.	.	.	7	....	.	*30	
56	*7679	565650N	1523508W	770528	2030	....	....	10	+	09	**9	35	**8	.	.	.	.	.	.	7	....	.	*30	
57	*7779	570022N	1523530W	770528	2040	....	....	10	+	09	**9	35	**8	.	.	.	.	.	.	7	....	.	*30	
58	*7878	570155N	1523554W	770528	2050	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	7	....	.	*30	
59	*7978	570308N	1523712W	770528	2100	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	7	....	.	*30	
60	*8079	570416N	1523823W	770528	2110	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	4	....	.	*30	
61	*8178	570548N	1523948W	770528	2120	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	4	....	.	*30	
62	*8279	570706N	1524106W	770528	2130	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	4	....	.	*30	
63	*8378	570830N	1524236W	770528	2140	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	4	....	.	*30	
64	*8479	571000N	1524044W	770528	2150	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	5	....	.	*30	
65	*8578	571116N	1524524W	770528	2200	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	5	....	.	*30	
66	*8678	571242N	1524648W	770528	2210	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	5	....	.	*30	
67	*8777	571707N	1525048W	770529	0400	....	....	20	+	09	**0	..	**4	.	.	.	.	.	.	7	....	.	*60	
68	*8873	571448N	1525027W	770529	1737	....	....	10	+	09	*10	18	**4	.	.	.	.	.	.	5	....	.	*30	
69	*8973	571310N	1525025W	770529	1747	....	....	10	+	09	*10	18	**4	.	.	.	.	.	.	5	....	.	*30	
70	*9073	571124N	1525028W	770529	1757	....	....	10	+	09	*10	18	**4	.	.	.	.	.	.	5	....	.	*30	
71	*9179	570942N	1525030W	770529	1807	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
72	*9278	570757N	1525100W	770529	1817	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
73	*9378	570612N	1525200W	770529	1827	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
74	*9479	570315N	1525250W	770529	1837	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
75	*9578	570255N	1525326W	770529	1847	....	....	10	+	09	*10	19	...	.	.	.	.	.	.	5	....	.	*30	
76	*9678	570114N	1525345W	770529	1857	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
77	*9779	565925N	1525345W	770529	1907	....	....	10	+	09	*10	18	**4	.	.	.	.	.	.	5	....	.	*30	

FIGURE 5: FWS - NODC CONVERSION ROUTINES

Field	FWS Cols	NODC Cols	Special Processing
CARD TYPE 1			
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Start Latitude	16-20	16-22	Degrees, minutes and tenths convert to degrees, minutes, seconds. Add hemisphere "N".
Start Longitude	21-27	23-30	Degrees, minutes, tenths convert to degs, mins, secs.
OBS Region	28-30	-	No NODC counterpart.
Date	31-34	31-36	Add year and convert from day and month to YYMMDD.
Time	35-38	37-40	-
End Latitude	39-43	41-47	Same as Start Lat above.
End Longitude	44-50	48-55	Same as Start Long above.
Elapsed Time	51-52	56-57	-
Time Zone Sign	53	58	-
Time Zone Number	54-55	59-60	-
Ships Speed	56-59	61-65	Round tenths to whole knots.
* Speed Type	60	-	No NODC counterpart.
Course Heading	61-63	64-65	Round whole degrees to tens of degrees.
Height of Eyes	64-66	66-68	Convert feet to meters (multiply by 0.3048, round).
Platform Type	67-68	69	Convert FWS to NODC code.
Sampling Technique	69	70	-
Ship Activity	70	71	convert FWS to NODC code.
* Photos Taken	71	-	No NODC counterpart.
OBS Number	72-73	-	No NODC counterpart.
OBS Location	74	-	No NODC counterpart.
Observation Cond	-	75	Move from col 19 of FWS card type 2.
Distance	-	76-79	No FWS counterpart.
Watch Type	-	80	No FWS counterpart.
Transect Width	-	83	No FWS counterpart.
(Blanks)	75-80	-	-

Field	FWS Cols	NODC Cols	Special Processing
CARD TYPE 2			
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Weather	16-17	55-56	-
Cloud Type	-	57	No FWS counterpart.
Cloud Amount	-	58	No FWS counterpart.
Water Color	-	59-60	No FWS counterpart.
Visibility	18	61	-
Observation Cond	19	-	Move to col 75 of NODC card type 1.
Wind Direction	20-22	45-46	Convert FWS degrees to NODC code (divide by 10, truncate, and add 1).
Wind Speed	23-24	47-48	-
Wave Ht/Sea State	25-26	49	Convert feet to NODC code.
Swell Direction	-	50-51	No FWS counterpart.
Swell Height	27-28	52-54	Convert feet to tenths of meters (multiply by 3.048 then round).
Sea Surface Temp	29-32	23-26	Move sign adjacent to first significant digit (remove embedded zeros or blanks).
XBT Temp	33-36	-	No NODC counterpart.
Wet Bulb Temp	37-40	34-37	Same as Sea Surf Temp above.
Dry Bulb Temp	41-44	30-33	Same as Sea Surf Temp above.
Relative Humidity	-	38-39	No FWS counterpart.
Barometric Pressure	45-49	40-43	Truncate left digit.
Barometric Trend	50	44	-
Bottom Depth	51-54	16-19	Convert fathoms to meters (multiply by 1.829, round).
Surface Salinity	55-57	27-29	-
Thermocline Depth	58-60	20-22	-
Sun Direction	-	62	No FWS counterpart.
Glare Intensity	61	63	-
Glare Area	62	64	-
Turbidity Code	63	-	No NODC counterpart.

Field	FWS Cols	NODC Cols	Special Processing
Light Level	-	65-67	No FWS counterpart.
Moon Phase	-	68	No FWS counterpart.
Tide Height	-	69	No FWS counterpart.
Tide Rise/Fall	-	70	No FWS counterpart.
Distance to Shore	-	71-74	No FWS counterpart.
Distance to Shelf	-	75-77	No FWS counterpart.
SECCHI Depth	-	78-79	No FWS counterpart.
Debris Code	-	80	No FWS counterpart.
(Blanks)	64-80	81-83	-

CARD TYPE 3

Field	FWS Cols	NODC Cols	Special Processing
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Ice In Transect			
Cover	16	16	-
* Pattern	17	40	Code groups nct convertible.
Type	18	17	-
Form	19	18	-
Relief	20	19	-
Thick	21	20	-
Melt	22	21	-
Ice Outside Transect			
Cover	23	22	-
* Pattern	24	41	Code groups nct convertible.
Type	25	23	-
Form	26	24	-
Relief	27	25	-
Thick	28	26	-
Melt	29	27	-
Open Water			
Type	30	28	-
Direction	31	29	-
Distance	32	30	-
Lead/Polyna Wd	33	31	-
Visible Ice			
* Form	34	50	-
* Cover	35	51	-
Description	-	32	No FWS counterpart.
Direction	36	33	Code groups nct convertible.
Distance	37	34	Code groups nct convertible.

	Field	FWS Cols	NODC Cols	Special Processing
	Ship in Lead/Polyna			
*	Location	38	42	-
*	Width	39	43	-
*	Distance	40	44	-
	Miscellaneous			
	Arctic Cod	41	35	Convert FWS to NODC code.
	Excess Sediment	42	36	Code groups not convertible.
	Ice Algae	43	37	Code groups not convertible.
	Mammal Trace	44	38	-
	Other Features	45	39	Code groups not convertible.
	Ice Not Coverable	46	-	No NODC counterpart.
*	Time of Ice Cond	-	45-46	No FWS counterpart.
	Water/Land Percent	-	47-48	No FWS counterpart.
	Pond Size	-	49	No FWS counterpart.
	(Blanks)	47-80	52-77	-
*	Sequence Number	-	78-80	No FWS counterpart.
	(Blanks)	-	81-83	-

CARD TYPE 4

Field	FWS Cols	NODC Cols	Special Processing
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Text	16-77	16-77	-
Sequence Number	78-80	78-80	-
(Blanks)	-	81-83	-

CARD TYPE 5

Field	FWS Cols	NODC Cols	Special Processing
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Species Name	16-19	-	No NODC counterpart.
Taxonomic Code	20-29	18-27	Blank out trailing zero doublets.
Sub Species	30-31	28-29	-
Species Group	32-33	30-31	-
No of Individuals	34-38	37-41	-

Field	FWS Cols	NODC Cols	Special Processing
Counting Method	-	42	No FWS counterpart.
Reliability	-	43	No FWS counterpart.
Dist Measure Type	-	44	No FWS counterpart.
Distance to Birds	-	45-47	No FWS counterpart.
Begin/Outside Zone	39-40	83	Convert to Outside Zone only when coded 97-99.
End Zone	41-42	-	No NODC counterpart.
Time into Transect	43-45	16-27	Round minutes and tenths to whole minutes.
Behavior	46-47	56-57	-
Flight Direction	48-49	48-49	Convert from clock position relative to ship to compass direction in tens of degrees (multiply by 30, add rounded heading from card type 1).
Age	50	32	-
Sex	51	33	-
Color	52	34	-
Plumage	53	35	-
Molt	54	36	-
Association Type	55-56	50	Convert FWS to NODC code.
Multi-Species Link	57-59	51-53	-
No of Species	60-61	54-55	-
Special Marks	62	58	-
Bird Condition	63	59	-
Food Source	-	60	No FWS counterpart.
Tax Code for Food	64-73	61-70	Same as Tax Code above.
Debris	74	71	-
Oil	-	72	No FWS counterpart.
Dist from Breed Colony	-	73-75	No FWS counterpart.
Habitat	-	76-77	No FWS counterpart.
OBS Observer No	75-76	-	No NODC counterpart.
Text Flag Code	77	-	No NODC counterpart.
Sequence Number	78-80	78-80	-
Substrata	-	81	No FWS counterpart.
Cover	-	82	No FWS counterpart.

The following fields will have Leading Zeros
or Leading Blanks inserted as necessary.

Leading Zeros	Leading Blanks
Station Number	Ships Speed
Start Latitude	Height of Eyes
Start Longitude	Wind Speed
End Latitude	Sea Surface Temp
End Longitude	Wet Bulb Temp
Date and Time	Dry Bulb Temp
Course Heading	Bottom Depth
Multi-Species Link	No of Individuals
Flight Direction	
Sequence Number	

NOTE: An * denotes a change to this entry since the previous report.

* FIGURE 6: NODC TRANSFORMATION ROUTINES

Field	Card:Cols	Processing
Sea Surface Temp	2:23-26	Move sign adjacent to first significant digit (remove embedded zeros or blanks).
Dry Bulb Temperature	2:30-33	Same as Sea Surf Temp above.
Wet Bulb Temperature	2:34-37	Same as Sea Surf Temp above.
Flight Direction	5:48-49	Compass reading of 36 replaced by 00 degrees.
Taxonomic Code	5:18-27	Blank out trailing zero doublets.
Tax Code for Food	5:61-70	Same as Tax Code above.

The following fields will have Leading Zeros or Leading Blanks inserted as necessary.

Leading Zeros	Leading Blanks
Station Number	Ships Speed
Start Latitude	Height of Eyes
Start Longitude	Wind Speed
End Latitude	Sea Surface Temp
End Longitude	Wet Bulb Temp
Date and Time	Dry Bulb Temp
Course Heading	Bottom Depth
Multi-Species Link	No of Individuals
Flight Direction	Transect Width
Sequence Number	

NOTE: An * denotes a change to this entry since the previous report.

QUARTERLY REPORT

Contract: 03-5-022-56
Research Unit: #529-77
Task Order: 33
Reporting Period: 4/1/78-6/30/78
Number of Pages: 15

SEDIMENT CHARACTERISTICS, STABILITY, AND ORIGIN OF THE BARRIER ISLAND-LAGOON COMPLEX, NORTH ARCTIC ALASKA

A. S. Naidu
Principal Investigator
Assistant Professor in Marine Science

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

30 June 1978

TABLE OF CONTENTS

LIST OF TABLES

I. TASK OBJECTIVES

The primary objective of this program is to collect all basic data on the size distribution, mineralogy, and certain biologically "critical" chemical attributes of sediments of the barrier island-lagoon complex of north arctic Alaska. In addition, research is being directed to assess the long-term directions and net volumes of alongshore transport of sandy sediments, as well as the stability and origin of the barrier island along the Beaufort Sea coast. The other objective of this program is to collect lithological and chemical baseline data from the contiguous area of the continental shelf of the Beaufort Sea. The chief purpose of this latter effort will be to fill in the small data gaps that exist on shelf sediments, principally between Barter Island and Demarcation Point.

II. LABORATORY ACTIVITIES

Laboratory work since March 30, 1978 has included analysis of iron and phosphorus concentrations in Simpson Lagoon sediment extracts and zinc, nickel, cobalt and chromium total abundances in nearshore Beaufort Sea sediments. Carbonate and organic carbon percentages as well as statistical grain size parameters were obtained for continental shelf and continental slope sediments retrieved in August, 1977 from the Beaufort Sea (GLA-77). Finally, clay mineral compositions of the less than 2 μm fractions of these same 1977 Beaufort Sea sediment samples (GLA-77) and of the Canning, Shaviovik, and Ugnuravik Rivers have been quantified.

Heavy minerals have been separated in bromoform from three size grades of sands (e.g., coarse, medium, and fine) of the Colville, Sagavanirktok, and Kuparuk Rivers. Characterization of heavy mineral separates has yet to be made.

Analytical Methods

Grain size distributions of the sediments were analyzed by the usual sievingpipetting method, and the conventional grain size parameters were computed after the formulae given by Folk and Ward (1957). Computation of the parameters was accomplished through the use of the University of Washington (Seattle) SEDAN program:UWMS-1147, with the University of Alaska Honeywell 66/40 computer.

Details on the procedure of clay mineral analysis have been included in Mowatt *et al.* (1974). Briefly, the clay minerals compositions were determined by X-ray diffraction on the <2 μm fraction of sediments, and the method outlined by Biscaye (1965) was followed to quantify the various minerals.

For chemical analysis, sediment samples were oven-dried at 90°C. One split of the dried sample was finely pulverized and the other coarsely ground for the purpose of total (refer to Naidu and Hood, 1971) and extractable elemental analyses, respectively.

The chemical extraction procedure used on the coarse splits was the acetic acid-hydroxylamine hydrochloride method (Chester and Hughes, 1967). In the Simpson Lagoon sediment extracts, phosphorus was analyzed using the molybdate-blue method (Strickland and Parsons, 1965), while heavy metal concentrations in the Simpson Lagoon sediment extracts and the nearshore Beaufort Sea total sediment digestions were determined using the Perkin-Elmer Model 603 atomic absorption spectrophotometer.

Portions of the fine-ground gross sediment powders were taken for analysis of carbonate and total carbon contents. Organic carbon was calculated from the difference between total carbon and carbonate carbon.

The total carbon was analyzed in a LECO, TC-12 automatic carbon determinator, whereas the carbonate carbon was determined manometrically (Hülsemann, 1969).

III. RESULTS

Table I lists the iron and phosphorus concentrations in the acetic acid-hydroxylamine hydrochloride extracts from the 1977 Simpson Lagoon sediment samples. Included in Table II are the zinc, nickel, cobalt, and chromium concentrations in the total digestions of nearshore north Alaskan sediments.

In Simpson Lagoon iron values range from 600 to 6900 µg/g with the lower concentrations generally associated with coarser-grained sediments. No areal relationships have as yet been found for the phosphorus results. Likewise, interpretation of Table II data is not completed at the present time.

Table III lists the carbonate and organic carbon data from the sediment samples collected on the U.S.C.G.S. *Glacier* cruise in 1977. Carbonate contributions to the total sediment range from 1.7 to 10.0 percent by weight. In general, higher carbonate percentages occur nearshore in the relatively shallow water. Organic carbon values range from 0.2 to 1.3 percent by weight of the total sediment. No clear regional distributional trend is seen for the organic carbon contents.

Table IV shows the grain size parameters of the Beaufort Sea continental shelf and slope sediments collected on the 1977 *Glacier* cruise. Not surprisingly, much finer textured sediments are found in deeper waters.

Table V lists the weighted peak area percentages of the <2 µm fractions (clay minerals) of sediments collected from the 1977 *Glacier* cruise, and

TABLE I

IRON AND PHOSPHORUS CONCENTRATIONS (μg/g) IN ACETIC ACID-HYDROXYLAMINE HYDROCHLORIDE EXTRACTS (CHESTER AND HUGHES, 1967) OF SIMPSON LAGOON SEDIMENTS COLLECTED IN SUMMER 1977.

Refer to Naidu, 1978 for Station Locations

Sample No.	Iron	Phosphorus	% Sand
SL877-1	1100	465	87
SL877-2	1400	232	96
SL877-3	3400	454	40
SL877-4	6000	664	22
SL877-5	2500	406	47
SL877-6	2700	376	34
SL877-8	1200	487	75
SL877-9	3100	387	28
SL877-11	2700	532	18
SL877-13	4100	487	8
SL877-14	3300	461	41
SL877-15	1800	399	79
SL877-17	1600	410	71
SL877-18	3200	520	60
SL877-19	1500	382	72
SL877-21	4300	465	19
SL877-22	4200	387	12
SL877-24	1100	454	77
SL877-25	2700	410	68
SL877-27	3400	476	22
SL877-28	6900	941	16
SL877-29	3500	476	25
SL877-30	800	299	80
SL877-31	3400	487	12
SL877-32	2400	299	30
SL877-33	2400	343	54
SL877-37	2900	476	41
SL877-38	2700	387	29
SL877-40	600	200	77

TABLE II

CONCENTRATIONS OF ZINC, NICKEL, COBALT AND CHROMIUM IN GROSS SEDIMENTS FROM THE CONTINENTAL MARGIN OF THE BEAUFORT SEA.

Refer to Naidu, 1976 for Station Locations, Depths, and Other Physical and Chemical Data.

Sample	Zn µg/g	Ni µg/g	Co µg/g	Cr µg/g
HB-1	90	32	20	65
HB-2	85	47	29	100
HB-3	52	21	16	46
HB-4	105	39	22	78
HB-5	74	32	20	59
HB-6	81	29	18	48
HB-7	47	20	18	42
BS70-18	55	32	13	23
BS70-19	37	16	8	20
BS70-21	69	47	21	57
BS70-22	66	43	20	58
BSS-83	72	70	32	112
BSS-84	74	50	28	78
71AER-15	67	38	17	44
72AER-20	43	21	9	25
72AER-22	79	51	20	53
72AER-23	63	38	15	38
72AER-24	55	38	14	37
72AER-25	61	38	14	36
72AER-26	140	84	39	127
72AER-129	83	NA	NA	NA
71AJT-31	94	48	18	53
71AJT-32	43	35	14	30
71AJT-33	82	45	38	108
71AJT-35	90	54	21	56
71AJT-36	70	36	14	30
71AJT-37	107	49	19	45
71AJT-38	69	45	19	43
71AJT-39	106	44	19	49
71AJT-40	109	49	19	49
71AJT-43	100	56	24	58
72AER-29	NA	57	26	NA
71AJT-5	NA	NA	13	30
71AJT-16	NA	NA	20	46
71AJT-20	NA	NA	24	116

TABLE II

CONTINUED

Sample	Zn µg/g	Ni µg/g	Co µg/g	Cr µg/g
72AER-134	92	61	30	77
72AER-137	43	21	NA	NA
72AER-166	73	43	17	47
72AER-167	81	NA	NA	NA
72AER-168	82	51	20	52
71AJT-1	63	50	16	32
71AJT-2	90	61	18	54
71AJT-3	46	43	14	32
71AJT-4	53	35	17	36
71AJT-6	71	53	19	32
71AJT-8	70	42	18	42
71AJT-10	54	35	17	31
71AJT-12	109	53	19	50
71AJT-13	97	107	36	70
71AJT-14	89	133	43	88
71AJT-15	91	66	26	44
71AJT-17	128	160	50	115
71AJT-18	214	62	33	87
71AJT-19	64	90	23	43
71AJT-21	47	38	16	34
71AJT-22	71	108	20	42
71AJT-25	242	70	27	30
71AJT-26	30	29	11	21
71AJT-29	47	35	13	32
71AJT-30	55	36	15	34

TABLE III

CARBONATE AND ORGANIC CARBON WEIGHT PERCENTS OF NORTH ALASKAN CONTINENTAL SHELF AND CONTINENTAL SLOPE SEDIMENTS RETRIEVED IN AUGUST 1977 (BEAUFORT SEA CRUISE OF USCGC *GLACIER*)

For Location of Stations Refer to Naidu, 1978

Sample No.	$CO_3^=$	Organic Carbon	Depth in Meters	% Sand
GLA-77-5	1.77	0.78	3593	6
GLA-77-6	2.48	0.56	3566	0
GLA-77-7	2.97	0.58	3566	0.08
GLA-77-8	4.27	0.6	2048	1.5
GLA-77-9	2.60	NA	640	2.6
GLA-77-10	4.51	0.93	678	1.2
GLA-77-11	3.65	1.06	406	1.9
GLA-77-12	7.32	0.75	22	42
GLA-77-14	6.36	0.71	35	63
GLA-77-15	4.36	0.7	54	22
GLA-77-16	8.05	0.67	118	15
GLA-77-17	4.52	NA	51	22
GLA-77-18	7.08	0.31	80	59
GLA-77-19	6.28	0.76	146	17
GLA-77-20	10.03	0.45	57	61
GLA-77-22	2.18	0.62	32	26
GLA-77-23	3.23	0.83	109	26
GLA-77-24	9.15	0.21	51	46
GLA-77-25	7.69	0.63	38	41
GLA-77-26	5.21	0.84	20	58
GLA-77-27	7.42	0.43	54	56
GLA-77-28	4.36	0.92	101	40
GLA-77-29	5.07	0.63	521	3.4
GLA-77-30	1.22	NA	1829	2.4
GLA-77-31	7.33	NA	28	30
GLA-77-32	8.32	NA	42	50
GLA-77-33	6.82	0.74	66	46
GLA-77-40	5.44	0.96	24	7.2
GLA-77-42	1.94	1.28		13

NA = Not analyzed

TABLE IV

STATISTICAL GRAIN SIZE PARAMETERS (AFTER FOLK & WARD, 1957) OF BEAUFORT SEA CONTINENTAL SHELF AND SLOPE SEDIMENTS

For Location of Stations Refer to Naidu, 1978

Sample No.	% Gravel	% Sand	% Silt	% Clay	Depth in Meters	Median Size Md	Mean Size M_z	Sorting δ_I	Skewness Sk_I	Kurtosis K_G
GLA77-5	0	3.76	30.39	65.85	3593	9.07	8.76	2.84	-0.13	0.92
GLA77-6	0	0	18.12	81.88	3566	9.78	9.85	2.01	0.01	1.00
GLA77-8	0	1.10	23.08	75.82	2048	9.33	9.22	2.02	-0.07	1.38
GLA77-9	0	1.68	26.91	71.41	640	9.24	9.31	2.22	0.03	0.98
GLA77-10	0	0.81	43.39	55.78	678	8.62	8.74	2.63	0.06	0.82
GLA77-11	0	1.15	33.47	65.38	406	9.21	9.14	2.49	-0.05	0.87
GLA77-12	0	33.91	34.99	31.10	22	6.06	6.44	3.49	0.19	0.69
GLA77-14	0	53.07	18.16	28.78	35	2.93	4.80	3.85	0.63	0.72
GLA77-15	0	12.95	22.23	64.82	54	9.33	8.83	3.36	-0.30	1.25
GLA77-16	0	11.22	47.17	41.61	118	7.33	7.53	3.34	0.03	0.89
GLA77-17	0.19	13.71	25.07	61.03	51	8.99	8.34	3.41	-0.26	0.91
GLA77-18	2.67	49.08	17.94	30.31	80	3.31	5.15	3.74	0.62	0.70
GLA77-19	0	11.75	33.19	55.06	146	8.41	8.13	3.50	-0.18	1.01
GLA77-20	3.33	51.42	16.84	28.42	57	2.85	4.01	4.88	0.29	0.70
GLA77-21	0	1.08	34.53	64.39	41	9.43	9.15	2.58	-0.12	0.78
GLA77-22	0	19.69	32.92	47.40	32	7.68	7.24	3.58	-0.14	0.86
GLA77-23	0	18.87	30.65	50.49	109	8.04	7.30	4.11	-0.28	1.13
GLA77-24	10.85	42.49	18.50	28.17	51	3.27	3.70	4.98	0.09	0.68
GLA77-25	3.21	31.40	28.13	37.25	38	6.32	6.52	4.27	-0.02	0.83
GLA77-26	0	51.22	28.38	20.4[illegible]	20	3.83	4.67	3.62	0.36	0.85
GLA77-27	0	44.46	19.93	35.61	54	5.65	5.99	4.13	0.09	0.74
GLA77-28	0	31.15	27.10	41.75	101	7.10	6.85	3.60	-0.03	0.68
GLA77-29	0	2.07	28.51	69.42	521	9.19	9.34	2.27	0.06	0.92
GLA77-30	0	1.76	31.19	67.05	1829	8.86	9.12	1.80	0.23	1.11
GLA77-31	0.50	23.99	41.34	34.17	28	6.49	6.86	3.35	0.16	0.77
GLA77-32	5.86	40.78	21.64	31.73	42	5.07	5.56	4.31	0.11	0.81
GLA77-33	19.25	41.20	17.87	21.67	66	2.53	3.38	4.91	0.24	0.79
GLA77-34	0	1.72	38.66	59.63	1646	8.70	8.80	2.44	0.02	1.01
GLA77-35	0	11.51	36.72	51.78	30	8.16	8.19	3.45	-0.10	1.02

TABLE IV

CONTINUED

Sample No.	% Gravel	% Sand	% Silt	% Clay	Depth in Meters	Median Size Md	Mean Size M_z	Sorting δ_I	Skewness S_{K_I}	Kurtosis K_G
GLA77-40	0	5.20	55.11	39.68	24	7.30	7.74	2.96	0.21	0.71
GLA77-42	0	8.76	38.84	52.40		8.17	8.17	3.11	-0.01	0.78

TABLE V

WEIGHTED PEAK AREA PERCENTAGES (AFTER BISCAYE, 1965) OF CLAY MINERALS IN THE LESS THAN 2 μm FRACTION OF THE BEAUFORT SEA AND SOME NORTH SLOPE RIVER SEDIMENTS

Refer to Naidu, 1978 for Station Locations

Sample No.	Expandable	Illite	Kaolinite	Chlorite
GLA77-5	9	56	17	18
GLA77-6	10	46	21	23
GLA77-7	9	56	16	19
GLA77-8	6	61	14	19
GLA77-10	11	56	13	20
GLA77-14	22	49	15	14
GLA77-15	16	53	15	16
GLA77-16	8	62	14	16
GLA77-18	10	58	13	19
GLA77-19	13	55	13	19
GLA77-20	11	59	12	18
GLA77-22	19	53	12	16
GLA77-24	14	56	13	17
GLA77-25	14	53	15	18
GLA77-26	8	64	11	17
GLA77-27	15	57	13	15
GLA77-28	12	56	12	20
GLA77-30	8	59	15	18
GLA77-32	12	58	13	17
GLA77-33	8	60	13	19
Canning R. (1)	0	79	4	7
Shaviovik R.	tr	66	15	19
Ugnuravik R. (2)	0	66	11	23

tr = trace

three North Slope river sediments. The distinction between the continental shelf sediments and the three river sediments based on the "expandable component" is noteworthy.

Discussion

At this point in time we have not critically analyzed all our data. Data are being plotted in the standard OCSEAP supplied Beaufort Sea map to show regional variations in the distributional patterns of various lithological, mineralogical and chemical parameters of sediments. However, some interesting data have been obtained on clay mineralogy of the Beaufort Sea sediments, which throw light on depositional processes in the Beaufort Sea. It would seem that the continental shelf and slope regions between Barter Island and the Demarcation Point of the Alaskan Beaufort Sea is blanketed by relatively higher concentrations of 'expandable' clay minerals, and that the kaolinite/chlorite ratios in the above region are also relatively high. Considering the clay mineral compositions of all possible terrigenous sources for the Beaufort Sea, it would seem that the clay mineral assemblages in the Barter Island-Demarcation Point area have the major source in the Colville River. However, we are not quite certain whether the surficial muds in the region are contemporary or relict in nature. Relatively strong water currents, moving towards the east, are known to occur in the middle and outer continental shelf of the Alaskan Beaufort Sea in summers. It is, therefore, not unlikely that significant amounts of the fine-grained sediments discharged from the Colville River is presently being caught in this eastward moving water mass and finally deposited in the shelf area of Barter Island-Demarcation Point. Nonetheless, our clay mineral studies suggest that sedimentation in the above shelf region has not been influenced to as large an extent as suspected before by the Mackenzie River clays.

Comments

On Dr. Naidu's request the OCSEAP Office, Boulder, has approved a subcontract to Dr. L. Larsen, University of Washington, Seattle. The subcontract will be funded from the ongoing OCSEAP grant that has been originally awarded to Dr. Naidu (R.U. 529). Arrangements are being made to finally process this subcontract, and get a Sediment Dynamics Sphere microprocessor unit checked and installed, through Dr. Larsen's help, for deployment in the Simpson Lagoon in summer 1978. Thus, steps are being now taken to initiate a comprehensive program to develop our understanding of threshold of sediment movements in the Simpson Lagoon.

REFERENCES

Biscaye, P. E. 1965. Mineralogy and sedimentation of recent deep-sea clay in the Atlantic Ocean and adjacent seas and oceans. *Geol. Soc. America Bull.* 76:803-832.

Chester, R. and M. J. Hughes. 1967. A chemical technique for the separation of ferro-manganese minerals, carbonate minerals and adsorbed trace elements from pelagic sediments. *Chem. Geol.* 2:249-262.

Folk, R. L. and W. C. Ward. 1957. Brazos River bar - a study in the significance of grain size parameters. *J. Sedimentary Petrology.* 27:3-26.

Hülsemann, J. 1966. On the routine analysis of carbonates in unconsolidated sediments. *J. Sedimentary Petrology* 36:622-625.

Mowatt, T. C., A. S. Naidu and N. Veach. 1974. Detailed clay mineralogy of the Colville River and Delta, northern Arctic Alaska: Alaskan Div. of Geol. and Geophys. Survey's Open File Report, Fairbanks. Rept. 45. 36 pp.

Naidu, A. S. 1976. Geologic Studies. *In* H. M. Feder, D. G. Shaw and A. S. Naidu, *The Arctic Coastal Environment of Alaska*, Vol. 1. The nearshore marine environment in Prudhoe Bay, Alaska. Submitted to the Atlantic Richfield Co., Rept. No. R76-3, Inst. Mar. Sci., Univ. Alaska, Fairbanks. pp. 8-36.

Naidu, A. S. 1978. Sediment Characteristics, Stability, and Origin of the Barrier Island-Lagoon Complex, North Arctic Alaska. Annual Report OCSEAP contract #03-5-022-56, Inst. Mar. Sci., Univ. Alaska, Fairbanks. 55 p.

Naidu, A. S. and D. W. Hood. 1972. Chemical composition of bottom sediments of the Beaufort Sea, Arctic Ocean. Proc. 24th Int. Geol. Congress, Montreal, Canada 10:307-317.

trickland, J. D. H. and T. R. Parsons. 1965. A Manual of Sea Water Analysis, 2nd ed. Bull. No. 125. *Fish. Res. Bd. Canada,* Ottawa, pp. 47-65.

QUARTERLY REPORT

Contract #03-5-022-56
Research Unit #530
Task Order #34
Reporting Period: 4/1-6/30/78

THE ENVIRONMENTAL GEOLOGY AND GEOMORPHOLOGY OF THE BARRIER ISLAND - LAGOON SYSTEM ALONG THE BEAUFORT SEA COASTAL PLAIN FROM PRUDHOE BAY TO THE COVILLE RIVER

P. J. Cannon
Geology Department
University of Alaska
Fairbanks, Alaska 99701

June 30, 1978

QUARTERLY REPORT FOR QUARTER ENDING JUNE 30, 1978

Project Title: The Environmental Geology and Geomorphology of the Barrier Island - Lagoon System Along the Beaufort Sea Coastal Plain from Prudhoe Bay to the Coville River

Principal Investigator: Dr. P. Jan Cannon

I. Talk Objectives

1. To determine the origin and evolution (geomorphic history) of the barrier islands and the coastal lagoons.

2. To determine the source(s) of the gravel size materials that make up the barrier islands.

3. To determine the stability of the barrier island - lagoon system in respect to natural processes and man induced effects.

4. To determine the magnitude of the geomorphological relationships between the barrier island - lagoon system and the landforms of the coastal plain such as the various streams, dune fields, ground patterns, thermokarst features, deltas, pingos, lugs, and lakes.

5. To construct a spatial and temporal model of the environmental geology of the region.

II. Activities

1. Attended LGL-NOAA-BLM review in Anchorage.

2. Began compilation of landforms map of study area.

3. Began detailed study of the Coville and Kuparuk deltas.

4. Made breakup field reconnaissance.

5. Attended LGL workshop in Vancouver, B.C.

6. Made several information exchanges and reviews with Dr. S.A. Naidu about geomorphic processes and summer field projects.

7. Began investigation into the possible vertical changes occurring in the study area and the impact of such changes.

8. Planned summer field activities.

III. Results

There appears to be both quantitative and qualitative methods to determine some of the effects of the deltas in the area. There also appears to be a relationship between some minor landforms and vertical subsidence in coastal areas. The investigation into these methods and relationships has just begun, mainly with research of the literature. A paper titled, "Quantitative Properties of Delta Channel Networks," by J.S. Smart and V.L. Moruzzi, will probably be a great help in parts of the study. A research colloquium syllabus on deltas compiled by Fisher, Brown, Scott and McGowen, of the Texas Bureau of Economic Geology, has information on deltas from all over the world which will be a great help with further study of the Beaufort Sea coast.

IV. Preliminary Interpretation of Results

Some of the problems in modeling Simpson Lagoon may be accounted for by the vertical subsidence of the lagoon. It also appears that unusual modifications to some of the landforms in the area can be accounted for by the minor vertical subsidence. The shorelines of the lakes are retreating, increasing the size of the lakes at a regular rate. The best generalization that can be made about the lakes is that the shorelines of the larger lakes are retreating faster than the shorelines of the smaller lakes. Breakup this year has been somewhat different than breakup of last year. It seems that the impact of minor climatic changes is totally unknown in the Beaufort Sea Coastal zone.

V. Problems Encountered

Breakup field reconnaissance has been running later than planned, due to weather problems.

Contract # 03-8-022-35182
Research Unit # 531
Reporting Period: 1 April 1978-30 June 1978
Number of Pages: 8 pages

Oceanographic Processes in a Beaufort Sea Barrier Island-Lagoon System: Numerical Modelling and Current Measurements

Principal Investigators: J. C. H. Mungall and R. E. Whitaker
Department of Oceanography
Texas A&M University
College Station, TX 77843
(713)845/1443

30 June 1978

A. Field or Laboratory Activities

1. Attendance/participation in meetings

Barrier Island-Lagoon System Ecological Processes Studies Workshop
University of British Columbia
Vancouver, British Columbia, Canada
24-26 April 1978

The workshop provided a forum for external review of the overall research program. Summaries of progress and planned activities were presented by investigators from each discipline. Partcipants also attended interdisciplinary sessions where the biological and physical numerical models were updated and the 1978 summer field program was discussed.

2. Numerical modeling

The three-space numerical model was applied to Simpson Lagoon to examine the effect of an often-used eddy viscosity parameterization. For this experiment the eddy viscosity was taken as

$$A_{kz} = \ell_0^2 \left|\frac{\partial Q}{\partial z}\right| ,$$

where Q is the total speed and the mixing length ℓ_0 is defined as

$$\ell_0 = k_0(H-z)z/H ,$$

where k_0 is von Karman's constant, H is the total mean depth and z is the elevation.

Figure 1 shows the variation of the eddy viscosity with depth. Figures 2 and 3 show the computed alongshore currents in vertical sections extending seaward from Milne Point and Point Storkersen, respectively. These results may be compared with those obtained with

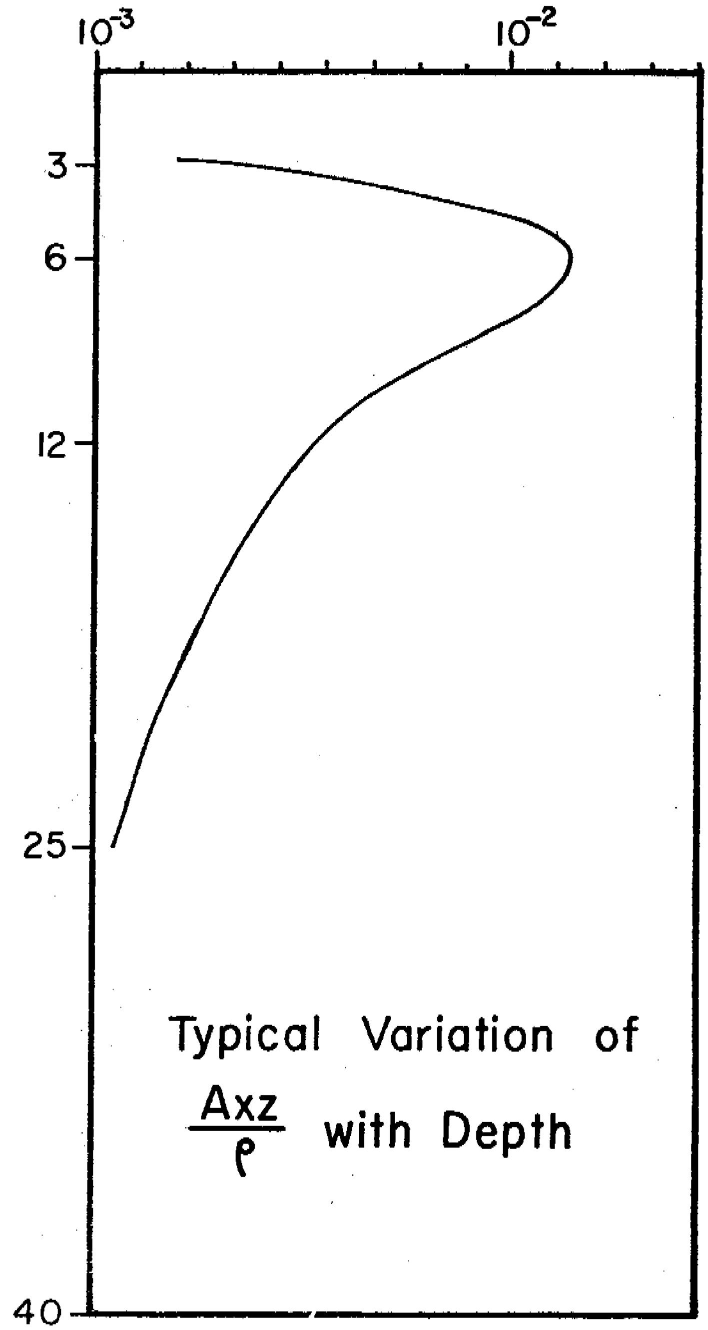


Figure 1. Typical variation of the eddy viscosity with depth.

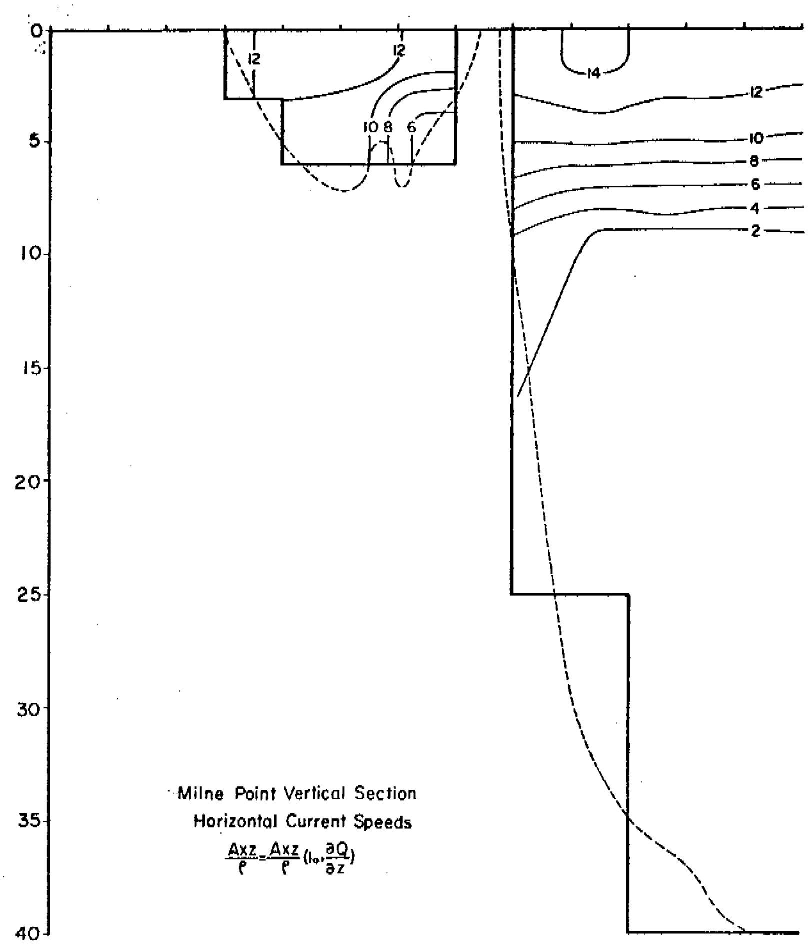


Figure 2. Computed alongshore current field off Milne Point.

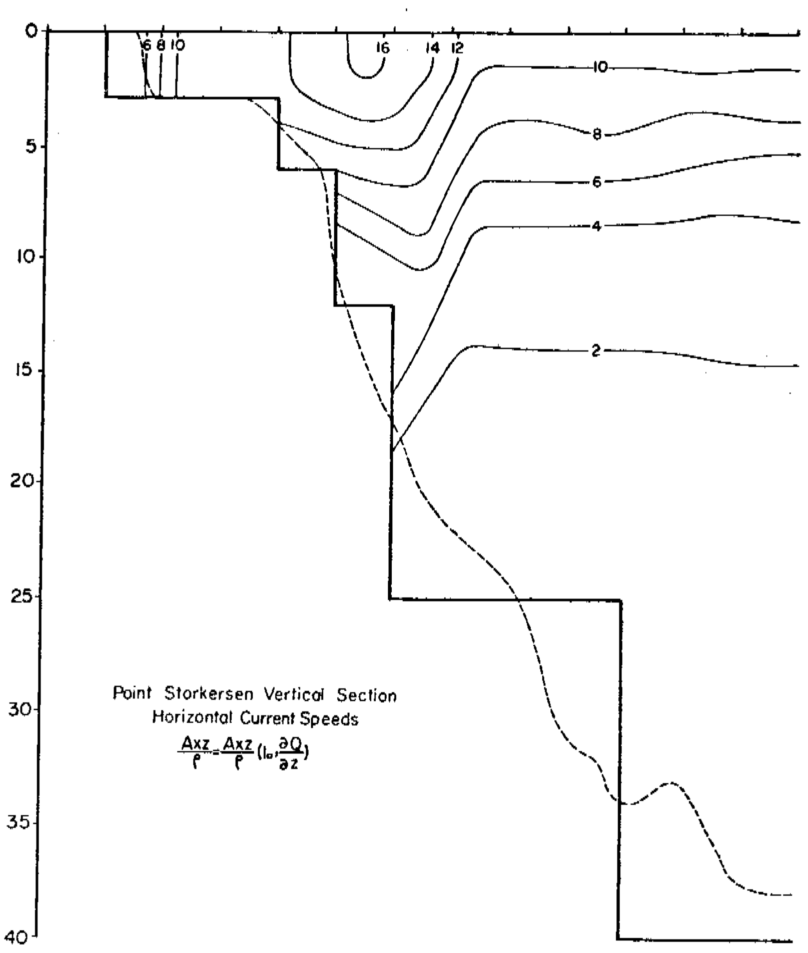


Figure 3. Computed alongshore current field off Point Storkersen.

a constant eddy viscosity as provided in this project's first annual report.

Responding to requests from the BLM and the NOAA-OCSEAP Arctic Project Office, we have applied a two-dimensional long-wave model to the Beaufort Sea coast extending from Camp Halkett to the Stockton Islands. Figure 4 shows the 2 × 2 km grid utilized. Note that this grid allows for interfacing with the Simpson Lagoon model. Due to the cost (approximately $50) of the computations only one simulation, that with a 5 ms^{-1} ENE wind, has been obtained.

The three-space model has also been applied to this region with a 4 × 4 km resolution in order to obtain better estimates of the wind-driven surface currents. These applications were of short prototype duration and were designed to establish the efficiency of the free surface and "rigid-lid" versions of the three-dimensional model. In the free-surface mode, simulations require 1.5 min for each hour of prototype time. At this time, the "rigid-lid" version takes approximately the same CPU time due to the inefficient methods available for determining the surface streamfunction.

3. Equipment ordered

The following equipment for use during the 1978 field program has been ordered:

a) A Marsh-McBirney two-axis electromagnetic current meter and display panel

b) Two capacitance-type wave gauge systems with associated electronics and strip-chart recording.

c) A Beckman RS5-3 conductivity and temperature cell with 400 ft of cable

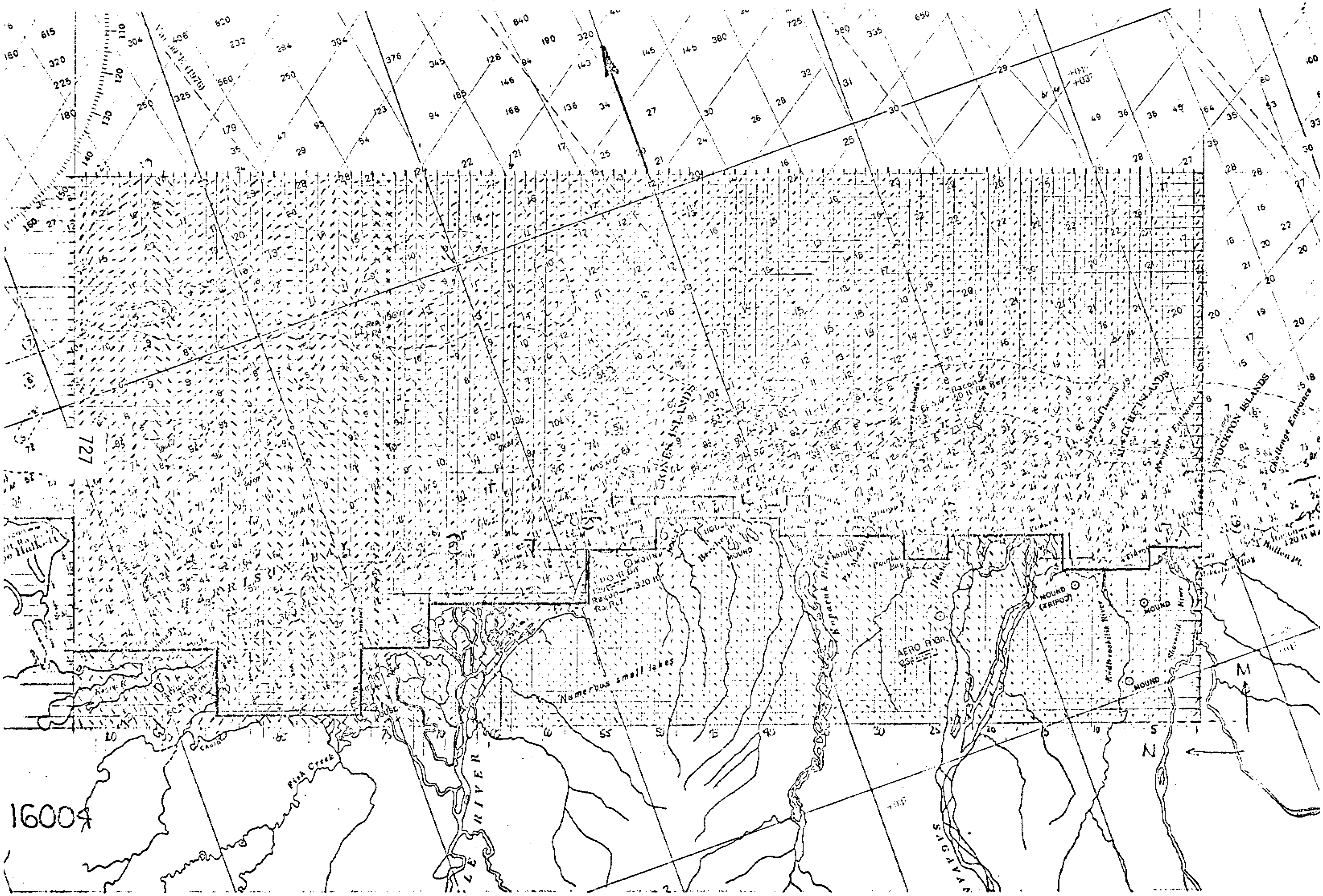


Figure 4. The 4 × 4 km grid used for the Beaufort Sea simulations.

d) Twenty buoys configured for 6 MHZ operation. Sixteen will have standard drogues and six will have shallow water drogues.

In addition to the above, we have borrowed two RDF sets owned by the Atlantic Environmental Group of the National Marine Fisheries Service (NMSF) in Narragansett, Rhode Island. A "smart" data nine-channel data logger with mini-computer and disc storage is being leased for use in the field.

B. 1978 Research and Measurement Capabilities

We now have the capability of obtaining time-series of current velocity, wave height, temperature and conductivity. A mini-tower is being constructed to support the sensors and attendant equipment. The instrumented tower will be placed off Milne Point initially. Since the tower can be dismantled, it can be moved at the discretion of the biologists. Data from the sensors on the tower will be recorded in analog (strip chart) and digital form. Redundancy in data recording is clearly desirable. Moreover, the "smart" data logger can perform initial processing, thereby minimizing data reduction time after the field program is completed.

The presence of a float plane during the field season will allow us to obtain synoptic lateral and vertical distributions of temperature, conductivity and salinity.

The float plane will also enable us to deploy the drogued drifters offshore. Using the RDF system instead of radar will provide drifter motion inside Simpson Lagoon as well as throughout the Prudhoe Bay region.

C. Personnel

Mr. Steve Pace of Pacific Grove, California, has been contracted to provide assistance during the 1978 summer field program. He is experienced in high latitude field work and should be an asset to our effort.

D. Estimate of Funds Expended:

Total expentidures to 30 June 1978	$ 48,260.60
Outstanding encumbrances	17,718.28
Unencumbered balance	44.424.36

QUARTERLY REPORT

Contract: 3-5-022-56
Research Unit: #537
Task Order #: 32
Reporting Period: 3/1/78-6/30/78
Number of Pages: 3

NUTRIENT DYNAMICS IN NEARSHORE UNDER-ICE WATERS

Dr. Donald M. Schell
Principal Investigator

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

30 June 1978

I. TASK OBJECTIVES

Specific objectives for the past three months in this research unit have been: (1) the collection of water and ice cores from Simpson Lagoon and Harrison Bay to establish nutrient concentrations and salinities prior to the spring ice algae bloom, and (2) the collection of water and ice samples from the same area at the peak of the ice algae bloom. These samples will contribute toward understanding the magnitude and spatial variation of ice algae populations along the Beaufort Sea coastline. The salinity and nutrient data will contribute toward estimating the effectiveness of thermohaline convection in exchanging under-ice waters in the shallow bays and lagoons and replenishing nutrients in the water column.

II. FIELD ACTIVITIES

Two field trips were undertaken during April and May 1978 for the collection of water and ice samples. On April 4-5, 1978, a Bell 206 helicopter was utilized for sampling in Simpson Lagoon and in the fast ice outside of the barrier islands. Flying conditions in April were very good in spite of low temperatures and moderate winds and all the projected sampling stations were occupied. In addition, two stations in the Colville River Delta and one station in central Harrison Bay were occupied to extend the data base. Ice algae were not evident in any of the cores taken within Simpson Lagoon, but clear ice pans cored in Harrison Bay and outside of the barrier islands had visible algal growth at the ice-water interface.

The May sampling trip also utilized a Bell 206 helicopter, but flying conditions were very poor. After waiting for weather to improve for two days, a sampling trip was undertaken on 25 May 1978. Seven stations were occupied before deteriorating visibility and a lowering ceiling forced a return to Deadhorse. On 26 May, weather was bad, but by noon we attempted to sample further west into Harrsion Bay. Snow squalls and fog increased and the trip was aborted after recovering an amphipod trap that had been left overnight in Simpson Lagoon of Milne Point. No additonal water samples were taken, and this effort concluded the May sampling. Currently, sampling of under-ice water and overflow water from the rivers emptying onto Simpson Lagoon is being conducted from the LGL-Limited camp at Milne Point.

III. LABORATORY ACTIVITIES

Salinity determinations have been made on all water samples collected during April, 1978. Nutrient analyses, chlorophyll analyses and salinities are to be run on ice cores and water samples from the May field trip. Work will continue as samples arrive from the field.

IV. PROBLEMS ENCOUNTERED

Logistic problems with weather which curtailed flying during the May field trip were the only difficulties encountered. The seven stations occupied were prioritized toward the optimum return of data and therefore the essential objectives in sampling were accomplished. Future sampling by boat when the ice cover melts in July will also be dependent upon logistics, but no serious problems are anticipated.

QUARTERLY REPORT

Contract No:
Research Unit No.: 549
Reporting Period: 1 April - 30 June 1978
Number of Pages: 1

Bristol Bay Oceanographic Processes (B-BOP)

J. D. Schumacher

R. L. Charnell

Pacific Marine Environmental Laboratory
3711 15th Avenue N. E.
Seattle, Washington 98105

29 June 1978

I. Objective:

This work unit attempts to relate oceanic advective and diffusive processes to problems that petroleum development may cause.

II. Field Activities:

Meetings: OCSEAP Physical Oceanography Workshop, Rosario, Washington, 2-4 May 1978.

III. Results:

CTD data from heliocopter operations and SURVEYOR LEG I - RP-4-78A have been translated and processed into the required format. These data are now in quality control.

IV. Interpretation of Results:

A scientific paper "A Structural Front Over the Continental Shelf of the Eastern Bering Sea" by J. D. Schumahcer, T. H. Kinder, D. J. Pashinski and R. L. Charnell has been accepted, with minor revision, for publication in the Journal of Physical Oceanography.

QUARTERLY REPORT

Contract No: R7120825
Research Unit No: RU-551
Reporting Period: March 1 - June 30, 1978
Number of Pages: 9

Part A

SEASONAL COMPOSITION AND FOOD WEB RELATIONSHIPS OF MARINE ORGANISMS IN THE NEARSHORE ZONE

Murray Hayes et. al

National Marine Fisheries Service
Northwest and Alaska Fisheries Center
Seattle, Washington
June 1978

Part A

PI QUARTERLY PROGRESS REPORT

Reporting Period: March 1-June 30, 1978

Project Title: Seasonal Composition and food web relationships of marine organisms in the nearshore zone--Element I (RU-551).

I. Highlights of Quarters's Accomplishments

Second quarterly cruise (4-DI-78) conducted in water contiguous to Kodiak Island from 28 March through 20 April 1978. A total of 116 biological stations were occupied, including 80 grid stations, nine supplemental stations, 20 special IKMT stations, five epibenthic sled stations and two diel stations. A total of 492 plankton samples were collected. One hundred twenty-one CTD measurements were taken and 960 sea bed drifters were released (see Section VII).

Ichthyo- and zooplankton samples from the fall 1977 cruise (4-MF-77) were received from the sorting contractor. Identification of ichthyoplankton from this cruise has been completed and data analysis is in progress.

The third quarterly cruise (4-MF-78) will be initiated on June 19, 1978.

II. Objectives

To determine the seasonal composition, distribution, and abundance of marine organisms in waters contiguous to Kodiak Island, and to relate these to oceanographic conditions, with emphasis on ichthyoplankton, meroplankton, and macroplankton.

III. Field or Laboratory Activities

A. Field Activities

1. Ship Schedules

Cruise 4-DI-78 conducted in Kodiak Island waters from March 28 through April 20, 1978.

2. Scientific Party

Name	Affiliation	Role
Jean Dunn	NWAFC	Chief Scientist
James Ingraham	NWAFC	Physical Oceanographer
Donald Fisk	NWAFC	Watch Supervisor
Jay Clark	Univ. Wa.	Watch Supervisor

Langdon Quetin	NWAFC	Biologist
David Tucker	NWAFC	Technician
Ronald Tanino	NWAFC	Technician
Jennifer Sassano	NWAFC	Technician

3. Methods

At each grid station a CTD probe was made to near bottom or to 1500 m in deep water. A neuston tow was made for 10 minutes to sample surface dwelling ichthyoneuston, followed by a double-oblique Bongo tow from near bottom to the surface. At selected stations a two net opening-closing Tucker Trawl was used to sample from near bottom to the bottom of the thermocline and from the thermocline to the surface. At other stations micronekton was sampled using a 6-foot Isaacs-Kidd midwater trawl.

Two stations were sampled over a 24 hour period using a neuston net and a Tucker Trawl to determine diel variation in catches.

4. Sample Collection Localities

The station plan is illustrated in Figure 1.

5. Data Collected and Analyzed

a. Number of samples collected

113 Neuston samples
170 Bongo samples
139 Tucker Trawl Samples
60 Isaacs-Kidd Midwater Trawl samples
10 Epibenthic sled samples

A total of 121 CTD measures (see Section VII) and 25 surface water samples were taken. Nine hundred and sixty seabed drifters were released at 16 stations.

b. Number and types of analyses

Plankton samples collected on cruise 4-DI-78 have been shipped to the contractor for sorting.

c. Laboratory Activities

1. Ship or field trip schedules

N/A

2. Scientific party

Jean R. Dunn	NMFS	Co-Principal Investigator (part-time)
Beverly M. Vinter	NMFS	Ichthyoplankton Specialist
Kevin Bailey	NMFS	Fishery Biologist (part-time)
Donald Fisk	NMFS	Physical Science Technician

3. Methods

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

4. Sample collection localities

These samples were collected during cruise 4-MF-77 as previously reported.

5. Data analyzed

a. Number of samples examined

Fish eggs and larvae from cruise 4-MF-77 were identified from the following samples:

Neuston	85
Bongo (0.505)	61
Tucker Trawl #1 (bottom net)	85
Tucker Trawl #2 (upper net)	85

b. Number and type of analyses

A total of 7810 larvae and 205 fish eggs were captured in the following samples (actual numbers).

Gear	No. Fish Larvae	No. Fish Eggs
Neuston	4764	19
Bongo (0.505)	729	54
Tucker Trawl #1	787	68
Tucker Trawl #2	1530	64
Total	7810	205

IV. Results

The kinds of fish larvae captured, by gear type, during cruise 4-MF-77 are listed in Table 1. Cottids of the genus *Hemilepidotus* accounted for nearly 69% of the total catch, followed by greenlings (*Hexagrammos* sp.) 15%, and Atka mackerel (*Pleurogrammos monopterygius*) 11.5%. Among the other taxa captured, only the capelin (*Mallotus villosus*) exceeded 1% of the total catch.

Few fish eggs were captured during this cruise (Table 2). Eggs of the bathylagid smelt, *Leuroglossus schmidti*, accounted for 50% of the catch of fish eggs. Pollock (*Theragra chalcogramma*) eggs made up 35% of the total, providing evidence of protracted spawning by a species which is normally a spring spawning species.

V. Preliminary Interpretation of Results

None

VI. Auxiliary Material

None

VII. Problems Encountered and Recommended Changes

The level wind on the MARCO winch on the Discoverer failed on numerous occasions during cruise 4-DI-78 causing plankton tows to be aborted. The system appears to be under-designed and needs priority attention. The necessity of towing plankton gear over the stern is another problem. The port Jered winch should be reconditioned so that Bongo nets and IKMT trawls could be fished away from the stern.

Although environmental data were monitored in real time by scientific personnel from the CTD strip chart, the DDL tapes from the CTD were not recording data during the Discoverer cruise 4-DI-78 and this was not discovered by the ship's personnel until cast 91. The back-up DBCON tapes cannot be processed until the software problems can be resolved, thus delaying the use of environmental data. Some method of on-line quality control needs to be implemented.

VIII. Estimate of Funds Expended

Approximately 40K was expended this quarter, not including soring costs.

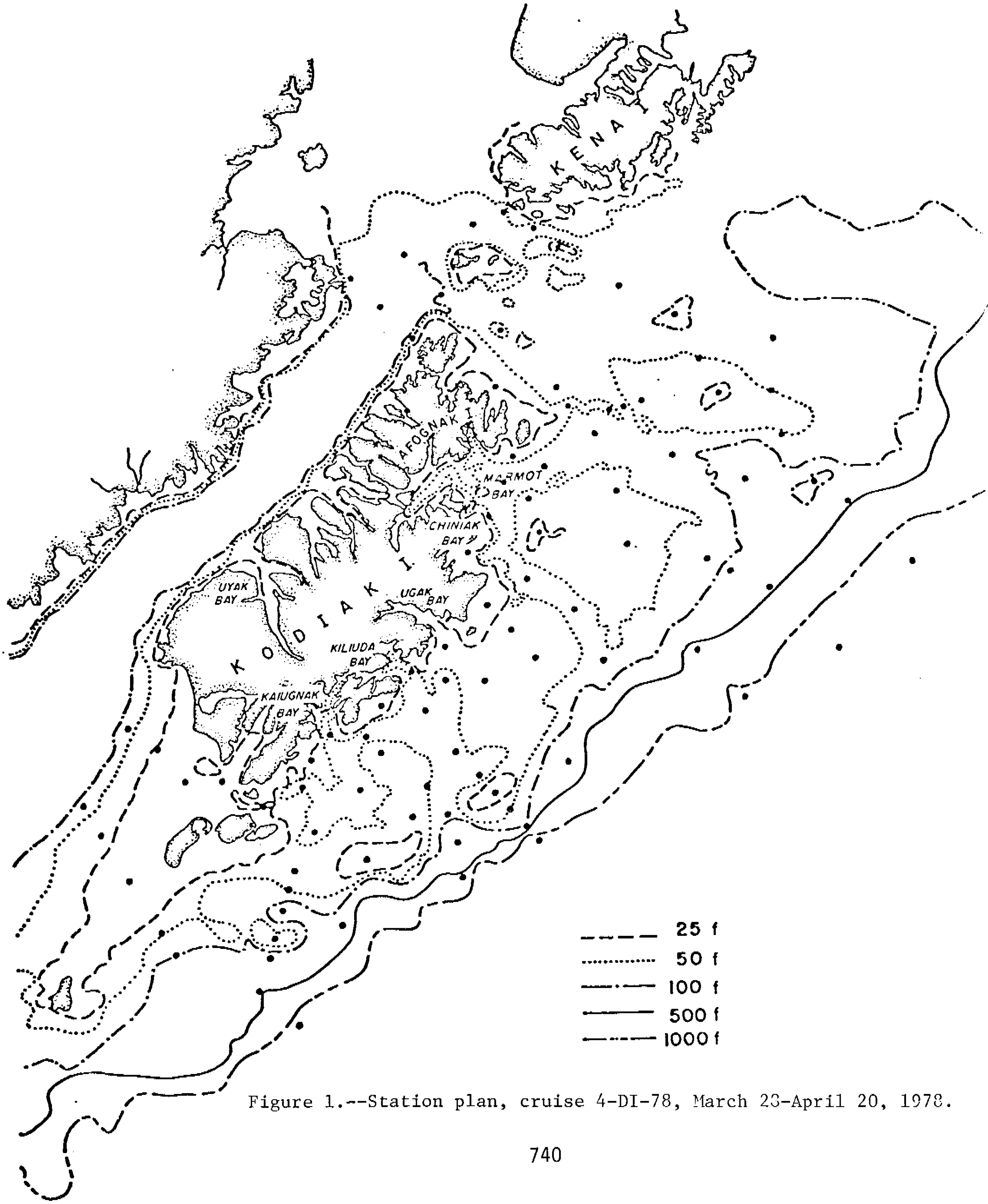


Figure 1.--Station plan, cruise 4-DI-78, March 23-April 20, 1978.

Table 1.--Preliminary list of catches (actual numbers) of fish larvae, by taxa, during cruise 4-MF-77.

Taxa	Neuston		Bongo (0.505)		Tucker Trawl #1		Tucker Trawl #2		Total	
	N	%	N	%	N	%	N	%	N	%
Osmeridae										
Mallotus villosus	19	0.4	80	11.0	54	6.9	84	5.5	237	3.0
Bathylagidae			4	0.5						
Leuroglossus schmidti			4	0.5	2	0.3	7	0.5	13	0.2
Bathylagus milleri							1	+	1	+
Myctophidae										
Stenobrachius leucopsarus			12	1.7	13	1.7	16	1.1	41	0.5
Protomyctophum thompsoni			5	0.7	8	1.0	5	0.3	18	0.2
Gadidae			2	0.3	1	0.1	2	0.1	5	+
Theragra chalcogramma			3	0.4	6	0.8	9	0.6	18	0.[illegible]
Gasterosteidae										
Gasterosteus aculeatus	1	+							1	+
Bathymasteridae										
Type "A"	3	+							3	+
Scorpaenidae										
Sebastes sp.							1	+	1	+
Hexagrammidae										
Hexagrammos sp.	989	20.8	21	2.9	18	2.3	48	3.1	1076	13.8
Hexagrammos "A"			1	0.1					1	+
Hexagrammos "D"	95	2.0	2	0.3			6	0.4	103	1.3
Pleurogrammos monopterygius	784	16.5	15	2.1	63	8.0	33	2.2	895	11.5
Cottidae							1	+	1	+
Hemilepidotus "A"	2871	60.3	575	78.9	614	78.3	1317	86.1	5377	68.8
Icelinus borealis			2	0.3	1	0.1			3	+
Artedius sp.					4	0.5			4	+
Cyclopteridae										
Aptocyclus ventricosus	2	+							2	+
Pleuronectidae					1	0.1			1	+
Unidentified			1	0.1					1	+
Disintegrated			2	0.3	2	0.3			4	+
Total	4764	61.0	729	9.3	787	10.1	1530	19.6	7810	100

Table 2.--Preliminary list of catches (actual numbers) of fish eggs, by taxa, captured during cruise 4-MF-77.

Taxa	Neuston		Bongo		Tucker Trawl #1		Tucker Trawl #2		Total	
	N	%	N	%	N	%	N	%	N	%
Bathylagidae										
Leuroglossus schmidti	1	5.3	26	48.2	36	52.9	40	62.5	103	50.2
Gadidae										
Theragra chalcogramma	18	94.7	18	33.3	18	26.5	18	28.1	72	35.1
Macrouridae										
Type "A"			7	13.0	9	13.2	1	1.6	17	8.3
Pleuronectidae										
Type "C"							3	4.7	3	1.5
Unknown	—	—	3	5.6	5	7.4	2	3.1	10	4.9
Total	19	9.3	54	26.3	68	33.2	64	31.2	205	100

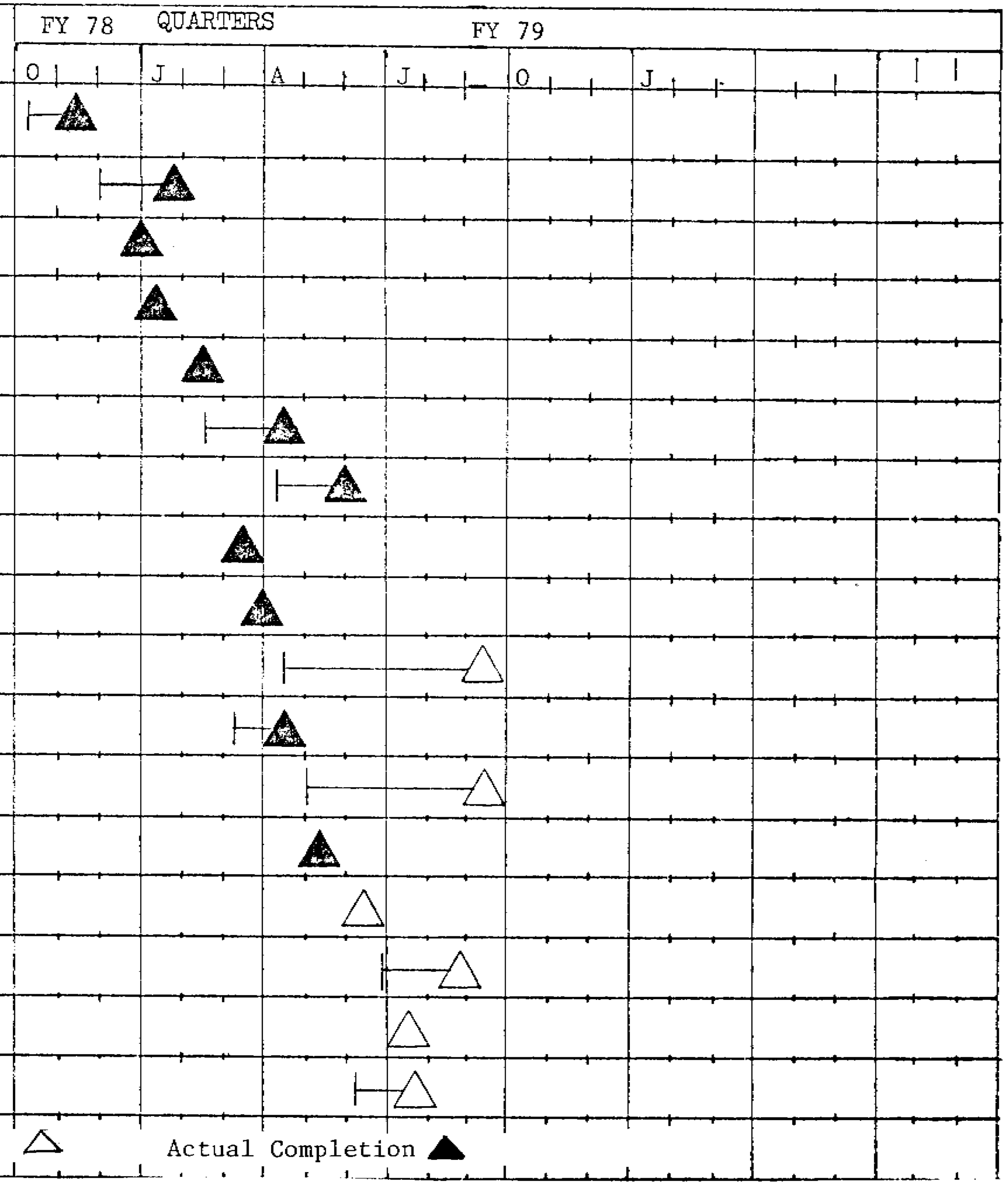
MILESTONE CHART

PROJECT Seasonal composition and food web relationships of marine organisms in the nearshore zone (RU-551)

DATE June 1, 1978

PRINCIPAL INVESTIGATORS J. R. Dunn and F. Favorite

	MAJOR MILESTONES/ ACTIVITIES
1	Miller Freeman cruise 4-MF-77
2	Quality control pre-sort
3	Quarterly report
4	Ship samples for sorting
5	Received sorted fish larvae
6	Fish eggs and larvae identified
7	Distribution of eggs and larvae plotted
8	Received sorted zooplankton
9	Quarterly report
10	Ichthyoplankton data analysis
11	Discoveror cruise 4-DI-78
12	Zooplankton data analysis (4-MF-77)
13	Ship plankton samples for sorting (4-DI-78)
14	Receive sorted ichthyoplankton
15	Fish eggs and larvae identified
16	Receive sorted zooplankton
17	Miller Freeman cruise 4-MF-78



Milestone: Start ├── Estimated Completion △ Actual Completion ▲

Quarterly Progress Report
March 15 to June 15, 1978

Seasonal Composition and Food Web Relationship
of Marine Organisms in the Nearshore Zone -- Decapod
Crustacea Larvae Part B

I. Abstract

During the reported quarter over 500 plankton samples were collected and shipped to the contracted sorting center for partial sorting into major taxa. Additional samples were collected for use in the laboratory to refine detailed sorting procedures and establish a voucher specimen collection of decapod crustacea species by larval stages.

II. Objectives

The objectives of R.U. 551B are to determine the seasonal composition, distribution, relative abundance and life stage development of commercially and ecologically important species of larval crabs and shrimps in four bay systems of Kodiak Island.

III. Field or Laboratory Activities

A. Ship or field trip schedule:

Field operation performed in conjunction with R.U. 553.

University of Washington Charter, R/V Commando

Cruise	Date
I	3/27-4/9
II	4/10-4/21
III	4/22-5/7
IV	5/8-5/30
V	5/31-6/12
VI	6/13- in progress

B. Scientific Party

Field operations were handled jointly by personnel from R.U. 553 and 551B. The scientific party for both R.U.'s includes:

Mr. D. Rabin, FRI, Biologist
Mr. W. Lew, FRI, Technician
Mr. K. Semmens, FRI, Technician
Mr. J. Bowerman, NMFS, Biologist
Mr. B. Birmingham, FRI, Biologist

C. Methods

Zooplankton is sampled bi-weekly at stations located in the central and outer areas of Izhut, Kalsin, Kiliuda and Kaiugnak Bays. Stations are sampled once every two weeks with a surface neuston sampler, bongo arrayed plankton nets, opening-closing Tucker trawl and an epibenthic plankton sled. Diel sampling is conducted in Izhut and Kiliuda Bays. Samples are preserved in buffered formalin solution and stored until shipment to the contracted sorting center. Following sorting of a subsample into major taxa at the sorting center, the unsorted portion of each sample and decapod crustacea forms from the subsample are shipped to the Kodiak Facility for detailed sorts and analyses.

D. Sample Collection Localities

Samples were obtained from five stations each in the Izhut-Marmot, Kalsin-Chiniak, Kiliuda and Kaiugnak bay systems. (See table.)

E. Data Collected and/or Analyzed

1. During this quarter 511 plankton samples were collected and shipped to the sorting center. Numbers of samples by gear type are:

121 surface neuston
224 bongo-arrayed plankton net
126 opening-closing Tucker trawl
40 epibenthic plankton sled

In addition to the plankton samples, environmental data was also collected at each station. This data consisted of water temperature and salinity profiles and identifying weather conditions.

Other plankton samples (11) were also obtained but not sent to the sorting center. These additional samples were used for refining sorting techniques and establishing a reference collection of decapod crustacea larvae from the survey region.

2. Number and types of analyses.

At this time only those plankton samples obtained for laboratory technique/reference collection have been examined. These samples were sorted into the following groups:

Brachyuran crabs
Lithodid crabs
Pandalid shrimps
Hippolytid shrimps
Crangon shrimps

In most cases, individual specimens were identified to species and stage of larval development. Samples sent to the sorting center have not returned at this time. The first set of samples from the sorting center are expected in late June.

IV. Results

In those few samples obtained for refining sorting techniques and establishing a reference collection, no prezoe and few stage 1 crab or shrimp larvae were present. The majority of crab and shrimp larvae were stage 2 and 3 with a few stage 4. Some Tanner crab megalops were also present.

V. Preliminary Interpretation of Results.

None to report at this time.

Table 1. Station locations for Kodiak Island nearshore zooplankton research, 1978.

Bay	Station	Latitude		Longitude		Gear used* remarks
Izhut	Z1	58	13	152	17	N,B
	Z2 (diel)	58	10	152	14	N,B,T,S
	Z3	58	06	152	10	N,B,S
	Z4	58	08	152	03	N,B
	Z5	58	05	152	18	N,B
	Z6**	58	15	152	16	N,B
	Z7**	58	13	152	18	N,B
	Z8**	58	11	152	20	N,B
Kalsin-Chiniak	C1	57	37	152	25	N,B
	C2	57	41	152	19	N,B,S
	C3	57	44	152	14	N,B,S
	C4	57	42	152	04	N,B
	C5	57	38	151	55	N,B
Kiliuda	L1	57	19	153	02	N,B
	L2 (diel)	57	16	152	55	N,B,T,S
	L3	57	12	152	45	N,B,S
	L4	57	16	152	37	N,B
	L5	57	36	152	54	N,B
	L6**	57	20	153	09	N,B
	L7**	57	18	153	06	N,B
	L8**	57	20	152	55	N,B
Kaiugnak	G1	57	04	153	36	N,B
	G2	57	01	153	29	N,B,S
	G3	56	56	153	27	N,B,S
	G4	56	58	153	14	N,B
	G5	56	52	153	35	N,B

*N = neuston, B = bongo, T = Tucker, S = sled.

**Stations added 5/78.

QUARTERLY REPORT

R.U. 552

April 1, 1978 thru June 30, 1978

Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Zone Including Icthyoplankton, Meroplankton, Forage Fishes, Marine Birds and Marine Mammals.

Principal Investigators

James E. Blackburn

Peter B. Jackson

Alaska Department of Fish and Game

June 30, 1978

I. Abstract of Quarter's Accomplishments

Primary activities for R.U. 552 during the April - June 1978 quarter center around the initiation and subsequent operation of the Kodiak nearshore fish survey. This survey effort in FY 78 consists of five successive monthly assessments of nearshore fish stocks in four bay systems which collectively represent the east side of Kodiak Island. Approximately one week per month is spent in each bay system. Surveys are conducted from a large (60 ft.) chartered fishing vessel and utilize a wide variety of fishing gear types to insure fishing effort in all habitat types. Surveys are organized and conducted by R.U. 552 which has primary responsibility for obtaining information on the spatial and temporal distribution. Activities of R.U. 552 are closely integrated with those of R.U. 553 which has the primary presonsibility of obtaining data on feeding habits of nearshore fish species. Also integrated into this fish assessment study are field activities of R.U. 5 (IMS) and 332 (NMFS).

Survey effort was initiated on April 1, has continued uninterrupted through the present, and will continue through August 31, 1978. Sampling has been conducted according to schedule throughout this reporting period. A total of 335 units of effort have been expended in the 195 established sampling stations through June 7, 1978. This includes two surveys of Izhut, Kiliuda and Kaiugnak bays and three surveys of Kalsin Bay. It is anticipated that an additional 130 units of fishing effort will be expended between June 8 and June 30, making a total of 456 units of effort expended during this quarter.

An additional aspect of this R.U. is to obtain ancillary data on nearshore pelagic and demersal finfish in Kodiak and lower Cook Inlet throughout the year on an opportunistic basis by placing trained observers aboard private fishing (primarily trawl) vessels and research vessels operating for various agencies. During this quarter observations were made on research vessels only as commercial trawl fisheries were closed or received little or no effort. A considerable volume of data on abundancy distribution and species composition of demersal finfish were obtained from lower Cook Inlet during a May stock abundance indexing survey of Katchemak Bay. This represents the first opportunity for the OCSEAP to obtain data on this species regeme during the spring. These data will be of immediate value as they can be compared with those obtained simultaneously from areas immediately inshore by R.U. 512. During June, the observer was able to participate in the M/V MILLER FREEMAN cruise of the southeastern portion of Kodiak Island. While data from this observed effort are not available as of this writing, it is anticipated that they can be compared directly with simultaneous work by R.U. 552 working immediately inshore in Kiliuda and Kaiugnak bays, thus providing a more synoptic picture of species composition and distribution.

II. Task Objectives

Objectives of this study are to develop an understanding of the seasonal changes in species compostion and food habits of selected marine organisms occurring in nearshore waters of the Kodiak area.

Specifically, these objectives are to:

(1) Determine and monitor the spatial and temporal distribution and relative abundance of some major life stages of demersal and pelagic fishes nearshore and in some selected areas offshore with emphasis on certain key species.

(2) Determine and monitor fluctuations in the food habits of selected nearshore fishes.

(3) Coordinate sampling of food organisms with ongoing trophic studies on benthic invertebrates, marine mammals and birds.

(4) Organize and conduct large vessel charter from which to conduct multidisciplinary but closely integrated studies by research units of four agencies.

(5) Obtain ancillary data on the abundance, distribution, species composition and relative maturity of critical life stages of key marine species in areas adjacent to ongoing nearshore fish studies in Kodiak and lower Cook Inlet.

III. Field and Laboratory Acitvities

A. Ship or Field Trip Schedule

1. Dates - Vessel Schedule

Area	Cruise No.	Inclusive Dates
Kalsin Bay	B - 1	4-1 thru 4-8
Izhut Bay	A - 1	4-9 thru 4-15
Kiliuda Bay	C - 1	4-17 thru 4-22
Kaiugnak Bay	D - 1	4-23 thru 4-30
Kalsin Bay	B - 2	5-1 thru 5-7
Izhut Bay	A - 2	5-10 thru 5-15
Kiliuda Bay	C - 2	5-17 thru 5-22
Kaiugnak Bay	D - 2	5-23 thru 5-31
Kalsin Bay	B - 3	6-2 thru 6-6
Izhut Bay	A - 3	6-8 thru 6-15
Kiliuda Bay	C - 3	6-17 thru —
Kaiugnak Bay	D - 3	— thru —

Coordinated deep water trawling operations are conducted one day per month aboard the M/V COMMANDO in Izhut and Kiliuda bays. The purpose of this effort is to expand the benthic trawl sampling from 30 to 50 fathoms and to promote simultaneous sampling by the two charter vessels. Personnel from R.U. 552, 553 and 5 go aboard the M/V COMMANDO to examine samples and record data obtained. These simultaneous sampling efforts to date have been conducted according to the following schedule:

	Izhut Bay	Kiliuda Bay
March	3-31	—
April	—	4-15
May	4-11	4-24
June	5-12&5-13	5-20&5-21

2. Name of vessel - M/V YANKEE CLIPPER. NODC code - YC.

3. Aircraft - N/A.

4. NOAA or chartered: The M/V YANKEE CLIPPER is chartered by the Alaska Department of Fish & Game at $950.00 per day for a period beginning April 1 through August 31, 1978. Funding for this vessel charter is provided by the OCSEAP specifically for this multidisciplinary charter.

B. Scientific Party - Persons named below have remained on the vessel since 4/1/78 unless indicated otherwise:

1. Peter B. Jackson, Principal Investigator R.U. 552: Alaska Department of Fish & Game. Functioned as crew leader on the vessel during the first month of the Kodiak study.

2. Colin Harris, Fisheries Biologist Representative of Principal Investigator for R.U. 553; Fisheries Research Institute. Aboard vessel from 3/28 thru 4/7 to orient R.U. 553 staff.

3. Mark Buckley, Fishery Biologist: Crew Leader for R.U. 552 & 553 sampling from 4/22 thru present. Alaska Department of Fish & Game.

4. Leslie J. Watson, Fishery Biologist: R.U. 552: Alaska Department of Fish & Game.

5. Steven Quinell, Fishery Biologist, R.U. 553: Fisheries Research Institute.

6. Michael Gross, Fishery Biologist, R.U. 553: Fisheries Research Institute.

7. Max Hoberg, Fishery Biologist, R.U. 5: Institute of Marine Science. Aboard vessel from 4/8 thru 4/21.

8. Steven Jewett, Fishery Biologist, R.U. 5: Insitute of Marine Science. Aboard vessel from 5/8 thru 5/22.

9. John Rose, Fishery Biologist, R.U. 5: Institute of Marine Science. Aboard vessel from 6/8 thru 6/21.

10. Bruce McCain, Fish Pathologist, R.U. 5: National Marine Fisheries Service. Aboard vessel 5/1 thru 5/15.

11. Bill Gronlin, Fish Pathologist, R.U. 332: National Marine Fisheries Service. Aboard vessel 5/15 thru 5/30.

12. Jolly Hibbitts, Fish Pathologist, R.U. 332: National Marine Fisheries. Aboard vessel 6/1 thru 6/16.

C. Methods:

1. Data will be obtained during five - one month surveys (April-August) conducted from a chartered research vessel.

2. Four study areas surveyed monthly are as follow:

   a. Izhut Bay - inside of a line between Pillar Cape and Peril Cape.

   b. Kalsin Bay - inside of a line between Broad Point & Isthmus Point.

c. Kiliuda Bay - inside of a line between Pivot Point and Shearwater Point.

d. Kaiugnak Bay - inside of a line between Cape Kiavak and Cape Kasiak.

3. Surveys will utilize a 58 foot seine vessel for primary logistical support as well as for certain fishing operations (i.e. try net and tow net operations).

4. Nearshore fishing operations will require the full time use of one 14-16 foot light skiff equipped with a 25 h.p. outboard engine. Tow net operations will require use of a 17-20 foot seine skiff equipped with a 70 h.p. engine.

5. Each study area will be sampled semi-systematically in respect to four sampling regions (Figure 1). The following suite of gear types will be fished. These gear types were selected on the basis of their combined aiblity to catch fish species throughout the nearshore zone:

   a. Beach seine: 155' - tapered from wings to 12' at center, ¼" mesh throughout.

   b. Variable mesh gill nets: ¼" - 2½" mesh - Floating and Sinking.

   c. Trammel Net: 150' x 6' (3 panel).

   d. Two net: 10' x 20' x 43'.

   e. 20' standard try net with 15" x 30" trawl doors.

   f. Midwater trawl - utilize 10' x 20' tow net as described above.

   g. Standard 400 mesh Eastern Otter Trawl (fished from M/V COMMANDO).

6. The exact location fished by each gear type in each sampling region will be determined during the April, 1977 survey and remain consistent between surveys; additional sets by various gear types may be added if time permits during successive surveys.

7. As effort cannot be allocated on a truly systematic basis, each of the four sampling regions are divided into three to four "strata" in an effort to distribute effort equally. Based on allocating two days per strata, the effort levels by gear type as shown in Table 1 are allocated to each region and distributed equally between strata.

Table 1. Planned sampling intensity by gear type for each monthly survey.

		# of hauls by gear					
Sampling Region	# of Strata	B.S.*	GN/ Tml.Net	Mwt.	Tow Net	Try Net	Otter-Trawl
Izhut Bay	4	24	12	12	30	16	6
Kalsin Bay	2	12	6	6	15	8	
Kiliuda Bay	4	24	12	12	30	16	6
Kaiugnak Bay	2	12	6	16	15	8	
Total Per Month	12	72	36	36	90	48	12
Total Per 5 Months		360	180	180	450	240	60

*B.S. = Beach Seine GN = Gill Net Tml = Trammel Net Mwt. = Midwater Trawl

8. Studies will be conducted by four scientific personnel (two from FRI and two from ADF&G) in addition to a one-two person vessel crew. Personnel from R.U. 5 and 332 are periodically on the vessel and obtain their samples incidentally to primary fishing operations. The only exception ot this is that one try net two per day is made in deep (50-70 fathoms) water specifically for IMS personnel to insure they obtain an adequate sample of king crab.

9. The four person scientific crew will be divided into 2 two person crews; one to handle beach seines, trammel nets, gill nets and tow nets from the open skiff and the other to remain on board the seine vessel to handle the tow net, try net and mid-water trawl. In most cases these two crews will be able to operate simultaneously.

10. Catch processing (i.e. species identification, enumeration, subsampling, measuring, weighing, foregut removal) will be done immediately following fishing operations whenever possible. When not possible, large fish will be processed in the field, their data recorded on appropriate forms and the remaining catch preserved and sent to Kodiak laboratory for final analysis or species identification (Figure 1).

11. Sample handling (beach seine, tow net, gill net, trammel net, and try net): While the net is being fished, haul data will be recorded. Small catches will first be sorted immediately by species and life history stage. From large catches, the obvious, large, infrequent species will be sorted out immediately and the remainder of the catch will be subsampled and preserved or subsampled and sorted depending on time available. Preserved samples will be sorted at a later time by species and life history stage. After samples are sorted, species and life history stage identifications are made and recorded, total counts and total weights by species taken and recorded, a subsample of primary species taken and recorded, a subsample of primary species measured and recorded and, from selected species, ovaries removed from adult fish and ova diameters measured (in the Kodiak laboratory).

12. Catch and data handling procedures are outlines sequentially in Figure 1. All data are recorded on the appropriate EDS-EDP data formats and in accordance with approved data management procedures.

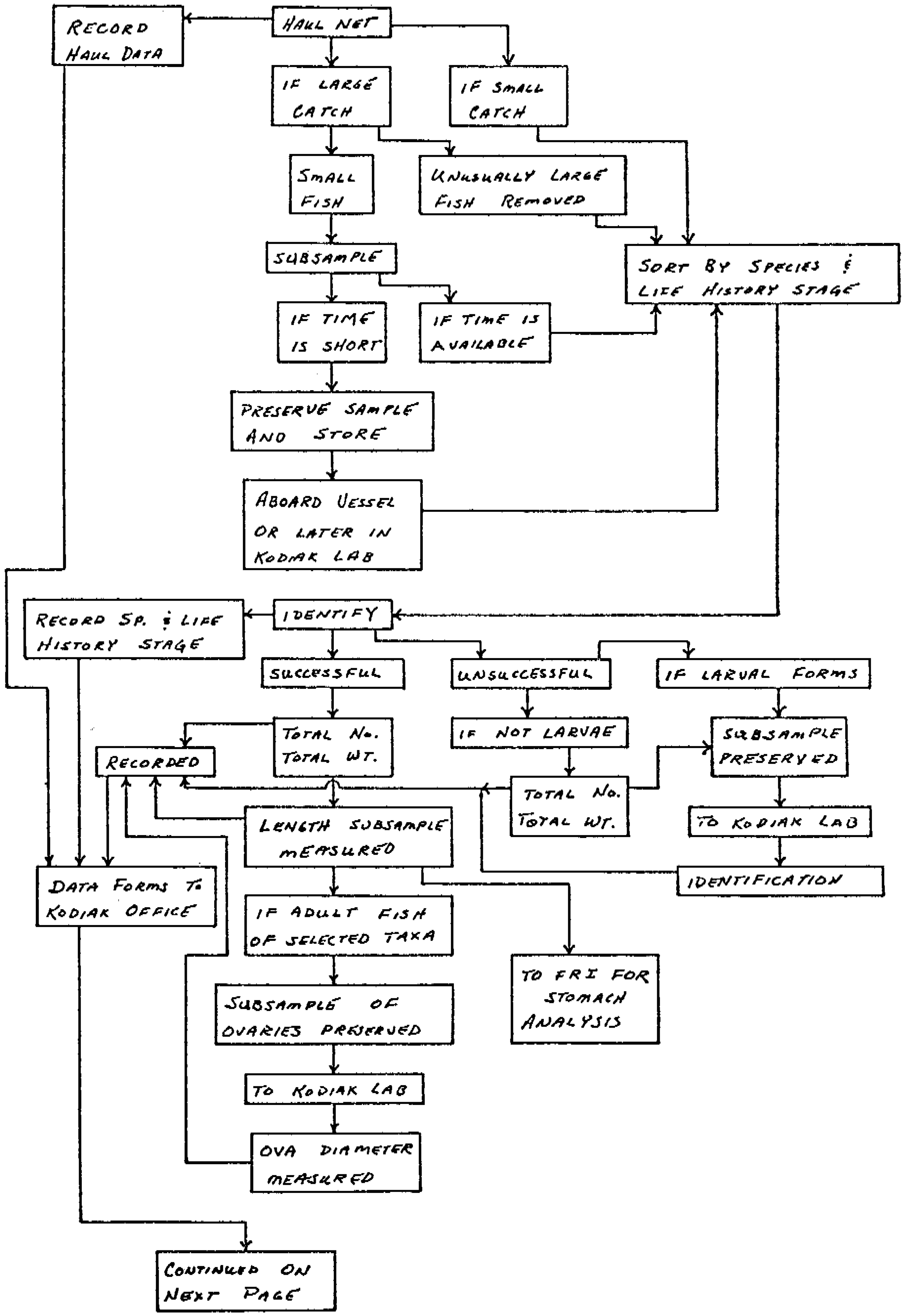
Otter trawling from M/V COMMANDO:

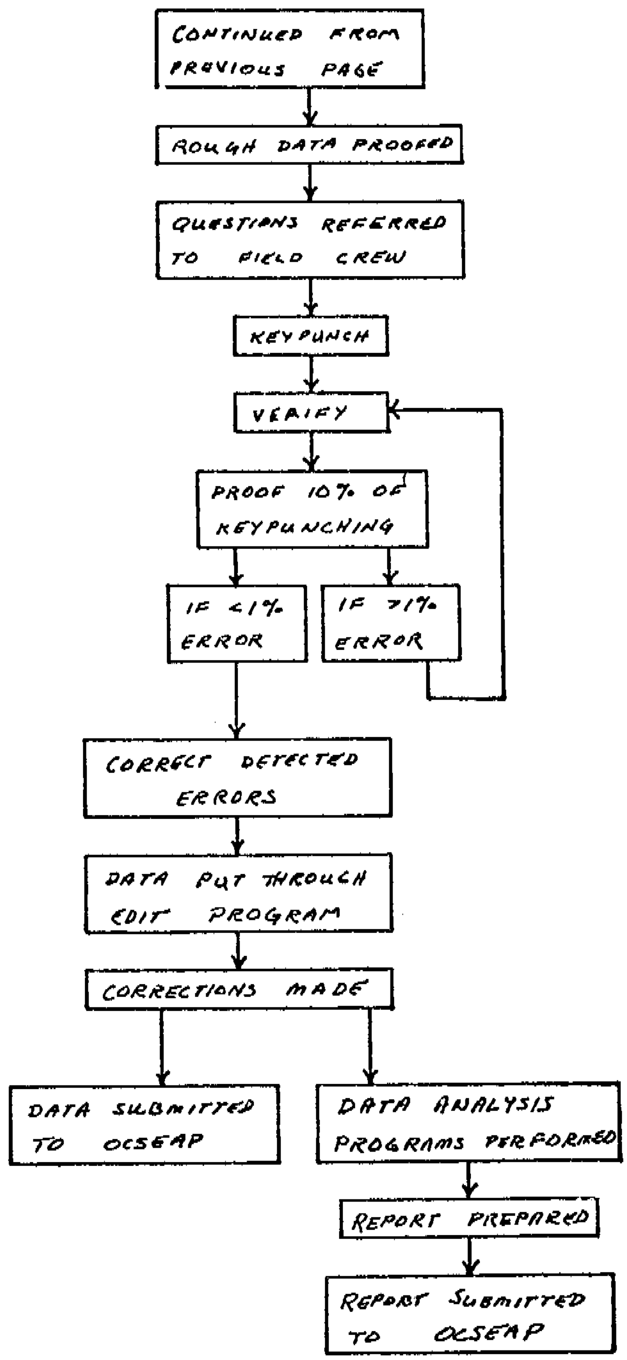
1. Sampling is accomplished in both the Izhut and Kiliuda Bay study areas during two days each month in each area from April thru July, 1978 (trawl vessel not available in August).

2. Trawling is done from the M/V COMMANDO using a standard 400 mesh Eastern otter trawl. A minimum of one biologist from the ADF&G Nearshore Finfish Study directs sampling operations. This vessel has scheduled a total of four days per month for this work.

3. All trawling is done at depths from 30 to 50 fathoms. A total of six hauls will be attempted daily. Exact trawl locations were made during the April 1978 durvey and will remain as consistant as possible to insure comparability.

Figure 1. Flow sample and data collection for nearshore fish assessment study - ADF&G.




CONTINUED FROM PREVIOUS PAGE
ROUGH DATA PROOFED
QUESTIONS REFERRED TO FIELD CREW
KEYPUNCH
VERIFY
PROOF 10% OF KEYPUNCHING
IF <1% ERROR
IF >1% ERROR
CORRECT DETECTED ERRORS
DATA PUT THROUGH EDIT PROGRAM
CORRECTIONS MADE
DATA SUBMITTED TO OCSEAP
DATA ANALYSIS PROGRAMS PERFORMED
REPORT PREPARED
REPORT SUBMITTED TO OCSEAP

4. All hauls are one nautical mile in length and, as far as possible, are made in a straight line.

5. Catch weights are obtained to the nearest 10kg as they come aboard the vessel. A subsample of each catch (not exceeding an estimated 200 lbs.) is then randomly selected. The number and combined weight of all fish of each species in this sample is determined and recorded. Prior to subsampling, all "large fish" such as halibut, skates, large cod, etc. are removed and their numbers , weights, and lengths recorded by species.

6. Of those species to be determined later as "primary species", not more than 100 specimens of each are measured by standard length to the nearest millimeter or 10 millimeters (Table 2).

7. All data obtained are recorded on the file type 023 format, key-punched, varified and submitted to the OCSEAP, Juneau Project Office as per required submission schedules and received data documentation.

The fishing gear types listed above for use by ADF&G to conduct nearshore fish assessment sutdies have been selected so as to sample fish species from the entire water column. The gear types and specifications given are of proven effectiveness and have been used by this agency on prior similar studies in this and other areas. These gear types are fished in respect to the sampling regions enumerated in Table 1, and in those depth zones and bottom types appropriate to each. A two man crew is deployed from the large vessel in a 17-20 foot skiff to fish beach seines, floating and sinking gill nets, and trammel nets. These latter three gear types are utilized from outside the intertidal zone to 4 or 5 fathom depths, and are especially effective in rocky and kelpy areas. Beach seines, of course, will be fished from the beach and be the primary gear for sampling the intertidal zone. The large seine vessel fishes two and possibly three gear types in waters from 5 to 20 fathoms depth — the tow net, try net, and possibly mid-water trawl; these gear types sample the surface, bottom and medwater regions of the study areas, respectively. The try net and mid-water trawl are fished with the large vessel only, whereas the tow net will require assistance by the 17-20 foot skiff during towing to hold the net in a proper fishing configuration. Sampling for benthic finfish species is with the standard 400 mesh eastern otter trawl from the M/V COMMANDO immediately offshore from this nearshore sampling. Sampling techniques for each gear type will remain consistant so as to insure comparability.

Cooperative OCSEAP - ADF&G trawl surveys:

1. Sampling is conducted year round on a monthly basis aboard ADF&G research vessels. These surveys are designed to assess shellfish stocks for management purposes. Surveys will also be conducted opportunistically aboard commercial trawl vessels fishing areas of special interest. Participation of OCSEAP — ADF&G personnel on these activities shall be at no cost for vessels, meals etc.

2. A biologist will be employed to participate in these Kodiak and lower Cook Inlet surveys monthly and incorporate data with results of R.U. 512 and 552. Participation aboard trawl vessels will involve ten days to two weeks each month.

Table 2. Sampling specification for Kodiak nearshore food habits study finfish assessment.

Sampling design

1) Locations or bays (number of regions in bay)
   a. Izhut Bay (4)
   b. Kalsin Bay (2)
   c. Kiliuda Bay (4)
   d. Kaiugnak Bay (2)

2) Months, 5 (April - August)

3) Habitat (gear)
   a. Nearshore, less than 10 fm (beach seine, trammel net, try net, gill net)
   b. Epipelagic (tow net, mid-water trawl)
   c. Demersal, greater than 10 fm (otter trawl)

4) Life history stage (juvenile and adult, length)

5) Species (tentative to be modified from early sampling results according to abundance in catches)

Primary species	Habitat		
a) Pacific sand lance	nearshore	epipelagic	
b) Capelin	"	"	
c) Pacific sand fish	"	"	
d) Masked greenling	"		
e) Rock sole	"	"	demersal
f) Great sculpin			"
g) Yellowfin sole			"
h) Flathead sole			"
i) Pacific cod			"
Secondary species (sampled as catch permits)			
a) Pink salmon	"	"	
b) Chum salmon	"	"	
c) Snake prickleback	"		
d) Rock greenling	"		
e) Irish Lord			"
f) Walleye Pollack			"

Sample size will be 40 fish per region (12), per month (5), per habitat type (1 -2) per life history stage (2) for each primary species.

3. Surveys in the Kodiak area include offshore waters of the Marmot-Chiniak, Kiliuda Bay and southern Sitkalidak straits; these areas lie immediately offshore from the four sampling regions for R.U.552. Surveys of lower Cook Inlet are conducted in Kamishak and Kachemak bays offshore from primary study sites in this region.

4. Trawling in the Kodiak area is with a 61' NMFS shrimp sampling trawl and 5.5' x 7.5' Astoria "V" trawl doors. Trawling in lower Cook Inlet is done with a 400 mesh Eastern otter trawl and 5' x 7' Asotria "V" trawl doors. Survey areas will be covered with a stratified-random strategy so as to eliminate bias.

5. The OCSEAP - ADF&G biologist is responsible for assessment of all catch other than shellfish with an emphasis on juvenile finfish. Data on pelagic and demersal fishes are taken in an identical manner and on the same parameters as that described earlier for R.U.552.

6. It should be emphasized that these year-round surveys utilize data on incidental finfish species caught on ADF&G stock assessment cruises to supplement and enhance OCSEAP finfish studies at areas immediately inshore. All results will be synthesized into R.U.552.

D. Sample locations/ship or aircraft tracklines

Charts of the four sampling regions surveyed by R.U.552 and 553 including major depth contours and sampling strata are shown in Figures 2A through 2D. Unfortunately, data depicting precise locations of established sampling sites for each gear type are presently being utilized aboard the M/V YANKEE CLIPPER and unavailable for inclusion into this report. It must suffice to say at this time that all sampling sites are selected on the following basis: 1) to insure as uniform as possible spatial and depth distribution of effort by each gear type through each sampling region, and 2) to insure sampling sites with depth and bottom type consistent with the merits of the particular gear type in question. The planned number of fishing effort units by each gear type by cruise, sampling region and strata is shown in Table 3.

E. Data collected or analyzed

The total number of fishing effort units expended from April 1 through June 7 consists of 129 beach seine sets, 40 trammel net sets, 70 try net hauls, 41 tow net hauls, 37 gill net sets and 18 mid-water trawl hauls. A tabulation of these data by sampling region and cruise are shown in Table 4. Shown also in Table 4 is the number of stations established to date by gear type in each sampling region.

As per previously described in Section III C of this report and listing of data to be formatted under File Type 023 in the R.U.512 Project Proposal, a complete record of catch, location and gear parameters as well as methodological conditions for each unit of fishing effort is available. While these data have not yet been subjected to detailed analyses, they have been checked for accuracy and are ready to subject to computer analyses.

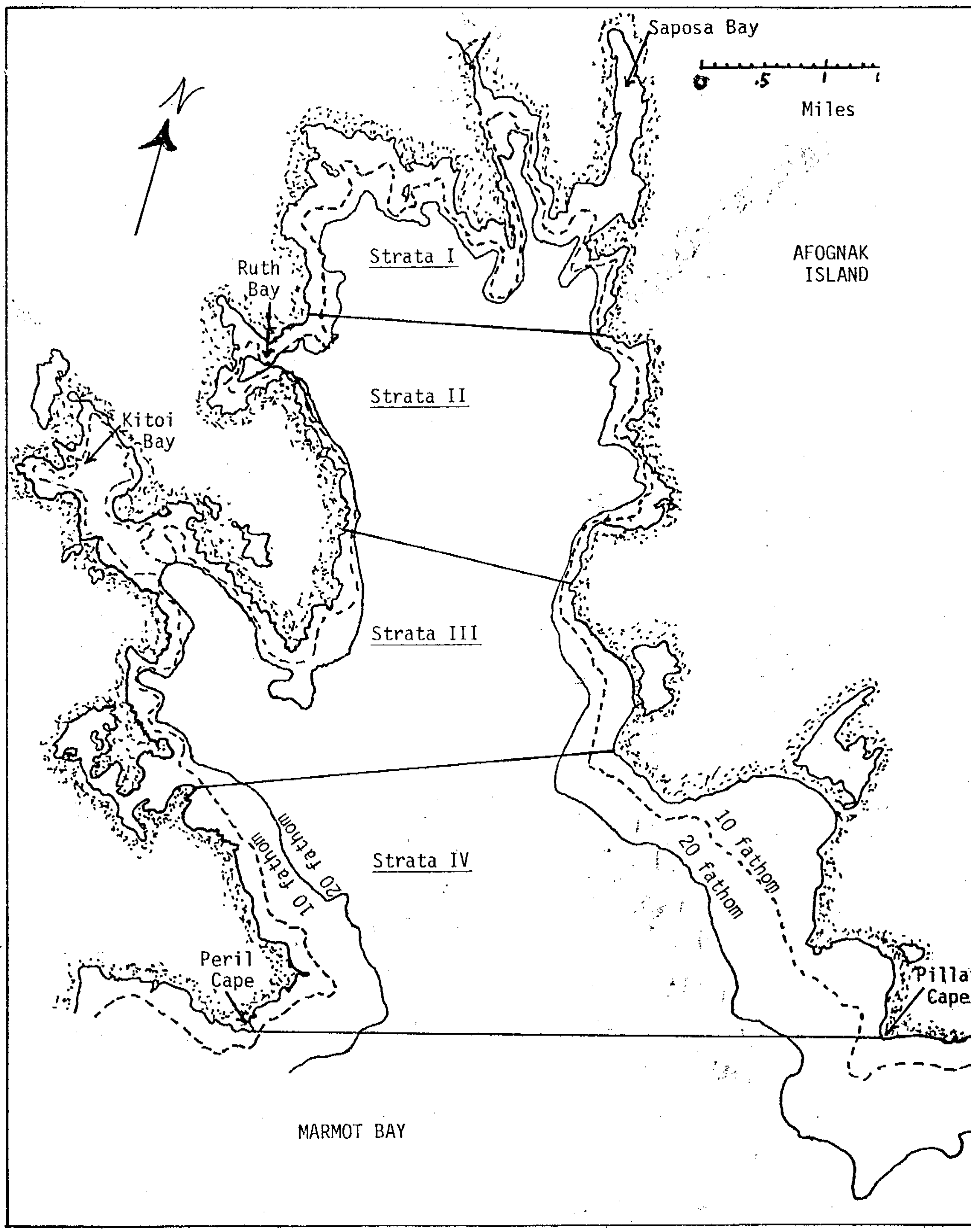


Figure 2A - Izhut Bay sampling region with 10 fathom (18.29 M) and 20 fathom (36.58 M) contours and sampling strata as utilized by R.U. 552 & 553 on Kodiak Nearshore Fish Assessment Study, 1978.

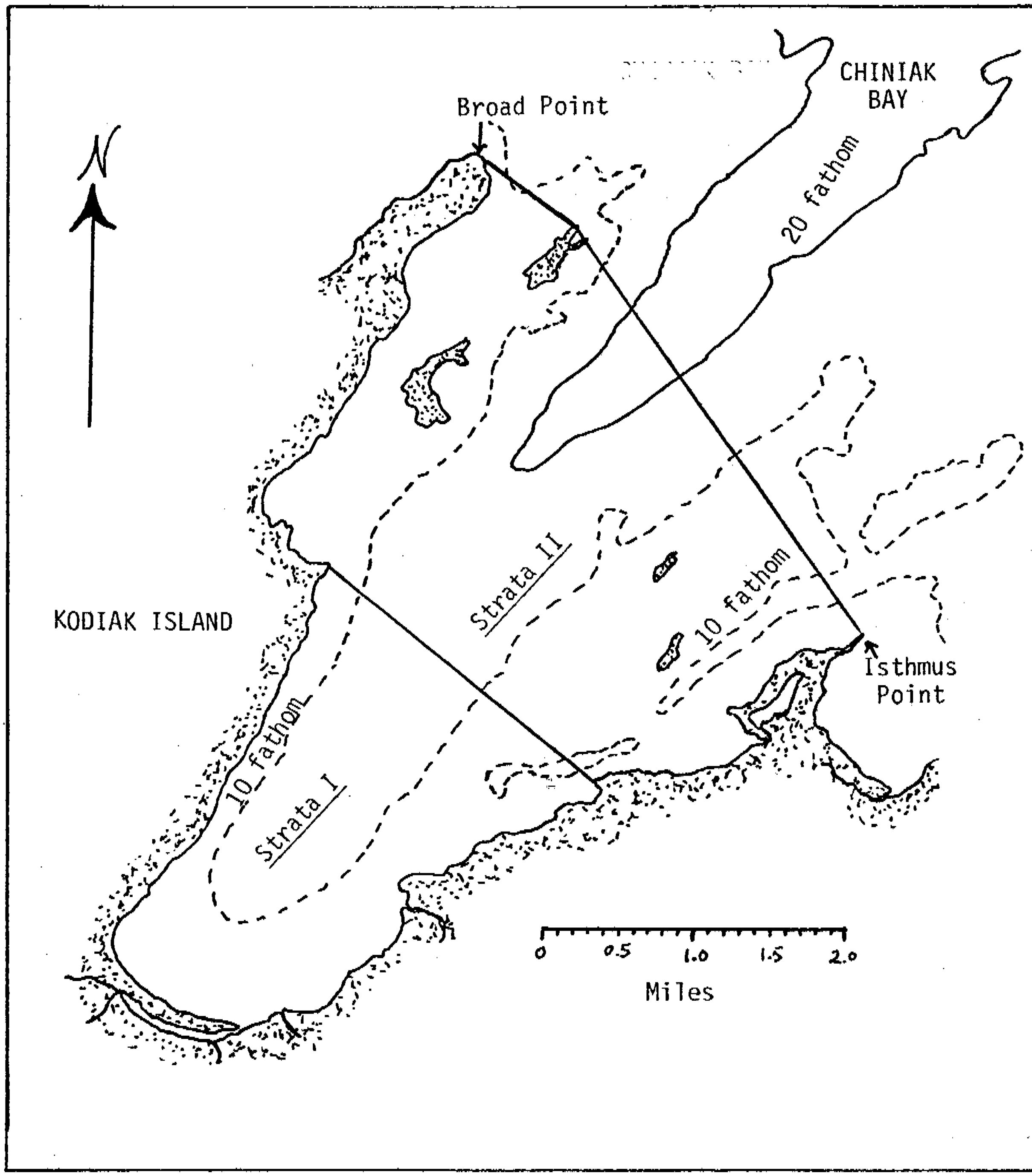


Figure 2B - Kalsin Bay sampling region with 10 fathom (18.29M) and 20 fathom (36.58M) contours and sampling strata as utilized by R.U.552 and 553 on Kodiak Nearshore Fish Assessment Study, 1978.

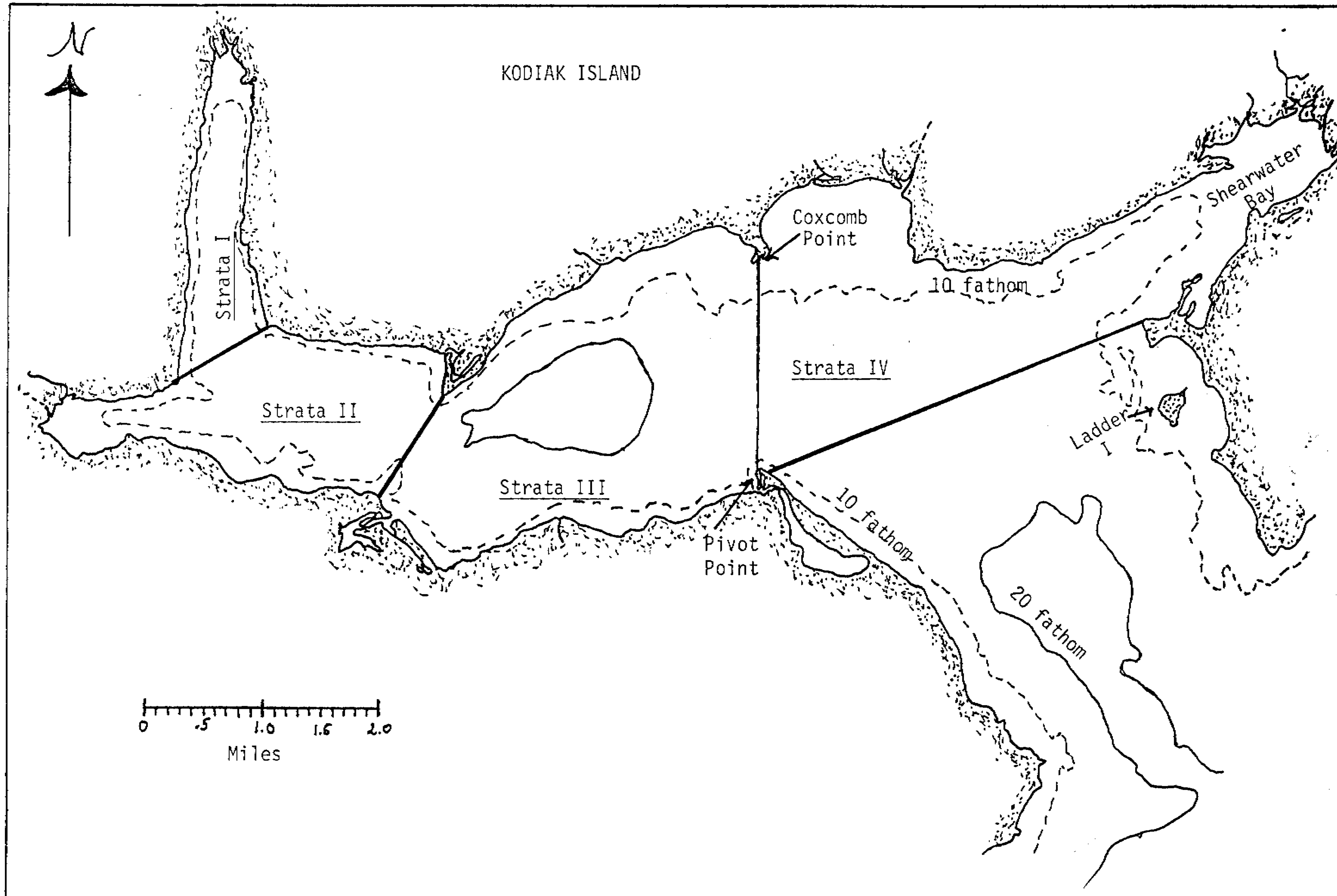


Figure 2C - Kiliuda Bay sampling region with 10 fathom (18.29M) and 20 fathom (36.58M) contours and sampling strata as utilized by R.U. 552 and 553 on Kodiak Island Nearshore Fish Assessment Study, 1978.

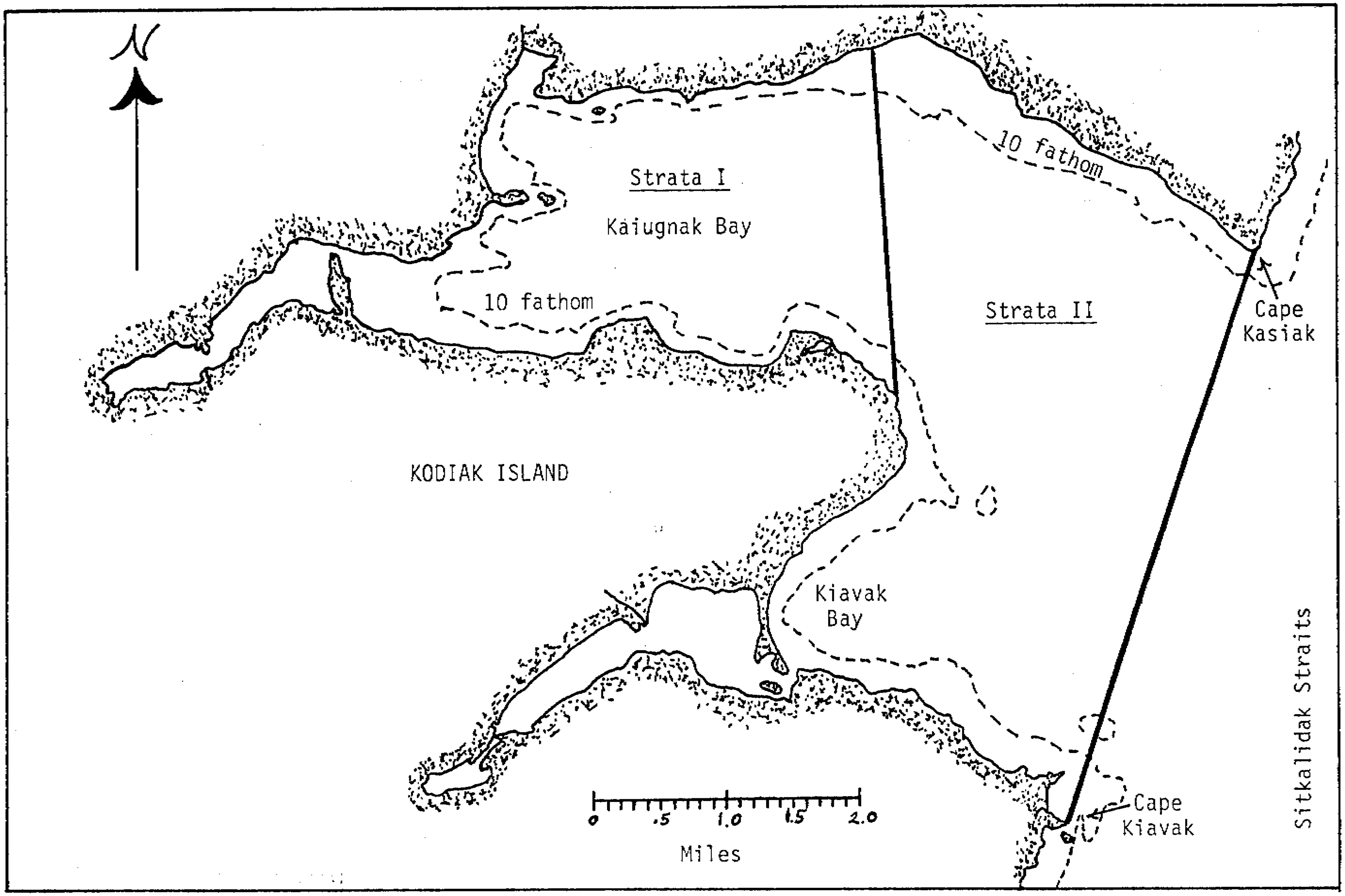


Figure 2D - Kaiugnak Bay sampling region with 10 fathom (18.29M) and 20 fathom (36.58M) contours and sampling strata as utilized by R.U. 552 & 553 on Kodiak Nearshore Fish Assessment Study, 1978

Table 3. Planned sampling intensity by region, strata and gear type for each monthly survey by R.U. 552 and 553.

Sampling Region	Strata	# of hauls planned* B.S.	Tml.Net	Mwt.	Tow Net	Try Net	Otter Trawl
Izhut Bay	1	6	3	3	8	4	0
	2	6	3	3	7	4	0
	3	6	3	3	7	4	3
	4	6	3	3	8	4	3
Kalsin Bay	1	6	3	3	8	4	0
	2	6	3	3	7	4	0
Kiliuda Bay	1	6	3	3	8	4	0
	2	6	3	3	7	4	3
	3	6	3	3	8	4	3
	4	6	3	3	7	4	0
Kaiugnak Bay	1	6	3	3	7	4	0
	2	6	3	3	8	4	0
Total Per Month		72	36	36	90	48	12
Total Per Season		360	180	180	450	240	60

*B.S. = Beach Seine GN = Gill Net Tml = Tramme Net Mwt. = Midwater Trawl

IV. Results

Other than the tabulations of effort levels by sampling locations and gear type shown earlier in this report, data obtained to date for R.U. 552 have not yet been subjected to detailed analyses other than reveiw for accuracy, completeness and adherence to data format. Catches have been made in nearly every haul of all gear types except the mid-water trawl. This latter result is not wholly unexpected based on the performance of this gear type by R.U. 487 in FY 76. Preliminary interpretations of catch results will be shown in Section V.

V. Preliminary Interpretation of Results

1. Progressive and substantial increases in total catches by all gear types in all areas between the April, May and June surveys. These increases were especially pronounced between May and June.
2. Preliminary examination of data suggests little change between months in catch composition, but obvious increases of total fish caught.
3. An exception to (2) above is abundance of king crab (*Paralithodes camtschatica*) which were caught in try nets at the rate of approximately three per haul in April, one per haul in May, and less than one-third per haul in June. Based on this author's experience with this species and work by Powell (1969), king crab tend to inhabit shallow (2-20 fathom) water during the Spring mating and molting period, after which they migrate into deeper waters. This is borne out further by the fact that the M/V COMMANDO (Fisheries Research Institute vessel) trawling immediately

Table 4. — Effort by survey area and gear type - Kodiak Nearshore Fish Assessment, 1978

Area Cruise	Gear Type: Beach Seine	Trammel Net	Try Net	Tow Net	Gill Net	Midwater Trawl
Kalsin Bay	12*	5*	9*	12*	5*	4*
B-1(April)	10	3	11	0	0	0
B-2 (May)	12	5	9	11	5	0
B-3 (June)	12	4	7	3	4	4
Subtotals	34	12	27	14	9	4
Ishut Bay	23*	8*	12*	8*	6*	4*
A-1(April)	18	5	13	8	0	0
A-2 (May)	16	6	15	0	7	4
Subtotals	34	11	28	8	7	4
Kiliuda Bay	23*	7*	5*	12*	9*	6*
C-1(April)	24	4	5	12	7	4
C-2 (May)	21	7	6	7	8	4
Subtotals	45	11	11	19	15	8
Kaiugnak Bay	12*	4*	2*	0*	5*	2*
D-1(April)	4	2	2	0	1	2
D-2 (May)	12	4	2	0	5	0
Subtotals	16	6	4	0	6	2
GRAND TOTALS	129	40	70	41	37	18

*Number of established stations

offshore from R.U.552 study area in 60-70 fathom waters is catching many more king crab. Further, king crab appear to be in less abundance in Izhut Bay than in the remaining three sampling regions.

4. The most productive gear types are the try net which is fished from the M/V YANKEE CLIPPER for benthic finfish and shellfish and the 155' beach seine which fishes the intertidal areas.

5. Obvious increases between months in mean size of juvenile salmonids, primarily pink salmon (*Oncorhynchus gorbuscha*).

6. Diversity of finfish species between sampling regions appears to be relatively stable.

VI. Auxiliary Material

A. Bibliography of References

1. Blackburn, J.E. 1973. A survey of the abundance, distribution and factors affecting distribution of icthyoplankton in Skaget Bay. M.S. Thesis, University of Washington, Seattle, Washington. 136 pp.

2. Hart, J.L. 1973. Pacific Fishes of Canada, Bulletin 180. Fisheries Research , Bd. Canada, Ottawa. 740 pp.

3. Powell, G.C. 1969. Some aspects of king crab biology. Proc. American Fisheries Society West Division Meeting, Jackson Hole, Wyoming. pp.142-143.

4. Wilimovsky, N.J. 1973. A survey of the abundance, distribution and factors affecting distribution of icthyoplankton in Skaget Bay. M.S. Thesis, University of Washington, Seattle, Washington. 136 pp.

B. Papers in Preparation or in Print

The project completion report for Kodiak Nearshore Studies in FY 76 (R.U. 486: Demersal fish & shellfish assessment in selected estuary systems of Kodiak Island) was completed during this quarter by P.I. James Blackburn.

C. Oral presentations: Brief review by James Blackburn of R.U. 552 at OCSEAP Hydrobiology Meeting in Santa Cruz, California during mid April, 1978.

VII. Problems Encountered and Recommended Changes

1. Failure to achieve desired sampling goals due to R.U. 553 (FRI) stomach processing taking longer than expected. This problem has been partially solved by reorganization of shipboard procedures, but has still resulted in sampling goals of R.U. 552 and 553 falling short of those originally planned. If similar integrated work occurs in FY 79, sampling plans and goals of all cooperating agencies should be jointly reviewed to insure their compatability.

2. Recall of OCSEAP owned 25 h.p. outboard engine currently being used by R.U. 552 and R.U. 553 by Juneau Project Office in order to use for other work. This request, while complied with, cause the unplanned expense of renting a replacement engine.

3. Scheduling of program review meeting during the first month of the FY 78 field season. It is during this time that P.I.'s must be in the field

getting programs started and orienting crews. Such meetings could more effectively be scheduled in late fall or winter.

4. Increased sampling time aboard research vessel precludes plans to take three days per month off charter. This will necessitate terminating the M/V YANKEE CLIPPER charter effective 8/21/78 rather than on 8/31/78 as originally planned unless an additional $10,450 becomes available. In the event early termination is necessary, the vessel owner must be informed of this fact by 7/20/78. The Juneau Project Office was informed of this matter on 6/19/78.

VIII. Estimate of Funds Expended

Personnel Services	$58,568.03 *
Travel	3,863.87
Contractual Services	2,602.37
Commodities	5,262.15
Equipment	1,409.40
	$71,705.78

*Projects salaries of permanent employees thru 9/30/78.

QUARTERLY REPORT

Contract No: 03-5-022-67
Research Unit: 553
Reporting Period: 1 April - 30 June 1978

Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Zone of Kodiak Island - Including Ichthyoplankton, Meroplankton, Forage Fishes, Marine Birds and Marine Mammals. Part A: A Report on the Ichthyoplankton Component of the Study.

Douglas Rabin and Donald E. Rogers
Fisheries Research Institute
University of Washington
Seattle, Washington 98195

July 1, 1978

I. Task Objectives

1. Determine spring and summer composition, inter-bay distribution, and relative abundance of planktonic stages of fishes, shrimp and crab.

2. Determine seasonal development and succession of selected commercially and ecologically important fish and invertebrate species.

3. Determine general relationships between seasonal changes in oceanographic conditions and the timing of occurrence and distribution of selected species or species assemblages.

II. Field or Laboratory Activities

A. Field work was initiated in late March from the R/V Commando. Six two-week cruises have been completed and cruise VII is in progress. During each (two-week) cruise, five stations were sampled per bay area with both the neuston and bongo nets. Bottom substrates permitted epibenthic-sled tows at two stations per bay area (Table 1, Figs. 1A and 1B).

Our diel (day-night) sampling is conducted once at mid-day and once at night. Five-minute horizontal tows are made at discrete depths--specifically, -10, -30, -50, -70, and -90 meters. In addition to these samples, double oblique Tucker trawl tows are made to -90 m with 505 μ and 3 mm mesh nets. Concurrent surface tows with the neuston sampler are also made. We added sampling sites close to the nearshore stations in Izhut and Kiliuda bays where surface and/or bottom trawl samples are taken by ADF&G. The additional sampling includes three stations per bay, and at each station neuston and double oblique bongo samples are taken. Samples from cruises I-IV have been sent to a commercial sorting center for zooplankton separation.

B. Fish eggs and larvae collected during cruises I and II were returned from the sorting center and are currently being identified and stored in a buffered formalin solution for future reference.

Additional laboratory activities include the typing of unknown species in cooperation with offshore ichthyoplankton investigators (RU 551).

III. Results

Fish larvae from late March and early April samples have been identified or typed for future identification. Larvae from families Ammodytidae (sandlance), Cottidae (sculpins), Hexagrammidae (greenlings), and Stichaeidae (pricklebacks) were relatively abundant. Larvae from families Agonidae (poachers), Bathymasteridae (ronquils), Cyclopteridae (snailfishes), Gadidae (codfishes), Osmeridae (smelts), Pholidae (gunnels), and Pleuronectidae (righteye flounders) have also been identified.

IV. Preliminary interpretation of Results

An interpretation of the results must be general and tentative at this time due to the recent commencement of laboratory activities. Accordingly, the laboratory findings indicate:

a. Larval stages of forage fishes, such as sand lance and snake prickleback , were present in the early spring period.

b. Occurrence of greenling larvae in surface (neuston) samples was relatively high.

V. Problems Encountered and Recommended Changes: None.

Table 1. Station locations for Kodiak Island nearshore zooplankton research, 1978.

Bay	Station	Latitude		Longitude		Gear used*
Izhut	Z1	58	13	152	17	N,B
	Z2 (diel)	58	10	152	14	N,B,T,S
	Z3	58	06	152	10	N,B,S
	Z4	58	08	152	03	N,B
	Z5	58	05	152	18	N,B
	Z6**	58	15	152	16	N,B
	Z7**	58	13	152	18	N,B
	Z8**	58	11	152	20	N,B
Kalsin-Chiniak	C1	57	37	152	25	N,B
	C2	57	41	152	19	N,B,S
	C3	57	44	152	14	N,B,S
	C4	57	42	152	04	N,B
	C5	57	38	151	55	N,B
Kiliuda	L1	57	19	153	02	N,B
	L2 (diel)	57	16	152	55	N,B,T,S
	L3	57	12	152	45	N,B,S
	L4	57	16	152	37	N,B
	L5	57	36	152	54	N,B
	L6**	57	20	153	09	N,B
	L7**	57	18	153	06	N,B
	L8**	57	20	152	55	N,B
Kaiugnak	G1	57	04	153	36	N,B
	G2	57	01	153	29	N,B,S
	G3	56	56	153	27	N,B,S
	G4	56	58	153	14	N,B
	G5	56	52	153	35	N,B

*N = neuston, B = bongo, T = Tucker, S = sled.

**Stations added 5/78.

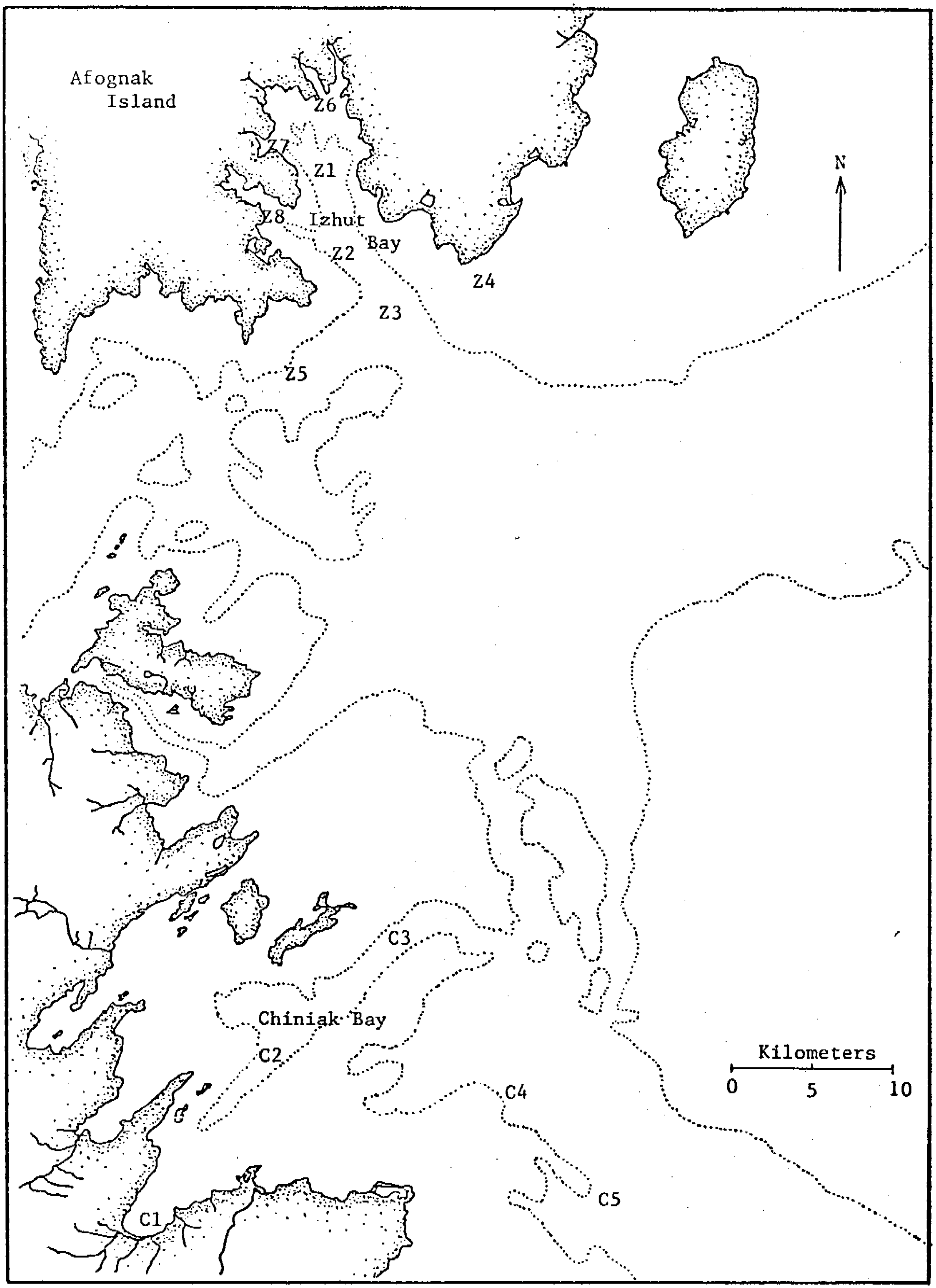


Fig. 1A. Station locations for Kodiak Island nearshore zooplankton research, 1978.

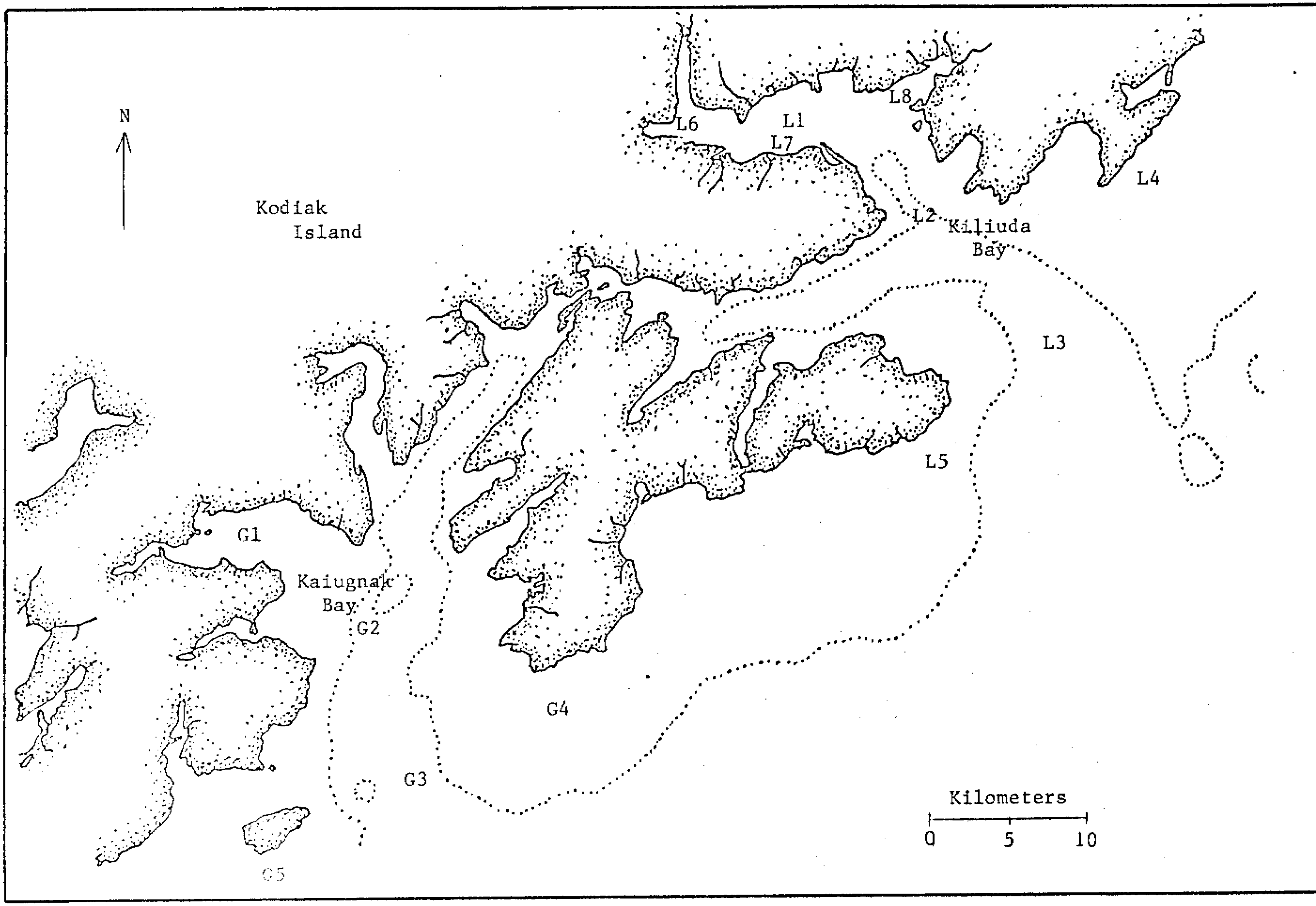


Fig. 1B. Station locations for Kodiak Island nearshore zooplankton research, 1978.

QUARTERLY REPORT

R.U. #562 Oil Pooling Under Sea Ice
NOAA R.D. No. RK-8-0065
Report Period: 1 April 1978 to
30 June 1978

Oil Pooling Under Sea Ice

Principal Investigator: A. Kovacs

U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755

25 June 1978

I. Task Objectives

The purpose of this project is to:

a. Determine the cause of the significant relief which exists under the fast ice.

b. Measure the variations in the relief under fast ice using impulse radar.

c. Determine if the under ice relief is a series of individual pockets or consists of long rills.

d. Estimate the quantity of oil which could pool up in the under ice depressions should oil be released under the ice cover.

e. Use impulse radar to study the electromagnetic properties and anisotropy of sea ice.

II. Field/Laboratory Activities:

During this quarter, field investigations were performed in the general area of Prudhoe Bay, Alaska, to investigate, through the use of impulse radar, the relief under first year sea ice and its anisotropic and electromagnetic properties.

III. New Results:

Impulse radar studies confirmed the findings of Kovacs and Morey (1978) that below the transition zone (the first 10 to 30 cm depth) in first year ice the "bottom ice" has a preferred horizontal c-axis azimuthal orientation which is aligned with the prevailing current direction. In areas of no under ice current, the c-axis was also found to be horizontal but was randomly orientated. DC resistivity measurements, made in 30° increments about a point, revealed no variation which could be correlated wiht the preferred crystal structure of the bottom ice. This is in direct contast with the results of

Kohnen, as reported under R.U. #88, who made DC resistivity measurements at 60° increments about a point.

Under ice relief was determined, as expected, to be caused by variations in snow cover thickness and not the result of current effects. Bottom relief of up to 20 cm was measured. The bottom pockets tended to be oblong as were the major drift patterns.

Initial results from using a polarized radar antenna in the air from the NOAA helicopter indicate that sea ice c-axis anisotropy can be determined from the air. Because this anisotropy is related to current direction, it should therefore be possible to measure current direction in the winter time under the sea ice from an airborne platform.

A laboratory investigation has been initiated to reproduce the c-axis vs current observations noted in the field. Preliminary findings verify that sea ice crystal c-axis alignment is current related.

Analysis of field data is in progress.

IV. Reports referenced:

Kovacs, A. and R. M. Morey (1978) Radar anisotropy of sea ice due to preferred azimuthal orientation of the horizontal c-axis of ice crystals AIDJEX Bulletin No. 38. Revised version to appear in Journal of Geophysical Research (Oceans and Atmospheres).

Reports submitted for publication:

Kovacs, A. (1978), Remote detection of water under ice covered lakes on the North Slope of Alaska, Remote Sensing of Environment.

V. Estimate of Funds Expended (as of 20 June 78).

Funded at	$26,000
Spent	20,000
Remainder	$ 6,000

QUARTERLY REPORT

03-78-DO-1-61

Research Unit: 567

Reporting Period: 1 May - 30 June 1978

Number of Pages: 3

THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE

Max D. Coon

R. S. Pritchard

Flow Research Company
A Division of Flow Industries, Inc.
21414-68th Avenue South
Kent, Washington 98031

I. Abstract:

This is the first quarterly report for this project and the main accomplishment was a planning meeting between ARCTEC Corporation and Flow Research Company, who are sharing the responsibility for this program.

II. Task Objectives:

The goal of the proposed work is to determine the locations to which oil spilled in or under the ice cover near Prudhoe Bay, Alaska, would be transported and to determine the behavior of the oil as the ice cover moves and deforms. Two separate tasks have been given Flow Industries. First, to determine a range of velocity fields which might be taken by the ice cover on the continental shelves of the Beaufort and Chukchi Seas by numerical modeling and synthesis of the results with manned and drifting station data. These velocity fields shall represent the climatological mean (or most probable) and extremes. As part of this task major breakouts of the ice from the Chukchi into the northern Bering Sea shall be considered. The second task is for the overall management of the program as well as to determine the likely trajectory and destination points for oil in several hypothetical scenarios by combining the relevant information obtained.

III. Field or Laboratory Activities:

None.

IV. Results:

The meeting was held at Flow Research Company in Kent, Washington, with representatives from Flow (Max Coon, Bob Pritchard) meeting with Larry Schultz of ARCTEC, Inc., on June 5-7, 1978. Gunter Weller attended the meeting on June 6. This meeting was a first planning meeting for the work to be conducted on this contract. The experiments to be conducted by ARCTEC were discussed, and a schedule for the first experiments outlined. The modeling calculations required to calculate mean and extreme trajectories of sea ice were outlined. The interaction of the ARCTEC experiments and the modeling of trajectories were considered. An outline for oilspill scenarios was developed. Also Max Coon agreed to prepare a program management plan to be submitted to Gunter Well in July 1978. A series of meetings have been planned to coordinate the work between Flow Research and ARCTEC. Max Coon will visit ARCTEC in October 1978 and either March or April of 1979. And Larry Schultz will again visit Flow Research in January 1979.

V. Preliminary Interpretation of Results:

None.

VI. Auxiliary Materials:

None.

VII. Problems Encountered/Recommended Changes:

None.

VIII. Estimate of Funds Expended:

As of 9 June 1978 actual expenditures under this contract total $10,947. The estimated obligations for the remainder of June are $10,404.

Quarterly Report

Contract No.: 03-78-B01-62
Research Unit: 568
Reporting Period: 1 May-30 June 1978
Number of Pages: 2

THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE-TASK 1

Paul Deslauriers

Lawrence A. Schultz

ARCTEC, Incorporated
9104 Red Branch Road
Columbia, Maryland 21045

July 1, 1978

I. TASK OBJECTIVES

The objective of Task 1 of the program is to determine by field and laboratory experiments the physical processes by which spilled oil gets incorporated in, and transported in and under, sea ice. The objectives of three subtasks are further stated as follows:

Subtask 1.1 - To determine how and at what rates oil moves upward through multi-year ice to the surface.

Subtask 1.2 - To determine how and at what rates oil gets incorporated into pressure ridges formed from ice of various thicknesses.

Subtask 1.3 - To determine how oil of different viscosities spreads and is moved by ocean currents under sea ice with different underside roughness characteristics.

II. FIELD OR LABORATORY ACTIVITIES

A. Ship or Field Trip Schedule

None

B. Scientific Party

None

C. Methods

Not Applicable

D. Sample Localities

Not Applicable

E. Data Collected or Analyzed

None

III. RESULTS

Work began on this project during this quarter with the major effort devoted to the preliminary development of preferred formulations for the various oil-ice interaction phenomena of interest. A major project meeting with the Principal Investigators for Tasks 2 and 3, and the COTR, resulted in an improved understanding of the work and interaction of all project participants, a restructuring of the laboratory tests comprising Task 1, and a redefinition of the hypothetical oil spill scenarios forming the basis for the