Environmental Assessment of the Alaskan Continental Shelf

Program Work Statements

FY 1979

Volume I

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

U.S. DEPARTMENT OF INTERIOR
Bureau of Land Management

1979 Work Statements

OUTER
CONTINENTAL
SHELF
ENVIRONMENTAL
ASSESSMENT
PROGRAM

WORK STATEMENTS
FOR FISCAL YEAR 1979
(October 1, 1978 - September 30, 1979)

VOLUME I

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL RESEARCH LABORATORIES
BOULDER, COLORADO 80303

April 1979

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The costs figures stated may not be the final figures agreed upon because modifications made in the budget were not always reflected in the work statements.

CONTENTS

VOLUME I

For information purposes the contents of Volume II are also given.

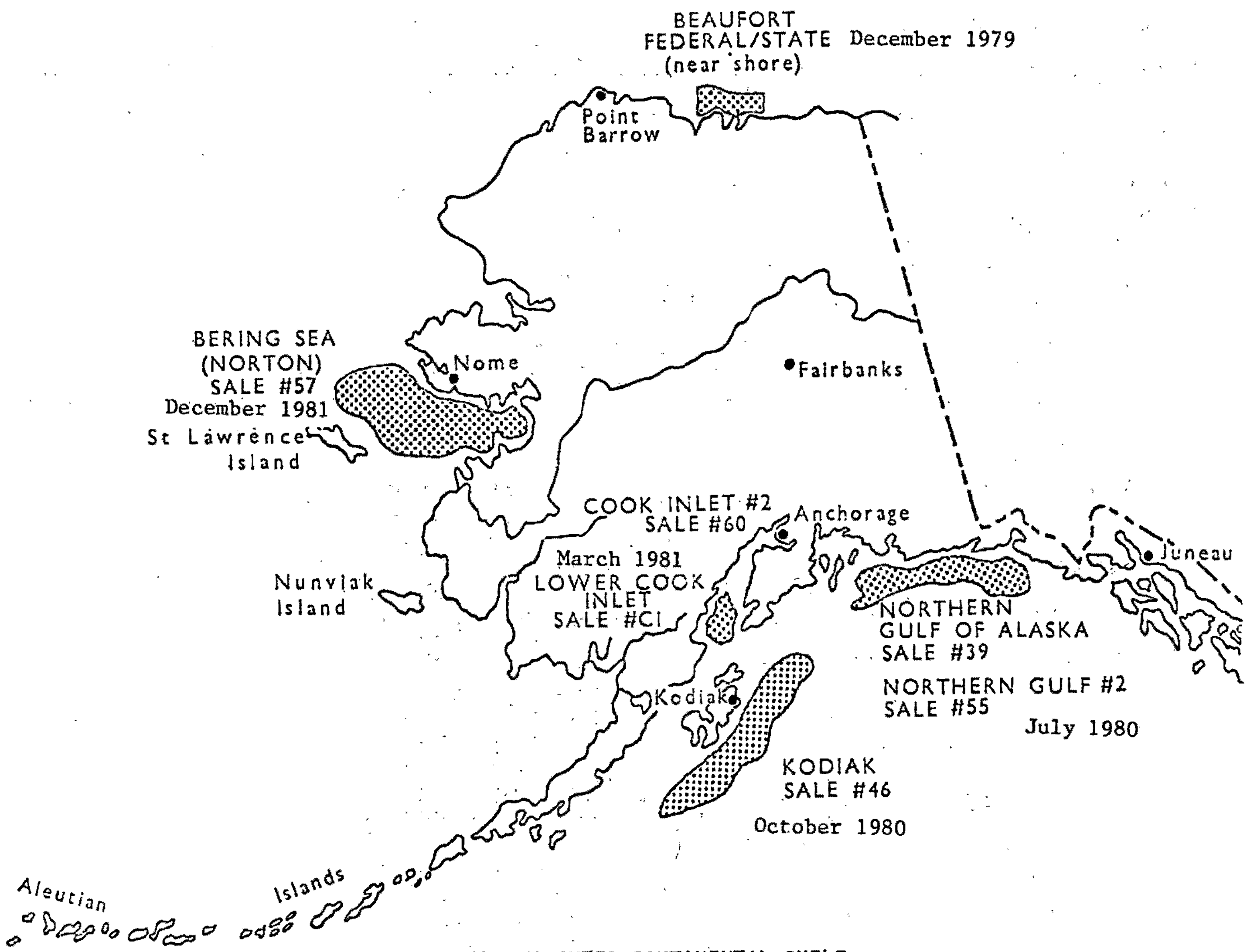
CONTENTS

VOLUME II

TABLE I

Distribution of Research Units in Lease Areas

Aleutians	Beaufort	Bristol Bay	Chukchi Sea	Kodiak	Lower Cook Inlet	NEGOA	Norton	St. George	Non-Site Specific
16	6	3	88	3	3	3	88	16	71
138	29	87	194	5	5	5	152	83	72
289	88	141	230	108	29	59	153	87	73
337	91	196	232	138	48	194	190	141	267
	105	232	460	194	138	212	194	196	350
	172	435	541	229	152	229	196	230	436
	190			243	153	243	208	232	497
	194			251	190	289	230	435	516
	196			289	194	341	232		527
	204			327	243	351	237		557
	205			341	251	417	435		563
	230			551	275		480		
	232			552	289		541		
	250			553	327				
	253				341				
	265				417				
	271				424				
	356				425				
	359				430				
	467				480				
	473				512				
	483								
	519								
	526								
	529								
	530								
	531								
	537								
	562								
	567								
	568								



ALASKA OUTER CONTINENTAL SHELF

AREAS PRESENTLY SCHEDULED FOR LEASING

COVER SHEET FORMAT

Proposal/Revision Date: 1 June 1978

To: Appropriate Project Office

Contract #: 03-5-022-69

NOAA Project #:

Institution ID#:

FY 1979 RENEWAL PROPOSAL

Research Unit Number 3

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

Cost of Proposal: $ 51,500 Lease Areas

Lease Area	%
NEGOA	10 %
LCI	50 %
Bristol Bay	40 %

(If joint proposal, show cost for each institution; if more than one fiscal year, show cost for each year - SEPARATE BUDGET SHEETS ALSO REQUIRED)

Period of Proposal: October 1, 1978 through September 30, 1979
(If proposal is for other than this period, please explain)

PRINCIPAL INVESTIGATOR(S):

Name Paul D. Arneson Date August 31, 1978

Signature Paul D. Arneson

Address 333 Raspberry Road, Anchorage, 99502

Telephone Number (907) 344-0541 FTS:

INSTITUTION (include Department, if appropriate)

Alaska Department of Fish and Game, Game Division

REQUIRED ORGANIZATION APPROVAL:

Name Ronald O. Skoog Date 9/8/78

Signature Carl L. Rosier for

Position Commissioner

Address Subport Building, Juneau, AK 99801

Telephone Number 465-4100

ORGANIZATION FINANCIAL OFFICER:

Name John Stewart Date 9/11/78

Signature

Position Fiscal Officer

Address 219 S. Franklin, Juneau, AK 99801

Telephone Number 465-4120

TECHNICAL PROPOSAL

I. Title: Identification, documentation and delineation of coastal migratory bird habitat in Alaska.

Research Unit: #3
Contract No: 03-5-022-69
Proposed Dates of Contract: October 1, 1978 to September 30, 1979

II. Principal Investigator: Paul D. Arneson

III. Cost of Proposal

A.	Science	$51,800
B.	P.I. provided Logistics	-0-
C.	TOTAL	$51,800
D.	Distribution of Effort	
	Lower Cook Inlet	50%
	Bristol Bay	40%
	NEGOA	10%

IV. Background:

Data on coastal birds and their habitat have been gathered since September 1975 in most areas from Cape Fairweather to Cape Newenham. Most information was gathered for the Lower Cook Inlet lease area because of a study done in cooperation with the Alaska Department of Fish and Game, Marine/Coastal Habitat Management Section in 1976. Seasonal bird distribution and abundance data were gathered. In other lease areas only partial seasonal data are available. Also, in cooperation with marine mammal observers at Cape St. Elias, marine bird data have been gathered during spring migration in NEGOA.

Only cursory narrative reports have summarized this data to date. A much more comprehensive analysis needs to be made to properly interpret the data and put it into proper prospective. It is hoped that the relative importance of each lease area to coastal marine birds can be discerned from the appropriate analyses.

V. Objectives:

To analyze all data on the seasonal distribution and abundance of coastal marine birds.

To summarize this bird data in a form most useful for future decision making on oil and gas leasing of the outer continental shelf.

To graphically and pictorially present coastal bird information so that the relative importance of lease areas or areas within lease areas are readily apparent.

VI. Strategy and Approach:

A. Sampling Method: All field sampling will be completed by September 1978 so that only analytical methods will be conducted during FY 1979.

B. Analytical Methods:

Computer programs will be written to summarize the data by species, geographic area, season, habitat and density. If applicable, statistical tests will be run to determine significant differences among habitats, seasons and geographic areas. Visual representations of differences will be portrayed in graphs and figures.

VII. Deliverable Products:

1. Digital Data: Attached is a list of checked parameters that have been collected during the duration of this project and that will be submitted in final form during FY 1979.

2. Attached is a list of maximum/minimum values for those parameters that were collected.

3. In order to insure that digital data is accurate, an initial check for obvious errors is made of the data immediately after transcription. It is submitted to a keypuncher who also verifies their accuracy. After keypunching, data is checked again line by line for errors. It is resubmitted to the keypuncher for those corrections. Data is then rechecked to make sure all corrections were made. In addition, a technique devised by Mike Crane, EDS, Anchorage is used to verify if data is correct by reordering species groups and by special arrangement of data in vertical columns.

B. Narrative Reports:

Most data for this research unit has been gathered in Lower Cook Inlet. Therefore, a comprehensive report on bird distribution and abundance will be submitted for this region. This will include sampling locations, frequency and duration; methods; critical habitata; literature review.

Several other narrative reports and/or publications are possible from the data gathered but insufficient funding may limit the extent of analysis for these reports. These include a comprehensive analysis of habitat utilization and distribution and abundance of birds in all regions studied, a more detailed report on the birds in Bristol Bay, a report on the spring migration of birds past Cape St Elias, and a winter bird population estimate for Kodiak Island.

File Type 040

Bird Habitat

Common to all records
- File Type
- File Identifier
- Record Type
- Station Number

Record Type 1 - Header Record
- Latitude/Longitude
- Date/Time/Elapsed Time
- Survey Condition Code
- Distance Surveyed/Area
- Sampling Technique
- Platform Type Code
- Speed/Altitude of Platform
- Photos Taken

Record Type 2 - Environmental
- Surface Temperature/Salinity
- Dry/Wet Bulb Temperature
- Relative Humidity
- Barometric Pressure/Trend
- Wind Direction/Speed
- Sea State/Swell Direction/Height
- Weather/Cloud Type/Amount
- Water Color/Visibility
- Sun Direction/Glare Intensity Codes
- Glare Area Code/Light Level
- Moon Phase Code
- Tide Height Code/Tide Trend
- SECCHI Disk Depth
- Debris Code

Record Type 3 - Ice Record
- Ice Inside/Outside Transect
- Open Water
- Visible Ice
- Misc/Other Features

Record Type 4 - Habitat Record
- Sequence Number
- Taxonomic/Subspecies Codes
- Species Group
- Number of Individuals
- Habitat Code
- Behavior
- Direction of Birds'Flight
- Distance from Shore to Birds

Record Type 4 (continued)
- Distance from Barrier Island/River Delta
- Depth at Observation
- Molt/Color/Plummage Codes
- Age Class/Sex Codes
- Association Codes
- Number of Species Participating
- Number of Species in Flock
- Counting Method Code

Record Type 5 - Text
- Sequence Number
- Text

Parameter Maximum/Minimum Values

Parameter	Limits
Record Type 1	
Latitude	50°to 61°
Longitude	137° to 170°
Date	Oct. 75 to Sept 78
Elapsed time	1 to 60 min.
Distance surveyed	0.1 to 115 km
Speed	90 to 250 km/hr.
Altitude	15 to 150 m
Record Type 2	
Temperature	-2 to 24°C
Wind speed	0 to 65 km/hr.
Record Type 4	
Number of individuals	1 to 99,999

C. Visual Data:

It is anticpated that much visual material will be prepared for the final report in the form of maps, figures, graphs and tables. Where applicable, mylar overlays will be prepared in standard OCSEAP format.

Maps and figures will include coastal bird distribution and densities in the various lease areas where data was gathered. For lower Cook Inlet and Bristol Bay, maps will depict the locations of all known bird colonies and foraging areas. Maps showing migration staging areas and migration corridors will be drawn.

Tables of bird numbers and densities by season and location will be presented. Also, tables of bird habitat preferences will be included.

E. Data Submission Schedule: See attached form.

VIII. Voucher Specimens: No sampling will be done in FY 1979.

IX. Logistics Requirements: No logistical support is necessary because only final report writing will be conducted.

X. Anticipated Problems:

An immediate problem is evident because of the funding level and product requirements listed in the guidance letter. Three separate final reports were required at a funding level of $30,000. It will be impossible to do a thorough analysis and write three adequate final reports for that amount of money. It could be expected that a thorough report with professional quality maps and figures could only be completed for the Lower Cook Inlet region for the amount of money suggested.

Reports for other areas studied including Bristol Bay and NEGOA would take additional analysis and therefore time. The entire FY 79 would be needed to do an adequate job of summarizing that past three years' field work. In all, 31 surveys have been conducted through May 1978 and over 20,000 records need to be analyzed.

The principal investigator's entire salary, time for a cartographer, computer and programming time, plus overhead all would come out of the allotted funds. Because the guidance funding level was not considered sufficient to do the proper job, a revised cost proposal has been included for evaluation. The new funding level was calculated to be $51,800. For this amount of mcney the following reports can be anticipated:

1. A comprehensive summary of seasonal bird use of Lower Cook Inlet. (16 of 31 surveys have been in this lease area so information is the most complete).

DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
1. Birds-aerial transects	Disks	1500 records	040	yes	April 78 to May 78	October 78
2. Birds-ground/ boat counts	Disks	500 records	040 or 033	yes	June 78 to August 78	October

2. A comparison of distribution and abundance of birds to include critical or sensitive areas for all regions studied.

3. A comparison of habitat use by bird species and geographic area.

4. A summary of the information being gathered by marine mammal observers on the spring migration of birds past Cape St. Elias.

5. A population estimate of nearshore wintering birds on Kodiak Island could be completed.

6. A publication on birds of Bristol Bay to include more data than that shown in reports #2 and 3 above would be attempted.

In my estimation it would be a grave error not to properly analyze, summarize and produce all the information that has been gathered since September 1975 under RU #3. For this reason, I am suggesting the increase in funds from $30,000 to $51,800. Lumping of a large amount of data into a few reports would likely make them unwieldy and confusing. I feel it would be best to write the reports on a more homogeneous subject matter. There would be a few more reports, but they would be less confusing and more readable.

XI. Information required from Other Investigators:

The information most useful to properly interpret bird distribution and abundance will come from bird food habit studies (Gerry Sanger) and food availability (Dennis Lees, Howard Feder, Tom English, Jim Blackburn and perhaps others). No problems are anticipated in gathering necessary data directly from the appropriate PI.

XII. Milestone Chart: See attached copy.

XIII. Outlook: No major gaps in knowledge are expected so that the final reports can be properly completed by the end of FY 1979.

XIV. The following standard statements will be adhered to:

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. If necessary quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or syntheses meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA Form 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U. S. Government pending disposition at contract expiration. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor" (no equipemnt will be purchased in FY 79).

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

JAY S. HAMMOND, GOVERNOR

333 RASPBERRY ROAD
ANCHORAGE 99502

August 31, 1978

Dr. Herbert E. Bruce
Bering Sea-Gulf of Alaska Project Manager
OCSEAP-NOAA
P.O. Box 1808
Juneau, Alaska 99802

Dear Herb:

The following are additions and corrections to the FY79 renewal proposal for RU#3 as per your most recent guidance letter dated 15 August 1978.

1. It is acknowledged that funding for FY79 will be $51,500.00 if the following changes meet with your approval.

2. Enclosed is a completed signature page containing all pertinent signatures, titles and addresses.

3. A Technician III will be hired upon acceptance of this proposal and the appropriation of necessary funding. It is unknown at present who will fill the position but at the time of hire the qualifications sought are: 1) Minimum of a bachelors degree in biology, zoology, wildlife management or related field. 2) An adequate knowledge of Alaskan birds. 3) Completed coursework in statistics and preferably computer science. 4) Expresses an interest and aptitude in the type of work being done for OCSEAP.

   The most qualified and best suited person who applies will be hired but I do not know who is presently available. Also, I may hire a person with cartographic experience on a short-term basis to appropriately display the material in figures, graphs and maps.

4. Objectives since the inception of the project have been:

   FY76 Gulf of Alaska, Bristol Bay; FY77 Bristol Bay, Aleutian Shelf.

   1. To summarize and evaluate existing literature and unpublished data on the distribution, abundance, behavior and food dependencies of birds associated with littoral and estuarine habitat.

   2. To delineate the storm-tide line and characterize vegetative types (bird habitats) seaward of the storm-tide line.

   3. To determine seasonal density distribution, critical habitats, migratory routes and breeding locales for principal bird species in littoral and estuarine habitats.

FY78 Lower Cook Inlet

Winter-Kamishak/Outer Kachemak Bays

1. To determine the winter distribution and abundance of marine birds in relation to ice conditions and other environmental parameters.

2. To attempt to determine the cause of various winter bird distribution patterns.

Spring-Kachemak Bay

1. To determine species distribution and abundance of waterfowl and shorebirds.

2. To determine if critical habitats exist for these species groups.

3. To determine periods of peak usage and duration of usage in spring for these species groups.

4. To determine, if possible, food organisms utilized by these species groups during migration staging.

Summer-Kachemak Bay

1. To determine species composition and abundance of marine birds on colonies.

2. To determine as many aspects as possible of the breeding biology of marine birds on the colonies.

3. To determine whenever possible the food habits of nesting marine birds and their young.

4. To determine changes in abundance of breeding populations of marine birds on colonies visited in 1976.

5. To make other incidental observations of habitat use, forage areas, migration areas and abundance of non-colonial marine birds.

FY79

1. To analyze all data on the seasonal distribution and abundance of coastal marine birds.

2. To summarize this bird data in a form most useful for future decision making on oil and gas leasing in the outer continental shelf.

3. To graphically and pictorially present coastal bird information so that the relative importance of areas within lease areas are readily apparent.

5. As you stated in your guidance letter, I will need some familiarity in working with the data before I will know which statistical analyses are appropriate and possible. The hypotheses which I am now considering to test are: 1. There is no difference in bird densities from the same lease area, same season but different year. 2. There is no difference in bird density between habitats in the same season from the same lease area. 3. There is no difference in bird density for the same season between lease areas. 4. There is no difference in bird density between seasons within the same lease area. 5. There is no difference in bird density between habitats for different seasons within a lease area. 6. There is no difference in bird density between habitats for the different lease areas within the same season. 7. Bird densities are not affected by tide levels. Also, an attempt will be made to statistically rank habitat preference of birds. If possible, species composition could replace bird density in the previous six hypotheses for additional testing.

   In order to do the necessary comparisons, the nonparametric tests that would be attempted include Chi-square (goodness of fit) and Mann-Whitney. Kendall's ranked correlation coefficient will be used when attempting to rank habitats. These tests may not work in all comparisons, and others may be tried if they are more appropriate. A biometrician will be consulted throughout the analysis process.

   The types of data that are applicable to the analysis are station number (location), distance surveyed, area surveyed, species, number of individuals, habitat and possibly tide level.

6. All bird colony data collected in FY78 will be submitted in File Type 135 format while all other data will be submitted in File Type 040 format.

7. Two sepatate final reports will be written. The first will be a comprehensive analysis of habitat utilization and distribution and abundance of birds in all regions studied. Because of the large amount and variety of data available for this report, I will likely subdivide into the categories of season, geographic region (lease area) and interpretive analysis of bird utilization within each region. Included in the Spring-NEGOA section will be a summary of bird migrations past Cape St. Elias and in the Winter-Kodiak section will be a bird population estimate for winter 1975-76.

   As much as possible, information from other OCSEAP bird studies and any related fields will be incorporated into the final analysis. An attempt will be made to determine a relative vulnerability index for birds and their preferred habitats. The vulnerability of birds to oil and gas development will be stressed where ever applicable.

   A second final report will be written on bird colonies documented in Bristol Bay in summer 1977 and in Kamishak Bay, Lower Cook Inlet in summer 1978.

8. Maps will not be drawn of specific colony locations to avoid duplication of effort with RU 341, but where other information, such as foraging areas, migration corridors, etc., need delineation, maps will show these areas.

9. Enclosed is an updated and more detailed Milestone Chart for FY79.

I hope these corrections meet with your satisfaction and that contracting procedures will be initiated soon. If you have any questions or need further information, please don't hesitate to contact me.

Sincerely,

Paul D. Arneson

Paul D. Arneson
Game Biologist III

Enclosure

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 3 PI: Paul D. Arneson

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
FY 78 FT040 Survey data logged and computerized	△														
FY 78 FT 135 Colony data logged and computerized		△													
All FY 78 computer listings corrected		△													
FY 78 data submitted to Juneau Project Office			△												
All FY 76 and FY 77 computer listings corrected				△											
Quarterly Reports	△			△			△			△					
Narrative report on bird habitat and distribution				△ 30%			△ 60%		△ 100%		△ A	△ B			
Narrative report on colony studies								△ 50%	△ 100%		△ A	△ B			

A - Final reports undergoing ADFG review

B - Final report submission to OCSEAP

Date: 9/30/78
Contract: 03-5-022-56
Task Order: #15
Research Unit: #5
Proposal No: OCS 79-9
Modified

Renewal Proposal
FY '79

to

National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental Assessment Program
Boulder, Colorago 80302
Juneau Project Office

DISTRIBUTION, ABUNDANCE, COMMUNITY STRUCTURE AND TROPHIC RELATIONSHIPS OF THE NEARSHORE BENTHOS OF THE KODIAK SHELF, COOK INLET AND NEGOA

R. U.:	#5	
Total Cost:	$162,158	
Lease Areas:	Kodiak	56.7%
	LGI	30.0%
	NEGOA	3.3%

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3. TECHNICAL PROPOSAL

I. TITLE

Distribution, Abundance, Community Structure, and Trophic Relationships of the Nearshore Benthos of the Kodiak Shelf, Cook Inlet, and Northeast Gulf of Alaska.

Research Unit No. 5.

II. PRINCIPAL INVESTIGATOR

Dr. Howard M. Feder

III. COST OF PROPOSAL (FY 78)

A.	Science	$162,158
B.	Logistics	-0-
C.	Total	$162,158
D.	Kodiak Shelf	56.7%
	Lower Cook Inlet	40.0
	NEGOA	3.3

IV. BACKGROUND

A. Kodiak Shelf

The operations connected with oil exploration, production, and transportation in the vicinity of Kodiak Island present a wide spectrum of potential dangers to the marine environment there. Adverse effects on a marine environment cannot be assessed, or even predicted, unless background data pertaining to the area are recorded prior to industrial development. Insufficient long-term information about an environment, and the basic biology of species in that environment can lead to erroneous interpretations of changes in species composition, abundance and interactions that might occur if the area becomes impacted (see Nelson-Smith, 1973; Pearson, 1971, 1972, 1975; Rosenberg, 1973, for general discussions on benthic biological investigations in industrialized marine areas; see Lewis, 1970 for discussion of population fluctuations of benthic invertebrates in time).

Benthic organisms (primarily the infauna and sessile and slow-moving epifauna) are useful as indicator species for a disturbed area because they tend to remain in place, typically react to long-range environmental changes and by their presence, generally reflect the nature of the substratum. Consequently, the organisms of the infaunal benthos have frequently been chosen to monitor long-term pollution effects, and are believed to reflect the biological health of a marine area (see Addy, 1976; Feder *et al.*, 1973; Pearson, 1971, 1972, 1975 and Rosenberg, 1973 for discussions on usage of benthic organisms for monitoring pollution). The presence of large numbers of benthic epifaunal species of actual or potential commercial importance (snow crabs, king crab, pandalid shrimp, scallops, snails, bottom fishes) on the shelf ecosystem of Kodiak Island further dictates the necessity of understanding benthic communities there since many commercial species feed on infaunal and small, slow-moving epifaunal residents of the benthos (see Feder *et al.*, 1977a, 1977b; Zenkevitch, 1963 for discussions of the interaction of commercial species and benthic biota in Alaska waters). Thus, drastic changes in density of the food benthos would undoubtedly affect the health and numbers of these fisheries organisms.

Few data on non-commercially important invertebrate components of the shallow, nearshore benthos of the Kodiak shelf were available until recent OCSEAP studies were initiated (Feder *et al.*, 1977b). To date, Russian workers have published most of the data from the western Gulf of Alaska (AEIDC, 1974), but OCSEAP investigations in the northeast Gulf of Alaska provide some comparable data from adjacent areas (Feder *et al.*, 1977a). The benthic invertebrate biomass on the Kodiak shelf appears to be greater than that of the NEGOA area, and a higher percentage of the Kodiak biomass is believed to be available as food for fish (see summary draft report by MacDonald and Petersen, 1976). Additional summary information for the Gulf of Alaska is also available in the literature review of Rosenberg (1972). The Soviet benthic work was accomplished in the deeper waters of the Kodiak shelf, and was of a semi-quantitative nature with little hard data to permit extrapolations useful for predictive analyses of the effects of oil on the benthos. The exploratory trawl program of the National Marine Fisheries Service is the most extensive investigation of commercially important species of the Kodiak shelf (unpub. data; reports available from the National Marine Fisheries Service Laboratory, Kodiak). However, most of the invertebrate data from the latter investigation are difficult to interpret, but some idea of the dominant organisms likely to be encountered in the offshore waters of the shelf is available from the study.

Additional, but unpublished, information on the epifauna in the vicinity of Kodiak Island is available as a byproduct of the Alaska Department of Fish and Game King Crab Indexing Surveys (inquiries concerning these reports may be directed to Alaska Department of Fish and Game, Box 686, Kodiak). The International Pacific Halibut Commission surveys parts of the Kodiak shelf annually, but only records commercially important species of crab and fishes; non-commercially important invertebrate and fish species are generally lumped together in the survey reports with little specific information available. A compilation of some relevant data on renewable resources of the Kodiak shelf is available (AEIDC, 1974). The only recent inshore survey of the invertebrate benthos of the Kodiak Shelf is that of Feder *et al.* (1977c) accomplished in conjunction with the fish studies of P. Jackson and J. Blackburn of the Alaska Department of Fish and Game (OCSEAP Annual Report, 1977). These studies intensively investigated the benthos of two bays of Kodiak Island, Alitak and Ugak, and described the distribution and abundance of epifaunal invertebrates and demersal fishes there. Sufficient data were available from these studies to develop a preliminary food web for these two bays and inshore waters around Kodiak Island. Feder *et al.* (1977b) discusses the relevance of the inshore benthic study in the two bays, and the Kodiak shelf in general, to petroleum development there.

Although OCSEAP sponsored research has initiated some inshore benthic studies in the Kodiak area, the coverage has been restricted geographically. Furthermore, little offshore benthic data is available to integrate with the inshore benthic work proposed for the coming year. Species found in bays, shallow inshore areas and deeper benthos of the Kodiak shelf are all highly mobile, and some of the more important species (e.g. king crab, snow crab, halibut) migrate between deep and shallow water during the course of a year. Data collected for these species from inshore areas only will not address their biological interactions in deeper shelf waters. Expansion of the data base from inshore to offshore waters is especially important to fully comprehend the biology of the commercially important king crab. The commercial pursuit of the latter species results in the most important invertebrate fishery in Alaska waters, and Kodiak king crab stocks support a substantial portion of the fishery.

Commercial catch statistics of the Kodiak king crab in past years showed classic exploitation patterns with a peak year catch occurring in the 1965-66 season. Since that time, annual harvest levels (quotas) have been imposed. Recent data substantiate that king crab stocks are responding to the reduced fishing pressure resulting from this management decision, and populations are apparently in the rebuilding phase. The two most commercially utilized stocks are southern district stocks II and III which cover Kodiak Island's southern waters to the continental shelf edge (unpub. Alaska Department of Fish and Game Reports). Recent trawl studies conducted in two Kodiak bays (Alitak and Ugak) show king crab as the dominant species there (Feder *et al.*, 1977b). Alitak Bay is also a major king crab breeding area (Gray and Powell, 1966; Kingsbury and James, 1971). Intensive king crab food studies within commercial stocks II and III should ultimately be pursued, and would help explain distribution and abundance patterns, including high commercial yield molting and/or breeding areas.

Based on OCSEAP feeding studies initiated in the northeast Gulf of Alaska (inclusive of Cook Inlet), and four bays and selected inshore areas on Kodiak Island (Feder *et al.*, 1977a, 1977b, Feder, 1978a, and unpub. OCSEAP data, it is apparent that benthic invertebrates play a major role in the food dynamics of commercial crabs and demersal fishes of the Kodiak shelf. Studies of relative abundance, seasonal distribution, life history and inter-specific relationships of nearshore fish communities in bays of Kodiak Island by Blackburn and Jackson (R.U. 486) will examine tropho-dynamic relationships within these communities. Investigations of this type are essential to comprehend these nearshore communities. Integration of invertebrate data from R.U. 5 with fish data resulting from R.U. 486 and bird data resulting from R.U. 341 will markedly strengthen our understanding of the nearshore benthic communities in the OCSEAP study areas.

B. Lower Cook Inlet

The operations connected with oil exploration, production, and transportation in Cook Inlet present a wide spectrum of potential dangers to the marine environment. Adverse effects on a marine environment cannot be assessed, or even predicted, unless background data pertaining to the area are recorded prior to industrial development. Insufficient long-term information about an environment, and the basic biology of species in that environment can lead to erroneous interpretations of changes in species composition, abundance and interactions that might occur if the area becomes impacted (see Nelson-Smith, 1973; Pearson, 1971, 1972, 1975; Rosenberg, 1973 for general discussions on benthic biological investigations in industrialized marine areas; see Lewis, 1970 for discussion of population fluctuations of benthic invertebrates through time).

Benthic organisms (primarily the infauna and sessile and slow-moving epifauna) are useful as indicator species for a disturbed area because they tend to remain in place, typically react to long-range environmental changes and by their presence, generally reflect the nature of substratum. Consequently, the organisms of the infaunal benthos have frequently been chosen to monitor long-term pollution effects, and are believed to reflect the biological health of a marine area (see Addy, 1976; Feder *et al.*, 1973; Pearson, 1971, 1972, 1975; Rosenberg, 1973 for discussions on usage of benthic organisms for monitoring pollution). The presence of large numbers of epifaunal species (juveniles and adults) of actual or potential commercial importance (snow crab, king crab, pandalid shrimps, scallops, bottom fishes) in Cook Inlet (Feder *et al.*, 1977a and draft copy of Lower Cook Inlet Synthesis Report, 1977) further dictates the necessity of understanding benthic communities since most of these commercial species feed on infaunal and small, slow-moving epifaunal residents of the benthos (see Feder *et al.*, 1977a,b; Zenkevitch, 1963 for discussions of the interaction of commercial species and benthic biota). Thus, it is apparent that drastic changes in density of the food benthos would affect the health and numbers of these commercially important epifaunal organisms.

Few data on non-commercially important invertebrate components of the benthos of Cook Inlet were available until recent OCSEAP studies were initiated (Feder *et al.*, 1977b; Feder, 1978b and D. Lees, unpub. data and reports; draft copy of Lower Cook Inlet Synthesis Report, 1977). The primary data available were principally catch and assessment records for commercial shellfish species. Based on OCSEAP feeding studies accomplished in lower Cook Inlet, it is apparent that benthic invertebrates play an important role in the food dynamics of commercial crabs and demersal fishes there. Proposed studies for 1977-79 by Feder (R.U. 5) and Blackburn (R.U.

512) on relative abundance, seasonal distribution, life history and inter-species relationships of nearshore invertebrate and fish communities in the inshore waters of Lower Cook Inlet will clarify some of the ecological interactions operating within these benthic assemblages. Further, intertidal and shallow subtidal investigations by Lees (R.U. 417) will examine inshore many of the same species found in deeper waters. His studies will not only expand our understanding of these species over the entire range of their distribution, but will closely integrate the life history of these species with land-derived nutrient materials (river runoff with contained terrestrial detritus) and algal detrital derivatives. Lees (R.U. 417) suggests that the macrophytes of the intertidal and shallow subtidal regions produce materials utilized by detritivores in shallow and deep waters throughout Cook Inlet. Many of the organisms depending on these plant materials are either of commercial importance or are food items important to commercial species. Lees indicates that in the past few years information linking the macrophyte producers to commercially important species has begun to emerge but that the full importance of this linkage has yet to be recognized. He also points out that many marine birds and mammals depend heavily on organisms living in the inshore areas which in turn are dependent on plant material produced by macrophytes. In Lees studies of the past two years and those proposed in his R.U. 417, great emphasis will be placed on acquiring data on primary production of major seaweeds from the high intertidal zone to a depth of 60 feet. These data and additional information from the proposal by Feder (R.U. 5) should assist in assessing the relative importance of macrophyte and terrestrial detrital materials as food sources to the biological assemblages of the inshore benthos of Lower Cook Inlet. Additional data collected by diving in 1978, and collections taken by boat in areas not accessible for divers will be used to examine the trophic dynamic processes operational in these inshore areas. These data will further supplement the initial food studies reported by Lees (OCSEAP and unpub. studies in Cook Inlet), Feder *et al.* (1977a) and Feder (1978b). These studies suggested that deposit feeders in Lower Cook Inlet are concentrated in regions of detrital accumulations (e.g. Kamashak Bay).

Thus, detrital materials as food for deposit feeders in lower Cook Inlet are important, and a large portion of this detrital input appears to be derived from inshore macrophytes. The role of detritus and the subtidal sediment system in Lower Cook Inlet should be clarified by way of studies on transfer of carbon from sediment and detrital materials to selected deposit feeders. Preliminary studies of this nature have been initiated and further studies are suggested for 1979. Carbon sources should be examined to evaluate the source and quality of food resources available to deposit-feeding species. The latter problems will be addressed by way of ongoing studies by Larrance (R.U. 425) concerned with source, identification and variability of detrital materials at various levels in the water column. Incidental to the latter data, it is suggested that information should eventually be gathered on food available to dominant suspension-feeding components of the nearshore areas.

Therefore, studies in lower Cook Inlet should focus on carbon flow from the sediment-detrital system through deposit-feeding species to epifaunal scavengers and/or predators. Disturbance or contamination, by oil-related activities, to sediment and detrital materials will directly affect the quality and quantity of food available to deposit-feeding species. Carbon flow and assimilation studies will establish the basic patterns to be expected in healthy systems. In conjunction with the sediment-infauna carbon transfer investigations suggested above, feeding data for such species as the snow crab (a dominant species in Cook Inlet and an important food resource for some bottom-feeding fishes) are needed. Intensive studies of the food of this crab in 1977, 1978 and 1979 will clarify the trophic role of this crustacean in Cook Inlet. The major food items identified are deposit-feeding clams, hermit crabs, and barnacles (Feder *et al.*, 1977a; Feder, 1978b; Paul *et al.*, in press). Further feeding data on the abundant king crab in Cook Inlet is also needed (see Feder *et al.*, 1977a; Feder, 1978a). The relationship of bottom-feeding fishes to benthic food webs has been examined in Cook Inlet and a preliminary food web constructed (see Feder *et al.*, 1977a), but it is suggested in this proposal that further documentation be obtained by additional frequency of occurrence and some quantitative data on selected species in collaboration with Blackburn (R.U. 512).

Examination of the relationships of the reproductive biology of shrimps and crabs to the appearance of meroplankton in the overlying waters will be possible in conjunction with the studies of English (R.U. 424). Interactions of bottom-feeding birds with inshore benthic invertebrates will be documented by way of discussions with Lensink (R.U. 341).

C. Northeast Gulf of Alaska

The operations connected with oil exploration, production, and transportation in the Gulf of Alaska present a wide spectrum of potential dangers to the marine environment there. Adverse effects on a marine environment cannot be assessed, or even predicted, unless background data pertaining to the area are recorded prior to industrial development. Insufficient long-term information about an environment and the basic biology of species in that environment can lead to erroneous interpretations of changes in species composition, abundance and interactions that might occur when the area becomes impacted (see Nelson-Smith, 1973; Pearson, 1971, 1972, 1975; Rosenberg, 1973 for general discussions on benthic biological investigations in industrialized marine areas; see Lewis, 1970 for discussion of population fluctuations in time).

Benthic organisms (primarily the infauna and sessile and slow-moving epifauna) are useful as indicator species for a disturbed area because they tend to remain in place, typically react to long-range environmental changes and by their presence, generally reflect the nature of the substratum. Consequently, the organisms of the infaunal benthos have frequently been chosen to monitor long-term pollution effects, and are believed to reflect the biological health of a marine area (see Addy, 1976; Feder *et al.*, 1973; Pearson, 1971, 1972, 1975; Rosenberg, 1973 for discussions on usage of benthic organisms for monitoring pollution). The presence of large numbers of benthic epifaunal species of actual or potential commercial importance (snow crab, king crab, pandalid shrimps, snails, bottom fishes) in the shelf ecosystem of the northeast Gulf of Alaska further dictates the necessity of understanding benthic communities since many commercial species feed on infaunal and small, slow-moving epifaunal residents of the benthos (see Feder *et al.*, 1977a,b; Zenkevitch, 1963 for discussions of the interaction of commercial species and benthic biota). Thus, drastic changes in density of food benthos would undoubtedly affect the health and numbers of these fisheries organisms.

Little was known about the biology of the invertebrate benthos of the northeast Gulf of Alaska at the time that OCSEAP studies were initiated there, although a compilation of some relevant data on the Gulf of Alaska was available in Rosenberg (1972) (also see the review in AEIDC, 1974). Some scattered data based on trawl surveys by the Bureau of Commercial Fisheries were also available but much of the information on the invertebrate fauna in these surveys was so general as to have little value. In the summer and fall of 1961 and spring of 1962 otter trawls were used to survey the shellfishes and bottomfishes on the continental shelf and upper continental slope of the Gulf of Alaska (Hitz and Rathjen, 1965). The surveys were part of a long-range program begun in 1950 to determine the size of bottomfish stocks in the northeastern Pacific Ocean between southern Oregon and northwest Alaska. Invertebrates taken in trawls were only of secondary interest, and only major groups and/or species were recorded. A short survey in the summer of 1975 added some benthic biological data for a specific area south of the Bering Glacier (Bakus and Chamberlain, 1975). Results of the latter study are similar to those reported by Feder and Mueller (1975) in their preliminary NEGOA investigation.

Further knowledge of invertebrate stocks in the north Pacific is scant. The International Pacific Halibut Commission surveys parts of the Gulf of Alaska annually and records selected commercially important invertebrates; however, non-commercial species are typically discarded. Thus, the benthic investigations summarized by Feder *et al.* (1977a) in their study of the past two and one half years represent the first intensive qualitative and quantitative examination of the benthic infauna and epifauna of the northeast Gulf of Alaska. Furthermore, information in a literature survey have uncovered data that will aid in the interpretation of the biology of some of the dominant organisms in the Gulf of Alaska (Feder and Mueller, 1977). Feder (1976) indicates that crustaceans, molluscs and echinoderms are the leading invertebrate groups on the NEGOA shelf with the commercially important crab, *Chionoecetes bairdi*, clearly dominating all other species. Stomach analysis of the Pacific cod *Gadus macrocephalus* on the Kodiak shelf, lower Cook Inlet, and presumably also the NEGOA region, reveals that *C. bairdi* is a dominant food item of that fish (Feder *et al.*, 1977a,b). Thus, the Pacific cod, a non-commercial species that has commercial potential

(Jewett, 1977; unpub. M.S. thesis), is preying intensively on a species of great commercial significance. Furthermore, laboratory experiments with *C. bairdi* have shown that postmolt individuals lose most of their legs after exposure to Prudhoe Bay crude oil (Karinen and Rice, 1974). The result of these experiments on this important crustacean must be seriously considered during development of petroleum resources in the Gulf of Alaska.

The shallow subtidal regions (those accessible by diving techniques) are little known but extremely important components of the shelf system of the northeast Gulf of Alaska. These regions are closely tied to the deeper shelf regions by way of nutrient and biotic interactions. The macrophytes in these shallow regions may produce materials utilized by detritivores in some areas of the shelf. Many of the organisms here that depend on these plant materials are either of commercial importance (e.g. shrimps, clams) or are food items (e.g. polychaete worms, amphipods, small crabs) important to non-commercial species. In the past few years, information linking the macrophyte producers to commercial fisheries has begun to emerge, although the full importance of this linkage has yet to be recognized (D. Lees, person. commun. and R.U. 417). Additionally, many important marine bird and mammals depend heavily on organisms living in the inshore areas which in turn are dependent on the detrital materials produced by macrophytes. Furthermore, the shallow inshore areas are important to many commercial species for spawning and rearing activities. It is obvious that increased information on nearshore communities is essential. The data produced from nearshore work will be of particular importance to investigators examining inshore fish and bird populations as well as shallow water and offshore benthic assemblages. An expansion of the data base on the seasonal and long-term variation in species composition and structure of the nearshore (shallow water) zone in NEGOA is recommended; regions accessible to SCUBA and to shallow-draft boats need intensive work on species composition and distribution.

Some preliminary information on feeding biology of epifaunal invertebrate species of the Gulf of Alaska is available from literature analysis and very preliminary information collected on NEGOA cruises of the past two years. Feeding habits of infaunal invertebrate species have been tabulated from literature sources and unpublished data (Feder and Mueller, 1975). The fact that (1) most of the food data for infaunal invertebrate species in Appendix Table VI of Feder and Mueller (1975) is based on literature extrapolations from related species or the same species from other areas, and (2) that food information for invertebrate epifaunal species in NEGOA is almost nonexistent, emphasizes the paucity of data on the feeding biology of Gulf of Alaska fauna. This lack of basis data dictates the urgency of immediate support of food studies and experimental work on species of the benthic infauna as well as epifauna in the nearshore and offshore waters of the Gulf of Alaska and elsewhere along the Alaska continental shelf.

Results of surveys of the offshore benthic infauna in NEGOA have shown that infauna throughout much of the area is dominated by deposit feeders both in terms of abundance and biomass. In the areas examined, energy transfer from detritus through deposit feeders and eventually to higher trophic levels probably accounts for the major portion of energy flow from infauna to epifaunal organisms and demersal fishes. If an understanding of the trophic dynamics of the benthos in NEGOA is to be achieved, it is important that the transfer of carbon from detrital food sources to selected deposit feeders, eventually be investigated. This research activity in NEGOA was not a part of the work for 1978 and is not included in the proposal for 1979. The species selected for investigation should be infaunal species that have been quantitatively documented as dominant or which demonstrate potential as a food resource for critical species at higher trophic levels. Furthermore, detrital sources and the nature of the detritus in the study areas should be examined to evaluate the quality of the food resources available to deposit-feeding infauna. Incidental to the latter data, information should be gathered concerning the food available to dominant suspension-feeding components of the infauna.

The ultimate goal of feeding studies in NEGOA should be the documentation of carbon flow from the sediment-detrital system through deposit-feeding species to the dominant epifaunal carnivores and/or scavengers. Disturbance or contamination, by oil-related activities, to sediment and detrital materials will directly affect the quality and quantity of food available to deposit-feeding species. Carbon flow and assimilation studies should establish the basic patterns to be expected in healthy systems. Furthermore, the importance of deposit feeders as nutrient-carbon recycling mechanisms of the benthos should be examined. In conjunction with the sediment-infauna carbon transfer investigations suggested above, feeding data for such species as the snow crab *C. bairdi*, should be obtained for NEGOA. Snow crab feeding data are available for four bays on Kodiak Island and lower Cook Inlet (Feder *et al.*, 1977a; Feder, 1978b; Paul *et al.*, in press). This crab, like the king crab, moves between shallow inshore and deeper offshore waters, and is an important component of all regions of the NEGOA shelf. Thus, data on the feeding habits of the snow crab from selected important shallow and deep NEGOA sites are necessary to understand a major component of inshore and offshore shelf benthic communities. It is further suggested that the feeding and other aspects of the biology of the major prey items used by the snow crab be examined in future studies. The relationship of bottom-feeding fishes to benthic food webs has been examined in preliminary investigations in waters of the Alaska shelf (Feder *et al.*, 1977a,b,c; Smith *et al.*, 1976), but it is suggested that further documentation is needed by way of additional frequency of occurrence data on selected species.

V. OBJECTIVES

A. The specific objectives that apply to all study areas are as follows:

1. Determine, as time, funding, and logistics permit, the feeding habits of the principal inshore epifaunal invertebrate species emphasizing the commercially important shrimp and crab populations.
2. Assess spatial and temporal distribution and relative abundance of epifaunal invertebrates in selected bays and inshore areas.
3. Exchange data and information with R.U.'s 551, 552, 553, 341, 243, 229, 417, 424 and 512 in order to develop a food web structure for lower Cook Inlet and the Kodiak shelf.
4. Review and analyze the existing data base to provide a comprehensive description of benthic biota and environment in Kodiak, lower Cook Inlet and NEGOA lease areas.

B. The objectives by study areas:

Kodiak Shelf. It is the intent of this investigation to (1) continue a qualitative and limited quantitative inshore survey of benthic invertebrates in selected bays adjacent to the Kodiak Island lease area, Izhut and Kiluida bays, via two cruises, and (2) analyze the biological material collected in 1978 in conjunction with R.U. 512.

The specific objectives of this investigation are:

1. On a limited basis, assess distribution and relative abundance of epifaunal invertebrates, exclusive of king and snow crabs, in selected bays and inshore areas.

2. Using available data, assess the distribution and abundance of king crabs and snow crabs in selected bays and inshore areas, and selected offshore areas.

3. Using available data, assess spatial distribution of selected, infaunal invertebrate species.

4. Determine, where possible, the feeding habits of the principal inshore epifaunal invertebrate species exclusive on king crab (see 5 below); the food habits of the pink shrimp and the snow crab are to be especially examined.

5. Continue studies on the feeding habits of the king crab. The following listed objectives should eventually delineate (a) what the major geographic areas are that support (in terms of food) king crab of various sizes and life stages, and (b) which food item(s) or group(s) are most important to the enhancement of the size of a particular king crab stock.

   a. Examine, to the extent that collected material permits, the the percent weight and/or volume composition of prey items of king crab of different sex, length and ecdysis stage by area (depth) and time of year.

   b. Examine the feeding intensity of king crab following the same parameters as in objective (a) above.

   c. Examine the relationship between catch number of king crab and their feeding intensity as determined by objective (b).

6. Develop food webs integrating invertebrate, fish and bird feeding data in collaboration with the Alaska Department of Fish and Game R.U. 512.

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

Lower Cook Inlet. It is the intent of this investigation to review and analyze the existing data base to provide a comprehensive description of the benthic biota and to develop a food web structure. Data and information exchange will be coordinated with R.U.'s 553, 243, 229, 424 and 512. Limited site-specific inshore studies will be continued in coordination with Lees (R.U. 417). Limited studies, as funding permits, on carbon flow from the subtidal sediment-detrital system to deposit feeders will be continued.

The specific objectives of this survey are:

1. Examine the spatial distribution and relative abundance of epifaunal invertebrates in selected inshore areas, and juvenile snow crab in the deeper areas adjacent to Cape Douglas primarily by way of data collected in 1977 and 1978 OCSEAP studies (see Feder *et al.*, 1977 and Feder, 1978 for comments on this nursery area).

2. Assess spatial distribution of selected, inshore infaunal invertebrate species by way of OCSEAP data collected by Lees in R.U. 417 and by way of a subcontract of Lees to R.U. 5 in FY 1978.

3. Assess available data that address carbon transfer from the subtidal sediment-detrital system to deposit feeders in lower Cook Inlet. Data and biological material collected by R.U. 5 in 1978 will form the major base for this objective.

4. Assess available data on the feeding habits of the principal inshore invertebrates (hermit crabs, shrimps, king crab), exclusive of snow crab. Data and biological material collected by R.U. 5 in 1977 and 1978 will form the major base for this objective.

5. Investigate the feeding biology of the snow crab by way of data collected by R.U. 5 in 1977 and 1978.

6. Investigate the basic biology of the major prey species of snow crabs; species to be examined will be chosen from selected bivalve and hermit crab species previously collected.

7. In conjunction with Blackburn (R.U. 512) and data currently available, determine the food habits of selected inshore, bottom-feeding fishes (species predominantly or exclusively utilizing invertebrates for food) (see Feder *et al.*, 1977a,b,c for examples of a similar approach using frequency of occurrence data).

8. Assess available data collected by R.U. 5 in 1978 on prey densities and feeding responses of larval snow crab, king crab and pink shrimp.

9. Develop food webs integrating invertebrate, fish, bird and marine mammal feeding data in collaboration with Lees (R.U. 417), Blackburn (R.U. 512), Calkins and Pitcher (R.U. 243), and Lensink (R.U. 341). See Feder *et al.* (1977a,b,c) and Lees (OCSEAP Reports) for examples of this approach.

10. Compile reproductive data (based on laboratory and field data currently available), on dominant benthic epifaunal invertebrates.

11. Continue limited age and growth, and mortality studies on important clam species (especially those important as food for dominant epifaunal invertebrate species, such as snow crab) and demersal fishes.

12. Utilize data obtained in this study and other available studies (e.g. R.U. 59) to suggest potential sensitivity of the inshore benthic communities to oil pollution. Commercial species will be emphasized.

Northeast Gulf of Alaska. It is the intent of this component of the investigation to review and analyze the existing data base and reports to provide a comprehensive description of the benthic biota and environment of the NEGOA study areas.

VI. GENERAL STRATEGY AND APPROACH

A. Kodiak Shelf

Most of the field data will be obtained in conjunction with trawling activities of Alaska Department of Fish and Game in Izhut and Kiluida

Bays. Sampling will be accomplished in these areas by way of two cruises in October-November 1978 and February-March 1979. Sampling will encompass stations established at the selected study sites. Several sizes of otter trawls will be employed as collection tools; otter trawls will generally be the same ones used by the ADF&G project. The intensity at which sites are sampled will be dependent on weather and available survey time. Care will be taken to maintain the same sampling locations and intensity at each collection period. Epifaunal material and some fish stomachs will be examined on shipboard, when time permits, according to the methodology described in Feder *et al.*, (1977a). All other material will be examined in the laboratory. The king crab feeding study will be coordinated with Guy C. Powell, king crab biologist, ADF&G, Kodiak. SCUBA will be used, if time and logistics permit, at selected locations for inshore collecting and direct observation of king crab activities. The major sites chosen for king crab SCUBA studies will be selected on advice of Guy Powell, and will be important sites used by these crabs for feeding and reproductive activities. Limited observations and experiments concerned with king crab feeding and reproductive biology will be accomplished at the Seward Marine Station.

Expanded information on king crab, snow crab, and pink shrimp feeding habits will be forthcoming by way of analysis of samples collected during FY 1978. Limited feeding data on bottom fishes will also be available from shipboard observations and laboratory analysis of small samples of a few selected species.

Field and Laboratory

Studies will be conducted in conjunction and close coordination with R.U.'s 553, 341, 243, 229, 417, 424, and 512. Close coordination between projects, besides promoting efficiency and economy, should enhance assimilation and interchange of data on inter-species relationships and seasonal succession of marine organisms.

B. Lower Cook Inlet

A major portion of the effort for the lower Cook Inlet study will be directed to analysis of samples collected during FY 78 and subsequent interpretation of the data with emphasis on the trophic relationships of the snow crab, *Chionoecetes bairdi*. It is suggested, that, as need warrants, participation by one member of the benthic group on cruises in lower Cook Inlet be considered; such occasional participation will make available field data as well as preserved and live material of use in carbon-flow studies and in the preparation of the Final Report.

The approach used to accomplish the objectives in water of diving depth initiated in FY 1978 will be to coordinate our data from FY 78 with that of Lees (R.U. 417) at some of his intensive study sites (see Lees OCSEAP Reports), e.g. Seldovia Point, Bluff Point, Iniskin Bay, Kamashak Bay. No diving will be accomplished by R.U. 5 in Cook Inlet. Funding from R.U. 5 in FY 1978 was used to enhance Lees investigation by extending his work into additional feeding and growth studies (e.g. as need dictates, initiate studies on selected species of crabs, and/or *Modiolus*, and/or *Saxidomus*, and/or *Mya* spp.), and should complement his R.U. 417 sponsored work. Analysis of data provided by Lees and Rosenthal (R.U. 417) and Rosenthal (subcontract) in 1978 will occur.

In order to assess carbon transfer from a sediment detrital system to deposit feeders, some estimate of prokaryotic (bacterial) biomass in sediment and in invertebrate gut contents is necessary. Although various techniques for measuring prokaryotic biomass are in use, all of them have limitations. One of the most specific is the assay for muramic acid, a component of prokaryotic cell walls (King and White, 1977; Moriarty, 1977a). Two major advantages of this technique are that it measures only prokaryotic biomass and can be used to assess the prokaryotic biomass in gut contents as well as sediment (Moriarty, 1976, 1977b). In the past six months the benthic group has been doing limited work with the methodology for the muramic acid assay. Serious problems still remain with the technique. We do not feel that usable data will be produced by this technique in the near future. Therefore, we are discontinuing this line of research.

Measurements of rate of deposition of sediment and its quality as a food source will be available from Larrance (R.U. 425). Existing data on distribution and abundance of benthic species can then be interfaced with the above information to provide a better understanding of the subtidal sediment-detrital system in lower Cook Inlet. This synthesis of information will be preliminary and brief in nature; an in-depth understanding of this system cannot be expected by the end of FY 1979.

The feeding habits of two important groups of shrimps and the snow crab in lower Cook were investigated at the Seward Station in FY 1978. Experimental studies on snow crab feeding rates were initiated in the laboratory in FY 1978. These studies have yielded moulting and reproductive information on snow crab as a spinoff of the maintainance of large numbers of these crabs in holding tanks at Seward. Similar moulting and the feeding habits of selected benthic invertebrate species (juvenile and adult snow crabs, hermit crabs, shrimps) will be examined in FY 79 by continued analysis of samples collected in FY 78. Food species will be tabulated; digestible organic material, non-digestible organic material, and sediment content of stomachs will be determined. These data will be integrated with laboratory experimental information.

Close coordination with R.U. 417, R.U. 341, R.U. 424, R.U. 275, and R.U. 243 besides promoting efficiency, should enhance assimilation and interchange of data.

C. Northeast Gulf of Alaska

Final analysis and interpretation of the benthic invertebrate data will be based on the published reports now available to OCSEAP (Feder, 1978b, in prep.; Feder and Mueller, 1975; Feder *et al.*, 1977a,b,c; Jewett and Feder, 1976; Jewett, 1977; Paul *et al.*, in press).

Sampling Methods

A. Kodiak Shelf

Sampling will coincide with that of ADF&G on two cruises in October-November 1978 and February-March 1979. Epifaunal material will be taken with gear fished by ADF&G personnel on each cruise. Invertebrates will be separated, enumerated and weighed according to the methodology described in Feder *et al.* (1977a,b). All invertebrates will be given tentative identifications, and representative samples of individual species preserved and labeled for final identification at the Institute of Marine Science and the Marine Sorting Center, University of Alaska, Fairbanks. Samples will be fixed in 10% buffered formalin, and examined in Fairbanks. Stomachs of selected species (e.g. pandalid shrimps, crangonid shrimps, king crab, snow crab, selected species of bottom fishes) will either be examined on shipboard or in the laboratory in Fairbanks. All species used in feeding studies will be measured. King crab examined in feeding studies will be separated into as many ecdysis stages as possible (up to 8 stages). Whenever possible, the entire gut (stomach and intestine) will be removed. This material will be fixed in 10% formalin.

The eight classes of king crab (classification adapted after Power *et al.*, 1974) are:

a. juvenile females: non-ovigerous females <120 mm (length).

b. Adult females: ovigerous females >95 mm.

c. Newshell males <100 mm: individuals that molted during the last molting period.

d. Oldshell males <100 mm: individuals that failed to molt during the last molting period; often referred to as skipmolts.

e. Very oldshell males <100 mm: indiviiduals that failed to mold during the last two or more molting periods; often referred to as double skipmolts.

f. Newshell males >100 mm.

g. Oldshell males >100 mm.

h. Very oldshell males >100 mm.

B. <u>Lower Cook Inlet</u>

One to two cruises may be required to obtain biological specimens for feeding and carbon flow studies (ses Section on General Strategy and Approach). Sampling will be accomplished on a substantial vessel that will have the capability of trawling with commercial gear, dredging and grab sampling (van Veen grab). In addition, this vessel should have sufficient space to permit preliminary workup of trawl material (see Feder *et al.*, 1977a for methodology), should have running sea water at an appropriate pressure to permit washing of grab and pipe dredge samples on board ship. Periodic collections of experimental animals (shrimps, snow crabs) will be made in Resurrection Bay on a charter boat (see Budget item in

Cost Proposal); samples collected will be used for feeding and carbon-flow studies at the Seward Marine Station.

All dredge and grab material will be washed on 1.0 mm screens. All trawled and dredged invertebrates will be given tentative identifications, and representative samples of individual species preserved in 10% buffered formalin, and labeled for final identification at the Institute of Marine Science and the Marine Sorting Center, University of Alaska, Fairbanks. Stomachs of selected species (e.g. shrimps, king crabs, snow crabs, hermit crabs) will either be examined on shipboard (see special shipboard examination need referred to above) or in the laboratories in Fairbanks. All species used in feeding studies will be measured, separated by sex where readily possible (e.g. in crabs but not necessarily in shrimps), and separated into as many size groups as possible. Clams to be used in growth and mortality studies will be separated from sediments on shipboard, and measurements made on them in the laboratory.

Sedimentation rates will be estimated by coordination with Larrance (R.U. 425). Organic nitrogen and organic carbon of suspended sediment load will be determined by Larrance (RU. 425) from water samples taken three to five meters above the substrate.

C. Northeast Gulf of Alaska

No sampling will be accomplished during this research period.

Analytical Methods

A. Kodiak Shelf

Final analysis of inshore epifaunal and infaunal material will be accomplished in the laboratory in Fairbanks and Seward by methods developed in past offshore OCSEAP studies by Feder (Feder *et al.*, 1977a,b,c). All species will be assigned Taxon Code numbers, and will be summarized according to computer programs developed previously (for example, see Feder *et al.*, 1977a). Community composition and structure will be described. Stomach analyses will be accomplished in the laboratory with quantitative data obtained for some species; weight or volume composition of prey items will be specifically taken for king crab material. If appropriate, feeding intensity of king crab will be calculated using the following Food Index (see Takeuchi, 1959):

$$F.I. = \frac{FW}{BW} \times 10^4$$

where FW = weight of food contents

BW = body weight

All data will be summarized and analyzed with available or specially written computer programs. Food webs will be constructed from accumulated and integrated (fish, bird, marine mammal) data (see Feder *et al.*, 1977a,b,c, for examples); semi-quantitative flow lines indicating the importance of a particular food item will be used in this project whenever possible.

B. Lower Cook Inlet

Final analysis of inshore epifaunal and infaunal material will be accomplished in the laboratory and the Marine Sorting Center, University of Alaska, by methods developed in past offshore OCSEAP studies by Feder (Feder *et al.*, 1977a,b,c). Analysis of some materials in collaboration with Lees (R.U. 417) is planned. All species will be assigned Taxon Code numbers, and will be summarized according to computer programs developed previously for other benthic studies by Feder (for example, see Feder *et al.*, 1977a). Community composition and structure will be described using data available from collections made on past Cook Inlet cruises by Feder and the data in Feder (1978b). Stomach analyses will be accomplished according to methods described in Feder *et al.* (1977a,b,c). Stomach data will be quantitative for some species, primarily the snow crab, but other species may be so exemined as field surveys indicate their importance. In the quantitative analysis of stomach contents, either total weight or volume of the contents will be measured relative to the size (weight) of the whole animal. Feeding intensity of the snow crab (and other species, if need and time permit) will be obtained by using a Food Index (e.g., Takeuchi, 1959). All data will be summarized and analyzed with available or specially written computer programs at the University of Alaska. Clam species will be analyzed according to Feder and Paul (1974) and Paul *et al.* (1976).

Food webs will be constructed in collaboration with Lees (R.U. 417), English (R.U. 424), Blackburn (R.U. 512), and Lensing (R.U. 314), from accumulated and integrated (invertebrate, fish, bird, marine mammal) data (see Feder *et al.*, 1977a,b,c; Feder, 1978b and Lees OCSEAP Annual Reports for example); semiquantitative flow lines indicating the importance of food items will be used whenever possible.

In the shallow-water sites examined in collaboration with Lees (R.U. 417), all techniques described in his R.U. 417 proposal will be used.

In research and development efforts designed to measure carbon transfer from sediment to infaunal deposit feeders, organic carbon will be determined using a CHN analyzer. The development of liquid scintillation counters and improved methods of tissue digestion have made it possible to use radiotracer experiments to examine ingestion and assimilation of labeled bacteria, benthic diatoms and detritus by benthic deposit and suspension feeders (Hargrave, 1970; Kofoed, 1975a,b; Moriarty, 1976; Tenore *et al.*, 1968, 1977; Wetsel, 1976; Yingst, 1976). If time and logistics permit, selected organisms will be measured using adaptations of the methods of Tenore (1975) and Yingst (1976).

The methods planned for studies designed to comprehend the feeding habits of two important groups of shrimps (pandalids and crangonids) are as follows: A detailed stomach content analysis of formalin-preserved specimens will be made with dissection and compound microscopic equipment. The detailed gut content analysis, will constitute the most important component of the study on feeding habits of these animals.

The analytical methods planned for laboratory investigation of snow crab food habits are as follows. Crabs collected in the field in FY 1978 (formalin preserved) and crabs fed (and sacrificed) in the laboratory will be used. The volume of the stomach and its contents will be determined, and the contents examined for prey items. The dry weight of the stomach contents are determined by drying to a constant weight at 60°C. The dry contents are then digested in KOH, dried again, and weighed to determine the digestible organic fraction. If the stomach contains sediment, the remaining material is digested with hydrochloric acid to remove all shell and crustacean exoskeletal material. The latter material is then dried to determine sediment weight. The percentage of each fraction of the stomach contents is then calculated. If time permits, stomach contents from shrimps taken at various stations in the field will be analyzed for organic carbon.

VII. DELIVERABLE PRODUCTS

A. Digital data

File tape 032 will be used as in past years to submit quantitative data on benthic abundance and distribution. Data submissions for this Research Grant are prepared by R.U. 350 contract 03-5-022-56. Procedures to ensure quality have been submitted by R.U. 350.

B. Narrative Reports

Scientific publications will be prepared and submitted as data becomes available. No publications of this nature are currently ready for submission. All or a portion of the Annual Report will be published as an Institute of Marine Science Technical Report.

The Final Report for lower Cook Inlet will include:

a. A final analysis and synthesis of all results on distribution and abundance; feeding habits and food web relationships of the animals studied; food web descriptions; age, growth, and mortality of clams; reproductive biology.

b. A final analysis and evaluation of carbon-transfer work conducted in FY 78.

c. A final analysis and synthesis of all of the above information relative to potential impacts by OCS Activities.

C. Visual Data

All data submitted on a map format will be included in standard maps specified by OCSEAP. Each map will be submitted as transparent Mylar film overlay to the BLM-Alaska OCS office. The Annual Report will include 8 x 11½ paper reductions of these maps in an appropriate scale and projection. Included with each submission of map products to BLM, labeled on the Mylar overlay, will be the appropriate information necessary to define the origin and interpretation of the map.

D. Other

Not applicable.

E. Data to be formatted and submitted through R.U. 350. Data submission schedules are prepared and updated quarterly.

VIII. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

Voucher specimens will be archived for the purpose of providing intercomparisons of taxonomic identifications. This archive will be maintained for the duration of this contract period; at which time the specimens will be handled in accordance with a plan presently being formulated by and negotiated with OCSEAP Juneau.

IX. LOGISTICS REQUIREMENTS.

See attached forms.

X. ANTICIPATED PROBLEMS

A. Kodiak Shelf

1. Weather precluding completion of the two monthly surveys of the periods October-November 1978 and February-March 1979 as planned.
2. Logistics problems precluding completion of diving studies. Specifically, inoperable weather conditions at planned survey periods and unavailability of proper small boat for support of diving activities.
3. Securing use of appropriate small fishing-type boat, on charter, with winch capability for use in trawling activities in Izhut and Kiluida Bays. Specifically, gear on boat capable of effectively dragging and recovering trawls with bags full of target species - king crabs, snow crabs, shrimps. This was a serious problem in FY 78.
4. Work plan for the small, charter boat not coinciding with the needs of RU 5. Specifically, cruise plan for the small boat not cooperatively organized so that all parties using the vessel receive sufficient time to enable them to fulfill objectives of their

respective projects. This was a serious problem in FY 78, the major usage of the small boat was planned independently of RU 5 and the resultant cruise plans did not coincide with the depths of water required by RU 5 to fulfill its objectives relative to king crab, snow crab and pink shrimp.

5. Relative to points 3 and 4 above, the problems alluded to in FY 78 will essentially prevent "adequate seasonal coverage for completion of a year or field sampling (April 1978-March 1979)". Also, the year-round coverage will take place in Izhut and Kiluida Bays, and coverage will not be equivalent to the excellent coverage that resulted from the intensive bay-wide activities in Alitak and Ugak Bays in FY 1977. Success of the FY 1977 cooperative effort with Alaska Department of Fish and Game (ADF&G) in the latter two bays is attributed to over-lapping goals; the problems of FY 78 and possibly FY 79 arise from Research Units with dissimilar goals sharing a boat platform. It should be emphasized that <u>cooperation between ADF&G and IMS has been excellent</u>; <u>the problems</u> in FY 1978 stem from <u>widely differing goals</u> for the two research groups.

6. Relative to points 3 and 4 above and the selection by OCSEAP of two bays for study that may not have large populations of target species (i.e. king crabs, snow crabs, pink shrimp). Specifically, insufficient sample sizes of these species, especially the pink shrimp, to utilize in the feeding studies listed in Objectives 1-5.

7. Resolution of the problem concerning availability of food data from the fish species chosen by RU 5 to be directly related to benthic invertebrates of importance. This access is essential to the continuing and ever-developing clarification of benthic food webs to be developed during the project period. A close integration of our project with the one concerned with the quantitative workup of fish stomachs must be achieved; the data flow should be as prompt as possible on the species of direct interest to RU 5. This did not occur in FY 78.

8. Acquisition of some crab (king and snow) material from water deeper than 40 m so that a more complete picture of crab feeding habits can be obtained. This need was only marginally met in FY 78.

9. Markedly reduced funding relative to FY 78 will necessitate a drastic cut in staff which in turn will greatly curtail the data output in FY 79 and the scope or the Final Report to be expected at the end of FY 79.

Contingency Plan

If weather precludes completion of both trawl surveys, it is assumed that sufficient data will be available from the spring and summer of 1978 to clarify some of the main invertebrate feeding relationships in Izhut and Kiluida Bays for a portion of the year. Mutual agreement between OCSEAP and RU 5 concerning lack of year-round coverage due to weather is anticipated.

If weather precludes completion of diving studies or seriously limits them, it is assumed that access to data from the summer of 1978 and discussions with Guy Powell (ADF&G) will give insights into the biology of king crabs, especially very young individuals, that will permit limited generalizations. Mutual agreement between OCSEAP and RU 5 concerning lack of a broad data base resulting from diving due to weather problems is anticipated.

Relative to points 3-5 above, it is assumed that sufficient data will be available from the spring and summer of 1978 to clarify some of the main invertebrate interrelationships. The major lack might be in-depth and comprehensive coverage of the bays; the data base might not be as comprehensive as that resulting from the studies in FY 1977 in Alitak and Ugak Bays. Mutual agreement between OCSEAP and RU 5 concerning problems caused by essentially insoluble logistics problems is anticipated.

Relative to point 6 above, if insufficient pink shrimp material is forthcoming from the inshore trawling activities in Izhut and Kiluida Bays, it is suggested that contact be made with a commercial shrimp boat in the Kodiak area to obtain material from them as part of a special charter.

Relative to point 9 (i.e., reduced funding and curtailed staff), priorities will be established as the project proceeds, and only major sections of the investigation will be completed. Minor sections of the project will be carried as far as funding permits and recommendations for completion of these studies in the future will be included with the Final Report.

B. Lower Cook Inlet

1. Weather, logistics and other unanticipated problems in the diving program (initiated in collaboration with Lee's RU 417 in FY 78) precluding; (a) completion of diving surveys and (b) submission of or late submission of biological samples (i.e. selected species of crabs, selected species of bivalve molluscs) to RU 5 to make it difficult to integrate this data into the Final Report.

2. Securing use of appropriate vessel with commercial trawling capability and laboratory space for shipboard analysis at least twice during the project period.

3. Acquisition of sufficient snow crab specimens to do feeding experiments could be a problem. This might be especially true if an appropriate trawling vessel, capable of dragging up the large numbers of crabs in Cook Inlet needed, cannot be available during FY 79.

4. The need for assurance that RU 5 will have access to invertebrate material obtained by dragging activities associated with OCSEAP programs in the inshore areas of Cook Inlet. It is especially important that RU 5 have access to appropriate samples of snow crab, shrimp, and molluscs on any OCSEAP cruises to Cook Inlet.

5. Acquisition of some juvenile and adult snow crabs from waters deeper than 40 m so that a complete picture of crab feeding and growth activities can be obtained. Sampling in the area off Cape Douglas (see Feder *et al.*, 1977a for comments on this apparent nursery area for snow crab) is especially important.

6. In the continuing research and development efforts concerned with carbon transfer from sediment to infaunal deposit feeders, difficulties will continue to be experienced in collecting, transporting and ultimately maintaining in the laboratory, healthy specimens of

desirable test organisms. The organisms eventually selected for the experiments will be ones that meet the above tests, and can be maintained for long periods of time in the sea water system at the Seward Marine Laboratory. Some additional delays in completing the experiments may also be anticipated when the organism(s) is chosen; experiments will have to be adapted to suit the feeding behavior of the organisms of interest. We have not completely resolved the muramic acid method as yet, and delay can be anticipated until all procedures are worked out. It is probable that the complexity of this particular segment of the proposal and markedly reduced funding will result in very preliminary data only during FY 79. However, it is anticipated that this data will be useful to make suggestions concerning carbon flow to infaunal feeding invertebrates.

7. Markedly reduced funding relative to FY 78 will necessitate a drastic cut in staff which in turn will greatly curtail the data output in FY 79 and the scope of the Final Report to be expected at the end of FY 79.

Contingency Plan

It is assumed that Lee's RU 417 will complete his project, and will collect considerable inshore invertebrate data based on the subcontract negotiated with him in FY 78. It is expected that despite the problems alluded to in 1 above that data and material will be forthcoming to enable predictions to be made for the inshore areas studied. Lee's 417 should have sufficient inshore data that occurrence of the worst possible weather conditions should still make it possible for RU 417 and RU 5 to collaborate effectively in their respective Final Reports.

If a vessel will not be periodically available in Cook Inlet to obtain the necessary snow crabs and shrimps for experimental work, it is anticipated that charter of a small boat to use in Resurrection Bay will make these species available on an alternative basis. It is suggested that this could cause a budget problem, and that additional fiscal support might be requested for this charter if Resurrection Bay is the sole source of the experimental material for FY 79. The approximate funds that might be needed are $6,000 for about 12 days of charter time.

Although problems must be anticipated in the limited studies on carbon-transfer from sediment to infaunal deposit feeders, it is assumed that sufficient information will be obtained to form the basis of a well-grounded study in future years.

Relative to point 7 (markedly reduced funding and curtailed staff) priorities will be established as the project proceeds, and only major sections of the investigation will be completed. Minor sections of the project will be carried as far as funding permits, and recommendations for completion of these studies in the future will be included with the Final Report.

C. Northeast Gulf of Alaska

1. No problems are anticipated if no cruise occurs in FY 78.

2. If a cruise is scheduled for summer of 1978, the low funding ($5,000) suggested for NEGOA in FY 79 will not be sufficient to workup the material collected while simultaneously making "final analyses and interpretation of data obtained through field sampling during the summer of FY 78."

Contingency Plan

If a cruise is scheduled and the value of the data obtained warrants in-depth workup of the material, it will be suggested at a later date than an additional 4-6 months of research assistant time be funded. The amount requested will be approximately $6,200 to $9,300 plus overhead and staff benefits.

XI. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

Coordinated sampling and sharing of results will be required from R.U.'s 341, 551, 552, 553, 341, 243, 229, 417, 424, and 512. The necessary interchange will be facilitated through informal contacts and OCSEAP Review, Planning and Synthesis Meetings.

XII. ACTIVITY/MILESTONE CHART

See attached form

XIII. OUTLOOK

The direction of the research effort for FY 78 shifted from the extensive, broad offshore shelf activities of the previous three years to one that primarily examines site-specific areas. Furthermore, direct research activity for FY 78 was directed away from a primary goal of species assessment to one that addresses biological processes in the site specific areas. Although many of the approaches suggested in the research proposal for FY 78 and FY 79 were either begun or, at least anticipated in 1976-77, no major effort had been funded during this period for process-oriented studies of the benthos. Thus, much of the work of FY 78 and FY 79 will represent initiation of new directions in research, and all of the experimental work suggested in the FY 78 and FY 79 proposals will be unique to the OCSEAP program in Alaskan waters. It is to be expected that much of the work suggested for the next few years of research will be designed to further strengthen the data base originally developed in FY 78. The understanding of processes operating in the benthic areas to be investigated will, by necessity, develop slowly, but the broadly based and interconnecting studies for FY 78 and FY 79 suggest that major progress should be made in our understanding of inshore benthic communities.

The outlook for the three study areas for FY 80 and FY 81 are treated below:

<u>Kodiak Shelf</u>

A. Nature of final results

1. Expand knowledge of spatial and temporal distribution and relative abundance of inshore and offshore epifaunal organisms.

2. Expand knowledge of trophic interrelationships of dominant inshore infaunal and epifuanal invertebrates and demersal fishes (emphasis on king and snow crab, pink shrimp, and other commercially important bottom-feeding species.

3. Documentation of the nature and extent of carbon transfer from the sediment-detritus system to infaunal deposit feeders (protobranch clams, *Macoma* spp. primarily) to king and snow crabs.

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

5. Comprehension of the importance of prey densities and feeding responses of larval snow crabs, king crabs, and pink shrimp as factors in the survival of year classes in Kodiak waters.

6. Expansion of knowledge of distribution, abundance, and general ecology of recently settled and very young juvenile king crabs by way of SCUBA in inshore waters.

7. Expansion of knowledge of distribution, abundance, and feeding biology of juvenile king crabs in offshore waters.

8. Data on the above from other bays and the outer shelf in the vicinity of the lease area as an expansion of the overall data base for the Kodiak shelf.

B. Milestones

a. Cruises: expanded seasonal coverage with cruises in July, September, November, January, March, May.

b. Report Submission: quarterly reports and annual reports; selected papers and Technical Reports.

C. Cost: $150,000

D. Addition of Major Equipment:

Chilling units (for larvae studies)
Isotope measurement equipment
Several swimming pools (for expanded feeding studies)

E. Location of future field effort:

Same plus additional inshore areas as diving needs dictate.

F. Logistics Requirements:

Roughly the same plus additonal cruises during the year. Addition of small boat support for SCUBA activity.

Lower Cook Inlet

A. Nature of final results

1. Expand knowledge of spatial and temporal distribution and relative abundance of epifuanal invertebrates.

2. Expand assessment of distribution of selected, inshore infaunal invertebrate species (specifically important food items of commercially important species).

3. Intensively pursue experiments on carbon transfer from a sediment-detrital system to infaunal deposit feeders.

4. Expand studies of feeding habits of principal inshore epifaunal invertebrates, exclusive of snow crab.

5. Expand the study of the feeding habits of snow crab. Interrelate the interaction of sediment-deposit feeder-snow crab as a logical extension of (3) above.

6. Intensively pursue investigations of the major prey species of snow crab.

7. Develop food webs interrelating all species from the benthos and pelagic regions, birds, and marine mammals.

8. Develop and pursue studies on reproductive biology of key species.

9. Expand age and growth and mortality studies on important clam species.

10. Comprehension of the importance of prey densities and feeding responses of larval snow and king crabs, and pink shrimp as factors in the survival of year classes in Cook Inlet.

11. Consider development of models of the Cook Inlet biotic systems.

B. Milestones

1. Cruises: continue cruises as dictated by the developing programs.

2. Report submission: quarterly and annual reports; publication of variety of papers and technical reports on results of biological studies.

C. Cost:

Approximately $150,000.

D. Addition of major equipment:

Some analytical units for the chemical analyses needed in carbon flow experiments.

E. Location:

Same plus additional sites as needed.

F. Logistics:

Roughly the same as FY 78 and FY 79.

Northeast Gulf of Alaska

A. Nature of final results

1. Expand knowledge of spatial and temporal distribution and relative abundance of epifaunal and selected infaunal invertebrates.

2. Intensive pursuit of experiments on carbon transfer from a sediment-detrital system to infaunal deposit feeders.

3. Expand studies of feeding habits of principal inshore epifaunal invertebrates.

4. Expand the studies on the feeding habits of the snow crab. Interrelate the interaction of sediment-deposit feeder-snow crab as a logical extension of (3) above.

5. Intensively pursue investigations of the major prey species of snow crab.

6. Develop food webs interrelating all marine species in the study areas.

7. Develop and pursue studies on reproductive biology of key species.

8. Expand age and growth and mortality studies on important clam species.

9. Consider development of models of the Northeast Gulf biotic systems.

B. Milestones

As per Cook Inlet comments.

C. Cost

Approximately $150,000

D. Additional major equipment

Equipment listed under Cook Inlet will be shared here.

E. Location

Sites to be chosen as needed.

F. Logistics

A boat with trawling capability.

XIV. CONTRACTUAL STATEMENTS

A. A schedule for data submission for each task order has been, and will continue to be, submitted and updated each quarter.

B. This statement is in accordance with our base contract, and we will continue to comply.

C. See Section VIII of this proposal. The University of Alaska will continue to negotiate a Voucher Specimen Policy with NOAA/OCS. We will comply with the then-agreed-to policy.

D. See Section VI of this proposal. The University of Alaska agrees that the Principal Investigators can travel to the Project Office at least twice during the contract year, provided that such travel is in accordance with University of Alaska travel policy and consistent with other University duties of the Principal Investigator. Funds for travel labeled "Administrative Travel" have been allocated in previous funding cycles for R.U. 350. We believe sufficient funds remain for this FY.

E. Data will be provided in the form and format agreed to by the University and NOAA/OCS in the negotiating of the Data Management Plans. Digital data will be accompanied by the D.D.F. (NOAA Form 24-13).

F. As per Article 9 of the base contract, the University of Alaska agrees to the following: "...all archivable data is to be submitted to the contractor to the Contract Data Manager within 120 days after acquisition. Certain data sets such as plankton counts or volume are not available until sorting of samples is complete. The data so obtained are archivable 120 days following the actual sorting or other laboratory procedure." NODC Taxonomic Code will be used where appropriate for FY79 data submission.

G. Within ten days of the completion of a cruise or data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager by the Chief Scientist.

H. As per the contract, the University of Alaska will maintain a property inventory including all information required by form CD-281 for all non-expendable equipment purchased with funds allocated under this contract. Furthermore, we will comply with the quarterly reporting of said inventory.

I. Three copies of all publications or presentation abstracts or manuscripts pertaining to technical or scientific material developed under OCSEAP funding will be submitted to the COTR prior to publication or presentation. Copies of all news releases mentioning OCS or using information gathered by OCS funding will be sent to the COTR. When made available, during the lifetime of the appropriate task order, five reprints will be sent to the Project Office.

J. The following acknowledgment of sponsorship will be used:

> "This study was supported under contract 03-5-022-56 between the University of Alaska and NOAA, Department of Commerce, through the Outer Contintental Shelf Environmental Assessment Program to which funds were provided by the Bureau of Land Management, Department of the Interior."

LOGISTICS REQUIREMENTS - Kodiak-R. U.# 5

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION University of Alaska PRINCIPAL INVESTIGATOR H. M. Feder

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.
Stations of opportunity in Izhut and Kiluida Bays.

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible. Primary otter trawl. Some dredge and/or grab samples may be requested.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

Two cruises in October-November 1978 and February-March 1979.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)
Approximately 7-8 days for each bay; thus 14-16 days for each cruise, dive survey-spring, summer.

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?
Cooperative effort; equal time requested. Dive survey-principal one.
Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.
Maximum of eight hours per day for trawl survey, maximum of six hours per day for dive survey.

6. What equipment and personnel would you expect the ship to provide?

Trawl. Assistance with trawling gear.

7. What is the approximate weight and volume of equipment you will bring?

Trawl-100 pounds; diving gear = 1500 pounds; 75 cubic feet.

8. Will your data or equipment require special handling? Yes If yes, please describe.

Diving bottles will need special care.

9. Will your require any gases and/or chemicals? No If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge.

10. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.

No*

11. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have your verified its availability?

Trawl charter to be arranged with ADF&G.

12. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.
Trawl survey-one person per leg (S. Jewett, M. Hoberg).
Diving survey-two persons per leg (S. Jewett, M. Hoberg).

*A small boat, 16-20 ft, with outboard motor is required in Kodiak for all diving operations.

D. QUARTERS AND SUBSISTENCE SUPPORT

1. What are your requirements for quarters and subsistence in the field area? (These requirements should be broken down by (a) location, (b) calendar period, (c) number of personnel per day and total man days per period).

   (a) Need diving personnel. Housing at BOQ, Coast Guard Base in Kodiak.
   (b) Spring-Summer.
   (c) Two personnel per day; approximately one week per dive period; probably 3-4 dive periods.

2. Do you recommend a particular source for this support? If "yes", please name the source and the reason for your recommendation.

   Yes. OCSEAP Support if funds available.

3. What is your estimated per man day cost for this support at each location?
   Not known exactly-per day cost at BOQ requested.

   How did you derive this figure, i.e., what portion represents quarters and what portion represents subsistence and is the figure based on established commercial rates at the location or on estimated costs to establish and maintain a field camp?

   NA

E. SPECIAL LOGISTICS PROBLEMS

1. What special logistics problems do you anticipate under your proposal and how do you propose that the problems be solved? (Provide cost estimates and indicate whether you propose handling the problems yourself or whether you must depend on NOAA to solve them for you).

   A seaworthy, small boat (16-20 ft.) with outboard moter and suitable for diving support needed in Kodiak. No boat of this tupe available RU 5 presently. Request that NOAA (OCSEAP) attempt to arrange for access to this small boat.

LOGISTICS REQUIREMENTS-Cook Inlet-R. U. 5

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION University of Alaska PRINCIPAL INVESTIGATOR H. M. Feder

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions. Appropriate stations in Lower Cook Inlet on grid established for R.U.5 in FY77-78

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible.
Otter trawl, pipe dredge, grab sampling.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

Winter, Spring, Summer: one cruise for each period if required.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

3-5 days.

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? NO

Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.
6-10 hours per day; at anytime during 24 hour period.

6. What equipment and personnel would you expect the ship to provide?
Large trawl. Personnel to assist in trawling, dredging, grab-sampling operations.

7. What is the approximate weight and volume of equipment you will bring?

Small trawl-100 pounds; grub-80#; dredge-120#; wash box-200#

8. Will your data or equipment require special handling? NO If yes, please describe.

9. Will your require any gases and/or chemicals? No If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge.

10. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.
NOAA Ship *Miller Freeman*. Essential because of proper laboratory space and ship stability needed for preliminary workup of data.

11. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have your verified its availability?
Small charter vessel if live material needed immediately; one day on 10-12 occasions; no vessel planned as yet.

12. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.

one-three people (A. J. Paul, H. M. Feder, J. McDonald, P. Shoemaker).

D. QUARTERS AND SUBSISTENCE SUPPORT

1. What are your requirements for quarters and subsistence in the field area? (These requirements should be broken down by (a) location, (b) calendar period, (c) number of personnel per day and total man days per period).

NONE

2. Do you recommend a particular source for this support? If "yes", please name the source and the reason for your recommendation.

NA

3. What is your estimated per man day cost for this support at each location?

NA

How did you derive this figure, i.e., what portion represents quarters and what portion represents subsistence and is the figure based on established commercial rates at the location or on estimated costs to establish and maintain a field camp?

NA

E. SPECIAL LOGISTICS PROBLEMS

1. What special logistics problems do you anticipate under your proposal and how do you propose that the problems be solved? (Provide cost estimates and indicate whether you propose handling the problems yourself or whether you must depend on NOAA to solve them for you).

Will need some vessel time in Cook Inlet and/or in Resurrection Bay primarily to obtain live snow crabs. Will need 10-12 days on charter boat in Resurrection Bay if live material cannot be obtained in Cook inlet. Would perfer NOAA (OCSEAP) to arrange charter if needed.

MILESTONE CHART

0 - Planned Completion Date
X - Actual Completion Date

R.U. # 5 P.I. H. M. Feder

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

MAJOR MILESTONES	1978			1979											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Kodiak Cruises	0				0										
Report Submissions			0			0			0			0			
LCI Final Report															0

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Proposal Date: 23 June 1978
Contract #: 03-5-022-68
Task Order #: 5
NOAA Project #:
Institution ID #: 936 00 1786 (IRS)

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

FY 1979 RENEWAL PROPOSAL

Research Unit Number: 6

TITLE: Distribution, abundance, composition, and variability of the western Beaufort Sea benthos.

Cost of Proposal: $83,343*

Lease Area: Beaufort Sea 100%

*Plus supplemental proposals and budgets for complementary research modules.

Period of Proposal: October 1, 1978 through September 30, 1979

Endorsements:

Principal Investigator	Department Head
Andrew G. Carey, Jr.	George H. Keller
Associate Professor (503) 754-2525 Date:	Acting Dean of Oceanography (503) 754-4763 Date:

Institution Administrative Officials

Hugh F. Jeffrey, Jr.	John V. Byrne
Director, Business Affairs (503) 754-3031 Date:	Dean of Research (503) 754-3437 Date:

TECHNICAL PROPOSAL

I. Title:

The distribution, abundance composition, and variability of the western Beaufort Sea benthos (with special emphasis on the benthic food web).

Research Unit #6
Contract No. 03-5-022-68
Proposed Dates of Contract: 1 October 1978 - 30 September 1979

II. Principal Investigator: Andrew G. Carey, Jr., Ph.D.
School of Oceanography
Oregon State University
Corvallis, OR 97331

III. Cost of Proposal (FY-79), October 1, 1978 through September 30, 1979:

A. Science: $83,343
B. Logistics: 0 (?)
C. Total: $83,343
D. Distribution of effort by lease area:
Beaufort Sea 100%

IV. BACKGROUND

The past and proposed OCS research on benthic ecology is directed toward defining the distribution and abundance of the sea floor organisms, estimating the natural range of spatial and temporal variability, determining the effects of the environment on the fauna, estimating various biological rates, and delimiting the food web interactions of the benthic invertebrates.

The present benthic ecological studies on the continental shelf 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 total numerical abundance and biomass of the large macro-infauna (>1.0 mm) are defined at stations across the 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. Species and station groupings are statistically analyzed and the relationships to the bottom enviornment and to biological relationships 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. Abundance patterns provide data on potentially productive areas of the shelf that may support the large and important top predators. Biological and ecological information on important prey species are necessary for an understanding of the functioning of the oceanic food web.

The development of the research on the continental shelf benthic invertebrates has proceeded along a logical sequence. As very little was known about the fauna at the initiation of the exploration and developmental phases of the oil and gas fields on the Alaskan North Slope, the early research involved basic survey work on the 1971 and 1972 U.S. Coast Guard oceanographic cruises in the Beaufort Sea, WEBSEC-71 and WEBSEC-72. Initial processing and analysis of bottom grab and otter trawl samples and bottom photographs were sponsored by the Oceanographic Section of the National Science Foundation by a grant to the Principal Investigator.

V. OBJECTIVES

In addition to the base research listed below, a series of sub-projects have been proposed for next year to provide fundamental data in a number of research areas (see Table 1). They are listed as a portion of the main FY-79 proposal with the philosophy that this structure provides the NOAA Arctic Project Office and the NOAA Boulder Office with the opportunity to select units most relevant to Beaufort Sea petroleum exploration and development, and that integrate best with other research. The proposal structure should also allow opportunistic funding if appropriate research opportunities, e.g. seasonal sampling, arise, or if proposed 1978 field work is cancelled or altered by extremely heavy summer sea ice conditions. Rough estimates of cost have been included for the individual sub-project research modules.

This approach to the construction of the FY-79 OCSEAP proposal for RU #6 is necessary because RFP guidelines for FY-79 list limited funding and broad research objectives. The estimated $75,000 and the requested $83,343 funding levels are both below the amount that is necessary to support an efficient research group with a critical mass that allows some specialization and expertise. Level funding by the addition of one to several of these sub-projects would allow more complete and more meaningful participation in the Marine Biota research. The supplemental funds are also requested for next year because phases of past and present research are considered by the Principal Investigator to be of primary importance to the OCSEA Program objectives now.

The objectives of the sub-project research modules are also listed in Section XVI (OUTLOOK), as they are considered by the PI to be necessary accomplishments to fulfill the present objectives. Several other more long-range objectives are also listed in this later section.

The base proposal is primarily concerned with samples from the 1978 food web cruise to the western Beaufort Sea on the USCGC NORTHWIND. More samples will probably be collected on the cruise than can be processed and analyzed during the new contract year under the proposed funding. Therefore, a selection based on BLM needs, the Arctic Project Office guidance, and the Principal Investigator's knowledge of the research program. The additional research modules are based on the OCS and BLM suggestions and tentative guidance, and on the research needs evident to the Principal Investigator. Additional research such as inshore seasonal studies would require further funding, and rough estimates of funding and manpower costs are listed.

Table 1. Summary of costs for proposed base research and for proposed supplementary sub-project research modules for RU #6 (FY-79) in Benthic Ecology.

Research Module	Scope of Research	Full-Time Effort (Man-Months)	Estimated Funding Level (FY-79)
Base Research			
	Food-web studies based on 1978 USCGC NORTHWIND cruise to the SW Beaufort Sea: macro-infaunal and epifaunal distributions and abundance, GI tract analyses of fish and invertebrate predators. Year-to-year variability of average community structure across the continental shelf. Ecological summaries of "key" invertebrate prey.	36	$83,343
Supplemental Research			
(1)	Numerical density, biomass, and taxonomic composition by phyla of small macro-infauna (0.5-1.0 mm) and meiofauna (0.064-0.5 mm) at integrated benthic food web stations (6).	12	$25,000
(2)	Seasonal variability of average benthic community structure in coastal and lagoonal environments. Macro-infauna and macro-epifauna.	24	$50,000
(3)	Life histories, reproductive activity and yearly variability of selected benthic infaunal species across the shelf (Pitt Point Transect).	24	$45,000
(4)	Quantitative ecological statistical analyses of community structure and faunal-environmental correlations. Analysis of sediment characteristics from 1978 samples	10	$24,000

A. Base Proposal: Beaufort Sea Macrofaunal and Megafaunal Benthic Food Web and Yearly Variability of Community Structure ($83,343)

Objective 1. The numerical density, biomass and gross taxonomic composition of the large benthic macro-infauna (>1.0 mm) will be obtained at selected water column and integrated benthic food web stations from samples collected during the 1978 USCGC NORTHWIND cruise to the western Beaufort Sea.

Objective 2. The identification of prey and predator species important in the benthic food web will be undertaken as far as possible for selected 1978 stations.

Objective 3. The gastrointestinal tract contents of selected species of benthic invertebrates and demersal fishes (to be supplied by ADF and G) will be analyzed as far as possible to determine the food web links within the benthic communities and the ocean ecosystem.

Objective 4. The species composition, distribution and relative abundance of the macro-epifauna will be determined at a minimum of six characteristic food web stations.

Objective 5. The distribution and abundance of primary benthic prey species (when identified) will be summarized for the Beaufort Sea continental shelf from extant processed samples and analyzed data plus the new data to be acquired from the 1978 summer field season samples.

Objective 6. The numerical density biomass and gross taxomonic structure of the large macro-infauna (>1.0 mm) at the 5 standard benthic seasonal stations will be obtained across the continental shelf on the Pitt Point Transect.

Justification

Foodweb studies are important because these feeding links are the routes by which energy, elements and pollutants are transferred from one trophic level to another. Such studies are necessary to identify the keystone species and important feeding areas on the Beaufort Sea continental shelf. During the 1978 cruise macro-epifauna (>1.0 mm) will be sampled with specialized gear. Vagile epibenthic crustaceans such as gammarid amphipods, shrimps, harpactecoid copepods and cumaceans are reported to be major food items of larger predators (Frost et al, 1978). Many of these organisms swim above or along the water-sediment interface and are difficult to sample by conventional infaunal techniques. These organisms can form dense aggregations in some of the lagoon environments (Griffiths and Craig, 1978). Coastal environments should be evaluated as well.

At least six inner shelf areas subject to man-caused environmental perturbations will be extensively sampled to fulfill the above objectives (see Figure 1). These have been chosen because: 1) there is unique biological activity (birds off Point Barrow); 2) historical seasonal and yearly data are present (Pitt Point); 3) the lease area is involved (Oliktok Point and Narwhal Island); 4) hydrographic data and casual observations indicate a region of coastal upwelling and higher primary production (Barter Island); and, 5) areas to the east are likely to be impacted first by Canadian drilling efforts in the Mackenzie Delta region (Barter Island and Flaxman Island). The U.S. Coast Guard's cooperation provides an

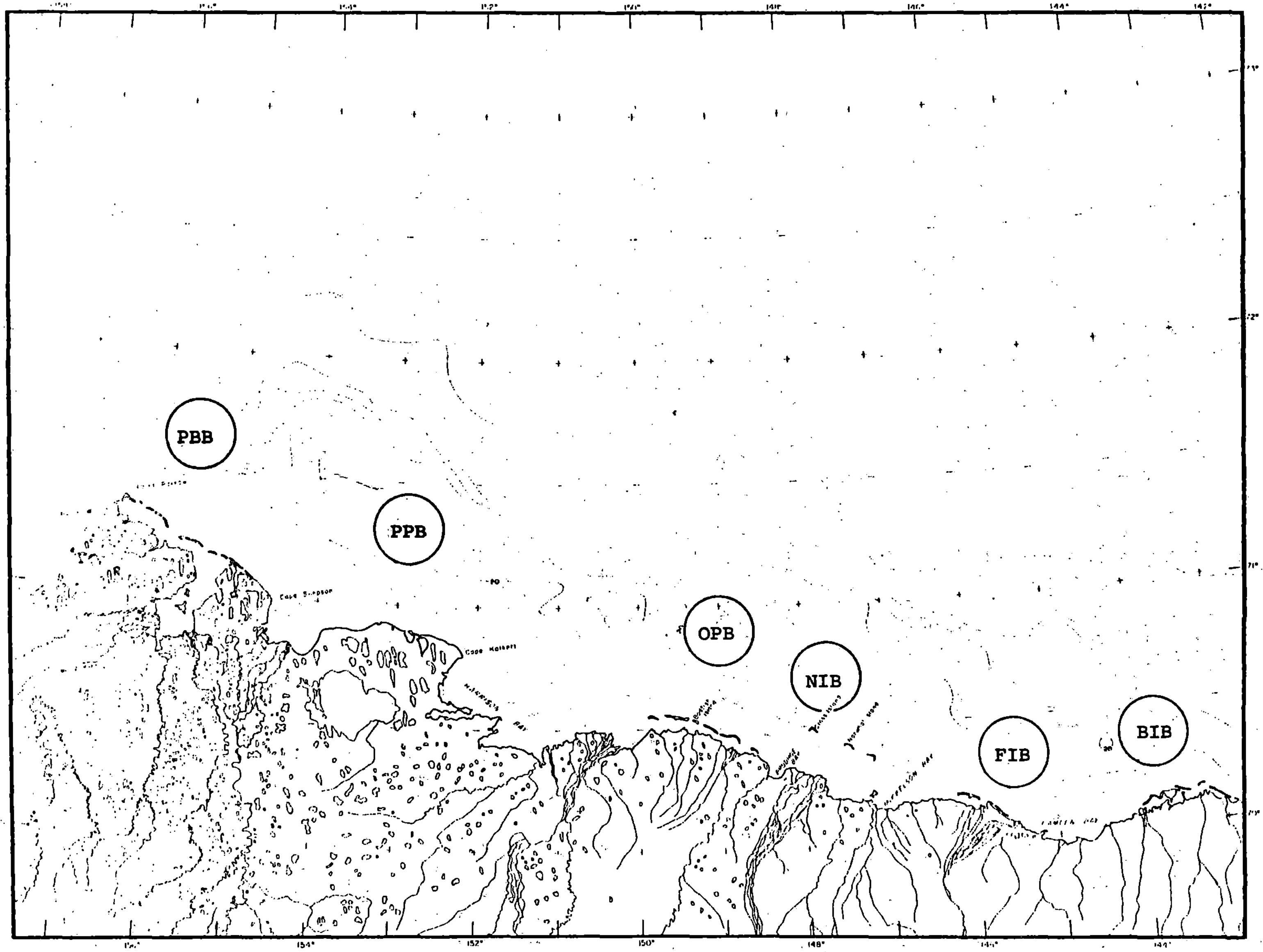

Figure 1. Location map for 6 areas of concentrated benthic sampling on 1978 USCGC NORTHWIND cruise. PBB=Point Barrow, PPB=Pitt Point, OPB=Oliktok Point (Jones Islands), NIB=Narwhal Island (Prudhoe Bay), FIB=Flaxman Island, and BIB=Barter Island.

When NOAA, under sponsorship of BLM, started an environmental assessment research program around the continental shelves of Alaska, Oregon State University participated in the benthic program in the Beaufort Sea. A combination NSF and NOAA/BLM research program supported several approaches and phases of research. Detailed analysis of benthic communities, e.g. identification of the total polychaete worm fauna over a wide range of depths, could be accomplished under the National Science Foundation's auspices. Further continental shelf survey sampling could be continued under the OCSEAP with the cooperation of the Coast Guard and their Beaufort Sea icebreaker program and the use of NARL's coastal vessel, the R/V ALUMIAK. With NOAA's interest and logistics support, seasonal sampling and study of temporal changes in the continental shelf communities could be accomplished for the first time.

The recent objectives for Task Orders E-3, E-4, E-6, and E-7 for RU #6 have emphasized the delineation of the benthic food web and the description of the coastal benthos. Efforts to characterize the composition of the Beaufort Sea fauna to the species level has been continuing as this is a critical step toward understanding the structure and dynamics of the benthic ecosystem.

As a basal portion of the oceanic ecosystem, the sea floor invertebrates utilize the food energy that reaches them, degrading it into simpler chemical compounds by metabolizing it for maintenance and transforming it into protoplasm for growth and reproductive products. In turn, many of these animals must provide a major source of energy for higher level carnivores, including seals, walrus, marine birds, and fish species that derive food from the sea floor.

As a logical extension of past benthic work in the Beaufort Sea, the research to be undertaken in FY-79 will explore the significance of the macro-benthic populations in relation to the larger predator species and to the smaller forms of biota, i.e. bacteria and benthic diatoms that may provide a large energy source for the benthic invertebrate organisms. A proposed research sub-project would include the description of the small-sized benthic invertebrates that may be an important link in this detritus-based food web. The research program has been designed to complement the food web studies being undertaken for the marine mammals, birds and fishes. This study integrates well with coastal benthic study and the lagoon ecosystem project in the southwestern Beaufort Sea and with the Canadian work that has been conducted in the eastern sector. As a portion of the ecosystem the benthic ecological studies complement the research in primary production and bacterial decomposers. Ecological patterns of benthic communities may aid the physical and geological oceanographers by providing indicators of average environmental conditions.

icebreaker as a suitable platform for integrated multidisciplinary research. Efforts will be made during the cruise to sample inshore of the 20 meter contour and in the lease area. Sampling will be coordinated as much as possible with the inshore efforts of Carter Broad (RU #356) on the R/V ALUMIAK. Overlap will be minimized, but defined gaps in areal coverage will be filled whenever possible. Data derived from these samples will demonstrate the degree of regional variation in the benthic fauna in different environments. Efforts will be made to include the outer edges of the oil and gas exploratory case area within the 20 meter contours. Particulary productive areas can be noted for special consideration.

The gross community structure data from the five macro-infaunal stations will further define the limits of natural variability. If species data can be obtained analysis of possible changes in species populations can be generated. As polar benthos have a low incidence of pelagic larvae (Thorson, 1950), the species composition and faunal abundance may not vary as greatly from year-to-year as those from temperate waters. Data from other areas on community variability through time cannot be extrapolated from elsewhere. The Pitt Point temporal data will provide further data on the degree of temporal variability.

B. Supplemental Sub-project Research Modules

Of the listed research modules, numbers (1) and (2) represent new research that would add much to our basic knowledge of Beaufort Sea benthos. Modules (3) and (4) are continued objectives of present research. Number (4) represents the support of a Computer Programmer-Data Manager-Statistician, plus appropriate computer support and is considered an essential continuation of the program.

(1) Small Benthic Macrofaunal and Meiofaunal Food Web Module.

($25,000)

(Man-Months: 12)

<u>Objective 1.</u> The numerical density and gross taxonomic composition of meiofaunal benthos (0.064 - 0.5 mm) and small macrofauna (0.5 - 1.0 mm) will be determined at selected integrated benthic food web stations.

<u>Objective 2.</u> The above bio-indices will be compared and contrasted with the benthic diatom standing stock and production, with bacterial concentration and activity, with macro-infaunal standing stocks, and with environmental characteristics such as organic carbon and peat detritus content of the sediments.

<u>Justification of Module (1).</u>

The smaller end of the food web in the Beaufort Sea ecosystem may be very important in transferring energy from oceanic and terrestrial detritus to the macrofauna upon which benthic-feeding fish, birds and marine mammals depend. The proposed studies could assess the relative importance of the small organisms in the inner shelf benthic food web in about six environmentally important areas subject to oil and gas development. Much of these data are now lacking for the Beaufort Sea, and no such integrated studies have been attempted before.

(2) Coastal and Lagoonal Seasonal Variability Module.

($50,000)

(Man-Months: 24)

<u>Objective 1.</u> The numerical density, biomass (wet-preserved weight), and gross taxonomic composition of the large macro-infauna (>1.0 mm) will be determined at selected intervals year-round at a pair of stations in Simpson Lagoon.

<u>Objective 2.</u> The numerical density, biomass (wet-preserved weight) and gross taxonomic composition of the large macro-infauna (>1.0 mm) and the abundance of important prey species will be determined at selected intervals year-round at a pair of stations in Beaufort Sea coastal waters.

<u>Justification of Module (2).</u>

The year-round biological activity of the shallow coastal waters and protected lagoons should be studied to determine if the fauna may be more sensitive to oil-related pollution problems at any particular season of the year. As the free or brooded larval phase of benthic invertebrate reproductive cycles is considered a very sensitive stage, life histories of the dominant and key food web species must be considered to estimate risks involved.

By contrasting stations in the lagoonal and coastal environments that freeze solidly to the bottom with those that maintain unfrozen water in isolated topographic lows, the hypothesis of refugia for vagile epibenthic organisms can be tested.

(3) The life history, reproductive activity and yearly variability of selected benthic species at standard stations on the Pitt Point Transect.

($45,000)

(Man-Months: 24)

<u>Objective 1.</u> The reproductive activity and population size structure of abundant species of bivalve molluscs, gammarid amphipods and polychaete worms will be determined from the 1975-76 Smith-McIntyre grab samples on hand.

<u>Ojbective 2.</u> The yearly variability in numerical density and biomass of dominant species will be determined at the benthic Pitt Point stations.

<u>Justification of Model (3)</u>.

The total and average data from the year-round benthic samples at five standard stations on the Pitt Point Transect across the Beaufort Sea continental shelf strongly indicate that the communities undergo seasonal reproductive cycles. Data on the reproductive activity and population size structure of individual species throughout the year are essential to test this hy othesis.

Species data are necessary to determine the year-to-year variation in population abundance, biomass, and rank order of abundance. If the 1978 USCGC NORTHWIND cruise is a success, three year's of August data will be available from the same locations and depths on the OCS Transect. Detailed analysis of these samples will provide estimates of the stability of the benthic community on the shelf of this polar sea.

(4) Quantitative Ecological Statistical Analyses.

($24,000)

(Man Months: 10)

<u>Objective 1.</u> The benthic data to date will be summarized and analyzed for ecological trends in species, species groups, and station groups.

<u>Objective 2.</u> The distributional patterns will be analyzed by multi-variate statistical techniques (Cooley and Lohnes, 1971) to determine species, species groupings and species-environmental relationships.

<u>Objective 3.</u> The sedimentary environment of the 1978 benthic samples will be analyzed for particle size, organic carbon and Kjeldahl organic nitrogen for use in the above statistical analyses. (To be subcontracted to S. Naidu, University of Alaska.)

Justification of Module (4).

Ecological trends give an over-view of the ecology of the benthic fauna that provides interpretations of the environmental and biological causes of the distributional and abundance patterns.

Trends in the distribution of species, species groups, station groups, and feeding types can only be determined and evaluated with the help of a computer programmer and quantitative ecological analyst. Such studies and those involving multi-variate analyses of faunal-environmental correlations are dependent on the continued cooperation and effort of the appropriate specialist. Computer summary, manipulation and analysis is the only practical means of utilizing so much data.

VI. STRATEGY AND APPROACH

For the FY79 contract year, the major approach will be further delineation of the fenthic food web and its interrelationships with the other components of the oceanic ecosystem. A second objective concerns the determination of year-to-year variation in the gross structure of continental shelf communities.

The definition of the food web structure in the Southwestern Beaufort Sea is a logical development in the research plan for OSEAP benthic research and for other marine biotic studies. If the major sources, the pathways, and the fate of carbon are known, then a conceptual model can be built for possible movement of pollutants through the food web. Critical interactive points in the food web fabric in the form of heavily utilized prey species can be defined. Continued stomach analyses and literature reviews on selected species will add to the knowledge of major food packages and areas of food sources on the shelf. Stomach contents of demersal fishes will be examined and identified as far as possible.

These species can then be singled out for ecological analysis in distribution and abundance and biological studies in life history and secondary production. Further sampling during the 1978 USCGC NORTHWIND cruise particularly in inner shelf environments will provide needed basin data for abundance and biomass estimates and distributional limits for the designated benthic invertebrate prey species. During the 1978 OCSEAP summer icebreaker cruise on the USCGC NORTHWIND macro-infaunal and macro-epifaunal benthos will be sampled from areas of interest particularly on the inner shelf. Rich bird feeding areas around Point Barrow, the standard benthos seasonal stations off Pitt Point, the lease area near Oliktok Point, Narwhal Island, and Flaxman Island, and the reported coastal upwelling region near Barter Island will all be sampled by bottom grab for infauna and epibenthic sled for epifauna. Sampling at characteristic inner shelf stations in each area will be undertaken in conjunction with studies of benthic diatoms and bacteria associated with these nearshore sediments.

Infaunal collections will be made with Smith-McIntyre bottom grabs with the same standardized techniques. They will be worked up from the areas of interest to at least the level of total biomass, numerical density and gross taxonomic structure. If funding and time permit selected animal groups will be identified to species, the fundamental unit for meaningful comparisons between stations and environments.

For the first time the macro-epifauna, e.g., small crustaceans, will be sampled with specialized gear to determine their abundance and distribution. The epibenthic sled will sample the surface layers of sediment and the overlying water layer. Sample picking/sorting and species identification will proceed as far as funding and time will allow.

The five standard benthic seasonal stations across the shelf on the Pitt Point Transect will be sampled for infauna to determine the variation in gross community structure from year-to-year. The same geographic locations and depth will be sampled that were occupied in 1975, 1976, and 1977. This will provide data for the third summer for the longer time scale variation. Gross bio-indices of biomass and numerical density will be determined. Identification of species will be accomplished if funding for specialized manpower and time permit.

VII. SAMPLING METHODS

A. Infauna

A 0.1 m^2 Smith-McIntyre grab (Smith and McIntyre, 1954) will be used to obtain infaunal samples. It is standardized gear that can be used with minimal difficulty in Arctic work. Six to ten quantitative samples will be collected from each station depending on the known faunal density at each environment. A sediment subsample will be taken from each grab to ensure the same environment was sampled in the patchy Beaufort Sea continental shelf environment. (N.B. They will be analyzed if supplemental funds are available.)

The standard benthic stations on the Pitt Point Transect will be sampled and analyzed for yearly variability in gross community structure. Stations located at 25, 40, 55, 70, and 100 meters depth will be sampled on the 1978 USCGC NORTHWIND cruise if sea ice conditions permit. If the plan is successful, collections from the same stations will have been obtained for three consecutive years.

Other sampling locations are located in areas of environmental, biotic and OCSEAP lease area interests (See section V). Stations will be located at the minimal operating depths of the icebreaker to provide information on the marine biota and their food web in the coastal zone. This is the region where large predators are known to feed and where oil could be wave-mixed to and into the sediments.

Sampling adequacy will be evaluated by cumulative species number, numerical density and biomass curves from multiple sample series. In the past, 10 and 15 sample series have been analyzed for these bio-indices and species rank order of abundance.

Washing of samples on shipboard will use the OSU Cascading Multiple Sieve System with a 0.42 screen as the smallest aperture unit.

Storage of samples will be temporarily in buffered 10% formalin-seawater. Upon return to the Oregon State University laboratory the samples will be resieved through 0.42 and 1.0 mm screens and placed in 20% isopropanol until picking and sorting.

B. Epifauna

1) Macro-epifauna (>1.0 m)

These animals associated with the sediment-water interface and bottom water layers will be sampled with a Hessler-Sanders epibenthic sled (EBS)(Hessler and Sanders, 1967). The EBS will be rigged with a 0.1 mm aperture plankton net and adjusted to sample the uppermost sediment layers and overlying 20 cms of water. If feasible, odometer wheels will be rigged to the sampler to provide estimates of distance towed, and therefore area sampled. The EBS will be towed for a standardized length of time. If possible, 2 samples per station will be obtained.

2) Mega-epifauna (>1.3 cm)

Larger and generally more scarce epifauna will be sampled by use of a 4 m otter trawl towed along the sea floor as time and ice conditions permit.

Collections will be coordinated with ADF and G. OSU sampling will concentrate on the second leg of the 1978 cruise in the eastern section of the study area.

VIII. ANALYTICAL METHODS

The analytical methods to be used will be the same as those employed by the OSU benthic group for all previous arctic research. Briefly, they are outlined as follows:

A. Infauna

1. The quantitative grab samples are sieved into two fractions, the large macro-infauna ($\geq$1.00 mm) and the smaller macro-infauna (0.42-1.00 mm).

2. The macro-infaunal organisms (>1.0 mm) are picked from the larger sediment particles and organic debris under a dissecting microscope, and sorted to major taxonomic category.

3. The organisms are enumerated.

4. The organisms in each gross taxonomic category are wet-weighed.

5. The dominant invertebrate species are identified as far as possible, as time and funding permit. Identifications are verified by taxonomic specialists whenever necessary.

B. Epifauna

1. The large epifaunal organisms are sorted from the otter trawl samples, and are counted and identified as far as possible.

2. Analyses are made of the stomach contents of the larger, more abundant forms.

C. Data Acquisition

1. The data from the quantitative grab samples and the trawl hauls, and the station information and environmental parameters are all coded for inclusion into a computer data base.

2. All data are keypunched onto computer cards.

3. All keypunching is verified before transfer to magnetic tape.

D. Statistical Analyses

The statistical analysis of the data is contingent upon the evenness and richness of the benthic communities. The types of analyses that are under consideration include multiple correlation analysis, species diversity indices, and similarity indices used in ordination techniques. Classification techniques such as multivariate factor analysis or canonical correlation analysis will also be evaluated (Cooley and Lohnes, 1971; Sneath and Sokal, 1963; Clifford and Stephenson, 1975).

IX. DELIVERABLE PRODUCTS

A. Digital Data (Type 032 - Benthic Organisms)

1. Parameters to be recorded:

   a. Common to all records
      - File Type
      - File Identifier (Cruise Number)
      - Record Type
      - Station Number (Record Types 2,3,5)
      - Segment Sequence Number (except Record Type 2)

   b. Record Type '1' - Text
      - Vessel Name
      - Text

   c. Record Type '2' - Station Header
      - Depth (Start and End
      - Date/Time (Start and End)
      - Geographic Position (Start and End)
      - Distance Offshore
      - Direction of Tow

   d. Record Type '3' - Segment Detail
      - Segment Depth (Start and End)
      - Penetration Depth
      - Bottom Temperature, Salinity, Oxygen *
      - Percent Sediment Carbon (Organic and Total) *
      - Percent Sand, Silt, Clay *
      - Minimum Sieve Size
      - Wire Length and Angle
      - Average Phi Size *
      - Equipment (code)
      - Sample Number
      - Sample Volume
      - Number of Grabs

   e. Record Type '5' - Species
      - NODC Taxonomic Code/Subspecies (code)
      - Number of Individuals
      - Total Weight of Speices
      - Qualitative Count (code)

   f. Record Type '6' - Comment
      - Text
      - Text Sequence Number

* Data product is not consistently available.

DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Benthic Organisms	Magnetic Tape	Maximum of 150 records per sample	032	Yes	8/78 - 9/78	10/79

B. Narrative Reports

Several manuscripts to be submitted for publication are planned. Initial results from the Pitt Point seasonal sampling have been described by Dickinson and Ruff at the Pacific Section, ASLO Meeting in San Francisco in June, 1977. A paper based on the time series study at five stations across the continental shelf will be prepared on the gammarid amphipod fauna during the fall, and submittal to an appropriate journal is planned. A second manuscript based on temporal changes in the structure of benthic macro-infaunal communities across the continental shelf on the Pitt Point Transect will be written when the necessary detailed data on the reproduction of dominant species are available. Additional manuscripts on the new benthic sample siever, on the distribution of species groups and communities and on the photographic and trawling survey of mega-epifauna are also scheduled for 1978-79.

C. Visual Data

All visual data presenting analyzed Beaufort Sea benthic ecological data will be presented in quarterly and annual reports. A set of representative sea floor photographs will be submitted separately.

D. Other

No deliverable data products are anticipated.

X. QUALITY ASSURANCE PLAN

A conservative approach is taken toward benthic ecological data; every effort is taken to maintain quality control. Monitoring and studies of our data are continually being undertaken in the following categories: (1) sampling, (2) sample preprocessing in the field, (3) laboratory sample picking and initial organism sorting, (4) quantification by weighing and counting, (5) identification of species, (6) any field or laboratory measurements of environmental characteristics, (7) quantitative ecological and statistical analyses, (8) transmittal of data via data report or magnetic tape, and (9) publication of the results.

1. Instrument calibration is undertaken whenever necessary. Use of instrumentation in the benthic ecology program has been limited to an *in situ* temperature-salinity probe during several seasonal field trips. Owing to malfunction in the field a detailed laboratory calibration and intercomparison is planned during the next contract year.

Other instruments utilized in the program include balances and microscopes. These are routinely serviced and calibrated by factory representatives.

2. Sampling.
(a) Smith-McIntyre Grab (Smith and McIntyre 1954)

The variability between samples at a station and the adequacy of the number of multiple samples are investigated by comparing quantitative faunal data between samples and by the cumulative addition of species with increasing numbers of samples. Our sample size per station generally ranges between 5 and 20 depending on the density of animals, the available wire time, and available laboratory manpower to process the samples.

Grab samples are only retained for quantitative faunal analysis if the sampler has penetrated into the sediments at least 6 centimeters. The penetration is measured at 5 locations (each corner and the center) upon retrieval and before unloading the sampler. The penetration varies according to the hardness of the sediment so each station cannot be sampled with the same amount of effort. If the penetration is uneven, the sample is also discarded.

If the collected sediment surface is washed, the quality is also classified as a discard. The surface of the samples can be washed if the grab jaws are partially wedged open by a rock or shell, and the retained water generally runs out down one corner and out the bottom.

Whenever possible a photograph is taken of the sediment surface of the grab for future reference. A sediment subsample is now removed from each grab to provide better control over the location of the sediment for particle size and organic content analyses.

The Smith-McIntyre grab was originally chosen because of its ease of handling on all size vessels and its reproducible results. It is an efficient and dependable sampler. Studies of the action of the grab and its comparison with other samplers have been undertaken (Gallardo, 1965; Wigley, 1967; Dickinson and Carey, 1975).

(b) Shipboard Sieving and Preservation

The samples are preprocessed aboard ship by washing through fine mesh sieves to separate the organisms from the major portion of the sediment. A high volume of filtered seawater at low velocity is used to wash the small particles through fine mesh (0.42 mm) screens. Care is taken to minimize damage to the infaunal organisms.

On the ship the samples are placed in containers with 10% formalin-seawater buffered with Borax. Immediately after the samples reach Oregon State University, they are transferred to 70% isopropyl alcohol until picking and sorting of the animals from the samples. The organisms are then placed in 70% ethyl alcohol for longer term storage.

For each project the adequacy of sampling is checked by collecting a large series of replicate samples at characteristic stations. Whenever possible each new sampler is compared with other gear either by literature searches or direct comparisons. Only adequate samples are returned to the laboratory for quantitative analyses.

3. Sample processing

The accuracy of picking-sorting-counting are evaluated and maintained by an experienced technician who spot-checks samples previously processed. Faunal identifications by the OSU research team are verified by competent specialists whenever possible.

4. Data analysis

Alternate approaches and methods for analyzing data are evaluated and compared. All data which are coded and keypunched for statistical analysis are routinely subjected to verification before they are transferred to magnetic tape. The data base is constantly updated and verified to minimize incorrect data. The magnetic tape uses information stored in the computer; a transcription step is eliminated and gives more flexibility in correcting errors and retrieving data.

XI. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

All infaunal organisms taken from the Beaufort Sea continental shelf and slope since 1971 have been maintained in 70% ethanol in fairly temperature-stable biological storage areas on the Oregon State University campus pending further taxonomic research. Unpicked and unsorted grab samples have been transferred as rapidly as possible from neutralized 10% formalin to 70% isopropanol. Invertebrates from trawl samples have been stored in five gallon sealed plastic buckets under similar conditions. All these samples are available as comparative material for a portion of the proposed foodweb research.

Voucher specimens, identified or verified by qualified taxonomic specialists, have been accessioned into the Oregon State University Benthic Invertebrate Reference Museum. Each species has been given an OSU species code number which is entered into a computer file for future reference (Carey, 1978). A range of sizes and developmental stages have been placed on taxonomically organized shelves in an air-conditioned room adjacent to a benthic laboratory in one of the main oceanography buildings. Approximately 250 arctic species now reside in the collection, and a comparable number remain to be entered. The available keys, reprints, and monographs pertinent to the arctic fauna are also being accumulated. The collection has been organized with the aim of forming a scientif cally useful reference museum and taxonomic literature library.

A parallel voucher specimen collection to be eventually submitted to the California Academy of Sciences will be produced as time, effort and funding permit. The species identifications will have been verified, and a representative series of specimens for each species will be part of the collection.

B. AIRCRAFT SUPPORT - FIXED WING

1. Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)

   NARL to Deadhorse, AK

2. Describe types of observations to be made.

   N/A

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

   Nov., May, May

4. How many days of flight operations are required and how many flight hours per day?
   Two flights

   Total flight hours? Two hours per day

5. Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback?

   No

6. What types of special equipment are required for the aircraft (non carry-on)?
   N/A
   What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.

   N/A

7. What are the weights, dimensions and power requirements of carry-on equipment?

   1200 lbs.

8. What type of aircraft is best suited for the purpose?

   Twin Otter

9. Do you recommend a source for the aircraft? NARL
   If "yes", please name the source and the reason for your recommendation.

10. What is the per hour charter cost of the aircraft?

   $3 50/hr.

11. How many people are required on board for each flight (exclusive of flight crew)?

   4

12. Where do you recommend that flights be staged from? NARL

C. AIRCRAFT SUPPORT - HELICOPTER (TENTATIVE ONLY)

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

Simpson Lagoon and Elson Lagoon(?) area(s). Short transect offshore.

2. Describe types of observations to be made.

Smith-McIntyre bottom grabs (6) at each station.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

(a) October-November, (b) March (early), (c) May (late).

4. How many days of helicopter operations are required and how many flight hours per day? 4 days sampling for 6-10 hrs. per day

Total flight hours? 40

5. How many people are required on board for each flight (exclusive of the pilot)?

4

6. What are the weights and dimensions of equipment or supplies to be transported?
Total weight is approximately 1,200 lbs. All gear will fit inside with the exception of 3 12ft steel pipes which can be lashed to helm skids.

7. What type of helicopter do you reommend for your operations and why?
Bell 205: This helicopter has proven to be well-suited for benthic sampling operations during past seasonal sampling. Gear is heavy and bulky.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

NO

9. What is the per hour charter cost of the helicopter?

?

10. Where do you reommend that flights be staged from? Prudhoe Bay - Oliktok
NARL

11. Will special navigation and communications be required?
Yes, accurate navigation is essential.

D. QUARTERS AND SUBSISTENCE SUPPORT (TENTATIVE ONLY)

1. What are your requirements for quarters and subsistence in the field area? (These requirements should be broken down by (a) location, (b) calendar period, (c) number of personnel per day and total man days per period).

   (1) NARL - Nov., Mar., May, 4 per day, 28 man days

   (2) Prudhoe Bay - Nov., Mar., May, 4 per day, 28 man days

2. Do you recommend a particular source for this support? If "yes", please name the source and the reason for your recommendation.

   NARL, OCSEAP Prudhoe Bay accommodations.

3. What is your estimated per man day cost for this support at each location?

   NARL - $40/day

   Deadhorse - ?/day

   How did you derive this figure, i.e., what portion represents quarters and what portion represents subsistence and is the figure based on established commercial rates at the location or on estimated costs to establish and maintain a field camp?

   NOAA and NARL figures

E. SPECIAL LOGISTICS PROBLEMS

1. What special logistics problems do you anticipate under your proposal and how do you propose that the problems be solved? (Provide cost estimates and indicate whether you propose handling the problems yourself or whether you must depend on NOAA to solve them for you?

   Heat Hydro hut (12'x16') necessary on ice nearshore in each staging location for sample washing to be provided by NOAA. Power for electrical pump motor necessary.

   Portable hydro winch necessary (from NARL).

   Continuously heated storage necessary (NOAA).

XIII. ANTICIPATED PROBLEMS

A. Funding

This is the fundamental problem that could bring the research program of RU #6 down to an inefficient and unproductive level. Environmental and ecological research, particularly with benthic invertebrates, is labor-intensive research that also demands a high grade of expertise to achieve even the first level of average information. The work-up of infaunal samples and identification of the fauna require much greater effort and greater taxonomic knowledge than the less diversified mega-epifauna collected by otter trawls. As an example of the identification problem refer to Gunnar Thorson (1971). He and other biologists estimate that 90-98% of the species of plants and animals in the sea are benthic. Data must be at the specific level for meaningful comparisons within and between studies.

If the $75,000 guideline were rigid, RU #6 would have no operating funds and lack one-two months salary for the principal investigator. The proposed cost over-run was considered a justified request.

Secondly, unless supplemental funds are available, only two full-time professional research assistants can be hired to pick and sort a reduced number of samples from the 1978 icebreaker cruise. Their time would be totally dedicated toward picking animals (>1.0 mm) from the samples and obtaining data at a gross level. A Ph.D. candidate, Gordon Bilyard, is totally involved in the last stages of thesis research, analysis and writing for next year.

The solution lies in funding one or more of the subproject research modules. This supplemental funding would allow the continuation of Paul Scott and a full time computer programmer/data analyst in the program. Both are considered essential to the research. Mr. Scott is a specialist in molluscan identifications and is experienced with RU #6 techniques in the laboratory and field. Funding is especially requested for the supplemental modules: 1) the integrated shallow shelf benthic food web studies, 2) temporal variability of coastal and lagoon benthic communities, and 3) quantitative analysis and summary of the benthic data.

B. Contingency Plans

If extraordinarily heavy sea ice or ship breakdown during the 1978 summer prevents fieldwork from an icebreaker in the Beaufort Sea, several alternate plans are possible. Benthic sampling on the Pitt Point Transect and other areas could be accomplished in cooperation with Carter Broad (RU #326). Alternately, continued work-up of our present collections could yield valuable results that are oriented toward NOAA/BLM-OCSEAP's objectives. Subproject research modules (3) on life histories and (4) on statistical analyses. Further species identifications and work-up of the small macro-fauna (0.5 - 1.0 mm) as suggested in section XVI (Outlook) could be undertaken.

These latter objectives would produce much stronger data and are recommended over the field contingency plans of operation in Norton or Kotzebue Sounds. A detailed research schedule cannot be finalized until the sampling success of the 1978 UVCGC GALCIER OCSEAP food web cruise is known. If samples are not collected during this summer effort, the alternative objectives utilizing samples obtained from previous OCS field efforts are proposed. It is apparent that the need for more comprehensive, solid, and detailed data from the Beaufort Sea is more important at this stage of the OSCEAP research than is a small amount of superficial data from the Chukchi Sea.

XIV. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

In most cases contacts have been made to obtain these data:

A. Hydrography: Bottom water salinity, temperature, O_2 concentration, position and depth. The OCS transect line off Pitt Point is of particular interest.

B. Ice dynamic: Extent of active ice gouging on the bottom sediments in terms of depth, location, and frequency.

C. Primary production: Location and timing of standing stock and production of phytoplankton and attached under ice diatoms.

D. Sediment: Particle size distributions on the southwestern Beaufort Sea continental shelf and the processes and sources of sedimentation.

E. Circulation: Predominent seasonal currents on the Beaufort Sea continental shelf and slope.

F. Benthic predators: The abundance, location and invertebrate prey items of such predators as benthic-feeding marine mammals, birds and fishes.

XV. MANAGEMENT PLAN

The management of all phases of the Beaufort Sea benthic ecological research during FY-79 will be organized so that as principal investigator, I will be responsible for the overall progress and results of the research program. A laboratory manager, R. Eugene Ruff, will work with me to ensure the proper quality and quantity of pertinent data and the timely reporting of results.

During the 1978/79 contract year, weekly briefings and progress report meetings with research personnel will be held for exchange and discussion of information. Updated schedules of field trips, scientific meetings, internal subproject deadlines, quarterly and yearly reports, scientific publications, and any special tasks will be maintained and used as guidelines for research progress evaluation. The lab manager and I will work with the Benthos research group to maintain schedules and to meet the necessary deadlines.

Research objectives, schedules, and priorities will be organized for the year at the beginning of the contract. As principal investigator, I will be involved in the writing of final and yearly reports, in the analysis and synthesis of data, in the reporting of results in scientific publications, and in the overall direction of the research program.

The Activity/Milestone chart outlines the major projects and deadlines proposed for FY-79.

0 - Planned Completion Date

X - Actual Completion Date

RU # 6 PI: Andrew G. Carey, Jr.

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

		1978					1979								
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Foodweb Research															
Macro-infaunal analysis										0					
Macro-epifaunal analysis													0		
Predator GI tract analysis										0					
Prey species distribution summary												0			
Yearly variability															
PPB macro-infaunal analysis							0								
Quarterly Report				0			0			0			0		
Annual Report							0								
Data - analysis			0			0			0			0			
transmittal				0			0			0			0		

XVI. OUTLOOK

Basic supportive research is necessary before the plateau level of data collection and analysis is reached where satisfactorily solid conclusions can be reached. This statement is true for the three major areas of research in benthic ecology that have been undertaken by RU #6 (see Table 1 for suggested subprojects).

A. Temporal variability of benthic communities across the Beaufort Sea continental shelf.

Data from the seasonal benthic infaunal samples collected during OCS 1-6 by Oregon State University is now available on the numerical abundance, biomass, and percent composition by phyla. Gammarid amphipods are the only animal group identified to species.

Species population data are needed on population size structure and reproductive activity for several species of abundant molluscs, polychaete worms and bivalve molluscs to prove or disprove the hypothesis of seasonal reproductive cycles of macro-infauna on the outer continental shelf (Carey, Ruff, and Montagna, unpublished M.S.). This lack of species data was the major reason for the rejection of a recently submitted paper on temperal changes in the fauna. The small macro-infauna (0.5 - 1.0 m) from our samples should be worked up to assess stages and timing of recruitment of juveniles to the adult benthic populations.

Cost by fiscal year would be about $45,000. No new equipment, field efforts or logistic requirements would be necessary.

Additional seasonal studies of benthic communities in the nearshore area in the lease zone would be valuable for determination of the reproductive cycles and distribution of nearshore benthos in the shorefast ice zone and in the lagoonal environments. The potential multi-disciplinary sampling effort for FY79 would be a valuable project to define benthic biology and behavior year-round.

B. The distribution, abundance, and spatial variability of abundant benthic fauna.

The major data lacks are in the research areas of species identifications, knowledge of the small macro-fauna (0.5 - 1.0 mm), and in statistical analyses. The species of dominant animal groups would be worked up for the different ecological zones and could be reported in stages. The initial data from small macrofaunal fractions would first be reported in terms of percent composition by phylum, numerical density, and biomass. Then identifications could be undertaken of selected groups, particularly the juveniles of polychaetes, bivalve molluscs, and gammarid amphipods. The harpacticoid copepods and other selected groups of small fauna would also be identified.

Statistical analyses would aid in summary and synthesis of the ecological patterns. Species and station groups would help define communities, and multivariate analyses would help determine the effect of the environment on the faunal distributions. In addition to basic data management, more sophisticated programming and analysis techniques are needed.

Basically more funds are needed to support one full-time invertebrate specialist as a research assistant and one in computer programming/data analysis. Salaries and supplies would cost approximately $40-50,000 per year. Funds are essential for subcontracting analysis of sedimentary characteristics to Dr. S. Naida of the University of Alaska.

C. Benthic food web studies

Further identification of dominant prey and predatory fauna in the present samples are required to provide complete summaries on the distribution and abundance of benthic invertebrates that are important in the oceanic food webs.

There are a number of gaps in the research based on the integrated sampling to be accomplished on the 1978 USCGC NORTHWIND cruise in the western Beaufort Sea. The base funding level of $75-83,000 will not allow the work-up of the small benthic fauna, the meio-fauna (0.064 - 0.5 mm) and the small macro-fauna (0.5 - 1.0 mm). These are the forms that would ingest bacteria, detritus, and benthic diatoms. The evaluation of the importance of the microbenthic food web must include these small organisms (Gerlach, 1971). Support for working up selected samples from the 1978 cruise would cost approximately $25,000.

SUMMARY

An evaluation of the dynamics of the total benthic community is the next logical step in the arctic research program. The natural temporal variability must be verified, the smaller members of the community must be determined, the growth rates of the dominant organisms must be measured, the modes and rates of repopulation must be ascertained, and the "key" species in the benthic food web must be determined before meaningful predictions can be made on the potential consequences of a major extinction event occurring on the Beaufort Sea continental shelf.

What is also urgently needed is more information of the functioning of the Beaufort Sea ecosystem. Basic carbon inputs should be evaluated. Even at a gross level, estimates of inputs from ice algae, terrestrial and marine detritus, phytoplankton production, and DOC and POC from the Bering and Chukchi Seas would be invaluable in estimating the relative importance of these energy sources. Then more detailed research on the major inputs could be studied in more detail. Such basic data are necessary for explaining the ecological patterns described in the benthic communities.

XVII. STANDARD CONTRACT STATEMENTS

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

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Thorson, G. 1971. Life in the Sea. World University Library, McGraw-Hill Book Company. 256 pp.

E. Other Relevant Information

It is apparent that the need for more comprehensive, solid, and detailed data from the Beaufort Sea is more important at this stage of the OCSEAP research than is a small amount of superficial data from the Chukchi Sea. The latter samples and data can be worked up and analyzed at a later date when there is more research emphasis placed in the Chukchi Sea environmental assessment for oil exploratory drilling in coastal and offshore waters.

(1) Justification for data transmittal lag. Benthic ecological research is labor intensive. It takes manpower to collect the samples, to initially process them by washing through fine sieves in the field, to pick and sort the fauna from the samples, to identify the many species, to study food habits, to estimate reproductive activity, and to analyze the derived data. There is, therefore, a necessary time lag involved with this type of oceanographic research. In spite of the extensive time and effort required to extract this type of data (Barnard and Jones, 1960), it is evident that the benthos lend themselves as one of the best ecological groups for detailed study in an environmental assessment program. They are a fixed part of the environment that is reacting to natural and man-made changes in their surroundings.

(2) Justification for the budget requests. (a) Personnel - My approach has been to develop a small but highly trained research group which can be depended upon to produce large amounts of accurate data to incorporate in environmental baseline-ecosystem studies of the Beaufort Sea. Much effort was expended to assemble a highly trained and experienced research group to undertake these studies. Their record during the contract years has demonstrated their abilities to fulfill the objectives of the program. The qualifications of these key personnel are listed in section D of the Addenda. It is evident, however, that only selected aspects of the benthic ecological program can be accomplished by the small staff.

General support wages are necessary for clerical and general school support, and for part-time routine laboratory labor. The laboratory labor has helped with the maintenance of field gear, the editing-processing-printing of bottom photographs, picking of samples, quantification of samples data, and the key-punching of data for computer summarization and analysis, and Invertebrate Reference Museum curation.

(b) Travel - Travel to a national meeting and to taxonomic collections and specialists has been requested because exchange of new ideas and data are essential for maintenance of an advanced and imaginative research program and for dissemination of ideas. It is a necessity for key personnel in a program who are identifying particular animal groups to be able to consult with qualified taxonomic specialists and to use museum collections. New and difficult species are frequently collected by us in the Beaufort Sea; confirmation of these identifications are essential. The species is the basic datum with which ecologists work; it is necessary that this fundamental level of knowledge is accurate and comparable with other data sets.

(c) Supplies and Services - Sufficient supplies for laboratory research are essential. The masses of ecological and faunistic data can only be analyzed statistically by computer. Computer manipulation allows us to transcribe the numerous data onto magnetic tape for transmission to NOAA-OCSEAP: the labor and computer time involved in these activities are high.

1978

Dr. Gunter Weller
NOAA Arctic Project Office
Room 506C, Elvey Building
University of Alaska
Fairbanks, Alaska 99701

Dear Gunter:

I have reviewed the final work statement by Carey (RU6) and have the following comments:

The work statement addresses objective 1 of the RU description, but makes no mention of objective 2. Synthesis is not really discussed in the basic work statement, especially with reference to the analysis of potential vulnerabilities of benthos to OCS actions. Modules 3 and 4 (additional cost to OCSEAP) address the analysis and synthesis of data and appear to be the routine workup of samples and data that should normally have been forthcoming from previous years' field work.

I recommend we ask Carey to eliminate the residual field work shown in the proposal (I can't tell whether this is extensive over the shelf or restricted to the Pitt Pt. transect), and only workup and analyze these samples "most relevant" to the proposed lease area. Any analyses which must be postponed beyond FY 79 should be clearly secondary objectives in the work statement. We obviously don't know whether there will be support for additional analyses in FY 80.

By the way, Carey's request for no-cost extension and use of overhead savings was approved and forwarded to contracts, so he has continuity past October 1.

Sincerely,

Douglas A. Wolfe
Acting Director, OCSEAP

bcc: Subject (RU 6)
Chrono
Read
Signer

DAWolfe/mv/29Sep78

To: Juneau Project Office
OCSEAP
NOAA/BLM

Proposal Date: January 1979

Contract #: NOAA 03-5-022-70

Task Order #: ____________

NOAA Project #: ____________

L-DGO ID: ____________

FY 1979 RENEWAL PROPOSAL

Research Unit Number 16

TITLE: A Seismotectonic Analysis of the Seismic and Volcanic Hazards in the Pribilof Islands - Eastern Aleutian Islands Region of the Bering Sea

Cost of Proposal:

L-DGO provided services	$130,000
NOAA provided logistics	$100,800
TOTAL	$230,800

Lease Areas

Aleutian Shelf	70 %
St. George Basin	30 %

Period of Proposal: October 1, 1978 through September 30, 1979

____________ Date____________

Dr. John N. Davies
Co-Principal Investigator
Lamont-Doherty Geol. Obs.
Palisades, New York 10964
(914) 359-2900 Ext. 228

____________ Date____________

Dr. Klaus H. Jacob
Co-Principal Investigator
Lamont-Doherty Geol. Obs.
Palisades, New York 10964
(914) 359-2900 Ext. 440

Institution: Lamont-Doherty Geological Observatory of Columbia University in the City of New York

____________ Date____________

Dr. Manik Talwani
Director
Lamont-Doherty Geol. Obs.
Palisades, New York 10964
(914) 359-2900

____________ Date____________

Ms. Beth Israel
Projects Officer
Office of Projects and Grants
Columbia University
(212) 280-3023

IRS NUMBER: 20

CONGRESSIONAL DISTRICT NUMBER: 13-5598093

TECHNICAL PROPOSAL

I. A. Title: A seismotectonic analysis of the seismic and volcanic hazards in the Pribilof Islands - Eastern Aleutian Islands region of the Bering Sea

B. Research Unit Number: 16

C. Contract Number: NOAA 03-05-022-70

D. Proposed Dates of Contract: October 1, 1978 - September 30, 1979

II. Principal Investigator(s)

A. Dr. John N. Davies

B. Dr. Klaus H. Jacob

III. Cost of Proposal Federal Fiscal Year 1979

A. Science:	$130,000
B. P.I. Provided Logistics:	None
C. Subtotal:	$130,000
D. NOAA Provided Logistics:	$100,800
E. Total:	$230,800

F. Distribution of effort by lease area:

1. Aleutians	70%
2. Beaufort Sea	
3. Bristol Bay	
4. Chukchi Sea	
5. Kodiak	
6. Lower Cook Inlet	
7. NEGOA	
8. Norton Sound	
9. St. George Basin	30%
10. Non-lease-area laboratory management	

IV. Background

We propose to continue to monitor seismic and volcanic activity on the Pribilof Islands, Eastern Aleutian Islands, and Western Alaska Peninsula. Since seismic and volcanic activity has periods on the order of decades and centuries, this project is conceived as a long-term effort to obtain the best record possible of the seismicity of the study area. This project is complementary to similar projects being carried out by the University of Alaska in the Kodiak and Lower Cook Inlet areas and the USGS in Lower Cook Inlet and the Gulf of Alaska. In addition it is viewed as a subset of a larger seismotectonic study of the Aleutian arc funded by ERDA. Relevant seismic and geodetic results from this ERDA study are reported to NOAA through the present contract.

We seek a major increase in funds to improve the reliability of our network operations in both the Aleutian and St. George Basin areas. A major upgrading of the recording center at Sand Point is being undertaken with D.O.E. support.

In the seismically active Dutch Harbor region we propose to add a non-seismic repeater and a strong motion accelerograph to increase the probability of obtaining useful strong motion accelerograph data for the eastern Aleutian Island arc. Only two such records presently exist. At the evaluation meeting held in Menlo Park early this year (1978), representatives of the oil industry reported that they had commisioned a study of Japanese strong motion data to develop estimates of acceleration vs. distance relations for the Aleutians. They stated that the acquisition of strong motion data from the Aleutians would allow formulation of better estimates for these relations and that the improved relations would be extremely valuable in designing structures for the Aleutian region.

In the St. George Basin region we propose to rewire the recording system to improve the signal to noise ratio of the records there.

At present, only a single local station exists (at St. Paul Island) so that only teleseismic locations for earthquakes are possible. During the past two years a few local and regional earthquakes have been detected by the local station. The locations of most of these events cannot be determined because they are too small to recorded by other seismograph stations. During the ten years, 1965-1975, six earthquakes have been located in the St. George Basin region using teleseismic data. The distribution of these events is elongate in the direction of the long axis of the basin. Seismic profile records indicate that at least one side of the basin is fault controlled. Geological work in the Pribilof Islands indicates the existence of faulting between the islands along a N.W. trend, subparallel to the long axis of the St. George Basin and to the elongation of the earthquake distribution. The time intervals between the arrivals of P (longitudinal) and S (shear) waves, at the St. Paul seismic station, indicate distances to earthquakes in the range ten to a few hundred kilometers. It is possible, therefore, that the minor seismic activity is associated with the N.W. trending faults described above.

We propose to attempt to locate the larger events recorded at St. Paul and at Dutch Harbor or Sand Point. If these events show a marked N.W. lineation, then more detailed investigations of their possible relationship to major faults would be mandated.

The D.O.E. funded upgrading of the recording center at Sand Point involves adding recording capability for the Pavlof Volcano network, improving the timing system and standardizing the recording format to reduce the data-reduction burden. By the end of summer 1979, we plan to have converted all of the Aleutian recording centers (Sand Point and Dutch Harbor) to analogue tape systems that automatically record only when an event occurs. This recording mode eliminates the necessity for time consuming scanning of tapes or films. For the present these tapes will be manually reduced on an existing playback system. Starting in mid 1979, a USGS supplied computer will be available at L-DGO for digitization of the analog data and subsequent processing.

The structural geology work proposed last year was successfully carried out this summer. A continuation of that work is proposed in a separate proposal to the National Science Foundation.

V. Objectives

The general objective of the proposed research is to analyze the seismic and volcanic hazards in the eastern Aleutians and St. George lease areas. The specific objectives of this research are as follows:

A. Record the locations and magnitudes of all detectable earthquakes within the study area and to develop frequency of occurrence versus magnitude relationships.
B. Correlate, where possible, the observed seismic activity with surface and near surface faults identified in geologic mapping.
C. Develop acceleration versus distance relations for major earthquakes.
D. Monitor seismic activity of volcanoes within the study area to evaluate volcanic hazards to OCS development and to contribute to an understanding of the regional tectonics.

Maps of earthquake locations are essential to determine whether or not there exist linear alignments of epicenters within a lease area that might be associated with the faults. Also, the spacio-temporal pattern of seismic activity is an important tool for earthquake prediction. Frequency of occurrence versus magnitude relationships are required for the production of earthquake risk maps.

The correlation of seismic activity with geologically mapped faults is strong evidence that the fault is active and a potential source for a large earthquake (depending upon the effective length of the fault). The identification of active faults is obviously critical to the evaluation of the seismic hazard in a lease area.

Acceleration-versus-distance relations for various earthquake magnitudes are the basis for predicting the peak acceleration and spectral content for strong ground motion as a function of position within a seismically active region. This predicted ground motion is required for designing of proposed or future structures with respect to their ability to withstand a given earthquake.

Very little is known of the detailed seismic and eruptive history of most of the Aleutian volcanoes. By placing some of the seismic stations of a regional network on active volcanoes, these stations can be used both to locate tectonic earthquakes and to monitor the seismic activity of the volcanoes. It is likely that the regional stress field which causes earthquakes controls volcanic activity as well. Conversely, it is possible that monitoring volcanic activity may be a useful tool in predicting major earthquakes in the Aleutian seismic zone that could constitute a severe hazard to most off and onshore installations associated with oil resource development and exploration.

VI. Strategy and Approach

General Strategy. The fundamental observation upon which this work is based is that seismic and volcanic activity is episodic with periods of the order of decades and centuries. To monitor this activity, therefore, requires a long-term commitment to the operation of a suitable seismographic network. For some purposes, such as characterizing the general level of seismic activity, determining the repeat times for large earthquakes, and delimiting aftershock zones for large earthquakes, teleseismic data will suffice. For other purposes a local seismic network is essential; these include (1) locating earthquakes accurately enough to associate them with a geologically known fault, (2) determining accurate source-receiver distances for strong motion records so that acceleration vs. distance relations can be computed and (3) utilizing the more frequent but smaller magnitude earthquakes that are below the detectability threshold of a world-wide network for (a) computing focal mechanisms, (b) determining spacio-temporal patterns of epicenters, and (c) reducing the time required to identify lineations in the distribution of epicenters that might indicate an active fault.

Experimental Design. The principal focus of our work in the eastern Aleutians has been a seismotectonic study of the Shumagin Islands seismic gap. Consequently a network of some 15 remote seismic stations exists in the Cold Bay-Shumagin Islands vicinity. There are also four strong motion accelerographs located within this region at Cape Sarichef, Cold Bay, Sand Point and Simeonof Island. In addition to the 15-station regional network we maintain a 12-station network around Pavlof Volcano to study its geothermal potential. Therefore, the Cold Bay-Shumagin Islands region is sufficiently instrumented to meet the objectives outlined above.

The Shumagin Islands seismic gap is presently, however, a region of fewer earthquakes compared to adjacent regions of the Aleutian arc like that around Dutch Harbor. To increase the probability of obtaining strong-motion accelerograph records we have proposed to add a second accelerograph in the Dutch Harbor vicinity. Utilizing this data depends on accurate hypocenter locations. There are, however, only 3 seismic stations in this area and they are poorly distributed to locate earthquakes. We propose to relocate MKV to improve the geographic distribution of the network and to better monitor Makushin Volcano (see Figure 1). To achieve an improved geographic distribution of the network will require a repeater station near Dutch Harbor. Because all of the remote stations will be repeated through this station (probably located on Ballyhoo Hill) we have proposed that it be made partially

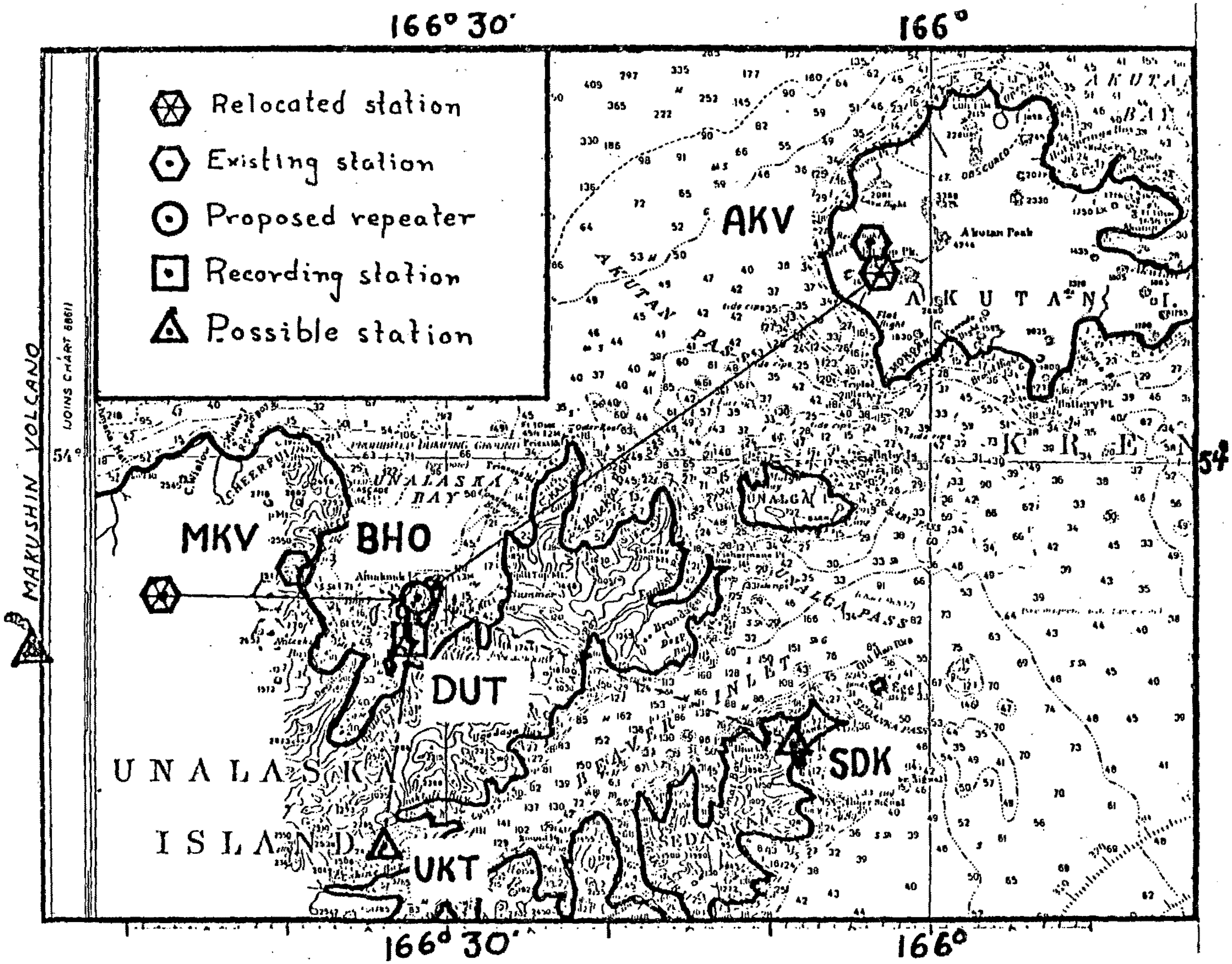

Figure 1. Proposed relocations of Dutch Harbor vicinity seismic stations. Existing stations, AKV and MKV will be relocated. A non-seismic repeater station, BHO, will be installed on Ballyhoo Hill to relay the signals from MKV and AKV to the recording station at Dutch Harbor, DUT. The location of BHO would allow reception of signals from two possible future stations, UKT and SDK.

redundant; i.e., that it have dual transmitters to Dutch Harbor. Finally, we have proposed to D.O.E. to add one horizontal seismometer at Dutch Harbor so that this central station will have a complete set of three orthogonally oriented seismometers. It is important to have at least one station at which there are horizontal seismometers so that the arrival times of shear waves can be reliably determined. These arrival times are strong constraints in locating hypocenters.

There is only seismograph station in the Privilof Islands. To meet the objective of locating nearby earthquakes that may be occurring in the St. George Basin we originally proposed to install two remote seismic stations on St. George Island and two on St. Paul Island and to install an analog, tape recording system that detects events and only records when an event occurs. This recording system would have been similar to one that is now in Dutch Harbor.

Because of budgetary constraints we have eliminated this expansion of the St. Paul system. To partially meet the objectives of that system we will attempt to locate earthquakes detected both by the St. Paul station and those at Dutch Harbor and/or Sand Point.

Management. The research work proposed will be directed by Drs. John Davies and Klaus Jacob. They will be assisted in carrying out this work by three graduate students: Leigh House, Janet Krause and Steve Hickman. The technical operation will be overseen by Doug Johnson who is the technical manager for all of L-DGO's seismic networks. Between this contract and that with DOE, 24 man-months of technician time are required to maintaining and upgrading the network and recording centers. Station operators have been hired for the Sand Point, Dutch Harbor and Saint Paul recording centers. Two full-time record readers will reduce the raw data.

Calibration. The most critical variable in seismographic work is time. It is necessary to read the arrival times of body waves at the various stations with a relative precision of better than one-tenth of a second. This precision is assured by telemetering regionally grouped stations to a common recording center so that all use the same time standard. At each of the recording centers a Sprengnether crystal-controlled clock is used as a local time standard. This clock is compared daily to WWV or WWVH. A strip chart record of this comparison is kept so that an accurate and verifiable plot can be made of the drift of the local time standard with respect to Coordinated Universal Time (CUT). Since most other seismic records are referred to CUT, our records can be used in conjunction with them to an accuracy of better than one-tenth of a second. The level of timing accuracy imposes a limit to the accuracy of location of hypocenters which is of the order of one to ten kilometers.

Computation of the magnitude of an earthquake is problematic at best and is further complicated when the recording system includes radiotelemetry links. A telemetry system imposes more elements needing calibration, and a limit to the dynamic range, of the overall seismographic system so that coda-length measures of magnitude become necessary. Because of incomplete knowledge of the site geology, it is difficult to assess the coupling of the seismometers to the ground and the transfer function of the local soils and crustal rocks. Therefore, there is no good way to directly calibrate the magnification of a seismic network. As a first approximation, we assume that the seismometer responds according to the manufacturer's specifications, electronically calibrate the rest of the system as installed and compute a theoretical magnification for each seismograph. Richter-type magnitudes are then computed for the set of earthquakes where arrivals are not clipped at most of the stations. The coda-lengths for these arrivals are plotted against the Richter-type magnitudes to obtain a coda-length magnitude scale. The standard deviation of magnitudes computed in this way is approximately one-half of a magnitude unit, which is about what is usually observed. We have examined the individual station deviations for bias and found none; therefore, there are no systematic errors in calibration for any given station.

Hypocenter Location. Hypocenter locations are found using a version of Lee and Lahr's computer program, HYPO-71. This program computes estimates of the error in the arrival times and the vertical and horizontal coordinates. We use only those events for which these estimates are less than 0.25 seconds and 15 and 10 kilometers, respectively. Hypocenter cross sections show a Benioff zone which appears to be 20 kilometers thick. Assuming that all of these events occurred on a plane, this would imply a standard deviation in the locations of about seven kilometers. Note that this is only an estimate of the level of precision in the locations.

VII. Deliverable Products

A. Digital Data: Derived earthquake parameters (e.g. date, time, location, depth, magnitude) will be submitted on punched cards in the standard Hypocenter Data File format. Minimum and maximum values of the range of each parameter will be provided with each data submission. Each event is reworked two or three times to improve the phase arrival time pick for each. This process compares the theoretical arrival times to the observed so that any significant errors are immediately obvious. Final hypocentral parameters are punched on cards. Before the cards are mailed, a listing is made that is compared to the intermediate solutions to assure that no punching error has been made.

B. Narrative Reports: As the data is worked up it will be presented in the quarterly report. Included will be (1) a detailed description of the operation of the seismic network (including the number and spatial density of instruments and resulting accuracy of derived earthquake parameters), (2) a summary and interpretation of seismic and volcanic events recorded, (3) evaluations of frequency versus magnitude relations, activity related to faults (if any), and acceleration versus distance relationships.

C. Visual Data: On the standardized bases we will provide maps of (1) hypocenter location and magnitudes, (2) magnitude versus frequency relationships for selected areas, (3) seismic activity related to faults along with supportive text (4) ground acceleration versus distance relationships, (5) volcanic activity, and (6) seismic and volcanic risk. It should be noted that much of the data needed to develop the above relationships and maps will be only slowly acquired so that some of the maps listed here may be based on very limited data and hence will have to be of a very preliminary nature. Some, such as acceleration versus distance relations, may take years to complete.

D. Other: None

E. Data Products Schedule:

Data Type: Seismic hypocenters

Media: Punched cards

Est. Volume: About 100 cards per quarter

OSEAP Format: Standard Hypocenter Data File format

Processing and Formating will be done by L-DGO.

Collection Periods	Submission Dates
Oct., Nov., Dec. 1978	1 April 1979
Jan., Feb., Mar. 1979	1 July 1979
Apr., May, June 1979	1 October 1979
July, Aug., Sept. 1979	1 January 1980

VIII. Archival Plans

All of the original records (tape, film, paper) are archived at L-DGO in the Seismology Department's seismogram archive. The only exception to this is a set of Helicorder records of the Pavlof Volcano station, PVV, which are made by the University of Alaska in parallel to the L-DGO develocorder film record of this station. These Helicorder records are archived by the University of Alaska (contact Dr. Juergen Kienle).

IX. Logistic Requirements

Institution: Lamont-Doherty   Principal Investigators: Davies & Jacob

A. Ship Support: None requested

B. Aircraft Support (fixed wing): None requested

C. Aircraft Support (helicopter):

1. Flights are requested to transport equipment and personnel from the following base locations to the listed seismic stations. Coordinates of the existing stations follow this list.

BASE LOCATIONS	TASK	SEISMIC STATIONS	CODE	HOURS
Dutch Harbor	B	Akutan Volcano	ADV	1
	N	Ballyhoo	BOO	5
	R	Makushin Valley	MKV	1
	N	Makushin Volcano	MNV	3
	N	Sedanka Island	SDK	4
	N	Uniktali Bay	UKT	3
	N	Cape Sarichef	CPS	3
Sand Point	B	False Pass	FPS	1
	B	Sanak Island	SNK	1
	B	(Baldy Mtn.)*	(BAL)	(8)
	B	Deer Island	DRR	1
	B	Dolgoi Island	DLG	1
	B	Coal Harbor	CHR	1
	B	Black Hill	BLH	4+3
	B	Pavlof North-1	PN1	1
	B	Pavlof North-2	PN2	1
	B	Pavlof North-3	PN3	1
	B	Pavlof North-4	PN4	1
	B	Pavlof North-5	PN5	1
	B	Pavlof North-6	PN6	1
	B	Pavlof North-7	PN7	1
	B	Pavlof North-8	PN8	1
	B	Beaver Bay Rep.	BVB	3+3
	B	Pavlof South-1	PS1	1
	B	Pavlof South-2	PS2	1
	B	Pavlof South-3	PS3	1
	B	Pavlof South-4	PS4	1
	B	Pavlof Volcano	PVV	2
	B	Zachary Bay	AKB	2
	B	Chernabura Island	CNB	1
	B	Nagai Island	NGI	2
	B	Squaw Harbor	SQH	2
	N	Simeonof Island†	SIM	5
	B	Big Koniuji	BKJ	1
	B	Ivanof Bay	IVF	1
	B	San Diego Bay	SGB	2
		TOTAL NUMBER OF HOURS		76

N--Install New Station
B--Change Batteries Only
R--Remove
*--Service by truck--within wildlife refuge
†--Service by boat or fixed wing--wildlife refuge

This is a total of 36 stations with an estimated 76 hours of transport; with 4 hours per day actual flight time, this requires 19 UHIH days to service these stations. For total number of UHIH days requested, see item 4 of this paragraph.

LAMONT-DOHERTY ALEUTIAN STATIONS, MAY 1978

STATION	CODE	COMPONENTS	N. LAT	W. LONG	ERROR (m)	ELEV. (m)	ELEV. (ft)
Saint Paul#	SNP	SPZ,LPZ	57°09.28'	170°13.09'	~ 1000	5	16
Dutch Harbor†	DUT	SPZ,SPH,LPZ	53°53.9'	166°32.2'	~ 1000	60	197
Makushin Valley†	MKV	SPZ	53°55.8'	166°39.0'	~ 1000	275	902
Akutan Volcano†	AKV	SPZ	54°07.8'	166°03.8'	151	381	1250
Sand Point*	SDP	A	55°20.48'	160°29.75'	22	30	98
Sand Point*	SAN	SPZ,SPN,SPE	55°20.40'	160°29.83'	22	23	75
Sand Point*	SAN	LPZ,LPN,LPE	55°20.40'	160°29.83'	22	23	75
San Diego Bay*	SGB	SPZ	55°32.75'	160°27.23'	31	275	902
Ivanof Bay*	IVF	SPZ	55°53.75'	159°31.80'	22	275	902
Big Koniuji Island#	BKJ	SPZ	55°09.64'	159°33.92'	~ 30	240	787
West Unga Island†	WUN	A (see CHR)	55°19.9'	160°44.4'	~ 500	150	492
Pavlof Volcano**	PVV	SPZ	55°22.451'	161°47.399'	10	164	538
Squaw Harbor*	SQH	SPZ	55°13.20'	160°33.74'	30?	360	1181
Nagai Island*	NGI	SPZ	55°02.36'	160°04.15'	27	240	787
Chernabura Island*	CNB	SPZ	54°49.22'	159°35.30'	~ 50	90	295
Zachary Bay¢	ZKB	SPZ	55°18.66'	160°44.43'	~ 10	183	600
False Pass†	FPS	SPZ	54°56.5'	163°26.2'	~ 2200	120	394
Sanak Island¢	SNK	SPZ	54°28.44'	162°46.52'	70	159	522
Deer Island*	DRR	SPZ	54°55.41'	162°16.99'	28	380	1246
Dolgoi Island*	DOL	A	55°05.75'	161°45.20'	32	275	902
Dolgoi Island*	DLG	SPZ	55°08.46'	161°50.15'	32	367	1204
Baldy Mountain¢	BAL	SPZ	55°11.593'	162°47.208'	1	28	918
Black Hills¢	BLH	SPZ	55°42.15'	162°03.95'	40	390	1279
Coal Harbor Repeater†	CHR	R	55°19.9'	160°44.4'	~ 500	150	492
Cape Sarichef†	CPS	SMA	54°35.8'	164°55.6'	178	30	98
Eagle Harbor††	EGH	TG	55°06.8'	160°05.9'	~ 1500	1	3
Pirate Cove††	PRC	TG	55°21.5'	160°21.9'	~ 1000	1	3
Balboa Bay††	BBB	TG	55°33'	160°45'	~ 5000	1	3

STATION	CODE	COMPONENT	N. LAT	W. LONG	ERROR (m)	ELEV. (m)	ELEV. (ft)
Pavlof South 1**	PS1	SPZ	55°25.339'	161°44.173'	10	300	983
Pavlof South 2**	PS2	SPZ	55°24.402'	161°48.154'	10	459	1506
Pavlof South 3**	PS3	SPZ	55°23.517'	161°49.014'	10	450	1476
Pavlof South 4**	PS4	SPZ	55°21.238'	161°52.091'	10	520	1707
Pavlof North 1**	PN1	SPZ	55°33.629'	161°57.118'	10	522	1712
Pavlof North 2**	PN2	SPZ	55°30.482'	161°58.177'	10	344	1127
Pavlof North 3**	PN3	SPZ	55°30.353'	162°00.495'	10	330	1082
Pavlof North 4**	PN4	SPZ	55°28.819'	162°01.369'	10	434	1424
Pavlof North 5**	PN5	SPZ	55°28.487'	161°53.524'	10	622	2040
Pavlof North 6**	PN6	SPZ	55°27.118'	161°54.888'	10	814	2670
Pavlof North 7**	PN7	SPZ	55°26.591'	161°56.781'	10	780	2258
Pavlof North 8**	PN8	SPZ	55°26.623'	162°01.246'	10	605	1984
Pavlof Repeaters 1,2	PR1,2	R	SEE BLH	SEE BLH	SEE BLH	SEE BLH	SEE BLH
Pavlof Repeater 3†	PR3	R	55°45.5'	161°12.1'	~ 500	488	1600
Beaver Bay††	BVB	R	55°31.9'	160°59.2'	~ 1000	518	1700

†† picked from C and GS chart 8802, September 1978

* picked from 1:63K maps, May 1978

† picked from 1:250K maps, May 1978

taken from October 1975 list of station coordinates

** taken from geodimeter/theodolite surveys made during June - August, 1977

¢ measured from nearby benchmark, June - August 1977

A abandoned station

R repeater only

APPROXIMATE COORDINATES OF PROPOSED DUTCH HARBOR NETWORK STATIONS

		N. Lat.	W. Long.	Elev. (ft.)
BHO	Ballyhoo Repeater	53°54.8'	166°31.9'	1400
MKV	Relocated Station	53°54.9'	166°47.9'	1200
AKV	Relocated Station	54°06.7'	166°03.1'	1500
SDK	Possible Station	53°39.9'	166°08.5'	1200
UKT	Possible Station	53°35.9'	166°33.9'	2100

2. The purpose of these flights is to change batteries, install, relocate and service remote seismic stations.
3. Optimum time is July-August plus or minus one month. June is okay for stations to be serviced out of Saint Paul and for most stations serviced out of Sand Point. Many of the stations serviced out of Dutch Harbor, and some out of Sand Point are still above the snow line in June. Dividing the work into two time frames allows a break for personnel and restocking of supplies which is necessary. The optimum interval between these time frames would be four (plus or minus one) weeks.
4. Assuming 19 routine service days, 2 days for travel to each base plus 2 days for travel to and from the general service area, and 5 days of mop-up time, we require:

   28 days of helicopter operations at
   4 hours per day, which equals
   112 hours total.

   Note that these estimates do not account for very unusual weather conditions or down-time of helicopter, i.e. for 100-hour inspections or repairs. Hence, the number of days required may be substantially more, although actual flight time may be not.
5. Usually there will be four people aboard each flight. With the UHIH, the number of people varies according to the logic of the particular situation, four people working in various combinations seems to be close to optimum.

6. Weight and dimension of equipment (per station):

5 air cells (dry)	22 lbs. ea.	9 x 10 x 12 inches
6 gallons water	50 lbs. total	14 x 14 x 14 inches
2 to 4 back packs	50 lbs. ea.	14 x 18 x 32 inches
1 spare antenna	20 lbs. ea.	36 x 36 x 6 inches
1 spare mast	20 lbs. ea.	96 x 2 (diam.) inches
4 spare guy-bars	10 lbs. total	96 x 1 x 1 inches
Misc. supplies	30 lbs. total	12 x 12 x 24 inches

7. We have used both the 206 and the 205. The 205 is preferable, but we can use either.

8. NOAA, if possible; Kenai Air, if not.

9. Per hour costs for Kenai Air are:

206B	$300 (4 hour min. per day)
205	$800 (4 hour min. per day)

10. Recommended staging areas are the base locations given in (1) above: Sand Point and Dutch Harbor. Note that commercial fuel is available only in Port Heiden, Cold Bay and Dutch Harbor. If arrangements are made several months ahead of field time jet fuel in sealed barrels can be shipped to and stored at Sand Point and possibly Port Moller or Cathedral River.

11. Require: Radio for base location and for helo. Base and field parties should be able to communicate with each other and with the helicopter on marine emergency frequency or communication on CB frequencies. L-DGO will provide 4, six-watt Handy-talkies on about 150 MHZ.

D. Quarters and Subsistence Support:

1. Scientific personnel will make their own arrangements for quarters and subsistence. Cost will be covered by per diem requested under this and the DOE proposal.

2. Scientific personnel plan to lodge as follows:

   Sand Point - Rent apt. from Shumagin Homes, Inc.

   Dutch Harbor - Room and board at hotel (?)

E. Special Logistics Problems:

The chief logistic problem is fuel. It is available at Cold Bay and Dutch Harbor. It must be cached at Sand Point and possibly at Port Moller and Cathedral River. If plans are made far enough in advance, it can be transported by sea to those places, saving a great deal over air freight from Anchorage. Because the fuel source determines the day-to-day logistics, it would be useful for the P.I. and the pilot to agree several months in advance on the sources so that jet fuel, batteries and equipment could be shipped directly to the base from which they will be used. Note that since some stations serve as repeaters for others, there is an optimum sequence for servicing the stations. If weather forces deviations from the optimum sequence extra trips will be required to some stations.

X. Anticipated Problems

Equipment failures from bears, icing and other natural causes continue to be a major problem. A program to upgrade and acquire spare equipment is proposed. A visit to a few selected remote sites in the early spring to repair critical stations would result in a better continuity of data. Preventative maintenance trips are scheduled to the recording sites. If weather forces a curtailment of the helicopter based servicing of stations, critical work will be attempted by boat, fixed wing aircraft or later helo scheduling. Other work may be abandoned for the season. An alternative would be to allot 10 to 20% more UHIH days than are requested for servicing operations.

XI. Information Required from Other Investigators

The following types of information may be needed:

A. Marine geophysical data; seismic profiles, gravity, etc.

B. Hypocentral parameters from other areas

C. Historical summaries of seismic activity

D. Current meter data

Informal letter contacts and verbal agreements have been made with several other investigators. So far, any needed data has been readily available.

XII. ACTIVITIES/MILESTONE CHART:

0 – Planned Completion Date

X – Actual Completion Date

RU # 16 PI: Davies & Jacob

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D	1980 J
Data Submissions	0			0			0			0			0			0
Annual Reports							0									
Quarterly Reports	0			0						0			0			0
Fieldwork									0		0					

XIII. Outlook

As was noted in the Background and Objectives sections of this proposal and as was discussed in last year's Outlook section seismic activity is episodic with periods of the order of decades and centuries. Almost all data based on a few years work must be regarded as preliminary. Seismic monitoring should be maintained throughout the planning, exploration and production stages of oil resource development. Initial data lays the basis for future conclusions regarding changes in seismic patterns and points out regions in which to concentrate future effort, such as areas of possible fault or volcanic activity.

The ultimate goal of seismic monitoring is some kind of earthquake prediction capability. The sophistication of this prediction capability will depend upon the quality and length of the data set available and upon the breadth of the multidisciplinary approach used (see last year's Outlook). Here we restrict our comments to seismic monitoring only.

A. Final Results and Data Products

1. Catalogue of annual seismicity maps.
2. Seismic risk map.
3. Graphs of acceleration versus distance.
4. Maps summarizing relation of seismic activity to faults.

B. Milestones are difficult to predict since they depend upon the availability of data. We plan preliminary versions of all of the above by the end the proposed contract year. However, to develop acceleration versus distance relatous will probably require as much as 5-10 years of data before they are really useful.

C. Cost by fiscal year to maintain present effort:

79--$130,000

80--$134,000

81--$143,000

82--$153,000

83--$164,000

This assumes 7% inflation, that DOE continues to provide 250-300 thousand dollars per year, and NOAA provides the helicopter support (see E).

D. Location of field effort--same.

E. Logistics Requirement.

Approximately 28 days (actual flying time) of UHIH time per year.

XIV. CONTRACTUAL STATEMENTS:

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

D. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

E. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

F. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental
Assessment Program
Bering Sea-Gulf of Alaska Project Office
P. O. Box 1808
Juneau, Alaska 99802

RFx41-16-2558

FEB 09 1979

TO : Rudolf J. Engelmann, Director
OCSEAP - Alaska Program Office, Boulder

THRU : Kay Jentsch, Contract's
OCSEAP - Alaska Program Office, Boulder

FROM : Herbert E. Bruce, Manager
OCSEAP - Juneau Project Office

SUBJ : OCSEAP Research Unit 16.

REFS : (1) Juneau Project Office Ltr to Drs. Davies and Jacob requesting renewal proposal dated May 22, 1978 (enclosed).
(2) Original Proposal dated July 1978 (enclosed)
(3) Copy of project office internal comments on proposal (enclosed)
(4) Juneau Project Office Ltr to Drs. Davies and Jacob, requesting revision to proposal dated December 15, 1978 (enclosed).
(5) Revised renewal proposal, dated January 1979, (enclosed).

Required Acceptance Letter for RU 16
Drs. Davies and Jacob

The enclosed revised FY 79 renewal proposal (dated January 1979, p. 1-39), entitled "A Seismotectonic Analysis of the Seismic and Volcanic Hazards in the Pribilof Islands - Eastern Aleutian Islands Region of the Bering Sea", has been reviewed by the Juneau Project Office and judged acceptable at the total funding level of $130,000. Pending availability of FY 79 supplemental funds, please send an acceptance letter to Drs. Davies and Jacob and initiate contracting procedures for this amount minus interim FY 79 funds already provided.

Enclosures: refs 1 - 5 (above)

Proposal Date: June 15, 1978
Contract #: 03-5-022-85

FY 1979 RENEWAL PROPOSAL

Research Unit Number 29

TITLE: Assessment of Potential Interactions of Microorganisms and Petroleum Pollutants in Alaskan Outer Continental Shelf Areas.

PRINCIPAL INVESTIGATOR: Ronald M. Atlas, Ph.D.
Department of Biology
University of Louisville
Louisville, Kentucky 40208

COST of PROPOSAL: $135,504

Lease Areas	
Beaufort Sea	52%
Cook Inlet	24%
Norton Sound	24%

PERIOD of PROPOSAL: October 1, 1978 - September 30, 1979

Ronald M. Atlas
Principal Investigator
502-588-6773

John A. Dillon, Jr.
Vice President
502-588-6153

TECHNICAL PROPOSAL

I. Assessment of Petroleum Interactions of Microorganisms and Pollutants from Petroleum Development.

RU #29
Contract # 03-5-022-85
Dates: October 1, 1978 - September 30, 1979

II. Principal Investigator: Ronald M. Atlas

III. Proposed Budget 10/1/78 - 9/30/79

A.	Science		$135,504
B.	P. I. Provided Logistics	$ -0-	
C.	Total		$135,504

D. Distribution of effort by lease area:

52% Beaufort Sea
24% Lower Cook Inlet
24% Norton Sound

IV. Background

Microbiological research in the Beaufort Sea was commenced in FY 75 but was discontinued during FY 77, mostly for fiscal reasons. During the first year of the work seasonal and spacial distributions of microorganisms between Pt. Barrow and Prudhoe Bay were determined and some work on hydrocarbon biodegradation was carried out. These studies showed that viable microbial populations had higher concentrations in water in this area than in non-polluted temperate waters. Sediment populations were of comparable densities to populations in Gulf of Alaska and Cook Inlet sediment. Populations were lower in surface water during winter than during summer. Microbial diversity was high in sediment during both summer and winter. An OCSEAP-sponsored workshop on microbiology in 1976 pointed out the many deficiencies in our understanding of microbiological processes and biodegradation of oil and recommended continuation of these studies in the Beaufort Sea. Investigations of the fate of petroleum in Arctic marine sediments and under sea ice were begun during FY 78.

Microbiological research in the Cook Inlet was commenced in FY 77. During the first year of the work distribution of microbial populations were determined and some work on biodegradation was carried out. This work was continued during FY 78. Four sampling cruises will have been carried out by September 30, 1978. The results of microbiological studies have been summarized in resent synthesis and review meetings (see attached reports).

V. Objectives

A. To determine the distribution of microbiological populations in the Beaufort Sea and assess the potential interaction of microorganisms and pollutants produced by petroleum development on the outer continental shelf. Specifically:

1) To examine the biodegradation of petroleum hydrocarbons in Beaufort Sea sediment.

2) To examine the biodegradation and weathering of of petroleum in and under sea ice.

3) To determine geographical distributions of taxonomic groups of microorganisms between the Colville River and Barter Island.

B. To determine the distribution of microbiological populations in Lower Cook Inlet and adjacent areas and assess the potential interactions of microorganisms and pollutants produced by petroleum development on the outer continental shelf. Specifically:

1) To determine distribution and densities of microbial populations in sediment and water.

2) To determine the potential rates of biodegradation of petroleum hydrocarbons in water and sediment.

3) To examine denitrification processes in sediment.

C. To determine the distribution of microbiological populations in Norton Sound and to assess the potential interactions of microorganisms and petroleum hydrocarbons. Specifically:

1) To determine if a natural oil seepage in Norton Sound has altered the density of taxonomic distribution of microorganisms.

2) To determine if a natural oil seepage in Norton Sound has altered potential rates of hydrocarbon biodegradation.

3) To determine if a natural oil seepage in Norton Sound has altered potential rates of denitrification.

VI. General Strategy and Approach

During FY 1978 a study was initiated to examine the long term fate of oil in Beaufort Sea sediment. Oil-contaminated Beaufort Sea sediment was placed in Plexiglas trays. During FY 79 replicate trays will be recovered during winter and summer. Microbial populations in the oil contaminated and adjacent uncontaminated sediment will be enumerated to determine if extended exposure to oil alters population levels of microorganisms. Enumeration of microbial populations will include total microorganisms by direct count, viable heterotrophs by plate count, and hydrocarbon utilizers by Most Probable Number procedures. Nitrogen fixation and denitrification activities of the indigenous microorganisms will be measured to determine if prolonged exposure to crude oil alters rates of nitrogen flux into and from Beaufort Sea sediment. Sediment collected from the trays will be supplied to project RU 190 for determination of other microbial activities. Project RU 190 will also determine nutrient levels in the sediment.

Residual oil in the sediment will be recovered by solvent extraction. Residual oil will be analysed for chemical changes resulting from abiotic weathering and biodegradation. Estimates will be made for persistence of petroleum hydrocarbons in Beaufort Sea sediments.

During FY 1978 miniature oil spills were established in stainless steel cylinders under ice in Elson Lagoon. A modification of this spill technique will be used to examine the fate of oil spilled under ice. Small quantities of oil will be spilled under ice within Elson and under shorefast ice of Pt. Barrow. The ice off Pt. Barrow is less even on the underside and has more apparent brine channels than ice within Elson Lagoon. After 4 days and 4 months exposure, ice cores containing the oil will be recovered. Rates of primary productivity and heterotrophic activity will be measured at the bottom of the ice core (ice-water interface) and within the ice core to determine if oil contamination under ice alters carbon cycling activities by microorganisms associated with sea ice.

Residual oil in the ice cores will be recovered by solvent extraction. Recovered oil will be analysed for compositional changes due to chemical weathering and microbial biodegradation.

Microorganisms will be enumerated from samples collected during an icebreaker cruise in the Beaufort Sea during September 1978. The cruise is planned to collect samples from the Canadian border to Pt. Barrow at the 10 fathom line. Intensive sampling will occur within an area of upwelling near Barter Island and within the proposed 1979 OCS lease area. Microorganisms will be isolated at random from enumeration plates. Numerical taxonomic procedures will be used to characterize microbial populations in surface water and sediment. The distribution of dominant taxa and the diversities of the microbial communities will be determined.

A cruise will be conducted during winter in Lower Cook Inlet and adjacent areas. The cruise should collect samples in Shelikof Strait where water from Cook Inlet flows and if possible on the opposite side of the Aleutian Islands in the Bering Sea. Sampling within the Lower Bering Sea will allow us to begin to determine if there is a gradual increase of densities of viable microorganisms north of Cook Inlet/Gulf of Alaska or if there is a major one step increase immediately north of the Aleutian Islands. The cruise within Cook Inlet will allow further seasonal resolution of the variation in densities of microorganisms. Microorganisms will be enumerated from samples collected on this cruise. Total microorganisms, viable heterotrophic microorganisms and hydrocarbon utilizing microorganisms will be enumerated. Hydrocarbon biodegradation potentials will be determined for paraffinic and aromatic petroleum hydrocarbons. Rates of denitrification potentials will be determined for sediment samples. Extensive numerical taxonomic testing of isolated organisms will *not* be performed for these samples. The major purpose of this cruise will be to further examine levels of microbial biomass and activities.

A cruise will be conducted in Norton Sound in coordination with chemical data acquisition projects. The cruise will traverse a submarine oil seepage. Densities of microbial populations will be determined in the seep area and in uncontaminated areas of the Sound. The objective of the cruise will be to determine if the oil seepage has altered microbial populations and activities. Since no microbiological studies have been performed in Norton Sound a second objective will be to gain preliminary information on the natural abundance and activities of microorganisms there. Enumeration procedures will include direct counts for total microorganisms, plate counts for viable heterotrophs, and Most Probable Number determinations for hydrocarbon utilizers. Rates of hydrocarbon biodegradation potentials for paraffinic and aromatic hydrocarbons will be determined. Rates of denitrification potentials will be determined for sediment samples. Numerical taxonomic procedures will be employed to determine taxonomic distribution and diversity of the microbial communities.

VII. Sampling Methods

In the Beaufort Sea sediment and water samples will be collected at approximately 24 stations during September 1978. Analyses using these samples will be accomplished during FY 1979.

Scuba divers will recover replicate trays containing oiled sediment during winter and summer.

Ice cores will be collected with a Sipre corer from the experimentally oil contaminated ice in Elson Lagoon and off Point Barrow. Ice cores will be collected during winter a few days after experimental oiling, and during spring, several months after oil contamination. The spring samples will be collected during the period of the spring, under-ice algal bloom.

Surface water and sediment samples will be collected during a winter cruise in Cook Inlet and adjacent areas and a summer cruise in Norton Sound.

Approximately 25 water and 25 sediment samples will be collected during each cruise. The exact sampling locations will be determined in collaboration with other microbiological and chemical projects. Water samples will be collected with a Niskin sterile water sampler. Sediment samples will be collected with box corer or a Van Veen grab sampler depending upon availability.

VIII. Analytical Methods

Enumeration of Microorganisms

Enumerations of bacterial populations will be performed using both direct count and viable plate count procedures. For direct counts, samples will be preserved with formaldehyde, one part formaldehyde:one part sample. Samples will be filtered through 0.2 μm cellulose nitrate black filters and stained with acridine orange according to the procedure of Daley and Hobbie (1975). Samples will be viewed with an Olympus epifluorescence microscope with a BG-12 exciter filter and 0-530 barrier filter. Ten fields per filter and two filters per sample will be viewed and the counts averaged.

For viable plate counts, surface spread inoculations from serial dilutions will be used. For some water samples concentration by filtration through 0.45 μm filters (Millipore Corp.) will also be used. Marine agar 2216E (Difco) will be used to enumerate viable heterotrophic microorganisms. Replicate plates will be incubated aerobically at 4 and 20 C to enumerate psychrophilic-psychrotrophic and mesophilic populations respectively.

Most Probable Number estimates of hydrocarbon utilizers will be performed. Dilutions of samples will be added to 30 ml stoppered serum vials containing 5 ml autoclaved Bushnell Haas broth (Difco) with 3% added NaCl, and 50 μl filter sterilized (0.2 μm Millipore filter) Cook Inlet crude oil spiked with 1-^{14}Cn hexadecane (s.p. act. = 0.9 μCi/ml oil). Sterility of the oil will be checked by plating portions of the oil onto marine agar 2216 (Difco) and observing for colony formation and by measuring $^{14}CO_2$ production from uninoculated vials. Poisoned controls will be prepared by adding 0.2 ml concentrated hydrochloric acid to the vials. A 3 tube MPN procedure will be used. Following incubation at 5 C for 4 weeks the solutions will be rendered alkaline with concentrated KOH to stop microbial activity. Solutions will then be acidified with concentrated HCl and the $^{14}CO_2$ will be recovered by purging the vials with air and trapping the $^{14}CO_2$ in 1 ml hyamine hydroxide in percolation tubes, 0.5 cm x 10 cm, containing glass beads (Atlas and Hubbard, 1974). The hyamine hydroxide will be washed from the tubes into scintillation vials with 3 one ml portions of methanol. The counting solution will be 10 ml Omnifluor + toluene (New England Nuclear). Counting will be with a Beckman liquid scintillation counter. Counts greater than or equal to 2 times control will be considered as positive; counts less than 2 times control will be considered as negative. The most probable number of hydrocarbon degrading microorganisms will be determined from the appropriate MPN Tables (APHA, 1971) and recorded as most probable number per ml for water samples or most probable number per g dry wt. for sediment samples.

Numerical Taxonomic Testing

Approximately 300 phenotypic characteristics will be determined for bacterial strains selected at random from enumeration plates. Characterization will include morphological, physiological, biochemical, nutritional and antibiotic sensitivity testing.

Cultures (1-4 d depending on growth rate), from Marine agar slants overlain with 1 ml Rila marine salts solution, will be examined for cell shape, size and motility (wet mounts); gram reaction (Hucker modification), and acid fastness (Ziehl-Neelsen method) (Society of American Bacteriologists, 1957). Cultures (10 d) on Marine agar will be examined for colony morphology and size, and production of diffusible and non-diffusible pigments. Fluorescent pigment formation on Marine agar + 0.15% w/v glycerol will be assessed with UV light of wavelength 260 nm. Growth on replicate Marine agar plates will be tested at 5, 10, 15, 20, 25, 37 and 43 C, and at initial pH 3, 4, 5, 6, 7, 8, 9 and

10 (adjusted with HCl or NaOH). Salt tolerance and requirement will be tested in the following medium without NaCl and with 3, 5, 7.5, 10 and 15% (all w/v) NaCl added: Bacto-tryptone, 0.5%; Bacto-yeast extract, 0.1%; $FeCl_3.6H_2O$, 0.01%; NH_4NO_3, 0.00016%; Na_2HPO_4, 0.0008%; Bacto Agar, 1.5% (all w/v); pH 8.0. Oxygen relations will be determined from stab cultures in Marine agar butts.

Cultures (10 d) on Marine agar will be tested for catalase (with 3% H_2O_2) and cytochrome oxidase production (Gaby & Hadley method, allowing one minute for the blue color to develop; Skerman, 1969) Methyl red tests (Society of American Bacteriologists, 1957) will be done in MR-VP broth (Difco) prepared with full strength Rila marine salts solution. Alkaline phosphatase detection (Baker & Kuper, 1951) will be done on cultures (10 d) grown in a medium containing Bacto tryptone, 0.5%; Bacto yeast extract, 0.1%; NH_4NO_3, 0.00016%; $FeCl_3.6H_2O$, 0.0005%; phenolphthalein diphosphate, 0.001% (all w/v) in 3/4 strength Rila marine salts solution at pH 7.2. Arginine, ornithine and lysine decarboxylase will be detected by the Falkow method (Skerman, 1969), modified by replacing distilled water with Rila marine salts solution. These tests measure alkaline end-products and do not distinguish between arginine decarboxylase and arginine dihydrolase.

Nitrate and nitrite reduction will be tested in nitrate broth (Difco) with full strength Rila marine mix. Nitrite will be detected with naphthylamine-sulphanilic acid reagent and residual nitrate with zinc dust (Skerman, 1969).

Acid production from D-ribose, D-fructose, D-cellobiose, lactose, sucrose and D-mannitol (all 1% w/v) will be detected in MOF medium (Difco). OF tests will be done in MOF medium containing 1% (w/v) D-glucose (Hugh & Leifson, 1953).

Agar hydrolysis will be tested on Marine agar. Sunken colonies and depressions around colonies will be scored as positive. Lipase activity will be tested in Marine agar containing 0.01% (w/v) $CaCl_2$ and 1% (w/v) Tween 20 or Tween 80 (Sierra, 1957). Starch hydrolysis will be tested by flooding plate cultures (7 d) on Marine agar + 0.5% (w/v) potato starch with Lugol's iodine. Gelatine hydrolysis will be tested by flooding cultures (7 to 10 d) on Marine agar + 10% (w/v) with acid $HgCl_2$ (Skerman, 1969). Casein hydrolysis will be tested on Marine agar overlaid with a double layer of 10% w/v skim milk agar. For the last three tests, clear zones around colonies will be recorded as positive.

Antibiotic sensitivity will be tested by spreading suspensions on Marine agar plates and applying BBL (Cockeyville, MD) antibiotic discs (ampicillin, 2 μg; colistin, 10 μg; erythromycin, 15 μg; kanamycin, 5 μg; kanamycin, 30 μg; neomycin, 30 μg; nitrofurantoin, 300 μg; novobiocin, 5 μg; oxytetracycline, 5 μg; penicillin G, 2 units, polymyxin

B, 300 units; strepomycin, 2 μg; tetracyclin, 5 μg). Zones of inhibition will be measured and sensitivity determined against standard inhibition zones (BBL).

The following medium (Basal medium B) will be used for substrate utilization testing: Portion 1; KH_2PO_4, 0.1 g; Trizma base, 6.0 g; NH_4NO_3, 1.0 g; $FeCl_3.6H_2O$, 0.005 g; Rila marine salts solution, 500 ml; pH adjusted with HCl to 8.0. Portion 2; Purified agar (Difco), 10 g; distilled H_2O, 500 ml. Portion 3; thiamine, sodium pantothenate, riboflavin, nicotinic acid, choline, pyridoxamine, cyanocobalamine, (all 1 μg); folic acid, sodium p-aminobenzoate, biotin (all 0.05 μg); distilled H_2O, 2 ml. Portions 1 and 2 will be autoclaved separately. Portion 3 will be filter sterilized. The 3 portions will be mixed at 55 C. Substrates will be sterilized by autoclaving or by filtration (Stanier, *et al*, 1966) except for hydrocarbons which will be sterilized ultrasonically. Substrates will be mixed with the basal media just before pouring to yield final concentrations of 0.1% w/v except for carbohydrates (0.15% w/v) and phenol (0.0125% w/v). A total of 100 substrates will be tested. To determine growth factor requirements, 2 additional basal media will be used. Basal medium A will be the same as basal medium B except that portion 3 (vitamins) will be omitted. Basal medium E will be the same as basal medium B except that it will be supplemented with Bacto yeast extract, 50 mg, casamino acids, 50 mg and L-tryptophan, 10 mg. Twelve substrates (D-ribose, D-fructose, D-glucose, acetate, succinate, fumarate, DL-β-hydroxybutyrate, DL-lactate, pyruvate, α-ketoglutarate, D-gluconate, glycerol) were used with each of the 3 basal media (A, B, E). Growth (colony formation with density greater than control lacking added substrate within 14 days) on any of the substrates on a given basal medium will be considered as ability to grow on that basal medium. Four classes of growth factor requirements will be recognized: type 1, bacterial able to grow on basal media A, B and E (do not require growth factors); type 2, bacteria able to grow on basal media B and E but not A (require vitamins as growth factors); type 3, bacteria able to grow on basal media E but not A or B (require complex growth factors such as amino acids); type 4, bacteria unable to grow on basal media A, B or E (require complex unknown growth factors).

All substrate utilization tests will be inoculated with a multiple syringe inoculator (Kaneko, Holder-Franklin & Franklin, 1977). Positive growth will be determined after 14 days incubation by visual reference to control plates on the same basal medium with no added substrate.

Data will be coded in binary form according to RKC format (Rogosa, Krichevsky & Colwell, 1971), punched on cards, and verified and proofread by two people. Errors also will be checked by computer with the CREATE program (Krichevsky, 1977). Test reproducibility will be checked by periodically retesting selected strains. The QUERY computer program (Krichevsky, 1977) will be used to arrange the data suitably for input to the numerical taxonomy programs. Similarities will be estimated with Jaccard coefficient (S_J) and cluster analyses will be done by unweighted average linkage sorting (Sokal & Sneath, 1963). Clusters of strains with similarities greater than 75% will be designated as taxonomic groupings (Liston, Wiebe & Colwell, 1963). The input data will be sorted into the same order as strains in the cluster analysis triangle. The feature frequencies of all characteristics will be determined with the feature analysis program, FREAK (Walczak, Johnson & Krichevsky, 1978). Probabalistic identifications will be attempted using the program IDDNEW and 3 identification matrices currently being developed at the American Type Culture Collection (Johnson, unpublished).

The number of taxonomic groups and the number of individuals in each group, determined by the cluster analyses, will be used to calculate the Shannon diversity index, $\bar{H}$. The formula

$$\bar{H} = \frac{c}{N}(N \log_{10}N - \Sigma n_i \log_{10}n_i)$$

will be used, where c = 3.3219, N = total numbers of individuals and n_i = total number of individuals in the i^{th} taxonomic grouping.

Activity

Natural Hydrocarbon Biodegradation Potential

Ten ml of water samples or 10 ml of a 1:100 dilution of sediment samples will be added to 30 ml stoppered serum vials containing 5 ml autoclaved Rila marine salts solution and 50 µl filter sterilized crude oil spiked with ^{14}C radiolabelled hydrocarbon. Poisoned controls will be prepared by adding 0.2 ml concentrated hydrochloric acid. Cook Inlet crude oil will be used for Cook Inlet studies. 1-^{14}Cn-hexadecane (Amersham Corp.), 1-^{14}C pristane (Cal Atomics), 1-^{14}C naphthalene (Amersham Corp.) and 1-^{14}C benzanthracene (Amersham Corp.) will be used. The compounds all will be 99+% purity analysed hydrocarbons. The concentrations will be adjusted to 0.9 µCi ^{14}C hydrocarbon/ml crude oil. After incubation at 5 C for 6 weeks, the $^{14}CO_2$ produced will be recovered and counted as described for the MPN enumeration procedure. Duplicate determinations will be made for each. Counts from the controls will be subtracted from the non-poisoned counts and recorded as arbitrary units (CPM $^{14}CO_2$ produced) of hydrocarbon biodegradation potential. Since there were approximately 100,000 CPM in the spiked oil, every 1,000 units of $^{14}CO_2$ produced is equivalent to 1% conversion of hydrocarbon to CO_2.

Non-nutrient limited hydrocarbon biodegradation potentials will be determined in an identical manner to the natural hydrocarbon biodegradation potentials, except that 5 ml Bushnell Haas broth with 3% NaCl will be added to each vial to remove inorganic nutrient limitations, replacing the Rila marine salts solution.

Denitrification in sediment will be examined using the acetylene blockage of N_2O reduction technique (Balderson, *et al.*, 1976; Yoshinari, *et al.*, 1976). Nitrogen fixation will be estimated by the acetylene reduction method (Hardy, *et al.*, 1973). A 5 ml portion of a 1:10 diluted sediment sample will be added to a 20 ml glass vial containing 5 ml of either H_2O, 0.05% KNO_3, 0.01% glucose, 0.05% KNO_3 plus 0.01% glucose, or 0.05% KNO_3 plus 0.01% glutamate. Vials will be sealed with rubber serum stoppers and flushed with argon. Vials will be injected with C_2H_2 generated from CaC_2 (Alpha Lux Company) to give a final concentration of 0.02 atm. Vials will be incubated in the dark at 15 C for one week. Gas samples will be removed from the sample vials with 5 ml Vacutainer evacuated glass tubes (Becton Dickinson) for later analysis. For gas analysis, 100 μl of gas from the vacutainer sub-samples were injected with a gas tight syringe (Glenco Scientific) into a Hewlett Packard 5992 gas chromatograph mass spectrometer with selected 10 m monitoring for N_2O and N_2 analysis. A Hewlett Packard 5830 gas chromatograph and a dual flame ionization detector will be used for C_2H_2 and C_2H_4 analysis. Separation of gases will be achieved on a stainless steel column (6 m x 0.3 cm) packed with 50/80 mesh Poropak Q (Waters Associates, Inc.). Operation will be at 90 C with a carrier gas flow of 35 ml He/min. Integrated area response units were converted to μl units by comparison with the area response of known concentrations of standard gases.

Recovery and Analysis of Oil from *In Situ* Studies

Residual oil will be recovered from ice cores and sediment by solvent extraction. Extraction will be sequential with aliquots of hexane, benzene and methylene chloride. Use of 3 solvents of increasing polarity will insure recovery of a very high percentage of the residual petroleum hydrocarbons including polynuclear aromatic compounds. Separatory funnels will be used for recovery of oil from ice. For recovery of oil from sediment solvent and oiled sediment will be mixed for 6 hours in a flask on a rotary shaker at 200 RPM. The solvent will then be decanted. Two-three aliquots with each solvent will be used. For separation of methylene chloride from sediment, filtration through Whatman No. 2 filter paper with solvent washing will be used. The solvent extracts will be concentrated with a rotary evaporation. The extracts will not be allowed to come to dryness to prevent loss of volatile compounds that may have remained "adsorped" in the sediment.

Extracted hydrocarbons will be quantitated and identified using gas chromatography and mass spectrometry. Gas chromatography will be performed with a Hewlett Packard model 5830 reporting gas chromatograph with flame ionization detector. Thirty meter glass capillary columns coated with SP2100 (Supelco) will be used for compound separation. A temperature program from 80 to 300 C at 4 C/min will be used to achieve separation. The same conditions will be used for GC-MS analyses using a Hewlett Packard model 5992 gas chromatograph-mass spectrometer. The peakfinder program will be used for identification of specific compounds. Both internal compound libraries and libraries at the National Institute of Health, linked through a dataphone, will be used for compound identification. Selected ion monitoring will be used for estimation of proportions of classes of compounds in the residual oil mixture.

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IX. DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
	Disks at NIH	1000 tracks	special	Yes		
Densities of Microbial populations	"				(Oct. 1 - Dec. 31/78 (Jan. 1 - Mar. 31/78 (Apr. 1 - June 30/78 (July 1 - Sept. 30/78	Jan. 31/78 Apr. 30/78 July 30/78 Oct. 30/78
Characterization of microbial isolates						

Products -

Narratives of methods and results, including tables, densities and geographic location of microorganisms. Tables of rates of hydrocarbon biodegradation. Table of chemical composition of petroleum residues under ice and in sediment and any new products that accumulate. Cluster analysis of microorganisms in the Beaufort Sea samples. To be included in quarterly reports and in reports in the scientific literature.

Digital data: Population counts and distributions (Disc. storage at NIH).

Visual data: Maps of seasonal distribution of microorganisms. Graphs of composition, biodegradation rates, etc.

X. Quality Assurance Plans

Instruments used in the analysis of petroleum residues will be routinely checked with internal standards. Statistical analyses of variance will be used on replicate samples to determine the level of significance of results. Numerous computer checks are built into the NIH data storage and analysis system to assure accurate entry of the data. Within the numerical taxonomic procedures used in characterizing microorganisms several organisms are routinely retested to determine reproducibility. In the past these tests have shown a maximal rate of error or variability of 3%.

It should be pointed out that no attempt is being made in the project to gather adequate data on seasonal variability. This would require 4 samplings per year rather than 1 or 2 within a sampling area. This is beyond the scope of of annual funding of this project.

This project is willing to participate in a GC-MS intercollaboration experiment using oiled sediment supplied by OCSEAP. It should be pointed out though that GC-MS analyses that are part of the project are aimed at identifying residual hydrocarbons from experimentally contaminated ice and sediment rather than trace background amounts of hydrocarbons as are some of the OCSEAP sponsored chemical projects.

XI. Sample Archival

Any necessary archival of isolated microbial strains will be made by deposition with the American Type Culture Collection, Rockville, MD.

XII. LOGISTICS REQUIREMENTS - BEAUFORT SEA

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION University of Louisville PRINCIPAL INVESTIGATOR Ronald Atlas

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.
   Plover Pt. for *in situ* oil exposure experiments.

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible.
   Diving to recover sediment trays.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

   Jan., May, August.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?

   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.

6. What equipment and personnel would you expect the ~~ship~~ lab to provide?
   Line tenders, hole through ice, diving hut, heater, generator, wet belts, scuba tanks, diving lights, Sipre corer.

7. What is the approximate weight and volume of equipment you will bring?

8. Will your data or equipment require special handling? _____ If yes, please describe.

). Will you require any gases and/or chemicals? ______ If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge.

.0. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.

1. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability?

NA

2. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.

2 - to be named

XII. LOGISTICS REQUIREMENTS - COOK INLET

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION University of Louisville PRINCIPAL INVESTIGATOR Ronald Atlas

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions. Sampling grid in Cook Inlet used on previous operations. Also samples along transect from Kodiak through Unimak Pass to Bristol Bay.

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible. For shipboard samplint, water and sediment will be collected with Niskin sterile water and bottom grab or box core sampler.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

   2 week duration cruise - December, 1978.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

   10-14

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?

   Can coordinate.

   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.

   1 hr 1 station, longer periods for collecting beach samples.

6. What equipment and personnel would you expect the ship to provide?

   Bottom grab and winch. STD casts. Positional data.

7. What is the approximate weight and volume of equipment you will bring?

   1000 lbs 200 cu ft

8. Will your data or equipment require special handling? Yes If yes, please describe.

   Fragile media requires refrigeration.

. Will you require any gases and/or chemicals? Yes____ If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge. CO_2 for dry ice.

). Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying. NOAA Miller Freeman or Discoverer. Need wet lab space, incubators and stable platform.

If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability?

NA

. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.

2 persons.

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

Norton Sound

INSTITUTION University of Louisville PRINCIPAL INVESTIGATOR Ronald Atlas

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A. SHIP SUPPORT

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1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions. Sampling grid through 1 seep area to be coordinated with chemical research groups and project RU 190.

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2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible. For shipboard sampling, water and sediment will be collected with Niskin sterile water and bottom grab or box core sampler.

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3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

June - July, 1978. 2 week maximal duration of cruise.

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4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

10-14

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5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?

Can coordinate.

Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations. 1 hr 1 station, longer periods for collecting beach samples.

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6. What equipment and personnel would you expect the ship to provide? Bottom grab and winch. STD casts. Positional data.

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7. What is the approximate weight and volume of equipment you will bring?

1000 lbs 200 cu ft

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8. Will your data or equipment require special handling? Yes If yes, please describe.

fragile media requires refrigeration.

Will you require any gases and/or chemicals? Yes If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge. CO_2 for dry ice.

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0. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying. NOAA Miller Freeman or Discoverer
Need wet lab space, incubators and stable platform.

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1. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability?

NA

---

2. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.

3 persons

XIII. Anticipated Problems

No major problems are anticipated. A major problem would occur if ice or a ship bottomed within the Beaufort Sea oil in sediment experimental area. Should this occur the experiment would be re-established as quickly as possible. Some problems have been encountered in ship scheduling and coordination of sampling dates and locations with other research projects. These problems usually occur when NOAA staff members have deemed it desirable to extend sampling beyond the capabilities of personnel and funding of this project. Only 2 sampling cruises are scheduled in this project. The ideal duration of each cruise is 14 days. It is projected that 50 samples from each cruise will be analysed. Additional cruises and/or samples to be analysed would require additional funding. Also funds are not included in this project nor time allocated for meetings with NOAA staff to review the accomplishments of this project beyond those specified in Item XVII. During the past year extensive syntheses and review meetings removed the Principal Investigator from the laboratory for more than 1 month.

XIV. Information Required from Other Investigators

The work in this project will be closely coordinated cruise samples shared with Dr. Morita's project RU 190. Nutrient analyses including inorganic N, organic N, and organic C will have to be supplied through Dr. Morita's project, or other NOAA OCSEAP supported source. Salinity, temperature and accurate positional data will be required from vessel personnel on each cruise. Sampling stations in Norton Sound will have to be coordinated with chemical research projects. It is anticipated that Dr. Calder, OCSEAP Boulder will coordinate this effort. Data analyses will have to be provided through separate interagency agreement with NIH.

XVI. Outlook

A major objective of this project is to determine the long term fate of oil under ice and in sediment. It will be necessary to continue the work in Elson Lagoon for several years to accurately determine the long term fate. It will be important to extend the oil biodegradation in sediment experiments to additional geographic locations and to a larger scale. The small oil contaminated sediment in Plexiglas tray experiments should be established at other locations in the Beaufort Sea and Cook Inlet to determine the importance of geographic variability in determining the fate of contaminating petroleum. Additional sites should be selected within areas that have a high probability of oil development. The site in Elson Lagoon was chosen in part because of the ability of NARL to support winter and summer diving operations. Additional sites could include Prudhoe Bay and the east and west lease boundaries in the Beaufort Sea, Kachemak Bay in Cook Inlet, and Chiniak Bay near Kodiak Island. It is likely that diving at these sites in the Beaufort Sea would be restricted to summer because of the difficulties inherent in supporting winter diving. Locations of experimental sites would have to be carefully marked and may require purchase or rental of sonic location devices.

It has also been noted by OCSEAP for several years that a large scale integrated oil spill experiment should be conducted. It is probably necessary to conduct two spills one in the Beaufort Sea and one in the Gulf of Alaska. Such a spill would be used by continuation of the project to examine the biodegradation of the oil, the factors influencing rates of biodegradation, the changes in density and diversity of the microbial community in response to the oil and the changes in essential microbial carbon and nitrogen cycling activities caused by the oil. Such a study also could be conducted following an actual accidental spillage assuming that background information on a suitable reference area could be obtained and that research could be initiated immediately after the spillage occurred.

There also has been recent recognition of the importance of microorganisms in the food web. Some studies have been initiated on the importance of detrital biomass in an area of the Beaufort Sea (LGL study) and others are planned for FY 1979 by project RU 190. Undoubtedly these projects will require more than one year. One aspect concerning the role of microorganisms in the food web that is not being addressed in these studies is the ability of microorganisms to sequester hydrocarbons and pass these into the food web. Our laboratory has the analytical capability and could in association with these projects begin to investigate the movement of hydrocarbons into the food web during FY 80.

There will remain a large geographic gap in our knowledge of the seasonal distribution of microorganisms and microbial activities in Alaskan OCS areas, i.e., the Bering Sea. Should future OCS lease interest focus on Bristol Bay or other Bering Sea areas then studies should be initiated to enumerate microbial populations, e.g., hydrocarbon utilizers and microbial activities, e.g., hydrocarbon biodegradation potentials. Microbial activities along the ice edge would be particularly important to determine as spilled oil could accumulate along an ice edge. Studies proposed for FY 79 should form the basis for further efforts in the Bering Sea.

Within the Beaufort Sea further seasonal data on microbial populations and activities should be gathered during the spring under ice algal bloom. The effects of oil on this algal bloom and associated microbial decomposition processes should be determined. Data gathered on microorganisms in the Beaufort Sea suggests that ice conditions are extremely important. Formation of ice may exclude microorganisms from the water column and concentrate microbial biomass in the sediment. This possible process and the effects of oil on it should be investigated as it may represent a very important controlling factor for productivity of higher organisms in this area.

In addition to these field oriented studies laboratory "effects" studies are needed. Adequecy of funding has not permitted such studies on microorganisms in the OCSEAP program. Effects studies should include an examination of how oil alters rates of carbon and nitrogen cycling. This should include decompositional processes involved in turnover of animal and plant polymer, nitrogen fixation and denitrification. Effects studies should also examine how oil alters survival of dominant groups of microorganisms such as the orange pigmented bacteria that have been found to repeatedly dominate the microbial community in surface water of the Beaufort Sea during summer.

With respect to levels of funding needed to continue or commence these efforts between 150 and 200 K should be allocated annually for continuation of this project during FY 80 and FY 81 as part of OCSEAP or subsequent programs. Each year there have been major cutbacks or attempts to completely eliminate microbiological research from the OCSEAP. Program reviews have repeatedly indicated the relevance and importance of microbiological research in the OCSEAP program. As a result of inadequecy of funding in previous years the microbiological research has had to try to catch up to where it should have been. This has meant that most personnel have been involved in extensive field work and data analysis and interpretation have lagged behind. Only with adequate funding can past data be interpreted so that it is of maximal usefulness for OCSEAP and BLM and the needed future data outlined above be gathered and synthesized. Hopefully for FY 80 appropriate microbiological research projects will be integrated into OCSEAP planning and will not be omitted or severely underfunded.

XVII. 1. Updated Activity/Milestone/Data Management Charts will be submitted quarterly.

2. Quarterly reports will be submitted in sufficient time during the contract year to be in OCSEAP hands by the first day of

3. At the option of the Project Office the P. I. will be prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office. Additional travel for OCSEAP review and synthesis efforts will be at the option of the principal investigator and is not required under the terms of this contract.

4. Data will be provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13) through NIH under interagency agreement.

5. Data will be submitted within 120 days of the completion of a cruise or 3 month data collection period, unless a written waiver has been received from the Project Office.

6. Within 10 days of the completion of a cruise or data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager. Sufficient ROSCOP forms will be forwarded to the principal investigator with instructions.

7. Title for all property purchased with OCSEAP funds remains with the U. S. Government pending disposition at contract termination.

8. Three (3) copies of all publication or presentation manuscripts pertaining to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

9. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following standard acknowledgement is acceptable.

   "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

0 - Planned Completion Date

X - Actual Completion Date

RU # 29 PI: Ronald Atlas

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

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Complete enumeration and numerical taxonomic analyses on Beaufort Sea isolates from FY 78 and deposit data at NIH					0										
Ship cruise in Cook Inlet								0							
Quarterly report				0						0			0		
Deposit enumeration data from Cook Inlet cruise.													0		
Collect oiled sediment samples in Beaufort Sea				0							0				
Annual report						0									
Norton Sound cruise										0					
Deposit enumeration data from Norton Sound cruise													0		
GC & MS analyses of petroleum residues from Beaufort Sea sediment												0			
Complete numerical taxonomic analyses on Norton Sound and Cook Inlet isolates															0
Complete hydrocarbon biodegradation and denitrification potentials from Cook Inlet, and Norton Sound cruises												0			

UNIVERSITY OF LOUISVILLE
LOUISVILLE, KENTUCKY 40208

COLLEGE OF ARTS AND SCIENCES
DEPARTMENT OF BIOLOGY

September 25, 1978

Dr. Herbert E. Bruce
Bering Sea-Gulf of Alaska Project Manager
U. S. Department of Commerce
NOAA
Environmental Research Laboratories
Bering Sea-Gulf of Alaska Project Office
P. O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

Please find enclosed revisions to the proposal to research unit 29 for FY 79 that you requested.

Sections V-VIII, XII-Cook Inlet, XV, and XVII of the original proposal should be replaced with the enclosed sections. A statement concerning our willingness to supply mylar overlays was included in the original proposal.

I trust that the revisions meet your requirements and that a formal contract can be issued shortly.

Sincerely,

Ronald M. Atlas

Ronald M. Atlas
Associate Professor

Dr. Herbert Garfinkel
Vice President for
Academic Affairs

RMA/jl

enclosures

cc: Lois Killewich ✓
Gunter Weller
Doug Wolfe
John Calder

V. Objectives

Beaufort Sea

Objectives in the Beaufort Sea will be:

a. to enhance knowledge of the geographical distribution of bacteria east of Prudhoe Bay through analyses of water and sediment samples collected in FY 78 for the potential of the microbial population for degrading hydrocarbons;

b. to determine the long-range effects on microbes of the release of oil into bottom sediments through rupture of a buried pipeline. This is a continuation of an experiment already in progress in the Beaufort Sea, in which plexiglas trays containing oil overlain with sediment collected at the experimental site are maintained in Elson Lagoon. The trays are sampled periodically for determination of the numbers of total and viable bacteria, denitrification rates, and hydrocarbon biodegradation potential. Chemical analyses are performed to monitor changes in the composition of the oil and its breakdown products over time.

Norton Sound

Objectives in Norton Sound will be to determine if the presence of a natural oil seep has altered the relative abundance of microbes and in particular of hydrocarbon-utilizing bacteria. Comparisons will be made of numbers of total and viable bacteria, numerical taxonomy, denitrification rates, and hydrocarbon biodegradation potentials in water and sediment samples collected inside and outside the seep area. This study will be coordinated with RU 190 and with chemistry research units, 152, 153, 275, 480, and P 902.

Upper Cook Inlet

Objectives in Upper Cook Inlet will be to enlarge the knowledge of the effects of oil platforms on the bacterial population by measuring total and viable bacteria, numerical taxonomy, denitrification rates, and hydrocarbon biodegradation potential in water and sediment samples collected adjacent to the existing platforms. This study will be performed in connection with RU 190 and with the chemistry research units 152, 153, 275, and 480.

VI. General Strategy and Approach

During FY 1978 a study was initiated to examine the long term fate of oil in Beaufort Sea sediment. Oil-contaminated Beaufort Sea sediment was placed in plexiglas trays. During FY 79 replicate trays will be recovered during winter and summer. Microbial populations in the oil contaminated and adjacent uncontaminated sediment will be enumerated to determine if extended exposure to oil alters population levels of microorganisms. Enumeration of microbial populations will include total microorganisms by direct count, viable heterotrophs by plate count, and hydrocarbon utilizers by Most Probable Number procedures. Nitrogen fixation and denitrification activities of the indigenous microorganisms will be measured to determine if prolonged exposure to crude oil alters rates of nitrogen flux into and from Beaufort Sea sediment. Sediment collected from the trays will be supplied to project RU 190 for determination of other microbial activities. Project RU 190 will also determine nutrient levels in the sediment.

Residual oil in the sediment will be recovered by solvent extraction. Residual oil will be analysed for chemical changes resulting from abiotic weathering and biodegradation. Estimates will be made for persistence of petroleum hydrocarbons in Beaufort Sea sediments.

Microorganisms will be enumerated from samples collected during an icebreaker cruise in the Beaufort Sea during September 1978. The cruise is planned to collect samples from the Canadian border to Pt. Barrow at the 10 fathom line. Intensive sampling will occur within an area of upwelling near Barter Island and within the proposed 1979 OCS lease area. Microorganisms will be isolated at random from enumeration plates. Numerical taxonomic procedures will be used to characterize microbial populations in surface water and sediment. The distribution of dominant taxa and the diversities of the microbial communities will be determined.

A cruise will be conducted during spring in Upper Cook Inlet. The cruise should collect samples near oil platforms and in areas not subject to contamination from oil production activities. Samples will be collected in coordination with other designated microbiological and chemical research units. Microorganisms will be enumerated from samples collected on this cruise. Total microorganisms, viable heterotrophic microorganisms and hydrocarbon utilizing microorganisms will be enumerated. Hydrocarbon biodegradation potentials will be determined for paraffinic and aromatic petroleum hydrocarbons. Rates of denitrification potentials will be determined for sediment samples. Approximately 400 microorganisms (20/sample) will be isolated for taxonomic testing. Due to the proposed late spring sampling date extensive numerical taxonomic testing of isolated organisms will *not* be completed for these samples during FY 79.

A cruise will be conducted during summer in Norton Sound in coordination with chemical data acquisition projects. The cruise will traverse a submarine oil seepage. Densities of microbial populations will be determined in the seep area and in uncontaminated areas of the Sound. The objective of the cruise will be to determine if the oil seepage has altered microbial populations and activities. Since no microbiological studies have been performed in Norton Sound a second objective will be to gain preliminary information on the natural abundance and activities of microorganisms there. Enumeration procedures will include direct counts for total microorganisms, plate counts for viable heterotrophs, and Most Probable Number determinations for hydrocarbon utilizers. Rate of hydrocarbon biodegradation potentials for paraffinic and aromatic hydrocarbons will be determined. Rates of denitrification potentials will be determined for sediment samples. Numerical taxonomic procedures will be employed to determine taxonomic distribution and diversity of the microbial communities. Due to the proposed summer sampling date numerical taxonomic testing will not be performed during FY 79. Approximately 400 organisms will be isolated for taxonomic testing during FY 80.

VII. Sampling Methods

In the Beaufort Sea sediment and water samples will be collected at approximately 24 stations during September 1978. Analyses using these samples will be accomplished during FY 1979.

Scuba divers will recover replicate trays containing oiled sediment during winter and summer.

Surface water and sediment samples will be collected during a spring cruise in Upper Cook Inlet and a summer cruise in Norton Sound.

Approximately 25 water and 25 sediment samples will be collected during each cruise. The exact sampling locations will be determined in collaboration with other microbiological and chemical projects, so that common stations will be used. Water samples will be collected with a Niskin sterile water sampler. Sediment samples will be collected with box corer or a Van Veen grab sampler depending upon availability.

VIII. Analytical Methods

Enumeration of Microorganisms

Enumerations of bacterial populations will be performed using both direct count and viable plate count procedures. For direct counts, samples will be preserved with formaldehyde, one part formaldehyde:one part sample. Samples will be filtered through 0.2 μm cellulose nitrate black filters and stained with acridine orange according to the procedure of Daley and Hobbie (1975). Samples will be viewed with an Olympus epifluorescence microscope with a BG-12 exciter filter and 0-530 barrier filter. Ten fields per filter and two filters per sample will be viewed and the counts averaged.

For viable plate counts, surface spread inoculations from serial dilutions will be used. For some water samples concentration by filtration through 0.45 μm filters (Millipore Corp.) will also be used. Marine agar 2216E (Difco) will be used to enumerate viable heterotrophic microorganisms. Replicate plates will be incubated aerobically at 4 and 20 C to enumerate psychrophilic-psychrotrophic and mesophilic populations respectively.

Most Probable Number estimates of hydrocarbon utilizers will be performed. Dilutions of samples will be added to 30 ml stoppered serum vials containing 5 ml autoclaved Bushnell Haas broth (Difco) with 3% added NaCl, and 50 μl filter sterilized (0.2 μm Millipore filter) Cook Inlet crude oil spiked with 1-^{14}Cn hexadecane (s.p. act. = 0.9 μCi/ml oil). Sterility of the oil will be checked by plating portions of the oil onto marine agar 2216 (Difco) and observing for colony formation and by measuring $^{14}CO_2$ production from uninoculated vials. Poisoned controls will be prepared by adding 0.2 ml concentrated hydrochloric acid to the vials. A 3 tube MPN procedure will be used. Following incubation at 5 C for 4 weeks the solutions will be rendered alkaline with concentrated KOH to stop microbial activity. Solutions will then be acidified with concentrated HCl and the $^{14}CO_2$ will be recovered by purging the vials with air and trapping the $^{14}CO_2$ in 1 ml hyamine hydroxide in percolation tubes, 0.5 cm x 10 cm, containing glass beads (Atlas and Hubbard, 1974). The hyamine hydroxide will be washed from the tubes into scintillation vials with 3 one ml portions of methanol. The counting solution will be 10 ml Omnifluor + toluene (New England Nuclear). Counting will be with a Beckman liquid scintillation counter. Counts greater than or equal to 2 times control will be considered as positive; counts less than 2 times control will be considered as negative. The most probable number of hydrocarbon degrading microorganisms will be determined from the appropriate MPN Tables (APHA, 1971) and recorded as most probable number per ml for water samples or most probable number per g dry wt. for sediment samples.

Numerical Taxonomic Testing

Approximately 300 phenotypic characteristics will be determined for bacterial strains selected at random from enumeration plates. Characterization will include morphological, physiological, biochemical, nutritional and antibiotic sensitivity testing.

Cultures (1-4 d depending on growth rate), from Marine agar slants overlain with 1 ml Rila marine salts solution, will be examined for cell shape, size and motility (wet mounts); gram reaction (Hucker modification), and acid fastness (Ziehl-Neelsen method) (Society of American Bacteriologists, 1957). Cultures (10 d) on Marine agar will be examined for colony morphology and size, and production of diffusible and non-diffusible pigments. Fluorescent pigment formation on Marine agar + 0.15% w/v glycerol will be assessed with UV light of wavelength 260 nm. Growth on replicate Marine agar plates will be tested at 5, 10, 15, 20, 25, 37 and 43 C, and at initial pH 3, 4, 5, 6, 7, 8, 9 and

10 (adjusted with HCl or NaOH). Salt tolerance and requirement will be tested in the following medium without NaCl and with 3, 5, 7.5, 10 and 15% (all w/v) NaCl added: Bacto-tryptone, 0.5%; Bacto-yeast extract, 0.1%; $FeCl_3.6H_2O$, 0.01%; NH_4NO_3, 0.00016%; Na_2HPO_4, 0.0008%; Bacto Agar, 1.5% (all w/v); pH 8.0. Oxygen relations will be determined from stab cultures in Marine agar butts.

Cultures (10 d) on Marine agar will be tested for catalase (with 3% H_2O_2) and cytochrome oxidase production (Gaby & Hadley method, allowing one minute for the blue color to develop; Skerman, 1969) Methyl red tests (Society of American Bacteriologists, 1957) will be done in MR-VP broth (Difco) prepared with full strength Rila marine salts solution. Alkaline phosphatase detection (Baker & Kuper, 1951) will be done on cultures (10 d) grown in a medium containing Bacto tryptone, 0.5%; Bacto yeast extract, 0.1%; NH_4NO_3, 0.00016%; $FeCl_3.6H_2O$, 0.0005%; phenolphthalein diphosphate, 0.001% (all w/v) in 3/4 strength Rila marine salts solution at pH 7.2. Arginine, ornithine and lysine decarboxylase will be detected by the Falkow method (Skerman, 1969), modified by replacing distilled water with Rila marine salts solution. These tests measure alkaline end-products and do not distinguish between arginine decarboxylase and arginine dihydrolase.

Nitrate and nitrite reduction will be tested in nitrate broth (Difco) with full strength Rila marine mix. Nitrite will be detected with naphthylamine-sulphanilic acid reagent and residual nitrate with zinc dust (Skerman, 1969).

Acid production from D-ribose, D-fructose, D-cellobiose, lactose, sucrose and D-mannitol (all 1% w/v) will be detected in MOF medium (Difco). OF tests will be done in MOF medium containing 1% (w/v) D-glucose (Hugh & Leifson, 1953).

Agar hydrolysis will be tested on Marine agar. Sunken colonies and depressions around colonies will be scored as positive. Lipase activity will be tested in Marine agar containing 0.01% (w/v) $CaCl_2$ and 1% (w/v) Tween 20 or Tween 80 (Sierra, 1957). Starch hydrolysis will be tested by flooding plate cultures (7 d) on Marine agar + 0.5% (w/v) potato starch with Lugol's iodine. Gelatine hydrolysis will be tested by flooding cultures (7 to 10 d) on Marine agar + 10% (w/v) with acid $HgCl_2$ (Skerman, 1969). Casein hydrolysis will be tested on Marine agar overlaid with a double layer of 10% w/v skim milk agar. For the last three tests, clear zones around colonies will be recorded as positive.

Antibiotic sensitivity will be tested by spreading suspensions on Marine agar plates and applying BBL (Cockeyville, MD) antibiotic discs (ampicillin, 2 μg; colistin, 10 μg; erythromycin, 15 μg; kanamycin, 5 μg; kanamycin, 30 μg; neomycin, 30 μg; nitrofurantoin, 300 μg; novobiocin, 5 μg; oxytetracycline, 5 μg; penicillin G, 2 units, polymyxin

B, 300 units; strepomycin, 2 µg; tetracyclin, 5 µg). Zones of inhibition will be measured and sensitivity determined against standard inhibition zones (BBL).

The following medium (Basal medium B) will be used for substrate utilization testing: Portion 1; KH_2PO_4, 0.1 g; Trizma base, 6.0 g; NH_4NO_3, 1.0 g; $FeCl_3.6H_2O$, 0.005 g; Rila marine salts solution, 500 ml; pH adjusted with HCl to 8.0. Portion 2; Purified agar (Difco), 10 g; distilled H_2O, 500 ml. Portion 3; thiamine, sodium pantothenate, riboflavin, nicotinic acid, choline, pyridoxamine, cyanocobalamine, (all 1 µg); folic acid, sodium p-aminobenzoate, biotin (all 0.05 µg); distilled H_2O, 2 ml. Portions 1 and 2 will be autoclaved separately. Portion 3 will be filter sterilized. The 3 portions will be mixed at 55 C. Substrates will be sterilized by autoclaving or by filtration (Stanier, *et al*, 1966) except for hydrocarbons which will be sterilized ultrasonically. Substrates will be mixed with the basal media just before pouring to yield final concentrations of 0.1% w/v except for carbohydrates (0.15% w/v) and phenol (0.0125% w/v). A total of 100 substrates will be tested. To determine growth factor requirements, 2 additional basal media will be used. Basal medium A will be the same as basal medium B except that portion 3 (vitamins) will be omitted. Basal medium E will be the same as basal medium B except that it will be supplemented with Bacto yeast extract, 50 mg, casamino acids, 50 mg and L-tryptophan, 10 mg. Twelve substrates (D-ribose, D-fructose, D-glucose, acetate, succinate, fumarate, DL-β-hydroxybutyrate, DL-lactate, pyruvate, α-ketoglutarate, D-gluconate, glycerol) were used with each of the 3 basal media (A, B, E). Growth (colony formation with density greater than control lacking added substrate within 14 days) on any of the substrates on a given basal medium will be considered as ability to grow on that basal medium. Four classes of growth factor requirements will be recognized: type 1, bacterial able to grow on basal media A, B and E (do not require growth factors); type 2, bacteria able to grow on basal media B and E but not A (require vitamins as growth factors); type 3, bacteria able to grow on basal media E but not A or B (require complex growth factors such as amino acids); type 4, bacteria unable to grow on basal media A, B or E (require complex unknown growth factors).

All substrate utilization tests will be inoculated with a multiple syringe inoculator (Kaneko, Holder-Franklin & Franklin, 1977). Positive growth will be determined after 14 days incubation by visual reference to control plates on the same basal medium with no added substrate.

Data will be coded in binary form according to RKC format (Rogosa, Krichevsky & Colwell, 1971), punched on cards, and verified and proofread by two people. Errors also will be checked by computer with the CREATE program (Krichevsky, 1977). Test reproducibility will be checked by periodically retesting selected strains. The QUERY computer program (Krichevsky, 1977) will be used to arrange the data suitably for input to the numerical taxonomy programs. Similarities will be estimated with Jaccard coefficient (S_J) and cluster analyses will be done by unweighted average linkage sorting (Sokal & Sneath, 1963). Clusters of strains with similarities greater than 75% will be designated as taxonomic groupings (Liston, Wiebe & Colwell, 1963). The input data will be sorted into the same order as strains in the cluster analysis triangle. The feature frequencies of all characteristics will be determined with the feature analysis program, FREAK (Walczak, Johnson & Krichevsky, 1978). Probabalistic identifications will be attempted using the program IDDNEW and 3 identification matrices currently being developed at the American Type Culture Collection (Johnson, unpublished).

The number of taxonomic groups and the number of individuals in each group, determined by the cluster analyses, will be used to calculate the Shannon diversity index, $\overline{H}$. The formula

$$\overline{H} = \frac{c}{N}(N \log_{10} N - \Sigma n_i \log_{10} n_i)$$

will be used, where c = 3.3219, N = total numbers of individuals and n_i = total number of individuals in the i^{th} taxonomic grouping.

Activity

Natural Hydrocarbon Biodegradation Potential

Ten ml of water samples or 10 ml of a 1:100 dilution of sediment samples will be added to 30 ml stoppered serum vials containing 5 ml autoclaved Rila marine salts solution and 50 μl filter sterilized crude oil spiked with ^{14}C radiolabelled hydrocarbon. Poisoned controls will be prepared by adding 0.2 ml concentrated hydrochloric acid. Cook Inlet crude oil will be used for Cook Inlet studies. 1-^{14}C n-hexadecane (Amersham Corp.), 1-^{14}C pristane (Cal Atomics), 1-^{14}C naphthalene (Amersham Corp.) and 1-^{14}C benzanthracene (Amersham Corp.) will be used. The compounds all will be 99+% purity analysed hydrocarbons. The concentrations will be adjusted to 0.9 μCi ^{14}C hydrocarbon/ml crude oil. After incubation at 5 C for 6 weeks, the $^{14}CO_2$ produced will be recovered and counted as described for the MPN enumeration procedure. Duplicate determinations will be made for each. Counts from the controls will be subtracted from the non-poisoned counts and recorded as arbitrary units (CPM $^{14}CO_2$ produced) of hydrocarbon biodegradation potential. Since there were approximately 100,000 CPM in the spiked oil, every 1,000 units of $^{14}CO_2$ produced is equivalent to 1% conversion of hydrocarbon to CO_2.

Non-nutrient limited hydrocarbon biodegradation potentials will be determined in an identical manner to the natural hydrocarbon biodegradation potentials, except that 5 ml Bushnell Haas broth with 3% NaCl will be added to each vial to remove inorganic nutrient limitations, replacing the Rila marine salts solution.

Denitrification in sediment will be examined using the acetylene blockage of N_2O reduction technique (Balderson, *et al.*, 1976; Yoshinari, *et al.*, 1976). Nitrogen fixation will be estimated by the acetylene reduction method (Hardy, *et al.*, 1973). A 5 ml portion of a 1:10 diluted sediment sample will be added to a 20 ml glass vial containing 5 ml of either H_2O, 0.05% KNO_3, 0.01% glucose, 0.05% KNO_3 plus 0.01% glucose, or 0.05% KNO_3 plus 0.01% glutamate. Vials will be sealed with rubber serum stoppers and flushed with argon. Vials will be injected with C_2H_2 generated from CaC_2 (Alpha Lux Company) to give a final concentration of 0.02 atm. Vials will be incubated in the dark at 15 C for one week. Gas samples will be removed from the sample vials with 5 ml Vacutainer evacuated glass tubes (Becton Dickinson) for later analysis. For gas analysis, 100 µl of gas from the vacutainer sub-samples were injected with a gas tight syringe (Glenco Scientific) into a Hewlett Packard 5992 gas chromatograph mass spectrometer with selected 10 m monitoring for N_2O and N_2 analysis. A Hewlett Packard 5830 gas chromatograph and a dual flame ionization detector will be used for C_2H_2 and C_2H_4 analysis. Separation of gases will be achieved on a stainless steel column (6 m x 0.3 cm) packed with 50/80 mesh Poropak Q (Waters Associates, Inc.). Operation will be at 90 C with a carrier gas flow of 35 ml He/min. Integrated area response units are converted to µl units by comparison with the area response of known concentrations of standard gases.

Recovery and Analysis of Oil from *In Situ* Studies

Residual oil will be recovered from sediment by solvent extraction. Extraction will be sequential with aliquots of hexane, benzene and methylene chloride. Use of 3 solvents of increasing polarity will insure recovery of a very high percentage of the residual petroleum hydrocarbons including polynuclear aromatic compounds. For recovery of oil, solvent and oiled sediment will be mixed for 6 hours in a flask on a rotary shaker at 200 RPM. The solvent will then be decanted. Two-three aliquots with each solvent will be used. For separation of methylene chloride from sediment, filtration through Whatman No. 2 filter paper with solvent washing will be used. The solvent extracts will be concentrated with a rotary evaporator. The extracts will not be allowed to come to dryness to prevent loss of volatile compounds that may have remained "adsorped" in the sediment.

Extracted hydrocarbons will be quantitated and identified using gas chromatography and mass spectrometry. Gas chromatography will be performed with a Hewlett Packard model 5830 reporting gas chromatograph with flame ionization detector. Thirty meter glass capillary columns coated with SP2100 (Supelco) will be used for compound separation. A temperature program from 80 to 300 C at 4 C/min will be used to achieve separation. The same conditions will be used for GC-MS analyses using a Hewlett Packard model 5992 gas chromatograph-mass spectrometer. The peakfinder program will be used for identification of specific compounds. A data link with the NIH-EPA commercial chemical information mass spectral search system will be used for compound identification. Alkanes up to molecular weights of at least C_{30} and aromatic hydrocarbons including 4 ring polynuclear aromatic compounds can be separated and identified with these procedures. Biodegradation products including fatty acids, esters and other oxygenated compounds can also be identified in these analyses.

XII. LOGISTICS REQUIREMENTS - COOK INLET

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION University of Louisville PRINCIPAL INVESTIGATOR Ronald Atlas

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions. Sampling grid in Upper Cook Inlet to be determined in coordination with other NOAA chemistry projects.

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible. For shipboard samplint, water and sediment will be collected with Niskin sterile water and bottom grab or box core sampler.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

   2 week duration cruise - May, 1979.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

   10-14

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?

   Can coordinate.

   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.

   1 hr 1 station, longer periods for collecting beach samples.

6. What equipment and personnel would you expect the ship to provide?

   Bottom grab and winch. STD casts. Positional data.

7. What is the approximate weight and volume of equipment you will bring?

   1000 lbs 200 cu ft

8. Will your data or equipment require special handling? Yes If yes, please describe.

   Fragile media requires refrigeration.

board the ship prior to departure from Seattle or time allowed for shipment by barge. CO_2 for dry ice.

Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.   NOAA   Miller Freeman or Discoverer.
Need wet lab space, incubators and stable platform.

If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability?

NA

How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.

2 persons.

XVII 1. Updated Activity/Milestone/Data Management Charts will be submitted quarterly.

2. Quarterly reports will be submitted in sufficient time during the contract year to be in OCSEAP hands by the first day of: January, April, July and October.

3. Data will be provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13) through NIH under interagency agreement.

4. Data will be submitted within 120 days of the completion of a cruise or 3 month data collection period, unless a written waiver has been received from the Project Office.

5. Within 10 days of the completion of a cruise or data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager. Sufficient ROSCOP forms will be forwarded to the principal investigator with instructions.

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7. Three (3) copies of all publication or presentation manuscripts pertaining to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

8. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following standard acknowledgement is acceptable.

   "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

9. At the option of the Project Office the P. I. will be prepared to travel to the Project Office twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. The P. I. will also be prepared to participate in a planning meeting for the Norton Sound and Upper Cook Inlet cruises scheduled for early 1980. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office. Additional travel for OCSEAP review and synthesis efforts are optional and are not required under the terms of this contract.

PROPOSAL

CURRENT MAPPING RADAR PROGRAM

submitted to

NOAA/Outer Continental Shelf Environmental Assessment Program

by

Donald Barrick, A. Shelby Frisch, and Robert L. Weber

NOAA/ERL/Wave Propagation Laboratory
Boulder, Colorado 80302

Research Unit 48

I. LOWER COOK INLET SURFACE CURRENT STUDIES USING HF RADARS

RU-48

APRIL 1, 1979 through SEPTEMBER 30, 1979

This is the period mutually agreed upon by RU48 and OCSEAP

II. PRINCIPAL INVESTIGATORS

Dr. Donald E. Barrick

Dr. A. Shelby Frisch

Dr. Robert L. Weber

III. COST OF PROPOSAL

a. Science

4 man month GS-13 @ 5,000/month	$20,000
4 man month GS-13 @ 4,682/month	18,728
3 1/2 man month GS-15 @ 6,800/month	23,800
Total	$62,718*
Travel - see attached	2,160
	$64,878

b. Logistics - none - no field trip this year.

c. Total $64,878

d. Distribution of Effort: 100% Cook Inlet

* Includes Other Agency Overhead

IV. BACKGROUND

During the summer of 1978, the Sea State Studies Group operated their HF current sensing radar in the western portion of Lower Cook Inlet, Alaska from sites on Augustine Island, and Cape Douglas. For a period of time, from July 1 through July 3, surface current observations were made at every 80 minutes, and from July 4 through July 8, every 3 hours. The area of good radar coverage started slightly to the east of a line drawn between Cape Douglas and Augustine Island to about 50 km from this line.

V. OBJECTIVES

It is our objective in this proposal to analyze the 1978 data and to provide a Final Report containing analysis and interpretation of data collected during 1977 and 1978. Specific objectives for analysis of the 1978 data include the following:

1. Produce an observed current map for each good data sample; i.e., 3 days every 1.5 hours, 5 days every 3 hours.

2. Produce non-tidal current maps, i.e., maps where the strong tidal effects are filtered out (namely the 12 and 24 hour periods). We would give a time-averaged map every 12 hours over the 8 day data collection period. This would be made up of a 24 hour segment of data least squares fit for the 0 frequency.

3. Produce x and y components of flow in a suitable format for the trajectory calculations and comparison with model results (RU436) over the entire 1978 data period.

4. Attempt to correlate the non-tidal current results with the local meteorology prevailing during the observation period.We will look for effects of storm and wind on the surface currents by using the Lower Cook Inlet data buoy and other meteorological data such as RU367 can provide.

5. Compare the tidal and non-tidal currents and time series data with the results of moored current meter observations provided by RU138. Compare the low passed time series every 12 hours.

VI. STRATEGY AND APPROACH

We will first calculate the direct radar observed surface currents for all of our data for this 1978 period. It will then be harmonically decomposed to determine the tidal amplitudes of the 12 and 24 hour tidal periods for each day. We will then subtract this out of our original data to obtain the steady currents (i.e., at zero frequency) which should correspond to the non-tidal component of motion due to such things as pressure, wind, or density induced currents. The sampling was done once every hour and 20 minutes for a period of 3 days and once every 3 hours for a period of 5 days. This should be more than adequate to resolve 6, 12 or 24 hour components of motion as well as the average current for a 24 hour period. We plan to compare our tidal amplitudes for the 12 and 24 hour component with PMEL's overlapping current meter obtained tidal amplitudes. Since the tides are fairly independent of depth, this would be the most logical way to compare the radar data to current meter data.

The true error of the radar is difficult to determine, since there is no other method of comparison that will give the same resolution or area averaging. Comparison with drifters in the Florida Stream produced rms differences of ± 25 cm/sec initially (Barrick, et al., 1977). Corrections to that data give better than ± 10 cm/sec at this time. Other data from Cook Inlet in 1977 compared with drifters gave about the same differences.

VII. DELIVERABLE PRODUCTS

A. Digital Data - The surface currents will be presented in x, y co-ordinates in digital form for the sample time in the OCSEAP format. This would be for the previously processed 1977 data and the 1978 data.

B. Narrative Reports - There will be one paper (now in draft form) on the tidal components determined in the neighborhood of Anchor Point and Seldovia. These were observations made in the summer of 1977. Quarterly report and Final report containing analysis and interpretations of results and representative maps from all processed 1977 and 1978 Cook Inlet data. (For details of 1978 products see preceding Section V and Section VIIC below.)

C. Maps of surface currents at each of the data periods during 1978. Maps of the "detided" (residual) surface currents for each 12 hours. Maps for tidal components every 3 hours. Data suitable to calculate trajectories in the coverage area.

D. Other - None

E. Data submission schedule - 1977 and 1978 data submission will be completed by August 30, 1979.

VIII. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

Not applicable.

IX. LOGISTICS REQUIREMENTS

None

X. ANTICIPATED PROBLEMS

None

XI. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

Wind data from RU367, current data from RU138, and model information from RU436.

XII. ACTIVITY/MILESTONE CHART - FINAL

Quarterly report will be submitted July 1, 1979 and the data and final report will be submitted by September 30, 1979.

XIII. OUTLOOK

Future work will be done to improve hardware reliability and reduce the weight, simplify the data processing, improve the current resolution, and further analyze the Cook Inlet data.

Bibliography

Barrick, B. L., Evans, M. E., and Weber, R. L., Ocean surface currents mapped by radar, Science, 198, pp. 138-144.

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

MAR 2 1979

Ref: NOAA/RD/ERL/I79-RW01

Dr. Rudy Engleman
Outer Continental Shelf Environmental
Assessment Program, Director
National Oceanic & Atmospheric Administration
Boulder, CO. 80303

Dear Dr. Engleman:

We are sending the attached proposal for your consideration for the completion of the data analysis taken with the h-f surface current sensing radar.

Estimated time for completion of the work outlined in the work agreement is September 20, 1979.

The cost estimate is distributed as follows:

Labor	$62,718
Travel	2,160
Total	$64,878

Work will not be performed on this project prior to the receipt of a transfer of funds from your office authorizing the work. Questions concerning the technical content of this proposal should be directed to A. S. Frisch or R. L. Weber, ext. 6209.

Sincerely,

C. Gordon Little

C. Gordon Little, Director
Wave Propagation Laboratory

Attachment

cc: Roy Overstreet
OCSEAP,NOAA

Proposal for extension of funding
of Gulf of Alaska Research Unit - 59
"Coastal Morphology, Sedimentation and Oil Spill Vulnerability
of Montague Island and the Kenai Peninsula"

Proposal Date: June 20, 1978

Funding Period Requested: FY '79 (October 1, 1978 - September 30, 1979)

Present Contract No.: 03-5-022-82

Co-Principal Investigators: Miles O. Hayes, Director
Christopher H. Ruby
Coastal Research Division
Department of Geology
University of South Carolina
Columbia, S. C. 29208

Total cost: $ 39,726.00

Task D-4: Evaluate present rates of change in coastal morphology with particular emphasis on rates and patterns of man-induced changes: locate areas where coastal morphology is likely to be changed by man's activities; and evaluate the effect of the changes, if any. The relative susceptibility of different coastal areas will be evaluated, especially with regard to potential oil spill impacts.

Donald T. Secor
Chairman, Geology Department

B. A. Daetwyler
Vice President, Finance

Miles O. Hayes
Principal Investigator

Christopher H. Ruby
Co-Principal Investigator

TECHNICAL PROPOSAL

I. Coastal Morphology, Sedimentation and Oil Spill Vulnerability of Montague Island and the Kenai Peninsula
Research Unit #59
Contract #03-5-022-82
1 October 1978 - 1 October 1979

II. Principal Investigators - Miles O. Hayes and Christopher H. Ruby

III. Cost of Proposal:

A. Science - $39,726.00
B. Field support provided by Juneau office
C. Total: $39,726.00
D. Distribution: 100% NEGOA

IV. Background: An Oil Spill Vulnerability Classification will be applied to the shoreline environments. The classification is explained below.

A PROPOSED ENVIRONMENTAL VULNERABILITY CLASSIFICATION

On the basis of two case studies and careful review of the literature, a scale of environmental vulnerability to oil spill impacts has been derived. This scale relates primarily to the longevity of oil in each environment. The subtleties of chemical weathering of the oil within each environment have not yet been studied in enough detail to be incorporated into the vulnerability scale. Studies have concluded that chemical weathering processes are more active on high energy coasts than on low energy coasts, although the details of this environmental classification are still rather obscure. Additionally, biodegradation rates are thought to be slower in cold water, although little documentation exists to adequately verify that notion.

Coastal environments are listed and discussed below in order of increasing vulnerability in case of oil spills:

1. Straight, rocky headlands:

Most areas of this type are exposed to maximum wave energy. Waves reflect off the rocky scarps with great force, readily dispersing the oil. In fact, waves reflecting off the scarps at high tide tend to generate a surficial return flow that keeps the oil off the rocks (Urquiola spill, Spain).

2. Eroding wave-cut platforms:

These areas are also swept clean by wave erosion. All the areas of this type at the Metula spill site (Chile) had been cleaned of oil after one year. The rate of removal of the oil would be a function of the wave climate. In general, no cleanup procedures are needed for this type of coast.

3. Flat, fine-grained sandy beaches:

Beaches of this type are generally flat and hard-packed. Oil that is emplaced on such beaches will not penetrate the fine sand. Instead, it usually forms a thin layer on the surface that can readily be scraped off by a motorized elevated scraper or some other type of road machinery. Furthermore, these types of beaches change slowly, so burial of oil by new deposition would take place at a slow rate.

4. Steeper, medium-to-coarse-grained sandy beaches:

On these beaches, the depth of penetration would be greater than for the fine-grained beaches (though still only a few centimeters), and rates of burial of the oil would be greatly increased. Based on earlier studies by our group in numerous localities, it is possible for oil to be buried as much as 50-100 cm within a period of a few days on beaches of this class. In this type of situation, removal of the oil becomes a serious problem, inasmuch as it would be necessary to destroy the beach in order to remove the oil. Another problem is that burial of the oil preserves it for release at a later date when the beach erodes as part of the natural beach cycle, thus assuring long-term pollution of the environment.

5. Impermeable muddy tidal flats (exposed to winds and currents:

One of the major surprises of the study of the Metula site (Chile) was the discovery that oil did not readily stick to the surfaces of mud flats. Also, penetration into the sediments was essentially non-existent. Threfore, if an oiled tidal flat is subject to winds and some currents, the oil will tend to be eventually removed, although not at the rapid rate encountered on exposed beaches.

6. Mixed sand and gravel beaches:

   On beaches of this type, the oil may penetrate several centimeters, and rates of burial are quite high (a few days in Spain). The longevity of the oil at the *Metula* site, particularly on the low-tide terrace and berm top areas, attests to the high susceptibility of these beaches to long-term spill damage.

7. Gravel beaches:

   Pure gravel beaches have large penetration depths (up to 45 cm in Spain). Furthermore, rapid burial is also possible. A heavily-oiled gravel beach would be impossible to clean up without completely removing the gravel.

8. Sheltered rocky headlands:

   Our experience in Spain indicates that oil tends to stick to rough rocky surfaces. In the absence of abrasion of wave action, oil could remain on such areas for years, with only chemical and biological processes left to degrade it.

9. Protected estuarine tidal flats:

   Once oil reaches a backwater, protected, estuarine tidal flat, chemical and biogenic processes must degrade the oil if it is to be removed.

10. Protected estuarine salt marshes:

    In sheltered estuaries, oil from a spill may have long-term deleterious effects. We observed oil from the *Metula* on the salt marshes of East Estuary, in the south shore of the Strait of Magellan, that had shown essentially no change in 1 1/2 years. We predict a life span of at least 10 years for that oil.

These concepts have been applied to the Northern Gulf of Alaska (Final Report was submitted in April, 1978; Technical Report No. 15-CRD) and to lower Cook Inlet in our study for the Alaskan Dept. of Fish and Game (Technical Report No. 12-CRD).

The Coastal Research Division of the Department of Geology has been studying numerous oil spills in coastal environments for the past several years. These studies include the following:

List of Spills Studied

Carrier	Location	Amount & Type of Product	Km of beach Affected	Dates of OSAT Field Study
Metula	Strait of Magellan	51,000 tons spilled, 40,000 tons deposited on beaches (Saudi Arabian crude)	225 km	12-20 Aug. '75 Jan-Mar. '76 Aug. '76 (still active)
Urquiola	La Coruna, Spain	90,000 tons spilled, 25-30,000 tons on beaches (Arabian crude)	215 km	17 May-20 June 1976 (still active)
Jakob Maersk	Porto, Portugal	80,000 tons spilled, 20,000 on beaches (Arabian crude)	40 km	6-9 June '76
Bouchard #65	Buzzards Bay, Mass.	81,000 gals #2 fuel oil	5-10 km	30 Jan-2 Feb. '77 17-18 June, '77
Ethyl H.	Hudson River, New York	420,000 gals #6 residual fuel oil	Sporadic shoreline contact	6-7 Feb. '77
Amoco Cadiz	Brest, France	216,000 tons (Arabian crude)	More than 200 km	Mar. 18-Apr. 8 '78 May 8-22, '78

As a result of these studies, funded by various Federal agencies and a number of advanced graduate level seminars, the personnel involved have developed an oil spill assessment team (OSAT). This group is presently very active publishing results and continuing studies as new spills occur. The personnel involved with the summer 1976 and 1978 field sessions in the Kotzebue Sound-Chukchi Sea, Beaufort Sea, and Kodiak Island areas (M. O. Hayes and C. H. Ruby) are members of OSAT. These members, plus possible, additional field personnel, will participate in the 1979 field work and analysis. Additionally, the principal investigators both presently participate in the NOAA Spilled Oil Research Team.

With this in mind, the primary emphasis of the proposed field work on Montague Island and the Kenai Peninsula will be to apply our Oil Spill Index, which is constantly upgraded as our experience increases. Our recent studies of the Amoco Cadiz spill will greatly facilitate the proposed work since the environment in northern France is much like sections of the proposed study area.

Objectives:

1. Collect field data on the intertidal sedimentary environments of Montague Island and the Kenai Peninsula. This would include measurements on the morphology, grain size, sedimentation rates, beach slope, vegetational characteristics, wave energies and longshore currents.
2. These data would be combined in an atlas format to produce maps of oil spill vulnerability as well as coastal morphology, beach sediment type, beach slope, and erosional-depositional characteristics for the study area.

Strategy, Approach and Sampling Techniques

Zonal Method

For the proposed general appraisal of the shorelines of the Kenai Peninsula and Montague Island, we would utilize the zonal method developed over the past few years by Hayes and associates of the Coastal Research Division at the University of South Carolina (Hayes et al., 1973)[1]

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[1] Hayes, Miles O., Owens, E. H., Hubbard, D. K., and Abele, R. W., 1973, The investigation of form and processes in the coastal zone: in Coates, D. R., ed., Coastal Geomorphology, Pubs. in Geomorphology, Binghamton, N. Y., p. 11-41.

Very briefly, the zonal method consists of the following essential steps:

1. After the selection of a single, large physiographic unit as the study area (e.g., Montague Island), extensive studies of aerial photographs, maps and charts precedes the field work.

2. Field work begins by aerial reconnaissance of the entire area during which the shoreline is photographed in detail.

3. Based upon observations during the aerial reconnaissance, a station interval is selected. Stations will be located approximately every 10 km along a straight-line shoreline configuration on 1:250,000 topographic maps.

4. At each of these locations, a beach profile is measured, sediment samples collected, beach sketch and taped description made, and aerial photos taken.

5. Approximately ten stations, representative of the various types of coastal morphology identified during the reconnaissance would be selected for detailed study. At each detailed study site (zonal station), the following studies would be carried out:

a. Construction of a three-dimensional block diagram of the shore zone by measuring two or more intertidal beach profiles.

b. Estimation of grain size and composition at regular intervals along one of the profile lines.

c. Detailed topographic surveys and statistical studies of features within the zone, both on the ground and from the air.

d. Detailed sketches of the zone. These are important because they force the observer to carefully inspect all aspects of the morphology and sediments within the zone.

Biological Considerations

Biological field studies would not be performed as part of the project. In recognizing the importance of the faunal communities in any oil spill vulnerability classification, however, we would incorporate published and unpublished data on coastal biota. On the basis of these pre-existing data, a biological susceptibility scheme would be superimposed on the residence time vulnerability classification derived from sedimentological studies.

Process Measurements

Oil spill vulnerability is, to a large extent, a function of physical process intensity, e.g., wave action and tidal range. Process variability within the study area would be assessed by (1) the morphologic response to processes, e.g., storm-tide lines, the degree of beach and berm development, etc., (2) hindcasting of storm wave energies, (3) direct measurements of wave heights, wave angles and longshore current velocities at the zonal sites, and (4) a thorough review of existing literature.

Analytical Methods

All sediment samples will be analyzed for grain size by sieving or with a settling tube. These data will be synthesized by computer and analyzed to determine grain size trends along the shorelines of the study area. All relevant vertical aerial photographs from available sources will be analyzed to determine long-term shoreline changes, especially any wave-induced changes.

Deliverable Products

A. Digital data:

Magnetic tapes of all sediment grain size analyses for both areas. Magnetic tapes of all beach profiles measured. Our current computer programs are already designed to meet OCSEAP requirements and have been verified correct by the NODC.

B. Narrative Reports:

We anticipate a number of publications related to this project, in addition to quarterly and annual reports.

C. Visual data:

Maps will be constructed as follows:

1. Beach morphology maps, which also display a coastal classification.
2. Application of our Oil Spill Vulnerability Index to the morphological base map.

D. Other non-digital data - None

E. Data submission schedule: All data collection will be done during June - August, 1979. Data will be submitted in quarterly reports. Expected final report date - April 1980. Digital data will be submitted with the quarterly report for December 1979.

Specimen Archival Plans:

All sediment samples are split prior to analysis and stored within the Department of Geology at the University of South Carolina.

Logistics Requirements

Most of the work could be done with a helicopter procured by NOAA and a Cessna 180 fixed-wing aircraft from a local flying service. A crew of three people plus pilot could do the data collection needed for the oil spill vulnerabilty map in about 3 or 4 weeks of working time. Approximately 4 hours of flight time per day are needed (more or less 100 hours total).

The exact area to be studied is shown on the map provided (Fig. 1). It encompasses the shoreline of Montague Island, the Kenai Peninsula from Latouche Island to the Chugach Islands. Stations will be set up at 10-15 km intervals along the shoreline. We would like to request the use of a Coast Guard station or similar space for use as a base of operations.

Anticipated Problems: None

Information Required from Other Investigators: None

Management Plans

All aspects of the project will be managed directly by the principal investigator and co-investigator. Field crews will consist of qualified graduate students using these projects for M.S. or Ph.D. problems.

Outlook

It is our desire to continue our regional studies of coastal morphology and sedimentation in all critical areas of the Alaskan coast. In particular, we would like to continue determining the relative vulnerability to oil spill impacts of the various coastal environments present.

In view of the present status of lease sales and potential offshore exploration, we feel that the southern shore of the Alaskan Peninsula between Cape Douglas and the Shumagin Islands would be a logical area to classify during FY '80. Funding required: Approximately $45,000.

The following guidelines will be adhered to:

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July and October. Annual reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studies, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Proeucts Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA Form 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached). Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgement is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office".

DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Sediment samples	1 tape	300	073	Yes	6/79 - 8/79	12/79
Beach profiles	1 tape	100	072	Yes	6/79 - 8/79	12/79

B. AIRCRAFT SUPPORT - FIXED WING

1. Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)

See enclosed map. Overflights will be made of the entire area.

2. Describe types of observations to be made.

Aerial reconnaissance and photography.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

June 15 - July 15, 1979. 4 day-long flights during periods of clear weather.

4. How many days of flight operations are required and how many flight hours per day?
4 flights - 8 hours each
Total flight hours?
32 hours total

5. Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback?

Yes, flights will last entire day; thus, piggybacking will be impossible.

6. What types of special equipment are required for the aircraft (non carry-on)?
None
What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.

7. What are the weights, dimensions and power requirements of carry-on equipment?

80 lbs. of cameras.

8. What type of aircraft is best suited for the purpose?

Cessna 180.

9. Do you recommend a source for the aircraft? Kenai Air Service. We have worked
If "yes", please name the source and the reason for your recommendation.
with this firm and their pilots previously with excellent results.

10. What is the per hour charter cost of the aircraft?

Approx. $100/hour

11. How many people are required on board for each flight (exclusive of flight crew)?
3

12. Where do you recommend that flights be staged from? Unknown at this time. Aircraft will be able to pick up wherever work is in progress at time of flight.

C. AIRCRAFT SUPPORT - HELICOPTER

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

See B1

2. Describe types of observations to be made.

Flights to sample locations, aerial reconnaissance

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

Projected field work dates are June 15 - July 15 - 1979.

4. How many days of helicopter operations are required and how many flight hours per day? 28 days, 4 hours a day total approx. 100 hours.

Total flight hours?

100 hours

5. How many people are required on board for each flight (exclusive of the pilot)?

3

6. What are the weights and dimensions of equipment or supplies to be transported?

Cameras and sampling gear - 100 lbs.

7. What type of helicopter do you reommend for your operations and why? Unknown, any helicopter capable of numerous beach landings with 3 persons, crew and 100 lbs of gear.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

No

9. What is the per hour charter cost of the helicopter?

NOAA helicopter

10. Where do you reommend that flights be staged from?

Unknown at this time.

11. Will special navigation and communications be required?

No.

D. QUARTERS AND SUBSISTENCE SUPPORT

1. What are your requirements for quarters and subsistence in the field area? (These requirements should be broken down by (a) location, (b) calendar period, (c) number of personnel per day and total man days per period).

   We are requesting a Coast Guard station or similar lodging location within the study area. Our field crew will consist of 3 persons for 5 weeks, June 15 - July 15, 1979.

   84 man days Suggested base of operations, Seward, Alaska.

2. Do you recommend a particular source for this support? If "yes", please name the source and the reason for your recommendation.

   No.

3. What is your estimated per man day cost for this support at each location?

   Unknown at this time.

   How did you derive this figure, i.e., what portion represents quarters and what portion represents subsistence and is the figure based on established commercial rates at the location or on estimated costs to establish and maintain a field camp?

E. SPECIAL LOGISTICS PROBLEMS

1. What special logistics problems do you anticipate under your proposal and how do you propose that the problems be solved? (Provide cost estimates and indicate whether you propose handling the problems yourself or whether you must depend on NOAA to solve them for you?

   None

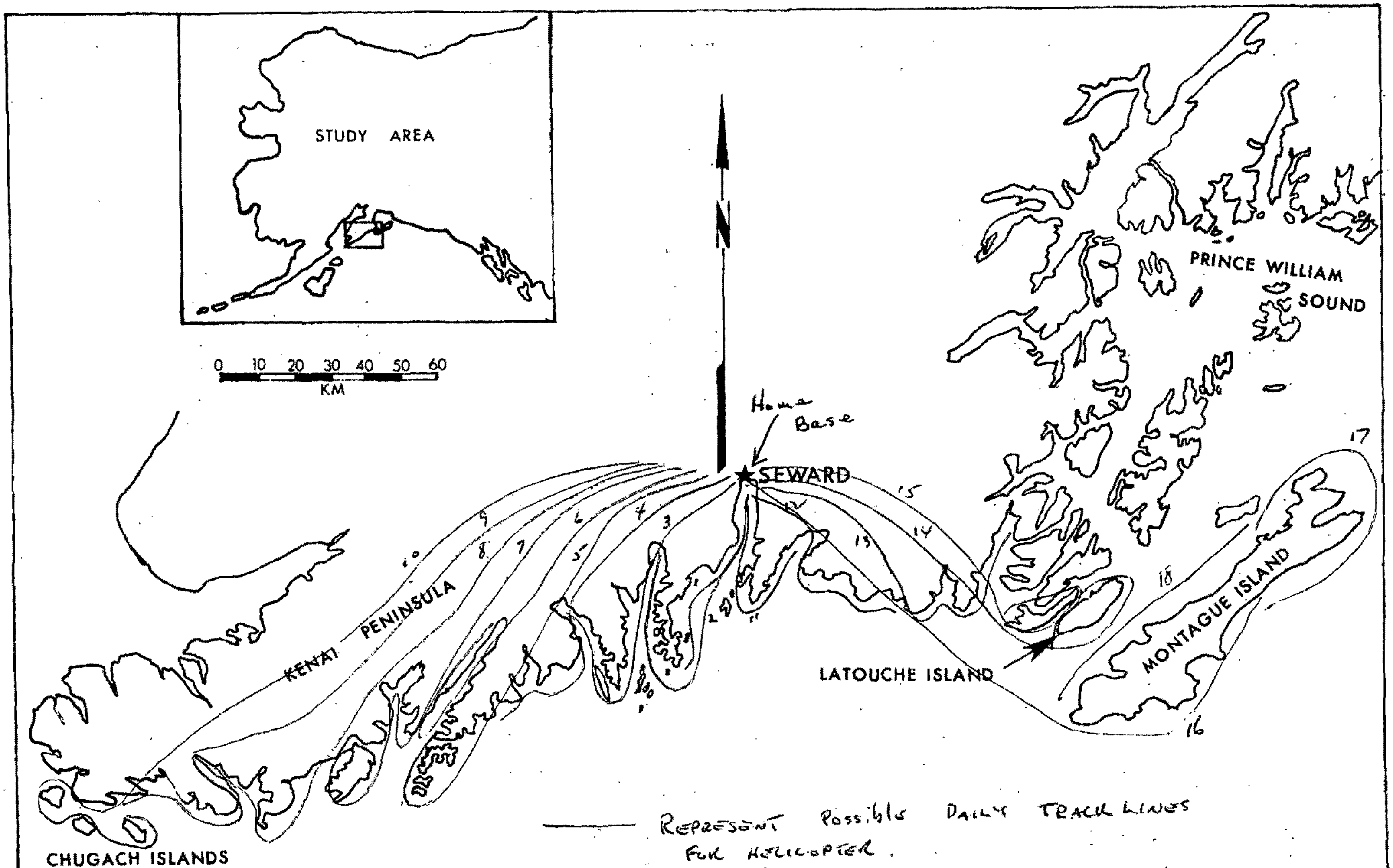

Figure 1. Study area.

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 59 PI: Miles O. Hayes, Christopher H. Ruby

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

		1978					1979											1980	
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
Montague and Kenai Field work									X	X									
Analysis of grain size data											X			X					
Submission of grain size data															X				
Analysis of beach profiles											X			X					
Submission of beach profiles															X				
Submission of Final Report																			X

A.

PROPOSAL NO.: UCSD- 1294

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA

University of California, San Diego

La Jolla, California 92093

Telephone (714) 452-4570

PROPOSAL FOR RESEARCH TO BE CONDUCTED UNDER THE SPONSORSHIP OF

U.S. DEPARTMENT OF COMMERCE, NOAA

TITLE OF PROPOSAL: EFFECTS OF OILING ON SEA OTTERS IN NATURE.

Research Unit 71

PROJECT PERIOD: 1 year From: 10/1/78 Through: 9/30/79

AMOUNT REQUESTED: $52,733

AGENCY CONTRACT OR GRANT NO.: NOAA 03-7-022-35130

PRINCIPAL INVESTIGATOR:
(NAME, TITLE, ADDRESS & TELEPHONE)

Dr. Gerald L. Kooyman
Research Physiologist
Physiological Research Laboratory
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, California 92093
(714) 452-2091

Make checks payable to The Regents of the University of California and mail to Accounting (Fiscal) Officer, UCSD

OFFICER TO WHOM AWARD DOCUMENTS SHOULD BE MAILED:

N. J. Sattler
Assistant Manager
Contract and Grant Administration, A-010

Signature G. L. Kooyman Date: 8/23/78
Typed Name & Title: Gerald L. Kooyman, Research Physiologist

Signature F. N. White Date: 8/23/78
Typed Name & Title: Fred N. White, Director, PRL

OFFICIALS AUTHORIZED TO SIGN FOR INSTITUTION:

Signature William A. Nierenberg Date: 8/25/78
Typed Name & Title: William A. Nierenberg, Director
Scripps Institution of Oceanography, UCSD

Signature Date:
Typed Name & Title:

(71475 1/79)

C. Technical Proposal Form

I. *Title and Task Statement Number*

Effects of Oiling on Sea Otters In Nature
Research Unit Number : 71
Contract Number: Renewal of 03-7-022-35130
Proposed Dates of Contract: 10/1/78 - 9/30/79

II. *Principal Investigator(s)*

Dr. G.L.Kooyman

III. *Cost of Proposal*

A. Science - 36,590.
B. Logistics - 8,880.
C. Total - 45,470. (w/o overhead)

IV. *Background: Outline the relationship and relevance of the proposed research to other scientific efforts in the area of interest, and how the proposed work relates to research previously conducted.*

Sea otters are a conspicuous and ecologically important member of the nearshore fauna throughout much of the Alaskan coast (Kenyon 1969). Sea otters act as a keystone predator maintaining the structure and composition of the nearshore shore communities they inhabit (Estes and Palmisano 1975; Lowry and Pearse, 1973). It is likely that sea otters living in the coastal margins near oil development will come in contact with and be impacted by crude oil. Any oil spill which significantly reduces the population of sea otters is also likely to result in a change in the nearshore community, by reducing or eliminating the sea otters foraging pressure (Simenstad et al., 1978).

We have found that crude oil contamination impacts sea otters by increasing their heat losses to the environment by reducing the insulating quality of their fur (Kooyman and Costa, 1978). An increased heat loss results in a higher energy maintenance cost, which requires an increased food consumption.

The ability of sea otters to survive oil contamination, and withstand both the thermoregulatory stress and an increase in their already high food consumption (23.5% of their body weight daily (Costa,1978), in nature is unknown. Siniff et al. (1977) has conducted some preliminary investigations into the effects of oil contamination in free ranging otters. However, they have only oiled a very small portion of the sea otters back with a very large (25 ml) amount of crude oil. Oil contamination in the wild is not comparable to their oil application method. The results from more realistic oilings may be interfaced with available sea otter population data in order to predict the impact of an oil spill in any sea otter habitat (Schneider 1976a, 1976b, 1975 and Calkins Pitcher and Schneider, 1975).

V. *Objectives: List the most important objectives of this research project. Indicate specifically the relevance of these objectives to an environmental assessment of the Alaskan Continental Shelf that will provide information for decision making during leasing and development.*

1. Quantification of the behavioral responses of oil fouled sea otters under natural conditions.

A. To determine if sea otters can withstand crude oil contamination in the field.

B. Measurement of the alteration of the normal activity patterns in oil fouled sea otters.

C. Determination of the length of time required for the oil fouled sea otters behaviour to return to normal.

2. To record the normal diving patterns of free ranging sea otters, with respect to the depth of subtidal habitats utilized, which might be effected by an oil spill.

3. To assess the sea otter population in Prince William Sound, with respect to areas most susceptible to oil spills.

These objectives will provide a data base from which estimates of the impact of oil contamination may be derived for any sea otter population given; the sea otter density, distribution and information concerning the severity of spill and possible drift pattern.

VI. *General Strategy: Discuss your strategy to meet the objectives described in the task statement.*

Our previous research has shown that oil has an impact on sea otters by increasing their energy utilization due to the increased heat lost to the environment as a result of pelage contamination. In order to maintain this elevated energy utilization, sea otters must increase their food consumption by a proportional amount. In nature sea otters may not be able to survive the increased thermoregulatory stress while increasing their rate of food consumption. Kenyon (1974) noted that malnutrition was common in contaminated fur seals. Finally we would anticipate direct effects of oil ingested while the otters groom. This proposed research will extend our previous physiological research to the field and will directly investigate the behavioral effects of oil contamination upon sea otters in nature.

1) The behavioral responses of sea otters to oil contamination will be investigated by comparing the activity patterns of 5 oiled and at least 10 control sea otters recorded by radio telemetry. Sea otters will be captured using tangle nets. We have used these nets with great success in Constantine Harbor, Prince William Sound Alaska. We do not anticipate any problems capturing sea otters. The netted sea otters will be anesthetized with gas anesthesia and a radio telemetry collar attached. Control animals will then be released and radio tracked for about two weeks. After attachement of a radio collar experimental animals will be brushed with up to 60 mls of crude oil, covering no more than 50% of the dorsal surface. These animals will be radio tracked in a similar fashion as controls. Duration of tracking will depend on the health of animals. Recapture attempts will be made to assess the condition of the sea otters pelt. Three distinct behavior patterns, resting, foraging and grooming can be distinquished on the event recorder. During the daylight hours observations will be made to validate the recorded telemetry patterns with the animals behavior.

2) The depth of dive of 5 free ranging sea otters will be monitored by attaching solid state dive depth recorders. These units are currently under development in our lab and will be ready by next summer. The recorders will measure the depth of the first, 64 dives. A timing device will cause the collar to be released from the otter at a precise time from 1 to 72 hours after attachment. Actual release time will be predicated upon field observation. Upon release we will then

recover the floating collar and depth recorder. An attached transmitter will aid in collar recovery, as well as record the animals' activity patterns during the experiment.

We tested a telemetry collar and a mock depth recorder in Constantine Harbor, Prince William Sound Alaska this summer. Both collars were recovered with little difficulty because the location of the otters was known for the majority of the time.

3) An assessment of the sea otter population in Prince William Sound, Ak. will be continued by Helicopter or fixed wing plane. The coastline will be visually observed and the number of sea otters recorded on U.S.Coast and Geodotic Survey Charts. From these data we will be able to predict how many sea otters may be impacted by an oil spill in the Prince William Sound area. The methods derived to estimate the impact of an oil spill on otters in Prince William Sound should be useful to derive the impact of an oil spill to sea otter populations in other areas.

VII. *Sampling Methods: Describe your temporal and spatial sampling scheme and the supporting rationale. What statistical measure of sampling adequacy will be used? (Complete only if applicable).*

A total of 5 experimental (oiled) and 15 control (5 diving behavior and 10 activity pattern) animals will be studied. The mean time spent grooming, resting and foraging will be calculated for each animal. The mean times observed for control and experimental animals will be compared by the student's two sample t-test. Sea otters require a U.S. Fish and Wildlife permit to capture. Our permit allows us a total of 25 animals, 5 of which can be oiled. During July we captured 4 animals under this permit. Therefore, we can only capture 21 animals during the 1979 field season.

VIII. *Analytical Methods: What methods of analysis are contemplated? Provide literature references. (Complete only if applicable).*

IX. *Anticipated Problems: Discuss any anticipated major difficulties associated with the task and recommend solutions.*

As with any field project weather is our biggest concern. Given reasonable weather we anticipate no major problems completing the project. We have tested our radio transmitters, collars receivers and capture equipment and we do not forsee any major problems.

X. *Deliverable products: Identify products to be generated as a result of this project.*

This project will produce a narrative report containing a thorough description of all procedures used and of all measurements taken during physiological studies of sea otters. The final report will include an analysis of prior fur seal research, studies of oil pollution effects on marine mammals by other investigators, and recommendation for future research.

Progress of this project will be reported on every 3 months unless special problems require more frequent reports.

XI. *Information Required from Other Investigators.*

Describe data required from other investigators to carry out your proposed work.

No new data are required of other researchers to successfully complete the proposed work. Research presently reported in the literature will be reviewed for comparison studies.

XII. *Quality Assurance Plans*

Briefly describe procedures and/or methods and schedule to be used for the calibration and intercomparison of instruments, techniques and analytical results.

The dive-depth recorders will be calibrated in a specially fabricated pressure vessel at the Physiological Research Laboratory prior to use in the field. The telemetry patterns on the event recorder will be compared with the observed sea otter behaviors.

XIII. *Special Sample and Specimen Archival Plans*

If, as part of this study, samples are collected which should be kept for future reference (e.g., core samples) describe the number of samples, special storage conditions, location of the archive, annual cost of archive, etc.

No specific samples will be collected which should be kept for future reference.

XIV. *Logistics Requirements: If the PI proposes to furnish logistics support, cost chargeable to the OCSEAP should be clearly identified in the Cost Proposal Form, Section CPF-4a. If the program subsequently furnishes the support, these charges can then be easily removed. If logistics support is not to be provided otherwise but will be provided by the program, then the estimated costs of logistics support to be provided by OCSEAP should be included in Section CPF-4b of the Cost Proposal Form. Questions regarding the form should be directed to the Project Office Logistics Coordinators (907) 586-7438 (Sub-Arctic), and (907) 479-7371 (Arctic). The OCSEAP Logistics Officer in Boulder is at (303) 499-1000 ext. 6562 (FTS 323-6562).*

We will supply transportation of equipment to Cordova Alaska and will supply all necessary field equipment (i.e. tents, cooking gear, receivers etc.). We will require from OCSEAP transportation of the field equipment and personnel from Cordova, to the field sites in Prince William Sound, (Port Etches, and Snug Corner Cove). We will also require a 21ft Boston Whaler or similar boat to conduct the field research. In addition we are requesting OCSEAP to provide air support for the sea otter population surveys in Prince William Sound

XV. *Management Plan: Briefly describe how you will manage your project. Also provide an Activity/Milestone chart.*

Dr. Daniel Costa, Postgraduate Research Physiologist (Associate Investigator) shall actively lead and supervise the proposed work with the advice and assistance of Dr. G.L.Kooyman.

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION Scripps Institution of Oceanography PRINCIPAL INVESTIGATOR Gerald L. Kooyman

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.
Chart Supplied

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible. The boat will be used to capture radio tag and truck sea otters. The boat will also serve as our means of transport to and from Cordova.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)
We need the boat from mid June thru August or mid September.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

N/A

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?

Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.

We need complete automony over boat operation.

6. What equipment and personnel would you expect the ship to provide?
Main outboard motor, and auxillary 10-20 hp outboard motor, gasoline tanks, gasoline in 55 gal drums, gas pump for 55 gal cans.

7. What is the approximate weight and volume of equipment you will bring?
Approximately 10 m^3 500/kg.

8. Will your data or equipment require special handling? _____ If yes, please describe.

N/A

9. **Will you require any gases and/or chemicals?** No **If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge.**

10. **Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.**

    No

11. **If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability?** .

12. **How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.**
    Boat must be capable of safely transporting 5 individuals. Daniel Costa Ph.D.; Gerald Kooyman,Ph.D and 2 unnamed field assistants

B. AIRCRAFT SUPPORT - FIXED WING

1. Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)
5 flights from Cordova to Pt. Etches, Hinchinbrook Island to bring in supplies initially and to restock field camp as necessary. (No more than 1 round trip flight every two weeks).
2 flights from Cordova to Snug-Corner Cover, Pt. Fidalgo.

2. Describe types of observations to be made.
Carry in personnel and field supplies

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)
The flights will take place during June 15 to September 15. 1979

4. How many days of flight operations are required and how many flight hours per day?
7 flight days
Total flight hours?
4 hrs or less per day

5. Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback?
Only our equipment and personnel can be transported

6. What types of special equipment are required for the aircraft (non carry-on)?
N/A
What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.
N/A

7. What are the weights, dimensions and power requirements of carry-on equipment?
N/A

8. What type of aircraft is best suited for the purpose?
De Hairlund Beaver

9. Do you recommend a source for the aircraft? Yes
If "yes", please name the source and the reason for your recommendation.
Sea-Airmotive Cordova Ak. A private charter allows us the flexibility to choose the time and date of our flights dependent upon the needs of the expedition.

10. What is the per hour charter cost of the aircraft?

11. How many people are required on board for each flight (exclusive of flight crew)?
Maximum of 4 people

12. Where do you recommend that flights be staged from?
Cordova, Alaska

C. AIRCRAFT SUPPORT – HELICOPTER

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed). Field camp site designated on chart
We need to cover as much of the coastline in Prince William Sound as possible.

2. Describe types of observations to be made.
Survey of sea otter populations and habitat types

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?
Observations can be made during any time from: June 15 - August 15, 1978

4. How many days of helicopter operations are required and how many flight hours per day? 14 days at 2-3 flight hours per day

Total flight hours? 35 flight hours

5. How many people are required on board for each flight (exclusive of the pilot)?
3

6. What are the weights and dimensions of equipment or supplies to be transported?
150 lbs, 2 camera cases, 2" x 2' x 3'.

7. What type of helicopter do you reommend for your operations and why?
The Bell 206 is a low noise aircraft with good visibility for census work.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.
No.

9. What is the per hour charter cost of the helicopter?

10. Where do you reommend that flights be staged from?
Cordova as the main base, for some surveys we may need to refuel or work out of Valdez, Whittier and San Juan Fish hatchery, Evans Island.

11. Will special navigation and communications be required?
A 3 person intercom system would be desirable for communication between pilot and observer and observer-recorder.

Sea Otter Survey Prince William Sound Alaska

Proposed flights for sea otter survey assuming 2-3 hours per leg. Refer to National Ocean Survey Chart 16700.

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leg 1	Hinchinbrook Island
leg 2	Hawkins Island and Pt. Gravina to Cordova
leg 3	Montague Island; Gulf side
leg 4	Montague Island; Sound side and Green Island
leg 5	Knight Island
leg 6	Knight Island
leg 7	Cape Puget to Whale Bay, Bainbridge, Evans, Erlington and Latouche Island,
leg 8	Whale Bay to Kings Bay
leg 9	Kings Bay to Whittier
leg 10	Whittier thru College Fiord to Esther Island
leg 11	Esther Island to Columbia Glacier; including Glacier Island
leg 12	Columbia Glacier to Valdez
leg 13	Valdez to Pt. Gravina
leg 14	Naked Island and Perry Island

Total projected flight time 35 hrs., allowing 14 days to complete survey.

Activity/Milestone Chart

October, 1978

Renewal of the contract.

October 1978 to May 1978

Complete analysis of metabolic data, prepare radio telemetry collars and finish construction of depth-recorders. Prepare equipment for field season.

June-September 1979

Field research on sea otters in Prince William Sound, Alaska.

September 1979

Prepare final report.

XVI. *Outlook: Assuming that the research proposed for FY78 is successfully carried out, please outline the remainder of the research effort which is required to complete the work or to reach the first major plateau of accomplishment before changing direction. This should be less detailed than the FY78 proposal, but should include a rough estimate of:*

1. The nature of the final results and data products.

The final results of this project will yield an assessment of the impact of crude oil contamination on free-ranging sea otters. These data will be integrated with our quantitative physiological information to give an overall synthesis of the effects of oil contamination on sea otters.

2. Significant milestones.

A. Completion and analysis of the general metabolic data.

B. Construction of dive-depth recorders.

C. Acquisition of all necessary field equipment.

D. Field:

1. Successful radio tracking of 10 control animals
2. Successful tracking of 5 experimental animals
3. Successful recovery of 5 depth-recorders
4. Time permitting move to Snug Corner Cove to continue work with depth recorders

E. Preparation of final report.

3. Cost by fiscal year.

About $52,733./year.

4. Additional major equipment required.

Depth recorders
Radio-telemetry receivers and digital scanner
Telemetry transmitters
Event recorders

5. *Location of future field efforts (if applicable).*

   Prince William Sound, Alaska

6. *Logistics requirements, if they are expected to differ greatly from FY78.*

Transportation of field equipment from Cordova Alaska to field sites at Pt. Etches (Prince William Sound,Ak.). From Pt. Etches to Snug Corner Cove from Snug Corner Cove to Cordova. We will need a boat to conduct our research from June 15, 1979 thru August 15, 1979. Preferably we would like a 21 ft. Boston Whaler, with a canopy. A boat of this type is absolutely necessary for completion of this project. In addition we will require 55 gal. drums delivered to our field camps at Constantine Harbor and Snug Corner Cover. The number of oil drums will depend on the type of boat supplied.

We will need a helicoptier or fixed wing aircraft to survey the sea otter population in Prince William Sound. We would prefer a helicopter due to the greater visibility and ease of counting animals. Ideally helicopter should be available at the beginning of the field project.

XVII. 1. Updated Activity/Milestone/Data Management Charts will be submitted quarterly.

2. Quarterly reports will be submitted in sufficient time during the contract year to be in OCSEAP hands by the first day of January, July, and October, annual reports by April 1. The Final Report will be submitted within 90 days of the termination of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labelled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are used, and sexes where these are morphologically distinguishable.

4. At the option of the Project Office the PI (or Associate Investigator) is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or 3 month data collection period, unless a written waiver has been received from the Project Office. This does not apply to report requirements (see par. 2).

7. Within 10 days of the completion of a cruise or data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract termination.

9. Three (3) copies of all publication or presentation manuscripts pertaining to technical or scientific material developed under OCSEAP frunds will be submitted to the appropriate Project Office at least sixty (60) days peior to release for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgement is standard.

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

D. Cost Proposal (See Attached form)

Cost-reimbursement or cost-plus-fixed-fee type contract is contemplated. The Government reserves the right to determine and select the final contract type, and effect any such negotiations as the Contracting Officer may conclude are necessary. The OCSEA Program operates on a Federal Fiscal Year (October 1 thru September 30 of the following year). Normal funding procedure will be on a 12 to 18 month basis. Budgets submitted for work other than a 12-month period (i.e. work spanning fiscal years) must be broken out to show funds required to each Federal Fiscal Year. If this research unit is utilizing non-federal government-owned equipment which has a high risk of loss, you may budget for replacement equipment to cover against possible loss. This equipment must be separately listed and budgeted. (Approval to purchase replacement equipment must be received from the Project Office.)

RFx41-71-598

SEP 20 1978

Dr. Gerald Kooyman
Dr. Daniel P. Costa
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093

Reference: OCSEAP Research Unit 71

Dear Drs. Kooyman and Costa:

Your FY 79 renewal proposal, entitled "Effects of Oiling on Sea Otters in Nature", has been reviewed by the Juneau Project Office. The proposal is approved at a funding level of $52,773, contingent upon your agreement to the following revisions.

A. Section V, Objectives, should be rewritten as follows:

1. To analyze the responses of an otter which becomes covered with crude oil after a spill. Specifically,

a. To determine if death from exposure is iminent following contamination of up to 25 percent of the otter's surface area;

b. If death does not occur, to determine whether normal activity patterns (resting, foraging, grooming) are altered;

c. If normal activity patterns are altered by oiling, to determine the time required for them to return to normal.

2. To record the normal diving patterns of free ranging sea otters, with respect to the depth of subtidal habitats utilized, which might be effected by an oil spill.

3. To draw conclusions, on the basis of existing information about Alaskan otters and the experiments conducted in this RU, about

a. the number of otters likely to be killed directly from oiling, per kilometer of oiled coastline or square kilometer of nearshore area;

b. the survival potential of otters that are residents of an impacted area but escape direct contamination or are oiled only to a sublethal degree. Given their feeding behavior and range, and the concentrations of otters in Alaska, will these otters be able to find enough food in the impacted area to meet metabolic demands, or to reestablish themselves in an adjacent area?

c. potential to capture and rehabilitate oiled otters.

B. Under Section VI, General Strategy, No. 3 (relating to Objective 3) should be rewritten as follows: To determine the number of sea otters likely to be impacted by oil, the information collected under objectives (1) and (2) will be correlated with knowledge of the location and density of sea otters along the Alaskan coastline. For the Prince William Sound area, an assessment of the sea otter population will be made by helicopter or fixed wing plane. The coastline will be visually observed and the number of sea otters recorded on U. S. Coast and Geodetic Survey charts. For the Lower Cook Inlet and Kodiak/Southern Bering areas, the sea otter populations will be assessed using existing information, including that collected by OCSEAP RU's 240 and 241. Thus, the thoroughness and accuracy of the assessment for these areas will depend on the quality of the existing information.

C. Section X, <u>Deliverable Products</u>, should be rewritten as follows:

This project will produce a final report containing

1. All experimental procedures used during (a) evaluation of the effects of oiling on oxygen uptake in California otters maintained at Scripps; (b) evaluation of alterations in Alaskan sea otter behavior caused by oiling in the field;

2. analysis of the effects of oiling on oxygen uptake in confined California otters, and the reduction in survival ability of these otters as a result of oiling.

3. conclusions regarding (a) the likelihood that Alaskan otters oiled in the wild will die immediately, and (b) if not, any changes in their normal activity patterns, caused by oiling and the effects these changes may have on their longer-term survival potential;

4. assessment of the sea otter populations in the Prince William Sound area, and to the greatest extent possible given the quality of existing information, of the populations in Lower Cook Inlet, Kodiak, and the southern Bering areas,

5. Conclusions regarding the number of otters likely to be impacted by oil in these areas, either through direct death or displacement from their normal habitats.

D. The cost proposal should be altered as follows:

1. Under CPF-2, car rental for four days should be increased from $100 to $300;

2. under CPF-3, the tent should be increased from $500 to $600;

3. Under CPF-3, the 12-gauge shotgun should be deleted. OCSEAP will provide one.

The final funding commitment and level are contingent on approval of the FY 79 OCSEAP budget by the Bureau of Land Management.

If you have questions concerning any of the above guidance, please phone Lois Killewich in the Juneau Project at Office(907)586-7441.

Your letter agreeing to these changes must be sent to and received in the Juneau Project Office, with a copy to Boulder, no later than September 25, 1978. If there are extenuating circumstances which prevent you from meeting this schedule, pleaase phone the Project Office.

Upon receipt of you work statement, revised in accordance with the above guidelines, we will initiate contracting procedures for FY 79. I look forward to your continued involvement in our program.

Sincerely,

Herbert E. Bruce, Ph. D.
Bering Sea-Gulf of Alaska Project Manager

cc: Program Office

Title: Lethal and sublethal effects on selected Alaskan marine species after acute and long-term exposure to oil and oil components. OCSEAP Research Unit #72.

Principal Investigators:

Stanley D. Rice
John F. Karinen
Sid Korn
(in collaboration with William D. MacLeod)

Total Cost of Proposal: $135.0k

Period of Work: October 1, 1978 to September 30, 1979.

Institution and Department:
Auke Bay Laboratory, Northwest and Alaska Fisheries Center, Physiology-Bioassay Section (in collaboration with the NOAA National Analytical Facility in Seattle, Washington under the Direction of William D. MacLeod).

Required Signatures:

Principal Investigators

Name Stanley D. Rice Date July 25, 1978

Name John F. Karinen Date July 25, 1978

Name Sid Korn Date July 25, 1978

Address: NOAA, National Marine Fisheries Service
Auke Bay Laboratory
P.O. Box 155
Auke Bay, Alaska 99821

Telephone Number: 789-7231

Required Organization Approval

Name [illegible] Date 28 July 78

Address:

8/8/78

Telephone Number:

Organization Financial Officer

Name ________ Date ________

Address:

Telephone Number:

Technical Proposal

I. Title and Task Statement Number

Lethal and sublethal effects on selected Alaskan marine species after acute and long-term exposure to oil and oil components.
OCSEAP Research Unit #72.

II. Principal Investigators

Stanley D. Rice
John F. Karinen
Sid Korn

III. Cost of Proposal

A.	Science	$135k
B.	Logistics	-0-
C.	Total	$135k
D.	Geographic distribution	Not Applicable

IV. Background: Toxicity and uptake-depuration tests have been completed at our lab with several subarctic species. The subarctic species are generally more sensitive than similar species in warmer environments. Temperature is suspected to be the major cause rather than specific differences because temperature has been found to affect the persistence of oil in static bioassays and to affect the physiological response of the animal. The animals respond differently to temperature (e.g., pink salmon fry were more sensitive at lower temperatures while shrimp were more sensitive at higher temperatures) and not equally to each component of the WSF.

Much less is known about the response of arctic species to oil, since arctic species have rarely been tested in quantitative bioassays. From our earlier temperature-oil studies with subarctic species, we think that several of the arctic species may be far more sensitive to the oil than subarctic animals, because of the temperature differences between subarctic and arctic environments. This proposed study will test the sensitivity of selected arctic species to oil WSF and pure aromatics at normal arctic temperatures. Uptake-depuration tests will also be conducted. Ultimately, we plan to assess the relative vulnerability between subarctic and arctic species.

The proposed studies are basically continuations of our previous contract but with arctic species. We have chosen the approach of collecting arctic animals and transporting them to our facility at Auke Bay, rather than attempting to establish a field station and wet lab in the arctic environment. This approach has the advantages of lower cost, availability of immediate chemical and isotope analyses, and the utilization of elaborate flow-through dosing devices with a proven record of successful functioning. In 1976 we successfully transported several species of arctic fishes from Nome, Alaska to Auke Bay for testing and demonstrated that transportation of arctic species is feasible.

V. Objectives: We have developed objectives around three major themes.

A. Acute Toxicity: We will determine the acute toxicity of oil and oil components to representative arctic organisms and determine effects of low arctic temperature on toxicity (1.5 man years).

1. Determine the toxicity of Prudhoe Bay WSF, toluene, and naphthalene on about 10 species of arctic organisms including fish (3-4 species), shrimp (1-2 species), crab (1-2 species), other crustaceans (2-4 species), echinoderms (1-2 species), and molluscs (2-4 species). Tests will be flow-through. (Target species include: Fish - *Boreogadus saida*, *Eleginus navaga*, *Myoxocephalus quadricornis*, *Liopsetta glacialis* or *Platichthys stellatus*; shrimp - *Pandalus* sp., *Crangon* sp.; crab - *Chionoecetes opilio*, *Paralithodes camtschatica* or *Pagurus* sp. or *Hyas lyratus*; other crustaceans - *Thysanoessa raschii*, *Saduria entomon*, *Mysis relicta*, *Onisimus littoralis*; molluscs - *Macoma* sp., *Mya* sp., *Natica* sp., *Buccinum* sp., *Neptunea* sp.; echinoderms - *Strongylocentrotus pallidus*).

2. Determine effects of extreme summer and winter temperatures on the sensitivity of at least three species of arctic organisms (one fish, one shrimp, one mollusc) exposed to toluene, naphthalene, and oil WSF. Tests will be flow-through. (Target species include: *Boreogadus saida*, *Pandalus* sp., and *Natica* sp.).

B. Long-term Toxicity Studies: We will determine tolerance of 2-3 species to naphthalene and oil WSF using long-term flow-through exposures with stable concentrations. (1.4 man years).

1. Determine the survival of one species each of arctic fish, shrimp, and mollusc exposed to naphthalene and oil WSF. Exposures will be flow-through for 25-40 days. Size, ability to feed, response to handling, number available will determine the final species choice.

C. Uptake and Depuration Studies: We will determine the accumulation and depuration rates of oil and oil components at arctic temperatures with arctic animals (1 man year).

1. Isotopes: At different temperatures, determine the accumulation and depuration of radiolabeled toluene and naphthalene in three arctic organisms (one species of each of fish, shrimp, and mollusc). Tests may be static, but dose levels will be constant. Key tissues will be sampled and total metabolites determined.

2. Oil WSF: At one representative low temperature, determine the uptake-depuration of several aromatic hydrocarbons analyzed by GC-MS by NAF in Seattle. Oil exposures will be flow-through and for at least 10 days. Metabolite concentrations may be determined.

VI. General Strategy and Approach: The seasonal availability of animals is quite limited, and forces this research effort to be primarily a summer project. Consequently, the first two quarters of the fiscal year will be limited to planning logistics, preparation for field collecting, and maximizing our chilling capacity at the lab. We have based our cost estimates on the assumption that we will work through the Naval Arctic Research Laboratory (NARL) at Barrow. (Other alternatives such as working with ADF&G at Nome or Prudhoe Bay will be investigated). As soon as the ice is out of nearshore lagoon areas, we will send a collection crew of 2-3 people to Nome or Barrow or Prudhoe Bay for approximately 1-2 weeks; collection will be repeated each month of the summer. The area around Nome has a limited lagoon area where we have previously collected animals. A few species can be collected there a few weeks before the lagoon areas at Barrow are ice free. Animals will be collected by small otter trawl, shrimp pots, and diving. Animals will be shipped in insulated boxes at low temperatures with battery powered aeration. Daily flights from Barrow make possible transit times of less than 10 h to Juneau. Shipments will be accompanied by one person to insure smooth transfer of the cargo to the Anchorage-Juneau flight. The wet lab will be modified to maximize our water chilling capabilities for holding and exposing animals at low temperatures. We can chill 25 gpm to 4°C in August, and most animals can be held at required low temperatures for 3-6 months. Experiments will begin in June and proceed through September 1979.

When the animals arrive, the acute toxicity will be tested, followed by uptake-depuration experiments on selected species. Finally, survival to long-term exposures will be examined. The results of these studies will be compared to similar studies on subarctic animals and conclusions drawn on relative vulnerabilities of arctic vs subarctic animals.

VII. Sampling Methods: Not applicable to laboratory tests.

VIII. Analytical Methods:

1. WSF:

   a. Gas chromatography--Cheatham et al. in preparation. Standard type GC method, but our column has been run in the GC-MS system at Seattle for verification of output.

   b. Gas chromatograph--mass spec. MacLeod. (Seattle lab may run some samples if needed).

   c. IR analyses by Gruenfeld 1973.

2. Pure compounds: (Toluene, naphthalene)

   a. UV spectrophotometry. (Neff and Anderson 1975)

3. Isotopes of pure compounds by liquid scintillation.

4. Tissue analyses:

   a. Isotopes by liquid scintillation.
      Total metabolites determined by method of Roubal.

   b. GC-MS for tissues exposed to WSF.
      (Seattle lab--MacLeod)

IX. Anticipated Problems: The greatest potential problem is acquiring sufficient numbers of organisms of the required age and size for extensive testing. Logistics, travel costs, and winter ice conditions will preclude reconnaissance trips to the field collecting sites to see what's there and test collection methods by trial and error. Extensive planning is required, and many contacts with local residents and scientists with previous arctic experience in the area will be made before spring. The target species identified are the priority animals that we will attempt to collect, but it may be impossible to collect sufficient numbers of each. We have had considerable experience collecting a variety of noncommercial species and do not expect insurmountable problems with collecting a variety of species in the nearshore area. To minimize these problems we will send experienced animal collectors to the field, and utilize local expertise for advice on locations for collecting. We will attempt to collect target species in the nearshore areas, and if they are not available, we will rely on alternate species. We will investigate the feasibility of offshore collecting of species not available nearshore; suitable large vessel logistic support may be required.

The transportation logistics, are relatively simple, and have been worked out. We have transported fish, crabs, shrimp, and lower invertebrates great distances (up to 48 h) with little problem so long as the animals are packed correctly and somone insures that the shipment makes the plane connections. We will use insulated boxes, battery-operated air pumps, ice, and plane connections using less than 10 h of transit time.

The studies we propose require no R&D; the flow-through devices have been tested, and biological measurements have been done before.

X. Deliverable Products. In addition to required quarterly and annual reports, our data will be presented in scientific journals as reviewed publications.

XI. Information Required from Other Investigators: We require specific information on organism abundance and distribution in the arctic from other OCSEAP investigators and will solicit advice from NARL and OCSEAP scientists on collecting techniques and locations. We have and will continue to have coordination meetings and information exchanges with the Seattle NMFS Lab (Malins, RU #73), Tiburon Lab (Whipple, RU #389), and with Anderson (RU #454).

XII. Quality Assurance Plans: Our gas chromatograph column and WSF have been run in the GC-MS system at Seattle (MacLeod). Any new procedure or column will be verified through the Seattle Lab.

XIII. Special Sample and Voucher Specimen Archival: We will continue to archive samples of newly tested species in case the taxonomy becomes a problem at a later date.

XIV. Logistics Requirements: See anticipated problems. If we work out of Barrow, we will arrange with NARL for lodging, boats, and other logistical support. If OCSEAP requires tests with arctic cod and euphasids, offshore trawling may be necessary. This plan makes no provision for offshore logistic support by large vessel.

XV. Management Plan: We currently plan our projects at three levels. At the General level, as in proposals such as this, objectives are stated, and enough planning to determine feasibility, costs, and allocation of resources. Detailed Plans are drawn for each individual study. Experimental details are given, as well as logistical problems with space, collection of animals, personnel, etc. These plans are reviewed by our senior staff (Karinen, Rice, Korn, Lindsay, and others) to see if the plans are adequate, feasible, scientifically sound, and compatible with the use of the available facilities. Weekly Meetings schedule the next week's activities and coordinate the chemistry laboratory analyses with the wet laboratory tests. Allocation of support help is made at this time.

Individual laboratory technicians are all monitored by a senior staff person. Some functions are specialized, such as water analyses. We operate four service functions within our section: chemistry laboratory analyses (quality control by Lindsay); wet laboratory mix generation-cleanup (quality control by Korn); animal collection for all tests coordinated through Budke; and data management-statistics by computerized probits done by Misch.

Detailed Plans for each study are due 60 days before the study begins and no later than December 15. This allows ample time for specialized construction, ordering of materials, and scheduling of experiments. When a unit of work is completed, a report with methods and results is due within 2 weeks. Manuscript assignments are then made.

XVI. Future Research Needs: The need for acute toxicity scans will have dwindled considerably once the arctic species have been tested. There will still be a need for finding concentrations that are harmful but sublethal, and these tests will require flow-through exposures for long periods of time. We believe that the experiments involving temperature and salinity have only scratched the surface. The effects of temperature vary considerably with the toxicant and the species. There is a continuing need for further studies on synergistic effects between different oil compounds and between compounds and environmental temperature-salinity interactions. The single most important need for laboratory studies is more long-term studies. Are the concentrations that cause adverse effects in long-term studies substantially lower than those that cause adverse effects in short-term studies?

XV. Milestone Chart

	1st. quarter	2nd. quarter	3rd. quarter	4th quarter
I. FY 78 Research Goals		Manuscript Synthesis		
II. FY 79 Research Goals				
A. Planning, logistics, animal collection	contact NARL plan logistics	Assemble collection gear modify wet lab for max. chilling	Collect animals	Collect animals
B. Acute Toxicity			Begin Tests	Tests
1. Determine the toxicity of oil components on arctic animals				
2. Determine effects of toxicity of oil and oil components to arctic animals				Test
C. Long-term Oil Exposures				Start Tests
1. Determine survival to long-term oil exposures				
D. Uptake and Depuration Studies			Begin Tests	
1. Determine accumulation and depuration in arctic animals				
2. Determine effects of temperature on uptake				

There is a need to verify the acute and sublethal effects of oil exposure in the field. Although controlled spills are one means of obtaining this information they are costly and approval is difficult to obtain.

Certain controlled field experiments can provide specific data on growth, survival, settling success of larvae, and avoidance of oil contaminated areas. The need to determine the settling success of invertebrate larvae is especially important. It is our plan to apply the concepts of placing movable control and contaminated substrates into the field to monitor settling success and avoidance, and of collecting substrate from the field with recently attached invertebrates which will be exposed to various oil concentrations and returned to the field to monitor survival and growth. The latter type of exposure duplicates a situation which may happen in many spills where exposure to oil is of short duration. The relative abilities of settling organisms from various clean and contaminated areas to survive oil exposures could also be tested by this means.

XVII. 1. Updated Activity/Milestone/Data Management Charts will be submitted quarterly.

2. Quarterly reports will be submitted in sufficient time during the contract year to be in OCSEAP hands by the first day of January, July, October, annual reports by April 1. The Final Report will be submitted within 90 days of the termination of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labelled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when they are used, and sexes where these are morphologically distinguishable.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs for the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or 3 month data collection period, unless a written waiver has been received from the Project Office. This does not apply to report requirements (see par. 2).

7. Within 10 days of the completion of a cruise or data gathering effort a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract termination.

9. Three (3) copies of all publication or presentation manuscripts pertaining to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgement is standard.

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

TO: OCSEAP
Bering Sea-Gulf of Alaska
Project Office
Juneau, Alaska

Proposal/Revision Date: 6/22/78
Contract #: R 7120819
NOAA Project #: FR1600/88C2U
Institution ID#: RB1000

FY 1979 RENEWAL PROPOSAL

Research Unit Number 73
TITLE: Sublethal Effects of Petroleum, Including Biotransformations, as Reflected by Morphological, Chemical, Physiological, Pathological, and Behavioral Indices
Cost of Proposal: $258.0 K   Lease Area: Non-Area Specific Lab. Studies
Period of Proposal: October 1, 1978 through September 30, 1979

PRINCIPAL INVESTIGATOR(S):

Name DONALD C. MALINS   Date 6/22/78
Signature Donald C. Malins
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Telephone Number: 442-7737   FTS: 399-7737

Name HAROLD O. HODGINS   Date 6/22/78
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Name NEVA L. KARRICK   Date 6/22/78
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Name DOUGLAS D. WEBER   Date 6/22/78
Signature Douglas D. Weber
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INSTITUTION:

Environmental Conservation Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration

REQUIRED ORGANIZATION APPROVAL:

Name DAYTON L. ALVERSON   Date 6/26/78
Signature A. S. Porter
Position Director, Northwest & Alaska Fisheries Center
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ORGANIZATION FINANCIAL OFFICER:

Name Edward B. Eshe   Date
Signature N/A
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Address 1700 Westlake Avenue North, Seattle, WA 98109
Telephone Number 206/442-1760

3. Technical Proposal

I. TITLE: Sublethal Effects of Petroleum, Including Biotransformations, as Reflected by Morphological, Chemical, Physiological, Pathological, and Behavioral Indices

RESEARCH UNIT NUMBER: 73

CONTRACT NUMBER: R7120819

PROPOSED DATES OF CONTRACT: October 1, 1978 to September 30, 1979

II. PRINCIPAL INVESTIGATORS:

Donald C. Malins, Ph.D., D.Sc.
Harold O. Hodgins, Ph.D.
Neva L. Karrick, M.S.
Douglas D. Weber, M.S.

III. COST OF PROPOSAL:

A. Science: 258.0
B. N/A
C. Total: 258.0
D. Non-area specific laboratory studies

IV. BACKGROUND

The research outlined in this proposal represents an interdisciplinary investigation of effects of petroleum on marine species. Included are studies to detect pathological changes resulting from exposure of juvenile flatfish to "weathered"-oil-contaminated sediment--including an examination for eye lens aberrations previously observed in salmonids; analyses of hydrocarbons in sediments and interstitial water to which flatfish are exposed; analyses of hydrocarbons and their metabolites in tissues of exposed fish; and studies of effects of "weathered" oil on development of eggs and larvae of salmon and flatfish.

It is now well established that a wide variety of aquatic organisms are able to take up petroleum hydrocarbons directly from water, via dietary routes, and from sediments (Roubal et al. 1977, Sanborn and Malins 1977, Varanasi et al. 1978a, McCain et al. 1978, Collier et al. 1978). Similar to terrestrial animals (Sims and Grover 1974), most aquatic vertebrate organisms are known to possess enzyme systems that convert petroleum hydrocarbons into oxygenated metabolites (Varanasi and Malins 1977, Malins 1977, Bend and James 1978). The ability to biotransform and dispose of potentially toxic compounds, such as those present in petroleum, may affect the long-term survival chances of an organism threatened by petroleum pollution. Moreover, since the covalent binding of polynuclear aromatic hydrocarbons (PAH) or their metabolites to cellular macromolecules (e.g., DNA) is implicated in mutagenesis and carcinogenesis, a detailed knowledge of the metabolism of PAH in marine organisms is essential in determining the potential consequences of petroleum pollution.

It is evident that certain important marine species may be especially susceptible to petroleum pollution and should be particularly investigated. For example, starry flounder (Platichthys stellatus) accumulated substantially more hydrocarbons than did coho salmon (Oncorhynchus kisutch) when both species were exposed to an equal concentration (≈1/2 ppm) of the seawater-soluble fraction of Prudhoe Bay crude oil for two weeks (Roubal et al. 1978). Furthermore, starry flounder and rock sole (Lepidopsetta bilineata) were shown to be able to extensively metabolize naphthalene (Varanasi and Gmur 1978, Varanasi et al. 1978b). Several sites (e.g., liver, skin, gills, bile, and brain) have been pinpointed where hydrocarbons and their metabolic products accumulate in exposed organisms. This information will be used in the proposed studies to assess any observed abnormalities resulting from exposure of flatfish to sediments containing petroleum.

Only a few experiments dealing with long-term pathological effects of petroleum on marine fish are reported in the scientific literature. In OCSEAP-supported studies in our laboratory when flatfish were exposed to crude-oil contaminated sediments for periods of 2 weeks to 4 mo, three main effects were observed (McCain et al. 1978). Two of the effects were liver abnormalities and hematological changes. The third effect was loss of body weight, which resulted in emaciation and morbidity in some cases. Additional unpublished preliminary experiments have demonstrated the following: (1) three species of flatfish [starry flounder, rock sole, and English sole (Parophrys vetulus)] were found to accumulate hydrocarbons from sediments to similar levels; and (2) English sole exposed to sediment with a high silt content, containing Alaskan crude oil [total extractable hydrocarbons (TEPH) 1,900 to 2,300 μg/g dry weight] had detectable levels of hydrocarbons in tissues only slightly above background. However, some of these oil-exposed fish had severe liver abnormalities, suggesting that sediment-derived petroleum compounds or their metabolites at extremely low concentrations, or components which are not being detected or defined by the analytical methods in use, may cause pathological effects in flatfish.

A few pathological effects resulting from long-term exposure of marine fish to petroleum have been reported by others. Payne et al. (1978) maintained cunners (Tautogolabrus adspersus) in (an undetermined concentration of) the seawater-soluble fraction of Venezuelan crude oil for 6 mo. After this time the exposed fish had no detectable histopathological changes, but an increase in eye lens diameter and decreases in plasma chloride and testis weight were observed. In work with mullet (Mugil cephalus) in estuarine ponds containing spilled crude oil, Minchew and Yarbrough (1977) reported that the oil-treated fish had a much higher incidence of fin erosion after 2 to 7 weeks exposure than did controls. Although the fin erosion was thought to involve a bacterial infection, the incidence increased with oil exposure.

In the present proposal, examinations for pathological effects of long-term exposure of flatfish to oil-contaminated sediment are scheduled to continue. Emphasis during this contract period will be on juvenile flatfish, and effects of "weathered" oil will be explored.

Trout (Salmo gairdneri), fed high doses of petroleum (1 g petroleum added to 1 kg food), showed severe changes in lens structure (Hawkes 1977, Hawkes and Gazarek, in preparation). Hydration of lens fibers and structural changes in the lateral projections of individual lens fibers were the first detectable alterations. Subsequently the interdigitating surfaces of the fibers separate from adjacent lateral projections or lose contact between fiber cell membranes. Eventually, intercellular organization degenerates and the gross appearance of the lens is cloudy, i.e., cataracts are formed. Cataract formation has been observed in 60% of trout fed the high dose of petroleum for 2-1/2 years (Hawkes and Gazarek, in preparation). Similarly, in laboratory studies with mammals, particularly rabbits, naphthalene was found to cause cataracts, which were preceded by lens hydration (Van Heyningen and Pirie 1967).

Early lens changes (i.e., hydration) can be monitored by measuring lens diameters of exposed fish and comparing these with lens diameters of unexposed fish. An increase in volume as great as twofold has been reported (Hawkes 1977).

Several questions remain unresolved concerning fish lens damage from petroleum, which include: (1) additional species that are affected, (2) threshold concentrations of petroleum components and the exposure conditions implicated, (3) the mechanisms by which the causative factors induce the lens changes, and (4) the significance of the lens aberrations to survival and well-being of affected individuals and species. In work proposed for study this contract year one or more species of flatfish will be studied to extend knowledge of affected species and of the types of exposure conditions and threshold levels which cause lens abnormalities. Finally, lenses from fish from oil-impacted areas will be examined, as feasible, when well-defined exposure information is available, to increase understanding of the nature, extent, and significance of eye lens changes resulting from petroleum.

Of the life stages of an organism, the early developmental stages usually represent the most susceptible period for impact of an environmental pollutant. In a recent review on the effect of oil on eggs and larvae of marine species Kuhnhold (1977) points out the astonishingly few reports concerning the effect of oil on this frequently "weakest link" in pollutant resistance of a species.

Several studies have been reported on the effect of petroleum on salmon eggs and larvae (Rice et al. 1975, Kuhnhold 1978); however, these investigations have largely concentrated on acute toxicity and the uptake of specific hydrocarbons. Studies were conducted by Lonning (1977) on the effects of crude oil on the development of a variety of fish eggs, including eggs of a flatfish species (Pleuronectes platessa). In this research there were severe effects noted on development of embryos exposed to Ekofisk oil.

In the present proposal, research is planned on the effect of "weathered" crude oil on salmon (Oncorhynchus sp.) and flatfish (Pleuronectidae) egg and larval development. Though there is no field element involved in the beginning studies, relevance to a field situation lies in recognizing parameters which may be pertinent in future research on effects from exposure of organisms to oil in the marine environment.

V. OBJECTIVES

The principal objectives proposed for OCSEAP studies for FY 79 are:

(1) To characterize the pathological effects resulting from long-term exposure of juvenile flatfish to sediments contaminated with petroleum.

(2) To determine concentrations of hydrocarbons and their metabolic products in various tissues of flatfish exposed to sediments containing hydrocarbons to attempt to correlate tissue levels with effects.
(3) To examine fish exposed to petroleum in the field for lens damage as feasible, when the history of exposure is well defined.
(4) To determine whether petroleum-exposed eggs and larvae of flatfish and salmon develop abnormally, and to evaluate the effect of any detected abnormalities on survival.

At the end of the contract period conclusions will be drawn regarding the relationship between exposure to petroleum components and observed abnormalities, and between exposure and the abilities of the organisms to survive normally.

VI. STRATEGY AND APPROACH

An interdisciplinary research program is proposed to provide information relating to the impact of petroleum on arctic/subarctic marine organisms and ecosystems. The research activities will employ elements of cell biology, physiology, chemistry, microbiology, and pathology. As in previous years, OCSEAP-funded research will closely interrelate with and be a part of the total interdisciplinary research of the EC Division on effects of petroleum on marine species.

The program will be managed by the Director of the Environmental Conservation Division (Dr. Malins) or by another of the Principal Investigators that he designates.

A. SAMPLING METHOD

Two general age groups (4 mo to 1 yr and 1 yr to 2 yr) of flatfish will be exposed to oil-contaminated sediments for up to 6 mo using aquaria the same as or similar to those described elsewhere (McCain et al. 1978). At intervals ranging between 2 weeks and 1 mo, the sediment and interstitial water will be analyzed for total extractable petroleum hydrocarbons (TEPH) and for individual aromatic hydrocarbons. At similar intervals fish will be sacrificed and tissue specimens analyzed by histological, hematological, analytical chemical, and electron microscopic procedures. Major emphasis will be placed on evaluating the effects of oiled-sediments on young, i.e., 4 mo to 1 yr-old, starry flounder, English sole, and/or rock sole (species available locally which are also present in Alaskan waters). Experiments with the older group of flatfish will only be performed if experiments iniated during the current contract period (FY 1978) require continuation.

Between 40 and 60 older fish or 80 to 100 of the younger fish will be used per test aquarium. At intervals ranging from 2 weeks to 1 mo for up to 6 mo, all fish will be weighed and measured, and 4 to 10 fish from each test group will be subjected to the following procedures: (1) blood will be removed for hematological tests and the serum will be analyzed for serum albumin, total protein, and possibly other serum components; (2) tissues--including samples from liver, heart, skin, spleen, olfactory organ, fin, kidney, intestine, gill, and gonad--will be preserved, processed by standard methods, and examined for histological changes; (3) muscle, skin, liver, and gill tissue will be analyzed for petroleum hydrocarbons and related compounds; and (4) eye lens, liver, and other selected tissues will be preserved and used for examination by electron microscopy.

At present, no laboratory techniques are being applied to the identification of either the extent of total metabolites or the nature of individual metabolites of non-radioactive hydrocarbons when more than one hydrocarbon is used in experiments. Studies on metabolism of single hydrocarbons in marine organisms, especially flatfish, have demonstrated clearly that within a short time most of the hydrocarbon is biotransformed to oxygenated products. Hence, assessment of levels of parent hydrocarbons alone in tissues of an exposed organism would be misleading. To overcome the problem of analysis of metabolites in fish, in some experiments known amounts of radioactively-labeled hydrocarbon(s) will be added to the sediments containing "weathered" oil. The tracer hydrocarbons will be selected on the basis of their importance as a component of the "weathered" oil and on the availability of isotopically-labeled material. Extent of metabolism of tracer(s) will be measured in the fish exposed to tracer hydrocarbons in sediments containing "weathered" oil, and levels of all hydrocarbons will be determined in tissues such as liver, skin, gills, and eye lens. The nature of individual metabolites of the tracer hydrocarbons will be determined to ascertain what types of compounds tend to be retained in tissues of exposed fish over a long period. Since covalent binding of hydrocarbons and/or their metabolites with cellular macromolecules is correlated with mutagenicity/carcinogenicity of these compounds, some samples of exposed tissues will be examined for covalent binding with DNA and protein. Moreover, extracts of tissues from hydrocarbon-exposed fish and hydrocarbons that have been treated with fish metabolic enzyme preparations will be assayed for mutagenicity using the Ames test (Ames et al. 1975).

Evaluation of the effect of oil on fish eggs and larvae will be conducted under laboratory conditions. Flatfish eggs will be collected from among the following commercially-important species depending upon local availability of spawning individuals: flathead sole (*Hippoglossoides elassodon*); English sole, and starry flounder. The species of salmon considered for these studies is chum (*Oncorhynchus keta*), with pink (*O. gorbuscha*) as an alternate. Eggs and larvae of the flatfish and salmon will be exposed to "weathered" Prudhoe Bay crude oil (PBCO) (and perhaps to "fresh" oil for comparison) and the following data collected: (1) rate of development by embryological stage; (2) abnormalities occurring during development; (3) hatching time and success; (4) survival, behavior, and pathology of larvae up to the stages of yolk sac absorption and initiation of feeding.

The methodologies used to assess the effect of petroleum hydrocarbons on eggs and larvae of various species will have several components in common: (1) The source of petroleum hydrocarbons used at the beginning of each exposure will be 2-3 day "weathered" PBCO generated in a flow-through wave machine or similar apparatus (or will be supplied by OCSEAP); (2) Samples of fish eggs and larvae will be collected at specific stages of development and examined for abnormalities by light microscopy. Eggs and larval stages exhibiting consistent pathological conditions or abnormal behavior patterns will be further examined in detail with scanning and transmission electron microscopy. (3) Variability observed in pathological changes and behavioral abnormalities will be accounted for by sufficient replication of experiments and careful comparisons between oil-exposed and control groups.

Specific experimental regimens for flatfish and salmon eggs and larvae are as follows:

Flatfish.

Mature male and female flatfish will be collected from Puget Sound areas by trawl net, and artificially spawned. The fertilized eggs will be continuously exposed to "weathered" oil after they attain the blastula or gastrula stage of development. The rationale for starting exposure after fertilization and the early cleavage stages is that pleuronectids generally spawn in deep water and the buoyant embryos do not reach the surface until development has progressed for several days (e.g., see Alderdice and Forrester 1971). When feasible, eggs will also be exposed to oil starting with more advanced stages of development.

Salmon.

Fertilized salmon eggs will be obtained from hatchery stock and reared in containers similar to those described by Nason and Fessler (1966) with the addition of gravel substrate. Starting with the first cleavage stage, eggs will be exposed 2-3 hours per day to "weathered" PBCO in flowing salt-water then held for 21-22 hours in clean flowing fresh water. After 4-5 days of this oil exposure schedule the initial group of eggs will be reared without further experimental petroleum contamination. A second group of eggs fertilized at the same time and, therefore, at the same stage of development as the initial group, will be exposed to 2-day old "weathered" oil for 4-5 days. The purpose of this type of exposure is to define effects of petroleum on specific developmental stages. This experimental regime will be carried through on different groups of eggs and larvae to time of yolk absorption.

B. ANALYTICAL METHODS

Tissue specimens from flatfish exposed to oiled sediments will be routinely analyzed histologically for structural changes by light microscopy; analyzed chemically by gas-liquid chromatography/mass spectrometry (GC/MS) (MacLeod et al. 1976) for unlabeled tissue hydrocarbons and by colorimetric methods for determining levels of albumin, total protein, and other components of serum; and analyzed hematologically for hematocrit, differential leukocyte, total RBC and leukocyte counts, and hemoglobin.

Sediment and interstitial water will also be analyzed periodically. The sediment will be characterized by particle size determinations and analyses for iron, copper, zinc, TEPH (gravimetrically), and for individual aromatic hydrocarbons (GC/MS, MacLeod et al. 1976). Interstitial water will be analyzed by the latter two methods.

Tissue samples will be analyzed for levels of the tracer hydrocarbon and its metabolites using a solvent-partition method described previously (Roubal et al. 1977, Varanasi et al. 1978a). Levels of all hydrocarbons accumulated in tissues will be assessed by GC/MS. Data will be statistically treated as also described previously (Varanasi et al. 1978a, Roubal et al. 1978). Individual metabolites of tracer hydrocarbons will be determined in tissues such as from liver, skin, and eye lens using thin-layer chromatography (Roubal et al. 1977, Varanasi et al. 1978b). Covalent binding of hydrocarbon and metabolites to cellular macromolecules will be determined by adapting methods reported for mammalian systems (Burke et al. 1977).

Assays for mutagenicity of selected petroleum hydrocarbons and metabolites will be conducted using a modification of the microbial method developed by Ames (Ames et al. 1975).

Samples of selected tissues from exposed and control fish will be obtained for fixation and processing for scanning and transmission electron microscopy (Hawkes 1974).

For egg and larval studies, 75 eggs or larvae of flatfish will be collected at designated sampling times from both control and oil-exposed groups. This sample size will provide a capability for detecting a statistically significant difference in occurrence of abnormalities if they occur at a 20% or greater frequency as the result of oil exposure (Feigl 1978). The selected sample size is based on the observation that approximately 15% of "normal" flatfish larvae show some abnormality of form or behavior (Wilson 1976). For salmon eggs and larvae, which have a lower percentage of naturally occurring abnormalities (approximately 5%), a sample size of 50 for each of treated and control groups will provide for statistical significance at the 5% level of probability.

VII. DELIVERABLE PRODUCTS

A. DIGITAL DATA - N/A

B. NARRATIVE REPORTS

It is anticipated that in addition to the required Quarterly and Annual Reports, several papers detailing results of the proposed research will be prepared and published in respected scientific journals. It is not possible _a priori_ to delineate these definitively, but examples of possible topics include: pathological effects on juvenile flatfish of exposure to oil-contaminated sediment; eye lens abnormalities in oil-exposed flatfish; hydrocarbon uptake and identification of metabolites in flatfish exposed to "weathered"-oil-containing sediment; effects of petroleum on development of flatfish and salmon.

C. VISUAL DATA

These will include graphs, tables, figures, etc. as appropriate to each of the research disciplines and the data generated. Of special note are light, scanning electron, and transmission electron micrographs which will be included in the deliverable products.

D. OTHER - None

E. N/A

VIII. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

Voucher specimens will be collected and retained or shipped as directed.

IX. LOGISTICS REQUIREMENTS - N/A

X. ANTICIPATED PROBLEMS

No major problems are anticipated.

We will continue to participate in OCSEAP-sponsored intercalibration programs as applicable to this research unit.

XI. INFORMATION REQUIRED FROM OTHER INVESTIGATORS - None

XII. ACTIVITY/MILESTONE CHART - See attached.

XIII. OUTLOOK

Long-term effects from petroleum entering the ocean during offshore drilling should be determined with regard to organisms, ecosystems, and food webs. The drilling process continually returns to the marine environment large volumes of petroleum (39 ppm) over extended periods. Biological effects from "weathered" oil or from combinations of "fresh" and "weathered" are largely unknown and the FY 79 OCSEAP proposed work relating to these problems is only a beginning. Determination of impacts from oxygenated compounds, including their biological transport, is needed to plan an efficient program to study "weathered" oil. Impacts from heterocyclic and high molecular weight aromatics are also largely unknown. The research discussed below includes examples of some types of needed experiments.

A. NATURE OF THE FINAL RESULTS AND DATA PRODUCTS

Current experiments involving exposure of flatfish to oil-contaminated sediments should be completed by the end of FY 79. Two logical extensions of this research would be to (1) use the laboratory results as a basis for evaluating the effects of accidental or controlled oil spills on bottom-dwelling marine fishes, and (2) initiate more definitive studies of the parameters which determine the types of effects resulting from exposure of flatfish to oil-contaminated sediments. Examples of these parameters are species of flatfish, sediment type (silty vs. coarse), concentrations and types of petroleum hydrocarbons present in the sediment, and relationships between pathological and physiological changes.

The important task of delineating damage wrought by xenobiotics, such as petroleum components, at a cellular and subcellular level is not easily accomplished; however, studies of damaging interactions of petroleum metabolites with macromolecules (e.g., DNA), coupled with the assessment of mutagenicity, are well established procedures for addressing the problem. Further studies under OCSEAP should continue to incorporate these procedures in a complimentary way with studies of alterations in cellular morphology and other indices of organism viability.

The relationship of eye changes to the behavior and survival of the fish is an important issue in completing the project on oil effects on fish lenses. A postdoctoral fellow or visiting scientist would be appropriate to work with the electron microscopy laboratory for one year in order to pursue correlative studies on the degree of morphological damage that results in loss of visual acuity and to follow up with the relationship of impaired vision and actual behavioral alterations such as the ability of the fish to avoid predators or to function in situations requiring vision (Ingles 1971, Northmore et al. 1978). Salmon could be used for the study since vision is required for many of their vital activities (Hoar 1956, Brett and Ali 1958). In addition, flatfish may be used for comparison since there are visual aspects to their behavior and data are available on their visual thresholds (Blaxter 1969).

Assuming the FY 79 proposed research demonstrates abnormalities and behavioral changes in eggs and larvae of flatfish and salmon exposed to 2 day old "weathered" oil, there are several additional studies which should be considered for FY 80-82. These include: (1) Repeat of the FY 79 proposed research except with petroleum which has been "weathered" for a longer period of time prior to exposure; (2) evaluate the effect of "weathered" oil on eggs and larvae of commercially important marine species whose early developmental stages are exposed to environmental conditions different from that of salmon and flatfish. Examples of these would be intertidal eggs of the herring (*Clupea harengus pallasi*), exposed beach spawn of the surf smelt (*Hypomesus pretiosus*), and exposure to oil contaminated sediment of eggs carried by gravid Dungeness crabs (*Cancer magister*); and (3) study effect of chemically dispersed "fresh" and "weathered" oil on egg and larval development of selected marine organisms.

Completion of an egg and larvae program as suggested above should provide valuable data to assist in predicting and assessing the ecological impact of an oil spill occurring under a variety of conditions.

B. SIGNIFICANT MILESTONES

1. Determination of pathological effects of petroleum on impacted flatfish or other demersal fishes and factors influencing the severity of the pathology.

2. Measurement of behavioral changes which depend on vision. For example, modifying Ingles' (1971) techniques for tests of goldfish visual discrimination for salmon or flatfish, if training techniques prove feasible for these species. Another approach would be to test a "startle" response dependent on vision only.

3. Completion of studies on effects of various petroleum components and exposures on development of eggs and larvae of different marine species.

C. COST BY FISCAL YEAR

The cost for a desired full-scale effort will be approximately $400 K/year. The studies as proposed will take two additional years (FY 80 and 81). Reduced versions of the proposed research projects can be undertaken for less.

E. N/A

F. N/A

XIV. STANDARD STATEMENTS

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI or his designate is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI or his designate may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. N/A

F. N/A

G. N/A

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI or his designate will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached.) Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

MILESTONE CHART

RU #: 73 PI: MALINS et al.

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

MAJOR MILESTONES	1978			1979														
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D			
1. Conclude evaluation of effects of oiled sediment on adult flatfish.					0													
2. Evaluate effects of oiled sediment on juvenile flatfish; including use of histology, chemistry, hematology												0						
3. Assess levels of hydrocarbons and their metabolites in tissues of oiled-sediment-exposed flatfish												0						
4. Test binding of hydrocarbons/metabolites to protein and DNA of oil-exposed flatfish												0						
5. Evaluate relation between hydrocarbon exposure, metabolite formation, and mutagenicity												0						
6. Process and examine tissues collected from oil-exposed flatfish for electron microscopy												0						
7. Expose salmon eggs and larvae to "weathered oil						0												
8. Examine salmon eggs and larvae for abnormalities											0							
9. Expose flatfish eggs and larvae to "weathered oil								0										
10. Examine flatfish eggs and larvae for abnormalities												0						
11. Process and examine eggs and larvae collected for electron microscopy												0						
12. Complete reports on results of studies and initial preparation of manuscripts for publication				0			0			0		0						

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Revision date: 9 June 1978
Contract #: 03-5-022-72
Institution I.D. #: 480870-26500

NOAA-OCSEAP
Bering Sea-Gulf of Alaska Project Office
P.O. Box 1808
Juneau, Alaska 99802

FY 1979 RENEWAL PROPOSAL

Research Unit Number: 083

TITLE: REPRODUCTIVE ECOLOGY AND FORAGING DISTRIBUTION OF PRIBILOF ISLAND SEABIRDS.

Cost of proposal: $96,628 Lease areas: St. George Basin 100%

PRINCIPAL INVESTIGATOR:

Name George L. Hunt, Jr.

Signature George L. Hunt Date 11 June 1978

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ORGANIZATIONAL APPROVAL:

Peter R. Atsatt

Peter R Atsatt Date 6/12/78

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Howard A. Schneiderman

HA Schneiderman Date 6-13-78

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ORGANIZATION FINANCIAL OFFICER:

Walter Selufsky

E. L. Bradt Date 6/14/78

Contracts and Grants Officer
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E. L. BRADT, ASST. MANAGER
CONTRACTS & GRANTS

Technical Proposal

I. Title: Reproductive Ecology and Foraging Distribution of Pribilof Island Seabirds

Research Unit: 83

Contract Number: 03-5-022-72

Proposed dates of contract: October 1, 1978 - September 30, 1979

II. Principal Investigator: George L. Hunt, Jr.

III. Cost of Proposal:

A.	Science	$96,628
B.	PI-provided logistics	-0-
C.	Total	$96,628

D. Distribution by Lease Area: St. George Basin, 100%

IV. Background:

In order to assess the impact of oil exploration, extraction and transport on seabirds of a given area, it is necessary to know: 1) the number of birds in the area, 2) their activity patterns (where they go and what they do there, eg. nest, roost, forage), 3) the timing of their activities, 4) the foods on which they depend, 5) the vulnerability of these food items to oil, and 6) the probability that oil related activities or spilled oil will impinge on the bird populations in question. Since natural populations exhibit daily and seasonal rhythms of activity and year to year fluctuations, studies should encompass a sufficient period of time to establish the normal limits of these fluctuations and the factors that may cause extraordinary perturbations of the system.

In the St. George Basin the University of Wisconsin team under the direction of Dr. J. Hickey obtained estimates of population sizes for marine birds nesting in the Pribilof Islands and U.S. Fish and Wildlife Service studies have provided estimates of the sizes of colonies of seabirds in other areas contiguous with the St. George Basin. While all of these estimates could be further refined to provide hard data for baseline comparisons, the present level of knowledge certainly allows us to know the areas supporting the major concentration of nesting seabirds. The Pribilof Islands clearly support one of the largest concentrations of marine birds in Alaska, if not the world.

Our efforts have been directed toward delineating the reproductive and foraging ecology of the seabirds of the Pribilof Islands. These efforts have been colony based and had a modest pelagic component conducted near the islands during the breeding season to determine major foraging areas used. Our studies are complemented by the work of the U.S. Fish and Wildlife Service and Mr. G. Devoky on food habits and at sea distribution over a wider area and in periods of the year when we are not in the field. Our work will also integrate the results of various fish and zooplankton studies that should allow us to relate the at-sea distributions of foraging seabirds to the distributions of their primary food resources. These efforts should culminate in the ability to model the Bering Sea Marine Ecosystem and relate the marine birds to other components of the system. To this end, a first step has been the integration of our Pribilof Island data into a model developed by Dr. John Weins of the Oregon State University, and cooperative studies of the distribution of foraging seabirds in relation to both biological and physical oceanographic features.

V. Objectives:

The objectives of the past four years of field research have been to:

1. Determine the phenology of the seabirds nesting on the Pribilof Islands in so far as timing of egg laying, chick hatching and fledging are concerned.
2. Determine clutch size, hatching success, fledging success and reproductive output for Fulmar, Red-faced Cormorant, Black-legged Kittiwake, Red-legged Kittiwake, Common Murre and Thick-billed Murre. These species are more accessible for study than others on the islands and the Kittiwakes and Murres account for the major portion of the biomass present. If time and opportunity permited, data on other species such as Horned Puffin and Least Auklets was also be gathered.
3. Determine growth rates of chicks and food used for all species for which data can be obtained.
4. Determine the distribution of foraging birds in the vicinity of the islands.

The objectives of the present, proposed research are:

1. To work up the data on the reproductive ecology, food habits and foraging areas of breeding seabirds gathered in 1978.

2. To provide an integrated evaluation of the inter-year variations of breeding success, phenology, food habits and foraging areas of breeding seabirds and to relate these variations to causal factors when possible.
3. To provide data applicable to seabird modeling studies.
4. To provide a spot check of phenology and reproductive ecology of Red-faced Cormorants, Black-legged and Red-legged Kittiwakes, and Common and Thick-billed Murres during the 1979 breeding season. This will allow a rough comparison with the first four years as well as with other 1979 study areas.

The Bering Sea is home to some of the greatest concentrations and the greatest diversity of seabirds in the world. Baseline studies of these populations are necessary in order to identify areas of particularly great sensitivity from which oil should be excluded, to identify areas in which special priority should be given to the clean-up of spilled oil, and to provide evidence as to the effects of spilled oil on avian populations.

Timing of breeding, number of eggs laid, hatching and fledging success and growth rates are all indicators of the health of seabird populations. Knowledge of when and why the normal stresses in the reproductive cycle occur will facilitate predictions of the possible effects of oil spills and disturbance on these systems. Nesting seabirds are particularly vulnerable to spilled oil, as they are tied to restricted areas by their need to incubate eggs or feed developing young. Young birds, newly departed from their nests, may also be unusually vulnerable to oil on the sea because of incomplete development of flying ability and inexperience in foraging. Thus, it is important to document reproductive phenology in order to know the periods of greatest vulnerability.

Data on the foods and foraging areas used by seabirds will be collected in order to determine in which ocean areas oil spills will be particularly damaging to Pribilof Island populations. Knowledge of the food chains upon which the seabirds are dependent is also necessary to establish both the role seabirds play in the marine ecosystem and the potential vulnerability of seabirds should certain other marine species be damaged by oil.

VI. General strategy and approach:

The overall strategy of the research has been to gather detailed, in-depth data over a sufficiently long time-base so statistically valid comparisons can be made between this area and the other areas on a contemporary basis and between this area now and later, after oil development is under way. Parameters of reproductive success and growth rates of chicks are sensitive indicators of food availability and population health and they are more easily and accurately measured than total population size. For these reasons, we are pursuing a detailed, thorough study of the Pribilof Islands colonies to provide a benchmark for future comparisons, as well as the means of predicting possible impacts.

Oil-related activity that may have a major impact on the birds includes, but is not limited to, exploration, especially by aircraft in the vicinity of colonies, drilling, production and transport. Critical features, the impacts of which need to be monitored, are disturbance of nesting birds, oiling at sea and reduction in the availability of food resources. The proposed research contributes to a baseline on reproduction and foraging ecology against which the effects of these impacts can be measured, and provides data useful for the assessment of the potential impact of oil development.

The research has been designed to provide a broad comparative baseline as well as predictive information. To this end, studies have been conducted on both St. Paul and St. George Islands. The relative species composition on these two islands differ, as apparently do the phenologies and reproductive success of some species. Species chosen for study are those with the greatest numbers present on the islands, as well as those for which large amounts of data could be gathered efficiently. Less effort has been put into those species that are difficult to work with, thus yielding little data for the effort expended. These species can be studied more readily in other areas.

The proposed research will involve analysis of the 1978 field data, an integration and comparison of the four years of field effort, plus the workup and integration of the results of a three week visit to St. Paul Island for an assessment of the 1979 breeding season.

In the integrated review of the field studies, we will attempt to relate changes in reproductive output and phenology to weather factors, food types used, and growth rates (a measure of energy balance). Distribution of birds at sea will be related to distance from islands, distance from shelf break, water depth, sea surface temperature and/or salinity, and when data are available, water column stratification and the abundance of food organisms. Analysis will be accomplished by a combination of mapping and regression analyses.

The results of this analysis of foraging areas should prove useful in predicting the distribution and abundance of birds at sea, and the likelihood of large concentrations of birds falling within an oil spill trajectory zone. The analysis of reproductive biology will show periods of greatest colony sensitivity to spilled oil or disturbance, as well as the effects of weather or changes in food supply (only in the most general sense) on reproductive output.

A. Sampling methods: For the field work on St. Paul we will choose a three week period that will allow us to plot the timing of hatching (phenology of successful nests) and growth rates for Black-legged and Red-legged Kittiwakes and Common and Thick-billed Murres. In addition we should be able to obtain data on productivity of Red-faced Cormorants. While this short a visit in late July and early August will not allow a determination of productivity in kittiwakes and will only give a partial look at productivity in murres, it will give us the ability to know whether the reproductive biology of these species in 1979 is similar to, or grossly different from that found in the years 1975-1978. To this end, methods used in 1979 will be similar to those used in previous years.

Several variables which influence reproductive success and growth rates impinge on any natural study. These variables include: 1) year to year changes in the ecosystem, 2) variations in the exposure of different nest sites, and 3) variations in the age and experience of nesting individuals being studied.

Variable 1, year to year variations can only be understood by a multiple year study; one year's efforts represent but a single data point for understanding the input of this variable. The possible distortions that variables 2 and 3 might cause to a baseline study can be minimized within a single year's study by choosing a sufficiently large number of subsampling areas and by following the success of an adequate number of nests in each area. The number of separate sites to be chosen will depend on the dispersal of nests and on local conditions but at a minimum for 1979 will include 3 sites on St. Paul. The number of nests to be studied in each area will be at least 15-20, if possible, so that individual variations and chance events will not unduly distort the results obtained.

Seabirds breeding on St. Paul Island either nest on cliff ledges or raise their young in holes and crevices in the cliffs or below ground among the rocks of boulder beaches. For those species which breed in the open (Red-faced Cormorant, Black-legged and Red-legged Kittiwakes, Common and Thick-billed Murres), data on reproductive success can be obtained relatively easily by observation of many nests at a time from locations at the top or bottom of the cliffs.

The basic techniques for obtaining data on the reproductive success of the five ledge-nesting species will be to locate nests, number them individually, and count the eggs or chicks contained in those nests usually every three to seven days, either until chicks hatch and leave the nest, or until total egg or chick loss occurrs. Inaccessible nests will be reidentified each visit using black-and-white photographs.

Part of the egg and chick counts for Red-faced Cormorant, Black-legged and Red-legged Kittiwakes and Thick-billed and Common Murres on St. Paul will be obtained by using a ladder at the bottom of the cliffs to reach into nests. This method, while causing some disturbance, allows more accurate assessment of timing of hatching and of mortaility than visual observations alone, as it is often hard to count eggs or tell when eggs first hatch under birds that sit very tightly. These nests will be identified by numbers painted on the cliffs.

In 1976 and 1977 on St. Paul we used two methods to assess murre reproductive success, to see whether or not our studies the previous year, involving scaring birds from ledges, had had unanticipated effects. At several sites the scaring methods employed in 1975 were used, and at other sites the observer did not scare the birds, but sat quietly for an hour or so at each visit watching to see by the birds' behavior whether they were incubating eggs, brooding young, or were not breeding. In 1976 and 1977 the use of black-and-white photographs of each ledge made the task of assigning an individual number to each egg or young far easier. The scaring techniques did depress reproduction. In 1979 we will rely primarily on long, quiet observation to determine "nest" contents for murres, although birds on one or two ledges will be scared off in order to obtain better data on phenology.

Growth rates of young seabirds have been shown in past studies to be strongly correlated with fledging success (Hunt, 1972; Hunt and Hunt, 1975, 1976).

Data on growth rates of the chicks of four species (Black-legged and Red-legged Kittiwakes, Common and Thick-billed Murre) will be obtained by weighing chicks at least twice a week. Chicks will be individually marked with numbered plastic leg bands or fingerling fish tags, placed in cloth bags and weighed with Pesola spring scales (300 g to 5kg capacity, depending on the species and the size of the chick). The weight of the bag and of any food regurgitated by the chick will be subtracted from the total weight to obtain the weight of the chick.

In all of the above species with the exception of the murres the typical growth pattern is a period of rapid and steady weight gain followed by either a plateau or a slight decline in weight prior to fledging. In these cases the growth rate for the straight-line portion of the growth curve will be calculated by the formula: $\frac{\text{weight}_2 - \text{weight}_1}{\text{day}_2 - \text{day}_1}$ where the gain in weight between the first weighing and the peak weight is divided by the number of intervening days, yielding an average number of grams gained per day.

Murre chicks hatch at 65-70 grams and gain weight for 10-15 days. Many of them will reach a plateau or begin to lose weight when their contour feathers begin to grow in. Then there is a second period of weight gain, sometimes followed by a slight drop in weight just before the chick goes to sea. This pattern is not always consistent, however; some chicks may not lose weight at all during the period of contour feather growth. We have used and will continue to use for comprative purposes the number of grams per day that a chick gains during the first growing phase.

An important parameter for chick survival is its weight when it leaves the cliffs to go to sea. It is presumed that a heavy chick will be more likely to survive than one which is light and has little fat reserves. Our data for both species of murres in 1976 and 1977 show a positive correlation between the number of grams gained per day until the first peak of growth and the last weight obtained before the chick leaves the island. When possible we will obtain peak or fledging weights of young.

Information on foods will be obtained from chick regurgitations. We will not seek large numbers of samples, but we will keep whatever regurgitations come our way in order to check that no radical changes in diet have occurred between the years.

Food samples will be preserved in plastic Whirl-pak bags in 80% ethanol, and labeled as to sample number, species, and date collected.

Food items used by birds will be identified as well as is possible, depending upon their state of digestion. The results will be catalogued by bird species on a % volume and % occurrence basis.

B. Analytical methods: No elaborate analytical methods are used in this research. Data on phenology, reproductive success, growth rates and food habits are compiled by straight-forward methods as outlined above. Differences between sub-colonies, islands or years will be tested using appropriate parametric and non-parametric statistics.

VII. Deliverable Products:

A. Digital Data

1. The 033 format will be used to submit all at-sea data gathered in 1978. Data to be submitted as checked on the following list specified by OCSEAP. We generally have not been given a report from the ship on depth of thermocline, and this parameter will not be reported.

   Colony data from 1978 and 1979 will be reported in the modified 035 format when that becomes available.

2. If maximum and minimum values for parameters have not already been submitted, they will be provided during the 1979 contract year.

3. In the event of coding from field forms, coding is checked before digitizing. The keypuncher has guaranteed 99% accuracy. Random checking of field forms against coding and printouts has proved that out. Since coding errors appear to be the likeliest source of errors we try to digitize from field forms whenever possible.

B. Narrative Reports

At present we expect to supply only the required quarterly reports and a final report in September 1979.

C. Visual Data

Mapped data will be supplied on standardized forms once they are provided by OCSEAP. Additionally, Mylar overlays will be provided for Spring, Summer and Fall counts of all birds seen, all birds on water, all gulls, all alcids, all waterfowl.

D. Not applicable.

E. See following schedule on OCSEAP form.

VIII. Special Sample and Voucher Specimen Archival Plans:

Not applicable.

File Type 033

Ship and Aircraft Census

Common to all records
- File Type
- File Identifier
- Record Type
- Station Number

Record Type 1 - Location
- Latitude/Longitude
- Year/Month/Day
- Hour/Minute
- Latitude/Longitude
- Elapsed Time/Time Zone
- Speed Made Good/Course Made Good
- Height Above Sea
- Platform Type Code
- Sampling Technique Code
- Ship Activity Code
- Photos Taken
- Width of Transect
- Angle of View Code
- Observation Conditions Code
- Distance Made Good
- Watch Type Code
- Transect Width

Record Type 2 - Environmental
- Depth to Bottom
- Depth of Thermocline
- Surface Temperature/Salinity
- Dry Bulb Temperature/Wet Bulb
- Relative Humidity
- Barometric Pressure
- Barometric Trend
- Wind Direction/Speed
- Sea State
- Swell Direction/Height
- Weather
- Cloud Type/Amount
- Water Color
- Visibility
- Sun Direction/Glare Intensity Codes
- Glare Area Code
- Light Level
- Moon Phase Code
- Tide Height Code
- Rising or Falling Tide
- Distance to nearest Shoreline/Shelf Break
- SECCHI Depth
- Debris Code
- Effects of Weather/Light

Record Type 3 - Ice
- Ice in Transect/Ouside Transect
- Visible Open Water
- Type of Opening/Distance to Codes
- Visible Ice
- Misc./Other Features
- Ice in/Outside Transect
- Ship in Water
- Width of Lead
- Distance of Ship from Edge of Lead or Polynya
- Time of Ice Conditions
- Percent Water Versus Land Covered
- Size of Ponds
- Description of Open Water Ice
- Sequence Number

Record Type 4 - Text
- Text
- Sequence

Record Type 5 - Data
- Time
- Taxonomic Code
- Sub Species/Species Group
- Age Class Group/Sex Codes
- Color Phase/Plumage/Molt Codes
- Number of Individuals
- Counting Method Code
- Reliability Code
- Dist. Measurement Type Code
- Distance from observation platform to birds
- Direction of Flight
- Association Code
- Linkage for Multispecies
- Number of Species Participating
- Behavior/Special Marks/Bird Condition Codes
- Food Source Assoc. Code
- Taxonomic Code for Food Species
- Debris/Oil Code
- Distance from Nearest Breeding Colony
- Habitat Code
- Sequence Number
- Substrate/Cover/Outside Zone Codes

DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Shipboard Survey 78	tape	40,000	033	yes	April '78 - Sept '78	1 June '79
Bird Colony 78	tape	?	035	yes	May '78 - Oct '78	February '79
Bird Colony 79	tape	?	035	yes	July '79 - Aug '79	Sept. '79

XII.

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 083 PI: George L. Hunt, Jr.

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
1) Analysis of 1978 Colony Data								0							
2) Analysis of 1978 Cruise Data											0				
3) Analysis of 1978 Foods Data							0								
4) Submission of 1978 Colony Data					0										
5) Submission of 1978 Cruise Data (for this we will most likely require more than 120 days for processing)									0						
6) Submission of 1978 Foods Data										0					
7) 1979 St. Paul Field Work											0				
8) Workup 1979 St. Paul Field Work												0			
9) Submission of 1979 Data													0		
10) Write-up of quarterly reports	0			0			0			0					
11) Write-up of final report													0		

XIII. Outlook:

Assuming that the research proposed for FY79 is completed successfully, I feel we will have met a first plateau for colony studies on the Pribilof Islands and surrounding waters. It is likely that some data gaps, particularly in reference to the modeling effort, may be identified. My expectation is that these data gaps will at most require a narrowly focused effort and probably one of relatively short duration. I do not anticipate another full-scale colony effort will be required until 1981 or 1982 when a thorough check of at least one island should be made to determine if there have been any major changes in productivity or food habits.

There are, however, several projects of limited scope and duration that are relevant to management decision making processes and the development of predictive models of the impact of offshore petroleum development:

1) We need to develop a better understanding of the factors controling distribution of birds at sea and to develop the ability to predict these distributions. To that end, in the Bering Sea continued cooperation with the PROBES effort is urged, as is the placing of bird observers on National Marine Fisheries Survey Vessels. The costs here would be the salaries and travel money for one or two field observers and funds for computer analysis of the data gathered. Because the cruises will be gathering data on physical and biological oceanography for other studies, we will gain access to a large amount of data at very low cost. The long-term goal of such studies would be to relate bird distributions to oceanographic features amenable to monitoring by remote sensing. This work will cost between $30-35,000 per year and could profitably be conducted for two-three years.

2) We do not presently understand why there are auklets breeding on the Pribilofs in large numbers, yet virtually none breeding at Cape Newenham or Cape Pierce. It would be useful for management purposes to test the hypothesis that a crucial difference is the turbidity of the water near shore. To test this hypothesis we could both make measurements of plankton near the Pribilofs and near Cape Pierce, coupled with measures of turbidity and we could conduct experiments by pumping drilling mud or an equivalent for a short time into the water near the Pribilofs to see if the number of birds using an area drops precipitously when turbidity is increased. The cost of the bird observations and plankton work would be modest, probably in the vicinity of $30-35,000. The

work would probably require 10-15 days of ship time in June or July. I have no idea of the cost of creating the turbid water conditions. This work would have management relevance throughout the Alaska OCS program.

3) Bogoslof Island apparently supports an important seabird breeding colony, about which we know relatively little. While it may be impractical to study the reproductive ecology and determine the productivity of this colony, it deserves at least a few checks during one or more breeding seasons and a set of radial transects to find out where the major number of the murres from that colony are foraging. If done in conjunction with the turbidity project above (#2), this project would probably incur no additional personnel costs beyond those needed for data management. My expectation is that about 10 days of ship time would be involved in June or July and maybe 5 days in August. If done alone, I would expect the cost of a Bogoslof study to be $25-35,000, or if done in conjunction with #2 above $5-10,000.

4) A final project of value would involve developing the means of detecting large flocks of seabirds using the radar and other remote sensing devices on the SEA SAT satelite that is to be put in operation. For this we will need ground truth information so that radar signatures from areas with large bird flocks can be compared with signatures from areas without birds. The management value of such a system is enormous, and the cost of development is likely minimal. We will know more about this at the end of the 1978 field season.

Although it is not classified as a field research project, I would be very interested in contracting to do an Alaska-wide synthesis of data on the kittiwakes, particularly if it can be done in conjunction with Dr. William Drury. Syntheses of the data on various species are urgently needed not only in order to identify data gaps, but also so we can pinpoint the most vulnerable or most valuable colonies. Integration of our data will also allow us to identify the situations in which the birds will be most vulnerable.

OTHER INFORMATION

A. Background of the Proposer - see section "QUALIFICATIONS" above and the attached Cirriculum Vitae.

B. Concurrent and proposed grants and contracts are listed on the following page with the principal investigator's time commitments to these projects.

C. The Principal Investigator shall actively lead and supervise the proposed work and shall take full responsibility for timely completion of all objectives, independent of the percentage of the Principal Investigator's salary requested in the budget. The Principal Investigator will spend a minimum of 25% of his time on the project.

D. All personnel assigned for direct work on the project are employees who have been attached to the project for at least one field season. Ron Squibb has worked on St. George Is. for four seasons and was largely responsible for work-up and write-up of the 1977 colony work. Bill Rodstrom has worked on St. Paul Island for two seasons and on Buldir for one year. He will help with the colony write-up. Maura Naughton has had a little over one field season on St. Paul Island and has worked for two years on our BLM sponsored study of seabirds in the Southern California Bight. She will be primarily responsible for the work-up of the at-sea data and will conduct the 1979 field work on St. Paul. Barbara Braun is currently a Master's candidate in my laboratory and will spend the 1978 field season on St. Paul. She will participate in the final report writing and the field work on St. Paul in 1979. Barbara Burgeson has been Administrative Assistant for our BLM Southern California Bight project for the past three years, has extensive experience with seabird survey and colony work and participated during her vacation time in colony work and at-sea work in 1977 in the Pribilofs. She will continue as Administrative Assistant and will be responsible for identification of food items obtained from birds. She has received on-the-job training for this and will have four month's experience by October 1978. Grace Bush has been in charge of data management since January 1977 and will continue on the project in that capacity.

E. For references cited, see G.L. Hunt, cirriculum vitae.

F. Names and phone numbers of persons authorized to conduct negotiations appear on the cover sheet.

XIV. A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA For 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U. S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached.) Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they became available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

UNIVERSITY OF CALIFORNIA, IRVINE

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DEPARTMENT OF ECOLOGY AND
EVOLUTIONARY BIOLOGY
SCHOOL OF BIOLOGICAL SCIENCES

IRVINE, CALIFORNIA 92717

28 August 1978

Dr. Herbert E. Bruce
NOAA/OCSEAP
Juneau Project Office
P.O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

In response to your letter of 14 August concerning Required Proposal Revisions for FY79 on RU83 I offer the following ammendments:

1) Funding will be at $95,628.00 with the difference between my original proposal amount and the revised amount coming from the line item Travel by P.I. to OCSEAP meetings.

2) A completed signature page is attached.

3) There will be a short field effort in July-August 1979 as specified. It will be approximately three weeks long and will run from about 20 July 1979 until about 10 August 1979.

4) The kinds of statistical tests to be run will include Chi-square, T-test, linear regressions, multiple linear regressions and possibly either Mann-Whitney U Tests or other non-parametric tests. These tests will be used to compare reproductive success between islands within years and within islands between years. We will also attempt to determine if food habits varied significantly between years or between islands. Distribution of birds at sea will be examined through regression analysis to determine which factors (depth, salinity, distance from island) are the best predictors of at-sea distribution.

5) For the A35 Format, we expect to use record types A and B, and depending upon the data (amount and quality) we can obtain we will either use records J and K or records G, H and I. What we are able to do will also vary from one species to another, but we will gather and report the maximum amount of data possible. This approach is the one agreed to with Rod Swope while I was in Juneau.

6) Selected specimens of foods gathered will be archived as requested. At present we are holding all food samples here. We will either send selected samples or the entire collection to the California Academy of Sciences as requested.

7) As for data required of other investigators, our needs in Physical Oceanography seem to be taken care of. Our needs in Biological Oceanography will depend, in part, on the work-up of plankton samples by Dr. Cooney or I.M.S. We presently expect these data to be available sufficiently soon to allow timely production of our final report. My greatest concern is obtaining data on bird distribution in the Bering Sea from other investigators. We will be working with Hal Peterson and the Juneau Project Office on this problem.

Other comments: The travel to Fairbanks of the person working on food samples needs to be done this fall so that she will have the greatest facility possible in working up food samples quickly.

I believe this covers all aspects brought up in your letter. Thank you for your help in Juneau.

Sincerely,

George L. Hunt, Jr.

George L. Hunt, Jr.
Associate Professor

George L. Hunt, Jr.
George L. Hunt, Jr., Acting Chairman

H.A. Schneiderman
H.A. Schneiderman, Dean

W.R. Selufsky
W.R. Selufsky, Contracts and Grants Officer

GH:bb

Enclosure: Revised Cover Sheet

cc: Boulder OCSEAP Office

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

TO:	Outer Continental Shelf Environmental Assessment Program National Oceanic & Atmospheric Administration
TYPE OF SUPPORT REQUESTED:	Contract
TITLE OF PROPOSED RESEARCH:	The Interaction of Oil with Sea Ice Contract #: 03-5-022-67, Task Order #: TA 6 Research Unit: 87
PRINCIPAL INVESTIGATOR:	Seelye Martin, Research Associate Professor Department of Oceanography University of Washington Seattle, Washington 98195 Telephone: (206) 543-6438
LEASE AREAS:	Bristol Bay: 50%, Saint George Basin: 50%
DESIRED CONTRACT PERIOD:	1 October 1978 - 30 September 1979
AMOUNT REQUESTED:	$33,771
UNIVERSITY OFFICE TO BE CONTACTED REGARDING CONTRACT NEGOTIATION:	Office of Grant and Contract Services 1 Administration Building, AD-24 Telephone: (206) 543-4043
DATE:	20 June 1978

Seelye Martin
Seelye Martin
Principal Investigator

G. C. Anderson
George C. Anderson
Associate Chairman for Research
Department of Oceanography

Franklin I. Badgley
Franklin I. Badgley, Chairman
Department of Atmospheric Sciences

Joe S. Creager
Joe S. Creager, Associate Dean
College of Arts and Sciences

OFFICIAL AUTHORIZED TO GIVE UNIVERSITY APPROVAL:

D R Baldwin
Donald R. Baldwin, Director
Grant and Contract Services
7-26-78

REF: P78-61

(3) TECHNICAL PROPOSAL

I. Title: The Interaction of Oil with Sea Ice

Research Unit Number: 87

Contract Number: 03-5-022-67

Proposed Dates of Contract: 1 October 1978 - 30 September 1979

II. Principal Investigator: Seelye Martin

III. Cost of Proposal:

A. Science: $33,771

B. P.I. provided logistics: 0.00

C. Total: $33,771

D. Distribution of Effort by Lease Area:

Bristol Bay: 50%

St. George Basin: 50%

IV. BACKGROUND

A. Introduction

During the past three years we have done research for the OCSEAP program in both the laboratory and the field. The laboratory program models the spreading of oil in wave-agitated grease and pancake ice, as well as studies its interaction with first year ice. The field studies, which have taken place in Norton Sound, Kotzebue Sound, the Chukchi Sea off of Cape Lisburne, and the Beaufort Sea, measure the sea ice properties such as crystal structure, drainage channels, and void spaces which are related to oil absorption.

The present proposal involves a change of direction from our previous work. Namely, in this document, we propose to gather surface truth data for the new SEASAT satellite operating over the Bering Sea. This surface truth data, which will be gathered from either a helicopter or a ship, will consist of measurements of the properties of the sea ice which is located under the path of the SEASAT. This surface data will then be used in combination with the satellite images to describe the sea ice behavior near the ice edge in the Bering Sea.

In the event that our SEASAT proposal is not funded, then we propose to carry out a limited program restricted to a desk study. In this program, the P.I. will spend three months on the organizing and writing-up, in time for the 1 March annual report deadline, of a survey of our field and laboratory work, both ONR and OCSEAP, on grease and pancake ice and the interaction of these kinds of ice with petroleum. This work will be of particular relevance to Norton Sound, Kotzebue Sound, and Bristol Bay, and should serve as a reference work for individuals concerned about grease and pancake ice and oil pollution. In the back of this proposal, we attach a separate budget page for this non-SEASAT option, the total cost will be $13,683.

Our SEASAT study is described in a proposal submitted to the NOAA SEASAT program titled "The Use of SEASAT Imagery to Study the Bering Sea Ice," and is summarized below. We hope to use the new Synthetic Aperature Radar (SAR) as well as other instruments on the SEASAT to study the sea ice properties adjacent to the Bering Sea ice edge. This will be the first civilian use of a SAR on a satellite. The advantages of the SAR are that (1) it is an active sensor, so that it can see through clouds and fog: (2) it has a high resolution of about 25 m over a 100 km wide swarth. The SEASAT will be at 800 km altitude with a 100 minute period, and its orbit will be such that there will be 80% overlap of a swarth after 12 hours. Also, because of the nature of the orbit, the coverage in the near polar regions will be very good (see Figure 1).

The disadvantage of the SAR is that because it works on a holographic principle, it requires 4 magnetic tapes <u>per-minute</u> to store the data. For comparison, the Scanning Multichannel Microwave Radiometer (SMMR) on the SEASAT requires 1 tape per day. The SAR data, then, must be immediately transmitted to a surface station; for the Bering Sea this station will be Gilmore Creek. Also, the large data storage requirements for the SAR means that there will be only a limited number of turn-ons, namely 100 per-year. In our SEASAT proposal, we have budgeted for 10 turn-ons each during the ten day periods in late October-November and in February 1979. This data, however, combined with the lower resolution SMMR and visual data and a good field plan should provide excellent information on the ice behavior.

Because our proposed field program is strongly dependent on the SEASAT proposal, we next summarize and describe the rationale and design of our SEASAT proposal.

B. Objectives of the Joint OCSEAP-SEASAT Study

The national interest of the Bering Sea, which Figure 2 shows in a satellite image, lies in three general areas: (a) it is extremely biologically productive; (b) it may be a major oil producing area with potential lease sites in Bristol Bay, Norton Sound, and near the Pribilof Islands; (c) it has a heavy seasonal ice cover which affects shipping routes and fishing techniques.

Previous work in the Bering Sea shows that the winter weather in the Bering Sea alternates between periods of cyclonic and anticyclonic circulation with a persistence for each case of 3-6 days. The anticyclonic case is driven by the combination of a stable high pressure system over Siberia and the successive lows which move along the Aleutians into the Gulf of Alaska. This yields strong northeast winds, clear skies, and the ice deformation shown in Figure 2. Cyclonic flow occurs when the low pressure systems displace the Siberian high and create winds from the south or southeast over the Bering. These winds advect the pack to the northwest, and are accompanied by warmer air temperatures and considerable clouds and fog, making visual imagery very difficult to obtain.

In our SEASAT proposal, we will use the all-weather SEASAT capability to study the ice behavior near the pack edge, and the effect of a change in atmospheric circulation on the 0.1-25 km scale ice features. In particular, we will look at two ice features which are important to the Bering Sea. The first is the growth of grease ice and the formation of Langmuir rolls in the large polynyas which form in Norton Sound, south of Saint Lawrence and Saint Matthews Island, and along the Alaskan coast south of the Yukon delta during periods of strong anticyclonic flow. The second is the development of certain interesting features occurring at the ice edge. We discuss these two in the above order.

1. Grease Ice and Langmuir Circulations. As Figure 3a shows, in the large polynyas south of Cape Prince of Wales and Saint Lawrence Island, the combination of the cold wind and the wind-generated waves causes the growth of a slurry of small ice crystals and seawater called 'grease ice.' Once this ice forms, the Langmuir circulation set up by the wind and waves drives it into the long parallel bands shown in Figure 3a. In our recent field work for OCSEAP during March 1978, we observed grease ice in Norton and Kotzebue Sound, and in our laboratory studies, we are looking at its interaction with spilled oil. From the SAR images of these regions, we will be able to run two-dimensional Fourier Transforms on the SAR images to determine the distribution of the Langmuir bands as a function of the atmospheric driving. Then from our laboratory work, we should be able to relate this information to the spread of pollutants.

2. The Ice Edge. Figure 3b and c show two images of the ice edge taken in March 1977 during northeast winds. These images, which are characteristic of a large number of winter images dominated by the anticyclonic circulation, show several interesting features. First, the cloud streets are parallel to the wind direction. Second, north of the ice edge, the pattern of leads is organized, with the major cracks running to the right and left of the wind direction. Third, the floes appear to be organized with respect to size, with the smaller floes occurring closer to the ice edge. Fourth, at the very edge, long thin ice filaments or plumes occur which lie almost at right angles to the wind. The zone of influence of the ice edge extends from the filaments to the end of the angled lead pattern for a distance of about 100-200 km.

Observations made under this contract from the SURVEYOR during February 1978 show that the filaments are made up of a mixture of hundreds of ice floes measuring 4-8 m in diameter and grease ice. The floes in these filaments serve as habitats for walrus, seals, and birds. In the event of an oil spill, these filaments may also serve as convergence zones for pollutants.

V. OBJECTIVES

The most important objectives of this research project will be to determine the following ice properties:

1. The response of the Bering Sea ice edge to changes in atmospheric forcing;

2. The scale of crack systems north of the ice edge as a function of ice thickness and temperature-salinity structure, and the response of these systems to atmospheric forcing;

3. The scale of the Langmuir ice plumes in the large polynya regions;

4. The interaction of ocean swell with the ice edge and the wave propagation into the pack; and

5. The forces which go into the formation of the filament-like structures which form at the ice edge.

Each of the features which occur at or near the ice edge, from the filaments to the spacing and direction of the crack systems, will be important to understanding the spread of pollutants in the pack ice. For example, the filament formations are evidence of convergence zones, so that spilled oil may accumulate in them. Also, the dynamics and scales of the regular crack systems above the edge, and their change in orientation with changes in atmospheric circulation will determine the spread and pumping of oil within the crack systems.

VI. GENERAL STRATEGY AND APPROACH

This experiment will employ three different observational scales: SEASAT images, aircraft overflights, and ice surface measurements consisting of the taking of ice cores and the recording of ocean waves propagating through the ice. We discuss these observations in the above order.

A. SEASAT Observations

We propose to use the high resolution SAR images to study the response of the ice during periods of cyclonic and anticyclonic circulation. We will need approximately 20 SAR images; 10 in the fall and 10 in the winter. If possible, we will coordinate our SAR turn-ons beginning with a strong anticyclonic flow over the Bering, then follow the transition to cyclonic flow over the next 4-8 days. During times of rapid change, we wish to use sequential SAR images with their large overlap areas to study changes in the mesoscale ice dynamics occurring at the time of both cyclonic and anticyclonic flows. These turn-on times will be coordinated with W. J. Campbell of the U.S.G.S.

In addition to the SAR images, we will use the SMMR and the V/IR to provide complimentary large-scale images of the ice in order to determine the distribution of ice types, the large scale response and the ice behavior preceding and following the SAR turn-ons. We will also look at the altimeter data to see if it yields meaningful data about either long waves propagating into the pack, or pressure ridge statistics.

Once we have the data in hand, we will first reproduce the SAR images photographically to study the small-scale ice edge features. Then, we will use the two-dimensional optical Fast-Fourier-Transform (FFT) being developed at PMEL for use with the SAR transparencies to determine the following:

i. The wavenumber and direction spectra and the long wave field south of the ice pack. This data will be examined to see how it correlates with the nature of the ice edge.

ii. The spectra of lead orientation of floe size within the pack ice. Also, we will run FFT's on the SAR images of grease ice formation within the polynyas to determine the scales of the Langmuir streaks.

This data will then be correlated with ice distribution maps developed from the SMMR and V/IR and with National Weather Service records of surface weather in order to determine the ice response to atmospheric forcing.

B. The OCSEAP Surface Truth Observations

We plan two periods of surface truth observations in support of the SEASAT. The first will be in October-November 1978; the second, in February 1979. The purpose of the fall observation will be to study the rapidly growing ice front; the winter observations will be to study the properties of the fully-developed sea ice cover.

1. October-November 1978. This experiment will not involve OCSEAP funding; we summarize it so that it can be compared with the February 1979 experiment, to which OCSEAP will contribute greatly. Also, we will submit copies of the data reports from this experiment to the OCSEAP offices. In this experiment, we will participate in the NASA CONVAIR-990 overflights being planned by William Campbell of the USGS. For this period a combination of low and high level flights will permit visual, radar, and simulated SMMR observations of the growing ice front. Also from the aircraft, we will study the nature of the large polynyas and the ice edge from both high-and low-level flights simultaneously with SEASAT observations.

2. February 1979. In this month, we propose to gather surface truth data in support of the SEASAT observations, in a region at or near the ice edge. We request two different kinds of logistic support for this project; a remote-sensing aircraft, and either ship or helicopter access to the ice. The charts (Figures 4-6) show the suggested area of operations; if we use a helicopter, we would probably work south and west of Nunivak Island; if we use a ship, we would work within the ice edge in this region.

At present, we do not know exactly either where the ice edge will be located or the SEASAT path over the Bering Sea in February 1979. The SEASAT orbit parameters will be available after launch; however, we can only design our experiment around a climactic mean ice edge. Therefore, we cannot at this time describe precisely either the locations of the stations which we will occupy, or the aircraft trajectories.

a. Remote sensing aircraft. We would like for a remote-sensing aircraft equipped with SLAR and photographic cameras to overfly the area which we will be coring, as well as fly along the trajectory of the SEASAT SAR. This work, for example, could be done by a MOHAWK flying out of Bethel. Our minimum requirement here would be one flight which would run from the ice edge over the surface truth stations along the SAR track at an altitude of 5,000-10,000 feet. Our maximum request would be for four such flights, spaced over the ten day SAR turn-on period.

b. Surface truth logistics support. Our purpose here is to take ice cores and wave data, and other information on the ice properties in the general region shown on the charts in Figures 4 and 6. We have two possible ways of gathering this data, either by helicopter or ship.

(i) Helicopter. From examination of the charts, it appears that the helicopter could be operated out of two locations, either Mekoryuk on Nunivak Island or Cape Newenham. According to Jim Schoumacher, who worked out of Nunivak in February 1978, this is a good location from which to work because the ice edge is generally accessible. If we worked out of Nunivak, we would have three persons in our crew. Our instrumentation would consist of our standard coring gear. In addition, we have arranged with Dr. Peter Wadhams of the Scott Polar Research Institute for one member of his group to join us as one of the three persons, and to bring the light weight strain gauge and accelerometer package which they use to look at the propagation of ocean waves through pack ice.

Using our coring tools, we will take ice cores, and determine ice thickness, salinity and crystal structure. In support of the SEASAT microwave and radar sensors, we will also make careful observations of the ice surface properties, as well as photograph the site from the ice surface, and from a low altitude from the helicopter.

At the same time, Wadhams will deploy his strain gauge array and record the propagation of waves through the ice. Given these two operations, our station time will be about one hour. All of this instrumentation has been tested; we carried out the coring observations in March 1978 in Norton and Kotzebue Sound for example; and Wadhams deployed his strain gauge array in February 1978 on the pack ice off Newfoundland. For long range flights, we will be able to restrict our instrument weight to 300 pounds and two people. We would take stations for a period beginning about three days before the SAR turn-ons, and lasting about three days after, which would give us two weeks to 16 days on the island. Coordination with the Mohawk and the SEASAT office at the Jet Propulsion Laboratory in Pasadena, California, will be done by telephone out of Mekoryuk. Alternatively, we can place a fourth person in Bethel or Fairbanks to coordinate the helicopter, aircraft, and SEASAT. As we previously explained, our traverse locations are not known; however, the chart (Figure 6) shows several possible traverses based on the location of this year's ice edge. Basically, we will try for 2-4 stations per flight, depending on distance travelled and the weather.

(ii) Ship. Our alternative will be to work from a ship in Bristol Bay at the ice edge. Ideally, we will need the following: first, the ability to get down on the ice floes for periods of up to one hour in order to take ice cores and to deploy our strain gauge array and, second, the ability to steam into the pack for distances of 10-40 km, and then remain at a station long enough to occupy a station.

If a ship is available, we will see if Wadhams can also bring his wave rider buoy with him, which will also allow us to obtain ocean wave spectra within the open water. As far as time goes, we would like to operate from the ship for a period of 10 days to two weeks.

Finally, if both a ship-of-opportunity and a helicopter are available in February, we would like to deploy the wave rider buoy with one person from the ship, and the coring equipment and strain-gauge array from the helicopter.

To summarize, if we work out of Mekoryuk by helicopter, we will have three people on the island, and possibly a fourth either on a ship-of-opportunity with a wave buoy or at Bethel or Fairbanks coordinating the operation. For this case, our program will concentrate on the ice properties inside of the ice edge. Alternatively, if we work from a ship, we will have three or four people on the ship and a program which will concentrate on the immediate properties of the ice edge.

VII. SAMPLING METHODS

We will try to occupy between 18 and 24 stations. At each station, we will pull a core with our SIPRE corer, measure its temperature profile with thermistors, then cut up half the core into horizontal sections which are 50-100 mm in thickness and package them in order to melt them down to measure the salinity. We will also photograph the core to record the vertical crystal structure, and look for evidence of rafting. In particular, we will also measure the surface salinity and record the surface snow depth and crystal structure for comparison with the SEASAT radiometer observations.

Also, at the present time, Dr. Peter Wadhams of the Scott Polar Research Institute will bring his strain gauge and accelerometer package which measures the frequency and amplitude of the ocean waves propagating through the pack ice. He may also bring his wave-rider buoy for use in open water.

VIII. ANALYTICAL METHODS

The ice data will be presented in tabular form for use in estimates of sea ice strength and on the effect of the ice surface properties on microwave frequencies. The wave data will be analyzed using standard computer programs on an ONR contract at the Scott Polar Research Institute.

IX. DELIVERABLE PRODUCTS

A. Digital Data: none

B. Narrative Reports:

1. Our ice core data will be written up in an OCSEAP narrative report.

2. The wave data will be analyzed at the Scott Polar Research Institute on an existing ONR contract and the results submitted to OCSEAP as a narrative report.

3. The final combined OCSEAP/SEASAT report which will combine the satellite and surface truth observations will be submitted to OCSEAP.

C. Visual Data: The results of the remote sensing flights will be submitted to OCSEAP as photographic and radar images.

To summarize, we will submit core reports on about 24 stations, for about one printed page each. We will submit an additional 20 pages of narration and core and site photographs. We will also submit the results of 1-4 overflights of the experimental area in the form of photographic strips from the MOHAWK. The wave data will be submitted as a narrative report of about 40 pages.

X. QUALITY ASSURANCE PLAN

Our data analysis follows standard techniques for the measurement of temperature and salinity. The wave data will be analyzed using standard Fourier spectral analysis techniques.

XI. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLAN

N/A

XII. LOGISTICS REQUIREMENTS

See attached forms.

DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year
sea ice properties and wave data	narrative report	70 pages	N/A	N/A	February 1979	August 1979
MOHAWK images	photographic strips	4 pages	N/A	N/A	February 1979	August 1979
SEASAT/ OCSEAP comparison	narrative report	80 pages	N/A	N/A	February 1979	September 19

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION University of Washington PRINCIPAL INVESTIGATOR Seelye Martin

---

A. SHIP SUPPORT

---

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.
   See chart (Figure 4) for possible ship track in and out of ice edge.

---

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible.
   SEE ATTACHED SHEET

---

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)
   SEE ATTACHED SHEET

---

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)
   SEE ATTACHED SHEET

---

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?
   Ours would be principal.
   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.
   We will take approximately 1 hour per station in daylight. Sample processing can be done at night. We will need about 8 vessel hours/day.

---

6. What equipment and personnel would you expect the ship to provide? A workbench with sink and fresh water, and we would like to have access to the weather observation

---

7. What is the approximate weight and volume of equipment you will bring?
   1,000 lbs; and a volume of about 5' x 5' x 5'.

---

8. Will your data or equipment require special handling? yes If yes, please describe.

   We will need help deploying the wave-rider buoy and in getting personnel on and off the ice.

9. Will you require any gases and/or chemicals? yes If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge. Gasoline and oil mix for our power head.

10. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.

No.

11. If you recommend the use of a non-NOAA vessel, what is the per sea day charter. cost and have you verified its availability?

N/A

12. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.

Three. Seelye Martin, Peter Kauffman, and Peter Wadhams (British citizen).

Attachment to "Ship Support" Logistics Form

2. Types of Observations to be made on the Tracks

In open water at the edge of the pack ice, we will deploy a wave rider buoy to measure the ocean wave spectra. This will involve deployment and recovery of a standard wave-rider buoy; the operation will last about one hour. At the grid points inside of the ice, we will need to get down on the ice surface for periods of about one hour, in order to take ice cores and deploy the strain gauge-accelerometer array to measure wave propagation through the ice. This will involve two to three people going out on the ice and working for a period of about one hour.

3. Chronology

The optimum time chronology will be from 1-15 February, with the option of any ten day period in 1 February to 15 March. The most important aspect of this experiment will be to synchronize our observations with the SEASAT, and to work at stations ranging from just outside the ice edge to stations 10-30 nautical miles inside the edge. The purpose is to gather data on ice thickness and surface properties.

4. Sea Days

The chart shows five traverses into the ice edge. If we figure two days per traverse, then the experiment will take 10 days.

B. AIRCRAFT SUPPORT - FIXED WING

1. Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)

SEE ATTACHED SHEET

2. Describe types of observations to be made.

SLAR and photographic mapping from MOHAWK or C-117.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

We wish to have 1-4 overflights simultaneous with the coring observations. Therefore 1-20 February.

4. How many days of flight operations are required and how many flight hours per day?

4 days at 3 hours/day

Total flight hours? 12

5. Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback?

N/A

6. What types of special equipment are required for the aircraft (non carry-on)?

What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.

N/A

7. What are the weights, dimensions and power requirements of carry-on equipment?

None

8. What type of aircraft is best suited for the purpose?

MOHAWK or C-117.

9. Do you recommend a source for the aircraft? No.
If "yes", please name the source and the reason for your recommendation.

10. What is the per hour charter cost of the aircraft?

N/A

11. How many people are required on board for each flight (exclusive of flight crew)?

None

12. Where do you recommend that flights be staged from?

Bethel

Attachment to "Aircraft Support-Fixed Wing" Form

1. Possible Flight Lines

The chart (Figure 5) shows two possible flight lines running out of Bethel. The exact determination of the flight lines will depend on the ice conditions and the satellite orbit; also on whether we operate from a ship or a helicopter. In either case, we would like the flight lines to overlap both the surface observations and the satellite track. The location of the flight lines will vary depending on our research platform; the details of the flight lines can be worked out in December-January.

C. AIRCRAFT SUPPORT - HELICOPTER

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

   See Figure 6.

2. Describe types of observations to be made.

   We will land at different sites, take ice cores, analyze site topography, and record wave data.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

   optimum: 1-18 February; maximum: February - 15 March

4. How many days of helicopter operations are required and how many flight hours per day? 14 days at 1 - 2 hours/day

   Total flight hours? 25 hours

5. How many people are required on board for each flight (exclusive of the pilot)?

   Three for short range flights; two for long range.

6. What are the weights and dimensions of equipment or supplies to be transported?

   SEE ATTACHED LIST

7. What type of helicopter do you reommend for your operations and why?

   Bell 205 with long range tanks.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

   NOAA, based on previous experience.

9. What is the per hour charter cost of the helicopter?

   N/A

10. Where do you reommend that flights be staged from?

    Mekoryuk, or possibly Cape Newenham

11. Will special navigation and communications be required?

    Global or other on-board navigation system.

Attachment to "Aircraft Support-Helicopter" Form

6. <u>What are the weights and dimensions of equipment or supplies to be transported?</u>

a. Short range flights; 3 people plus the following:

Description	Weight (lbs)	Volume
sled	140	4' x 1' x 2.5'
power head	40	1.5' x 1.5' x 1.5'
2 auger flights	40 (total)	3' long x 0.75' diameter
2 instrument cases	40 (total)	2' x 2' x 0.5'
Strainmeter	100	2' x 1' x 1'
data logger	60	1' x 1' x 1'
instrument case	50	2' x 1' x 1'
Accelerometer	80	2' x 1' x 1'
	550 lbs	

b. For long range flights, we will restrict ourselves to 2 people and 200-300 lbs.

XIII. ANTICIPATED PROBLEMS

Our major uncertainty is the unknown position of the ice edge in February 1979. One advantage of Nunivak Island is that the pack ice nearly always surrounds the island. Another problem might be the formation of a large area of open water around Nunivak, thus prohibiting helicopter operations. A solution to this problem would be to use a ship as the research platform.

Contingency Plan

If adverse field conditions prevent accomplishment of our field objectives, we will be forced to rely on the remote sensing data for analysis of the ice motion. Because we have used our instrumentation for the past three ice seasons, I feel that "bad ice" or "open water" would be the major cause of mission failure, instead of instrument failure. Again, problems with "bad ice" would be minimized by working from a ship.

XIV. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

This whole proposal is built around a cooperative proposal with the SEASAT program. Since I am the P.I. on that proposal as well as this one, any required remote sensing data will come to me through the SEASAT program.

XV. MANAGEMENT PLAN

The principal investigator will direct and/or participate in all phases of the work. Much of the photographic and instrumentation work will be done by Peter Kauffman.

By:	10 January 1979	Finish preparations for field experiment
	20 March 1979	Complete field traverse
	30 August 1979	Submit field report
	30 September 1979	Submit preliminary analysis of satellite data and comparison with field data.

(Note: Because the dates at which the satellite data will be available to the individual P.I. is unknown, the date for submission of the satellite data is a guess.)

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date

RU # 87 PI: Seelye Martin

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

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Finish preparation for field traverse				0											
Do field traverse					0										
Submit report on traverse											0				
Submit OCSEAP/SEASAT report												0			

XVI. OUTLOOK

If this joint OCSEAP/SEASAT effort is successful, it will certainly represent the attainment of a plateau of accomplishment. Further work will probably be necessary in 1980 for the analysis of the SEASAT images, but this will probably be funded through SEASAT. We will, however, submit copies of all of our SEASAT work to OCSEAP.

If the satellite is still operating in 1980, the one remaining area of study would be to study the withdrawal and melting of the Bering Sea pack ice from a combination of shipboard observations and satellite and aircraft overflights. This program, however, would depend upon the successful completion of the February 1979 observations.

XVII.

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the P.I. is prepared to travel to the Project Office to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The P.I. will

maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

FIGURE CAPTIONS

1. An example of the dense SEASAT coverage at high latitudes (from the NOAA SEASAT Development Plan).

2. NOAA-4 image of the Bering Sea on 13 January 1975 during a period of strong anticyclonic circulation.

3. LANDSAT images of the Bering Sea ice for anticyclonic circulation. The frames measure 185 km across in the horizontal. (3a) The Bering Straits to Saint Lawrence Island, 17 March 1976. (3b) West of Saint Matthews Island to the pack edge, 18 March 1976. (3c) Bristol Bay, 23 March 1975.

4. A chart of a possible ship tracks with ice and open water stations marked by 'x's.

5. Chart showing two possible overflight tracks.

6. Chart showing possible helicopter landing sites.

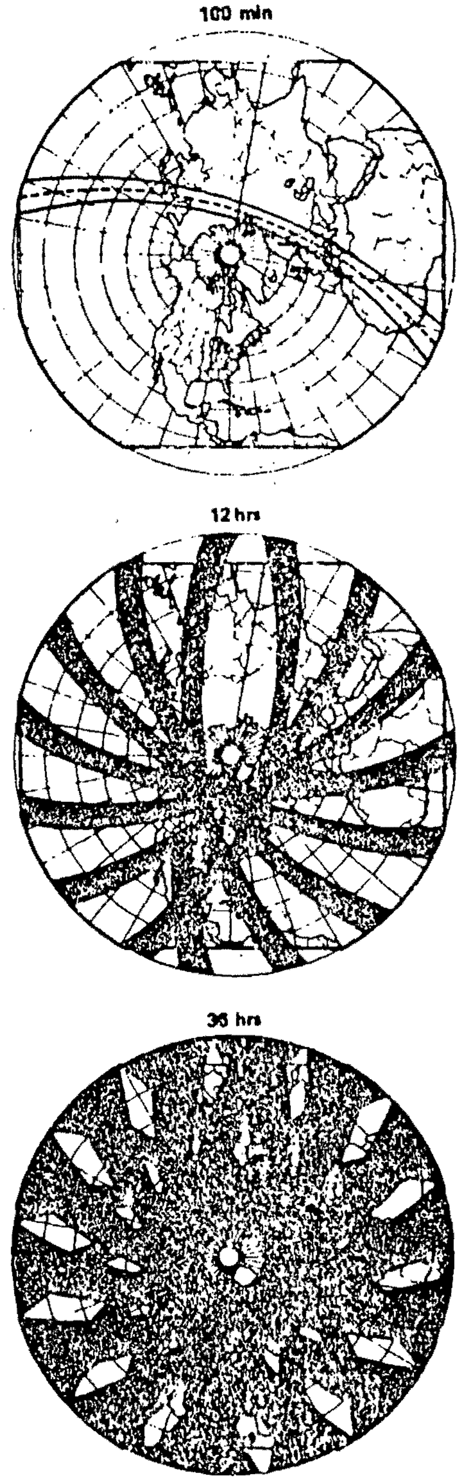

Figure I-19.--SEASAT-A global coverage.

Figure 1

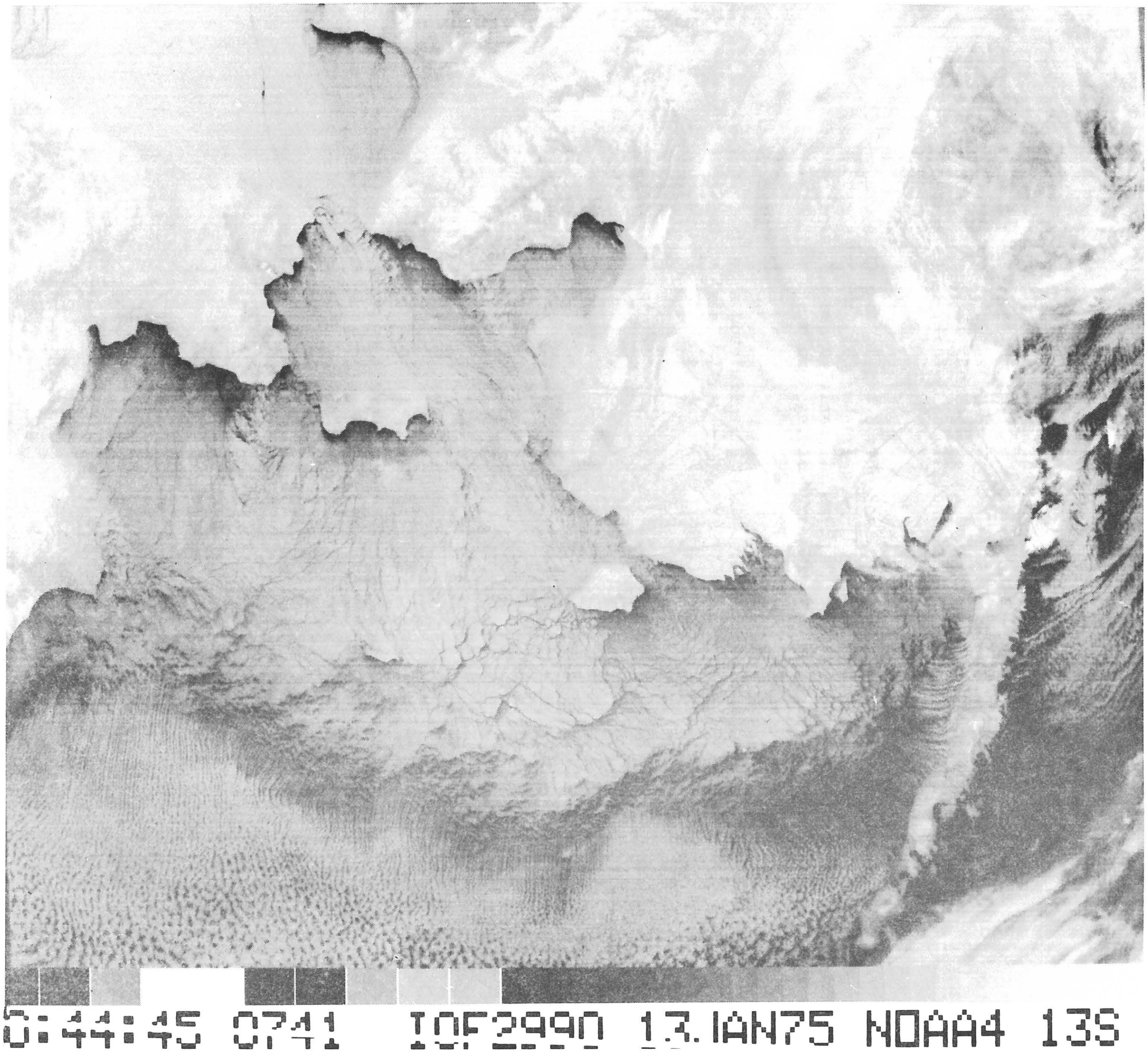

Figure 2

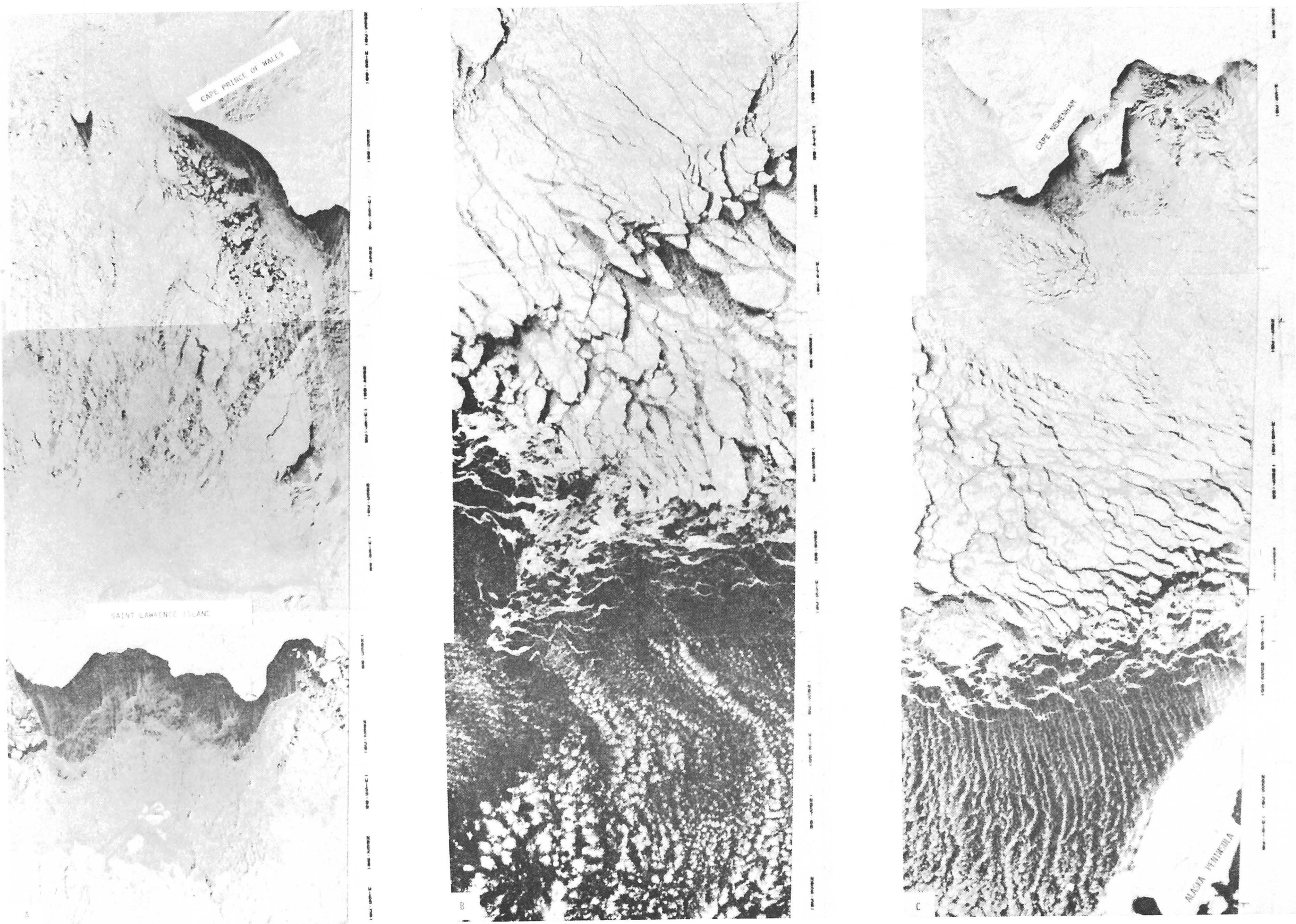
CAPE PRINCE OF WALES
SAINT LAWRENCE ISLAND
B
CAPE NEWENHAM
ALASKA PENINSULA
C

Figure 3

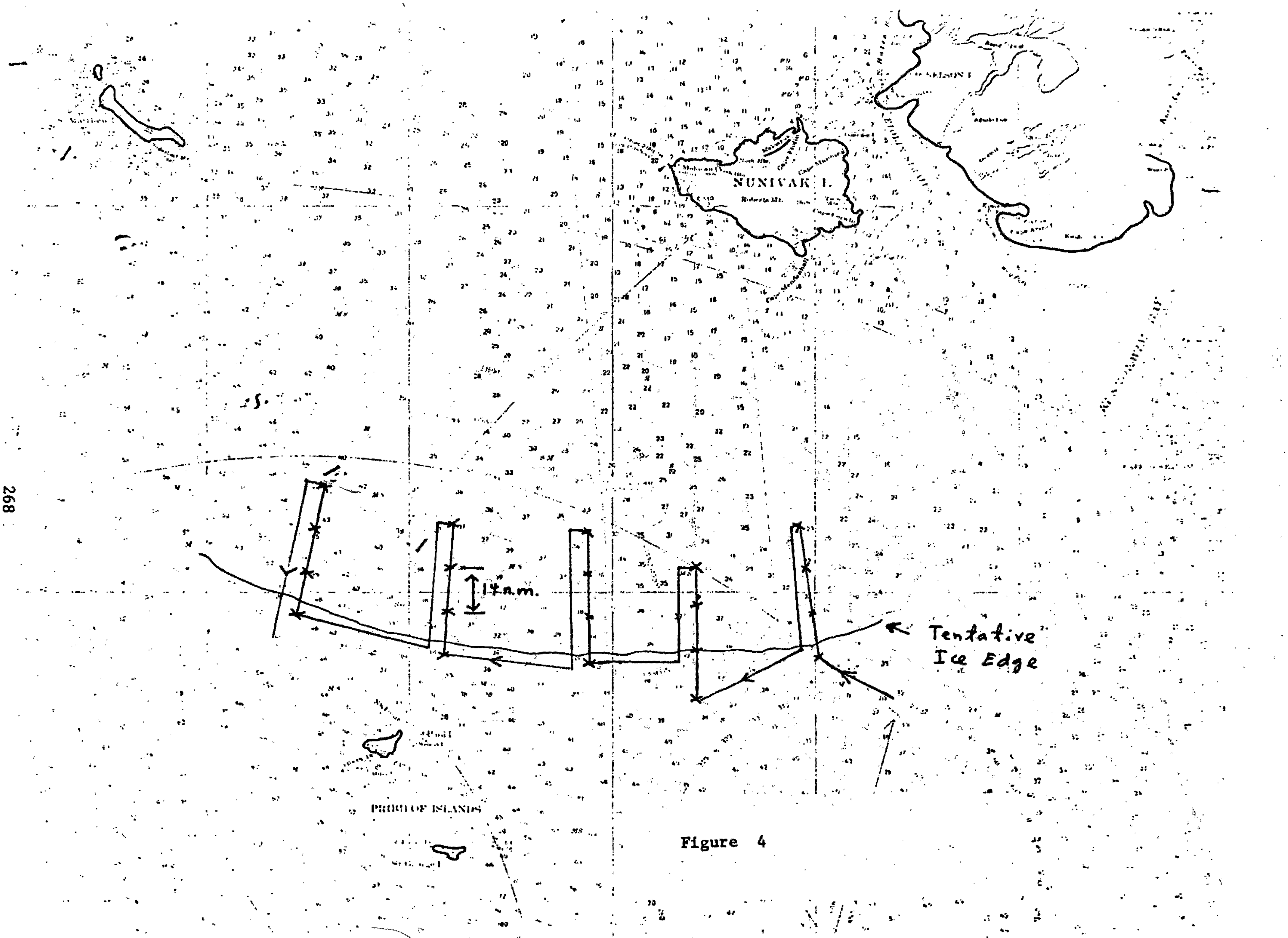

Figure 4

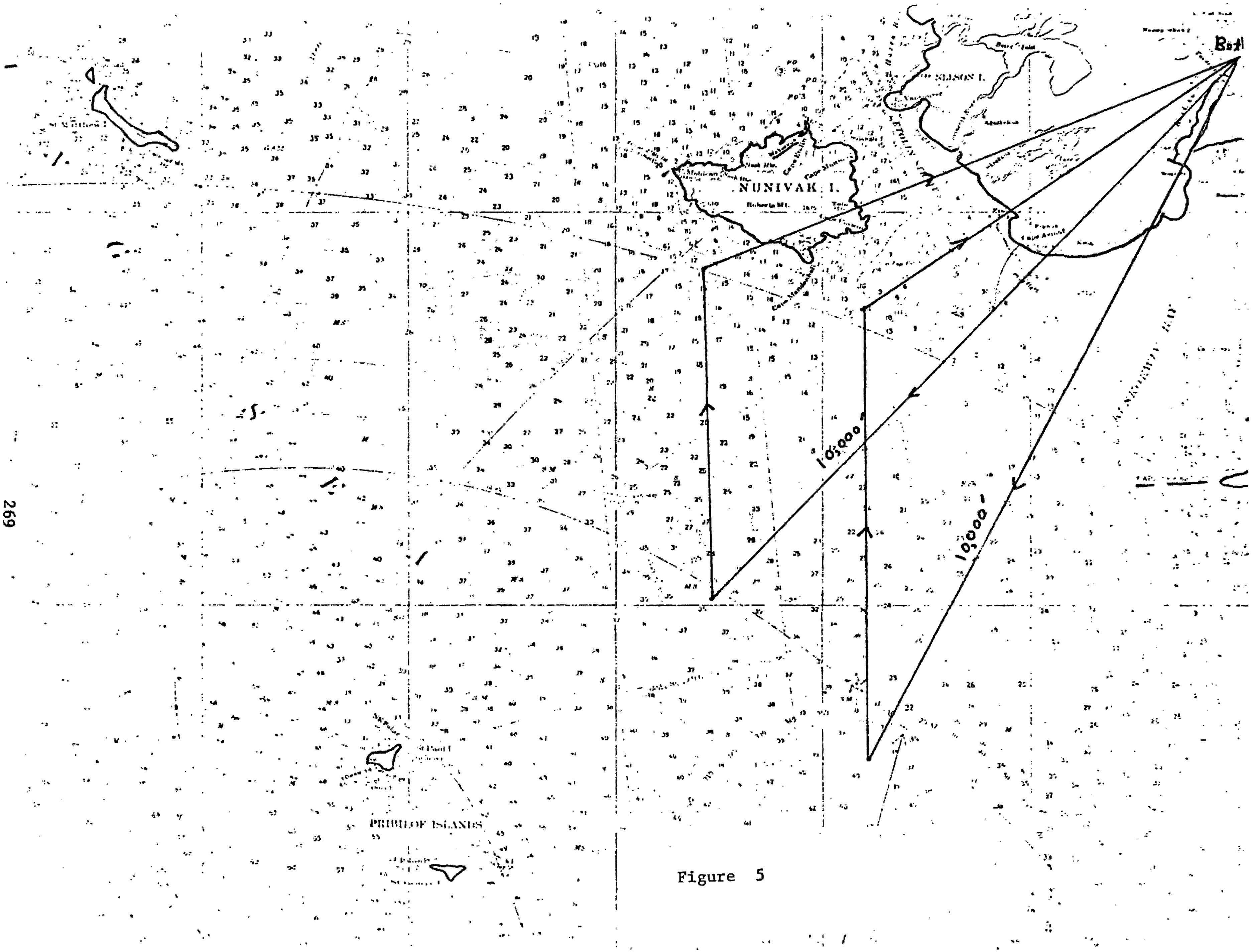

Figure 5

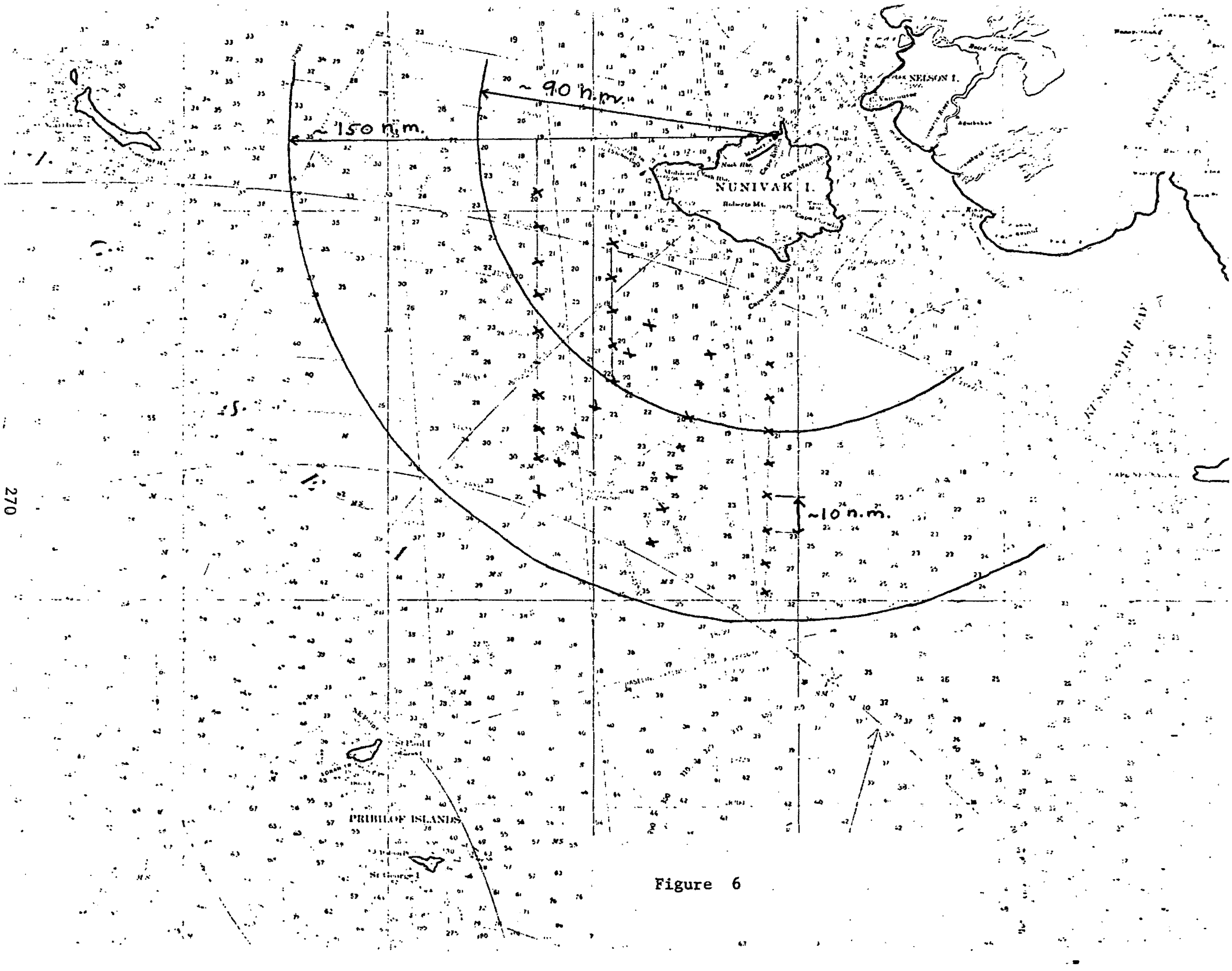

Figure 6

1. COVER PAGE

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Proposal Date: 15 June 1978

Contract #: 01-5-022-1651

Task Order #: N/A

NOAA Project #: R.U. #88

Institution ID#: N/A

FY 1979 RENEWAL PROPOSAL

Research Unit Number 88.

TITLE: Dynamics of Near-Shore Sea Ice

Period of Proposal: October 1, 1978 through September 30 1979

Institution: U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755 (603) 643-3200

W. F. Weeks

W. F. WEEKS (ext 261)
Principal Investigator

A. Kovacs

A. Kovacs (ext. 411)
Principal Investigator

D. R. Freitag

D. R. FREITAG (ext 200)
Technical Director

Frank J Ferraro

F. Ferraro (Ext. 315)
Comptroller

3. TECHNICAL PROPOSAL

I. <u>Title</u>

Dynamics of Near-Shore Sea Ice

OCSEAP Research Unit #88

Contract #: 01-5-022-1651

Proposed Date of Contract: 1 October 1978 - 30 September 1979

II. <u>Principal Investigators</u>

W. F. Weeks and A. Kovacs

III. Cost of Proposal for Federal Fiscal Year (1 October 1978 - 30 September 1979).

A.	Science	$55671
B.	P.I. Provided logistics	0
C.	Total	$55671

D. Distribution of Effort by Lease Area.

Beaufort Sea	60%
Chukchi Sea	20%
N. Bering Sea	20%

IV. Background

There are three main thrusts to the present proposal. These are concerned with the study of ice movements and coastal pile-ups along the coast of the Beaufort Sea, the study of ice movement through the Bering Strait, and the occurrence of large scale preferred crystal orientations in the near shore ice of the Arctic Ocean and the use of these orientations to map mean ocean current directions via remote sensing. All this work is a direct extension of our previous field studies.

V. The objectives of the different sections of this proposal are as follows:

A. Beaufort Sea Ice Movement and Ice Pile-up Studies:

We plan to complete the final preparation of the Narwhal Island "overview" report on our two years of study of near-shore ice motion north of the Prudhoe Bay area. In addition Kovacs plans to prepare a report on his observations of near-shore ice pile-ups in the Beaufort Sea. [These studies have direct bearing on design and on hazard assessment for proposed offshore oil and gas operations along the margins of the Beaufort Sea.]

B. Bering Strait Imaging Radar Studies:

It is planned to continue the operation of the X-band ice radar system at Tin City during the 1978-79 ice season; [This research provides an essential part of the information needed to develop an adequate scenario for a major oil spill in either the Beaufort or Chukchi Seas in that the movement of the oil is largely controlled by the movement of the ice, which in turn is influenced by the flux of ice through the Bering Strait. This data also can be used to provide boundary conditions for ice drift models for the Bering and Chukchi Seas.]

C. Remote Sensing of Under-Ice Current Directions:

Our studies this present year suggest that essentially all the fast ice along the Arctic Coast of Alaska shows crystal alignments in the horizontal direction. The orientations are sufficiently strong to affect the properties of the ice. Inasmuch as the direction of the crystal alignment is believed to be controlled by the direction of the current under the ice, it should be possible to develop a remote sensing technique to measure current direction indirectly via sensing the orientation direction. We propose to perform tests to see if such a technique can be developed by using polarized continuous wave reflectometry. [If these studies are successful they will result in a technique that will allow the OCSEAP to rapidly collect data on under-ice-current directions from a helicopter platform. Such data is very important to a variety of OCSEAP needs and is now largely non-existent, particularly during the ice growth season.]

As will be seen in the budget for this program, we are only requesting support for travel and logistics for OCSEAP. It is anticipated that the rest of the costs of this work (salaries, equipment, etc.) will be funded by NSF. Our earlier work (1977-78) on this subject was also supported by joint OCSEAP/NSF funding.

VI. <u>General Strategy and Approach</u>

A. Beaufort Sea Ice Movement and Ice Pile-up Studies:

This program is completely concerned with the analysis of data that has already been collected.

B. Bering Strait Imaging Radar Studies:

Again this is an on-going program. The proposed work simply consists of operating and maintaining the radar unit presently installed at Tin City.

C. Remote Sensing of Under-Ice Current Directions:

This program will be a simple field experiment using polarized continuous wave reflectometry. The majority of the equipment is already available at CRREL. The reflectometry measurements will be checked by making crystal observations at a number of locations near Barrow. Barrow is an ideal site in that our previous work has shown that strong fabrics with a variety of widely different orientations exist there. The maximum time in the field would be two weeks. If the test is successful, then an operational system can be designed for regional current mapping via a helicopter.

VII. Sampling Methods

A. N/A

B. Bering Strait Imaging Radar Studies:

The radar screen is photographed every 2 1/2 minutes. Considering the rate of ice movement, this gives an essentially contonuous picture of ice drift through the Strait.

C. Remote Sensing of Under-Ice Current Directions.

Tests will be made at several locations near Barrow where the crystal orientations (and current directions) are known (and quite different). The structure of the ice will be independently characterized as will the ice temperature and salinity profiles.

VIII. Analytical Methods

We plan to examine the statistical nature of the ice motion in time-series as revealed in our radar data. We are particularly interested in peak motions and their correlations with meteorological variables such as either observed or calculated wind velocity. Inasmuch as the coastal pile-ups study is primarily devoted to describing natural ice pile-ups, the end result is a "static" description of the pile-ups. However particular attention will be paid to examining shear planes in the ridges and relating these to theories of the failure of granular materials. In the reflectometry study of crystal orientation the nature of the returns will be compared with the statistical characteristics of the crystal alignments. It is also hoped that this technique will be useful in revealing horizontal discontinuities in the ice.

IX. Deliverable Products:

The main output from this program will be a series of CRREL reports focused on the different specific aspects of the program outlined above. Each of these reports will contain maps, graphs, photographs, and data tabulations selected to best illuminate the material being discussed.

X. Quality Assurance Plan:

In the ice movement studies from Narwhal Island a transponder was placed on land and ranges were determined continuously to it. This measurement of a fixed distance was used to check the operation of the system. Also for each value that was used, 5 independent measurements were made. There were a few bad values but they were very easy to identify and discard. In the Bering Strait study there are several clearly discernable land features that do not move and are located in the image (Fairway Rock, Little Diomede, and the barrier island that bounds Lopp Lagoon). If there are problems with distortion of the image they are therefore immediately apparent and can be corrected. The strength of the radar returns as shown on the photographic record is, however, set arbitrarily to bring out the maximum contrast of the sea ice features.

XI. Archival Plan;

Out program is completely focused on sea ice. At the present time we do not plan to archive sea ice samples as they change with time unless kept at very low temperatures. All sample characterization will be carried out in the field. If this plan changes we will then file an archival plan.

XII. Logistics Requirements

The only logistics requirement will be support from NARL for the Under-Ice Current Direction Study. The support required will consist of 4 days of single Otter time, 10 days of skidoo and sled use.

A specific listing of support requirements is as follows:

Remote Sensing of Under-Ice Current Directions

Point-of-Contact - W. F. Weeks

B. Air Craft Support - Fixed Wing

1. Location of Flights

   Local flights to advantageous ice sites between Barrow and Lonely.

2. Types of Observations

   Aircraft used for transportation only.

3. Time of Flights

   Late March or April 1979.

4. Days of operation

   4 days, approximately 5 flight hours per day.

5. Relation to other investigations

   No strong interactions but piggy-backing is possible

6. Special equipment

   None

7. Weights, etc.

   300 lbs.

8. Type of aircraft

   Single Otter

9. Source

   NARL

10. Cost

    Approximately $175/flight hour

11. Number of people on board

    4 people

12. Staging Area

    NARL

D. Quarters and Subsistence Support

1. Requirements

   Food and lodging for 4 people for 14 days (max) each.

2. Source

   NARL

3. Man-day cost

   ∿$90/day (depends on final rates set at NARL)

XIII. Anticipated Problems/ Contingency Plan:

In the event of an aircraft failure, a similar airplane can be procured from commercial sources in Barrow.

The only cure for bad weather is to wait for a better day.

XIV. Information Required from Other Investigators.

All information on currents in the shallow waters of the Beaufort and Chukchi Seas.

XV. Management Plan

All investigators involved with this program are experienced and have worked on a variety of similar programs in the past. General administrative control of the project will be handled by Dr. G. D. Ashton, Chief, Snow and Ice Branch, CRREL, who is well acquainted with the subject area of the proposed studies.

Major Milestones	Date
1. Tune-up and check radar at Tin City	30 October 1978
2. Complete crystal orientation paper (1978 data)	30 November 1978
3. Complete final Narwhal Island paper	30 January 1979
4. Complete field observations from Barrow	15 April 1979
5. Complete coastal ice pile-ups paper	30 June 1979

XVI. Outlook

It is likely that we will propose some additional studies on ice pile-ups, near shore ice motions and the determination of fabric variations (and current directions) via remote sensing. Additional analysis of the Bering Strait radar imagery will undoubtedly be proposed.

O - Planned Completion Date

X - Actual Completion Date

RU # 88 PI: Weeks, Kovacs

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
1. Tune-up radar at Tin City	30														
2. Complete crystal orientation paper			15												
3. Complete pressure ridge review						1									
4. Complete field observations at Barrow							30								
5. Complete coastal ice pile-ups paper									30						
6. Complete final Narwhal I. paper												1			

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

TO:	Arctic Project Office 506 Elvey Building Geophysical Institute University of Alaska Fairbanks, AK 99701
TYPE OF SUPPORT REQUESTED:	Contract (Renewal)
TITLE OF PROJECT:	Current Measurements in Possible Dispersal Regions of the Beaufort Sea Research Unit: 91 Present Contract No.:03-5-022-67 T.O. 3
PRINCIPAL INVESTIGATOR:	Knut Aagaard, Research Professor Department of Oceanography College of Arts & Sciences University of Washington Seattle, Washington 98195 Telephone: Area Code (206) 543-7978
AMOUNT REQUESTED:	$60,300
DESIRED GRANT PERIOD:	1 October 1978 - 30 September 1979
UNIVERSITY OFFICE TO BE CONTACTED REGARDING CONTRACT NEGOTIATION:	Grant and Contract Services 1 Administration Building, AD-24 University of Washington Seattle, Washington 98195 Telephone: Area Code (206) 543-4043

DATE: 21 June 1978

Knut Aagaard

Knut Aagaard, Research Professor
Principal Investigator

G. C. Anderson

George C. Anderson
Associate Chairman for Research
Department of Oceanography

Joe S. Creager

Joe S. Creager, Associate Dean
College of Arts & Sciences

OFFICIAL AUTHORIZED TO GIVE UNIVERSITY APPROVAL:

D R Baldwin

Donald R. Baldwin, Director
Grant & Contract Services
1 Administration Building, AD-24

7-3-78

REF: P78-66

Technical Proposal

I. Title: Current Measurements in Possible Dispersal Regions of the Beaufort Sea
Research Unit No.: 91
Present Contract No.: 03-5-022-67, T.O. 3
Proposed Dates: 1 October 1978 - 30 September 1979

II. Principal Investigator: Knut Aagaard

III. Cost: A. $60,300
B. none
C. $60,300
D. Beaufort Sea - 100%

IV. Background

Until the present, physical oceanographic efforts in the Beaufort Sea have been concentrated in the two extreme portions of the continental shelf area: the very shallow (yet extensive) nearshore areas and the deeper parts of the shelf. The objective of this work has been to determine dispersal mechanisms for pollutants. The results of these efforts in the nearshore area (RU 526, Matthews) indicate a strong wind-driven mechanism, providing a net westward motion during the ice-free months. Meanwhile, results from the deeper part of the shelf (> 100 m) by this research unit indicate a net eastward motion of water originating in the Bering Sea. These currents appear to be strongly aligned along bathymetric contours and contain a strong low-frequency component, comparable with meteorological frequencies. However, no obvious connection with meteorological events has been found. This flow continues year-round and its forcing mechanism is not clear. To date, little is known about flow under ice in the nearshore area. However, it is assumed that the motion is severely diminished except during storm-surges which probably cause substantial flows under the ice.

These results have raised the following questions:

1. How are these two flow regimes linked?

2. What is the nature of the transition zone, and where is it located:

3. What mechanisms exist for cross-shelf transport through this transition zone and what is their temporal nature?

4. Do the outer-shelf low-frequency components represent an indication of meteorological forcing that is possibly stronger in the transition zone?

5. What is the seasonal variation of effects in the transition zone?

V. Objectives

In order to answer these questions, measurements of currents and temperatures should be made along two sections extending across the apparent transition zone from the nearshore area to the outer shelf.

VI. - VIII. Strategy and Methods

In order to answer questions 1, 2, 3 and 5, research unit 91 would work cooperatively with research unit 526 in the following way:

1. RU 526 would deploy two bottom-mounted current and temperature instruments about 149°W, the offshore one being in water 20 m deep.

2. RU 91 would deploy two moorings in the same section, each with two instruments. The mooring depths would be 60 and 100 m.

Question No. 4 will be answered by a similar deployment along a second section near 146°W.

These deployments would be made about the third week of February 1979 by means of a combined logistical effort on the part of the two research units. Instrument recovery would be made in the following way:

1. In order to avoid loss of instruments, RU 526 would pick up the bottom-mounted instruments just prior to break-up of the ice in summer and re-deploy them just after break-up of the nearshore ice.

2. At the end of the open water season all instruments would be picked up by boat just prior to freeze-up or by helicopter after freeze-up.

IX. Output

1. Digital Data: Long time series of current meter measurements, including position, depth, time, current components, and temperature. See attached data products schedule.

2. Narrative Reports: Narrative of the circulation on the Beaufort Sea shelf, including a calculation and analysis of vector means and trends over various time scales, examination of unusual or special current events with particular attention to processes related to the transition zone between the nearshore.

3. Visual Data: Graphic presentations of current meter data.

DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submissic (Month/Ye
Current Meter						
Mooring Lonely 2 92m 167m	Tape		015	Yes	4/77 to ?	?
Mooring Lonely 5 64m 84m	"		015	Yes	3/78 to 10/78	1/79
Mooring Lonely 6 68m 188m	"		015	Yes	3/78 to 10/78	1/79
Mooring Lonely 3 65m 85m	"		015	Yes	11/77 to 10/78	1/79
Mooring Lonely 4 57m 178m	"		015	Yes	11/77 to 10/78	1/79
Mooring Oliktok 1 40m 50m	"		015	Yes	2/79 to 8/79	12/79
Mooring Oliktok 2 40m 90m	"		015	Yes	2/79 to 8/79	12/79
Mooring Flaxman 1 40m 50m	"		015	Yes	2/79 to 8/79	12/79
Mooring Flaxman 2 40m 90m	"		015	Yes	2/79 to 8/79	12/79

File Type 015

Current Meter

Common to all records
- File Type
- File Identifier
- Record Type
- Meter Number

Record Type 1 - Text Record (optiontal)
- Meter Number
- Text
- Sequence Number

Record Type 2 - Master Record
- Latitude/Longitude
- Depth to Bottom
- Depth of Current Meter
- Meter Usage Sequence Number
- Institution Code
- Axis Rotation
- Location Name
- Number of detail Records

Record Type 3 - Detail Record
- Year/Month/Day/Time
- East-Weat Current Component
- North-South Current Component
- Temperature, Pressure, Conductivity } if present
- Sequence Number

X. Quality

Instruments will be calibrated at the Bonneville towing facility, at the Northwest Regional Calibration Center in Bellevue, and/or with the University of Washington facilities as required.

Normal time series analysis will be used with the current records.

XI. Special Sample Plans

None

XII. Logistics Requirements

See attached forms.

XIII. Contingency Plan

Full execution of the above program requires retrieval of instruments presently deployed in the Beaufort, scheduled for fall 1978. Should such retrieval not be complete, proposed instrument deployment will be reduced accordingly.

XIV. Other Information Required

As in VI - VIII above, in conjunction with RU 526.

C. AIRCRAFT SUPPORT - HELICOPTER

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).
The four mooring sites are approximately 40 and 46 nautical miles NNE from Oliktok and 30 and 36 nautical miles N from Flaxman Island.

2. Describe types of observations to be made.
Deploy and retrieve moored current meters.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?
Deployment must be in February 1979 and recovery in September 1979.

4. How many days of helicopter operations are required and how many flight hours per day? 2-4 days are required to deploy and 4-8 days to recover, each of approximately 6 hours flying.
Total flight hours? 36-72 hours, staging not included.

5. How many people are required on board for each flight (exclusive of the pilot)?
3 men on deployment
3-4 men on recovery

6. What are the weights and dimensions of equipment or supplies to be transported?
Total weight is about 3600 lbs. each mooring on deployment and recovery.
All equipment can be broken down to fit inside a Bell 205 or UH1H.

7. What type of helicopter do you reommend for your operations and why?
Bell 205 or UH1H, based on previous experience. Must have muff heater and VLF navigation.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.
Charter, e.g. ERA, Evergreen, or NOAA, based on previous experience.

9. What is the per hour charter cost of the helicopter?
N/A

10. Where do you reommend that flights be staged from?
Deadhorse/Prudhoe

11. Will special navigation and communications be required?
VLF (GLOBAL or ONTRAC) is required.

XV. Management Plan

See attached milestone chart.

XVI. Outlook

No further work is anticipated once analysis of these data is completed.

XVII.

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

O - Planned Completion Date

X - Actual Completion Date

RU # 91 PI: Knut Aagaard

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

	1978			1979												
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
Instruments deployed																
Processing and data submission																
Analysis and final report																

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Proposal Date: 30 June 1978
Contract No: 01-5-022-2313
Task Order No: ____________
NOAA Project No: ____________
Institution ID No: USACRREL

FY 1979 RENEWAL PROPOSAL

Research Unit Number 105

TITLE: Delineation and Engineering Characteristics of Permafrost Beneath the Beaufort Sea

Cost of Proposal: $65,000 Lease Area: Beaufort Sea 100%

Period of Proposal: October 1, 1978 through September 30, 1979

Required Signatures:

Paul V. Sellmann 30 June 1978
PAUL V. SELLMANN, PI
U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755
Telephone: (603) 643-3200 Ext. 318

for Ronald Atkinson 30 June 1978
EDWIN J. CHAMBERLAIN, PI
U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755
Telephone: (603) 643-3200 Ext. 236

Frank J Ferraro 30 June 1978
FRANK J. FERRARO, Comptroller
U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755
Telephone: (603) 643-3200 Ext. 315

30 June 1978
LT COL ALFRED B. DEVEREAUX
Commander and Director
U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755
Telephone: (603) 643-3200 Ext. 200

TECHNICAL PROPOSAL

I. Title:

Delineation and Engineering Characteristics of Permafrost Beneath the Beaufort Sea.

Research Unit Number:
RU-105

Contract Number: (For current year)
01-5-022-2313

Proposed Dates of Contract:
1 October 1978 - 30 September 1979

II Principal Investigator(s):

Paul V. Sellmann
Edwin J. Chamberlain

III. Cost of Proposal for Federal Fiscal Year (FY79):

A. Science $65,000

B. PI provided logistics 0

C. Total $65,000

D. Lease Area:

Beaufort Sea - About 90% of the total effort will be in this lease area. Some data may be examined beyond its limits, although this information should be applicable to the Beaufort Sea study.

IV. Background:

Drilling, probing and seismic methods and the analysis of core data have provided useful information on the occurrence, depth and characteristics of subsea permafrost in the Beaufort Sea. From these local site specific investigations (carried out by RU 105, as well as RU's 204, 253, 271 and 473) regional extrapolations now have to be made. These are partially carried out by RU's 253, 473 and 516 (thermal regime, shoreline history, etc.). A promising means of regional investigation of the extent and position of the top of bonded subsea permafrost is through seismic methods as indicated from recent studies in the Canadian Beaufort Sea. This can be done by reprocessing the upper part of seismic records obtained by commercial and industry sources for petroleum exploration. The final interpretation of these regional seismic data depends on availability of control data acquired as part of the probe and detailed seismic studies from current RU 253 and 273 activities. The control also is provided by the geological investigations such as RU 204 and RU 473. The specific importance of these projects lies in determining whether seismic data are yielding information on the top of bonded permafrost or other lithologic differences in the section.

V. Objectives:

Obtain data on the occurrence and depth of shallow subsea permafrost on the Beaufort Sea continental shelf. This information would be used in assessing the hazards that permafrost presents to offshore development.

VI. General Strategy and Approach:

Assuming the results of the current pilot study are promising, additional seismic data coverage will be acquired in an attempt to determine distribution patterns of shallow, high velocity layers that may be the top of bonded permafrost. The objective would be to acquire several lines through the lease area and determine what permafrost information they contain. The program will also be coordinated with the proposed CRREL chemistry study of samples obtained as part of the new USGS Conservation Division Subsea Permafrost project. Results of studies of some specialized engineering properties that may be conducted at CRREL, as part of the new USGS program, will be incorporated with previous engineering property investigations.

VII - VIII. Methods:

The spacing and location of seismic data selected for analysis will depend on the distribution of available data and on areas having some subsurface control. An attempt will also be made to acquire some processed data from closely spaced lines to determine lateral variability. It now appears that data will be available across the lease area. The depth of detectable high velocity layers will be plotted along the seismic lines. Supplemental data from any drilling program and data generated by RU's 253, 271, 473 and 516 will be used to determine if high velocity zones correspond with the position of the top of bonded permafrost. This approach has been covered in detail by Hunter et al, 1976 (Permafrost and Frozen Sub-sea Bottom Materials in the Southern Beaufort Sea. Beaufort Sea Technical Report No. 22, Beaufort Sea Project, Department of the Environment.)

IX. Deliverable Products:

A. Digital Data: (None.)

B. Narrative Reports:

Since reporting during the FY78 program was restricted primarily to the chemistry and engineering property studies, emphasis will be placed on the seismic study during 1979. In addition to quarterly and annual reports, one report will cover all results of the seismic studies, with a discussion of methods and results of determining the extent of the top of bonded permafrost, including the confidence level that should be assigned to both methods and results.

C. Visual Data:

The map information included in the report will locate zones where the top of bonded permafrost was indicated by seismic and control data. Supporting information on material properties and distribution of sediment will be included when available.

D. Other: None.

X. <u>Quality Assurance Plan</u>:

The only procedures employed that may require discussion are those used for processing the field seismic data. The techniques used will be the same as those that have evolved from the Canadian Beaufort Sea study. These techniques, involving increasing the gain on this part of the record, have provided considerable data on the first high velocity returns. The data used for most of the study will be processed by the company that processed the Canadian data. Results of the current pilot study will also indicate if records are of adequate quality for the project to continue.

XI. <u>Special Sample and Voucher Sample Archival Plans</u>: Not applicable.

XII. <u>Logistics Requirements</u>: None.

XIII. <u>Anticipated Problems</u>:

Record quality may vary considerably depending on parameters such as water depth and properties of the subsea sediments. It will be determined if records can be obtained that are suitable for interpretation before (FY79) funding has been transferred to the project. This will be based on limited existing data and new data that are being processed.

XIV. <u>Information Required from Other Investigators</u>:

All information on permafrost distribution and properties, and the geology of the lease area, will be required. Coordination continues between all work units in the subsea permafrost program. A recent meeting was held at CRREL in an attempt to integrate some of the results of the CRREL-USGS efforts.

XV. Management Plan:

Coordination will be maintained with Beaufort Sea subsea permafrost projects as well as with Canadian co-workers. A working session will be arranged with Osterkamp and Harrison and USGS personnel to review program results and determine future thrust of our activities.

MILESTONE CHART

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

				1978					1979						
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Acquire unprocessed industry data	—	—	—	—	—	—	—	—							
Have data adjusted and processed	—	—	—	—	—	—	—	—	—						
Analyze seismic data			—	—	—	—	—	—	—	—					
Analyze core properties	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -					
Prepare report summarizing results									—	—	—	—			

XVI. Outlook:

If the study of industry type seismic data provides all anticipated results and a large amount of promising data remains available, attempts to continue the effort will be made, possibly on a jointly funded basis.

XVII. The following standard statements are to be included as Section XVII of all FY79 proposals and will be binding under the contract:

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October; Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

D. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

E. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

F. Data will be submitted within 120 days of the completion of a cruise or three months data collection period, unless a written waiver has been received from the Project Office.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

TO: Bering Sea-Gulf of Alaska Project Office, Outer Continental Shelf Environmental Assessment Program, P.O. Box 1808, Juneau, Alaska 99802

PROPOSAL DATE: 1 July 1978

INSTITUTION ID #: 105-227

FY 1979 RENEWAL PROPOSAL

Research Unit No. 108

Title: SIMULATION MODELING OF MARINE BIRD POPULATION ENERGETICS, FOOD CONSUMPTION, AND SENSITIVITY TO PERTURBATION

Cost of Proposal: $50,000

Lease Area: Kodiak

Period of Proposal: October 1, 1978 through September 30, 1979

PRINCIPAL INVESTIGATOR:

Name: John A. Wiens

Date: 8 July 1978

Signature:

Address: Department of Biology, University of New Mexico, Albuquerque, New Mexico 87131

Telephone Number:

INSTITUTION: Department of Biology, University of New Mexico

REQUIRED ORGANIZATION APPROVAL:

Name: James S. Findley

Date: 18 July 1978

Signature:

Position: Chairman, Department of Biology

Address: Department of Biology, University of New Mexico, Albuquerque, New Mexico 87131

Telephone Number:

ORGANIZATION FINANCIAL OFFICER:

Name: Edmund B. Kasner, Director

Date: 19 July 1978

Signature:

Address: Office of Research Administration Bandelier West, University of New Mexico

Telephone Number: (505)277-3746 or 2256

TECHNICAL PROPOSAL

I. TITLE: Simulation Modeling of Marine Bird Population Energetics, Food Consumption, and Sensitivity to Perturbation

RESEARCH UNIT NO.: 108

CONTRACT NUMBER: NA

PROPOSED DATES OF CONTRACT: 1 October 1978 - 30 September 1979

II. PRINCIPAL INVESTIGATOR: John A. Wiens

III. COST OF PROPOSAL

A. Science: $50,000

B. PI-provided logistics: none

C. Total: $50,000

D. Distribution of Effort by Lease Area: Kodiak (100%)

IV. BACKGROUND

Consideration of population energetics of marine birds is an important avenue of research in OCS programs for several reasons. First, marine ecosystems are structured around the patterns and magnitudes of energy flows between ecosystem components. Given this, it follows that at least one way to assess the overall impact, role, importance, or potential sensitivity to disruption of a component such as marine bird populations in the system is to measure the energy flow through these populations (e.g. Wiens and Dyer 1977). Second, energetics directly link marine bird populations to the oceanic areas they use for feeding, and consideration of energy demands may thus provide a means of assessing the importance of feeding areas. Third, several research efforts in the Alaskan OCSEAP program have generated data on diverse aspects of marine bird biology (e.g. breeding colony structure, food habits, pelagic distribution and abundance, flock dynamics), and energetic measures can provide a common organizing framework within which these different data sets can be combined. Finally, since the energy demands of individual organisms directly reflect metabolic processes, they may be among the more sensitive aspects of marine bird biology in responding to local environmental perturbations (e.g. oil development accidents). If we can somehow measure or estimate the energy dynamics of marine bird populations, then, it is likely that we can project the interrelationships between these populations and the marine environment with substantially better understanding, or at least in an important additional dimension, than at present.

Obtaining information on the energy demands of natural populations of free-living birds at sea, however, is virtually impossible. Faced with this fact, we have chosen to employ computer simulation models that incorporate data on basic life history attributes and metabolism to derive estimates of population dynamics and energy demands. A model (BIRD II) developed by Wiens and Innis (1973, 1974) was expressly designed with such objectives in mind. This model generates estimates of patterns of population size changes, energy demands, and food consumption rates for marine bird species, using data that are generally more readily available than the estimated variables. The simulation model contains three basic submodels. In the population submodel, information on population sizes at selected points in time (as obtained, for example, from colony censuses), reproductive biology and timing, and mortality is used to project daily estimates of the population size of each age class of each of up to 15 species. The second submodel generates estimates of individual, age class, population, and total aggregate energy demands using data on ambient temperatures, photoperiod, body weights, growth patterns of young, and basic metabolic relationships. A third submodel combines the daily energy demand estimates with information on dietary composition at several points in time to project food consumption rates for various major prey categories.

This modeling approach has now been applied to a wide variety of situations, ranging from local populations of grain-feeding blackbirds (Wiens and Dyer 1975) through breeding bird communities of coniferous forests or grasslands (Wiens and Dyer 1977). The approach has served as the foundation of our initial investigations of marine bird energetics in the vicinity of the Pribilof Islands during 1977-78, and is the basis of extensions of energetics modeling into a heterogeneous spatial framework (see below). There are two applications of this modeling approach to seabirds that are relevant to the research proposed here, and which thus merit brief review.

1. Oregon Seabirds.--Wiens and Scott (1975) employed the BIRD model to explore the patterns and magnitudes of population density changes and population energy and food demands in Oregon populations of Sooty Shearwaters, Leach's Storm-petrels, Brandt's Cormorants, and Common Murres on a state-wide basis. Using information no more detailed (and in some cases less detailed) than that obtained in several of the OCSEAP studies, they determined that murres required 3.5 kcal/m^2/year, cormorants 2.3, shearwaters 1.7, and storm-petrels 0.1. The species occupied different-sized ocean areas, however, and when these per m^2 values were adjusted to consider the total area occupied by each species population the overwhelming dominance of shearwaters in the energy dynamics of the bird community became apparent. Shearwaters are transients along the Oregon coast (as they are in Alaskan waters), but during

their fall passage they consumed nearly seven times as much energy as any of the other species. By combining information on dietary habits with model estimations of energy demands, patterns of food consumption of these populations could be estimated by the model. Murres annually consumed nearly twice as many herring as any other prey, and consumed roughly equal quantities of anchovy, smelt, cod, and rockfish. Cormorants consumed a relatively small quantity of bottom-dwelling fish, while storm-petrels took roughly equal quantities of euphasids and hydrozoans. Anchovies accounted for 43% of the 62,500 metric tons of prey the four species were estimated to consume annually, and 86% of the anchovy consumption was by shearwaters. Wiens and Scott calculated that consumption of pelagic fishes by these four bird species populations within the neritic zone might represent as much as 22% of the annual production of these fish, an estimate closely paralleled by that obtained through similar modeling procedures by Furness (1978) for Shetland marine birds.

2. Gulf of Alaska-Pribilof Islands Marine Birds.--A more recent application of the BIRD model has evaluated energy flow on a broad scale in marine birds in the Gulf of Alaska, and on a narrower scale in Pribilof Island breeding seabird colonies, both employing data gathered during OCSEAP investigations. The first of these applications used data gathered on pelagic transect censuses in the Gulf of Alaska from August 1975 to November 1976 as part of the initial phase of research in RU No. 108. Total energy flow through pelagic bird populations in the Gulf was greatest in the Kodiak area during August-September (24,300 kcal/km^2/day), but varied both between areas and with season (Fig. 1), primarily as a consequence of movements of species populations associated with reproductive status. As in the Oregon coastal ecosystem, shearwaters were usually the energetically dominant species, accounting for up to 92% of the total community energy demand.

A second set of model analyses considered the dynamics of breeding marine bird colonies associated with St. Paul and St. George in the Pribilof Islands, using data

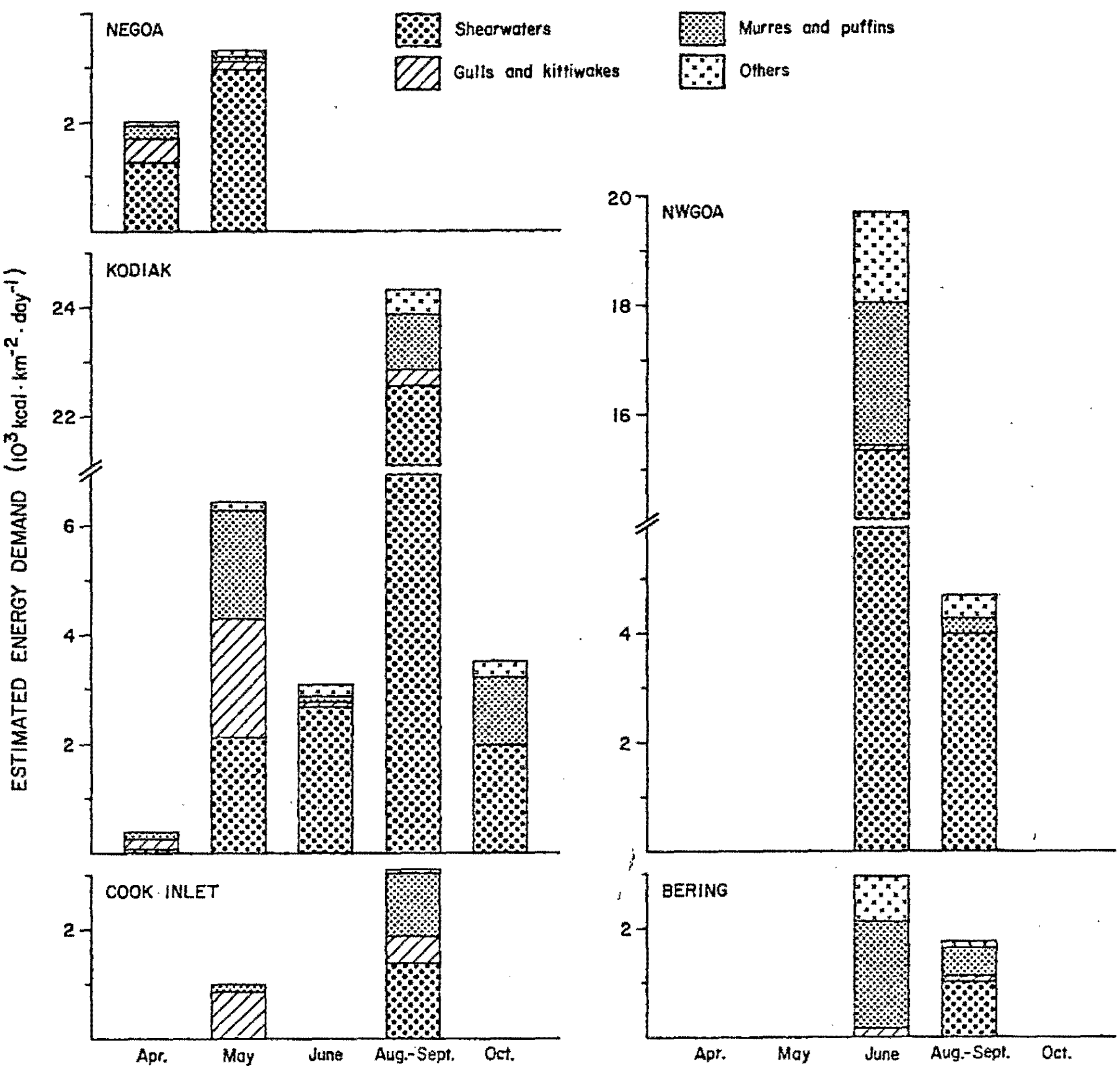

Fig. 1. Apportionment of total energy demand among the species groups recorded during transect censuses in five areas of the Gulf of Alaska/southeast Bering Sea, according to time of censusing.

gathered during transect censuses by George Hunt and his colleagues in their OCSEAP studies. By expressing the densities of seabird censused during Hunt's transects for each 10' x 10' latitude-longitude block in the survey area about the Pribilofs, we could project the spatial patterns of energy flow in some detail. Total community energy demand was concentrated in the area about St. George (Fig. 2), largely as a result of the major contribution of murres to community energetics (Fig. 3). There also energy demands varied both with season and year, and different species populations exhibited different spatial patterns of energy demands in relation to distances from islands and depth of water, especially in relation to the continental shelf break. The model analysis revealed that the area about St. George is obviously quite important in terms of overall avian energy demands, and some other foci of apparent feeding concentration also appeared to be critical.

These examples indicate the directions application of a simulation modeling approach to marine bird systems can take. Current research in RU No. 108 is extending the analysis of the Pribilof Islands data to consider interrelations of breeding attributes and performance at the colony to the patterns and magnitudes of energy flow from areas surrounding the colony, and is exploring the potential effects of various perturbations in the system via simulation. The modeling approach has also proven to be useful in defining areas in which the present data base is unsatisfactory, and in fact during his 1977-78 studies Hunt modified his data collection scheme to rectify some deficiencies in the data base revealed by our preliminary analyses.

V. OBJECTIVES

The objectives of this research are to use simulation model analyses to estimate the energy demands and food consumption patterns of marine bird populations in space and time, emphasizing dynamics of major colonies in the Kodiak lease area for which baseline data are available from other OCSEAP investigations. Our analyses will use and synthesize existing data derived from field investigations of these colonies to

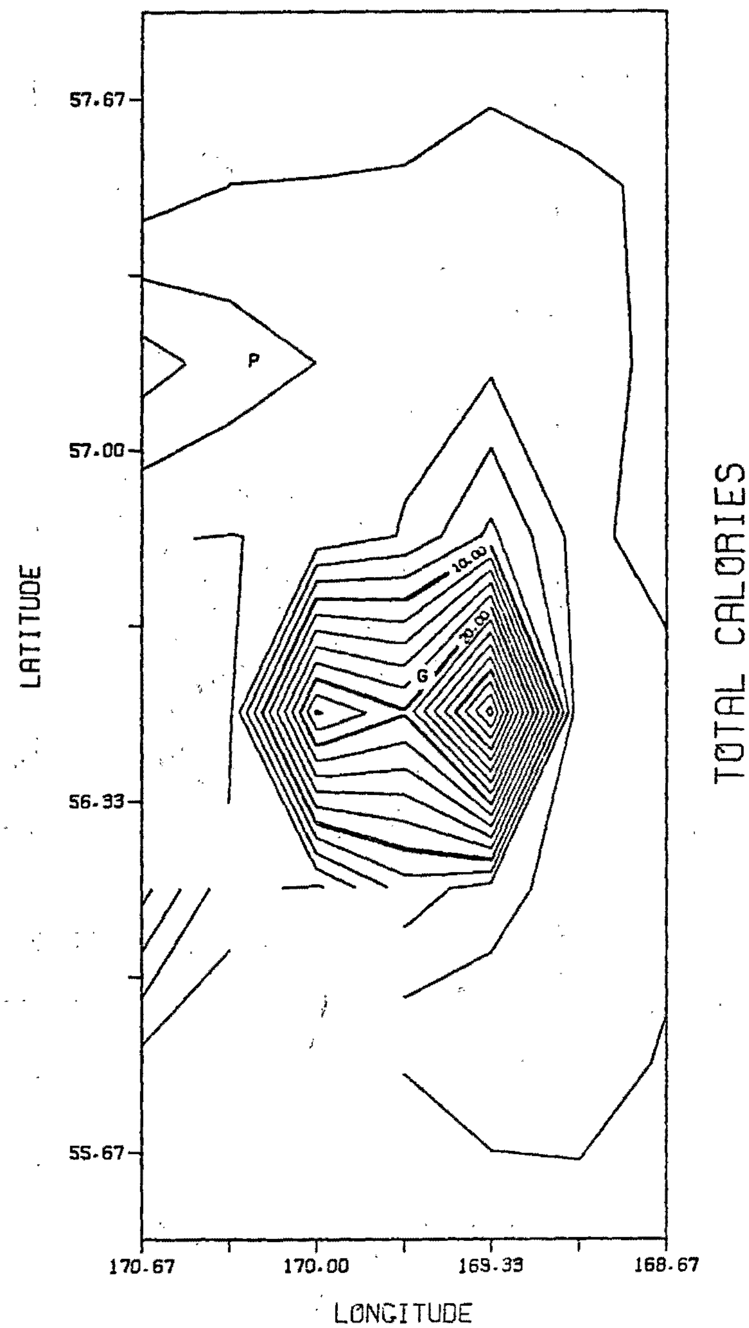

Fig. 2. Plotting of contours of total marine bird "community" energy demand for the intensive analysis area about the Pribilof Islands. G = St. George, P = St. Paul.

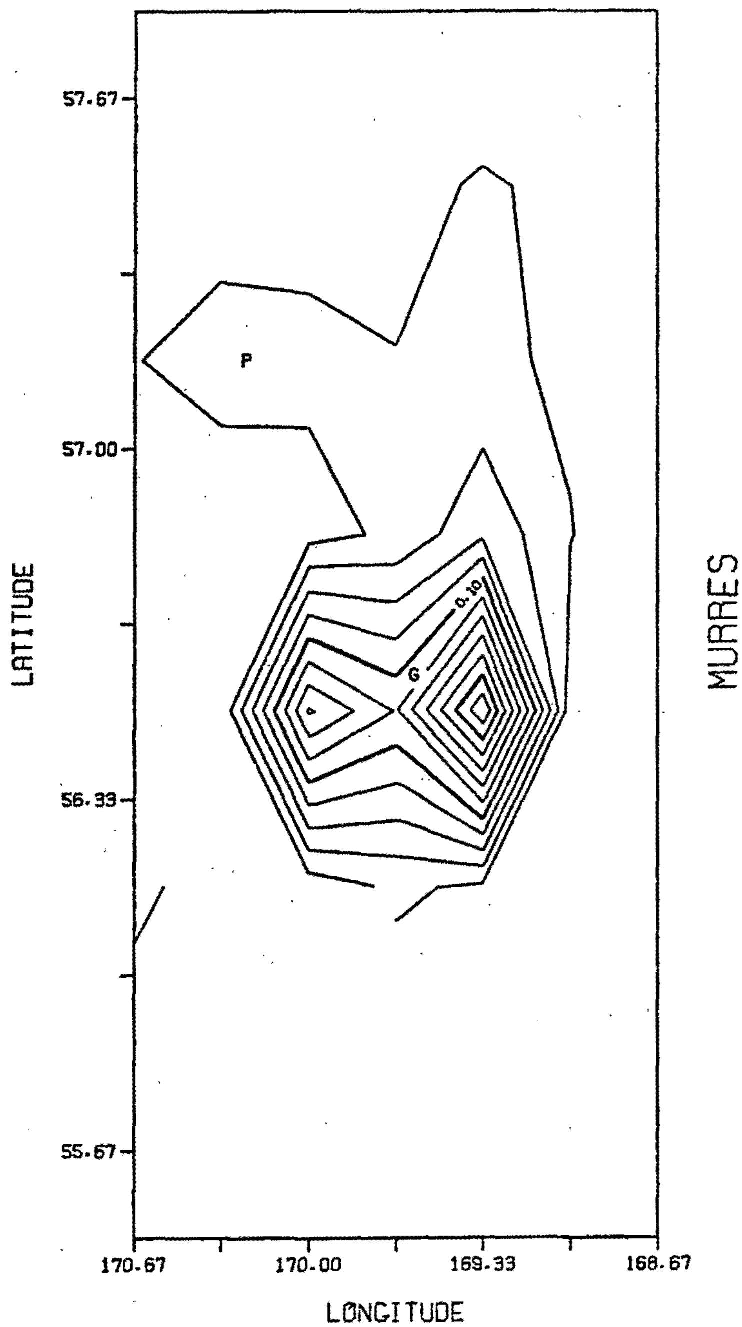

Fig. 3. Plottings of contours of frequency of occurrence of murres in the intensive analysis area. Contour intervals (0.02) indicate the frequency of occurrence of the group in 20' blocks, as derived from weighted averages of transect censuses.

project daily and seasonal patterns of energy demand and food consumption for major life stages of the dominant and/or most important bird species, and will consider the distribution of such population bioenergetics in the space surrounding the colony locations. The simulation powers of these models may be used as a gaming tool to project the effects of varying baseline conditions of the environment and/or the populations on the patterns of energetics or trophic dynamics. In these simulation exercises, attention will be focused on alterations that might accompany environmental changes related to oil development, especially oil spills. Such analyses will serve to identify gaps in the existing knowledge of these marine bird systems and so specify species, time periods or areas within the lease area that may be especially sensitive to oil development, or that may serve as indicators of environmental quality. The approach also may serve as a basis for making standardized comparisons between different lease areas or colonies, in which similar data sets have been gathered by different OCSEAP observers.

VI. STRATEGY AND APPROACH

There are three phases to the research proposed here, which follow in sequence.

1. Data Acquisition.--As our modeling operates on a data base gathered in other OCSEAP field investigations, the initial phase of any analysis is to obtain and clarify the available data. Our experience with Hunt's group in the Pribilof Islands analysis during 1977-78 has indicated that this is itself a major task. While conscientious OCSEAP investigators have filed timely and complete reports of their research findings with NOAA offices, these frequently contain data summarizations, while our needs are often for more detailed or "raw" data. As a result, this initial research phase involves close personal cooperative work with the investigators who have been actively involved in gathering the data we intend to use in the model analyses. For the work in the Kodiak lease area, we will rely primarily on information gathered as parts of RU No. 337, "Seasonal Distribution and Abundance of Marine

Birds" (C. Lensink and K. Wohl, Principal Investigators) and RU No. 341, "Population Dynamics and Trophic Relationships of Marine Birds in the Gulf of Alaska" (C. Lensink and K. Wohl, Principal Investigators). In particular, investigations carried out in the Barren Islands, Chiniak Bay, Sitkalidak Straits, and perhaps the Wooded Islands and/or Chowiet Island appear to have good possibilities for providing adequate information for model analyses, but the final decision of which colonies to model will follow a comprehensive review of colony work in the Kodiak lease area.

Initial contacts will be made with these investigators early in fall 1978. In general we will follow the procedure of first explaining to an investigator what information we desire, in what level of detail. After the investigator has been given sufficient time to prepare the necessary data, a member of our group will travel to meet with the investigator to spend several days reviewing the data and the modeling efforts so that both parties fully understand the nature of the data and the uses to which they will be put. Following the model analyses and initial interpretations of the results, we will contact the field investigator again to review our analyses and interpretations and modify them, if necessary, in accordance with the knowledge and insights of the individuals actually involved in field studies of the populations we have modeled.

2. Data Processing.--Once the necessary data have been gathered from the field investigators, we must subject them to initial processing to place them in a computer-compatible format and/or to derive the actual values used in the model structure. This step serves both to "clean" the data sets (i.e. identify and resolve any discrepancies in the data, mark missing values, etc.) and to undertake some preliminary analyses that are specifically tailored to our modeling paradigm.

3. Model Analysis and Simulation.--Once the essential data have been placed into the proper form and coded for computer analysis, we subject each data set to several modeling exercises, depending upon the adequacy of the data set and its

position in relation to our overall objectives. Each data set is analyzed to derive estimates of population bioenergetics and (where appropriate) population dynamics and food consumption rates. In addition, selected colony data sets are analyzed to determine the spatial distribution of energy demands, where suitable information on the off-colony distribution of birds at sea is available from quantitative transect census in the area. Such data sets may also be subjected to model analyses exploring the influences of these spatial patterns on colony reproductive output. Finally, the energetics of major colonies can be subjected to simulated perturbation analyses, in which different feeding areas for the colony are disrupted at varying times and/or for varying lengths of time (as by oil spills), and the influences on energy flow or colony productivity examined.

The emphasis of the 1978-79 studies for the Kodiak lease area will be on several of the major breeding colonies, partly because these sites generally provide the most complete and reliable data sets, and partly because the dynamics of colonies are so important in considerations of petroleum development, as it is the breeding colonies and the attendant concentrations of seabirds that are more likely to be affected by oil events than the broadly-ranging pelagic populations.

A. Sampling Method.--Not applicable, since no new data will be gathered by this project, other than computer simulation output.

B. Analytical Methods.--The analyses of the data sets are part of the model structuring, described above. However, we are presently working to define manners to generate confidence intervals about model estimates of energetic values, in a manner paralleling that suggested by Furness (1978). Any analyses of the "raw" data that we undertake involve conventional calculations of means and variances, where appropriate. Part of the presentation of the results of the analyses of the spatial distribution of energy flow involves calculations and graphings of contours of space-use probabilities, following the procedures of Ford and Krumme (in press); as

Dr. Ford is a member of our research team, this procedure is straightforward and direct.

VII. DELIVERABLE PRODUCTS

A. Digital Data.--No new digital data will be generated in this project. Instead, use will be made of existing data gathered by other OCSEAP investigators to conduct computer simulations. Implementation of these simulations will involve coding these data in a format appropriate for input to the BIRD model. This will be done by the staff of the project at the University of New Mexico.

B. Narrative Reports.--Reports will provide detailed descriptions of the model, documentations of new computer programs developed, and analysis and interpretation of results based on various inputs to the models. Major information gaps and sensitivity of populations to environmental changes or oil spills will be discussed.

C. Visual Data.--Visual displays or computer graphics will be submitted showing (1) areal and temporal changes in population densities and energy demands for major life stages of selected species or species groups; (2) daily energy demands for major life stages of selected species; and (3) effects of altering model constants or input variables on estimates of energy demands and population densities.

D. Other Non-digital Data.--None.

E. Data Submission Schedule.--Not applicable.

VIII. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

As no samples are being collected in this research, there is nothing to be archived.

IX. LOGISTICS REQUIREMENTS

As no direct field investigations are involved in this project, we have no special logistics requirements.

X. ANTICIPATED PROBLEMS

A project such as ours places great reliance on data gathered by other OCSEAP investigators. Our general research plan involves close cooperation with key field investigators as the initial phase, and the model analyses and simulations are dependent upon the success of this initial phase in identifying and obtaining the critical data promptly. We intend to work closely with the field investigators, the Principal Investigators, and personnel in the Juneau Project Office to insure that no problems arise in obtaining the critical information. This effort must be truly cooperative, as it is partly our responsibility to explain fully to investigators how and why we intend to employ their data so that they will not feel pre-empted or jeopardized, and partly the responsibility of the investigators to provide OCSEAP-generated data to a companion OSCEAP project in a timely manner. Our contingency plan for a failure to obtain information needed for a given colony is, first, to use all possible avenues to obtain the data; failing that, second, to employ estimates or ad hoc assumed values as substitutes for some real values in the model analyses, keeping the attendant limitations in mind throughout the exercise; or, if that involves too many assumptions, third, delete the colony analysis from the overall project. We are confident that the final contingency will not need to be followed, but the second may be necessary in some cases.

XI. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

In order to perform model analyses for a given marine bird population or assemblage, information is required on several aspects of population size, reproductive phenology and performance, individual growth rates, and population distribution. More specifically, the inputs required for population size for each species are: a) pre-breeding population density, b) breeding population density, c) the proportion of (b) that are reproductively active females, and d) the population size at the conclusion of the breeding season. For reproductive phenology and performance, we require for each species: a) the times at which immigration to the colony by breeding birds begins and is completed, b) the times at which emigration of adults from the breeding colony begins and is completed, c) the times of emigration onset and completion for juvenile birds, d) the dates on which incubation of the initial clutches for the population is initiated, and on which incubation of the last complete clutch for the population is initiated (better than this is actual information on the number or proportion of clutches being incubated during each week), e) the duration of the incubation period, f) the duration of the nestling period, g) the duration of the fledgling period, h) the clutch size (mean and variance, or, better, actual frequency distribution for the population), i) the hatching success of eggs, j) the fledging success of nestlings, k) the survival of young birds during the fledgling stage, and l) the non-breeding mortality rates of adult and young-of-the-year. For individual growth rates, information is required for each species on: a) adult body weight, and b) actual daily or at least frequent measures of weights of growing young as a function of age; failing that, weights at hatching and fledging are essential. For population distribution, we require information on the number of individuals that are associated with a breeding colony that are present in specified spatial blocks at varying distances from the breeding colony.

Obviously, few studies can supply detailed quantitative information on all of these parameters, and where values are lacking or are fuzzy in their resolution we must employ approximations or substitute values from other areas or from the literature. In this phase, close consultation with the field investigators is essential.

Our studies will concentrate on the most completely-studied colony locations in the Kodiak lease area. These will be defined through examination of the seabird colony survey findings (RU No. 338) and through discussions with investigators in the studies of colony dynamics undertaken as part of RU No. 341. At the present time, colony locations on the Barren Islands, Chiniak Bay, in Sitkalidak Straits, and perhaps the Wooded Islands and/or Chowiet Island appear to be possibilities for concentrated attention. Final selection of colonies for detailed simulation analysis will be made in December 1978, after careful review with the Principal Investigators, the field personnel, and the staff of the Juneau Project Office overseeing activities for the Kodiak Lease area.

XII. ACTIVITY/MILESTONE CHART: Attached

XIII. OUTLOOK

Part of the intention in developing this modeling approach to the analysis of marine bird population dynamics and energetics is to provide a synthesizing framework for consolidating the results of many divergent OCSEAP bird studies within a common framework. In this way, the "role" or "importance" or "sensitivity" of colonies in different areas may be objectively compared using at least one common framework. This is <u>not</u> to say, of course, that an energetics-based approach such as we are following is necessarily the only or the best approach for assessing colony dynamics, but it is one approach that we feel is operational and realistic.

Our initial studies during FY 1978 have produced advances in the structuring of the models and in our knowledge of how to deal with the assimilation and processing of data gathered by other investigators, and our proposed activities during 1979 will apply this approach to colonies in another lease area. This pattern has two rather obvious future extensions. First, we feel that it is a mistake to undertake model analyses of a given set of colonies for a year and then leave that area to concentrate our efforts entirely elsewhere. Our initial simulations of the Pribilof Island colonies, for example, suggested to George Hunt improvements in his data collection scheme that could provide better information for our model input requirements, and he is implementing some of these during his 1978 field studies. By the time his results are at hand, however, our emphasis will have shifted from the Pribilof area to the Kodiak area; there is no provision in the FY 1979 contract for continuation of model analysis of the Pribilof colonies. In a like manner, should our efforts be shifted to another lease area in 1980, any suggestions that we would make for improvements in data collection in the Kodiak area as a result of our modeling exercises would not be able to be recycled into improving subsequent analyses of the Kodiak area. There should be some mechanism to insure continuation for more than one year of modeling efforts for specific colonies, at least where field data collection at those colonies is continuing. Second, it seems likely that with the present manpower and funding level, we should be able to undertake a model analysis of 3-4 major colony locations in a given lease area each year, provided good data exist for the colonies and the field investigators are cooperative. Exactly where the modeling efforts should be applied following FY 1979 depends upon the priorities of areas for lease sales and upon the adequacy of existing field data on primary colony locations in those areas; these should be considered well in advance of the establishment of contract guidelines, so that initial liaison with field investigators and Principal Investigators may be established early.

XIV. PROGRESS REPORTS

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA Form 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor." Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

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MILESTONE CHART

O - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 108 PI: J.A. WIENS

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
Survey Kodiak area colony data; select colonies for modeling			△												
Confer with field investigators; acquire necessary data						△									
Process Data							△								
Conduct Initial Model Analyses										△					
Discuss Initial Results with field investigators											△				
Conduct Final Model Simulations												△			
Prepare Reports				△			△			△			△		

To: Bering Sea - Gulf of Alaska
Project Office

Proposal Date: 15 June 1978
Amendment No. 1: 1 September 1978
Contract No.
NOAA Project No. R7120847

FY 79 RENEWAL PROPOSAL

Research Unit Number 138

TITLE: Northwest Gulf of Alaska Oceanographic Processes

Cost of Proposal: $292,000

Lease Areas:

Aleutian	20%
Kodiak Island	43%
Lower Cook Inlet	37%

Period of Proposal: 1 October 1978 - 30 September 1979

- -

PRINCIPAL INVESTIGATOR:

Name J. D. Schumacher — Date 15 June 1978
Signature James D Schumacher
Address 3711 15th Ave. NE, Seattle, WA 98105
Telephone Number 206-442-1960

INSTITUTION PMEL/NOAA — FTS: 399-1960

REQUIRED ORGANIZATION APPROVAL

Name J. R. Apel — Date 15 June 1978
Signature Jokull C. Apel
Position Director, PMEL
Address 3711 15th Ave. NE, Seattle, WA 98105
Telephone Number 206-442-4079 — FTS: 399-4079

ORGANIZATION FINANCIAL OFFICER

Name Cynthia L. Loitsch — Date 15 June 1978
Signature Cynthia L. Loitsch
Position Program Support Officer
Address 7600 Sandpoint Way NE, Seattle, WA 98115
Telephone Number 206-442-4090 — FTS: 399-4090

PART 3

TECHNICAL PROPOSAL

I. Northwest Gulf of Alaska Oceanographic Processes
Research Unit Number: 138
Contract Number: RP0000R7120847
Proposed Dates of Contract: 1 October 1978 to 30 September 1979

II. Principal Investigators:

J. D. Schumacher
S. P. Hayes
R. L. Charnell
R. D. Muench
R. K. Reed

III. Cost Proposal

A. Science $292,000
B. PI-provided logistics
C. Total $292,000
D. Distribution of effort by lease area:

Lower Cook Inlet	- 37%
Kodiak Island	- 43%
Aleutian	- 20%

IV. Background: We have drawn several conclusions regarding circulation and hydrography over the continental shelf of the Northwest Gulf of Alaska and the Lower Cook Inlet/Shelikof Strait region. These have been presented in Annual Reports, at the Lower Cook Inlet and Kodiak Island Synthesis Meetings, at the PI Workshops, AGU Conferences and in the scientific literature (see PART 5A)

In accordance with FY79 guidance, we will conduct no new field work this year although equipment deployed during FY78 will be recovered. During FY79 we will concentrate our efforts toward processing and submitting to NODC all data heretofore not submitted, refurbishing all field equipment, and continuing interpretation of the data. This task includes processing tapes from 42 current meters, tapes from 6 pressure gauges and approximately 400 CTD casts; all of these data will be collected during October 1978. Further, field equipment which will be recovered at that time must be refurbished, calibrated, and properly stored for future use.

Analysis and interpretation of the data during FY79 should result in Technical Reports or journal level manuscripts. A synthesis report on the state of knowledge of physical oceanography in the Western Gulf of Alaska will be prepared in conjunction with all PI's working in this area. Anticipated titles, authorship, and brief statements of content are given in VII B.

V. Objectives: The general objective of this research unit is to provide information leading to an improved understanding of hydrography and circulation in the study area. During FY79, this includes:

1. To process and submit to NODC all data collected through October 1978.
2. To refurbish and recalibrate all field equipment.
3. To provide physical oceanographic data and an interpretation of this data for use by other PI's and for use in Synthesis Reports.

VI. General Strategy and Approach: Analysis and interpretation will continue along the lines already established and proven fruitful (see Section 5). We note that elapsed time between data acquisition and presentation of this data in a viable format, including interpretation and synthesis with environmental data not collected by ourselves, appears long and unpredictable. Therefore, it is impossible to schedule professional scientific products such as manuscripts. For example, the manuscript "Winter circulation and hydrography over the Northwest Gulf of Alaska continental shelf" (see attached copy) essentially began with equipment recovery and CTD station occupation during March 1977. Analysis and interpretation began in September 1977, with preliminary results presented at the Issaquah PI Workshop in November 1977. Comments made during this presentation were addressed and a revised presentation was made at the Spring AGU Conference in April 1978 and at the Rosario PI Workshop. Again, constructive interactions resulted in refinement of the manuscript, which is presently being reviewed by two referees for publication as a PMEL/ERL Technical Report. Optimistically, this report will be published and available for general distribution approximately 1 year after its inception, and 1½ years after data acquisition. Our professionalism inhibits us from premature speculation and requires that we exchange ideas with our colleagues, both within OCSEAP and in the larger oceanographic community, thoroughly analyze all available data, and satisfy ourselves that our interpretation is realistic. This approach not only requires time, it also implies that data have been properly processed and quality controlled and that field equipment is reliable. Thus, all field equipment must be refurbished, calibrated, and properly stored for future use. Further, all data which have not been submitted, e.g. current records with time base errors, must be carefully examined so that any segments deemed valid can be submitted.

To facilitate analysis of the very large amount of available data, a computer-based data retrieval and analysis system has been installed. Presently, only CTD data are handled. Incorporation of software to handle analysis of current meter data will be accomplished this fiscal year in order to speed up the process of reporting results.

Operation of the data analysis system requires full time effort by one person to install new programs, make production runs of data products and to incorporate new data into storage. However, the utility of the system is available to other OCSEAP investigators who need oceanographic data analyses and products. It is expected that funds for operation of this data recall system on the ERL-Boulder CDC 6600 will be provided separately to PMEL from the OCSEAP pre-funded contribution.

The Plan for preparing the synthesis report on Physical Oceanograpny of the NW Gulf of Alaska is composed of the following elements:

a) Establish the level of understanding by reviewing work to date from reports, manuscripts and personal communications.
b) Solicit updates from each of the participating P.I.s.
c) Produce annotated outline to be circulated among possible participants who may be requested to produce sections of the report.
d) At the first planning meeting, participants will modify the outline and receive writing assignments once the objectives have been clearly established.
e) Upon receipt of input from participants, the coordinator will digest and reformulate material into a First Draft Synthesis Report, and provide appropriate introductory, bridging and conclusion material.
f) The document will be returned to the participants and selected outside persons for review. Modifications will be made and at a second workshop the final form of the document will be produced.

The designated Synthesis Report coordinator will attend all OCSEAP-scheduled synthesis meetings and special planning meetings in Juneau, be responsible for organizing the report, for editing the contributions to it, and reviewing the literature for information which is relevant but not immediately available from OCSEAP sources. Since the synthesis report will be a condensation of relevant information from reports by many OCSEAP investigators they will need to provide summaries or condensation of their work in their own words in order to expedite preparation of the synthesis report. Because of the scope of this task it is anticipated that this process will be completed nine (9) months after commencement. Tentative schedule of these tasks are noted on the attached Milestone Chart.

VII. Products

A. Digital Data: All current meter, CTD and pressure gauge data will be in digital form for submission to OCSEAP in approved format on processed data tapes using formats 012, 022 and 017 respectively.

B. Narrative Reports: Reports will be prepared for OCSEAP which, taken together, address all of the objectives requested to be covered. The reports will include drafts of the several publications listed below, with additional detail added as necessary to address specific objectives. Maps of hydrographic and circulation features to a scale size to be agreed upon will be appended, though they may not be part of the final publication.

The reports which we plan for FY 79 are as follows:

1. A Synthesis Report - (Coordinated by R. Charnell)
All pertinent data (including non-OCSEAP), will be assembled into a synthesis of physical oceanography of the Cook Inlet, Kodiak Island and Aleutian lease areas. This report will include contributions from all present principal investigators and will incorporate results of workshops and synthesis meetings called by NOAA/BLM. The report will be designed to provide a single-source reference for physical oceanographic information, conclusions and inferences which bare on key issues answerable by BLM's study types.

27. Currents and Tides
28. Wind Fields
29. Residence Times and Flushing
30. Dispersion and Mixing of Contaminants
32. Trajectories of Oil Spills

2. Cook Inlet Currents - Muench, Mofjeld and Charnell. An updated version of our Cook Inlet paper (Muench et al., 1978) will be prepared. Our report to OCSEAP will include a draft of that paper plus an appendix which contains a tabulation of tidal constituents and a chartlet showing observed mean currents.

3. "Circulation and hydrography over the continental shelf of the Northwest Gulf of Alaska: September to November 1977", Schumacher, Reed, Grigsby, and Dreves". This report will present analysis of CTD data collected at over 400 stations off Kodiak Island. These data will be interpreted in terms of dynamic topography and stratification and will be compared to the results from the winter report. We also will include current record segments from the Bank/Trough experiment which was conducted during this period. This report will in a preliminary sense elucidate such features as possible interchange of waters between Middle and Southern Albatross banks and possible shoreward flow events through Kiluida Trough.

4. "Seasonal variability of the Alaska Current", Reed, Schumacher, and Royer. This manuscript will present our interpretation of CTD data in terms of transport off Kodiak Island. We will examine CTD data collected between September 1975 and October 1978 for seasonal trends, as suggested by seasonal wind stress, or to determine if the vast addition of freshwater to the system masks any trend. Further, examination of all the CTD data may elucidate any seasonal trend in the axis of the Alaska Current.

5. "Observations of bottom pressure, currents and hydrography over the Northwest Gulf of Alaska shelf: October 1977 to March 1978", Hayes and Schumacher. This report will present results from the Mitrofania experiment which will increase our understanding of circulation features and hydrography in the Aleutian Lease area, and will constitute a final report to OCSEAP on that area.

We note that more complete answers to such questions as residence time in Kiliuda Trough/Horsehead Bight, limited exchange of waters between Middle and South Albatross banks, and up-trough flow through Kiliuda Trough await recovery, scheduled for October 1978, of equipment from these areas. These data are to be processed and submitted during FY79; however, we expect to provide only preliminary interpretations by the end of FY79 and no scientific level reports. Such reports will be undertaken as objectives during FY80.

C. Visual Data: Current, pressure, and CTD data will be graphically displayed as appropriate in the above reports, including but not restricted to:

Appropriately filtered time-series
Progressive vector and/or scatter diagrams
Temperature, salinity, and sigma-t spatial and vertical distributions

[Note: In these reports we will continue to use standard NOS charts; however, where appropriate, we will also present data on "standard synthesis maps" supplied by the Project Office, including Mylar overlays as required by the Project Office].

D. Other: N/A

E. Data Submission Schedule: see attached form.

VIII. Special Sample and Voucher Specimen Archival Plans: N/A

IX. Logistics Requirements: see attached form

X. Anticipated Problems:

As part of the budget summary, your office requested information on cost of providing data in special formats. In general, most costs for special data handling have been anticipated and require no additional support. It is appropriate to schedule early in FY79, a meeting between Mr. Pelto, BLM and me in which specific products and formats are discussed. I propose such a meeting for November, 1978.

There is, however, a problem which was not anticipated. Since the FY79 proposal was submitted to your office, we have received a special request from the Program Office in Boulder to provide Gulf of Alaska data on a special map series. The special maps are Universal transverse Mercator projections on conic sections. On the chosen scale, these maps have the unfortunate character that latitutde and longitude lines are neither straight nor parallel. This makes it almost impossible to enter data on these maps unless they contain a fine mesh grid. We can rewrite computer programs to plot data on these projections, but for plotting equipment we have, the map size is too large. Rather than force all RU's to duplicate a cartographic component to go from maps on which researchers can plot data to the desired maps, it is more appropriate for OCSEAP (through SAI?) to set up a single facility for conversion of all RU output. Because of the large continuing cost necessitated for us, and hence BLM, we are taking no steps to comply until this situation is resolved.

XI. Information Required From Other Investigators: We will continue our close coordination with: Hansen (RU217), Royer (RU289), with the Kodiak Island Food Web Study (RU551, 552, 553), Hampton and Bouma (RU327), Larrance (RU425), Galt (RU140), Cline and Feely (RU135) and Reynolds (RU367).

Since the synthesis report will be a condensation of relevant information from reports by many OCSEAP investigators they will need to provide summaries or condensation of their work in their own words in order to expedite preparation of the synthesis report. Such a request will be negotiated with each affected-RU P.I.

XII. Activity/Milestone Chart: see attached form

XIII. Outlook: During this contract year all data which has not been submitted to NODC will be. We have optimistically planned to produce up to five manuscripts whose contents address the goals outlined in VII., however, further analyses will be required in order to extend our knowledge of shelf processes, e.g., a comprehensive examination of current, bottom pressure, mass distribution and wind data from the Bank/Trough experiment is required prior to understanding possible up-trough flow and its biological implication with respect to reseeding the near-shore region. We suspect that up-trough flow does exist (see enclosed report: Note: the format of our proposed reports will be similar to this report), but how often does this occur, what volume may be transported, and most importantly, can we understand the physics of this process? If we can answer these questions, then in order for our knowledge to be valuable to decision making, we must synthesize our knowledge with those who understand the biology. Are the waters which flow up the trough biologically rich enough to reseed? Do these waters contain significant quantities of nutrients? Other important questions will surface as we begin to understand any particular natural system; however, we realize time constraints exist and, given that no further field work is conducted, we envision that a Final Report will be produced during FY80. During that FY, we also believe that we will be able to be involved with Synthesis Report i.e. interdisciplinary, writing. An estimated cost for FY80 is $225K.

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.
B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties; In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and perdiem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA Form 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U. S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached). Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowlegment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

IX. Logistics Requirements:

INSTITUTION: Pacific Marine Environmental Laboratory

PRINCIPAL INVESTIGATOR: Schumacher, Hayes, Charnell

A. SHIP SUPPORT:

1. DISCOVERER-LEG A: Cruise track will consist of selected stations from the PMEL Western Gulf of Alaska Standard Grid.

   OCEANOGRAPHER-LEG A: Cruise track will be determined by the order in which she recovers the moorings deployed in May-June 1978, which will be determined by weather conditions.

2. DISCOVERER: CTD casts at approximately 200 stations.

   OCEANOGRAPHER: 24 mooring recoveries and about 100 CTD casts.

3. Operations should be conducted during October. Recoveries in a given region, e.g., Lower Cook Inlet, should be conducted after the DISCOVERER has conducted CTD casts in that region.

4. DISCOVERER: 10 days

   OCEANOGRAPHER: 28 days

5. Other activities could piggyback on a not-to-interfere basis.

6. Standard CTD and winch equipment which the ships have been providing.

7. DISCOVERER: 7-track magnetic tapes

   OCEANOGRAPHER: Storage space required for 48 current meter boxes, 24 release boxes, and 24 (28" diameter) subsurface floats.

8. N/A

XII. MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 138 PI: Schumacher, Hayes, Charnell

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

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
CRUISES	0														
Quarterly Report				0											
Submit CTD data to NODC					0										
Submit current and pressure data to NODC					0										
Annual Report							0								
Quarterly Report									0						
Quarterly Report													0		
PI Workshop		0													
PI Workshop								0							
Kodiak Island Synthesis Meeting		0													

MILESTONE CHART (continued)

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 138 PI: Schumacher, Hayes and Charnell

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

		1978					1979								
OR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
ırrative Report Circulation and															
hydrography ...						0									
Seasonal variability ...									0						
Observations ...									0						
Cook Inlet Currents ...				0											
·nthesis report											0				
First planning meeting			0												
First input						0									
Return for review									0						
Final meeting											0				
ɔduct discussion with BLM			0												

DATA PRODUCTS SCHEDULE

Data Type i.e. Inter-tidal, Benthic Organisms, (etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formatting done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
	Mag. tape	600 casts	022	Yes	three weeks during Oct/78	Feb/79
Current record	Mag. tape	46 sta.	015	Yes	May/78 to Oct/78	March/79
Pressure Record	Mag. tape	6 sta.	017	Yes	May/78 to Oct/78	March/79

University of Washington
Seattle, Washington 98195

To: Outer Continental Shelf Environmental Assessment Program
National Oceanic & Atmospheric Administration

Type of Support Requested: Contract (Renewal) Research Unit 141

Title of Project: Norton Sound/Chukchi Sea Oceanographic Processes

Principal Investigators: L. K. Coachman, Professor

K. Aagaard, Research Professor and

Assoc. Principal Investigator: T. H. Kinder, Research Associate
Department of Oceanography
College of Arts & Sciences
University of Washington
Seattle, Washington 98195
Telephone - area code (206) 543-5047

Amount Requested: $50,000

Desired Period: 1 October 1978 - 30 September 1979

University Office To Be Contacted Regarding Contract Negotiation: Grant & Contract Services
1 Administration Building, AD-24
University of Washington
Seattle, Washington 98195
Telephone - area code (206) 543-4043

Date: June 15, 1978

L K Coachman
Principal Investigator

Knut Aagaard
Co-Principal Investigator

Thomas H. Kinder
Associate Principal Investigator

G. C. Anderson
George C. Anderson
Associate Chairman for Research
Department of Oceanography

Joe S Creager
Joe S. Creager, Associate Dean
College of Arts & Sciences

Official Authorized To Give University Approval:

D R Baldwin
Donald R. Baldwin, Director
Grant & Contract Services
1 Administration Building, AD-24

7-3-78

Ref: P78-71

3. Technical Proposal

I. Title: Norton Sound/Chukchi Sea Oceanographic Processes
Research Unit Number: 541
Contract Number: 03-5-022-67, TO 14
Proposed Dates of Contract: 1 October 1978 - 30 September 1979

II. Principal Investigators:
L. K. Coachman
K. Aagaard
T. H. Kinder

III. Cost of Proposal for Federal Fiscal Year:

A. Science $50,000
B. PI-provided logistics -0-
C. Total $50,000
D. Distribution of effort:
Chukchi Sea: 25%
Norton Sound: 75%

IV. Background

Since 1976 we have been using CTD (conductivity-temperature-depth profiling systems) surveys and moored instruments to study the region around Bering Strait: the northern Bering Sea, including Norton Sound and the southern Chukchi Sea, including Kotzebue Sound. With the field work ending in FY 78, we can now finish data reduction and submission.

Because of the massive sampling program, data analysis has thus far lagged data collection, and the synthesis of the data into scientific reports has lagged further (see list of contributions, below). During FY 79 we will complete reduction and submission of all data, and continue analysis of these data. Because of the amount of data and the level of funding, however, synthesis into scientific reports will be delayed.

List of Contributions:

1. Muench, R. D., R. L. Charnell, J. D. Cline and L. K. Coachman, 1978. Oceanography of Norton Sound, Alaska: September-October 1976. Submitted to *Journal of Geophysical Research.*

2. Kinder, T. H., J. D. Schumacher, R. B. Tripp and D. Pashinski, 1977. The Physical Oceanography of Kotzebue Sound, Alaska, during late summer, 1976. University of Washington, Department of Oceanography Technical Report, Ref.: M77-99. 84 pp.

3. Muench, R. D., C. Pearson, and R. B. Tripp, 1978. Winter Currents in the Northern Bering Sea and Bering Strait. Talk given at April 1978 AGU meeting, abstract in *EOS 59*(4):304.

V. Objectives

Specific objectives are:

1. To submit all data that has been collected;
2. To refurbish all instruments as necessary;
3. To elucidate the temporal and spatial variability of the predominantly northward flow;
4. To elucidate the circulation and hydrography within Norton and Kotzebue sounds,
5. To provide data for modeling (RU 435, Leendertse).

Attaining these objectives will increase understanding of the regional physical oceanography. This will contribute to predicting pollutant trajectories and to understanding the ecosystem.

VI. Strategy and Approach

A. Sampling method, N/A

B. Analytical method, N/A

VII. Deliverable Products

A. Digital Data

1. Data will be submitted in formats 022,017, or 015.
2. Limits:

temperature:	-2°C to +20°C
salinity:	0 g/kg to 40 g/kg
pressure:	0 db to 1600 db
speed:	0 cm/s to 300 cm/s
direction:	000° to 360°

3. Verification. All data are examined either as a printout or as a plot, prior to filtering.

B. Narrative Reports. We believe that we have sufficient data in hand to produce reports on the variability of the flow through Bering Strait, and to elucidate further the oceanography of Kotzebue Sound (both in cooperation with RU 550, PMEL). Because of the necessary emphasis on data reduction and submission (in large part to service another research unit), however, we forecast that we will only do preliminary work on these in FY 79. Quarterly and annual reports will describe progress and preliminary results.

C. Visual Data. N/A. All our data are submitted in digital format. Reports will be illustrated by the most effective figures, as before.

D. Other, none.

E. See attached data products schedule.

VIII. Special sample and voucher specimen archival plans: N/A.

IX. Logistics Requirements: None.

X. Anticipated Problems: None.

XI. Information required from other investigators:

We will continue cooperating with RU 289 (Royer) and RU 550 (Schumacher, Muench, and Charnell).

XII. See attached milestone chart.

XIII. Outlook

Assuming that data processing and analysis proceeds smoothly through FY 79, two or three reports of scientific merit should emerge in FY 80. There will be sufficient data for a useful description and some explanation of the variability of flow through Bering Strait, an important influence on the Arctic Ocean. Muench et al. (see contributions, above) have begun to outline this problem. These also seems to be sufficient data to supplement and extend the report of Kinder et al. on Kotzebue Sound, including winter data gathered by Aagaard. We anticipate that more detailed and concrete plans for these reports will emerge in FY 79. We also have several ideas that are preliminary: the oceanographic connection between the northern and southern Bering seas, the northward extension of the structural front, wind and current interaction along the ice edge, etc. All these require extensive data analysis, and comparison to existing meteorological data. Because of the emphasis on data reduction and the limited funding in FY 79, we anticipate that the first two reports may evolve in FY 80, and one or more of the preliminary ideas probably will come to fruition in late FY 80. This assumes continued funding of about $50,000 in FY 80, but this money will be spent on the scientific problems, and not on data processing.

A. Results. Two-three scientific reports (in addition to quarterly and annual reports).

B. Milestones: One-two reports in early FY 80, one-two reports in late FY 80. A fruitful synthesis of the regional physical oceanography could begin in late FY 80.

C. Cost. $50,000 per annum

D. None.

E. Field Efforts. None planned; a small field effort may be useful to test hypotheses, but this cannot be predicted.

F. Logistics. None.

XIV. Standard Statement

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA For 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U. S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached.) Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they became available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

VII.E.

DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Mooring NC-24A (24m)	Tape		015	Yes	9/77 to 7/78	11/78
(40m)			015			
Mooring NC-24B (24m)	"		015		7/78 to 9/78	1/79
(40m)			015			
Mooring LD-5 (15m)	"		015		7/78 to 9/78	1/79
(21m)			017			
Mooring FX-1A (18m)	"		015		7/78 to 9/78	1/79
(40m)			015			
Mooring FX-2A (18m)	"		015		7/78 to 9/78	1/79
(43m)			017			
Mooring FX-3A (18m)	"		015		7/78 to 9/78	1/79
(40m)			015			

XII.

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 541 PI: Coachman, Aagaard, Kinder

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
Complete submission of any outstanding data				0											
Attend PI workshops	0							0							
Submit annual and quarterly reports			0			0		0				0			0

RFx41-141-845

8 SEP 1978

Outer Continental Shelf Environmental
Assessment Program
Bering Sea-Gulf of Alaska Project Office
P.O. Box 1808
Juneau, Alaska 99802
PH: 907-586-7432

Dr. Larry Coachman
Department of Oceanography
University of Washington
Seattle, Washington 98115

Reference: OCSEAP Research Unit 141

Dear Larry:

Your proposal has been reviewed and found generally acceptable except for the following specifics:

1. Item 3-d in may renewal letter requested that a Mylar overlay be provided of currents and water masses. This item should be addressed in your proposal specifically, because it is of great concern to BLM that we provide crucial data in a form which is directly applicable to their needs. Therefore, a commitment is necessary that these results be provided.

2. The schedule should show the expected completion dates for the Mylars in item 1.

We will furnish base maps over which the Mylars should register.

The final funding commitment and level are contingent on approval of the FY 79 OCSEAP budget and the transfer of funds by the Bureau of Land Management.

If you have any questions concerning any of the above guidance, please phone the Juneau Project Office, (907)586-7436.

Your letter agreeing to these changes, or a revised work statement, must be sent to and received in the Juneau Project Office, with a copy to Boulder no later than September 15, 1978. If there are extenuating circumstances which prevent you from meeting this schedule, please phone the Project Office. The short deadline is required to ensure continuous funding of your project in FY 79.

Upon receipt of your work statement, revised in accordance with the above guidelines, we will initiate contracting procedures for FY 79. I look forward to your continued involvement in our program.

Sincerely,

Herbert E. Bruce, Ph.D.
Bering Sea-Gulf of Alaska Project Manager

cc: Program Office

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

To:	Outer Continental Shelf Environmental Assessment Program National Oceanic & Atmospheric Administration
Type of Support Requested:	Contract (Renewal) Research Unit 141
Title of Project:	Southeastern Bering Sea Circulation (B-BOP)
Principal Investigator:	L. K. Coachman, Professor and
Assoc. Principal Investigator:	T. H. Kinder, Research Associate Department of Oceanography College of Arts & Sciences University of Washington Seattle, Washington 98195 Telephone - area code (206) 543-5047
Amount Requested:	$40,000
Desired Period:	1 October 1978 - 30 September 1979
University Office To Be Contacted Regarding Contract Negotiation:	Grant and Contract Services 1 Administration Building, AD-24 University of Washington Seattle, Washington 98195 Telephone - area code (206) 543-4043

Date: June 15, 1978

L K Coachman
Principal Investigator

Thomas H. Kinder
Associate Principal Investigator

G. C. Anderson
George C. Anderson
Associate Chairman for Research
Department of Oceanography

Joe S. Creager
Joe S. Creager, Associate Dean
College of Arts & Sciences

Official Authorized to Give University Approval:

D R Baldwin
Donald R. Baldwin, Director
Grant & Contract Services 7-6-78
1 Administration Building, AD-24

Ref: P78-70

3. Technical Proposal

I. Southeastern Bering Sea Circulation
Research Unit 141
Contract Number: 03-5-022-67, TO-4
Proposed dates of contract:

1 October 1978 - 30 September 1979

II. Dr. L. K. Coachman
Dr. T. H. Kinder

III. Cost of proposal

A. Science $40,000
B. PI Logistics -0-
C. Total $40,000
D. Distribution of effort by lease area:

Bristol Bay: 55%
St. George Basin: 45%

IV. Background

The proposed research is a continuation of the previous work of RU 141 and RU 549 (Schumacher and Charnell). Since late summer 1975 we have been studying the ciruclation and hydrography over the southeastern Bering Sea continental shelf, including both the Bristol Bay and St. George Basin lease areas. We have collected large quantities of data from CTD (conductivity-temperature-depth profiling systems) surveys, moored instruments (current meters and pressure gages), and also have used standard meteorological data and satellite imagery. Our emphasis has been on data acquisition and data processing; because of the size of the field program data analysis has lagged data collection.

With the collection of data complete, we now begin a new phase. While we will continue to process the data still outstanding, a larger percentage of our effort will now be applied to data analysis. Where possible and fruitful, we will attempt to synthesize these results into scientific contributions (see list of contributions, below).

Through annual reports, quarterly reports, and other contributions we have refined and revised previous ideas concerning the hydrography and circulation over the shelf, and we have identified several features not previously emphasized:

(1) finestructure and lateral water mass interaction;
(2) a front generated by tidal stirring;
(3) features along the seasonal ice edge;
(4) anomalous tidal behavior;
(5) the role of ice in transporting salt across the shelf;
(6) the separation of the shelf into distinct structural domains;
(7) low frequency flow episodes over the shelf;
(8) a diffuse haline front overlaying the continental slope; and
(9) a baroclinic eddy southeast of the Pribilof Islands.

During FY 79 our primary effort will be to complete the data processing now in progress and that required by the summer 1978 fieldwork, and to continue analysis of these data. Specific objectives, and narrative reports that can now be planned are listed below (sections V. and VII.B).

Contributions

A. Papers

1. Coachman, L. K. and R. L. Charnell, 1977. Finestructure in Outer Bristol Bay, Alaska. Deep-Sea Res. 24(10):869-889.

2. Kinder, T. H. and L. K. Coachman, 1978. The Front Overlaying the Continental Slope of the Eastern Bering Sea. J. Geophys. Res., in press.*

3. Muench, R. D. and R. L. Charnell, 1977. Observations of Medium Scale Features along the Seasonal Ice Edge in the Bering Sea. J. Phys. Oceanogr. 7(4):602-606.

4. Reed, R. K., 1978. Heat Budget in the Eastern Bering Sea. J. Geophys. Res., in press.

5. Coachman, L. K. and R. L. Charnell. Lateral Water Mass Interaction - A Case Study, Bristol Bay, Alaska. Submitted to J. Phys. Oceanogr.

6. Schumacher, J. D., T. H. Kinder, D. J. Pashinski, and R. L. Charnell. A Structural Front over the Continental Shelf of the Eastern Bering Sea. Submitted to J. Phys. Oceanogr.

B. Reports

1. Kinder, T. H., 1977. The Hydrographic Structure over the Continental Shelf Near Bristol Bay, Alaska. University of Washington, Department of Oceanography Technical Report, M77-3, 61 pp.

2. Kinder, T. H., J. D. Schumacher, R. B. Tripp, and J. C. Haslett, 1978. The Evolution of the Hydrographic Structure over the Continental Shelf near Bristol Bay, Alaska, during Summer 1976. University of Washington, Department of Oceanography Technical Report, Ref: M78-16, 72 pp.

C. Talks

1. Kinder, T. H. and L. K. Coachman, 1977. The Front Overlaying the Continental Slope of the Eastern Bering Sea, Chapman Conference on Oceanic Fronts, October, 1977. EOS 58(9):888.*

2. Schumacher, J. D., T. H. Kinder, D. Pashinski, and R. L. Charnell, 1977. Observations of a Boundary Front During Early Summer: Bristol Bay, Alaska, Fall AGU Meeting, December, 1977. EOS 58(12):1163.

3. Kinder, T. H., J. D. Schumacher, D. Pashinski, and R. L. Charnell, 1978. Structural Fronts over the Continental Shelf of the Eastern Bering Sea, Spring AGU Meeting, April 1978. EOS 59(4):304.

4. Charnell, R. L., H. O. Mofjeld, and J. D. Schumacher, 1978. On the Tidal Currents of Bristol Bay, Alaska, Spring AGU Meeting, April, 1978. EOS 59(4):305.

*These were funded primarily by the National Science Foundation, and mostly reflect earlier research. They are included, however, because OCSEAP work was involved and because the results are relevant to OCSEAP objectives.

V. Objectives

The specific objectives are:

1. to continue processing and submission of current meter and pressure gage data;
2. to refurbish and calibrate instruments as necessary;
3. to continue providing data to RU 435 (Leendertse) for modeling;
4. to analyze our data, and as resources permit, to synthesize these results with other work into scientific reports (see VII.B, below).

These objectives complete our obligation to submit data, to maintain equipment, and to assist RU 435. We also want to increase our understanding of the hydrography and circulation of the area. From this we can contribute to understanding transport and mixing processes over the shelf, and to understanding the Bering Sea ecosystem.

VI. Strategy and Approach

There will be no field work. Data reduction and submission will continue until completed. Data analysis will continue (see V. above and VII.B. below).

A. Sampling method. N/A

B. Analytical method. N/A

VII. Deliverable Products

A. Digital Data

1. We will submit data in formats 022, 017, or 015.

2. Limits:

temperature:	-2°C to +20°C
salinities:	0 g/kg to 35 g/kg
pressure:	0 db to 1600 db
speed:	0 cm/s to 200 cm/s
direction:	000° to 360°

3. We examine either a printout or a plot of all the (unfiltered) data prior to submitting it.

B. Narrative Reports

In addition to annual and quarterly reports, we plan two reports during FY 79; others may be generated as the year progresses:

1. Drifter and Hydrographic Observations of a Baroclinic Eddy in the Southeastern Bering Sea by Kinder (RU 141), Schumacher (RU 549), and Hansen (RU 217). The title is tentative, and an outline would be premature. We believe that using drifter data from summer and fall 1977 with CTD data from July 1977 - February 1978, we can comprehensively describe this eddy. We anticipate that a report suitable for submission to a scientific journal will result.

2. We plan an integration of drifter, current meter, and hydrographic data for the region north of the Alaska Peninsula during summer 1976.

C. Visual Data

All our data are submitted in digital format. Illustrations will continue to accompany annual reports, quarterly reports, and scientific reports.

D. Other N/A

E. Data Products Schedule

(attached sheet)

We agree to provide mylar overlays of: (1) Summer water masses; and (2) Mean measured currents. Sufficient data exist to produce these. We further agree to submit these mylar overlays by 1 June 1979.

VIII. Special Sample and Voucher Specimen Archival Plans: N/A

IX. Logistics Requirements: none

X. Anticipated Problems: none

XI. Information Required from Other Investigators:

We are interchanging data and cooperating directly with RU 549 (Schumacher and Charnell), RU 217 (Hansen), and RU 289 (Royer).

XII. Activity/milestone chart

(attached sheet)

DATA PRODUCTS SCHEDULE

ata Type i.e. Intertidal, enthic Organisms, tc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Mooring BC-4F (18m)	Tape		015	Yes	9/77 to 7/78	11/78
(46m)			015		"	"
(53m)			017		"	"
Mooring BC-4G (18m)			015		7/78 to 9/78	1/79
(46m)	"		015		"	"
(53m)			017		"	"
Mooring BC-21A(28m)	"		015		9/77 to 7/78	11/78
(40m)			017		"	"
Mooring BC-21B(28m)	"		015		7/78 to 9/78	1/79
Mooring BC-20A(22m)			015		9/77 to 7/78	11/78
(52m)	"		015		"	"
(65m)			017		"	"
Mooring BC-20B(22m)	"		015		7/78 to 9/78	1/79
(52m)			015		"	"

XII.

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 141 PI: Coachman, Kinder

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

MAJOR MILESTONES	1978			1979											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Complete submission of any outstanding data				0											
Attend PI workshops	0							0					0		
Submit annual or quarterly reports			0			0			0			0			0
Submit drafts of scientific report on eddy (tentative)						0									
Submit draft of scientific report on drifter/current meter comparison (tentative)												0			

XIII. Outlook

We have now amassed a large quantity of data from the continental shelf of the Bering Sea. With the conclusion of major field work, we can soon concentrate on data analysis. Much of the FY 79 effort will be completing data reduction and submitting these data. A large part of the scientific return will come after FY 79, and this knowledge should be the fruition of the contract. Included in the future work may be a synthesis of the regional physical oceanography, and contributions towards understanding the Bering Sea ecosystem.

Significant questions, which we can now pose and which the data will permit us to address, include:

1. What are the implications to mixing of the finestructure, which is ubiquitious in the shelfbreak domain?

2. What is the velocity field surrounding the structural fronts? What is the dynamical balance of the fronts? What effect do the fronts have on mixing? What effect to the fronts have on the biology?

3. What is the nature and cause of the anomalous reduction in tidal currents in Bristol Bay?

4. What is the character and cause of the episodic or quasi-oscillatory low frequency currents?

As analysis proceeds, these questions will be modified, or may be replaced as more important questions arise.

Milestones will be scientific reports answering these and similar questions. Major milestones will be synthesizing the physical oceanography, or writing a multi-disciplinary synthesis of the region.

At a continued funding of $40,000 per annum, one to three scientific reports should emerge in FY 80. Additionally, a beginning should be made on the important task of synthesizing the various scientific features into an integrated picture of the regional physical oceanography.

As questions arise and answers are proposed, modest field efforts may prove fruitful to test hypotheses, but these cannot be predicted.

XIV. Standard Statements

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA For 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U. S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached.) Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they became available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

To: Department of Commerce, NOAA
OCSEAP Program
Juneau Project Office
P. O. Box 1808
Juneau, Alaska 99802

Research Unit: 152

TITLE: Composition, Transport and Deposition of Suspended Matter in Lower Cook Inlet and Norton Sound, Alaska

Cost of Proposal: 111.4 K   Lease Areas: Cook Inlet: 85%
Norton Sound: 15%

PRINCIPAL INVESTIGATORS:

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Date July 28, 1978

ORGANIZATIONAL APPROVAL:

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Date 28 July 78

FINANCIAL OFFICER:

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Date 28 July 1978

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Date 28 July 1978

IV, V, and VI. BACKGROUND, OBJECTIVES, AND GENERAL STRATEGY

The development of petroleum and natural gas resources on the Alaskan outer continental shelf will undoubtedly result in an increased potential for crude oil contamination of its coastal water. Of particular concern are the major accidents which cause massive oil spills, such as the ARGO MERCHANT oil spill on Fishing Rip near Nantucket (NOAA Special Report, 1977). However, chronic release of oil through minor spills and localized transfer operations may be more important over the long term.

Oil spilled onto the surface of the ocean is acted upon by several physical processes, including evaporation, solution, emulsification, and injection into the atmosphere (Kreider, 1971; McAuliffe, 1966, 1969; Baier, 1970). With respect to the oceanic environment, only the solution and emulsification processes represent important mechanisms by which spilled oil becomes entrained in the water column, thus increasing its potential for impacting marine organisms.

Since crude oil is sparingly soluble in seawater, it tends to form emulsions when introduced into seawater, especially under intense wave action. The emulsions have a high affinity for particles and tend to be adsorbed rapidly. Recent studies of oil spills in coastal waters containing high suspended loads have indicated rapid dispersal and removal of the oil by adsorption onto suspended matter (Forrester, 1971; Farrington and Quinn, 1973).

There is very little published information about the processes by which oil is transported in association with suspended particles or the quantities of oil that can be adsorbed onto the particles. Early investigators have shown that flocculation of oil bears an inverse relationship to salinity (Chipman and Galtsoff, 1949; Hartung and Klinger, 1968). Later investigations indicate that sedimentation of oil involves a two-step process (Bassin and Ichiye, 1977; Huang and Elliott, 1977). This process begins with the adsorption of oil onto the suspended particles and is followed by the flocculation of these oil-sediment emulsions by electrostatic interactions. The amount of oil that can be accommodated by a specific quantity of suspended matter appears to be dependent upon the physical and chemical nature of the suspended particles as well as the amount of naturally occurring organic matter that is associated with the particles (Poirier and Thiel, 1941; Meyers and Quinn, 1973).

Cook Inlet and Shelikof Strait

For the past 1½ years we have been conducting integrated studies of the distribution, composition, transport, and adsorptive properties of suspended matter from Lower Cook Inlet and Shelikof Strait. While detailed descriptions of the results of these studies are available in our annual reports, brief summaries of the most significant findings which are relevant to the processing occurring in Lower Cook Inlet are listed below.

1. The suspended matter distributions appear to follow the general pattern of circulation in Lower Cook Inlet and Shelikof Strait. The inflowing relatively clear Gulf of Alaska water, which contains significant amounts of biogenic particles, flows northward along the eastern side of Lower Cook Inlet until it reaches Cape Ninilchik, where it mixes with the outflowing turbid brackish water. The outflowing turbid water moves along the western side of the Inlet past Augustine Island and Cape Douglas into Shelikof Strait where is mixes with the oceanic water and disperses. Comparisons of suspended matter and sediment characteristics indicates that net sedimentation of suspended matter in the central basin of Lower Cook Inlet is minimal. However, sedimentation may be occurring in the numerous embayments along the coast.

2. Time-series studies of the concentrations and compositions of suspended matter near the bottom in Lower Cook Inlet show evidence for resuspension and redistribution of the fine-grained fraction of the sediments. The resuspended fine sediments are then transported to quiescent nearshore environments where they are redeposited. Thus, it is possible that once dispersed contaminated sediments may be concentrated in areas of active sedimentation by the interactions between bottom currents and surficial sediments.

3. Chemical analysis of suspended material from Lower Cook Inlet reveals that aluminosilicate minerals from the coastal rivers comprise about 80-95% of the suspended matter, with biogenic matter making up the rest. Analysis of seasonal variations of C:N ratios of the particulate organic matter indicates that organic matter of marine origin is dominant in summer when productivity is high, whereas organic matter of terrestrial origin predominates in winter when primary production is low.

4. Controlled laboratory studies of the interactions between Cook Inlet crude oil and suspended matter from Cook Inlet show that the accommodation capacity of suspended matter for crude oil increases with the concentration of added oil. Important parameters in the accomodation process include: The chemical nature and viscosity of the oil; the mineralogical composition and size characteristics of the suspended matter; temperature and degree of mixing.

These findings clearly show that suspended matter could play an important role in the dispersal and deposition of petroleum hydrocarbons in Lower Cook Inlet. However, the picture is incomplete and more data is required before the fate of petroleum hydrocarbons in Lower Cook Inlet can be accurately predicted. Specifically, at present there is very little information about sedimentation of particulate matter in the Inlet. We are presently conducting a few short-duration measurements to determine what is essentially instantaneous vertical fluxes of suspended matter in two regions believed to be undergoing active sedimentation, i.e., Kachemak and Kamishak Bays. While these data are very useful for estimating the vertical fluxes of oil that would be associated with suspended matter during an oil spill, they provide little information about the ultimate depositional sites for the oil contaminated suspended matter. Accordingly, in addition to the continuation of our suspended matter compositional studies, we propose to conduct an investigation of the sediment accumulation rates in Lower Cook Inlet and Shelikof Strait to determine the major sinks for recently derived suspended matter. The general strategy and objectives of the laboratory and field studies will be briefly described below.

A. Laboratory Studies

As part of the suspended matter program for FY 78, suspended matter samples were collected during shipboard operations in May and August of this year. In addition, sediment traps were deployed in May for recovery in October. During FY 79, these samples will be analyzed for total and extractable Al, Fe, Mn, Cr, Cu, Pb, Ni, and Zn. The objectives of this portion of the program will be twofold: (1) determine whether or not production of organic matter in Kachemak Bay causes seasonal variations in the trace metal content of suspended matter, and (2) determine whether or not present oil production activities in Upper Cook Inlet contribute significantly to the trace metal content of suspended matter in Lower Cook Inlet. In order to insure that the results of the chemical analyses of the suspended matter are comparable with similar data being generated for the sediments (Research Units 162 and 506), the same analytical procedures will be applied to the suspended matter as for the sediments (These procedures are outlined in the methods section of the proposal).

B. Field Studies

The field program in Lower Cook Inlet and Shelikof Strait will have two major objectives: (1) determine sediment accumulation rates at selected regions in the study area where active sedimentation is suspected; and (2) provide the hydrocarbon chemists with ancillary data on the temporal and spatial distributions of suspended matter at two locations in Cook Inlet i.e., Kachemak Bay and near Kalgin Island. Both objectives will be accomplished during a single cruise in May, 1979.

To accomplish the first objective approximately 20-40 cores will be collected at several locations throughout Cook Inlet and Shelikof Strait (Fig. 1). The cores will be subsectioned in the field, frozen and returned to the laboratory for subsequent radiometric dating by the ^{210}Pb technique

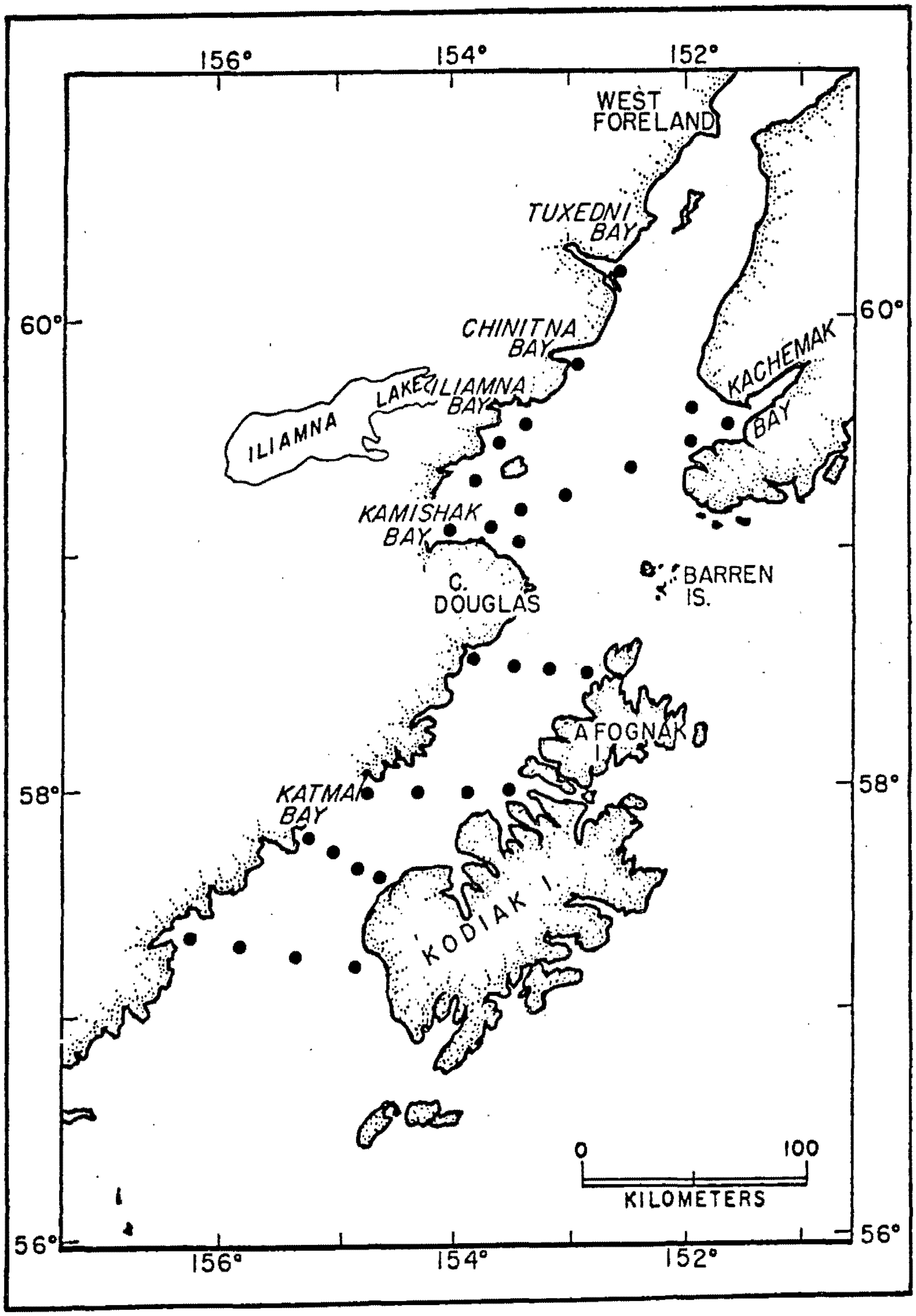

Figure 1. Proposed sampling grid for ^{210}Pb dating of sediment cores from Lower Cook Inlet and Shelikof Strait.

(Flynn, 1968). In this procedure excess ^{210}Pb, which is derived from the decay of atmospheric ^{222}Rn and is deposited in the sediments in association with suspended matter, is measured in subsections of a core and the accumulation rate (w) is determined by the relationship:

$$wi = \frac{xi}{Ti} \tag{1}$$

where x is the depth of the "i" th subsection and Ti is the ^{210}Pb age of the subsection. A plot of log activity of excess ^{210}Pb versus depth in the core yields a straight line over a depth interval in which the accumulation rate is constant (usually below the zone of mixing and bioturbation). The net accumulation rates generated in this manner will be used to develop a map of sedimentation rates for recent sediments in Lower Cook Inlet. This map will be useful for identifying the major sinks of suspended matter (and associated contaminants) and for identifying possible locations for future site specific studies, such as diagentic alterations of contaminants in recent sediments.

In addition to the field experiments described above, we will support the work of the hydrocarbon chemists by providing them with ancillary data on the spatial and temporal variations of suspended matter at two locations in the Inlet, i.e., Kachemak Bay and the region near Kalgin Island (Fig. 2). The data, which will be collected in the form of CTD-nephelometer profiles and discrete water samples and presented in the form of suspended matter distribution maps and time series plots, are necessary for the chemists to compute fluxes of hydrocarbons associated with suspended matter in Cook Inlet. When this data is combined with the information on the accumulation rates for fine-grained sediments a clear picture of contaminant sources and sinks should evolve which will be an important feature of any model of contaminant transport for Cook Inlet.

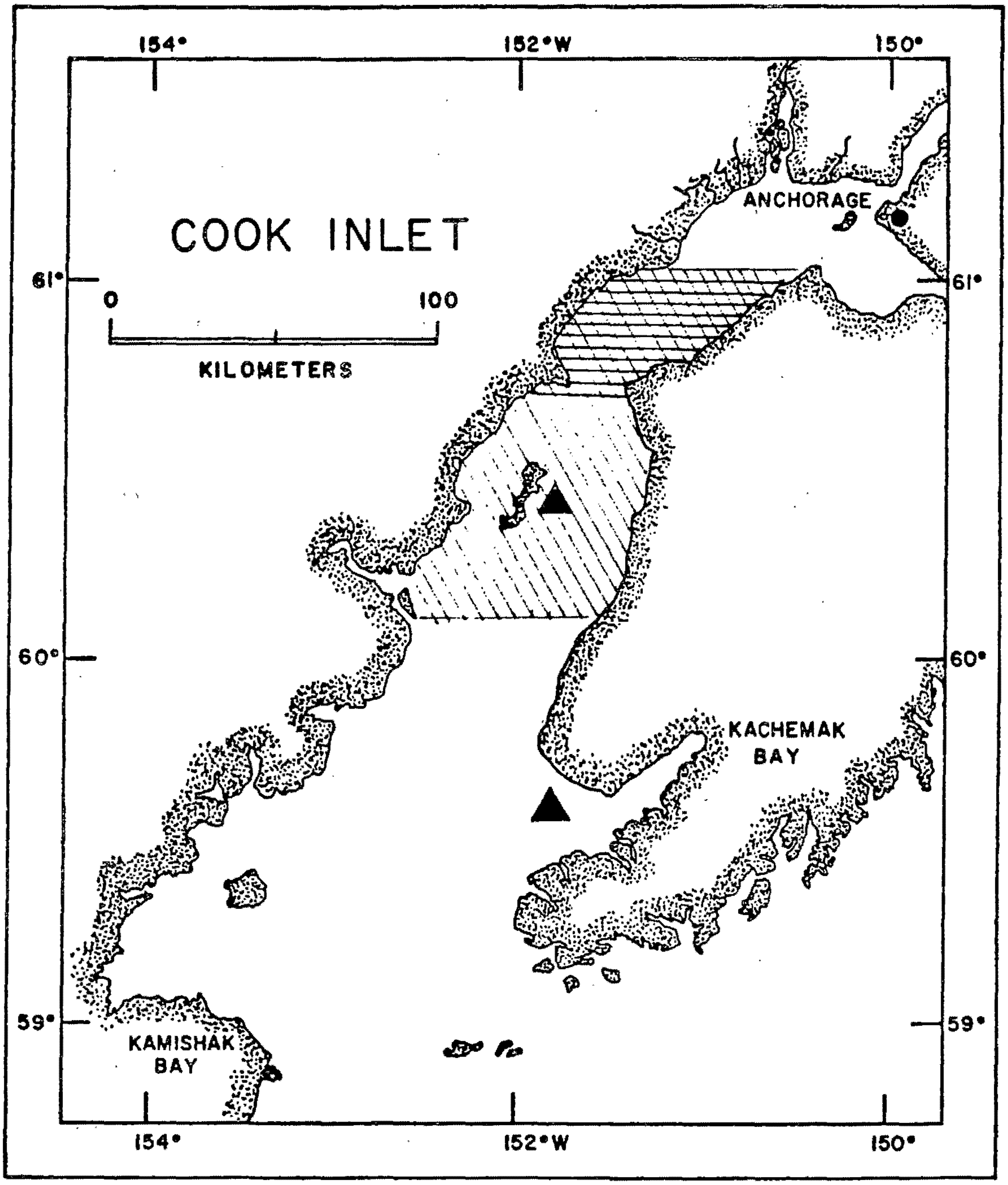

Figure 2. Proposed sampling grid for Cook Inlet. The crosshatched area represents water column sampling for TSM; a small boat will be required north of The Forelands. The time series stations (▲) are shown in Kachemak Bay and east of Kalgin Island. Detailed station locations will be submitted prior to the cruise in May 1979.

Norton Sound

The objectives of this phase of the suspended matter program are largely in support of the intensive study of the area surrounding the Norton Sound Gas Seep. In this study, which is being planned for implementation in late summer of 1979, investigators from PMEL, U of A, UCLA, and the USGS will conduct a thorough survey of water column properties and hydrocarbon distributions in the region of the Seep. Some parameters to be investigated include (1) hydrocarbons in water, suspended matter, sediments, and biota; (2) temperature; (3) salinity; (4) turbidity; and (5) suspended matter distributions. Our objectives will be to collect data on the water column properties, i.e., temperature, salinity, turbidity and suspended matter distributions. We will also characterize the suspended material for its chemical and morphological composition. This data will be neccessary for evaluating the role of suspended matter as a vehicle for transporting hydrocarbons through the water column.

The Norton Sound sampling strategy is shown in figure 3. Major emphasis will be placed on the region of the gas seep south of Nome, Alaska. Water sampling for temperature, salinity, nephelometry measurements, and suspended matter will be carried out at all stations. A minimum of three suspended matter samples per vertical profile will be taken.

Suspended matter samples and CTD-nephelometers will be taken in 2-hour time series stations (illustrated in Fig. 3 by triangles). These samples will be used for the suspended matter characterization work.

Program management, data processing, and products submission will be under the direction of Drs. Cline and Feely. Cruise planning and data integrity will also fall under the management purview.

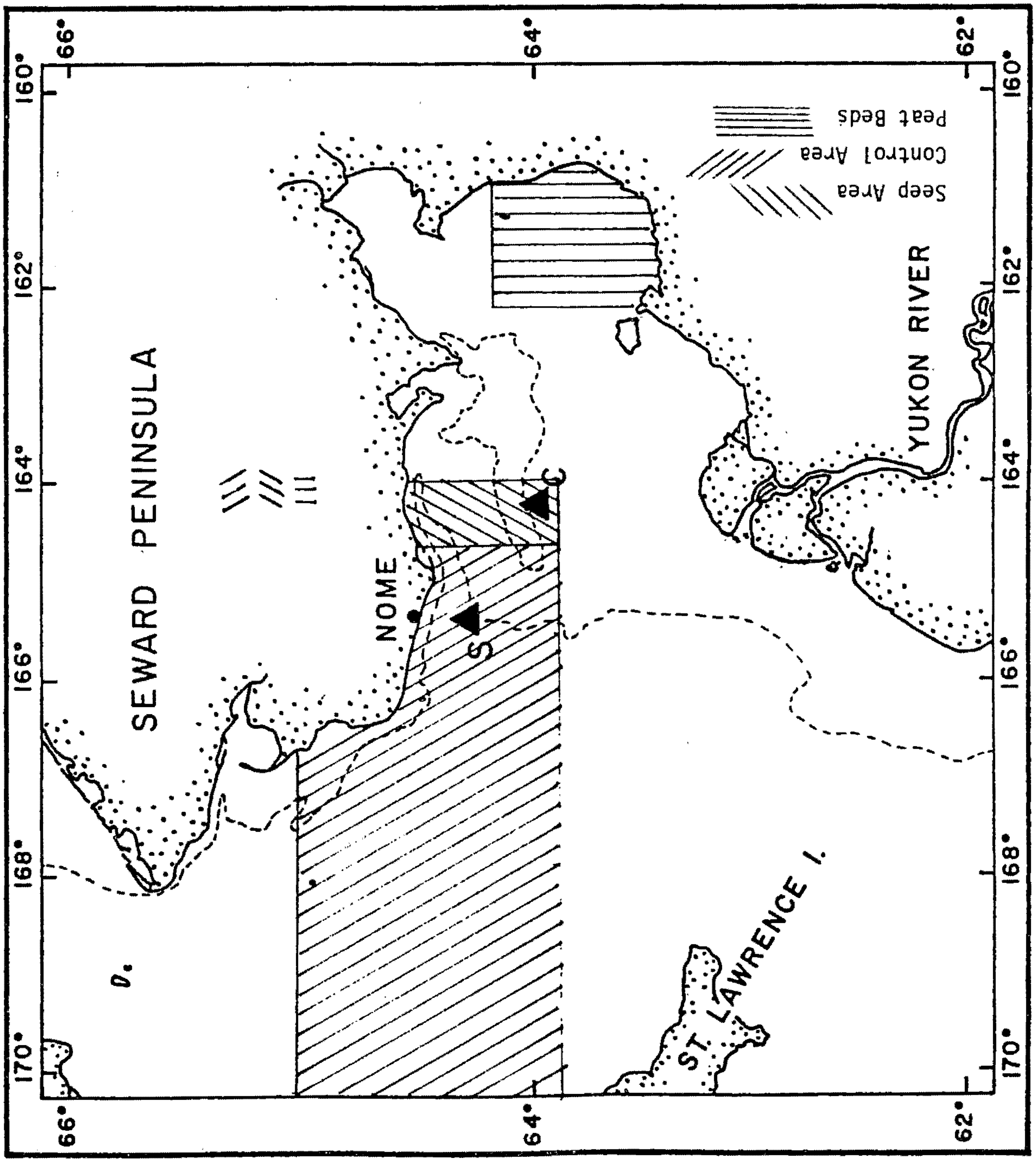

Figure 3. Proposed sampling grid for Norton Sound. The time series stations are shown as triangles. Actual station locations will be provided prior to the cruise in August 1979.

C. Sampling Methods

The distribution of temperature, salinity, turbidity, and suspended loads will be determined using a CTD-nephelometer-rosette system. Water samples will be collected in 10-liter PVC Model 1070 Drop-Top Niskin® bottles and filtered through preweighed 47 mm 0.4 μm Nuclepore filters. The filters will be washed with three 10 ml aliquots of deionized filtered water, dried in a desiccator, stored in plastic petri dishes, and frozen to reduce bacterial activity. At the laboratory the filters will be reweighed on a seven-place Cahn Electrobalance.

The vertical distribution of suspended particulate matter will also be determined using a continuously recording integrating nephelometer (Sternberg, et al., 1974). The nephelometer will be interfaced into a Plessey 9040 CTD system using the sound velocity channel (14-16 kHz) such that real time measurements of forward light scattering can be obtained. Since the light scattering measurements are relative, the instrument must be calibrated against suspended loads from discrete samples.

Sediment cores will be obtained with a three-inch diameter gravity corer equipped with a plastic core liner. Upon retrieval, the cores will be subsectioned into 1 cm sections, frozen and returned to the laboratory for subsequent radiometric analysis.

D. Analytical Methods

The suspended matter samples from Lower Cook Inlet will be analyzed for extractable Al, Fe, Mn, Cr, Cu, Ni, Zn, and Pb using a combination of two extraction treatments followed by flameless atomic absorption spectrophotometry. The first extraction procedure involves the use of hydrogen peroxide to release organically-bound trace metals. The second treatment utilizes 0.3 N hydrochloric acid to release trace metals which are weakly bound to inorganic phases. The details of the procedures are outlined below.

A. H_2O_2 Treatment. Clean the H_2O_2 by passing a 10% solution (reagent grade) through a 25 cm^3 Amberlite A-200 column (H^+ form) at a flow rate of approximately 5 ml/min. The pH of the cleaned H_2O_2 should be about 5.5. Combine 3 to 5 ml of cleaned H_2O_2 and 100 to 500 mg of sample material in a precleaned centrifuge tube equipped with a non-sealing cap. The volume and mass of extractant and sample, respectively, may vary within the above limits depending on the relative magnitude of the organic fraction in the sample. We are currently using polypropylene centrifuge tubes and caps. Heat the extractant-sediment solution in a water bath at approximately 50°C for 48 hours. During the final 24 hours of heating, virgorously sonicate the solution to assist in dispersal and breakdown of the organic matter. Centrifuge the tube contents at 2000 rpm for 1-hour. Decant the supernate into a precleaned and tared polyethylene (CPE) bottle. Rinse the residual particulate matter with two 5 ml aliquots of quartz-distilled water. Centrifuge, as above, after each rinse and combine all supernates in the polyethylene bottle. Determine the weight of the final supernatant solution by difference.

B. 0.3 N HCl Treatment. The sediment-water mixture, following H_2O_2 Treatment is diluted to 200 ml with deionized water. One ml of 6 N HCl is added, and the suspension is mixed and heated to just below boiling on a hotplate. Heating at this temperature is continued for 30 minutes. The mixture is centrifuged at 2000 rpm for 1-hour. The supernate is placed into an acid washed 25 ml polyproylene volumetric flusk. The residue is washed three more times with hot dilute HCl (1 + 19) and centrifuged the supernate is added to the volumetric flusk and brought to volume with deionized water.

For the suspended matter characterization work in Norton Sound, the major major elements in the suspended matter (i.e., C, N, Al, Si, K, Ca, and Fe) will be determined by two techniques. Particulate C and N will be analyzed by the micro-Dumas combustion method, employing a Hewlett Packard 185B C-H-N analyzer (Sharp, 1974). Particulate matter will be removed from 1-liter volumes by vacuum filtration and the carbon and nitrogen combusted to CO_2 and N_2. After separation by standard gas-solid chromatography, the gases are quantitatively determined by thermal conductivity. Standardization will be effected with acetanilide (Sharp, 1974). Particulate Al, Si, K, Ca, and Fe will be determined by secondary-emission x-ray fluorescence spectroscopy using an Ag x-ray tube and the thin-film procedure (Baker and Piper, 1976).

The ^{210}Pb dating of the sediment cores will be performed by C. Holmes and E. A. Martin of the USGS in Corpus Christi, Texas, employing the techniques outlined by Flynn (1968).

VII. DELIVERABLE PRODUCTS

A. Digital Data

The results of the chemical analysis of the suspended matter will be arranged into tabular format and submitted to EDS/NODC on IPM cards (File Type 021).

B. Narrative Reports

Quarterly and annual reports will be submitted in narrative form in accordance with preestablished schedules. The reports will contain appropriate figures and tables showing relationships and distributions of the parameters observed. These reports will be augmented with formal reporting of scientific findings in the scientific literature.

C. Visual Data

Area charts and maps will be presented on OCSEAP provided standard maps. This includes the Mylar overlays produced from these maps.

D. Nondigital Data

Any nondigital data will be kept as a permanent record by the principal investigators and are available for inspection or inclusion in the standard data base at the request of the Project Office.

E. DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submiss (Month/
Suspended Matter	cards	100	021	Yes	5/78	3/79
Suspended Matter	cards	100	021	Yes	8/78	6/79
Suspended Matter	cards	100	021	Yes	5/79	3/80
Suspended Matter	cards	100	021	Yes	8/79	6/80

VIII. SAMPLE ARCHIVAL

Since all samples are essentially destroyed during the analytical portion of the program, we do not have any plans for archiving samples.

IX. LOGISTICS REQUIREMENTS

INSTITUTION Pacific Marine Environmental Laboratory/NOAA

PRINCIPAL INVESTIGATORS Dr. Richard A. Feely and Dr. Joel Cline

A. SHIP SUPPORT

1. Proposed tracks and/or sampling grids, by leg, on a chart of the area: See figures 1, 2, and 3.

2. Types of observations to be made on tracks and/or at each grid station: CTD, bottle casts, bottom grabs, and gravity coring.

3. Optimum time chronology of observations on a leg and seasonal basis and the maximum allowable departure from these: Cook Inlet: 5/79 and Norton Sound: 8/79.

4. Number of sea days required for each leg: Cook Inlet: 4 days and Norton Sound: 1 day.

5. Investigation is considered to be a: Cook Inlet: principal activity, and Norton Sound: support activity. Approximate number of hours per day required for observations: 24-hour sampling - 1 hour for station sampling; 3 hours between stations.

6. Equipment and personnel we expect ship to provide: CTD, gravity core, Van Veen sampler, survey technician.

7. Approximate weight of equipment we will bring: 2,000 lbs.

8. Will data or equipment require special handling? No.

9. Will you require any gases and/or chemicals? No.

10. Ship preference: (1) DISCOVERER (2) MILLER FREEMAN

11. Requirement for a non-NOAA vessel: Small vessel required for work in Upper Cook Inlet.

12. Number of people we must have on board for each let: Usually 4 people.

X. ANTICIPATED PROBLEMS

We anticipate no significant problems with this program as we have outlined it. If major or modifications in the scope of the research are initiated, we may have to modify our posture and response to the milestones described in the following section.

In the event that cruise plans are aborted through some unforeseen circumstances, such as weather or ship breakdown, we are prepared to complete the sampling program on another cruise if additional funds are provided for shipping and travel. If another cruise cannot be scheduled we will continue the laboratory analyses on previously collected samples.

XI. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

The suspended matter program will require information from portions of the geological and physical oceanography programs. Detailed maps of the size distribution and mineralogical composition of the sediments should be made available to us as soon as possible. We also need detailed descriptions of the circulation patterns. Special emphasis should be placed on net water mass transport through the study regions.

XII. MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 152 PI: Dr. Richard A. Feely and Dr. Joel Cline

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

MAJOR MILESTONES	1978			1979												1980				
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
Quarterly Report				0																
Submission of Cook Inlet Data taken 5/78						0														
Annual Report							0													
Cruise to Cook Inlet								0												
Submission of Cook Inlet Data obtained on 8/78									0											
Quarterly Report									0											
Norton Sound Cruise										0										
Quarterly Report												0								
Quarterly Report																0				
Submission of Cook Inlet Data taken 5/79																		0		
Annual Report																			0	
Submission of Norton Sound Data obtained 8/79																				0

XIII. OUTLOOK

The field portion of the suspended matter program represents an interdisciplinary approach to understanding the dynamics of suspended matter transport in Lower Cook Inlet, requiring inputs from the physical and geological programs. It is possible that the present study will unveil new problems which may require more intensive study. However, it is impossible at this point to project what will be the actual nature of and scope of the studies until the results of this year's work have been examined. Nevertheless, we can anticipate that because of the tentative schedules for the field programs, additional funding of about 50-60 K in FY 80 will be required to complete the analysis of the data collected in FY 79.

XIV. GENERAL STIPULATIONS

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA Form 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and nonexpendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

I. Three copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least 60 days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than 60 days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

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To: NOAA, OCSEAP
Bering Sea - Gulf of Alaska Project
P. O. Box 1808
Juneau, Alaska 99802

Proposal Date: July 5, 1978

NOAA Project: R7120841

FY 1979 RENEWAL PROPOSAL

Research Unit: 153

TITLE: Characterization and Source Identification of Anthropogenic and Natural Low Molecular Weight Petroleum Hydrocarbons in Cook Inlet and Norton Sound, Alaska.

Cost of Proposal: $163,984

Lease Areas: Norton Sound: 40%
Cook Inlet: 60%

Period of Proposal: October 1, 1978 through September 30, 1979

PRINCIPAL INVESTIGATORS:

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Date 21 July 1978

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Date July 21, 1978

IV. Background

A. Low Molecular Weight Hydrocarbons - Cook Inlet

Observations into the distributions and abundances of the low molecular weight aliphatic hydrocarbons in numerous lease areas of Alaska have been carried out over the past three years. These studies have shown that, under certain constraints, the abundances of the higher homologs of methane, together with the alkane/alkene ratio, serve as an operational indicator of the presence of petroleum-derived hydrocarbons. This was shown to be the case in Norton Sound with the discovery of a submarine gas seep (Cline and Holmes, 1977) and more recently in Cook Inlet.

Recent surveys of LMWH in the region just north of The Forelands documented the occurrence of unusually high concentrations of ethane, propane, and butanes, not accompanied by a similar increase in the olefins. Examples of the distributions of ethane and propane are shown in Figures 1 and 2 for the month of July 1977 (Cline, 1977). The source of these hydrocarbons appears to be the MacArthur oil field located in Trading Bay, but no attempt was made to delineate the source or nature of the input. In a survey of dissolved LMWH conducted in 1968, elevated concentrations of methane were observed in the region between The Forelands and just to the north in Trading Bay (Kinney et al., 1970). Unfortunately, analytical difficulties precluded the analyses of the higher homologs of methane although we assume they were present.

The source of these gaseous hydrocarbons may include subsurface seepage from structural faults or leakage from production platforms. The earlier measurements of Kinney et al. (1970) and those of ours in April and July of this year suggest that the source is chronic in nature. Moreover, the

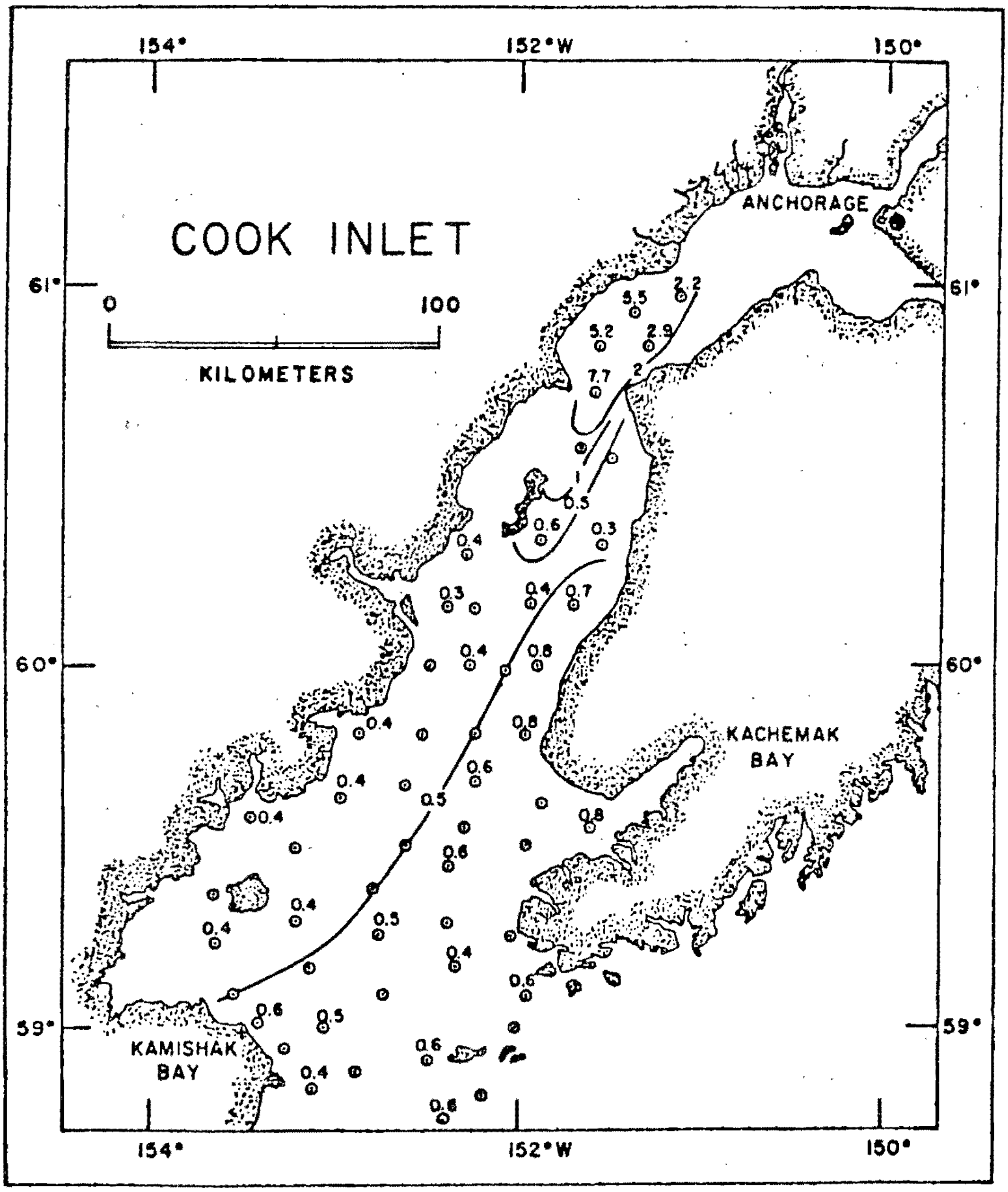


Figure 1. Distribution of ethane (nℓ/ℓ, STP) in the surface layers during July 1977. Concentrations not shown at all stations for the purpose of clarity.

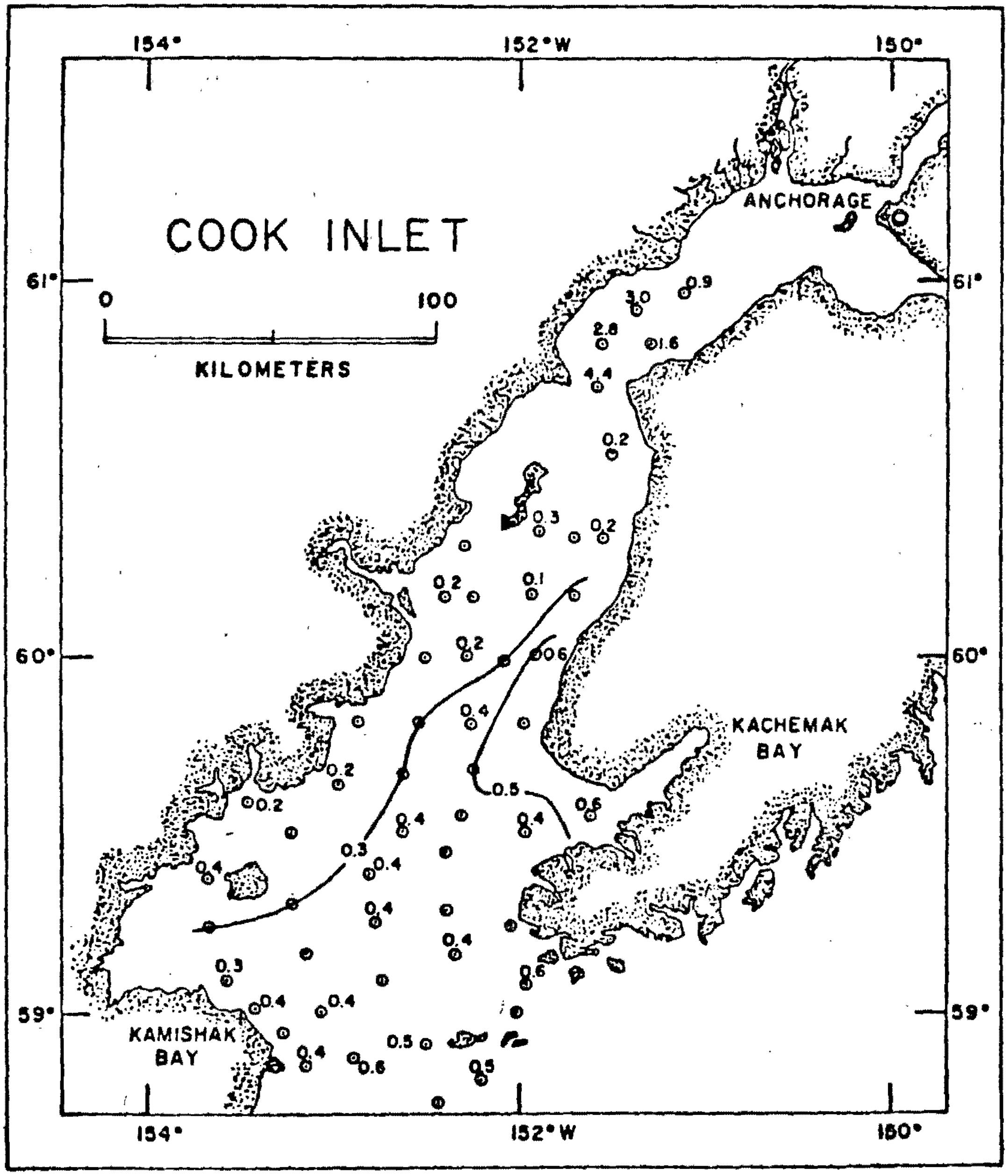


Figure 2. Distribution of propane (nℓ/ℓ, STP) in the surface layers during July 1977. Concentrations not shown at all the stations for the purpose of clarity.

heavier fractions of petroleum may be associated with it, since the MacArthur field produces mostly petroleum (API 33) with the dry gas component being used to run machinery associated with the liquid extraction plant (Blasko, 1974).

The occurrence of the LMW alkanes was largely confined to the region between Trading Bay and Kalgin Island. It is assumed that strong tidally-induced vertical and horizontal mixing (see Figures 1 and 2) results in rapid dilution and volatilization of these components. The lower inlet, in contrast to the area above The Forelands, reflects a strong seasonal biological component of LMWH (Cline, 1977). Lower Cook Inlet, in particular the region near Kamishak and Kachemak Bays, reveals elevated concentrations of the C_2 and C_3 alkenes during summer, which is presumably related to primary productivity, either directly or indirectly, or to possible photochemical effects (Wilson et al., 1970). Our work has shown that under normal conditions the ethane/ethene ratio rarely exceeds 0.5 in most shelf areas and is most nearly 0.1-0.2 for Cook Inlet during summer. There is a concomitant rise in the concentration of ethane that accompanies increases in ethene, but the $C_{2:0}/C_{2:1}$ ratio rarely exceeds 0.5. How these two C_2 aliphatics are related is not clearly understood, but that relationship has direct bearing on the utility of the LMW aliphatics for the detection and discrimination of petroleum-induced hydrocarbons, whether it be in Cook Inlet or elsewhere in Alaskan shelf waters.

The LMWH also appear to be produced in marine sediments (Bernard et al., 1977). A systematic transect across the Texas Gulf coast shows a preponderance of methane, followed by ethene, propene, ethane, and propane in order of decreasing abundance. The average pore water concentration of LMWH shows that concentration of ethene generally exceeds that of ethane by a factor of 2, not unlike the results of our extensive water column work. To our knowledge, no systematic analyses of pore waters for LMWH have been undertaken in Cook Inlet, although the influence of this source on the composition observed in the water column must be assessed. This is particularly true in the southern portion of Cook Inlet where fine-grained sediments are more prevalent, but not necessarily abundant.

This year's study focused on the occurrence of LMW aromatics (e.g., benzene, C_1-benzenes, etc,), since their occurrence above background would provide the highest order of distinguishability of petroleum hydrocarbons. Preliminary data taken in May of this year indicates a significant accumulation of LMW aromatics north of The Forelands, particularly on the western side of the Inlet. Depicted in Figures 3-6 are the aliphatic and aromatic chromatograms for stations UC-05, UC-06, and CB-4; all samples were taken near the surface. Stations UC-05 and UC-06 are located near the upper extremity of Trading Bay, but are representative of most stations occupied in Trading Bay as well as The Forelands. The aliphatic chromatogram from UC-05 shows a slight predominance of alkanes (cf. Figure 3A); whereas the aromatic spectra reveals a complex array of peaks, not totally resolved by our GC procedure (i.e., packed column). Prominently identified aromatic compounds were benzene, toluene, xylenes, and C_2-benzenes. Compounds of lower boiling point than benzene were also apparent, presumably hexanes and cycloparaffins. By way of contrast, station CB-5, located just east of Kamishak Bay was largely devoid of LMW aromatics, except toluene (Figure 5B). Toluene was not present in the blanks (e.g., Figure 6), thus it appears to represent a natural background component. It may be an unknown compound of similar retention indices.

The concentration of LMW aliphatics and aromatics at station UC-06 are shown in Figure 4. At this station the concentration of ethane and propane was relatively high (Figure 4A) as was benzene (Figure 4B). Ethyl benzenes

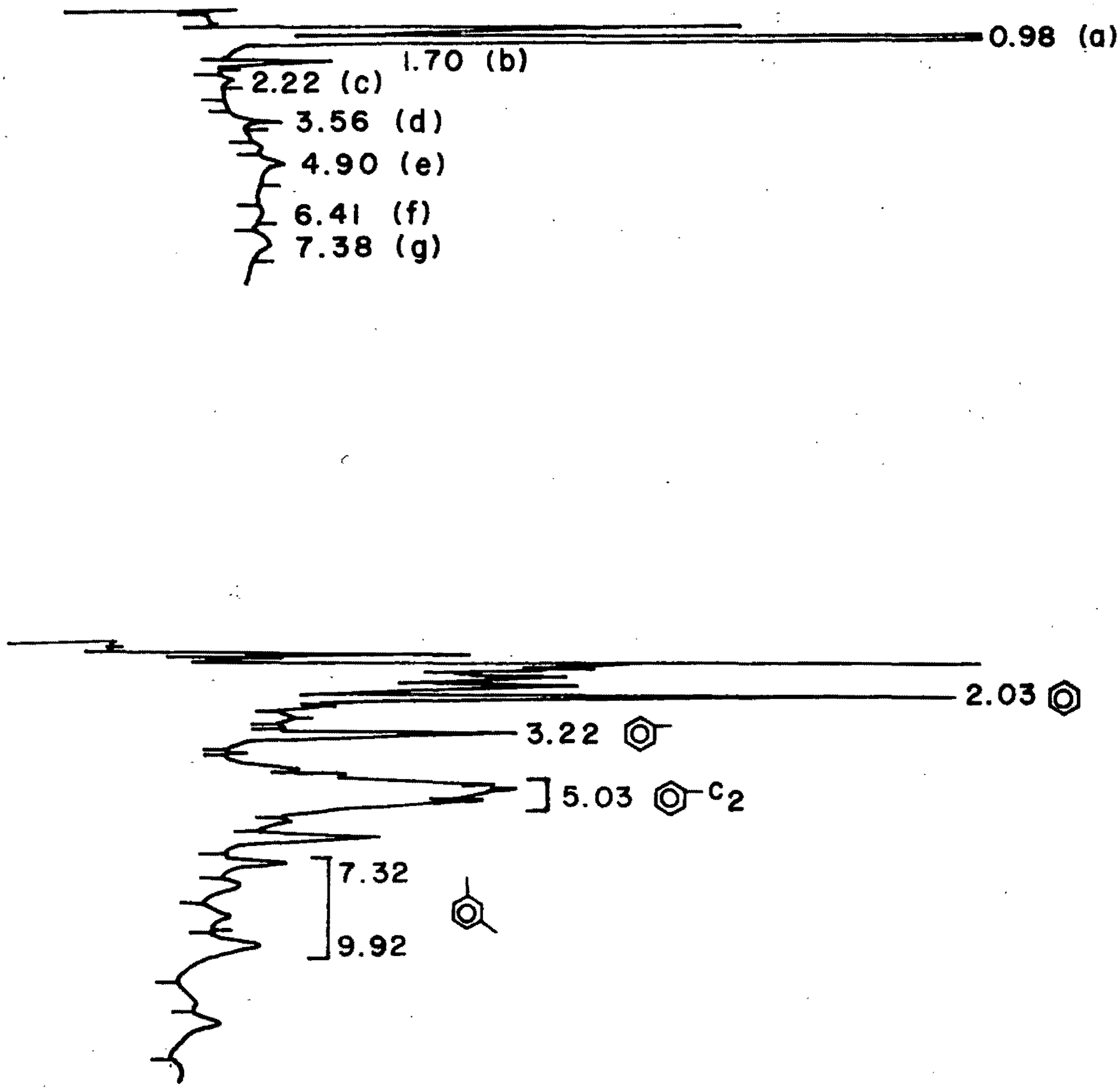


Figure 3. Chromatogram of dissolved LMW aliphatics (A) and aromatics (B) extracted from the surface waters at station UC-05 in Trading Bay. The aliphatics analyzed include methane (a), ethane (b), ethene (c), propane (d), propene (e), isobutane (f), and n-butane (g).

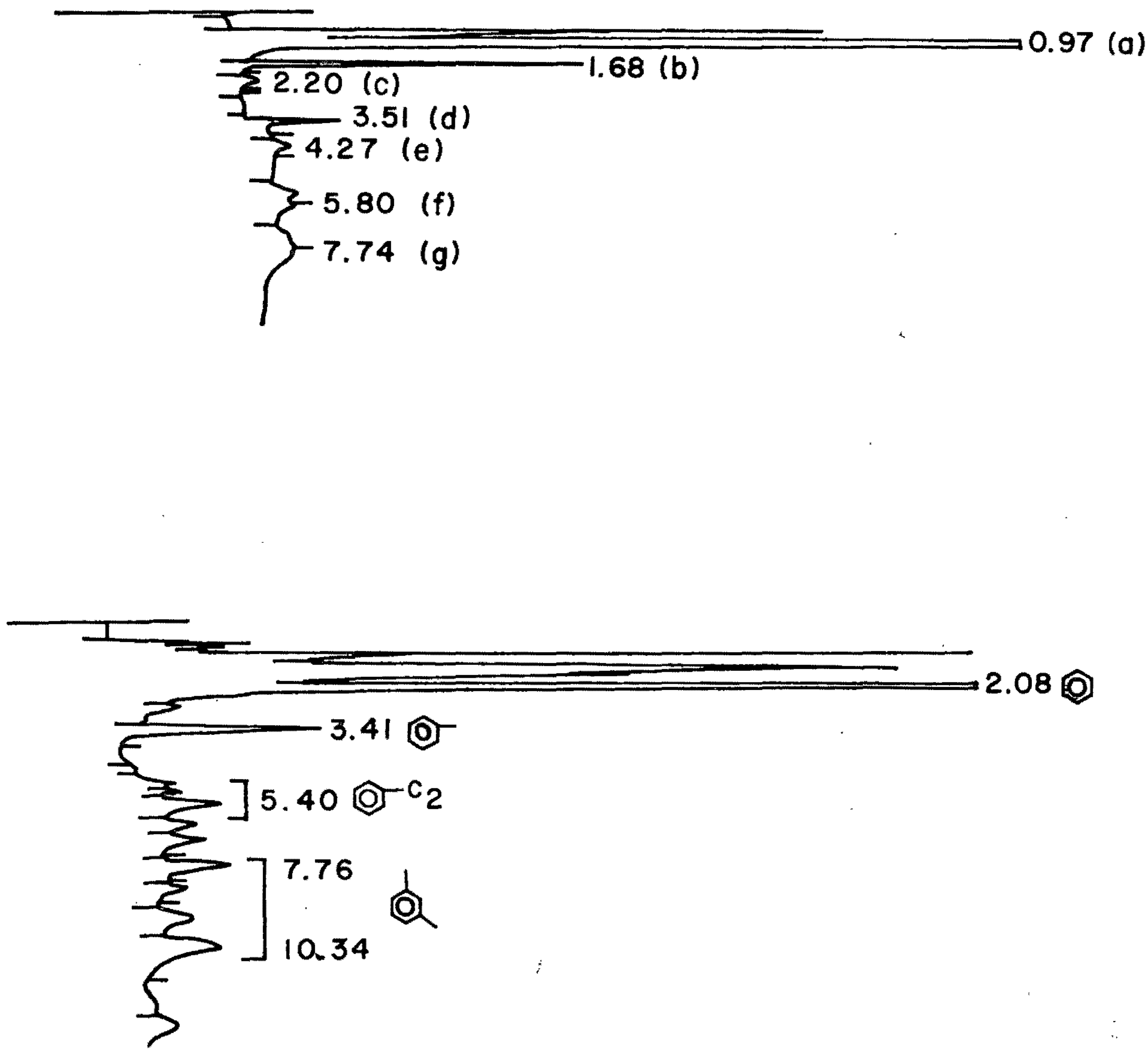
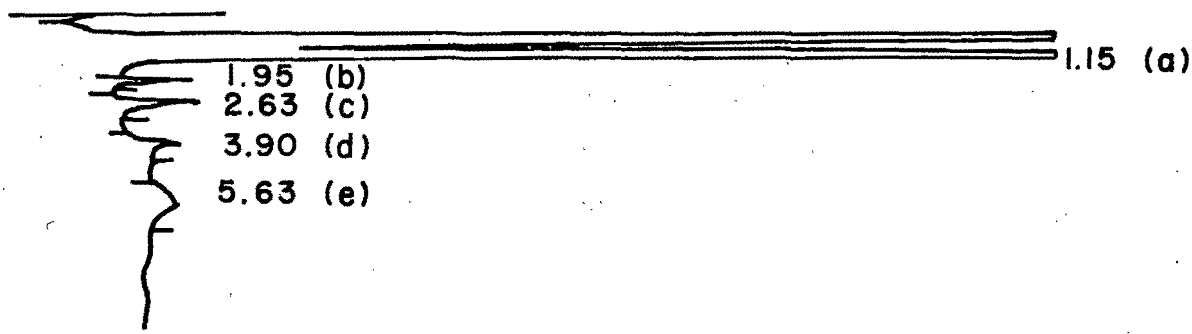


Figure 4. Chromatogram of dissolved LMW aliphatics (A) and aromatics (B) extracted from the surface waters at station UC-06 in Trading Bay. The aliphatic composition is given in Figure 3.



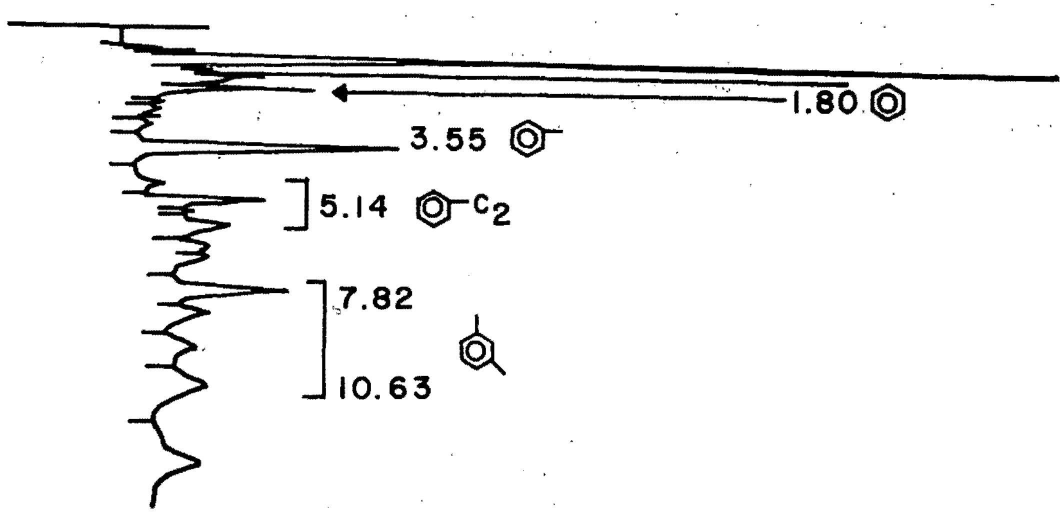


Figure 5. Chromatogram of dissolved LMW aliphatics (A) and aromatics (B) extracted from near bottom waters at station CB-5 near Kachemak Bay. The aliphatic composition is given in Figure 3.

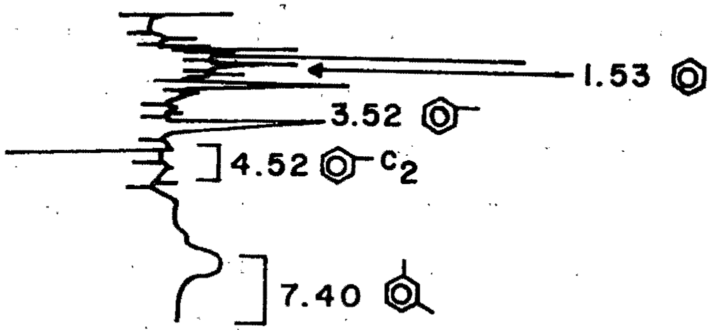


Figure 6. Characteristic chromatographic blank from seawater previously stripped of LMW aromatics.

were found in lesser concentrations than observed at station UC-05. At both UC-05 and UC-06, lower boiling point components were observable in the aromatic chromatogram (cf. Figures 3A and 4B). Recent conversations with Dr. D. Shaw of IMS indicate that heavy hydrocarbons also were found in the waters north of The Forelands. Thus, the evidence to date suggests that petroleum hydrocarbons are present in upper Cook Inlet and probably originate from anthropogenic sources. Before definitive statements can be made as to sources, it will be necessary to characterize the compounds shown in the aromatic spectra.

B. Low Molecular Weight Hydrocarbons - Norton Sound

During a general survey of LMWH in Norton Sound during September of 1976, an unusual source of LMW n-alkanes was observed emanating from a point source in the sea floor (Cline, 1977). Subsequent analysis and model studies showed the gaseous hydrocarbons to be rich in ethane, propane, and higher homologs of methane, but deficient in the unsaturates such as ethene and propene (Cline and Holmes, 1977). The plume of hydrocarbons was restricted to the lower 10 m of the water column (cf. Figure 7) and moved toward the north and northwest in agreement with the general circulation pattern (Muench et al., 1979). Seismic data taken in the region of the seep reveal strata truncated by an unconformity, acoustic anomalies, and numerous steeply dipping faults which provide favorable avenues for the migration of mobile hydrocarbons to the sea floor (Cline and Holmes, 1977). The possibility of petroleum-bearing source rocks beneath Norton Sound is also suggested by the presence of oil seeps in lagoons near Nome (Cathcart, 1920), Sinuk Valley north of Nome (Miller et al., 1959), and the mouth of the Inglutalik River in Norton Bay (Miller et al., 1959; Johnson, 1971).

More recent studies in Norton Sound have shown the presence of petroleum-like hydrocarbons in the pore waters in the vicinity of the gas seep (personal communication, K. Kvenvolden, U.S.G.S. Menlo Park). Unexpectedly, analysis of the bottom sediments, presumably near the seep location, showed no evidence of heavy petroleum hydrocarbons (personal communication, J. Calder, OCSEAP). Geophysical data indicate the origin of the gas seep is deep and of large scale (Holmes and Cline, 1978), which would imply the gases are thermogenic in origin. It remains to be shown conclusively that heavy hydrocarbons are associated with the Norton Sound gas seep. If the heavy petroleum compounds are associated with the observed gas seep, Norton Sound would serve to investigate the fate of natural oil under subarctic conditions. In effect, Norton Sound would become a natural laboratory in which to investigate the dispersion and weathering of oil under marine conditions.

C. Oil-Suspended Solid Agglutinization Studies

Oil spilled onto the surface of the ocean is acted upon by several physical processes, including evaporation, solution, emulsification, and injection into the atmosphere (Kreider, 1971; McAuliffe, 1966, 1969; Baier, 1970). With respect to the oceanic environment, only the solution and emulsification processes represent important mechanisms by which spilled oil becomes entrained in the water column, thus increasing its potential for impacting marine organisms.

Since crude oil is sparingly soluble in seawater, it tends to form emulsions when introduced into seawater, especially under intense wave action. The emulsions have a high affinity for particles and tend to be adsorbed rapidly. Recent studies of oil spills in coastal waters containing high suspended loads have indicated rapid dispersal and removal of the oil by adsorption onto suspended matter (Forrester, 1971; Farrington and Quinn, 1973).

There is very little published information about the processes by which oil is transported in association with suspended particles or the quantities of oil that can be adsorbed onto the particles. Early investigators have shown that flocculation of oil bears an inverse relationship to salinity (Chipman and Galtsoff, 1949; Hartung and Klinger, 1968). Later investigations indicate that sedimentation of oil involves a two-step process (Bassin and Ichiye, 1977; Huang and Elliott, 1977). This process begins with the adsorption of oil onto the suspended particles and is followed by the flocculation of these oil-sediment emulsions by electrostatic interactions. The amount of oil that can be accommodated by a specific quantity of suspended matter appears to be dependent upon the physical and chemical nature of the suspended particles as well as the amount of naturally occurring organic matter that is associated with the particles (Poirier and Thiel, 1941; Meyers and Quinn, 1973).

Cook Inlet has a history of chronic exposure to crude oil arising from both production and transfer operations. Preliminary estimates place the input in the range of 9,500-17,500 bbl/yr (Kinney et al., 1970), mostly above The Forelands, where suspended matter concentrations generally exceed 100 mg/ℓ (Feely and Cline, 1977). While our measurements in the laboratory suggest that these sediments have a modest capacity to retain oil, the measurements by Kinney et al. (1970) and Shaw (1977) show no significant increases in the levels of hydrocarbons in the water or associated with suspended sediments north of The Forelands. In the former case, the sample volumes were 4 ℓ; in the latter, the volume was 1 ℓ. While these results show no gross pollution of either the waters or the suspended matter, the sample volume may have been too small to detect incipient contamination of suspended matter with crude oil. More refined techniques are required to assess the importance of suspended matter in the transport of oil in Cook Inlet, particularly in view of the high transport rates of water and associated suspended matter.

During the past two years, our efforts (R.U. #152) have been directed toward defining the load capacity of Cook Inlet suspended solids for Cook Inlet crude oil as a function of sediment/oil ratios and temperature. These results show that Cook Inlet sediments have a modest affinity for crude oil (up to 20% of the sediment weight). Initial condition reaction studies reveal that the adsorption phenomenon is rapid, largely completed in less than one hour. No fractionation of the normal alkanes ($> C_{12}$) was apparent up to 48 hr. reaction times.

V. Objectives

The proposed studies for FY 79 will focus on two marine environments characterized by the inputs of natural and anthropogenic hydrocarbons. They are Norton Sound and Cook Inlet. In each of these environments the long-range goal is to develop procedures by which the introduction of oil can be reliably documented and to use these methods to investigate the fate of petroleum under natural conditions. These studies were initiated this year in Cook Inlet and will be expanded during FY 79.

In support of our program to understand the fate of oil under arctic and subarctic conditions, we will continue the oil-suspended matter interaction studies with emphasis on the dynamics. The specific objectives of the program in each lease area are described below.

The program for FY 79 will expand upon the framework developed this year. One phase of this expansion includes more detailed analysis of aromatics, both the light and heavy compounds. Because aromatics are more toxic than the paraffins, and because of their ubiquitous presence in crude oils and refined products, the occurrence and fate of these compounds is of paramount importance. The program outlined for next year involves the analysis of waters, and suspended sediments for aromatics. In addition, our absorption experiments involve partitioning of hydrocarbons between oil and sediments, with particular emphasis on aromatics. Since aromatic analysis cannot be carried out solely with GC procedures, we are requesting to purchase a Hewlett-Packard model 5992 GC-mass spectrometer under a shared cost plan (see section XV).

In the past we have used the facilities of NNAF on a contract basis for aromatic analysis. The results of this service have been varied. In general, their workload has been excessive resulting in long delays in analysis. In a few instances, poor quality control was experienced. Our particular application of the GC-MS system for the identification of dissolved aromatics also is not compatible with the system configuration at NNAF. For these reasons we feel that the highest data integrity can be maintained by having the GC-MS system dedicated to the objectives of this project. Assuming that an additional two years of laboratory and site-specific studies are in the offing (even at reduced funding levels), the cost of the instrument would be amortized over the duration of the program.

While these experiments have been useful in defining the loading characteristics of Cook Inlet suspended matter, they do not address questions of dynamics. In Cook Inlet, the suspended loads are substantial (~ 100 mg/ℓ upper end of Inlet), providing a large scavenging potential for oil. When oil is spilled on the surface, turbulence transports suspended solids to the lower surface of the slick, where continuous scavenging may take place.

Not only are the mechanisms of oil-sediment interactions poorly understood, but also the effect of oil weathering. For example, how does the weathering of oil change its absorption characteristics. Both of these questions will be addressed in next year's study.

A. Cook Inlet

This year's studies have shown rather conclusively that the region north of The Forelands is a source of petroleum hydrocarbons, presumably originating from the production region of Trading Bay. These conclusions are largely derived from the abundance of alkanes versus alkenes and the occurrence of soluble LMW aromatics. The methodology employed for the detection of aromatics was not highly quantitative, but served to identify the presence of aromatics. With this knowledge in hand, next year's study will focus on compound identification and quantification of LMW aromatics using glass capillary chromatography and GC-MS characterization. Considerable attention will be given to the identification of unique aromatic compounds present in crude oils and their abundance in Cook Inlet.

Our current studies will continue into the biological production of LMW aliphatics, both in the water column and in the sediments. Laboratory experiments were initiated this year in an attempt to more fully understand the conditions under which LMW alkenes are produced. Preliminary results indicate that light is an important factor, but we have not ruled out the importance of microorganisms.

Where possible, attempts will be made to determine the composition and fluxes of LMW aliphatics from the sediments. We are interested in elucidating the significance of sedimentary hydrocarbon production toward the HC budget of Cook Inlet. Efforts are currently underway to develop a simple compartment model describing the mass flow of hydrocarbons from Cook Inlet. Several models are currently being explored, but preliminary results are at least one year away.

Specifically, next year's objectives will be:

1. Investigate the time variation of LMWH (aliphatics and aromatics) in the water at two 48-hour time-series stations in the spring of 1979.

2. Investigate the distribution of adsorbed hydrocarbons on suspended matter at the same time series stations. These are the heavy hydrocarbons ($\geq C_{12}$) collected by high speed centrifugation.

3. Determine the vertical distribution of LMW aliphatics in the interstitial pore waters at the time series station in Kachemak Bay. We will compare the gas harpoon to conventional gravity coring techniques.

4. Determine the abundance and content of petroleum-like hydrocarbons associated with suspended matter collected in sediment traps (Dr. Feely, R.U. 152). This study is designed to evaluate the

vertical transport of petroleum hydrocarbons associated with suspended matter. The responsibility for sediment acquisition falls under R.U. 152.

5. Participate in continuing intercalibrations and methods evaluation programs for both light and heavy hydrocarbons.

B. Norton Sound

The objectives of this phase of the work are largely the same as proposed two years ago, but not implemented. At the present time, our knowledge of the Norton Sound gas seep is restricted to the analysis of water for LMW aliphatics. These data suggest that the hydrocarbons are of thermogenic origin and presumably are associated with the heavier fractions. Since these hydrocarbons are not anthropogenic in origin, the general strategy is to characterize the hydrocarbons associated with the gas seep and determine their areal extent. This includes the dissolved fraction (LMWH) as well as the adsorbed material. These data are to be used to investigate suitable hydrocarbon components as tracers from a bottom source and to evaluate their dispersion and transport characteristics. Specifically, we intend to:

1. Assess the composition of LMW aliphatics and aromatics in the water near the seep and evaluate the dispersion characteristics of the plume. This will be coordinated with R.U. 435.

2. Determine the vertical profile of LMW aliphatics in the interstitial waters near the locus of the seep and compare it to distributions found to the east (upstream). The gas harpoon and conventional gravity coring will be attempted, but may not be successful due to the high impermeability of the bottom. Also, an attempt will be made to characterize the LMW aromatic fraction in pore waters to the extent sampling is successful.

3. Determine the composition and concentration of petroleum-like hydrocarbons associated with suspended matter. Suspended solids will be obtained with a high speed centrifuge. Analysis of the heavy fractions will include both aliphatic and aromatics. Two 24-hr. time series stations will be occupied for the purpose of acquiring sufficient sediment for HC analysis. One of these stations will be a control.

These objectives will be carried out during a summer cruise to Norton Sound.

C. Oil-Sediment Interactions

The past year's work has stressed the loading characteristics of Cook Inlet suspended matter for Cook Inlet crude oil. Our experiments have shown that under high oil loadings (see Figure 7), suspended matter will accommodate up to 10% its weight in oil, a value substantially less than observed with Skagit River sediments and Prudhoe Bay crude oil. While these experiments serve to assess the loading characteristics of sediments, they do not address the dynamics occurring between sediments and a surface oil slick. Of equal importance is the release of oil from the flocs and the subsequent compositional changes that may take place.

Specifically, the objectives are:

1. to assess the interaction between suspended matter and a surface oil slick under controlled laboratory conditions.

2. to evaluate any compositional changes that may occur in the oil associated with the suspended matter. This includes both the aliphatic and aromatic fractions.

3. to document the compositional changes occurring in oil flocs as a function of time using LC, GC, and GC-MS techniques.

The goal of this study is to define and evaluate relevant oil, sediment, and environmental parameters controlling the adsorption-desporption of oil from particles. Subsequent studies in the future would concentrate on the interactions between suspended solids and a weathering oil slick (laboratory controlled) and the compositional changes occurring on the solid phases as well as the weathering oil slick. Ultimately, oil should be fractionated into its compound classes and the effect on the bulk properties of the oil investigated. By identifying the active compounds of oil and their relative abundance, a clearer understanding of the physical chemical interactions between oil and sediments will be developed. Since crude oils and sediments differ widely in their physical and chemical properties, an understanding of

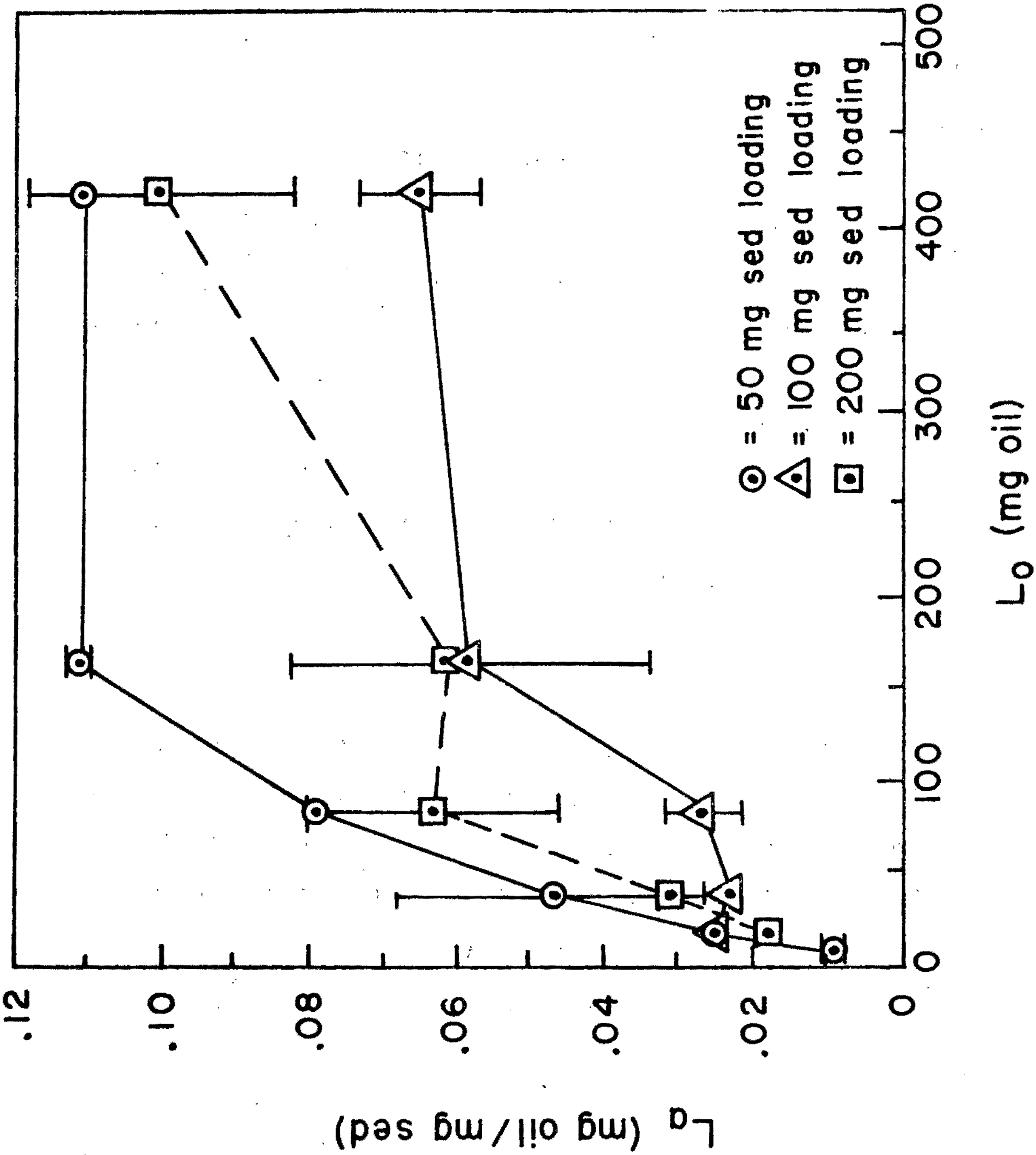


Figure 7. The loading characteristics or affinity of Cook Inlet sediment for Cook Inlet crude oil. Maximum loading observed was about 10%.

the fundamental adsorption process as a function of intrinsic properties of both substrates is required.

VI. Strategy and Approach

The implementation of the proposed program will be initiated in Cook Inlet in spring and in Norton Sound during summer. The study will be fully integrated with other PMEL investigators as well as other institutions such as IMS, UCLA, and the USGS. All observations will be conducted from an oceanographic vessel.

Program management, data processing, and products submission will be under the direction of Drs. Cline and Feely. Cruise planning and data integrity will also fall under the management purview.

A. Sampling Strategy

1. Cook Inlet

Sampling for LMW aliphatics and aromatics in the water column will be conducted at the station locations shown in Figure 8.

The two 48-hour time series stations are located in Kachemak Bay and east of Kalgin Island. At these stations, the water column (3 depths) will be sampled every 4 hours for LMW aliphatics and aromatics. At the same time, suspended matter will be collected every 6 hours at Kalgin Island and every 24 hours at Kachemak Bay for the analysis of suspended hydrocarbons. The sampling protocol is based on the nominal concentration of suspended solids. The recovered suspended matter is transferred from the centrifuge tubes to a precleaned jar, frozen, and returned to the laboratory for subsequent HC analysis.

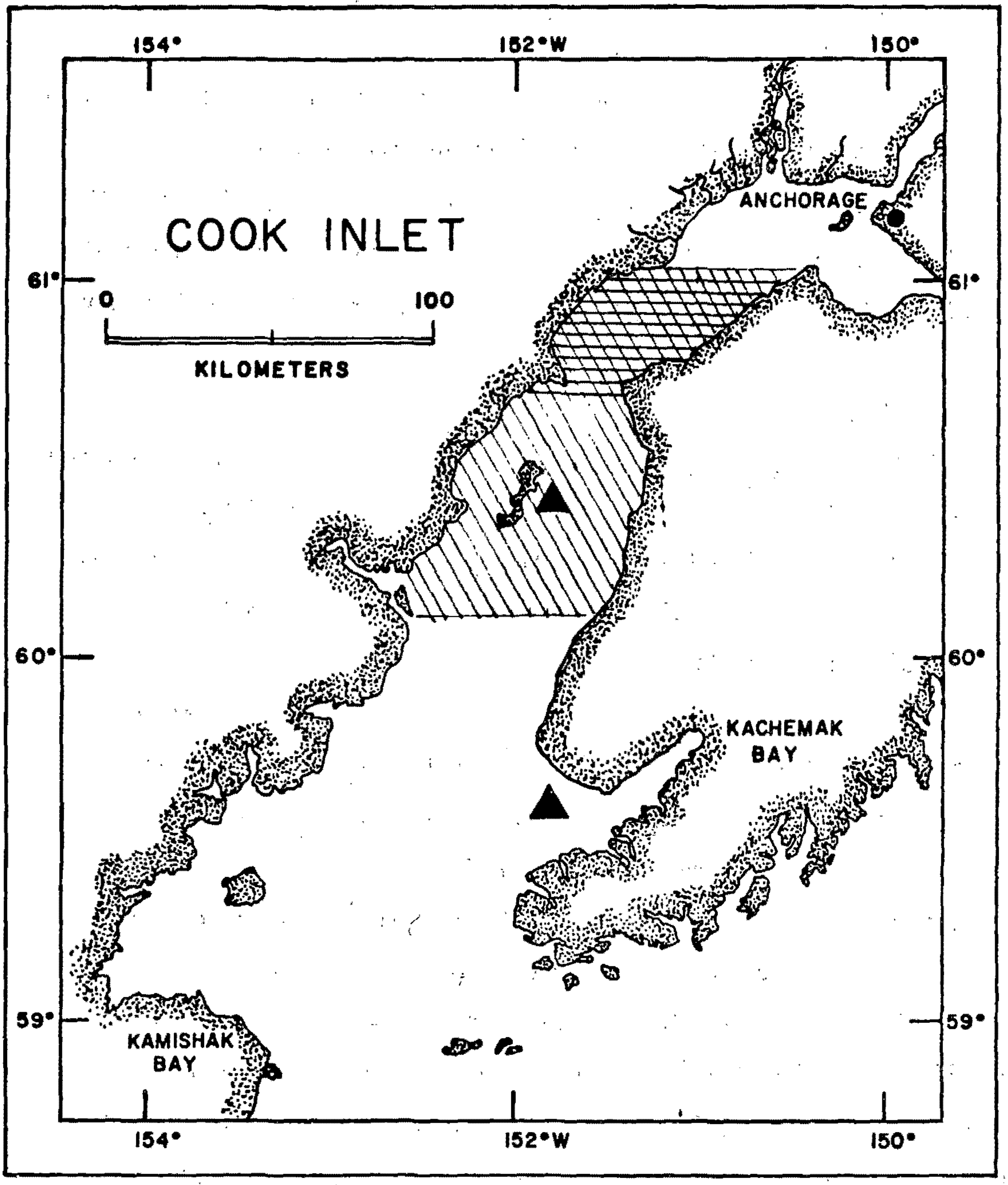


Figure 8. Proposed sampling grid for Cook Inlet. The crosshatched area represents water column sampling for LMWH; a small boat will be required north of The Forelands. The time series stations (▲) are shown in Kachemak Bay and east of Kalgin Island. Detailed station locations will be submitted prior to the cruise in May 1979.

Analysis of water samples for LMW aliphatics and aromatics will be conducted in the general region east and north of Kalgin Island. Samples north of The Forelands will be taken from a small boat and analyzed aboard the mother ship. A minimum of three samples per vertical profile will be taken.

The analysis of interstitial water aliphatics will be conducted at the time series station in Kachemak Bay or at some nearby location. Fine-grained sediments are a requirement. The gas harpoon will be compared with a conventional gravity coring device.

2. Norton Sound

The Norton Sound sampling strategy is shown in Figure 9. Major emphasis will be placed on the region of the gas seep south of Nome, Alaska. Water sampling for dissolved LMWH will be carried out at all stations. A minimum of three samples per vertical profile will be taken, additional samples if water column stratification dictates.

Suspended matter will be taken at two 24-hour time series stations shown by triangles. These samples will be analyzed for heavy aliphatics and aromatics. Station C is the control station, against which hydrocarbon composition will be compared at the seep station (S).

The composition of LMW aliphatics will be investigated at two stations near the locus of the seep. For this purpose, the detailed surface profiles obtained by USGS will be used to identify the locus of the seep. Deployment of the gas harpoon will be attempted, but the hard bottom may prohibit successful penetration. The peat beds at the eastern extremity of the basin also will be sampled for LMW aliphatics. Both the gas harpoon and a conventional gravity core will be used. These studies will be coordinated with the work of Dr. Kvenvolden of USGS.

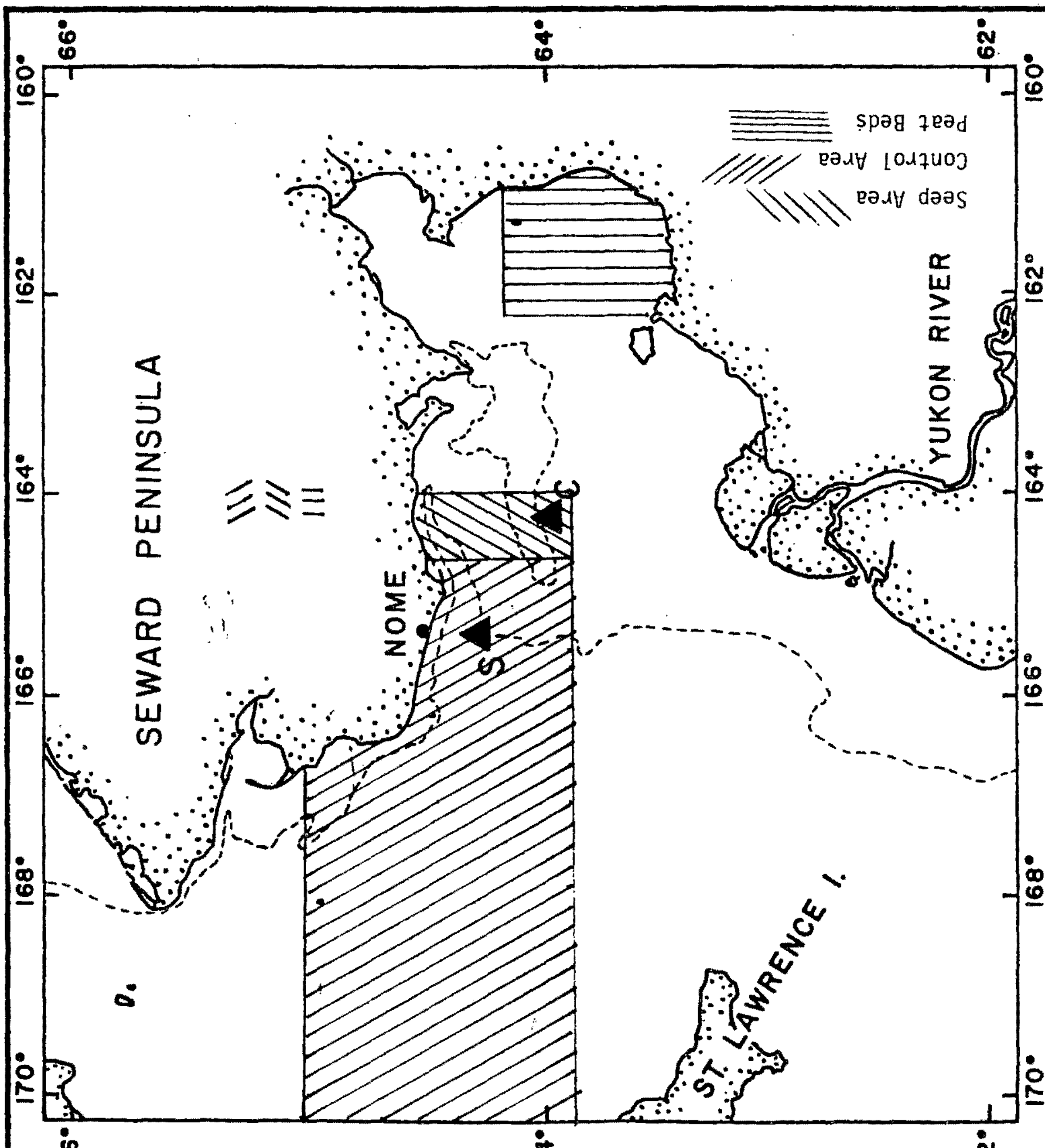


Figure 9. Proposed sampling grid for Norton Sound. The time series stations are shown as triangles. Actual station locations will be provided prior to the cruise in August 1979.

As shown in Figure 9, the sampling grid is expanded to include the area west and north of the seep. This sampling strategy will allow for complete plume definition in the direction of advective transport.

3. Oil-Sediment Adsorption Studies

The fate experiments involving the adsorption of oil will be carried out under controlled laboratory conditions. A thin layer of oil will be spread on the surface of a small tank containing seawater to which has been added a quasi-realistic concentration of suspended matter (20-50 mg/ℓ). The sediment will be aggitated gently in order for it to come into contact with the oil film. Both Cook Inlet crude oil and suspended solids will be used in the study. The reaction will run for fixed periods of time and the suspended matter allowed to settle and be recovered. The amount of oil retained and its composition will be determined by gravimetry, GC and GC-MS procedures. The initial experiments will be conducted in the dark at 10°C. Natural salt water from Cook Inlet will be used.

Oil flocs from this experiment will be placed in fresh seawater and stirred for various time durations at 10°C. The amount of oil retained and its composition will be determined by gravimetry, GC, and GC-MS procedures.

4. Intercalibration

At the present time we are engaged in an intercalibration study with NNAF involving hydrocarbon analysis of sediments. This is limited to n-alkanes currently, but with the incorporation of a GC-MS capability, would necessarily include aromatics as well.

B. Analytical Methods

1. LMW Aliphatics

LMWHs are stripped from a 1-ℓ volume of seawater using modified procedure recommended by Swinnerton and Linnenbom (1967). A diagram of the gas phase extractor is shown in Figure 10. Although the system actually used by us is somewhat simpler in detail than that reflected in Figure 10, the principal remains the same.

Chromatography of the components is effected on a column of Poropak® Q (4' x 3/16"), 60-80 mesh, in series with a small column of activated alumina (3/16" x 2") impregnated with 1% silver nitrate by weight. This dual column configuration results in sharper peaks, better separation of olefins, and reduced component retention times. Chromatography of LMWH components through C_4 is accomplished in less than 6 minutes. Detection of the component hydrocarbons as they emerge from the column is performed with a flame ionization detector.

2. <u>LMW Aromatics</u>

Aromatics will be stripped from solution in an analogous fashion (T = 70°C) and trapped on Tenax GC®, which does not retain water. The LMW aromatics will be backflushed off the Tenax column at 200°C and chromatographed on a 10 m glass capillary column wall coated with SE-54. The aromatics will be cold trapped on the first loop of the capillary column with liquid N_2 prior to injection. This should result in sharp, well-defined peaks. This procedure will be utilized this year in Cook Inlet (Aug.-Sept., 1978). If successful, the mass spectra will be elucidated with a HP 5992 GC-MS system for component identification. Actual GC-MS analysis will be performed in the laboratory on parallel samples trapped on small Tenax columns. GC analysis in the field will be used to screen samples containing petroleum compounds.

Calibration will be effected by extracting small volumes of water saturated with selected aromatics. Currently, these include benzene, toluene, xylenes, and ethylbenzene. As more aromatic compounds are identified, additional standards will be added to quantify their response to the GC.

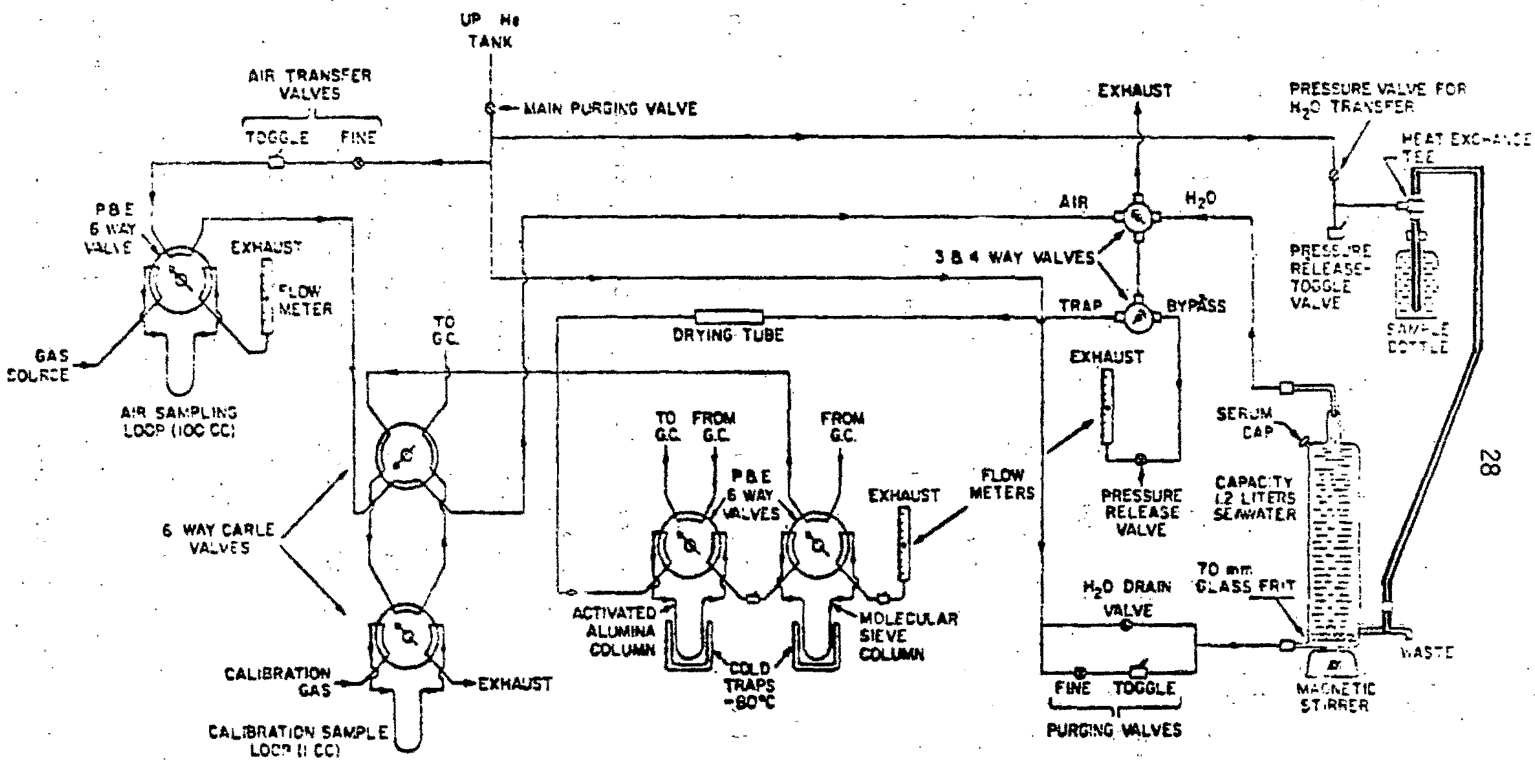


Figure 10. Schematic Diagram of Gas Extractor.

Our first effort this year at aromatic analysis was marginally successful. Major problems included poor stripping efficiency from water and poor resolution from packed columns (5% SP-1200/1.75% bentone on Supelcopert). In the new procedure, the water will be stripped at 70°C with He and the aromatics trapped on Tenax at 5°C. Using wall-coated glass capillary (SE-54), the resolution should improve substantially.

3. LMW Aliphatics - Interstitial Waters

Interstitial water samples will be taken with a harpoon sampler similar to that described by Sayles et al. (1973). Its obvious advantage is that dissolved gases in pore waters can be sampled without contaminating or exposing the sediment to ambient degassing. This instrument acts as a large syringe with a spring-loaded master cylinder providing the suction. Full 1½-m penetration triggers the suction, and at each of the 8 to 10 sampling ports interstitial water is drawn through a Whatman filter into precalibrated stainless steel loops. The maximum capacity of each port is 20-25 mℓ. The captured pore water is extruded into a 25-mℓ gas stripper and purged of its hydrocarbon gases. Analysis of the components is the same as presented in subsection 1 above.

A shorter version of the harpoon was successfully deployed in the Northeast Gulf of Alaska in April 1977. Ambient concentrations of the LMW aliphatics (not in a seep area) were sufficiently high to give a strong signal for each of the C_1-C_4 hydrocarbon components stripped from 20 mℓ of pore water.

This device will be intercalibrated with a conventional gravity coring device in which the sediment core is sectioned and degassed by shaking in a helium headspace (Bernard et al., 1978). If the sediments are not gas-rich, this procedure should provide a useful standard against which to compare the results obtained by the gas harpoon.

4. Aliphatic and Aromatic Analysis of Suspended Matter

Suspended matter collected from the traps and by continuous flow centrifugation will be analyzed according to the procedures established by MacLeod et al. (1976). Briefly, an appropriate weight of sediment (1-10 g) is dewatered with methanol, then extracted with a methylene chloride/methanol mixture for 18-24 hours in a ball mill tumbler. The extraction is repeated and the washings and extracts combined. Additional dewatering is accomplished and removal of particulates and humic material is effected by passing the extracts through a small bed of silica gel and washing with methylene chloride. The eluate is concentrated to approximately 2 mℓ. At this point the sample is chromatographed on silica gel to separate the aliphatic and aromatic fractions; sulfur is removed from each fraction. After concentration of each fraction to approximately 0.5 mℓ, the two samples are ready for GC and GC-MS analyses.

This laboratory will collect the samples, extract the petroleum hydrocarbons, and determine the major aliphatic components (C_{12}-C_{32}), including pristane and phytane. We are also capable of analyzing the aromatic fraction, but component identification will require GC-MS spectroscopy. This will be done only after a preliminary screening in our own facilities has been carried out. All of our procedures and calibrations will be coordinated with OCSEAP/BLM requirements and cross-checked with the same procedures in NNAF.

Analysis of the aliphatic and aromatic fractions will be made on a Packard model 5730 GC equipped with a model 3385 microprocessor and automatic sampler. Resolution of components will be made with a wall-coated, 30-m open tubular glass capillary column. For the analysis of both aliphatics and aromatics, the mobile phase is SE-54.

Both aliphatic and aromatic standards are currently on hand and will be intercompared with those of NNAF.

VII. Deliverable Products

A. Digital Data

The low molecular weight aliphatic components (methane, ethane, ethene, propane, propene, iso- and n-butanes) will be reported in digital form on IBM punch cards. An OCSEAP format currently exists for their submission to NODC/EDS.

The aromatic components, benzene, toluene, o-, p-, m-xylenes, and several of the chromatographable ethylbenzenes will be reported in digital form. The present strategy is to add these components, and others that are identified later, to the present LMW hydrocarbon format (043). We will discuss the appropriateness of a separate format for aromatics with Mr. Dean Dale of EDS/NODC.

Analyses of suspended matter for associated petroleum hydrocarbon will include the quantifiable range of both aliphatics and aromatics. Major aliphatic contributions in the range C_{14} to C_{30} will be reported, as well as 2- to 5-ring aromatics determined by GC-MS spectroscopy. Those compounds currently included in the 044 format will be reported to the extent that they are identifiable and quantifiable.

At the present time there is no format for interstitial water LMW aliphatics, although the present format may be modified. We will discuss with Mr. Dean Dale of EDS the suitability of the present format. Because the data base is small, it may not be feasible to establish a separate file for these data.

Integrity of Digital Data

All chromatograms are checked visually for correct peak integration. The peak areas are then converted into engineering units (i.e., concentration) and these values submitted for card punching. All card punch data are checked for correctness by a second person. The final check is made by having the cards verified prior to submission to EDS/NODC.

B. Narrative Reports

Quarterly and annual reports will be submitted in narrative form in accord with preestablished schedules. For the purpose of brevity, the results presented in graphical and tabular form will be kept to a minimum and will contain the most relevant findings relative to the stated objectives. These reports will be augmented with formal reporting of significant findings through scientific journals and technical memos, as seems appropriate. Because of the integrated nature of this study, it is highly likely that several journal publications will result.

All reports and publications will contain, in addition to the narrative discussion, relevant tables and graphs depicting relationships and distributions of the various parameters being observed. Various hydrocarbon parameters will be tested for uniqueness in the identification of petroleum-derived hydrocarbons. Data on the subsurface distribution of LMWH will be presented in vertical profiles.

C. Visual Data

Areal charts and maps will be presented on OCSEAP-provided standard maps. This includes the Mylar overlays produced from these maps.

D. Nondigital Data

All hydrocarbon analysis performed with a gas chromatograph results in analog chromatograms, consisting of detector response as a function of component retention indices. Peak areas are numerically converted into concentration units via appropriate standardization procedures. These recorder traces and detector response characteristics are kept as a permanent record by the principal investigator and are available for inspection or inclusion in the standard data base at the request of the Project Office.

E. Data Products Schedule

Data Type (i.e., Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (if known)	Processing and Formatting done by PI (Yes or No)	Collection Period (Month/Year to Month/Year	Submission (Month/Year)
LMW-aliphatics[1]	cards	300 cards	043	completed	Apr./1979 and Aug./1979	May/1979 Sept./1979
LMW-aromatics[1]	cards	approx. 400 cards	none	(negotiable)	Apr./1979 and Aug./1979	June/1979 Oct./1979
Heavy hydrocarbons-suspended matter	cards	60 cards	044	completed	Apr./1979 and Aug./1979	July/1979 Nov./1979

[1]No format exists for the reporting of interstitial water aliphatics or aromatics.

VIII. Sample Archival

None of the samples collected in this study will be archived for later reference. Analyses of waters for LMW hydrocarbons are performed in the field. The samples cannot be preserved, since the components are largely gaseous at normal temperature and pressure. Analysis of suspended matter for heavy hydrocarbons will be performed in the laboratory; the residue will be discarded unless the Project Office deems it necessary to archive this material.

IX. Logistics Requirements

INSTITUTION Pacific Marine Environmental Laboratory/NOAA

PRINCIPAL INVESTIGATORS Dr. Joel Cline and Dr. Richard Feely

A. SHIP SUPPORT

1. Proposed tracks and/or sampling grids, by leg, on a chart of the area:

   See Figures 9 and 10.

2. Types of observations to be made on tracks and/or at each grid station:

   CTD, bottle casts, bottom grabs, gravity coring, deployment of submersible pump.

3. Optimum time chronology of observations on a leg and a seasonal basis and the maximum allowable departure from these

   Timing is not critical.

4. Number of sea days required for each leg: Cook Inlet: 8 days
Norton Sound: 8 days

5. Investigation is considered to be a: principal activity.

   Approximate number of hours per day required for observations:

   24-hour sampling - 1 hour for station sampling; 3 hours between stations.

6. Equipment and personnel we expect ship to provide:

   CTD, gravity core, Van Veen sampler, survey technician.

7. Approximate weight of equipment we will bring: 2,000 lbs.

8. Will data or equipment require special handling? Yes, as follows:

   Liquid N_2 dewars: must be kept upright

   Compressed gases: not to be dropped.

   Electronic gear: handled carefully and kept out of weather.

9. Will you require any gases and/or chemicals? Yes. Compressed gases will be loaded in Seattle or shipped by Sea Land, Inc.

10. Ship preference: (1) DISCOVERER (2) MILLER FREEMAN (3) R/V ACONA

11. Requirement for a non-NOAA vessel: Small vessel required for work in Upper Cook Inlet.

12. Number of people we must have on board for each leg: Usually 4 people.

X. Anticipated Problems

The analysis of dissolved LMW aliphatics and the extraction of heavy hydrocarbons has been performed in this laboratory for 3 years and 1 year, respectively. Analysis of dissolved LMW aromatics was attempted this year with marginal success, necessitating a change in procedure. This new procedure employing GC^2 will be tried this year in Cook Inlet (Aug.-Sept. 1978), with approximately 7 months available for changes and modification. Our method is essentially the purge-and-trap procedure recommended by EPA for LMW trace organic analyses. Currently, NNAF is exploring this procedure for the analysis of trace organics in water and state-of-the-art technology transfer, if required, should be easily accomplished between the laboratories.

Analysis of sedimentary pore waters for LMW aliphatics presents a major problem. Attempts were made this past spring to core in Kachemak and Kamishak Bays with the gas harpoon. All efforts were unsuccessful because of unsuitable bottom characteristics (i.e., sand to gravel bottom or low porosity muds, etc.). Conversations with Dr. Kvenvolden of the Geological Survey of Menlo Park suggest that equal difficulty will be experienced in Norton Sound because of the coarse bottom textures and low sediment porosity. In the event the deployment of the gas harpoon is not successful, a gravity core will be employed and the sediments degassed by He headspace stripping.

In the event the cruise is not conducted according to schedule, we are prepared to make modest alterations in our schedule. Should equipment fail, several contingency plans are available, as they have been since the first OCSEAP cruise. LMW aliphatics may be stored in the dark for a period of 2 months without significant loss of hydrocarbons. LMW aromatics will be stripped from water and trapped on small clean Tenax® traps and returned to the laboratory for analysis.

Recovery of suspended matter is effected with a continuous flow centrifuge. We have spare parts, including an extra motor, which can be replaced in about 1 hour. A spare submersible pump is also included in our equipment list.

In the past, these contingency plans have resulted in 80 to 100% efficiency in meeting our field obligations.

XI. Ancillary Information

The work to be performed under this proposal will be supplemented by hydrocarbon, suspended matter, and circulation studies (Nos. 152 and 435). The requirement for basic data on suspended matter concentration and composition are only required for Norton Sound. For the purpose of describing and modeling the hydrocarbon distributions, salinity and temperature data are required in both Cook Inlet and Norton Sound. Nutrient data also are required for the comprehensive description of the biological state of the system in both Cook Inlet and Norton Sound.

XII. Milestone Chart

0 - Planned Completion Date
X - Actual Completion Date (to be used on quarterly report)

RU #153 PI: Drs. Cline and Feely

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

MAJOR MILESTONES	1978 O	1978 N	1978 D	1979 J	F	M	A	M	J	J	A	S	O	N	D
Progress Report				0											
Development of LMW Aromatics Analysis					0										
Annual Report							0								
Cruise to Cook Inlet								0							
Submission of Cook Inlet Data															
LMW - Aliphatics; Pore Water Analysis										0					
LMW - Aromatics										0					
Heavy HC											0				
Quarterly Report										0					
Cruise to Norton Sound											0				
Submission of Norton Sound Data															
LMW - Aliphatics; Pore Water Analysis													0		
LMW - Aromatics													0		
Heavy HC															0
Quarterly Report													0		

XIII. Outlook

Upper Cook Inlet is presently the site of significant gas and oil production, and it appears that Lower Cook Inlet might achieve similar status. The input of spilt oil into the waters of Cook Inlet could conceivably double in the next few years. With this in mind, it is suggested that a concerted effort into the fate of oil in Cook Inlet be continued. Evidence derived during our April and July 1977 cruises to LCI showed high concentrations of LMWH in the southward-flowing current west of Kalgin Island. Numerous small tar balls (~1 mm dia.) also were observed in the water samples. Evidence collected this year revealed the presence of a complex mixture of aromatic hydrocarbons, presumably derived from the production region north of The Forelands.

In contrast to the situation in Cook Inlet, the gas seep in Norton Sound is a natural phenomenon. Nevertheless, if liquid petroleum is associated with the observed leaking gas, Norton Sound becomes a natural laboratory in which to study the natural dispersion and weathering of oil under subarctic conditions.

Emphasis should be placed on the identification of sources of anthropgenic oil in Upper Cook Inlet (i.e., subsurface and surface platforms, transportation, etc.), quantities being introduced, and the ultimate fate of the oil. Distribution and composition of the LMWH (aliphatic and aromatic) should provide identification of the sources, as well as the residence times, of the dissolved components of petroleum.

Intensive studies will commence in FY 79 to identify major LMW aromatics in the water column and to establish concentration ranges for these components. Emphasis will be placed on the identification of unique petroleum descriptors within the suite of LMW aromatics. These compounds are particularly attractive because of their relatively high solubility in water.

Work will also continue in FY 79 toward a better understanding of the importance of suspended solids in the transport of oil from upper Cook Inlet. The object in this program element is to establish the presence of petroleum-like hydrocarbons in association with suspended matter and to construct a transport budget. Depending on the results of our analyses this year and next, supplemental studies may be required to better document the fate of sorbed HC. This may include more detailed sampling north of The Forelands on a seasonal basis.

Studies in Cook Inlet beyond FY 79 should concentrate on refining the knowledge gained to date or gap filling. This would include the construction of simple compartment models to estimate the flux of hydrocarbons through the system. Whether or not additional sampling is required in Cook Inlet for FY 80 and FY 81 will largely depend on the results of next year's sampling. A substantial portion of time during FY 80 and 81 should be directed to synthesizing data already collected and the publication of these results. A crude budget estimate for Cook Inlet for the fiscal years 80 and 81 would be $60 K and $40 K, respectively.

A somewhat similar problem exists for Norton Sound. If oil is not present, then our objectives concerning plume dynamics will be largely met after next year's study. This will include the occurrence and distribution of LMW aromatics. Assuming that Norton Sound will become a suitable natural laboratory, our original strategy will hold. Emphasis would be given to dispersion mechanisms, sediment transport, chemical weathering, and the impact of natural oil seepage on the benthic biological communities. This effort, by definition, would be interdisciplinary.

For fiscal years 80 and 81, emphasis would be given to dispersion modeling and chemical weathering of petroleum in sediments. Suspended matter transport of HC may be an important process, requiring additional laboratory work on the adsorption-desorption characteristics of Yukon River sediments. Since these sediments are highly enriched in clay minerals, their adsorption characteristics may be much greater than those observed with Cook Inlet suspended matter.

The preliminary budget estimates for Norton Sound are difficult to predict in view of the uncertainty surrounding the nature of the seep. In the event oil is found, we estimate our budget at $75 K for FY 80 and $50 K for FY 81. If no oil is found, the syntheses of data and finalizing of results would cost about $40 K for FY 80 and $30 K for FY 81.

XIV. General Stipulations

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA Form 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and nonexpendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

I. Three copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least 60 days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than 60 days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

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

August 8, 1978

MEMORANDUM FOR Herbert Bruce, Project Manager, OCSEAP

From: Joel Cline, Oceanographer, PMEL

Joel Cline

Subject: Addendum to the FY 79 LMWH Proposal - R.U. #153
INFORMATION MEMORANDUM

In accord with John Calder's request, we hereby amend the proposal to include the statement that both aromatic characterization and analysis will be performed in the field, assuming that the quality of power available is not a deterring factor. Under the geographical headings (pages 18 and 19), include the following statement:

"Characterization of low molecular aromatics will be conducted in the field using a Hewlett Packard model 5992 GC-MS system. In the event that GC-MS system is not available for shipboard deployment, aromatics will be stripped and trapped on Tenax® for subsequent analysis in the laboratory."

If there are any questions, please call me.

cc: Herb Curl
R. Feely

MODIFICATIONS TO FY 79 PROPOSAL (R.U. #153)

Add to page 19 of proposal:

6. To spatially determine the concentrations of the low molecular weight hydrocarbons in upper Cook Inlet. Emphasis will be placed on the distributions and abundances of LMW aromatics (benzene, C_1-benzenes, C_2-benzenes, etc.) associated with production activities in Trading Bay and Middle Ground Shoal.

Replace section 2, page 27 of proposal:

2. LMW Aromatics

Aromatics will be stripped from solution in an analogous fashion (T = 70°C) and trapped on Tenax GC^R, which does not retain water. The LMW aromatics will be backflushed off the Tenax column at 250°C and chromatographed on a 30 m glass capillary column wall coated with SE-54. The aromatics will be cold trapped on the first loop of the capillary column with liquid N_2 prior to injection. This should result in sharp, well-defined peaks. This procedure will be utilized this year in Cook Inlet (Apr.-June 1978). For the purpose of characterizing LMW aromatics from the myriad of compounds present in the volatile fraction, a H.P. model 5992 g.c.-m.s. system will be deployed at sea. Because of the complexities involved, it may prove advantageous to perform selected ion monitoring on the compounds of benzene, toluene, xylenes, and ethylbenzene. Whether or not a g.c.-m.s. system is available, we will be prepared to collect volatile aromatics on either activated charcoal or Tenax^R contained in small s.s. traps. These samples will provide backup in case the system at sea does not perform up to expectations.

The g.c.-m.s. system also will be used in Norton Sound to characterize LMW aromatics associated with the gas seep.

Calibration will be effected by extracting small volumes of water saturated with selected aromatics. Currently, these include benzene, toluene, xylenes, and ethylbenzene. As more aromatic compounds are identified, additional standards will be added to quantify their response.

Our first effort this year at aromatic analysis was marginally successful. Major problems included poor stripping efficiency from water, poor resolution from packed columns (5% SP-1200/1.75% bentone on Supelcopert), and the abundance of LMW organic compounds. In the new procedure, the water will be stripped at 70°C with He and the aromatics trapped on Tenax or activated charcoal at 10°C. In view of the interference caused by numerous LMW organics present in seawater, new chromatographic and trapping techniques must be developed.

Add to page 36 of the proposal:

7. Change to read 3,000 lbs.

13. The g.c.-m.s. system will require a stable 220 v, 30 amp circuit in a dry laboratory. The required space is about 8' x 3'; typical bench top is sufficient. It is our hope that the instrumentation could be purchased early enough to prompt trial runs on one of NOAA's oceanographic vessels.

Add to page 37 of the proposal (as par. 2):

Under the current strategy, an attempt will be made to analyze volatile aromatics, using a g.c.-m.s. on board ship. If the instrument is available in January 1979, only 3-5 months will be available for method development and troubleshooting. Because of the shortness of time, it is unlikely that definitive results can be obtained next year, and additional R&D will be required during the second year. The projected transfer of the instrument to Alaska for FY 80 also will impact our performance significantly. If there is some assurance of a minimum 2-year study into the characterization of LMW aromatics in upper Cook Inlet, I believe significant headway can be achieved. In either event, samples of LMW aromatics will be taken and stored on Tenax^R for subsequent analysis.

Add to page 44 of the proposal:

K. Our studies in Cook Inlet and Norton Sound will be integrated with microbial, physical, and other chemical research units. Specifically, these research units include R.U.'s 29, 152, 190, 275, 430, 480, and P902. I also will participate in a cruise planning session to be organized by the OCSEAP Project Office for the purpose of outlining research and observational strategy in Cook Inlet and Norton Sound.

1. Title: Shorebird Dependence on Arctic Littoral Habitats
Research Unit #172

Principal Investigator: Robert W. Risebrough

Research Coordinator: Peter G. Connors

Total Cost: Science Budget: $49,842

Institution: Bodega Marine Laboratory, University of California

Date of Proposal: October 1, 1978 - September 30, 1979

Required Signatures

Principal Investigator: Robert W. Risebrough

Name Robert W. Risebrough Date 13 Nov 78
Address Bodega Marine Lab., Box 247, Bodega Bay, CA 94923
Telephone Number (707) 875-3585

Required Organization Approval: Cadet Hand, Director

Name C. Hand Date 10 Nov. 78
Address Bodega Marine Lab., Box 247, Bodega Bay, CA 94923
Telephone Number (707) 875-3511

Organization Financial Officer: August G. Manza

Name August G. Manza Date 11-29-78
Address Campus Research Office, Univ. of CA, Berkeley
Telephone Number (415) 642-0120

3. Technical Proposal

I. Title: Shorebird Dependence on Arctic Littoral Habitats
Research Unit #172
Contract Number 03-5-022-84
Proposed Dates of Contract: October 1, 1978 to September 30, 1979

II. Principal Investigator: Robert W. Risebrough, Research Ecologist

Research Coordinator: Peter G. Connors, Assistant Research Ecologist

III. Cost of Proposal:

A. Science: $49,842

B. P.I. provided logistics: None

C. Total: $49,842

D. Beaufort Sea: 100%

IV. Background

Before 1975, very little quantitative information was available on the use of littoral areas by shorebirds in the Alaskan Arctic, since prior work had concentrated on tundra breeding phenomena. Work in 1975-78 on this R.U. has documented normal dependencies of a wide variety of shorebirds on habitat features and prey items of Beaufort and Chukchi Sea littoral habitats. Year-to-year variability in abundance, timing, habitat use and diets of shorebirds has been outlined, and extreme variation between years in density of zooplankton prey has emerged. Temporal differences in movements and habitat use of the mobile shorebird populations, as well as regional differences in species habitat use patterns between Chukchi and Beaufort coasts, have also been identified.

Work in FY78 has initiated studies of shorebird littoral zone use in artificially altered situations, such as the ARCO causeway in Prudhoe Bay. In order to devote greater effort to analysis and synthesis of existing data during FY79, we do not propose to repeat these studies at Prudhoe Bay. (We do, however, appreciate the value of a second season of comparative data at this site.) Instead, we hope to retain the possibility of one or two brief visits to Prudhoe Bay or Barrow during summer 1979 to focus on specific questions or comparisons which emerge as important in the course of our continuing analysis of 1978 and prior seasons' data from RU 172, together with the concurrent analysis of results from RU 467 and RU 356 (see below for examples). The relevance of these questions would be determined as they emerge from our analyses through discussions with OCSEAP scientific personnel. The resulting field efforts, if required, would be minor compared to the efforts in prior seasons. The major focus of FY1979 work would remain on analysis and synthesis of information already gathered.

Discussions are currently underway involving ARCO personnel, State of Alaska representatives, and OCSEAP staff and PI's, concerning the possible modification of the Prudhoe Bay causeway in the future. Breaching of this presently continuous gravel causeway may produce changes in local currents, sedimentation patterns, benthic and planktonic invertebrate distributions, and bird use. Data gathered during summer 1978 have provided a one-year baseline before this manipulation occurs. In the event that the proposed breaching of the ARCO causeway becomes a reality in 1979, we would suggest a full field effort following our established transects in that vicinity at Prudhoe Bay.

V. Objectives

1. Continue analysis of seasonal use patterns of shorebirds, gulls, and terns, by species and age class, in arctic littoral and nearshore habitats, with special emphasis on altered habitats, coastal structures, and disturbed sites of several kinds, bearing on questions of OCS development effects.

2. Complete analysis of foraging habitat preferences, by species and age class, within altered littoral zone areas as compared with undisturbed areas.

3. Summarize data on prey species taken by shorebirds in disturbed and undisturbed littoral areas.

4. Evaluate and discuss the dependency of littoral zone foraging birds on zooplankton in terms of the variability of zooplankton among years and locations, to estimate the flexibility of birds to potential development-caused variation.

5. From these information classes, assess the probable effects of disturbance and alterations associated with OCS development.

6. Prepare, or cooperate in preparation of, species accounts of ecology and migration of the key species Red and Northern Phalaropes, according to OCSEAP prescribed formats.

VI. General Stragegy and Approach

FY79 marks a shift in general strategy of RU 172 toward an increase in analysis and synthesis efforts at the expense of full-scale field data-gathering efforts. Emphasis will be devoted to summarizing previously obtained data to derive final products relating to the objectives listed above. Any 1979 field efforts will be brief, and will focus on specific questions arising from this analysis.

VII. Sampling Methods

If any field work is required in 1979, methodology will probably follow that of prior seasons. Possible efforts could include: (1) census of previously established shoreline transects during periods of heaviest use, especially near the ARCO dock in Prudhoe Bay or on Barrow Spit, and (2) collection of juvenile Red and Northern Phalaropes during mid or late August, since prior data from Ru 172 and RU 467 suggest that these similar species may have very different fat accumulation schedules. If verified, this latter surprising result could indicate differing littoral zone dependencies for the two phalaropes.

VIII. Analytical Methods

Transect census data will be used to construct seasonal frequency histograms of bird density by species, age, and sex in different habitats. Analysis of frequency of association of each species with different transect habitat types will define the habitat use characteristics of all species measured and will help to evaluate the dependence of shorebird species on particular littoral habitats. Other analyses will utilize standard statistical tests (parametric and non-parametric). See Annual Reports for Ru #172: 1976, 1977, 1978.

IX. Deliverable Products

A. Digital Data

(1) See File Type 034, page 5.

(2) See Digital Data Products Schedule, page 6.

File Type 034

Marine Birds - Land Census

Common to all records
- File Type
- File Identifier
- Record Type
- Station Number

Record Type '1' - Location
- Geographic Position (Start and End) related to grid system
- Date/Time
- Unit Dimension 25-200
- Number of 'X' and 'Y' units 1-60

Record Type '2' - Environmental Data
- Wet/Dry Bulb Temperature
- Wind Information (codes)
- Weather (code)
- Visibility (code)

Record Type '3' - Ice
- Ice Characteristics in Transect (codes)

Record Type '4' - Text
- Text
- Sequence Number

Record Type '5' - Data X/Y
- EDS Taxonomic Code/Subspecies Group (codes)
- Age/Sex (codes)
- Number of Individuals
- Behavior (code)
- Food Source/Species (codes)
- Sequence Number

DIGITAL DATA PRODUCTS SCHEDULE

Data Type	Media	Estimated Volume	OCSEAP Format	Formatting Done by Project	Collection Period	Submission
Bird Transect Census	Tape	0 to 500	034	Yes	6/79-9/79	1/80

B. Narrative Reports

Periodic results and progress reporting, as prescribed. In particular, this project will report on analysis of differences in shoreline habitat use between natural and altered sites, attempting to predict the impact of some of the development disturbances and constructions which may be associated with OCS oil development. Reports will also summarize information gathered on temporal and spatial variability in prey densities and bird densities, seasonal patterns of habitat use by shorebirds and other species at several arctic sites, relative susceptibility of shorebird species to different types of development disturbances, and the location and timing of critical or high density use areas along the arctic coast. Special emphasis will be devoted to the distribution and ecology of Red and Northern Phalaropes, toward the eventual product of species accounts as discussed at the Vertebrate Consumer Workshop in Fairbanks, October 19, 1978.

C. Visual Data

Maps, overlays, charts, and diagrams as required to illustrate habitat dependency and use patterns to predict effects of OCS related events on littoral and nearshore zones.

D. Other Data

None anticipated

X. Quality Assurance Plan

If required, bird census data will be direct counts, requiring no calibration.

XI. Specimen Archival Plans

Bird museum specimens, if any, will be submitted to the Museum of Vertebrate Zoology, University of California, Berkeley. Invertebrate samples, if any, will be stored at the Bodega Marine Laboratory, Bodega Bay, California.

XII. Logistics Requirements

Field studies, if any, will be brief in 1979. We describe here the probable requirements if field efforts in Prudhoe and/or Barrow are required.

A. Ship Support: None

B. Aircraft - Fixed Wing: Commercial flights, Prudhoe Bay to Barrow, 3 round trips, $500

C. Helicopter: None

D. Quarters and Subsistence:

1. Requirements:

Prudhoe Bay and/or Barrow; dates undetermined, probably mid-August; 2 persons; total person-days approximately 40.

2. Sources:

Prudhoe Bay: no recommendation

Barrow: NARL

3. Costs:

Prudhoe Bay: present rate $100 per day

Barrow: present rate approximately $80 per day

E. Special Problems:

1. NARL: Laboratory rental: up to 20 days @ $10 per day = $200

Vehicle rental, storeroom charges: $400

2. Prudhoe Bay: We would require daily use of a pickup truck during any brief period spent at this site.

XIII. Anticipated Problems: None

XIV. We require continued prompt exchange of results from RU 467 and from RU 356.

XV. Management Plan

Management of this project for FY 1979 will proceed as it has for prior years. Budgetary matters will be managed, in consultation with the principal investigator, by the business office and accounting staffs of U.C. Bodega Marine Laboratory and U.C. Berkeley. Expenditures will follow the activity/milestone chart included here, and a monthly financial accounting will allow any necessary adjustment of expenditure rate. Note that data coding, submission, analysis and report preparation will require extensive efforts after September 30, 1979, since the field season ends in late September. Anticipated expenditures to satisfy basic contract requirements for these tasks are included within the budget.

XVI. Outlook

Final synthesis may require some continued effort in FY 1980. Recognizing the changing emphasis within OCSEAP, we do not envision continued field studies except for these possibilities:

(1) Breaching the ARCO dock at Prudhoe Bay, as discussed above, would provide an experiment almost demanding a renewed field effort.

(2) A proposed oil spill experiment, described separately in response to the proposed research unit P-924, we consider valuable for 1979 or 1980.

(3) Specific questions arising from the continuing analysis and synthesis, or from studies done under (1) and (2), may require an additional limited field program.

Any of these efforts would be directed toward specific answers predicting the effects of particular disturbances on bird populations. Costs would be considerably below the 1979 budget unless a continued field effort is required.

XVII. 1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past years' data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

*8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All equipment will be accounted for in accordance with University of California's policies and procedures applicable to government owned equipment. Auditable records on such equipment are available for inspection at anytime during normal business hours. A final property inventory will be resubmitted in accordance with the government property clause (ART 33).

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

    "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

*The University of California (Berkeley) maintains a property record system approved by the DOD and DHEW.

MILESTONE CHART

RU #: 172   PI: R. W. Risebrough

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

MAJOR MILESTONES (Data set equals one field season.)	1978			1979														
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D			
Coding and submission of 1978 data; preliminary analysis																		
Final analysis; annual report preparation																		
Planning 1978 season																		
Field season, if required																		
Coding and submission of 1979 data; analysis																		
Final analysis; annual report preparation																		

Publications reporting research results from RU #172:

1. Connors, P. G., J. P. Myers, F. A. Pitelka. Seasonal patterns of habitat use by coastal plain shorebirds in arctic Alaska. In Shorebirds in Marine Environments, ed. F. A. Pitelka. Studies in Avian Biology No. 2, Cooper Ornithological Society. In press.

2. Connors, P. G., K. Hirsch, C. Hohenberger. Effects of coastal oil development on shorebirds in arctic Alaska. Abstract submitted to Pacific Seabird Group Meetings, December 1978.

3. Connors, P. G., C. S. Connors. 1978. Wet coastal tundra I (breeding bird census). American Birds 32: 118.

4. Hirsch, K., D. Woodby. 1978. Wet coastal tundra II (breeding bird census). American Birds 32: 118-119.

5. Connors, P. G., D. Woodby, C. Connors. Wet coastal tundra I (breeding bird census). Submitted to American Birds for 1979.

6. Myers, J. P., F. A. Pitelka. 1979. Variations in summer temperature patterns near Barrow, Alaska: analysis and ecological interpretations. Arc. and Alp. Res. 12(2), in press.

TO: Bering Sea-Gulf of Alaska Project Officer	Proposal/Revision Date: 1 September, 1978 Contract #03-5-022-68
OCSEAP Research Unit #190	Institutional/ID #6001768

STUDY OF MICROBIAL ACTIVITY AND CRUDE-OIL MICROBIAL INTERACTIONS IN WATERS AND SEDIMENTS OF COOK INLET, NORTON SOUND, AND THE BEAUFORT SEA

Co-principal Investigator: Robert P. Griffiths, Ph.D., Assistant Professor--Senior Research

Co-principal Investigator: Richard Y. Morita, Ph.D., Professor of Microbiology and Oceanography

Lease Areas		
	Cook Inlet	76%
	Beaufort Sea	12%
	Norton Sound	12%

Institution: Oregon State University
Department of Microbiology
Corvallis, OR 97331

Period of Proposal October 1, 1978 to September 30, 1979

TECHNICAL PROPOSAL

I. Study of Microbioal Activity and Crude Oil-Microbial Interactions in the Waters and Sediments of Cook Inlet, Norton Sound, and the Beaufort Sea.
Research Unit #190
Contract Number 03-5-022-68
Inclusive Dates: October 1, 1978 to September 30, 1979

II. Co-principal Investigator: Robert P. Griffiths, Assistant Professor-Senior Research.
Co-principal Investigator: Richard Y. Morita, Professor of Microbiology and Oceanography

III. Cost of Proposal:

A.	Science		$130,000
B.	P.I. provided logistics		0
C.	Total. Including approximately $7,000 for nutrient analysis of samples collected by Dr. Atlas (RU#29) and ourselves		$130,000
D.	Distribution by lease area:	Lower Cook Inlet	76%
		Beaufort Sea	12%
		Norton Sound	12%

IV. Background:

A. General

The goals of the OCSEAP microbiology program are to determine the numbers and types of bacteria present in each lease area and to determine their contribution to the productivity of the area through studies of carbon and nitrogen cycling in the marine environment. Spatial and seasonal variation can be enormous; hence sampling should be done on a seasonal and spatial basis. In addition, the interactions between oil and microorganisms should be studied, including the capabilities of the microbial population to degrade oil and the effects of oil on microbial abundance, diversity, and functions.

These objectives have been addressed by RU's 20 and 190. To date we have some understanding of the types and numbers of bacteria and their productivity in Cook Inlet on a seasonal and broad geographical basis. Geographical data only has been obtained on types and numbers of bacteria, bacterial biomass, and nitrogen fixation rates in the Beaufort Sea.

Emphasis in FY 79 in Lower Cook Inlet will be placed on evaluating possible effects of crude oil and weathered petroleum contaminants on the nature and extent of microbial involvement in the food webs of selected littoral and shallow subtidal study sites. These determinations will be made using several different measurements in sediment samples that have been exposed to these pollutants for varying lengths of time. Our basic approach will be to study entire microbial populations under conditions that are as close to *in situ* as possible rather than isolating representative bacterial strains and conducting pure culture studies under entirely artificial conditions. The types of measurements made will, in part, be dictated by the time frame of the experiment and the techniques available for making measurements on marine sediments.

B. Beaufort Sea Studies

During the last two Beaufort Sea synthesis meetings, it was apparent that there was very little data available on the distribution and function of marine microorganisms in the area from Prudhoe Bay to Demarcation Point. An icebreaker cruise which is scheduled for August, 1978 should fill most of those data gaps. In addition, it was noted that there was no information concerning natural rates of crude oil degradation in marine sediments and there was little information about the effects of crude oil on microbial function in marine sediments in and under the ice. We are currently undertaking a study with Dr. Atlas (RU 29) which is designed to supply some of that information. This study involves the analysis of sediment samples which were mixed with crude oil, placed in plastic trays which are anchored to the bottom of Elson Lagoon by divers. Trays were then removed at specific time intervals and analyzed by both Dr. Atlas and ourselves. The first trays were set in July, 1977. Unfortunately, all but three out of a hundred trays were emptied by the prop wash of a NARL boat. In January, some trays were once again set by divers. Two of these were recovered for analysis in April, 1978 and another set will be recovered this coming August. The analyses of the remaining trays will be made during this funding period.

C. Norton Sound

To our knowledge, there is no data available on levels of microbial activity in Norton Sound. The fact that no information of this nature is available coupled with the fact that there are natural oil seeps in the region make it an important area to study. These oil seeps constitute an ideal natural control where the adaptation of the natural marine microflora to chronic crude oil input can be documented. For these reasons, a cruise in the Norton Sound has been planned.

D. Upper Cook Inlet Cruise

At this time, there is very little microbiological data available for the Upper Cook Inlet. This cruise is designed to provide the chemical oceanographers with supportive microbiological data while they study the distribution of hydrocarbons in the water column. This region is also of great interest to us because the Upper Cook Inlet is a source of high microbial activity which is found in the waters of the Lower Cook Inlet. It will be very interesting to trace this high microbial activity to a source within the inlet and to determine if it is natural or man-made.

E. Cook Inlet

It is becoming increasingly evident that a thorough study of the food web in the Cook Inlet is a high priority concern because of the potential impact of crude oil exploration and development on the commercial fisheries in this region. It is also becoming increasingly evident that the food for all trophic levels in inshore environments is largely dependent on microbial process associated with the organic detritus in the marine sediments (Fenchel and Jorgensen, 1977, Advances in Microbial Ecology, 1:1-58; Morita, Microbial contributions to the various trophic levels. Intern. Symp. on Marine Microbiol. [in press]). After an extensive survey of the literature, we have concluded that a major food source for the ecosystem in this region probably originates in the detrital food web. The transfer of the potential food in the detritus to much more usable forms for higher organisms is dependent on microbial processes. Of these processes, probably the most important are the control of nitrogen availability and the colonization of detrital particles. The detrital particles themselves have very high carbon to nitrogen and carbon to phosphorous ratios and thus, by themselves, provide a poor food source for higher organisms. When these particles are colonized by bacteria, the food value is substantially increased due to the lowering of carbon to nitrogen and phosphorus ratios plus ectocrine compounds found in the bacterial biomass. When detrital particles are ingested by marine animals, the bacteria are digested and the remaining material is defecated. The resulting fecal particles are recolonized by bacteria and reingested. The recycling of phosphorous by bacteria is fast enough that it is not usually a growth limiting factor; however, fixed nitrogen might be limiting. For this reason nitrogen fixation and denitrification become important to the bioenergetics of the whole system.

There are a number of other factors involved in the efficiency with which detrital particles are converted into usable food. One of these factors is the cropping of bacteria by protozoa. The exact mechanism is not known, but it is known that this process affects the rate of detrital particle breakdown. When protozoa are present to crop bacteria, microbial rates are significantly higher. In such a situation, a high population of protozoa signifies that the microbial productivity is also high in order to furnish enough cells for the protozoa to eat, but the bacterial population does not increase significantly due to protozoan cropping. Somehow, methods must be developed to determine the productivity (increase in numbers) of bacterial cells in a system where they are constantly being cropped. At present these processes are poorly understood. We are thus proposing to study these processes and to determine how fresh crude oil and weathered crude oil components affect these vital functions.

The following measurements will be made to help us quantitate and evaluate microbial involvement in detrital food webs; relative microbial activity, respiration ratios, biomass, pH, Eh, energy charge (E.C. = [ATP] + 1/2[ADP]/[ATP] + [ADP] + [AMP], growth rates, cropping rates by protozoa, concentrations of NO_3, NO_2, PO_4 and NH_3. The microbial functions in marine sediments are so complex that a large number of variables must be studied to determine what is occurring in a given population. For instance, if the population had a large biomass, a high growth rate and a high metabolic activity, the cell numbers should be high, the percent respiration should be low, the total energy charge should be high, the relative microbial activity high, the ATP/cell should be high, the biomass/cell should be high, the relative microbial activity/cell should be high and the cropping rate by protozoa should be low. On the other hand the EC may be high, the ATP high, but a low bacterial biomass exist in the environment. This latter situation may just indicate that the productivity of the bacterial cell population is high but the bacterial biomass is being cropped by the protozoa, nematodes, etc. Actually the bacterial productivity in terms of biomass is very important because it is constantly being cropped by higher forms which in turn are being eaten by still higher forms. The productivity of bacterial cells during the winter months is very important because the phytoplankton productivity is very low--hence the initiation of the food web may be mainly bacterial. There are at least eight possible combinations of cell number, growth rate and metabolic activity which would produce different patterns in the above mentioned variables. By comparing these variables in a number of sediment samples, we will be able to obtain important information about the physiological state, productivity and standing crop of the microbial populations.

V. Objectives:

1. In Lower Cook Inlet, to determine the effects of petroleum on the extent and nature of microbial involvement in detrital food webs at selected nearshore study sites. More specifically this will involve:

a. Literature review and synthesis of all available information of the role microbiota in detrital food webs with emphasis on the arctic marine environments.

b. The determination of microbial biomass, relative microbial activity, respiration ratios, microbial growth (by indirect means), and rates of nitrogen fixation and denitrification in control and petroleum impacted sediments of selected nearshore areas.

c. The determination of the rates of hydrocarbon biodegradation in control and petroleum impacted sediments of selected nearshore areas.

Measurements should also be made of the effects of oil on the following physiochemical variables, and correlations should be made with the microbial measurements listed above: pH, Eh, salinity, temperature, NO_2, NO_3 NH_4, O_2 total organic C, and total organic N.

2. In the Beaufort Sea, to determine the effects of petroleum on relative microbial activity, respiration ratios, rates of nitrogen fixation, and inorganic nutrients in bottom sediments provided by RU 29 from the plexiglass tray experiment.

3. In Norton Sound, to determine whether the presence of a natural oil seep has altered the activity of the microbial population. Relative microbial activity, respiration ratios, rates of nitrogen fixation, and inorganic nutrients will be measured in the same water and sediment samples used by RU 29 for measurements of the relative abundance of microbes.

4. In the Upper Cook Inlet, we will participate in a joint cruise with the chemical oceanographers. We will be providing supportive data for the chemists during this cruise and we will also be conducting studies which will be designed to pinpoint the source of the high microbial activity which is found in this area.

5. To continue laboratory studies to determine the effects of crude oil on relative microbial activity, respiration ratios, and rates of nitrogen fixation.

VI. General Strategy and Approach:

A. Beaufort Sea

In the Beaufort Sea, we will continue the same work that we have initiated with Dr. Atlas. Both the scope and experimental design will be essentially the same as that previously described. As techniques are developed for the Cook Inlet detrital food web study, we will expand the scope of our study of microbial function in the Elson Lagoon sediment samples.

B. Norton Sound

The study in Norton Sound will be conducted essentially in the same way as our past studies of the Cook Inlet. The main difference will be the emphasis on the comparison between areas where natural oil seeps occur and areas where they do not occur. This comparison should give information on how natural marine microbial populations have adapted to a chronic imput of petroleum hydrocarbons into the marine environment. These observations will be made during a cruise on board a NOAA ship in the late spring, 1979.

C. Cook Inlet

During the Upper Cook Inlet cruise, the chemists will be looking for sources of hydrocarbons in the water column of Upper Cook Inlet. We will be collecting the same type of data that we collected during the May, 1978 cruise in the Cook Inlet with the same chemists. We will determine if there is any correlation between the level of hydrocarbons in the water column and the relative microbial activity, percent respiration, and the acute effects of crude oil on the uptake and respiration of glucose and glutamic acid.

The studies in the Cook Inlet will be conducted from the OSCEAP laboratory at Kasitsna Bay (Kachemak Bay) Alaska. The basic approach will be to take sediment samples from several sites in Kachemak Bay and to process them in the field laboratory. A small boat with a suitable winch and sediment sampler will be used for sample collection. In some instances, sediment will be treated with oil, placed in trays and lowered to the bottom. The placement and retrieval of these samples may require the use of divers supplied by OCSEAP. Additional studies using aquaria are also contemplated.

The selection of sampling sites will be made in coordination with Dennis Lees (RU #417) and James Blackburn (RU #512). From the information that they have accumulated, it will be possible to select sites where the detrital food web is of particular importance in the biological energetics of Cook Inlet. The data collected during our studies can then be used as a basis for designing the integrated studies which are planned for FY 80.

The sites that will be selected in Kachemak Bay will be representative of the most dominant ecosystems within the Cook Inlet bays. More specifically, we will study a site with freshwater influence and at least two sites with different sediment types as well as sites with contrasting levels of microbial activity. To date, we have not seen statistically significant seasonal differences in the variables that we have been monitoring in the marine sediments of the Cook Inlet; however, this does not mean that seasonal changes in microbial function do not occur. We plan to conduct seasonal studies in all the sites that are selected for this study. The ability to repeatedly sample the same sediment and the larger number of variables that we are able to monitor in this new series of studies makes it much more likely that seasonal variations will be observed if indeed they do occur.

D. Sampling Methods:

1. Beaufort Sea

We will retrieve the plexiglass trays containing oil-sediment mixtures on three occasions during this contract period. The sediment samples will be retrieved using divers as we have done in the past.

2. Norton Sound

We will collect water samples using the Niskin sterile bag water samplers that we have used in the past. Sediment samples will be taken using a Haps corer or small box corer. Unfortunately, we do not have such a sampling device available to us at this time. In the past, we have had to use either a VanVeen sampler or Shipak sampler which is standard equipment on NOAA ships or have taken samples using more appropriate samplers provided by other PIs. The VanVeen and Shipak samplers are not satisfactory for our work. It is our understanding that NOAA will provide a small box corer which may be used by the microbiologists. This sampler should be small enough to be deployed on the winch which is to be placed on the small boat to be used in Kachemak Bay.

During the Norton Sound cruise, a minimum of 30 stations will be occupied in a grid which will cover representative areas in regions within and outside of natural oil seeps. Samples of surface water and sediment will be taken at each station. Repeated samplings at several locations will provide information on local variability.

3. Cook Inlet

1. The sampling methods that we have used in the past cruises in Cook Inlet will be continued during the proposed Upper Cook Inlet cruise. We will collect samples along with the chemists so that the best possible correlation of data can be achieved. Also a sampling pattern with approximately the same density as that used in the Lower Cook Inlet will be used in the Upper Cook Inlet.

2. Samples will be collected during three, two to three week field trips to the laboratory at Kasitsna Bay. Both sediment and water samples will be taken from a small boat provided by OCSEAP fitted with a suitable sediment sampling device. Initially, one major site will be studied while techniques are refined and preliminary observations are made. After the data from the first field trip are analyzed, three or more major sites will be studied during subsequent field trips. The location of the sampling sites will be

dependent on logistical considerations and the potential importance of the sites as areas where the detrital food chains are particularly active.

During this funding period, preliminary experiments will be established which will be designed to determine what changes occur in sediments that have been exposed to crude oil or weathered oil components. The sediment will be removed at the first study site and a portion mixed with crude oil. These samples along with controls will be placed into trays and submerged similar to those used in the Elson Lagoon study in the Beaufort Sea. At various intervals, these trays will be retrieved either by divers or with a line attached to a buoy. Subsamples will be retrieved which will be analyzed for any chemical, physical or biological changes that might have occurred.

Benthic organisms will be collected in Kachemak Bay using a small otter or other suitable trawl. The guts of these organisms will be analyzed for nitrogen fixation rates.

At this time the methodologies are not established for many of the observations that we plan to make but the same general experimental procedures will probably be followed at each sample site. A sample site will be selected from those which should give us the most representative sample possible. A sediment will be sampled using a small grab device to determine if the desired sediment is present. If the site looks good, the spot will be marked with a buoy. A water sample will be taken on which measurements such as those that we have routinely made in the past will be conducted. Sediment samples will be taken with a small bax or Haps corer. Subcores will be taken from this sample to be used for the studies of changes in CO_2, O_2 and methane production. Subsamples will also be taken for the determination of Eh, pH, NH_3 and NO_3 in the field and NO_3, NO_2, NH_3, PO_4, TON and TOC determinations to be made at Oregon State University. Subsamples will also be taken for nitrogen fixation, and denitrification rates and the rates of glucose and glutamic acid uptake and respiration. Since the multi-concentration method for determining heterotrophic potential will be used, the calculated variables of V_{max}, T_t, and $K_t + S_n$ will be reported. Subsamples will also be taken for biomass determinations using epifluorescent microscopy and total energy charge as outlined below. These observations will be made at least twice during a given field study period. In addition to these studies, we will initiate a series of long-term studies on the effects of crude oil on microbial populations in marine sediments. This will be accomplished by placing crude oil augmented sediment samples in plastic trays similar to that currently being used in the Beaufort Sea experiments. These trays will be placed in the same location that the sediment samples were originally collected. During the subsequent field study periods, these trays will be removed and subsamples taken from them for analysis. Acute effects of crude oil on nitrogen fixation, denitrification, respiration, substrate uptake and cropping rates will be made on all sediment samples collected.

B. Analytical Methods

1. Relative microbial activity

The same methods that have been used in the past will be continued. In the Cook Inlet laboratory studies, the multiconcentration Wright-Hobbie method will be used as we have done in the past NOAA studies. Only those samples with a correlation coefficient at 0.8 or better will be reported.

2. Biomass determinations

a. Direct bacterial counts will be made using epifluorescent microscopy. Sample preparation will be made using the technique described by Watson et. al. (1977, Appl. Environ. Microbiol. 33:940-946). All other factors used in these determinations will be the same as those used in the past.

b. Direct protozoan counts will be made using light phase microscopy.

c. Protozoan concentrations will also be made using standard MPN determinations.

d. Total adenylate pools in sediments will also be measured. The methods used to extract the adenylates from sediments as well as the procedures used to assay ATP, ADP, and AMP concentrations have been discussed at length in our current quarterly report. Briefly the procedures used are as follows: the adenylates are extracted with acid using a modification of a method described by Karl and LaRock (1975, J. Fish. Res. Board Can. 32:599-607). Two internal standards are used for each sample, a known concentration of ATP and live bacterial cells from a pure culture with a known ATP concentration. These are used to correct for the efficiency of ATP extraction from the cells and the efficiency of ATP extraction from the sediment. The assay procedure itself is a modification of that described by Pradet (1967, Physiol. Veg. 5:209-221). Preliminary measurements will be made on a scintillation counter until we receive the ATP photometer that we have requested in our FY78 supplemental budget request.

We have recommended that these measurements be made because they can reflect subtile changes in the physiology of marine bacteria. This approach was used in a recent study entitled "Use of the adenylate energy charge ratio to measure growth state of natural microbial communities" reported by Wiebe and Bancroft (P.N.A.S. USA, 72:2112-2115). We have already documented a reduction in the uptake of glucose in natural marine microbial populations which are exposed to crude oil.

When bacteria are "healthy", that is they are actively growing and metabolizing, the energy charge is relatively high. In contrast to this condition, cells that are relatively dormant tend to have much lower energy charge ratios. This is just another index of the physiological state of a given population at a given time and it could be a valuable tool in monitoring the effects of crude oil or petroleum products on microbial populations. Furthermore, it may give us an index of the bacterial productivity--a problem not yet experimentally addressed by marine microbiologists.

3. Analysis of chemical and physical variables

a. During the cruises, temperature and salinity data will be taken from CTD measurements made by the ship. During the field studies, salinities will be measured using a portable Yellow Springs salinometer as we have done in the past or with an Orion specific ion electrode for sodium.

b. The pH and the redox potential of sediment samples will be made using the appropriate electrodes which will be standardized against a known O-R solution.

We have observed pH differences in sediment samples that we have analyzed in the past. We suspect that there is a correlation between this and both cell growth and Eh but we have not made enough observations to come to any conclusions at this time. The Eh of a sample will give some information about the types of microbial mediated reactions that we would expect to find in a given sample.

c. Analyses of NH_3, NO_2, NO_3 and PO_4 will be made on all water and sediment samples collected by both ourselves and Dr. Atlas (RU 29) as they have been made in the past. The techniques used are outlined in our current quarterly report.

The analysis of NH_3, NO_2, and NO_3 will be made to determine what if any reactions in the nitrogen cycle are effected by crude oil under long-term exposure. To date, we have not found any significant differences in nitrogen fixation rates in sediment samples that had been exposed to crude oil as compared to untreated samples; however, these were relatively short term experiments. Analysis of these nitrogen species, will be useful in estimating the long-term effects of crude oil on all phases of the nitrogen cycle.

Whenever one studies any natural microbial system, it is important to learn what factor might be growth limiting to a given population. The availability of both fixed nitrogen and phosphate are potential limiting factors in any microbial system and are therefore measured.

d. Field determinations of NH_3 in sediments collected in Kachemak Bay will be made using an Orion specific ion electrode designed for this purpose.

e. Changes in O_2, CO_2 and methane in sediments will be made using a gas chromatograph fitted with the thermal conductivity detector requested in our FY78 supplemental budget request.

Changes in O_2 and CO_2 can be used to determine metabolic rates on sediment samples which are relatively undisturbed. The presence of methane will tell us somethimg about the availability of O_2 within the sample as well as the types of microbial activity that are taking place within a given sample.

4. Nitrogen fixation and denitrification.

a. Nitrogen fixation rates will be determined as previously described. Denitrification rates in Kachemak Bay sediment samples will be made using the acetylene blocking technique described by Balderston et. al. (1976, Appl. Environ. Microbiol. 31:504-508). The end product in this assay is nitrous oxide. This compound can be detected at relatively high concentrations using a gas chromatograph fitted with a thermal conductivity detector. The concentrations that we are most likely to encounter in this study, however, will require an electron capture detector which is very sensitive to nitrous oxide. This is the reason for the request for this detector in the current proposal.

b. The concentration of nitrogen fixing bacteria found in the sediments of Kachemak Bay will be determined using the same plate count procedures that have been previously described.

5. Bacterial-protozoan interactions

The methodology required to study bacterial-protozoan interactions in marine sediments are not well standardized since very little work has been done in this field. Regardless of the experimental design, there is a requirement to separate these two populations either physically or functionally. There are two methods that are most promising. One is a discontinuous, two phase density gradient centrifugation technique (Berk et. al., 1976, Appl. Environ. Microbiol. 31:450-452). The other procedure separates these two populations by filtration fractionation. At this time, we do not know which of these procedures will be most appropriate for this study. We plan to initiate a pilot study using Yaquina Bay, Oregon sediment to determine which approach will be the most useful.

Attempts have also been made to isolate these two populations by using antibiotics and specific inhibitors (Fallon and Pfaender, 1976, Appl. Environ. Microbiol. 31:959-968). Unfortunately, this approach is of very limited value because there are currently no inhibitors known which will completely inhibit all functions in one group without altering function in the other. There are points in this study where the use of inhibitors may be of value. During this funding period, we will initiate a pilot study which will help us evaluate this alternative.

The use of ^{14}C labeled tracers is a well established method of estimating feeding rates (Lee et. al., 1966. J. Protozool. 13:657-670). One approach that we anticipate using is one in which sediment samples are amended with labeled bacteria and then the rate of ^{14}C incorporation into protozoan biomass is measured. Another approach that we will evaluate is the addition of a labeled compound to sediment that will be taken up by the bacteria but not by the protozoa. We will then follow the uptake of this tracer into protozoa.

Once these techniques have been thoroughly evaluated, the effects of crude oil and/or weathered crude oil components on the conversion of bacterial biomass to higher trophic levels can be measured.

The techniques that we will be using will not require intercomparison with those used by other investigators; however, we will use standard methods for calibrating our own equipment and we will use the necessary controls to insure the validity of our observations.

6. Statistical analysis

As with any other similar study, only a given number of measurements can be made with the resources available. One must thus determine which is the best balance between making a sufficient number of identical observations on a given sample to produce a reasonably accurate value yet not make so many observations that too few samples are analyzed. As a rule, if the variation between two observations is usually less than 10%, duplicate measurements are made. If the experimental error is larger than that, triplicate observations are made. When two groups of data are compared, we try to obtain at least 10 measurements. The comparisons are made using Students "t" test to determine if there is a significant difference at the P 0.05 level. In our narrative reports, we will report the mean value along with the number of observations and standard deviation. This information is all that is required for future statistical analysis that might be used on these data.

VII. Deliverable products:

A. Digital data

1. We will continue to submit our digital data on cards to Dr. Krickevsky (RU #s 371 and 391). These data will be incorporated into the NIH data base to be placed into a compatable format with the data submitted by Dr. Atlas (RU #29). This will facilitate the direct comparison of all microbiological data generated thus far in the program.

2. We will continue submitting our cruise data in digital form. In this case, it is desirable to place routine data into the computer system because these data include relatively few observations on a large number of samples. We do not, however, plan to submit the data collected at Elson Lagoon, Beaufort Sea nor the data collected in the initial stages of the detrital food web study in this format. The reasons for this are that during these studies we will be making a large number of different observations on a relatively limited number of samples and that the type of observations made will probably change as the study progresses.

3. The following digital data products in the standard format will be reported on station locations sampled during the cruises : relative microbial activity, respiration ratios, rates of nitrogen fixation in sediments, and the standard nutrient variables that we have reported in the past.

4. Please note: During this funding period, the only data that will be reported in digital form (computer format) will be the data collected during the two proposed cruises.

B. Narrative reports

As we have done in the past, our narrative reports will include information of the general state of knowledge, methodology, results and conclusions. These reports will include all data collected in the field and the results of all laboratory studies. These data will include all of the digital data mentioned above as well as such measurements as bacterial biomass, protozoan biomass, bacterial cropping rates, rates of nitrogen fixation and denitrification in sediments and in the guts of selected animals, and physiochemical measurements made on the sediment samples collected during our detrital food web studies. An analysis of the effects of crude oil will also be made on the above mentioned variables. In addition, measurements of crude oil biodegradation potentials will be made on all sediment samples collected.

Where appropriate, data will be presented in graph form to determine if any seasonal variations have been observed and to illustrate any correlations between variables that have been noted.

No special narrative reports other than routine quarterly and annual reports are anticipated.

C. Visual data

Visual data will be presented in the narrative reports (see above). In addition, Transparent Mylar film overlays will be submitted of data presented in chart form in the narrative reports.

D. Other (none)

E. Data products and data submission schedule (see attached sheets).

VIII. Special Sample and Voucher Archival Plans

Does not apply to our study

IX. Logistics Requirements

1. See attached sheets for logistics requirements for the cruises and for the crude oil degradation study in Elson Lagoon.

2. The logistics requirements for the detrital food web study to be conducted at the field station at Kasitsna Bay are unique enough that they do not fit easily into the format provided in the logistics forms. We are therefore describing these requirements in this section. Many of the potential logistics problems associated with this study are described in section X.

3. Laboratory requirements

a. Living accommodations for up to two persons from our group.

b. The laboratory should be equipped with a hood, hot and cold running fresh water, standard line current, and a minimum of 20 feet of bench space with adequate under-counter storage.

c. The laboratory should also be equipped with at least one low temperature incubator, one freezer, a refrigerated centrifuge, water bath, spectrometer, balances, two-15 gallon aquaria, and water deionizer or still. It would be very helpful to have the following equipment available; scintillation counter, epiflourescent microscope, gas chromatograph, and a minicomputer.

d. The following equipment could be provided by us for our use at this laboratory; autoclave, ATP photometer, vacuum pump, rotary shaker, Millipore filtration system, water samplers, specific ion probes and analyzer, miscellaneous glassware, and chemicals. This equipment could be transported to and from the field as required for our use if it is not made available to us at the field laboratory.

e. In this proposal, we have not included any funds for transportation between Homer and the field laboratory. It is assumed that OCSEAP will provide a suitable sampling platform and will cover all costs in it's operation.

f. As mentioned under section X, we will require a suitable sampling platform for our work in the detrital food web study. We will also require a sediment sampling device which will take undisturbed sediment samples for microbiological study. The small boat which is to be used at the Kasitsna Bay laboratory should have a large enough winch to handle the above mentioned sampling device. It is our understanding that during this funding period, there will be no other PI associated with this project that will be collecting benthic organisms. As it stands now, we will have to collect our own animals for the nitrogen fixation studies. In order to accomplish this, we will require a small trawl that can be towed by the small boat.

X. Anticipated Problems

a. Logistical and equipment problems

We do not anticipate any significant logistical problems associated with the Beaufort Sea work (assuming that NARL is still open), nor with the Norton Sound work. There could be some problems with the detrital food chain field work to be conducted in the

Kasitsna Bay laboratory. We will require a small boat which is capable of operating in relatively open waters without difficulty yet is fast enough to move personnel to and from the sampling sites with reasonable speed. This craft should be equipped with a winch which is capable of lifting 500 lbs and should be large enough to deploy a small box corer. If this type of craft is not available, work in this area will be very difficult.

B. Experimental

Many of the techniques that we anticipate using are relatively standard and we anticipate no particular problems in conducting the research as outlined above. The one exception to this however, is the study of bacterial-protozoan interactions. The potential problems involved in these studies are outlined in the "Analytical Methods" section. In order to obtain as much preliminary data as possible, we have requested funds for the necessary equipment in a supplimental request for funds on the FY78 budget. It is our intention to start work on these problems as soon as we receive the necessary funds for the equipment requested. We have also purposefully kept our field study commitents to a minimum for the first few months of the contract period. By working in our laboratory at OSU on sediments taken from the Oregon coast, we will be able to work out the necessary techniques for field use in Alaskan waters.

Unfortunately as of 9/6/78, we have not received the supplemental funds that were requested in April of this year. We made that request hoping that even with the lag time inherent in the purchasing system, we would receive this equipment during the month of July. Even if we receive these funds tomorrow, we will not have the equipment in our hands for approximately two more months with delivery sometime in mid-November. As a result, we will not have enough time to check out all of our techniques before our first scheduled field trip to the Kasitsna Bay lab. In short, due to the lag time involved in receiving this equipment, our program is 2-3 months behind where it should be at this time.

XI. Information required from other investigators

For our study of the Norton Sound area, any information that we can acquire concerning the currents and hydrography, light hydrocarbon content of the waters and sediment in the area would be very helpful. In addition, we will require information about the location of known natural oil seeps in the Norton Sound. As in the past, we will require temperature, salinity, sample location, water depth and tide state data from the ship.

For the detrital food chain study in Cook Inlet, we will require any information generated by others concerning all potential inputs into the detrital food chain. This would include such data as particulate and disolved organic carbon from freshwater runoff, and all primary productivity data. Also any data that might be available on secondary productivity on all trophic levels would be helpful.

Throughout this study, we have been working closely with Dr. Atlas and his associates. We are continually comparing their data with ours and we will continue to do so in the future.

The techniques that we will be using will not require intercomparisons; however, we will use standard methods for calibrating our own equipment and we will run the necessary controls to insure the validity of our observations.

XII. Milestone Chart (see attached form)

XIII. Outlook:

A. Overview

The following ultimate goals should eventually be realized to insure that sufficient information about crude oil-microbial interactions are available as a data base from which informed managerial decisions can be made.

1. Data on the rates of key microbial reactions in water and sediments should be available for all areas within the major lease sites which have been identified as critical areas. These critical areas are those which have been identified as being unusually subject to impact by crude oil production by marine biologists. Since the normal function of bacteria is critical either directly or indirectly to biological processes at all trophic levels, this information must be made available to management so that the long term impact on all organisms, including those of commercial value, can be properly assessed.

2. A better understanding of the effects of crude oil on specific microbial function should be obtained before the potential impact of crude oil perturbation can be fully understood. These studies should also include measurements on the effects of any dispersants which might be used in the event of an oil spill in any of the proposed lease areas. It is quite possible that the perturbations made by crude oil and dispersants together may be much greater than either one of these alone. Both the short and long term effects should be considered since certain effects may not be noted until there has been an extended exposure period. This is of particular importance in marine sediment-microbial functions. The microbial functions which are of primary importance are; microbial involvement in the entire nitrogen cycle, heterogrophic activity of bacteria utilizing dissolved nutrients and microbial function involved in the conversion of detrital particles to a usable food source for higher trophic levels.

3. The estimation of <u>in situ</u> crude oil biodegradation rates is another area which needs to be explored further. Dr. Atlas and his associates (RU 29,30) are expending a greater share of their total effort on this problem so that a better assessment of potential biodegradation rates can be made. We on the other hand, are expending a larger share of our research effort studying the effects of crude oil on microbial processes, especially those associated with the detrital food web.

B. Results and data products

1. The study of new lease areas will provide information concerning both the temporal and spacial patterns of microbial activity. Once this information is collected, it can be used to assist in defining which regions are most likely to be impacted by crude oil development. The data products from these studies will be essentially the same as those provided in the past subject to modification as more information and better techniques become available.

2. The site specific studies of microbial function in the detrital food web will provide information about the role of microorganisms in converting detritus into usable food for other trophic levels. During FY79, the initial observations of microbial function in selected Kachemak Bay sites will be completed. At the end of this time, the methodology should be perfected to make the desired measurements, and key functions should be identified. During FY80, this study should be expanded to look at representative sites in other locations in Cook Inlet. This study should also be expanded to include in situ studies of the effects of crude oil on these processes using oil contaminated sediments. At the end of FY80, the effects of crude oil on key microbial functions should be more clearly understood. It will take an additional year before the long term effects of crude oil on microbial function in key Cook Inlet sites will be assessed with a reasonable degree of certainty.

B. See above

C. Cost by fiscal year

The cost should be approximately the same as that proposed in this contract with adjustments for inflation if we do not have to increase our field work associated with the study of new lease sites. If additional demands are placed on us to conduct field studies in excess of this effort, we will require funds for an additional technician (approximately 16K) and additional funds for travel and consumable supplies.

D. Location of future field efforts

See above

E. Logistics requirements

Our logistics requirements will remain at about the same level and kind that will be required during this funding period provided that no additional sampling sites are studied. However, if, as we anticipate, several different sampling areas are studied in the detrital food web program, we will then require additional logistic support. Since we make our measurements on samples within a few hours of when they are collected, we will either require a suitable laboratory on location (either a land station or small ship) or we will need an aircraft which will be able to transport our samples to a land based laboratory.

XIV. A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the optin of OCSEAP, the PIs are prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such review will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A through E. Digital data submissions will be accompanied by a DATA Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA For 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and the inventory will be done annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached). Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixth days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

J. All publications and presentations of material developed under OCSEAP funds will acknolwedge BLM/OCSEAP sponsorship. The following acknowledgement is standard:

"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 of petroleum development of the Alaskan Continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

MILESTONE CHART

O - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 190 PI: Griffiths/Morita

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

			1978				1979								
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Quarterly reports			X						X			X			
Annual report						X									
Cruise in Upper Cook Inlet								X							
Cruise in Norton Sound								X							
Sampling of trays in Elson Lagoon				X			X				X				
Field studies for detritus food web studies					X				X				X		
Complete data analysis of cruise data												X			

LOGISTICS REQUIREMENTS NORTON SOUND AND UPPER COOK INLET

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION Oregon State Iniversity PRINCIPAL INVESTIGATOR Griffiths/Morita

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.
   See attached sheet.

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible.
   See attached sheet

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)
   Norton Sound , May, 1979 Upper Cook Inlet, May, 1979

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

   14 working days

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? **We will be working with Dr. Atlas (RU 29) taking subsamples from the same samples. We could coordinate with other groups.**
   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations. **We require approximately 1 hr per station of wire time. We can sample around the clock but we can not normally process more than 6 stations during a 24 hour period.**

6. What equipment and personnel would you expect the ship to provide?
   See attached sheet

7. What is the approximate weight and volume of equipment you will bring?
   500 lbs, 250 cu ft

8. Will your data or equipment require special handling? yes If yes, please describe. **Much of your equipment is fragile. We will have samples that will require refrigeration or freezing. We normally need 5 cu ft of freezer space and 7 cu ft of refrigerator space.**

ill you require any gases and/or chemicals? yes If yes, they should be on oard the ship prior to depar e from Seattle or time allow for shipment by arge.

6-CO_2 cylinders for dry ice making.

you have a ship preference, either NOAA or non-NOAA? If "yes", please name the essel and give the reason for so specifying. **We have sucessfully worked off the Miller Freeman, Surveyor, and Discoverer. Of these NOAA vessels, we have found the Miller Freeman to be the best suited for our purposes.**

you recommend the use of a non-NOAA vessel, what is the per sea day charter ost and have you verified its availability? .

NA

ow many people must you have on board for each leg? Include a list of partici- ants, specifically identifying any who are foreign nationals.

2 persons - no foreign nationals

SUPPLEMENTAL INFORMATION ON LOGISTICS REQUIREMENTS FOR

NORTON SOUND AND UPPER COOK INLET CRUISES

A. SHIP SUPPORT

1. We will occupy approximately 15 stations during the Upper Cook Inlet cruise as well as any time stations that are occupied by the chemists. Since the Norton Sound cruise is not scheduled for another year, it is too early to give a detailed cruise plan at this tims. Information collected by other PIs between now and next spring will quite possibly influence our sampling strategy during this cruise. In general terms, we will take samples at a minimum of 30 stations which will give us a good comparison between areas that contain known natural seeps and those that do not.

2. Water and sediment samples will be taken at all stations using a Niskin sterile bag water sampler and a sediment sampling device provided by NOAA. In addition, we will want to collect benthic organisms to analyze nitrogen fixation rates in gut samples. For this purpose, we will require a bottom trawl provided by NOAA. We will routinely require the following information from the ship; sample site location, water temperature and salinity at the surface and just above the bottom, water column depth, and tidal state.

In the past, only Van Veen and Shipak bottom grab samplers have been available to us using the ship's equipment. These samplers are no longer adequate for the type of sampling that we require. We have requested funds for a small box corer for microbiological field work conducted on NOAA ships and for use at the Kachemak Bay laboratory.

3. We will require assistance from the ship's crew in obtaining sediment samples and benthic organisms. We will also need assistance in obtaining the data that is mentioned above. We will require the above mentioned sampling equipment and both refrigerator and freezer space.

Date: 6/28/78
Contract: 03-5-022-56
Task Order: #8
R.U. No.: 194
Proposal No.: OCS 79-6

Renewal Proposal

to

National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado 80302
Juneau Project Office

MORBIDITY AND MORTALITY OF MARINE MAMMALS

R.U. No.:	194
Total Cost:	$50,198
Lease Areas:	Kodiak 60%
	L.C.I. 20%
	NEGOA 20%

Institute of Arctic Biology
University of Alaska
Fairbanks, Alaska 99701

F. H. Fay, Principal Investigator
University of Alaska
Fairbanks, Alaska
(907) 479-7026

for
John Bligh, Director
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(907) 479-7340

K. B. Mather
K. B. Mather, Vice Chancellor
Research and Advanced Study
University of Alaska
Fairbanks, Alaska
(907) 479-7282

I. Title:

Morbidity and Mortality of Marine Mammals
Research Unit #197

II. Principal Investigator:

Francis H. Fay

III. Cost of Proposal (by federal fiscal year)

A. Science $50,198
B. Logistics (not included in request) 5,400
C. Total $50,198
D. Distribution:
Kodiak 60%
Lower Cook Inlet 20%
NE Gulf of Alaska 20%

IV. Background:

The natural balance of marine mammal populations is a function of complementary birth and death rates. The productivity of Alaskan marine mammal populations has been under study for more than 20 years, but the causes of illness and death have received little attention until now. This project has been concerned with investigation of the natural causes of morbidity and mortality in marine mammals of the eastern Bering Sea and South Central Alaskan oil lease areas, with emphasis on determination of the kinds of incidences of pathological conditions, identification of the causative agents, and estimation of the potential effects of future stresses brought to bear by offshore oil exploration and development. In the study proposed here, that work would be continued in Lower Cook Inlet, Kodiak and Northeast Gulf of Alaska lease areas.

Field work will involve necropsy of marine mammal specimens taken in connection with one other OCSEAP project (R.U. #243). It will include also surveys of and post mortem examinations of beached carcasses of marine mammals.

V. Objectives:

A. Determine the normal rate of occurrence (by species, sex, and age) of stranded marine mammals along selected protions of the coast in Lower Cook Inlet, Kodiak, and the Gulf of Alaska.

B. Determine the pathological conditions and agents that cause or contribute to the moribund condition or death of stranded animals.

C. Determine the annual variation in kinds and frequency of occurrences of the pathological agents that cause or contribute to moribund conditions or death of marine mammals.

The relevance of these objectives to an environmental assessment of the Alaskan Continental Shelf lies mainly in their providing baseline information on (1) the current state of health of marine mammal populations and (2) the current rate of occurrence and causes of death of beach carcasses, prior to large scale petroleum development.

VI. Strategy and Approach:

The main effort in FY '79 will be directed toward completing the analysis of materials and data collected in previous years from the Bering Sea, Gulf of Alaska and Cook Inlet. New field work will be limited to opportunistic surveys of beach dead carcasses in the Kodiak, Cook Inlet, and NEGOA lease areas, as logistic support is available, and to autopsy of a few additional specimens taken in connection with R.U. #243 (Calkins). The purpose of the latter will be to identify the cause(s) of premature births in Steller sea lion populations of the Gulf of Alaska.

A. Sampling Methods:

Non-selective sampling of living populations will be completed in FY '78. Further sampling of sea lions in FY '79 will be selective of animals identified as having recently aborted a fetus. Insofar as possible, surveys of beach dead and moribund animals will be replicates of areas and at times comparable to previous surveys.

Beached carcasses and newly collected animals will be autopsied by standard methods, with examination of all organs and systems, descriptive notation of gross lesions, preservation of representative normal and pathological tissues in 10% buffered formalin, swabs of suspected microbiological infections in Amies transport medium stored at $4^{o}C$ and in viral transport medium stored at $-10^{o}C$ or lower, scrapings of suspected mycotic infections innoculated directly into Savouraud's agar, and other preparations as appropriate for special agents, such as Leptospira. Tissue samples will be taken for hydrocarbon, pesticide, and heavy metals assessment and stored frozen. In fresh specimens, blood will be drawn from the intervertebral venous sinus immediately after death, centrifuged, and the serum stored at $-10^{o}C$ or lower.

Beached carcass surveys via helicopter at 100-150 ft., with beach landings for closer examination were feasible. Locations of specimens marked on charts directly.

B. Analytical Methods:

Most of the histopathology of tissues will be done by Department of Pathology, The Johns Hopkins Medical School; microbiological cultures by the Alaska Department of Health and Social Services; parasites identified by various specialists; serology by ADHSS and Naval Biosciences Laboratory. Species and sex of animals determined at autopsy; age from sagittal thin sections of teeth.

VII. Deliverable Products:

A. Digital Data:

Surveys of beach dead and moribund mammals will be submitted in OCSEAP Format 027 - Mammal Sighting 01. Pathological information will be submitted to Juneau Project Office in tabular form, using the Morbidity and Mortality Code.

B. Narrative Reports:

Narative reports describing the distribution of stranded dead and moribund animals along selected sections of the Alaskan coast, the type of pathogenic activity that caused or contributed to the moribund condition or death of stranded animals, and the annual variation in mortality and incidence of selected pathogenic agents in natural populations of marine mammals.

C. Visual Data:

1. Maps showing the location of stranded marine mammals.

2. Charts showing probable carcass drift trajectories.

3. As appropriate, figures or tables illustrating:

   a. The occurrence and frequency of pathogenic agents in selected species.

   b. The annual variation in the occurrence of pathogenic agents for selected species.

D. Other:

N/A

E. List of Data Products and Data Submission Schedule:

See attached Data Products Schedule.

VIII. Special Sample and Voucher Specimen Archival Plans:

Voucheer specimens of normal and pathological tissue sections on 2.5 x 7.5 cm microscope slides (glass) presently stored in appropriate containers in Room 209, Arctic Health Building, University of Alaska-Fairbanks, at no cost. Total number of slides at termination of project likely to be about 2,000, storable in containers occupying about 35 x 40 x 50 cm. at temperatures not exceeding 30°C.

IX. Logistics Requirements:

See attached forms. NOAA helicopter support requested for one beach survey each in LCI and Kodiak areas, with third survey combined with collecting trip via PI chartered helicopter in NEGOA. Other surveys and/or collections may be done where logistic support is available in connection with other projects.

X. Anticipated Problems:

None.

XI. Information Required from Other Investigators:

Charts or overlays, showing route covered and mammal carcases sighted, along coastal areas of LCI, NEGOA, and Kodiak areas, in relation to date, time, aircraft type, speed, and elevation. Such data are currently being supplied by Arneson (R.U. #3), Wohl and Sanger (R.U. #341), for LCI and NEGOA, and various ADF&G contacts in these and the Kodiak area.

XII. Milestone Chart:

See attached.

XIII. Outlook:

Approximately 30K needed in FY '80 to complete preparation of final report.

XIV. Contractual Statements:

1. A schedule for data submission for each task order has been, and will continue to be, submitted and updated each quarter.

2. This statement is in accordance with our base contract, and we will continue to comply.

3. See section VIII of this proposal. The University of Alaska will continue to negotiate a Voucher Specimen Policy with NOAA/OCS. We will comply with the then agreed to policy.

4. The University of Alaska agrees that the Principal Investigators can travel to the Project Office at least twice during the contract year, provided that such travel is in accordance with University of Alaska travel policy and consistent with other University duties of the Principal Investigator.

5. Data will be provided in the form and format agreed to by the University of Alaska and NOAA/OCS in the negotiating of the Data Management Plan.

6. As per Article 9 of the base contract, the University of Alaska agrees to the following: "...all archivable data is to be submitted by the contractor to the Contract Data Manager within 120 days after acquisition. Certain data sets such as plankton counts or volumes are not available until sorting of samples is complete. The data so obtained are archivable 120 days following the actual soring or other laboratory procedure."

7. Within 10 days of the completion of a cruise or data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager by the Chief Scientist.

8. This is in accordance with the base contract with which we shall comply.

9. Three copies of all publications or presentation abstracts or manuscripts pertaining to technical or scientific material developed under OCSEAP funding will be submitted to the COTR sixty days prior to publication or presentation. Copies of all news releases mentioning OCS or using information gathered by OCS funding will be sent to the COTR.

10. The following acknowledgement of sponsorship will be used:

> "This study was supported under contract 03-5-022-56 between the University of Alaska and NOAA, Department of Commerce through the Outer Continental Shelf Environmental Assessment Program to which funds were provided by the Bureau of Land Management, Department of Interior."

DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Beached Mammal			027	Yes	April, July, August 79	June, Sept 79
Mammal Pathology	Tables	500 entries	025	Yes	6/75- 8/79	12/78- 9.
Narrative Reports	NA	3 Quarterly, 1 Annual	NA	Yes	10/78- 9/79	Quarterly & annual(March)
Beached Mammal	Charts	15	NA	Yes	6/75- 9/78	3/79
Carcass Drift	Charts	5	NA	Yes	Same	Same
Pathological Conditions & Agents	Tables	5	NA	Yes	4/76- 9/78	FY80

C. AIRCRAFT SUPPORT - HELICOPTER

R.U.#194 FY79

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

See attached charts Cook Inlet and Kodiak-Tugidak (Figs. 1&2)

2. Describe types of observations to be made.
Survey and necropsy of beached mammal carcasses.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?
August ± 1 month (Cook Inlet); preferably July in Kodiak-Tugidak area

4. How many days of helicopter operations are required and how many flight hours per day?
4 days, 6 hrs/day in Cook Inlet; as available in Kodiak-Tugidak area (2 da, 4hr/da)
Total flight hours?
24 Cook; 8 Kodiak

5. How many people are required on board for each flight (exclusive of the pilot)?
Two

6. What are the weights and dimensions of equipment or supplies to be transported?
30 lb maximum; 3x2x2 ft max.

7. What type of helicopter do you reommend for your operations and why?
Any with above capacity.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.
NOAA

9. What is the per hour charter cost of the helicopter?

10. Where do you recommend that flights be staged from?
Cook Inlet: Surveyor a/o Homer, Kenai, & Anchorage; Kodiak-Tugidak: Surveyor

11. Will special navigation and communications be required?
No

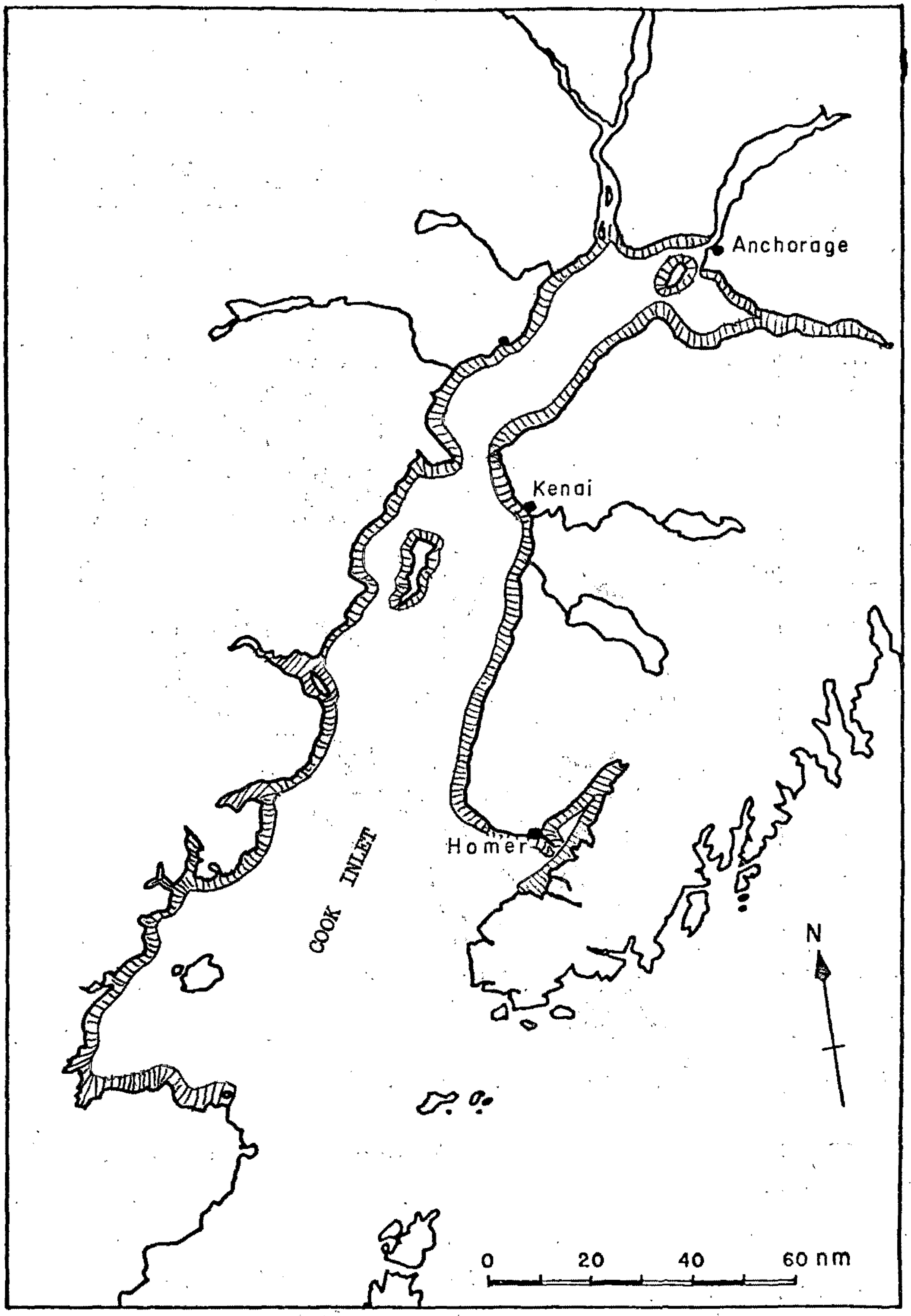

Fig. 1. Proposed survey area (cross-hatched) for beached marine mammals, Cook Inlet, in August FY79.

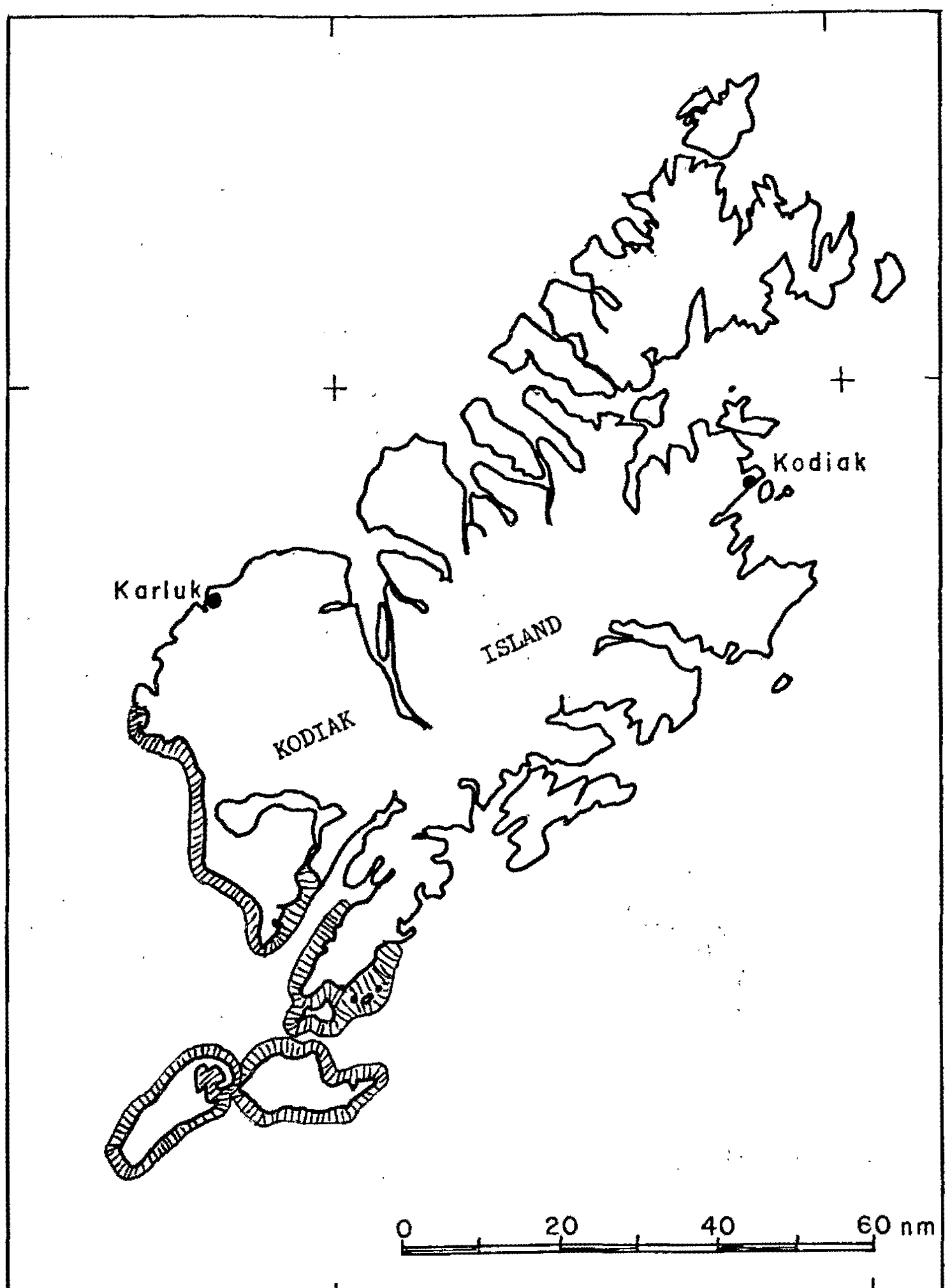

Fig. 2. Proposed survey area (cross-hatched) for beached marine mammals, Kodiak-Tugidak area, in FY79.

C. AIRCRAFT SUPPORT - HELICOPTER

R.U.#194 FY79

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

See attached chart NEGOA (Fig. 3)

2. Describe types of observations to be made.
Survey and necropsy of beached mammal carcasses; observation, collection, and necropsy of aborting sea lions.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?
25 March & 10 April/ Cordova-Cape St. Elias & C. St. Elias-Cordova
Need 10 days to 2 weeks on Cape St. Elias; timing could be 1 week later

4. How many days of helicopter operations are required and how many flight hours per day? 2 days, 4 hrs/day working time, plus about 8 hrs transit time, with allowance for unfavorable weather.
Total flight hours?
16 to 18

5. How many people are required on board for each flight (exclusive of the pilot)?
Two

6. What are the weights and dimensions of equipment or supplies to be transported?
200 lb 3x3x2.5 ft

7. What type of helicopter do you reommend for your operations and why?
Any with above capacity. Flight times indicated are for Bell 206

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.
Kenai Air; previous experience in the area

9. What is the per hour charter cost of the helicopter?
300/hr

10. Where do you recommend that flights be staged from?
Cordova

11. Will special navigation and communications be required?
No

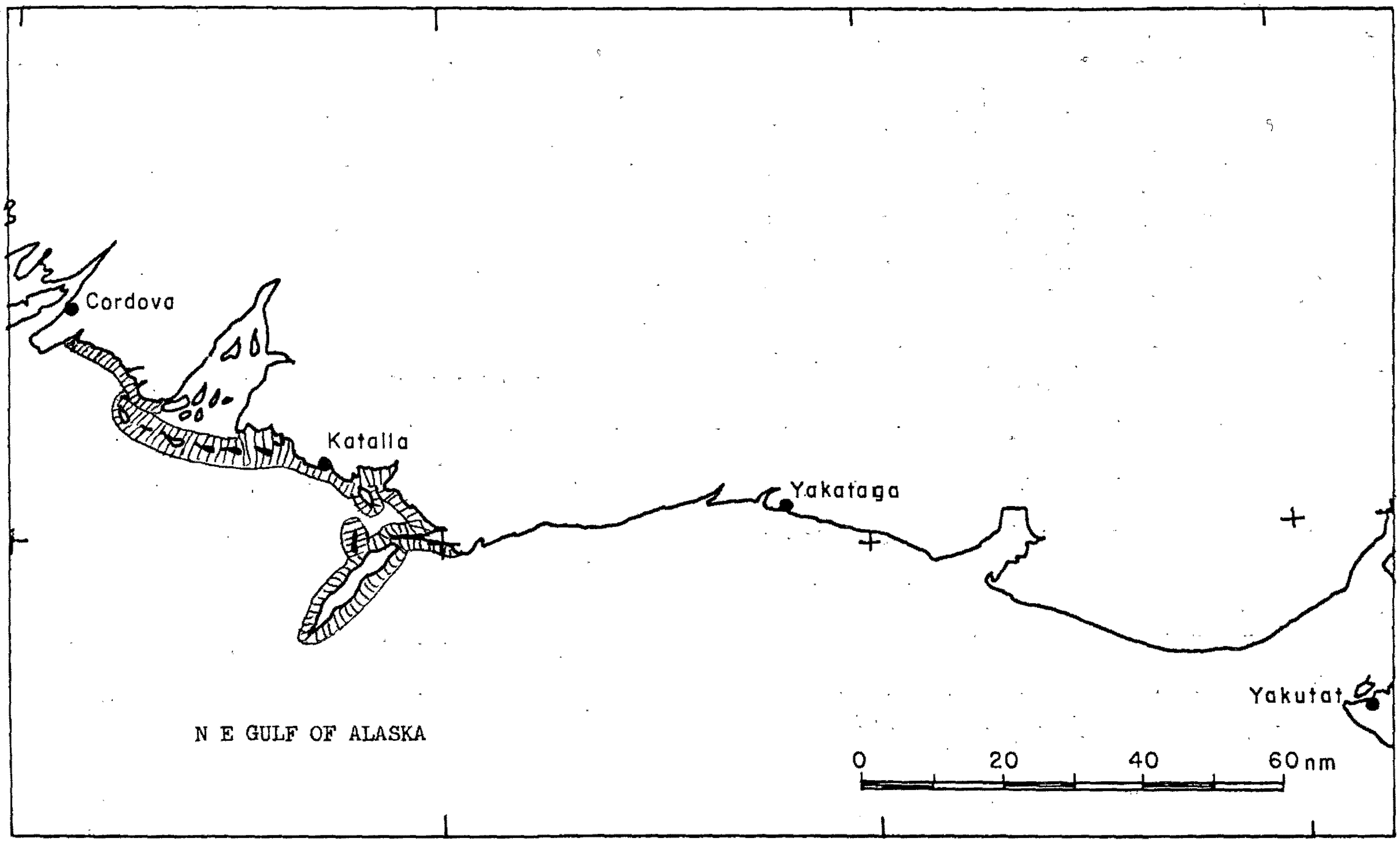

Fig. 3. Proposed survey area (cross-hatched) for stranded marine mammals in April '79.

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 194 PI: F. H. Fay

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

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Quarterly Reports			0						0			0			
Annual Report						0									
NEGOA/Cordova-C. St. Elias							0								
Kodiak beach survey											0				
Cook Inlet survey												0			

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Proposal Date: 22 June 1978
Contract #: 03-7-022-35140

FY 1979 RENEWAL PROPOSAL

Research Unit Number: 196

TITLE: Distribution, abundance and feeding ecology of birds associated with pack ice

Cost of proposal: ~~$59,027~~ 50,001 DUN

Lease Areas:

Beaufort Sea	60%
Chukchi Sea	20%
Norton Sound	20%

Period of proposal: 1 October 1978 to 30 September 1979

Principal Investigator: George J. Divoky

Institution: Point Reyes Bird Observatory

George J. Divoky
Mr. George J. Divoky
Point Reyes Bird Observatory
4990 Shoreline Highway
Stinson Beach, CA 94970
Phone (415) 868-1221

Jane P. Church
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Phone (415) 868-1221

IV. Background

During its annual formation and retreat the Arctic pack ice covers a major part of the outer continental shelf being considered for development as part of the OCS program. The annual cycle of the pack ice has a profound effect on the marine birds in the Beaufort, Chukchi and Bering Seas. The proposed research is part of a continuing project aimed at obtaining predictive understanding of the distribution, abundance and biology of bird species associated with the ice environment. Because aerial censusing over ice has been shown to provide unreliable data, this project is dependent on the availability of ships that operate in and next to the ice. Thus seasonal and year to year patterns emerge slowly through repetitive observations. Ice edge habitats are sites of major concentrations of marine birds under certain circumstances and at the same time can be expected to be subject to build-up of any marine contaminants.

OCSEAP-funded cruises from 1975-78 and additional cruises from 1970-73 have provided information on densities and feeding behavior of seabirds in the pack ice of the Bering, Chukchi and Beaufort Seas.

While there are still major temporal and geographic gaps that need to be filled, the data in hand will provide a major contribution to our knowledge of the pack ice avifauna. The bulk of the work conducted in FY 1979 will be to analyze data gathered in previous years and to present the analyses in reports. Satellite imagery of ice conditions obtained as part of R.U. 267 will be used to correlate bird densities with large scale ice features. Trophic information obtained as part of this project will be compared with other trophic studies (R.U. 6,29,230,232 and 359). Species accounts of the Arctic Tern and all Alaskan gulls other than *Larus* and *Rissa* will be initiated. Field work in FY 1979 will be undertaken only to fill specific information gaps, or to conduct specific studies on manipulation of breeding habitat. The latter are a result of hypotheses based on OCSEAP-funded studies in 1975-77.

The 1979 work on this project will thus have four basic emphases:

- Wrap-up and exposition of pagophilic species' interactions with ice edge habitats;

- Analysis and synthesis of integrated trophics studies carried out in 1977 and 1978, with possible limited field follow-up;

- Analysis and continuing observation of manipulated nesting conditions for Arctic Terns, Pacific Eiders, and Black Guillemots on Cooper Island and other typical Beaufort barrier islands, begun in 1976;

- Species accounts formulated for small gulls and terns for all Alaskan OCS areas.

V. Objectives

1. Sample bird occurrence in relation to all major seasonal ice events (formation, maximum extent, minimum extent) in each lease area (Norton, Chukchi, Beaufort).

2. Develop predictive understanding of repetitive ice/polynya features on distributions of birds.

3. Develop predictive understanding of the importance of anomalous ice features in year-to-year variations to occurrence and abundance of pagophilic species.

4. Use all appropriate techniques to identify and follow ice and water mass dynamics seasonally to learn what influence events such as breakouts, variable shear zones, and major lead systems have on the avian community.

5. Develop an understanding of trophic ecology of pagophilic species to the point that major prey items can be identified as requiring additional understanding/experimentation in view of offshore development.

6. Assess recovery potential of artifically reduced breeding populations, probably at Cooper Island, with Arctic Terns.

7. Evaluate effects on island 'carrying capacity' of increased driftwood availability or other appropriate nest habitat modifications, in presence and absence of foxes as predators.

8. Begin species account summaries on Arctic and Aleutian Terns, Ross' and Sabine's Gulls, according to OCSEAP-specified format, statewide for Alaska.

These objectives will allow the determination of which areas in the ice are most critical to pagophilic birds and the primary prey species that support these bird populations. Such information is needed prior to the proposed OCS leases. Manipulation of breeding success and conditions is being carried out in order to see how human activities on barrier islands may benefit or harm populations breeding on the islands. Species accounts are being initiated as part of an attempt by OCSEAP to correlate and condense the available information on the major Alaskan seabird species.

VI. General Strategy and Approach

Over the past nine years pelagic observations have been made on 16 cruises in the pack ice of the Bering, Chukchi and Beaufort Seas. In general the data obtained since 1975 are the most valuable due to ice information avilable from satellite imagery and the physical and biological studies conducted concurrently with pelagic bird observations. Most of the cruises (all since 1975) have been put into a standard OCSEAP format (033) and are on magnetic discs. FY 1979 efforts will center on the analysis of information already in hand. The quantity of data to be analyzed necessitates the use of a computer. A micro-computer already owned by the PRBO will be used to correlate bird abundance with ice and other environmental parameters.

Field work will be limited in time and will deal primarily with barrier island breeding populations. The breeding populations of Arctic Terns and Black Guillemots on Cooper Island will be censused in order to assess the effects of 1978 manipulations (egg destruction by fox or humans). In addition the islands east of Prudhoe Bay and west of Flaxman Island will be visited to determine how the increased nest cover placed on other islands in 1978 has affected bird numbers. This is part of an experiment to determine if breeding populations on barrier islands can be affected by artificial cover. An attempt is being made to lessen the impact of industrial use of the islands.

VII. Sampling

No cruises are planned or budgeted for in FY 1979 but should an ice cruise take place the following will be done. On a given cruise an attempt is made to conduct observations south of the ice, at the ice edge and at varying distances within the ice. Observations are usually made continuously as the ship steams during daylight hours so that gradients north and south of the ice are discernible. Observations are divided into 15-minute periods with all birds seen in a 300-meter transect on one side of the ship being counted. Birds seen in this transect are used to compute birds per km^2. This is done for all birds seen and by species. Ship followers are counted once every 15 minutes but are not included in density computations. Information gathered on birds includes age, sex, activity, and direction of flight. For each observation period, information on ice cover, type and a number of other ice parameters is taken. Oceanographic information and distance to land and shelfbreak are obtained for each 15-minute transect. All observations are coded in OCSEAP data format 033.

Bird specimens are collected from a small boat with a shotgun. On returning to the ship all specimens are weighed, sexed, analyzed for fat, and the stomach removed. Stomach contents analysis is done immediately. The weight, number and size of each prey organism is recorded. All bird specimen and stomach contents data will be entered into an OCSEAP data format as soon as the format is approved by NODC

Barrier island censuses will be taken 2 or 3 times during the breeding season and all eggs, chicks and adults counted. Nesting chronology will also be determined.

VIII. Analytical Methods

Bird densities (birds per km^2) will be analyzed in relation to ice cover, distance to ice edge, distance to land and a number of oceanographic parameters. In this way the principal factors determining bird distribution in and next to the ice can be ascertained.

Stomach contents will be analyzed by determining frequency of occurrence for all prey items and percent of toal weight. Frequency of prey species in stomachs will be compared with the frequency of the species in otter and Tucker trawls.

IX. Deliverable Products

A. Digital Data

See attached sheets showing parameters obtained in 033 and list of digital data products and submission schedule. Processing of data will be done by project.

B. Narrative Reports

1. Analyses of densities, age classes, activities and stomach contents of birds, including tabular and graphic trophic presentations.

2. Reports on manipulative experimental results.

3. Species synthesis accounts.

4. Word-schematic modeling of ice features, deformations, anomalies, as necessary to illustrate and interpret mechanisms and dynamics of the bird/ice relationships in average and extreme cases, all lease areas and seasons.

C. Visual Data

Maps of occurrence and densities of each species for each cruise, in relation to major ice features and habitat types.

X. Quality Assurance Plans

The Principal Investigator will participate in all cruises and oversee all data gathering methods in order to assure standardization of technique. In addition all personnel hired as field assistants in this project have conducted similar observations as part of this project and R.U. 3/4. The techniques used in this project allow data to be compared with other pelagic distribution and feeding data.

Bird densities are computed by counting all the birds in a given area and deriving a birds per km^2 value. These densities are calculated by computer as are all correlations and regressions with environmental factors.

Stomach contents are separated to lowest possible taxonomic unit, each category is weighed and the length of individual prey items measured to the nearest millimeter.

XI. Special Sample and Voucher Specimen Archival Plans

Voucher specimens of all prey organisms found in bird stomachs are being kept at Point Reyes Bird Observatory.

XII. Anticipated Problems

The proposed work consists almost entirely of office and lab work with only limited field operations. If OCSEAP conducts cruises in lease areas affected by ice, additional funds would be needed. Every month of field work would add an additional $2,000 to the budget.

Much of the analysis of data will be done by computer. While sufficient funds are included in the budget for purchase of hardware to aid in the preparation of data outputs, there is always the possibility of malfunctions that would require the purchase of new equipment or repair of equipment already purchased. This could result in additional costs.

XIII. Information Required from Other Investigators

Contacts have been established with research units whose work interfaces with R.U. 196. These include units concerned with trophic studies (R.U.6, 29, 230, 232, 259) and ice dynamics (R.U. 257).

XIV. Management Plan

The principal investigator will oversee all operations in the laboratory, field and office. He will be responsible for the preparation of all digital and narrative data. Personnel involved in the preparation of data products will be experienced workers who have gathered the information being reported on.

Computer programming will be done by Leo Karl of Custom Computing.

Information on the chronology of data gathering is shown on the attached milestone chart.

XV. Outlook

FY 1979 is considered a time in which the large amount of data gathered over the past four years will be analyzed. The analysis will allow the determination of geographic areas, ice habitats and time periods that still need to be sampled. Thus any further sampling will be a result of the analysis in FY 1979. In addition, censusing proposed will be conducted in lease areas in order to obtain more information.

Information obtained as part of R.U. 3/4 demonstrates the importance of cover to birds breeding on barrier islands. Cover will be increased on certain islands in 1978 and 1979. These islands will need to be censused in future years to determine the effect of the cover.

Office work after FY 1979 will include the completion of the reports on each of the seas where sea ice is present. The species accounts started in FY 1979 will also be completed. The micro-computer data input system developed in FY 1977 and FY 1978 will be developed into a data output system in FY 1979. This will be done after purchasing a printer plotter and developing a program which will compute densities from the data entered into the 033 format. These densities can then be correlated with the ice, oceanographic and geographic factors. Maps showing densities will also be produced. The development of such a system will benefit not only R.U. 195 but will provide OCSEAP with the capability of fast processing of pelagic bird information with minimum turnaround time. Such a capability will be of great use to future work since the amount of office time spent analyzing cruises will be minimized.

Future work will also center on specific lease areas where more information is needed prior to a lease sale. Sampling will be done on a pre-determined grid that will provide maximum information. Cruises in the past have usually covered too broad a geographic area to provide such information.

XVI. Standard Agreements

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to tec-nical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

File Type 033

Ship and Aircraft Census

Common to all records
- File Type
- File Identifier
- Record Type
- Station Number

Record Type 1 - Location
- Latitude/Longitude
- Year/Month/Day
- Hour/Minute
- Latitude/Longitude
- Elapsed Time/Time Zone
- Speed Made Good/Course Made Good
- Height Above Sea
- Platform Type Code
- Sampling Technique Code
- Ship Activity Code
- Photos Taken
- Width of Transect
- Angle of View Code
- Observation Conditions Code
- Distance Made Good
- Watch Type Code
- Transect Width

Record Type 2 - Environmental
- Depth to Bottom
- Depth of Thermocline
- Surface Temperature/Salinity
- Dry Bulb Temperature/Wet Bulb
- Relative Humidity
- Barometric Pressure
- Barometric Trend
- Wind Direction/Speed
- Sea State
- Swell Direction/Height
- Weather
- Cloud Type/Amount
- Water Color
- Visibility
- Sun Direction/Glare Intensity Codes
- Glare Area Code
- Light Level
- Moon Phase Code
- Tide Height Code
- Rising or Falling Tide
- Distance to nearest Shoreline/Shelf Break
- SECCHI Depth
- Debris Code
- Effects of Weather/Light

Record Type 3 - Ice
- Ice in Transect/Ouside Transect
- Visible Open Water
- Type of Opening/Distance to Codes
- Visible Ice
- Misc./Other Features
- Ice in/Outside Transect
- Ship in Water
- Width of Lead
- Distance of Ship from Edge of Lead or
- Polynya
- Time of Ice Conditions
- Percent Water Versus Land Covered
- Size of Ponds
- Description of Open Water Ice
- Sequence Number

Record Type 4 - Text
- Text
- Sequence

Record Type 5 - Data
- Time
- Taxonomic Code
- Sub Species/Species Group
- Age Class Group/Sex Codes
- Color Phase/Plumage/Molt Codes
- Number of Individuals
- Counting Method Code
- Reliability Code
- Dist. Measurement Type Code
- Distance from observation platform to birds
- Direction of Flight
- Association Code
- Linkage for Multispecies
- Number of Species Participating
- Behavior/Special Marks/Bird Condition Codes
- Food Source Assoc. Code
- Taxonomic Code for Food Species
- Debris/Oil Code
- Distance from Nearest Breeding Colony
- Habitat Code
- Sequence Number
- Substrate/Cover/Outside Zone Codes

DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Bird stomach contents	Floppy discs	1,000 stomachs		Yes	June '75 to August'78	June 1979
Pelagic bird	"	500 stations	033	Yes	FY 1979	One month after cruise

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date

RU # 196 PI: George J. Divoky

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
Completion of field work at Barrow	0														
Analysis of 1978 Cooper Island data	0														
Analysis and mapping of 1978 cruise	---	---	--0												
Development of programs to analyze 033	---	---	---	-----	-0										
Submission of annual report							0								
Computer analysis of all cruises					---	---	---	---	---	---	---	---	-0		
Submission of bird stomach contents data to NODC							0								

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION Pt. Reyes Bird Obs. PRINCIPAL INVESTIGATOR George J. Divoky

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.
   Cruises planned only in areas where OCSEAP requires information prior to leasing.

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)
   Observations of birds are made when the ship is steaming in daylight. Birds collected from small boat when on station.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)
   28

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?
   I can piggyback.
   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.
   4 hours per day; must be in daylight.

6. What equipment and personnel would you expect the ship to provide?
   Small boats and operating personnel.

7. What is the approximate weight and volume of equipment you will bring?
   300 lbs., 21 cu. ft.

8. Will your data or equipment require special handling? No If yes, please describe.

9. Will you require any gases and/or chemicals? No If yes they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge.

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10. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying. No

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11. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability?

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12. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals. Two

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B. AIRCRAFT SUPPORT - FIXED WING

1. Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)
Barrow to Cooper Is.
Prudhoe Bay to barrier islands to east.

2. Describe types of observations to be made.
To observe nesting populations and manipulate nesting cover.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)
June and July

4. How many days of flight operations are required and how many flight hours per day? 10 days 3/day

Total flight hours? 30 hours

5. Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback?
Anyone else needing to go to a barrier island could go.

6. What types of special equipment are required for the aircraft (non carry-on)?
None
What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.

7. What are the weights, dimensions and power requirements of carry-on equipment?
None

8. What type of aircraft is best suited for the purpose?
Cessna 180 or single otter.

9. Do you recommend a source for the aircraft? Yes
If "yes", please name the source and the reason for your recommendation. NARL

10. What is the per hour charter cost of the aircraft?
Cessna 180 $85/hour
Single Otter $150/hour

11. How many people are required on board for each flight (exclusive of flight crew)?
Two

12. Where do you recommend that flights be staged from?
Barrow and Prudhoe Bay

C. AIRCRAFT SUPPORT - HELICOPTER

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed). Helicopter flights will only be needed if no fixed wing is available. Requirements will be the same as for fixed wing.

2. Describe types of observations to be made.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

4. How many days of helicopter operations are required and how many flight hours per day?

   Total flight hours?

5. How many people are required on board for each flight (exclusive of the pilot)?

6. What are the weights and dimensions of equipment or supplies to be transported?

7. What type of helicopter do you reommend for your operations and why?

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

9. What is the per hour charter cost of the helicopter?

10. Where do you reommend that flights be staged from?

11. Will special navigation and communications be required?

D. QUARTERS AND SUBSISTENCE SUPPORT

1. What are your requirements for quarters and subsistence in the field area? (These requirements should be broken down by (a) location, (b) calendar period, (c) number of personnel per day and total man days per period).

Location	Period	Total man days
Barrow	June, July, August	20
Cooper Island	"	20
Prudhoe Bay	"	20

2. Do you recommend a particular source for this support? If "yes", please name the source and the reason for your recommendation.

   NARL facilities and support while at Barrow.

3. What is your estimated per man day cost for this support at each location?

   Barrow - $84, Cooper Island - $15, Prudhoe Bay - $80.

   How did you derive this figure, i.e., what portion represents quarters and what portion represents subsistence and is the figure based on established commercial rates at the location or on estimated costs to establish and maintain a field camp?

E. SPECIAL LOGISTICS PROBLEMS

1. What special logistics problems do you anticipate under your proposal and how do you propose that the problems be solved? (Provide cost estimates and indicate whether you propose handling the problems yourself or whether you must depend on NOAA to solve them for you?

1979 Proposal
R.U. 204

TITLE: Offshore permafrost studies, Beaufort Sea

PRINCIPAL INVESTIGATOR: David M. Hopkins

TOTAL COST OF PROPOSAL:	OCSEAP		$ 42,076
	NOAA-provided logistics		2,400
	U.S. Geological Survey		21,145
		Total	$ 66,621

(All work will be conducted in Beaufort Lease Area)

INSTITUTION AND DEPARTMENT: U.S. Geological Survey, Branch of Alaskan Geology

DATE OF PROPOSAL: June 29, 1978

REQUIRED SIGNATURES:

Principal Investigator David M. Hopkins

Name David M. Hopkins Date June 29, 1978

Address 345 Middlefield Road, Menlo Park, CA 94025

Telephone FTS 467-2659

Required Organization Approval

Name A. Thomas Ovenshine James G Smith (Acting Chief, Branch of Alaskan Geology)

Address 345 Middlefield Road, Menlo Park, CA 94025

Telephone FTS 467-2231

Organization Financial Officer

Barbara L Keville

Name Elwood H. Like for

Address Office of Mineral Resources, U.S. Geological Survey,
National Center, Mail Stop 913, 12201 Sunrise Valley Drive,
Reston, VA 22092

Telephone FTS 928-6572

TECHNICAL PROPOSAL

I. Title: Offshore permafrost studies, Beaufort Sea
Research Unit: 204
Proposed Dates: October 1, 1978-September 30, 1979

II. Principal Investigator: D. M. Hopkins

III. Cost of Proposal for Federal Fiscal Year

A.	Science	$ 42,076
B.	Logistics	none
C.	Total	$ 42,076
D.	NOAA-provided logistics	[2,400]
E.	USGS Contribution	[21,145]
F.	Grand total	[$ 66,621]
G.	Distribution of Effort:	Beaufort Sea: 100%

IV. Background

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

IV. Background (cont.)

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 augur, 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 during the past few thousand years downcurrent from the present-day rivers.

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:

IV. Background (cont.)

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 flood plains 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, impermeable 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, sealing the gravel from further interchange with sea water.

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 across the Beaufort shelf 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.

IV. Background (cont.)

The Conservation Division of the Geological Survey now intends to undertake a series of 22 boreholes to be scattered over the entire lease area. Drilling will be done by a contractor, and the objective will be to collect geotechnical information, appraise the availability of gravel resources, and determine the depth to and temperatures of bonded permafrost. Osterkamp and Harrison (R.U. 253) will undertake geothermal logging, Chamberlain (R.U. 105) will undertake pore-water salinity measurements, and Hopkins and Hartz (this proposal) will do lithologic logging, all with joint USGS-OCSEAP support. The new drilling program will provide an opportunity to test the model put forth above and thus will lead to development of a regional and predictive knowledge of the distribution of permafrost on the Beaufort Sea shelf.

V. Objectives

1. Log and sample a series of shallow boreholes on the continental shelf within the Beaufort Sea lease area.

2. Determine geochronology of the sequence of sediments recovered from the boreholes, using radiocarbon, amino-acid racemization, and paleontological determinations and geological correlations.

3. Complete reports on 1976 and 1977 boreholes.

4. On the basis of this data and data from the coastal geologic studies (R.U. 473), determine history of sea level, lateral migration of shoreline, and other paleogeographic parameters for the Beaufort Sea lease area during the past 120,000 years.

5. From these data, develop a model to explain and predict the distribution of shallow and deep permafrost on the Beaufort Sea shelf.

Relevance:

Industry planners persistently underestimate the seriousness of the hazards and problems that may be introduced by shallow offshore permafrost. They have no independent knowledge of the distribution and character of offshore permafrost, but assume conditions quite different from those that we have found. By default, it is the responsibility of the Federal Government to learn enough about offshore permafrost conditions so that proper and appropriate site-specific testing procedures can be required of lease holders where they are needed.

Permafrost potentially represents a serious hazard to drilling platforms and buried pipelines on the continental shelf. OCSEAP investigators have found ice-bonded permafrost at depths of less than 10 m below the sea bottom. In some places the lower part of the overconsolidated clay is ice-bearing and may be ice-rich. In these sites, serious thawing and subsidence could result from placement of a pipeline.

Relevance: (cont.)

Although gravel is widely available on the shelf, it is ice-bonded in many areas. The presence of ice-bonding will affect choice of excavation methods, excavation costs, and configuration of the finished excavation--or possibly it will result in a decision to haul gravel from a more remote site. Removal of the covering overconsolidated clay may permit salt water to enter the more permeable frozen gravel and lead to rapid thawing and subsidence in the vicinity of a dredge excavation. All of these are reasons why it is important to know about the distribution and state of shallow permafrost.

Experience gained during the past 3 years by R.U. 105, R.U. 204, and R.U. 253 has shown that recognition of ice-bonded permafrost is difficult, and requires a combination of physical observation of recovered core, geothermal measurements of stabilized in-hole temperatures, and measurement of pore-water salinities. Consequently, it is very important that the contract drillers be backed up by scientifically oriented core-loggers, geothermal geophysicists, and sediment geochemists.

VI. General Strategy and Approach

Hopkins and Hartz will participate in offshore permafrost drilling planned for spring, 1979, and will provide lithologic logs which will be made available to Conservation Division of U.S.G.S., NOAA, and BLM no later than September 30, 1979. The upper 10 meters of sediment has proven to be critical for gaining an insight into submergence and thermal history, and these intervals will be cored continuously and sampled at close intervals. Samples from selected holes will be examined for their micropaleontological content, and samples from the remaining holes will be archived until needed. All woody horizons will be sampled for radiocarbon dating and mollusks from selected holes will be submitted for amino-acid racemization study. All cores will be radiographed. Gravel-sized constituents of the surficial marine sediments and samples of the deeper gravel will be scanned for occurrence of ice-rafted pebbles of Canadian origin. These studies will lead to development of a chronological submergence history and an understanding of the physiographic and paleoclimatic history of the lease area.

Meanwhile, analytical work is far advanced but not complete for the four boreholes completed during 1977. The autumn and winter of 1978-79 will be devoted to completing study and analysis of samples from these boreholes.

Data from the 1976, 1977, and 1979 boreholes will be combined to delineate and date paleoshorelines and paleodrainage and as a method of predicting the distribution of shallow and deep ice-rich permafrost. A preliminary report on the distribution of shallow- and deep-permafrost areas will be prepared no later than October 15, 1979, so that it can be used in planning the Beaufort Sea lease sale.

VII. Sampling Methods

According to U.S.G.S. Conservation Division plans, 22 boreholes will be scattered as uniformly over the Beaufort Sea lease area as ice conditions and social and wildlife factors permit. We will urge the Conservation Division managers to place some holes in former sea valleys and others in ancient upland areas presumed to be underlain by shallow permafrost. Past experience indicates, however, that detailed location of holes will be largely determined by ice conditions and logistic factors. Five boreholes are intended to reach depths of 90 m and the rest are intended to reach depths of 30 m. The surficial fine-grained section is to be cored continuously and the gravel section is to be cored at 3-m intervals. Samples will be divided in the field to provide splits for geotechnical studies by the contractor, pore-water-salinity measurements by CRREL, and lithologic-stratigraphic studies by our research group (R.U. 204).

VIII. Analytical Methods

Identification of counts of foraminiferal and ostracode populations will be based on 100-gram samples. Pollen from selected boreholes may be identified in standard 2-gram samples taken at 25- or 30-m intervals. Selected samples will be washed for concentration of seed, insect, mollusk, and other remains, and selected samples will be submitted for radiocarbon- and amino-acid-racemization analysis. Pebble counts will be made for samples in which exotic pebbles occur in order to establish ratio of ice-rafted to local Brooks Range pebble types.

IX. Deliverable Products

A. No digital data.

B. Narrative Reports

Interpretive report on geologic history of lease area during the last 125,000 years and its significance for prediction of distribution of shallow and deep offshore permafrost. Report will deal with local sea-level history and will present a model of thermal history of ground-air interface at selected borehole sites.

C. Visual Data

1. Graphic logs for 1979 boreholes.

2. Graphic log and identification chart listing and interpreting marine microfauna and pollen from selected boreholes.

3. Map and cross-sections showing location of filled sea-valleys and probable areas of deep permafrost.

4. No other non-digital data.

X. Quality Assurance Plan

1. Not applicable.

2. Cores will be visually examined and described in the field. Short core segments will then be sealed in twist-top sample sacks and large ones will be wrapped in saran-wrap and then placed in split polyvinyl core-tubes wound in filament tape. They will be kept in cool, humid storage in the field and in Menlo Park (at approximate temperature of 5° C) until needed for further study.

3. Samples will be radiographed within 2 months after arrival in Menlo Park. Foram and ostracode studies will consist of species counts based upon total population remaining on a .0625-mm screen concentrate of a standard 100-g sample. Pollen, radiocarbon, and amino-acid studies will employ standard techniques.

4. Not applicable.

XI. Special Sample and Voucher Specimen Archival Plans

As much as 100 meters of unused core segments may remain after principal studies have been completed under this program. They will be held in Geological Survey facilities in Menlo Park for 5 years and then must be either archived in another facility or discarded. Shelf space would be needed; the value of the cores would be enhanced if they can be kept in a cool, humid environment.

Mollusks, foraminifera, ostracodes, and pollen specimens concentrated for study will be permanently archived in the Geological Survey facilities at Menlo Park, Denver, or Seattle, Washington.

XII. Logistics Requirements

INSTITUTION U.S. Geological Survey
Branch of Alaskan Geology
Menlo Park, CA 94025

PRINCIPAL INVESTIGATOR D. M. Hopkins

A. SHIP SUPPORT	None
B. AIRCRAFT SUPPORT--FIXED WING	None
C. AIRCRAFT SUPPORT--HELICOPTER	

1. We will need to be assisted by several round trips to transport personnel and equipment from logistics base at Prudhoe Bay to drill sites and to transport personnel, equipment, and samples from drill sites to Prudhoe Bay. Timing is tentatively set for Feb. 1-April 1, 1979, but may slip back to March 1-May 1.

   These trips can be shared with other OCSEAP projects cooperating in offshore drilling.

XII. Logistics Requirements (cont.)

C. AIRCRAFT SUPPORT--HELICOPTER (cont.)

2. No observations

3. Not applicable

4. Between four and eight round trips from Prudhoe Bay to drill sites within the lease area. Flight time will range from 20 to 120 minutes for round trip. Flights can be shared with other OCSEAP participants.

5. One or two individuals

6. Up to 100 kg of samples and 20 kg of equipment. Largest dimension: 2-m polyvinyl core tubes.

7. Bell 204 or equivalent

8. NOAA or ERA Helicopters

9. $350

10. Prudhoe Bay.

D. SUBSISTENCE

1. We need quarters during staging, demobilization, and R & R periods at Prudhoe Bay, at various times during the drilling period (between 2/1/70 and 5/1/79).

   There will be one or two men, 1 or 2 days at a time, for a total of about 10 man-days.

2. NANA hotel, because OCSEAP has a contract there.

3. $100/day which is, I believe, the commercial rate.

XIII. Anticipated Problems and Contingency Plans

Conservation Division's plan to complete 22 boreholes scattered uniformly over the lease area within a 6-week period seems very ambitious and perhaps unrealistic. Furthermore, ice conditions will govern the locations in which holes can be placed, so that some hoped-for sites may not be occupied. The difficulties will increase with progressive increase in distance from shore. Also, it will be disadvantageous if drilling is not allowed during April, because the ice is thicker then, the days are longer, and the weather is much less severe. It will be extremely short-sighted to attempt to protect the sea mammals from the noise of this shallow core-drilling and thus enhance the danger of major spills at a later time because inadequate hazard data has been gathered.

XIII. Anticipated Problems and Contingency Plans (cont.)

In spite of these problems, this well-funded effort seems certain to result in a number of new boreholes with a much broader geographic coverage than has been possible during the 1976 and 1977 seasons.

If this ambitious plan is to be completed, two or more drill rigs will probably be functioning simultaneously. Hopkins and Hartz can easily cover two rigs. If a third is active, a third geologist, perhaps R. E. Nelson, will have to be added. This will result in unexpected costs for salary, travel, and subsistence which would have to be accommodated by curtailing some other part of the program of either R.U. 204 or R.U. 473.

XIV. Information needed from other investigators

It will be essential to pool the lithologic-stratigraphic information, the geothermal data, and the pore-water salinity data. I am in constant and frequent communication with the P.I.'s of R.U. 105 and R.U. 253. We telephone each other, meet at least once a year (more often twice or three times), and exchange quarterly and annual reports. I have budgeted trips to Anchorage and Hanover in order to continue these meetings.

XV. Management Plan

Management of the project is the responsibility of the Principal Investigator and the administrators of the Geological Survey. The Principal Investigator will lead and supervise the proposed work.

Activity/Milestone/Data Management Chart is given on the following page.

XVI. Outlook

Drilling will be completed in spring, 1979, and no further fieldwork is contemplated. No additional equipment will be required, and no further logistic requirements are anticipated after spring, 1979.

Preliminary logs and permafrost maps necessary for the Beaufort Sea lease sale will require about 6 months work and will be ready in late September or early October, prior to the lease sale.

Analytical work on the cores will consume about 15 months after drilling is completed and should be finished on approximately June 30, 1979.

Writing and final reporting will require about 30 months after drilling is completed and should be finished on approximately September 30, 1981. The final report will include drill logs, cross sections, a permafrost map, results and interpretation of paleontological and geochronological studies, and a general discussion of paleogeographic and paleoclimatic factors governing distribution of permafrost on the central Beaufort

MILESTONE CHART

O - Planned Completion Date

X - Actual Completion Date

RU # 204 PI: D.M. Hopkins

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

MAJOR MILESTONES	1978			1979																
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
Analysis of radiocarbon spls, 1977 holes	- -	- -	- -	- - -	- - -	- -	-	- - -	- O											
Prepare for 1979 drilling			- -	- - -	O															
Participate in On-Ice drilling					—	- -	- - O													
Prepare preliminary logs and cross-sections							- -	- -	- - -	- -	- -	- - O								
Prepare preliminary permafrost map									- -	- -	- -	- -	- O							
Process cores for paleo+ geochronology									- -	- -	- -	- -	- -	- -	- O					
Analysis of foraminifera													—	- -	- -	- -	- O			
Ostracode analysis													- -	- -	- -	- -	- O			
Radiocarbon dating													- -	- -	- -	-	- -	- -	- -	- -
Amino-Acid analyses													—	- -	- -	-	- -	- -	- -	- -
Write Final Report																- -	- -	- -	- -	- -

XVI. Outlook (cont.)

Sea shelf. The report may take the form of several short articles and journal reports.

Costs:		
	FY 1980	$40,000
	FY 1981	$40,000

XVII. 1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

XVII. 9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

Arctic Project Office
506 Elvey Building
Geophysical Institute
Uiversity of Alaska
Fairbanks, AK 99701

Proposal date: June 20, 1978
Contract #: RK6-6074

FY 1979 RENEWAL PROPOSAL

Research Unit Number 205

TITLE: Geologic Environment of the Beaufort Sea Shelf and Coastal Regions

Cost of Proposal: $80,000   Lease Areas: Beaufort Sea 100%

Period of Proposal: October 1, 1978 through September 30, 1979

Required Signatures:.

Principal Investigators: Peter Barnes and Erk Reimnitz

Name____________________ Name____________________

Pacific Arctic Branch of Marine Geology
U.S. Geological Survey
345 Middlefield Road, Menlo Park, CA 94025

Telephone: (415) 323-8111 (Extension 2114,1695)

Required Organization Approval

Name____________________ Date________________

345 Middlefield Road, Menlo Park, CA94025

Organizational Financial Officer

Name____________________ Date________________

TECHNICAL PROPOSAL

I. Title: Geologic Environment of the Beaufort Sea shelf and Coastal Regions

II. Principal Investigators: Peter Barnes, PhD. - Research Geologist
Erk Reimnitz, PhD. - Research Geologist

III. Cost of Proposal for FY 1979

A. Science	\$80,000.
B. P.I. Provided Logistics	-0-
C. Total	\$80,000.
D. Distribution of Effort in Lease Area: 100% Beaufort Sea	

IV. Background:

This project has studied the geology of the arctic shelf environment, where ice plays a dominant role. Using sediment profiling, core sampling, diving, underwater TV and photography, thermoprobes, oceanographic sensors and remote sensing, the effect of ice on sediments, bathymetry, heat transfer, river discharge and sediment transport have been investigated. This resulted in a significant advance in the understanding of the marine geologic environment of the arctic

Because offshore development is likely to be limited to the ice zone inshore of the stamukhi, our studies emphasized this region (0-30 m) although interest in the outer shelf for utilization will necessitate consideration of this area in the near future. To date we have learned a great deal about the dominating influence of ice on the geologic environment. The overall character and development of the sea-ice regime on the shelf is apparently controlled by the morphology of the coast and sea bed. The process and rates of gouging inside the stamukhi are reasonably understood, however, the seasonal distribution of events is unknown. Our understanding of sediment thickness and distribution is only crudely known. Our seismic records have shown at least two features which may be hazards; unexplained hyperbolic reflectors and acoustic anomalies which may be related to ice or gas in near surface sediments. Delta front processes have addressed the interaction of rivers and the coastal zone with only a partial understanding of the stability and potential hazards in this environment. Results from summer suspended sediment studies along with near bottom current measurements has helped define transport vectors along the coast in summer, although rates, composition and seasonality are poorly understood. Morphologic features on the inner part of the shelf are very dynamic. Shoals, coastlines and islands are changing, although the rates, volumes and timing of change are poorly understood. In most aspects of our studies we have found it to our advantage to relate to other projects including: Hopkins ;(473), Osterkamp and Harrison (253) Rogers (271) Aagaard (91), Naidu (52k9), Shapiro (250), Weeks (88), Stringer (257), Carey (6), Broad (356), and Hufford (48).

In our work to date each new data gathering and analysis effort has brought to light areas where further research is needed to define a hazard or to understand a process. The proposed work is primarily a result of questions rasied by our earlier work. We anticipate that this year's field effort will be no different and new problems will be delineated which need to be assessed. The proposed work expands or builds on earlier studies either by extending the geographic area in which we presently have data or elucidates on a specific data set which has brought a potential problem to our attention. Proposed research of the first type includes our ice gouge studies, the delineation of the "boulder patch", and the sediment transport investigations. Our work on sediment gasses, fault delineation and the investigation of fast ice turbidity are studies of the second type.

V. Objectives

1) Our studies of ice gouging as a potentially hazardous process will be continued. A longer time base for evaluating the repetitive rate of ice gouging in different environments and relating this data to ice conditions is desirable. We also need to expand this base geographically eastward and westward to cover more of the lease area. Further attempts will also be made to extend our studies offshore through the stamukhi zone where the most intense ice gouge events are expected.

2) An understanding of the shelf sediment transport regime, including ice rafting, river effluents, and bottom reworking by ice and benthos is needed to evaluate the impact of offshore development on the environment.

3) Seismic anomalies in reflection records remain a real potential hazard for offshore construction as their causes are still not understood. This summer's fieldwork may shed some light on the problem, but a systematic mapping effort should be undertaken.

4) The "boulder patch" is a unique area of the sea floor where rich fauna and flora thrive. As protecton of the area from certain kinds of development is contemplated, we propose to clearly define the extent and boundaries of this feature.

5) A fault that has been active during the last 12,000 years has been found between Prudhoe Bay and Cross Island. Knowledge of the extent of this fault and of the kind of movement that occurred there is necessary.

6) Knowledge of the stamukhi zone, including processes of ice/bottom interaction with shoals, and the origin and stability of the stamukhi shoals will lead to an understanding of ice zonation on the shelf.

7) Evaluation of coastline and barrier island stability as related to marine and thermal processes, sediment sources and transport, and man's construction of causeways, artificial islands, and ice pads as drill bases.

8) To delineate in detail the configuration of a pronounced subbottom reflector cropping out on the shelf landward of Stamukhi- and Cat Shoals. Trackline coverage off Oliktok is inadequate to trace this reflector into Harrison Bay. Knowledge of the nature and configuration of this reflector will contribute to an understanding of the surficial geology of the shelf, important for studies of permafrost, foundation design, and gravel resources.

9) Continuation of data reduction and preparation of reports. We anticipate that some shifts in study emphasis will result as further knowledge from our and other projects becomes available.

VI. General Strategy and Approach

The methods of study will be discussed following the sequence of objectives listed above.

1) The test lines established in 1973, and a new one established off Cape Halkett in 1977 will be re-surveyed for newly formed gouges. Attempts will be made to establish still another line east of Prudhoe Bay in 1978, and to monitor this new line along with the others. We will also do detailed studies of internal sedimetary structures on several specific gouges using SCUBA diving in order to learn more about the physical process of gouging.

2) The ice-free conditions of 1977 and large wave regime lead to the formation of a considerable thickness of turbid fast ice by inclusion of suspended matter. Many cores of turbid ice were taken over a wide area during May 1978, and these will be analyzed. We also propose to use bottom drifters to monitor bottom sediment transport, as we have monitored surface water transport by surface drifters.

3) Existing seismic reflection records would be used to map seismic anomalies within the lease sale area, and these maps would serve to show gaps to be filled during the summer of 1979 with additionaal tracklines. Mapping the anomalies in itself may lead to some insights regarding their nature and causes.

4) As discussed in our diving report on the "boulder patch", side-scanning sonar is not a tool suited for delineating the extent of the boulders, probably because of the masking effect of marine growth in the area. The Simrad Skipper Sounder, however, reveals the occurrence of marine growth by a "mushy" appearance of the bottom reflector. This would be used as a tool to define the limits of boulders.

5) The Raytheon RTT 1000 subbottom records will be obtained along the east-west extensions of the known fault trace. If geologic conditions are favorable somewhere along the fault to obtain a better estimate of its age, we would use suitable techniques to attempt this.

6) Landsat and Seasat images would be studied for the formation of distinct ice features over known shoals, and for evidence of still unknown shoals within the stamukhi zone. The R/V Karluk will be used for bathymetric and seismic surveys on key shoals, and for sampling and diving support on such shoals.

7) We will continue to monitor changes in coastal configuration and water depth that may be related to man's activity, such as construction of the new causeway. This monitoring is done in part by re-running precisely controlled bathymetric surveys around such structures. The chain of islands bordering Simpson Lagoon experience longshore transport to the west, a process that should deplete the first one of sediment, and extend the last one (Spy Island) or build up the sea floor around it. We plan to study volume changes around this island by comparative bathymetry (25 yr. interval since the first survey) to help understand the sediment source problem for the barrier islands. A similar approach will be used on other site-specific studies, in order that we may gain knowledge on the stability of sea-floor and shoreline morphology.

8) Several additioal seismic reflection profiles in eastern Harrison Bay should serve to fill the gap in our knowledge of the configuration of the outcrop, and grab samples from the zone of outcrops will be collected to identify the nature of the outcropping unit.

VII. Sampling Methods:

Temporal and spacial sampling scheme will be dictated by field conditions of ice and logistics capabilities Sample locations will also be delineated on the basis of the analysis of previously obtained data and records and on data yet to be gathered in FY 78. Sampling locations will often be determined on the basis of real time profiling, side-scan sonar, SCUBA, TV or other on-site observation tools. In general, our sampling transects have run perpendicular to the coast. The broad scope of this project requires a varied sampling effort. This includes:

Towed temperature, salinity, transmissivity sensors
High-resolution seismic equipment
Side-scan sonar
Precision fathometer
Precision navigation system
SCUBA techniques
Hand corers
Grab samplers
Bottom-plow and strength measuring tools

VIII. Analytical Methods:

Sample analysis and data reduction will generally follow techniques previously used in the study area or which will have general acceptance.

These are explained in: Barnes, P., Reimnitz, E., 1974, Sedimentary processes on arctic shelves of northern coast of Alaska, in Proceedings of the Arctic Institute of North America Symposium on Beaufort Sea Coast and Shelf Research, Arlington, VA., Arctic Inst. No. Am. p. 301-353.

Reimnitz, E., and Barnes, P., 1974, Sea ice as a geologic agent on the Beaufort Sea shelf of Alaska, ibid, p. 439-467.

Barnes, P., Reimnitz, E., Drake, D., Toimil, L., 1977, Miscellaneous hydrologic and geologic observations on the inner Beaufort Sea Shelf, Alaska, U.S. Geol. Survey Open-file Report 77-477, 82p. IX.

IX. Deliverable Products:

A. Digital Data: none

B. Narrative Reports:

Reports describing survey and sampling techniques, analytical and interpretive methods and summarizing the nature and comprehension of Beaufort shelf geologic environment as it might interact with proposed offshore development. These would be in the form of U.S. Geological Survey Open-file reports and journal articles. These reports will include: a) discussions of ice gouge distributon and evaluation of ice hazards, b) discussions of the sedimentary processes on an ice-covered shelf, including the shelf sediment transport regime in the form of ice rafting, bottom reworking and resuspension by ice and benthos, for assessing the dispersal of pollutants. c) Reports on unique sedimentary environments such as gas-charged sediments, the "boulder patch" and nearsurface faults.

C. Visual Data:

Maps and graphs displaying tracklines, ice gouging, the "boulder patch", and other items warranting visual display.

D. Other Non-digital Data:

Microfilm of seismic and side-scan data to NGSDC.

E. Data submission schedule;

Field sampling reports will be submitted within four weeks after the termination of the sampling efforts, outlining the data gathered, field party, station and trackline location and description of accomplishments.

Additional data from analysis and reduction of records and samples will be presented in the quarterly and annual reports.

X. Quality Assurance ns:

The data gathered under this project will be compared and calibrated either against standard physical measurements (as in the case of the navigation systems and fathometers) or against laboratory instruments at Menlo Park (as in the case of temperature and salinity). Whenever the opportunity arises, intercomparison of our instruments will occur in the field with other OCSEAP investigators.

XI. Special Sample and Voucher Specimen Archival Plans:

Samples and data collected that should be kept for future reference will be archived and microfilmed and split cores/samples/filters, will be stored in Menlo Park by the U.S. Geological Survey.

XII. Logistics requirements:

The R/V Karluk and operating personnel will be provided by the U.S. Geological Survey. Other required logistics support is detailed on the attached forms.

LOGISTICS REQUIREMENTS

Research Unit 205, Fiscal Year 1979

A. Ship support.

The operating expenses of the USGS R/V KARLUK are detailed under the ship budget section of the integrated proposal.

B. Aircraft support - Fixed Wing

1,2,3, & 4) Flights in the vicinity of Prudhoe Bay and along the coast as far as Cape Halkett on the west and Flaxman Island on the east. The flights would be to service navigation beacons, for ice observations for KARLUK operations, and other additional logistics support requirements. We would estimate approximatly one flight per week of two hours duration during the 8 weeks that the KARLUK is operating in the Beaufort Sea. Total flight hours - 26.

5) Yes

6) N/A

7) Two lead acid automobile batteries are needed to service the navigation sites. The navigation beacons themselves are less than 20 pounds.

8) Depending on the landing sites avaialble, tundra tires or floats would be needed. A Cessna 206 with floats would be ideal, although in many cases a super-cub would be adequate.

9) Jim Helmericks — Proven ability, reasonable cost, familiar with our operation.

10) Unknown at present time - estimate $90 -$120 per hour.

11) One

12) Primarily from Prudhoe Bay.

C. Aircraft Support - Helicopter

1,2,3, & 4) Flights in the vicinity of Prudhoe Bay and along the coast as far west as Cape Halkett and as far east as Flaxman Island. The flights will be to service navigation sites and provide additional support logistics for the KARLUK as required. We estimate approximately one flight per week of two-hour duration during the 8 weeks that the KARLUK is operating in the Beaufort Sea - total flight hours - 16.

5) One

6) Two lead acid automobile batteries are needed to service the navigaton sites along with occasional propane bottles - #150 and thermogenerators, #40.

7) Bell Jet Ranger on floats cheapest for weight and flight range proposed.

8) No

9) Estimate $400

10) Prudhoe Bay

11) Communication with R/V KARLUK will be needed.

D. Quarters and subsistance support

1)Prudhoe Bay, 1979

Early July, 1979 KARLUK mobilization	4 men - 3 days
Mid July - mid August, coastline observations and navigation support	1 man - 60 days
Mid august - KARLUK crew transfer	3 men - 2 days
Mid September - KARLUK demobilization	4 men - 3 days
TOTAL	90 man days

2) No

3) $100-150/day based on per diem and commercial rates.

E. Special Logistics Problems

None are anticipated.

XIII. Contingency Plan

If the KARLUK is unavailable for a field effort in the summer of 1979, it is anticipated that no field effort would be undertaken. Rather, the laboratory and office effort would be intensified on those objectives not requiring extensive additional field data.

XIV. Information Required from Other Investigators:

Results from studies of permafrost, hydrographic and current meter measurements, barrier island and ice dynamics studies will greatly improve the usefulness of the proposed work. We have and will continue to maintain open communications with the workers in these studies.

XV. Management Plan:

The principal investigators will actively lead and supervise the proposed work. Using the assistance of two full-time technicians, they will make use of the field and laboratory facilities available at the U.S. Geological Survey. Field efforts will take place in the summer of 1979. During the contract period samples and records from the FY 78 program will be thoroughly worked up to further define the areas and processes to be studied during the FY 79 field efforts. A summary of our proposed activities during the 1979 fiscal year is shown on the accompanying Activity/Milestone/Data Management chart.

XVI. Outlook

Most of the information required of us prior to the forthcoming lease sale should be in hand at the end of the period covered by this proposal. But the push seaward and still farther out on to the ice will contiue after the nearshore sale, and raise additional questions. Only some of these presently can be anticipated. Furthermore, ongoing work will point to new areas of research. Thus the new questions, plus some remaining ones will add up to a considerable amount of work to be done. Some examples follow:

1) The problem of offshore gravel resources has not been solved adequately. We anticipated that the offshore permafrost studies and our vibracoring would supply more information on shelf stratigraphy than it did, and that this information together with our seismic reflection records would allow us to delineate gravel units over wide regions of the shelf. More drilling is required as a basis for delineating this resource. The USGS Conseervation Division is preparing for a drilling operation within the lease area, and the data obtained from this could serve as a basis for further geophysical work over specific areas.

2) Ongoing research into gas in offshore sediments and into the seawater on the shelf of the Beaufort Sea is anticipated to provide data pointing to the need for site-specific studies on gas-charged sediments and gas hydrates recognizeable on seismic records, thus requiring further site-specific studies using geophysical techniques and bottom observations.

3) The problem of how the shoals of the stamukhi zone interact with the ice to control ice zonation will be critical to developing the area seaward of the first offshore lease sale. We do not have any firm ideas on how to approach this problem, only prelimiary thoughts. Lines drawn on by bulldozers of the geophysical crews operating on the shelf in winter are clearly identifiable on certain remote images, such as side-looking radar. Similar lines drawn over specific areas by suitable techniques, possible with a radar reflective liquid applied from a low flying aircraft, if monitored by remote sensing at given intervals, and redrawn after their elimination by snow drift and ice deformation, would allow a study of how the ice canopy intercts with a shoal, and how the large ridges form in contact with the bottom. This information should be supplemented by side-scan sonar work in the same area during the following smmer, to learn about the bottom interaction. We would be interested in being involved in such an undertaking in the future, but not alone. Ice researchers, and engineers with suitable instrumentation systems, should participate and perhaps lead the study. The study should also provide informaton on how future fixed platforms would behave in similar environments, and on how they might be protected. The winter from 1977 to 1978 would have been ideal for such a study, because there was no multiyear ice on the shelf during the freeze-up, and some of the shoals in May were marked by massive grounded ridges lacking multiyear ice. We are wonderng how a canopy of first-year ice, not nearly thick enough to contact the crests of the shoals, focused the major ridge building events on the shoals.

4) There is mounting evidence for bottom ice and ground ice occurring at certain times of the year in the Beaufort Sea. For example, we have found large kelp fronds, even with small attached pebbles (hold-fast), in the surface layers of the fast ice of the inner shelf during winter coring. Such kelp has never been found floating on the sea during many years of sea experience in the Beaufort Sea, suggestng that bottom ice lifted it to the surface during the early winter. Such a process would present another means of distributing future pollutants.

5) The problem of ice gouging on the outer shelf will require much work under almost impossible conditions. We have good reason to believe that modern ice gouging does not stop at 48 m water depth, as postulated by a number of workers. K. Aagaard reported 1 knot currents at 100 m depth along the shelf edge. Such currents are strong enough to transport sand-size material. Thus the gouges we see in those depth zones cannot be several thousand years old. The proposed use of submarine tankers and bottom-mounted discharge and loading facilities at the shelf edge, is still considered a viable alternative to the oil and gas transport problem. Development surely will extend beyond the stamukhi zone, and our understanding of geologic hazards in those areas is minimal. For example, seismic and fathometer records suggest the presence of large slump blocks along the shelf edge, which may require specific studies in the future.

6) Ongoing developments on the inner shelf, as the construction of a long causeway and of a large ice pad for support of offshore drilling, and of future artificial drilling islands, have their effects on the environment. We are interested in monitoring some of the anticipated changes, for what they teach about the environment, and for what one may learn about the prevention of adverse effects.

We cannot be involved in all of the remaining problems outlined here and known to us and presently do not even know enough to even assign priorities of what needs to be done first. Because we have large amounts of still undigested data in our files, it might be wise not to do field work after 1979, particularly if we can not get adequate support for new research in new directions.

XVII. Standard Statements

1. Updated Activity/Milestone/Data Management Charts will be submitted quarterly.

2. Quarterly reports will be submitted in sufficient time during the contract year to be in OCSEAP hands by the first day of January, July, and October, annual reports by April 1. The Final Report will be submitted within 90 days of the termination of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labelled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are used, and sexes where these are morphologically distinguishable.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three-month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiraton. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

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RU 205 PI: Barnes, Reimnitz

Activity/Milestone/Data Management Chart

Reporting data management and other significant contractural requirements: perioeds of field work

	1978			- 1979 -											
Major Milestones	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Field effort											x	x			
Data reduction and analysis 1978 data	x	x	x	x	x	x	x	x	x	x					
Data reduction and analysis 1979 data													x	x	x
Data input													x		
Report to OCSEAP	x			x			x			x			x		
Workshops x				x											

OTHER INFORMATION

1. The principal investigators will actively lead and supervise the proposed work and and will take full responsibility for completion of the objectives.

2. Time commitment of principal investigators:

Reimnitz - 75% ice gouging, sedimentary processes, coastal erosion, bathymetry

Barnes - 75% ice gouging, sedimentary processes, coastal erosion, oceanography, bathymetry

3. Key project personnel:

The persons listed below are presently working on the project and demonstrate the qualifications of replacements or additions as needed:

Larry Toimil - M.S. Marine Geology -6 years U.S.G.S. arctic experience, data collection on shipboard and sea ice. Extensive analysis of arctic geologic processes. Thesis on ice gouge in Chukchi Sea. Publications.

Dave McDowell - B.S. Geology, 1 year U.S.G.S. experience data analysis and collection.

Doug Maurer - B.S. Geology, 2 years U.S.G.S. experience - data analysis and data collection.

4. Phone numbers - (415) 323-8111 (To be changed around Aug. 1, 1978)

Barnes x-2114	New number	(415) 856-7008
Reimnitz x-2695		(415) 856-7004

COVER SHEET FORMAT

To: National Oceanic and Atomospheric Adm.
Outer Continental Shelf Environmental Assessment Program
Bering Sea - Gulf of Alaska Project Office
P.O. Box 1808
Juneau, Alaska 99802
Attn: Dr. Herbert Bruce

Proposal/Revision Date: 6/7/78
Contract #: 03-7-022-35128
NOAA Project #: N/A
Institution ID#: H-GEO-M-44

FY 1979 RENEWAL PROPOSAL

Research Unit Number 208

TITLE: Yukon Delta Coastal Processes Study

Cost of Proposal: $ 11,000 Lease Areas Norton Sound 100 %
(If joint proposal, show cost $11,000 %
for each institution; if more ($ 8,000 FY 79; $3,000 FY 78 carryover)
than one fiscal year, show
cost for each year - SEPARATE BUDGET SHEETS ALSO REQUIRED)

Period of Proposal: October 1, 1978 through September 30, 1979
(If proposal is for other than this period, please explain)

PRINCIPAL INVESTIGATOR(S):

Name William R. Dupre Date 6/7/78

Signature William R. Dupre'

Address Dept. of Geology, University of Houston

Telephone Number (713) 749-3710 FTS: 6/13/78

INSTITUTION (include Department, if appropriate)

Dept. of Geology, University of Houston Central Campus

REQUIRED ORGANIZATION APPROVAL:

Name Julie T. Norris Date 6/13/78

Signature Julie T. Norris

Position Dir., Ofc. of Research Adm.

Address 4800 Calhoun, Houston, Texas 77004

Telephone Number (713) 749-3412

ORGANIZATIONAL FINANCIAL OFFICER:

Name Dr. John J. Willingham Date 6/13/78

Signature John J. Willingham by Kenneth McCollum

Position Interim Controller

Address 4800 Calhoun, Houston, Tx. 77004

Telephone Number (713) 749-2222

TECHNICAL PROPOSAL

I. Title: Yukon Delta Coastal Processes Study
Research Unit Number 208
Contract Number: 03-7-022-35128
Proposed Dates of Contract: 10/1/78 - 9/30/79

II. Principal Investigator: William R. Duprè

III. Cost of Proposal for F.Y. 79:

A. Science: 11,000
B. P.I. provided logistics: 0
C. Total: $8,000 (FY 79) and $3,000 (FY 78 carryover)
D. Distribution of Effort by Lease Area: Norton Sound (100%)

IV. Background

The combined Yukon-Kuskokwim delta complex is an area of unique natural resources covering over 31,000 square miles. It has a large native population living in large part on a subsistence economy. It provides access to most of the spawning areas for salmon in the region. It is, in addition, one of the most significant breeding grounds for migratory birds in North America. Probably no other area of similar size is as critical to so many species of water fowl as is the delta region.

The Yukon River is the 17th largest river in the world (Lisitzin, 1972), providing over 90% of the sediment introduced into the Bering Sea. Its freshwater discharge is sufficient to noticeably dilute the salinity of the Alaska current. Yet for all its importance, relatively little is known of the Quaternary history of the region.

The ancestral Yukon River emptied into the Pacific in the vicinity of Cook Inlet during the early Cenozoic. Late Miocene uplift of the Alaska Range resulted in the diversion of the drainage system into the

Bering Sea, where it has remained to the present (Nelson et al., 1974). Gradual submergence during the late Miocene and Pliocene was followed during the Pleistocene by repeated glacioeustatic fluctuations of sea-level. Glacial intervals were characterized by emergence of the shallow Bering Sea. During this time the major rivers, including the Yukon and the Kuskokwim, emptied near the heads of major submarine canyons at the shelf edge (e.g., Scholl, Buffington et al., 1970; Hopkins, 1972). River valleys cut into the exposed continental shelf were filled during the most recent rise in sea level with estuarine and marine sediments (e.g., Moore, 1964; Creager & McManus, 1967; Knebel and Creager, 1973). This was apparently accompanied by a general northward shift of the Yukon River to the north (Knebel & Creager, 1973; Shepard and Wanless, 1971).

Geologic mapping in the delta region (e.g., Hoare, 1961; Hoare and Coorad, 1959a, 1959b; Hoare and Condon, 1966, 1968, 1971a, 1971b) has been largely concerned with defining the pre-Quaternary history of the region. Much work has been done on studying the Cenozoic sedimentary and tectonic history of the Bering Sea (see summary by Nelson et al., 1974), including studies of the Holocene sediments of the Yukon River at its mouth (Matthews, 1973) and on the Bering Sea shelf (McManus et al., 1974), yet this study is the first to deal in detail with the processes and events by which the present day Yukon-Kuskokwim delta was formed.

V. Objectives

The overall objective of this project is to provide data on the geologic processes in the Yukon-Kuskokwim delta region in order to better evaluate the potential environmental impacts of oil and gas exploration and production in the adjacent Norton Basin. In particular, I plan to do the following:

1) Develop an understanding of the morphology, processes (including sea ice), and potential hazards along the Yukon-Kuskokwim delta shoreline
2) Determine processes active on the delta plain, including their potential hazards and possible effects of man-made structures
3) Map surface geologic units, including a description of their physical properties (e.g., depth and stability of permafrost)
4) Map areas of Quaternary volcanism and faulting and determine the relative age of activity of these features

VI. General Strategy and Approach

The basic tenet of this project is that by studying the processes by which the present-day delta formed, we may gain insights as to how those processes might affect and be affected by proposed offshore drilling and related activities in the future. This study emphasizes not only the processes (e.g., flooding, erosion, sedimentation), but also the products (e.g., permafrost stratigraphy, textural parameters) as they are fundamental in determining the potential environmental impact of increased development in the area.

A. Sampling Methods:

The coastline has been divided into units which are characterized by similar processes and properties. Ground truth in support of this classification has been in the establishment of 40 benchmarks (at approximately 10 km intervals) where detailed vegetation and sediment samples have been collected, in combination with measuring beach profiles. These coastal stations were re-occupied in 1978, in order to measure short-term rates of change.

Historical rates of change are being determined by comparison of old bathemetric maps and aerial photos taken in 1950-54, 1975, and 1976. In addition, geomorphic criteria are used to evaluate long-term trends as well as dominant direction of longshore drift.

Inland sites are selected to be characteristic of major depositional units within the delta region (e.g., natural levees, abandoned channels, point bars). Sampling at these sites include short cores, description of vegetation, depth to frozen ground, and samples for radiocarbon dating where significant.

Sampling and beach profiling was done in late June and early July during spring tides, in order to allow maximum exposure of the near-shore zone. In addition, offshore samples were taken at 1 mile intervals up to 5 miles offshore using a helicopter and bottom sampler, where feasible.

B. Analytical Methods

Short cores have been collected at different sites and will be x-rayed for sedimentation structures, split, and then analyzed for grain-size analysis. Surface samples will also be analyzed for grain size distribution.

Both grain size analyses and beach profiles will be formatted using NOAA formats. Selected samples will be analyzed for radiocarbon dating. Similarly, some samples have been collected for pollen analysis to aid in the interpretation of a 5-1/2 meter core taken from a volcanic lake in 1976.

Patterns of ice movement and deformation are being studied by the use of sequential LANDSAT and NOAA (VHRR) satellite imagery, in combination with surface synoptic weather maps.

VII. Deliverable Products

A. Digital Data:

Grain size analyses and beach profile data collected through 1978 will be submitted on punch cards or magnetic tape using standard NOAA formats. Computer printouts will be verified against original lab sheets and hand-drawn beach profiles to minimize potential errors. Location coordinate will be checked against original field maps as well.

B. Narrative Reports:

A report (and associated maps) will be submitted which will discuss the geologic hazards in the delta region, including those related to tectonics, permafrost, and active fluvial and coastal processes. A separate report will emphasize coastal geomorphology and sediment transport.

C. Visual Data:

Several maps will be submitted with the accompanying narrative reports. The maps will include a) geologic map of Yukon-Kuskokwim delta region, b) map emphasizing tectonic hazards, c) map of coastal morphology, stability, and directions of sediment transport, and d) maps showing patterns of ice movement and deformation. All maps will be submitted on Mylar and will be at an appropriate scale approved by the Project Office. The PI annual reports will also include 8x11" reductions of the maps at a reduced scale.

D. Others: N/A

E. See attached Data Products Schedule

VIII. Special Sample and Archival Plans

Samples collected for textural data (approximately 100-150) will be stored in the Geology Department at the University of Houston, as will replicate samples collected for radiocarbon dating (approximately 20). Approximately 50 core samples will also be stored. Samples collected for pollen analysis will be stored by Dr. Thomas Ager, U.S. Geological Survey, Reston, Virginia. Aerial photos, original maps, and 35 mm slides, as well as field notes, will be on file at the University of Houston.

IX. Logistics Requirements

There will be no field work, thereby eliminating logistical requirements.

X. Anticipated Problems

None

XI. Information Required From Other Investigators

No data are required from other investigators to carry out the proposal work. However, there will be an exchange of data with interested P.I.s (e.g. Hans Nelson, R.U. 429).

E. DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Grain Size Analysis	Tape	100-150	073	yes	7/75-8/75; 6/76-7/76; 7/77-8/77; 6/78-7/78	9/79
Beach Profiles	Tape	90-100	072	yes	7/75-8/75; 6/76-7/76; 7/77-8/77; 5/78-7/78	12/78
Vegetation	Report	30	N/A	N/A	7/75-8/75; 6/76-7/76; 7/77-8/77; 6/78-7/78	12/78
Radiocarbon Dates	Table	20	N/A	N/A	7/75-8/75; 6/76-7-76; 7/77-8/77; 6/78-7/78	6/79
Geologic Map	Map	1	N/A	N/A	7/75-8/75; 6/76-7/76; 7/77-8/77; 6/78-7/78	9/79
Coastal Stability Map	Map	1	N/A	N/A	7/75-8/75; 6/76-7/76; 7/77-8/77; 6/78-7/78	9/79

XII. MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 208 PI: William R. Dupré

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

		1978					1979								
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Quarterly Report	X			X			X			X			X		
Annual Report							X								
Grain Size Analyses and Beach Profiles							X								
Final Maps and Reports													X		

XIII. Outlook

A. The final results and data products of this project should include the following:

1) Report on the geologic hazards in the delta region, including a geologic map, a map of potentially active tectonic features, and a map of coastal erosion and sedimentation.

2) Report on coastal morphology and coastal sediment transport, including maps showing direction of sediment transport and patterns of ice movement and deformation in adjacent areas.

3) Appendices to these reports will include grain-size analyses, beach profiles, and descriptions of vegetation assemblages, as well as index maps of existing photo coverage (incl. 35 mm slides).

B. The appendices will be available April 1, 1979. The final report and associated maps will be submitted October 1, 1979.

C. There is no future work planned at this date, hence no costs beyond FY 79.

D. No purchases of major equipment are anticipated.

E. No future field work is anticipated, however, more work needs to be done on field studies of ice, the effect of storms, and the reoccupation of coastal stations on an annual basis.

F. No logistics requirements are necessary.

XIV. A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A through E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completerion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA For 24-33) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached). Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they became available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

OTHER INFORMATION

A. Qualifications of Principal Investigator

B. The principal investigator will be working for the U.S. Geological Survey for 5 months during FY 79, however no significant overlaps in research are anticipated.

C. The principal investigator shall actively lead and supervise the proposed work, and shall take full responsibility for timely completion of all objectives. He will spend 3 months (Jan-March) working full time on the project. The next 5 months (April-August) will be spent on other USGS projects at Menlo Park, California. The last two months will be spent at the University of Houston, during which time the reports will be finalized and submitted.

D. The principal investigator is the only person presently scheduled for this project. If assistants are hired, the granting agency will be notified.

E. Bibliography

F. Persons authorized to conduct negotiations

Julianne Kirk, Grants Analyst, (713)749-3412

Julie T. Norris, Director, Office of Research Administration, (713)749-3412

Bibliography

Creager, T.S. and McManus, D.A., 1967, Geology of the floor of Bering and Chukchi Seas - American studies; in Hopkins, D.M. (ed.) The Bering Land Bridge, Stanford Univ. Press, Stanford, Calif., pp. 32-46.

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Hoare, J.M., 1961, Geology and tectonic setting of lower Kuskokwim-Bristol Bay region, Alaska; Am. Assoc. Petroleum Geologists Bull., Vol. 45, p. 594-611.

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Knebel, H.J. and Creager, J.S., 1973, Yukon River: Evidence for extensive migration during the Holocene Transgression; Science, Vol. 79, p. 1230-1231.

Lisitzin, A.P., 1972, Sedimentation in the world ocean; Soc. Economic Paleontologists and Mineralogists Spec. Pub. No. 17, 218 p.

Marlow, M.S. and others, 1976, Structure and evolution of Bering Sea shelf south of St. Lawrence Island: Amer. Assoc. Pet. Geologist, Vol. 60, p. 161-183.

Matthews, M.D., 1973, Flocculation as exemplified in the turbidity maximum of Acharon Channel, Yukon River delta, Alaska; Unpublished Ph.D. dissertation, Northwestern Univ., 88 p.

McManus, D.A., Venkatarathnam, K., Hopkins, D.M., and Nelson, C.H., 1974, Yukon River sediment on the northernmost Bering Sea shelf; Journal of Sed. Petrology, Vol. 44, p. 1052-1060.

Moore, D.G., 1964, Acoustic reflection reconnaissance of continental shelves: eastern Bering and Chukchi Seas; in Moore, R.L. (ed.) Papers in marine geology, MacMillan Co., N.Y., pp. 319-362.

Nelson, C.H., Hopkins, D.M., and Scholl, D.W., 1974, Cenozoic sedimentary and tectonic history of the Bering Sea; in Hood, D.W., and Kelley, E.J. (ed.), Oceanography of the Bering Sea; Inst. Marine Sci., Univ. of Alaska, Fairbanks.

Scholl, D.W., Buffington, E.C., and Hopkins, D.M., 1968, Geologic history of the continental margin of North America in the Bering Sea; Marine Geology, Vol. 6, p. 297-330.

Title: Erosion, deposition, faulting and instability of shelf sediments: Eastern Gulf of Alaska   TASK RU 212

Principal Investigators: Bruce F. Molnia and Paul R. Carlson

Total cost of proposal: $100,000

Period of work: October 1, 1978 - September 30, 1979

Institution and department: U.S. Geological Survey, Pacific-Arctic Branch of Marine Geology

Required signatures

Principal Investigators

Name Bruce F. Molnia Bruce F. Molnia

Paul R. Carlson Paul R Carlson

Address 345 Middlefield Road

Menlo Park, California 94025

Telephone Number 467-2804 and 2612

Date June 20, 1978

Technical Proposal:

I. Erosion, deposition, faulting and instability of shelf sediments:
EGA (RU #212)
1 October 1978 - 30 September 1979

II. Principal Investigators:

Bruce F. Molnia
Paul R. Carlson
U.S. Geological Survey
Menlo Park, CA 94025

III. Cost of Proposal:

A. Science :
B. Logistics :
C. Total : $100,000
D. Lease Area: 100% will be expended for NEGOA research

IV. Background

This study of geo-hazards on the continental shelf in the NEGOA is being coordinated with the following studies; 1) resource assessment and geologic structure studies on the continental shelf by Bruns and Plafker (USGS); 2) continental geologic mapping and earthquake assessment problems by Plafker, Winkler and Hudson (USGS), 3) earthquake monitoring program by Lahr and Stephens (USGS) and geohazards studies on the Kodiak shelf by Hampton and Bouma (USGS). Our study (RU 212) will investigate in greater detail critical areas and processes that may create hazards to exploration and development of the OCS, lease sale area 55. In order to better understand such problems as sea floor instability, excessive erosion and sediment accumulation near surface gas, and the effects of active faulting, additional geophysical and sedimentological data are needed in this area. Previous studies for lease sale 39 have concentrated on the area between Montague Island and Yakutat Bay. For fiscal year 1979, we will expand this area to include the lease sale area 55 from 136° to 142°.

V. Objectives:

Our objectives in FY 79 are to determine as precisely as possible the length, orientation, and displacement of shallow faults; the geometry and boundaries of major slumps; the areas of present-day sediment erosion, deposition, and bypassing; and the distribution and depth of gas charged sediments as interpreted from seismic records. The various sedimentary, structural and physiographic provinces will be characterized. In addition, elements of the Quaternary geologic history of the EGOA-OCS will be reconstructed to more fully understand today's geologic setting. Data collected in FY 79 will be integrated into our existing data base in an effort to couple the newly acquired data with previous data so as to characterize and evaluate the study area for decision making prior to siting of seafloor installations in the OCS area.

VI. General Strategy and Approach:

The continental shelf of the eastern Gulf of Alaska is a very dynamic environment. Rivers and streams carry vast quantities of glacial silt and clay to this shelf, which is affected by strong, longhsore currents, frequent periods of high energy storm waves, and occasional seismic sea waves (tsunamis).

The stability and maintenance of drilling rigs, production platforms, pipelines, and shorelines based facilities are all affected by the erosional and depositional hazards of this high energy shelf. (For example, the rapid shoreline retreat and associated spit growth at Icy Bay).

Major earthquakes will occur that may damage installations on the shelf or along the coast. Hazards include ground shaking, fault displacement, and tectonic warping, and ground failure. Numerous onshore faults (especially the Fairweather Fault, known to have been active in the past 20 years) have been mapped to the shoreline of the Gulf of Alaska. Their offshore distributions are incompletely known. It is, therefore, imperative that offshore faults be mapped and a determination made regarding magnitude and age of offset. A related hazard is that of ground failure, such as submarine slumps or slides. The thick sequences of unconsolidated sediment, some of which contains Methane, which are being deposited off rivers (e.g., Alsek River) and streams draining this glaciated region are susceptible to failure caused by earthquakes or by agitation related to storm waves, seismic sea waves (tsunamis), and internal waves. Ground failure can also result if these water saturated sediments are overloaded by continuing deposition or by improperly designed and overloaded man-made structures. In order to make environmentally safe decisions, knowledge is therefore needed about the distribution, thickness, and type of these unconsolidated sediments.

Field and laboratory work in FYs 75-78 was designed to gather reconnaissance level information about the regional environmental geology of the EGOA, identifying general areas of active surface faulting, slope instability, and sediment erosion and deposition, as well as to classify the surface and near-surface sediment and deposition, as well as to classify the surface and near-surface sediment types. Attention was focused on OCS Lease Area No. 39. In FY 79, we will expand our study to include the entire area of OCS sale 55. A 21 day cruise on the R.V. SEA SOUNDER in June or July will conduct a high resolution geophysical survey of lease area 55 designed to compliment previous data collected from SURVEYOR. Two to three thousand km of data is anticipated. Preliminary tracklines are shown in Fig. 1. Side-scan sonar will be used and site specific investigations will be conducted as time permits.

A ten day sampling cruise on a NOAA ship equiped to handle core weight stands and grab samplers is requested to supplement data collection by the SEA SOUNDER. If ship time can not be obtained, then the goals of the SEA SOUNDER program will have to be reevaluated.

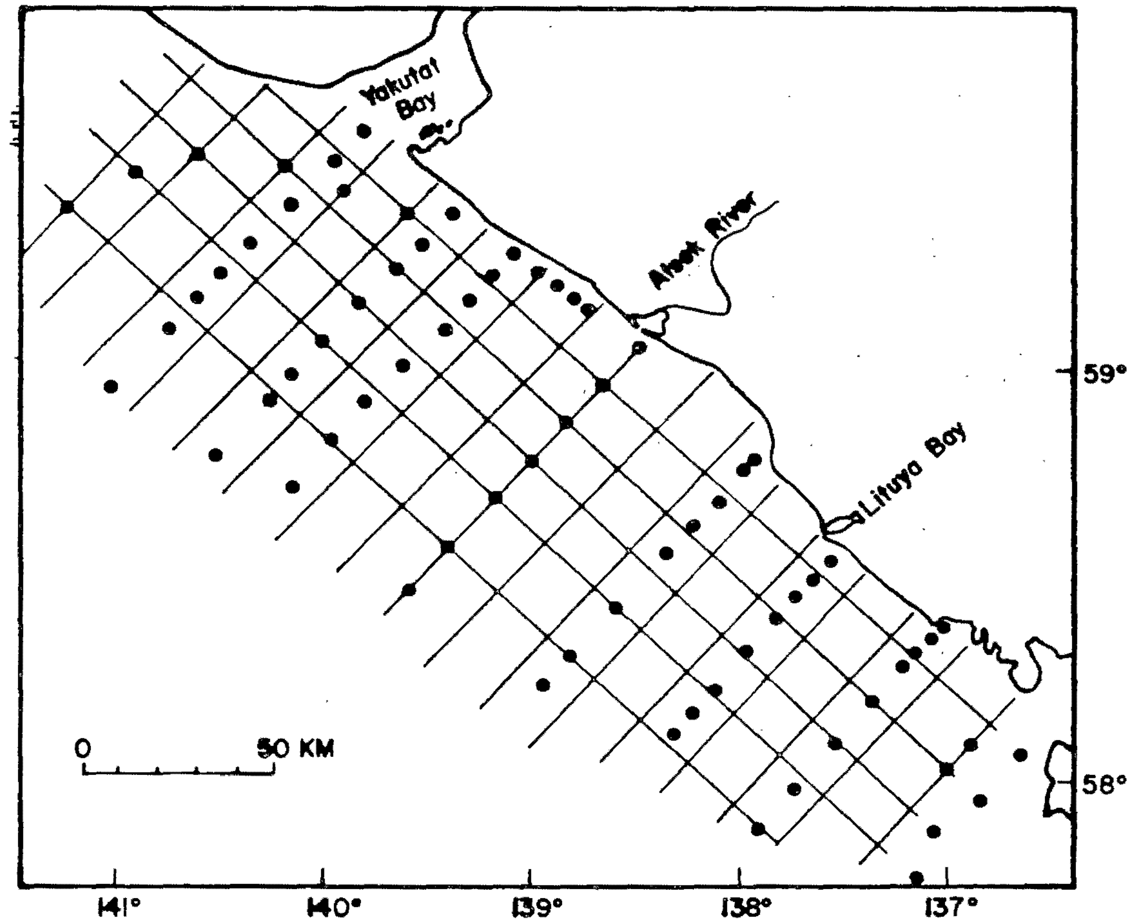
Current meters (N.O.A.A.) are needed to obtain near bottom current velocities. Three are requested, to be deployed for at least two months; 1) offshore of Alsek River, 2) on Fairweather ground and 3) in Alsek Sea Valley. Management of the project will be the Office of Marine Geology, Pacific-Arctic Branch. Work described in this proposal is OCSEAP funded, although principal investigators salaries and some ship costs are being funded by the U.S.G.S.

VII. Sampling Methods:

State of the art high-resolution geophysical equipment (120 kj sparker, uniboom, mini-sparker, 3.5 kHz, side-scan sonar), bottom samplers (piston corer, box corer, gravity corer, grab, dart-corer), visual format instrumentation (underwater TV and still photography), and navigation (Miniranger and Loran C) will be used for our program of about three weeks of shipboard operations during the summer of 1979. Reconnaissance track lines will be extended into the new area east of Yakutat Sea Valley (lease area 55) where seismic and side-scan sonar surveys will be used to complement the 1975-1978 data and complete the regional picture.

VIII. Analytical Methods:

The geophysical records will be analyzed by standard methods, whereby slumps and shallow faults are identified by discontinuity of reflectors and by characteristic geometry, and seismic stratigraphic units are correlated by their continuity and seismic-reflection signature. The sediment cores will be studied megascopically and microscopically in order to classify sedimentary units and to gather data for deciphering dispersal patterns. Cores will be X-radiographed for study of internal structures that provide inferences as to depositional mechanics and post-depositional disturbance. Geotechnical index properties such as water content, vane shear strength, Atterberg limit, and bulk density will be measured. In addition, grain size and mineralogy will be used to determine provenance and sediment pathways.



Tentative track lines and sample stations.

IX. Deliverable Products;

A. Digital Data: grain size analyses.

B. Narrative Reports:

Survey and sampling techniques, analytical and interpretative methods, and data interpretations of hazards and processes on the NEGOA continental shelf and upper slope.

The reports will be issued as:

Quarterly reports,
USGS open-file reports,
Presentations at scientific meetings,
Papers in scientific journals

C. Visual Data:

1. Maps of surface and near-surface faults indicating apparent recency of movement, where detectable.

2. Maps of existing and potential slumps and other unstable sediment masses, indicating present relative stability, where discernable.

3. Isopach maps of unconsolidated sediment.

4. Maps summarizing sediment grain size properties.

5. Geologic cross-sections of potentially unstable sediment masses, where sufficient data are available.

6. Maps showing areas of severe erosion, deposition, and large-scale bedform movement, where discernable.

7. Maps showing the distribution, of gas-charged sediments, plus any identifiable oil and gas seeps.

8. Bathymetric map of area.

9. Geologic map of surficial units.

D. Other Data: Sub-bottom profiles, fathograms, side-scan sonar records, and associated navigation will be submitted for inclusion in the OCSEAP data base. This will include navigation log and trackline map annotated for accuracy.

E. Data Submission Schedule:

Data collected during the FY 79 field season will be submitted as soon as practical after termination of the cruise. At least preliminary maps of the hazards (slumps, faults, areas of gas-charged sediment) will be submitted before January 1980.

ROSCOPS will be submitted immediately after each cruise.

Additional data from analyses of records, samples and observations will be presented in quarterly reports and other reports - see VII-B.

X. QUALITY ASSURANCE INFORMATION FOR GEOPHYSICAL, OCEANOGRAPHIC AND LABORATORY INSTRUMENTATION CITED IN OCSEAP WORK

SHIPBOARD EQUIPMENT

I. Acoustic Systems

1) 160 kj sparker (30-150 hz) system for intermediate resolution and penetration seismic-reflection profiling. (See Table 1)

2) 800 j minisparker system (1-3 Khz) for high-resolution seismic-reflection profiling. (See Table 1)

3) Uniboom (0.7-1.5 Khz) system for high-resolution seismic-reflection profiling. (See Table 1)

4) 3.5 Khz system with signal correlator for very high-resolution seismic-reflection profiling. (See Table 1)

5) 12 Khz system for bathymetric profiling. (See Table 1)

6) Side-scan sonar system for lateral surface profiling. (See Table 1)

II. Navigation System

1) Integrated satellite and Loran C receivers with speed log and gyro compass inputs controlled by minicomputer. (See Table 2)

2) Miniranger radio navigation system for precision near-shore controls ($<$ 100 km), also integrated into basic system. (See Table 2)

III. Remote Sensors

1) Transmissometer for measuring suspended sediment concentration. (See Table 3)

2) Savonius-rotor current meter. (See Table 3)

3) Expendable bathythermograph for measuring temperature versus water depth. (See Table 3)

4) Thermosalinograph for measuring salinities and temperatures of the surface waters. (See Table 3)

Table 1 - Resolution of Seismic System

	Approx. Peak Frequency	Range of Minimum Resolution (in m)*
Sparker	100 Hz	3.2 to 11.2
Uniboom	1.5 Khz	0.25 to 0.75
Minisparker	2.0 Khz	0.18 to 0.56
3.5 Khz	3.5 Khz	0.1 to 0.3
12 Khz	Sediment/water interface	
Side - Scan sonar	Sediment/water interface	

* Moore (1972 states that the minimum resolution of a seismic system is between 0.25 and 0.75 of the wave length of the peak (dominant) frequency.

Table 2 - Resolution of Navigation System*

Integrated Satellite and Loran C (rho - rho)

Long - course offset	± 0.0789 km
Cross - course offset	± 0.0891 km
Radial offset	± 0.1341 km

* Average of 25 updated satellite fixes and computed versus the Loran C rho - rho position.

Miniranger Accuracy ± 3 m

Sedimentological Laboratory

I. General

1) PDP-11/34 computer serving as controller for several analytical devices. Used to store analyzed data and interface with the main U.S.G.S. computer.

2) X-radiography units (two) for analyzing sedimentary structures in core samples. In addition, a track-mounted X-radiography unit is available for making continuous strip films of cores.

II. Particle Size Analysis

1) Three rapid sediment analyzers (height: 2.3 m; diameter: 20 cm) to measure grain-size distribution in the range of 2000 to 64 microns; fall velocities measured by a semi-conductor strain-gauge element. (See Table 4)

2) Coulter Counter for analysis of fine-grained sediments in the size range 2 to 64 microns. (See Table 4)

3) Hydrophotometer for analysis of fine-grained sediments in the size range 2 to 64 microns by measuring changes in light transmission. (See Table 4)

III. Mineral and Chemical Analysis

1) LECO Carbon Analyzer - automatic analysis of total and organic carbon concentrations in sediments. (See Table 4)

2) Carbonate Determiner for measuring the amount of calcium carbonate in marine sediments. (Attached to LECO Unit) (See Table 4)

3) Scanning Electron Microscope (a Mini-SEM) having a capability for magnifications up to 40,000 X for viewing, identifying and photographing particulate matter.

Table 3 - Resolution and Precision of Miscellaneous Gear

Transmissometer:		
	Calibration:	Calibrated to 85% transmission with cleaned windows in air. (per manual)
	Precision:	Data are taken both going down and up.
		Precision ± 2% Accuracy ± 2%
Current Meter (profiling)		
	Calibration:	Manufacturer calibrates each year prior to field season. Bench tested in Lab.
	Precision:	Data are taken both going down and up.
		Precision ± 5% full scale; Accuracy ± 3 cm/sec, ± 5° direction
XBT		
	Calibration:	Calibrated with test canister and box approximately every other day.
	Precision	± 0.1° C; Accuracy ± 0.1° C
Thermosalinograph		
	Calibration:	Calibrated by manufacturer.
	Precision:	Temp. ± 0.1° C Sal ± 0.1 o/oo
	Accuracy	Temp. ± 0.1° C Sal ± 0.1 o/oo

Table 4 - Resolution and Procedures for Analytical Equipment Shorebased

Rapid Sediment Analyzers

Calibration: System is calibrated using glass spheres.

Precision: One out of every four analyses is replicated

± 5% precision and accuracy of ± 5% 2000 to 63 um

Coulter Counter: Not used for present OCSEAPS programs.

Hydrophotometer

Calibration: System is calibrated using distilled water for 100% transmission.

Precision: One out of every six analyses is replicated

± 10% precision and accuracy of ± 1% 63 to Z um

LECO Carbon Analyser

Calibration: System is calibrated using LECO - provided calibrated carbon rings. In addition:

a) The combustion tube is cleaned every 15 runs.

b) The dust trap is changed every 30 runs.

c) The anhydron filters are changed every four hours of running time.

Precision: A standard is run every 30 runs and each sample is run twice and the values averaged.

± 2% precision and accuracy ± 1% full range.

XI. Archival Plans: USGS will archive samples.

XII. Logistics Requirements: See attached form.

XIII. Contingency Plan: In case of bad weather, we will adjust our schedule to work in the bays (Icy, Yakutat, Lituya, Cross Sound) where onshore treatment facilities may be planned.

XIV Information Required from other investigators: none.

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION USGS PRINCIPAL INVESTIGATOR Molnia/Carlson

A. SHIP SUPPORT We request the DISCOVERER.

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the are: Include a list of proposed station geographic positions.
See enclosed map.

2. Describe types of observations to be made on tracks and/or at each grid statio Include a description of shipboard sampling operations. Be as specific and co prehensive as possible. Gravity coring where possible - otherwise grab sampling of seafloor sediments.

3. What is the optimum time chronology of observations on a leg and seasonal basi: and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

Summer 1979 (June - August).

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.) 10 days.

5. Do you consider your investigation to be the principal one for the operation tl requiring other activities to piggyback or could you piggyback? Yes - ours will be principal study.
Approximately how many vessel hours per day will be required for your observat and must these hours be during daylight? Include an estimate of sampling-time station and sample processing time between stations. 24 hrs./day, 1-2 hrs. on station and 1/2 hrs. sample processing time.

6. What equipment and personnel would you expect the ship to provide?
Winch and operator, gravity corer and grab sampler. 3.5 kHz seismic system & E.T.

7. What is the approximate weight and volume of equipment you will bring?
1000 kg and 8 m^3.

8. Will your data or equipment require special handling? Yes If yes, please describe. Winch able to pull 10,000 kg.

XV. Management Plan:

The principal investigators shall actively lead and supervise the proposed work. We will be assisted by two full-time technicians and will make use of laboratory and data-analysis facilities available at the USGS.

XVI. Outlook

We anticipate a minimum of two additional years of work would be necessary to complete evaluations of faulting, slumping and sediment dynamics for the OCS area. Specific site investigations would be in addition to the above. The intensity of the effort would determine cost. No major new items are required.

MILESTONE CHART

O – Planned Completion Date

X – Actual Completion Date

RU # 212 PI: Molnia - Carlson

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

		1978		1979												1980				
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
SEASOUNDER Cruise									X	X										
ROSCOP 11											O									
GSA Paper Presentation													X							
AGU Paper Presentation															O					
Quarterly Report							X			X			X							
Final Report																			O	
Analysis of Seismic data														O						
Sample Analyses															O					
Maps generated															O					

XVII. Standard Statement

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be presented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

D. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

E. Data will be provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13).

F. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

G. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

H. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

I. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental
Assessment Program
Bering Sea-Gulf of Alaska Project Office
P. O. Box 1808
Juneau, Alaska 99802

RFx41-212-2559

FEB 2 ? 1979

TO : Rudolf J. Engelmann, Director
OCSEAP - Alaska Program Office, Boulder

THRU : Kay Jentsch, Contract's
OCSEAP - Alaska Program Office, Boulder

FROM : Herbert E. Bruce, Manager
OCSEAP - Juneau Project Office

SUBJ : OCSEAP Research Unit 212.

REFS : (1) Juneau Project Office Ltr to Drs. Molnia and Carlson requesting renewal proposal dated June 3, 1978 (enclosed).
(2) Original Proposal dated June 24, 1978 (enclosed).
(3) Copy of project office internal comments on proposal (enclosed).
(4) Juneau Project Office Ltr to Drs. Molnia and Carlson reqůesting revision to proposal dated October 25, 1978 (enclosed).
(5) Revised renewal proposal, dated January 25, 1979 (enclosed).

Required Acceptance Letter for RU 212
Drs. Molnia and Carlson

The enclosed revised FY 79 renewal proposal (p. 1 - 21), entitled "Erosion, Deposition, Faulting, and Instability of Shelf Sediments: Eastern Gulf of Alaska", has been reviewed by the Juneau Project Office and judged acceptable at the funding level of $110,000 (includes 10,000 for USGS overhead @ 10%. Please send an acceptance letter to Drs. Molnia and Carlson and initiate funding procedures for this amount.

Enclosures: refs. 1 - 5 (above).

BIOLOGY OF THE HARBOR SEAL, *PHOCA VITULINA RICHARDI*,

IN THE GULF OF ALASKA

OCSEAP RESEARCH UNIT #229

Contract Number - #03-5-022-69

Principal Investigators

Kenneth W. Pitcher

Donald G. Calkins

Alaska Department of Fish and Game

Division of Game

Period of Performance: 1 October 1978 - 30 September 1979

Total Cost	-	$51,528
NEGOA	-	17,004
LCI	-	8,760
Kodiak	-	25,764

Date of Proposal - 5 June 1978

Contract Number: #03-5-022-69

Proposed Dates of Contract: 1 October 1978 to 30 September 1979

II. Principal Investigators: Kenneth W. Pitcher

Donald G. Calkins

III. Cost of Proposal:

A. Science - $51,528

B. P.I. Provided Logistics - 0

C. Total - $51,528

D. Distribution of effort by lease area

NEGOA	33%
Lower Cook Inlet	17%
Kodiak	50%

IV. Background: This proposal is a request for funding to complete specimen processing, data compilation and analysis and to prepare a final report on harbor seal studies conducted in the Gulf of Alaska during the past three years. Basic objectives of these studies have been to obtain information on growth, physical condition, reproduction, prey utilization, distribution and location of "critical" habitats. During the current field season (FY 78) baseline data on population abundance are being collected in all three lease areas in the Gulf of Alaska with the most intensive work being conducted on Tugidak Island. Other expected products of the Tugidak work include activity data, particularly haul out patterns, movements and haul out area fidelity. Information on the effects of disturbance on groups of hauled out harbor seals is also being collected.

V. Objectives: The overall objective for FY 79 is to prepare a comprehensive final report on all harbor seal work conducted with OCSEAP support in the Gulf of Alaska. Emphasis will be placed on findings which relate to potential impacts of OCS development on harbor seal populations.

VI. Strategy and Approach: A considerable backlog of specimen materials from collected animals is expected to accumulate by the beginning of FY 1979 as a nearly continuous field program is planned for the remainder of this contract period. Therefore the first three months of FY 79 will be devoted to laboratory activities i.e. tooth sectioning for age determination, analysis of reproductive tracts and processing of stomach and intestinal contents. Submission of the resulting data to the OCSEAP data management system will require one month after completion of specimen processing. Analysis of data should be completed by early June and the resulting final report completed by the end of the contract period, i.e. 30 September 1979.

VII. Deliverable Products;

A. Digital Data

Collection Location	Ovary/Corpora lutea
Date/Time	Corpora albicantia
Habitat	Follicles
Behavior	Number of Uterine Scars
NODC Taxonomic Code	Sperm Determination
Sex	Baculum/Testes Measurements
Activity	Weight and Volume Food Contents
Measurements/Weights	Stomach Content Species
Age/Age Determination	NODC Taxonomic Code
Reproductive Status	Life History Code
Number of Fetuses	Misc. Stomach Contents
Number/Volume/Weight of Identified Items	Mean/Maximum/Minimum Length of Identified Items
Digestive Organ	

B. A final narrative report will be prepared covering all research conducted under RU 229. Sections of the report will include: rational of the research, prior knowledge, methods of research, growth, physical condition, age of sexual maturity, age specific reproductive rates, seasonal reproductive activity, food habits, haul out patterns, haul out area fidelity, individual movements, effects of disturbance on hauled animals, locations of animal concentrations and "critical" habitats and baseline data from trend count areas.

C. Visual displays will include maps of the study area and collection locations with appropriate mylar overlays, maps illustrating harbor seal concentrations, tables presenting reproductive and food habit data, and figures showing growth and condition patterns. Haul out patterns of individual radio-tagged seals will be presented in figures.

VIII.

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studies, and sexes where these are morphologically distinguishable.

D. At the option of OCESAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutally satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Date Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA For 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor", (copy attached.) Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 229 PI: Pitcher

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

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Specimen Processing				0											
Data Submission					0										
Data Analysis									0						
Submission Final Report													0		

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

JAY S. HAMMOND, GOVERNOR

333 RASPBERRY ROAD
ANCHORAGE 99502

August 22, 1978

Dr. Herbert E. Bruce
OCSEAP, Juneau Project Office
P.O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

Following are the requested changes and additions for the FY79 proposal to prepare a final report for RU 229--Biology of the Harbor Seal, *Phoca vitulina richardi*, in the Gulf of Alaska.

Qualifications of Proposers

Dennis McAllister is a Fish and Game Technician with the Alaska Department of Fish and Game. He has worked on the OCSEAP harbor seal and Steller sea lion projects for about 15 months. His primary duties and responsibilities have included data management, laboratory tasks including sorting of stomach contents and histological preparations of tooth sections for age determination, participation in collections and radio telemetry activities. His duties have also included data tabulation and the preliminary stages of data analysis.

IV. Background: From November 1975 through 15 August 1978, 337 harbor seals were collected in the NEGOA, WEGOA and LCI lease areas in the Gulf of Alaska. An additional 15-25 animals are scheduled to be taken in August and September 1978. From these collected animals, a series of physical measurements and specimen materials have been taken which are the basis of investigations on reproduction, growth, physical condition and food habits.

During the summers of 1976 and 1978 observational studies of harbor seals were conducted on Tugidak Island. The goals of these projects were to determine the progression and timing of important life history events and their apparent effect on harbor seals. Repetitive counts were made at the primary hauling area in order to provide a baseline for population abundance. In 1978, radio tracking studies were conducted to collect information on individual movements, population discretness and activity patterns.

During all field work observations of harbor seal concentrations have been recorded to gain insight into the relative abundance and distribution of harbor seals in the Gulf of Alaska.

V. Objectives: Basic objectives of the research applicable to all three lease areas in the Gulf of Alaska have included: (1) investigation of food habits and identification of important prey species, (2) examination of growth and physical condition and (3) examination of reproductive biology with emphasis on determining timing of reproductive events, determination of age of sexual maturity and estimation of pregnancy rates. Peripheral objectives, pertinent to all lease areas, have been to collect information on distribution, use of critical habitats, effects of disturbance, population composition and collection of specimen materials for disease and environmental pollutant analyses.

Intensive site specific studies have been conducted on Tugidak Island in the WEGOA lease area. While these studies were conducted exclusively in the Kodiak area, portions of the results are expected to have relevance to other populations. Objectives of this work were examination of: activity patterns, individual movements, population discretness and formation of a baseline to monitor population levels.

VI. Strategy and Approach: The proposed format for the final report centers around a detailed life history of harbor seals in the Gulf of Alaska based on data collected during this study and on information previously presented in the scientific literature. Proposed sections of the report will include: Pupping, Lactation and Weaning, Ovulation and Breeding, Delay of Implantation, Female Age of Sexual Maturity, Age Specific Pregnancy Rates, Reproductive Failures, Sexual Maturity in Males, Seasonal Spermatogenetic Activity, Fetal Growth, Postnatal Growth, Physical Condition, Food Habits, Harbor Seal Concentrations, Haul-out Activity Patterns, Individual Movements, "Critical Habitats", Effects of Disturbance, Potential Effects of OCS Oil and Game Development on Harbor Seals in the Gulf of Alaska and Recommendations.

Statistical qualifications of the data will be provided when feasible in the form of confidence limits. Standard statistical tests primarily the students T test, chi square test, analysis of variance and linear regression analysis will be used to analyze the data and test for differences between "populations".

VII. Sampling Methods

1. Harbor seals were collected systematically from different areas and habitat types throughout the year. This was done in order to detect variations in food habits with season, area and habitat type.

2. Weights and standard measurements were taken from each collected animal including: total weight, standard length, curvilinear length, axillary girth, hind flipper length and blubber thickness. These data were collected to establish growth rates, seasonal condition patterns and assist in making calculations. of biomass.

3. Age determinations were made. This was done by decalcifying a canine tooth from each animal, using a microtome to produce thin sections, staining the sections with hematoxylin and counting the annual growth rings with the aid of a microscope.

4. The ovaries and uterus were taken from each female seal and preserved in formalin. Presence or absence of a conceptus in the uterus was determined using standard laboratory techniques for reproductive analysis and a partial reproductive history was reconstructed by examination of ovarian structures.

5. Testes and epididymides from each male seal were collected and preserved. A microscopic examination was made of epididymal fluid to determine whether sperm were present or not.

6. Stomach contents from each seal were preserved in formalin. Weights and volumes were determined for all contents. Identifications of prey species were made by examination of recognizable individuals and skeletal materials of diagnostic value. Frequency of occurrence and numbers of individual prey species were determined.

7. Tissue samples were collected and frozen so that baseline levels of heavy metals, pesticide residues and hydrocarbons can be determined.

8. Observations of harbor seals are recorded during collecting cruises and during aerial surveys conducted by personnel of other marine mammal projects in the Gulf of Alaska. These data are being compiled and will eventually be of value in delineating areas with high harbor seal concentrations, patterns of seasonal distribution and critical habitat.

9. From May to September 1976 a field camp was established on Tugidak Island. Periodic censuses were conducted. Instances of disturbance, both man related and natural were recorded along with their apparent effect on the seals. The progression of life history events i.e. birth, lactation, weaning and molting were documented.

10. From April to September 1978 another field camp was manned on Tugidak Island. In addition to activities detailed above radio transmitters were placed on 36 harbor seals and their frequency of hauling monitored on the island. In addition, periodic aerial radio tracking surveys were flown along the coast of the Kodiak Archipelago, Chirikof Island, Semidi Islands and portions of the Pacific coast of the Alaska Peninsula to evaluate the extent of movement away from the place of capture.

VIII. <u>Deliverable Products</u>: The following parameters will be submitted where appropriate for all collected harbor seals. File type 025 was designed for several species and for several research units and not all parameters are appropriate for this project.

Record Type 1 - Location
- Latitude/Longitude
- Date/Time of Collection
- Habitat/Behavior Codes

Record Type 2 - Physical 1
- Taxonomic Code
- Sub Species/Sex Code
- Accompanied by Pup
- Mammal Lactating/Sunk
- Group Size
- Curvilinear Length
- Axillary Grith
- Hind Flipper Length/Width

Record Type 3 - Physical 2
- Blubber Thickness
- Gross Weight/Standard Length

Record Type 4 - Age-Reproductive-Male
- Age/Age Unit Code
- Age Dermination/Accuracy Code
- Baculum Length/Weight
- Testes Volume/Length/Width
- Presence of Sperm/Sperm Method of Determination

Record Type 5 - Age-Reproductive-Female
- Age/Age Unit Code
- Age Determination/Accuracy Code
- Reproductive Status/Condition Code
- Number of Fetuses
- Ovary Weight
- Number of Corpora Lutea
- Diameter of Largest Corpora Lutea
- Number/Diameter of Corpora Albicantia
- Number/Diameter of Follicle
- Number of Uterine Scars

Record Type 6 - Stomach Contents
- Total Volume of Contents

Record Type 7 - Stomach Content Species
- Taxonomic Code
- Life History Code
- Miscellaneous
- Number/Volume of Items Identified
- Mean/Maximum/Minimum Length
- Digestive Organ Code

Record Type 8 - Text
- Text

VIII.B. Narrative Report.

1. Pupping - timing, duration and location of major pupping areas.

2. Lactation - length of lactation period and onset of weaning.

3. Ovulation - timing and duration of breeding and ovulation.

4. Delay of implantation - length of delay and timing of implantation.

5. Female age of sexual maturity - based on percentages of each age class and may include both initial ovulations and intital pregnancies.

6. Age specific pregnancy rates - probably will be presented overall for the Gulf of Alaska as samples for individual populations are not large enough in most cases.

7. Reproductive failures - quantification of reproductive failures and cause i.e. missed pregnancies, resorptions and abortions.

8. Male age of sexual maturity - proportion of males in each age class which are sexually mature.

9. Seasonal spermatogenetic activity - delineation of the annual period of breeding potency.

10. Fetal growth - presentation of growth patterns of harbor seal fetuses based on weights and measurements of collected fetuses. Records of size at birth and comparison between "populations".

11. Postnatal growth - analysis of growth patterns with comparisons between sexes and "populations".

12. Physical condition - analysis of annual patterns of condition based on blubber reserves. Comparison between sexes and populations and examination of annual variations.

13. Food habits - composite presentation of both volumetric and frequency of occurrence analysis of all areas, seasons and age classes in the Gulf of Alaska. Data will be analyzed by area and by season.

14. Harbor seal concentrations - tabular and visual presentation of counts of seals at major hauling areas in the Gulf of Alaska.

15. Activity patterns - examination of frequency and timing of haul-outs by the radio equipped seals.

16. Individual movements - records of movements of radio equipped harbor seals.

17. Critical habitats - Definition of "critical habitats" as applicable to harbor seal populations and listing and discussion of "critical habitats" in the Gulf of Alaska.

18. Effects of disturbance - report of observations of disturbance of hauled out harbor seals and their apparent effects.

19. Potential effects of OCS gas and oil development on harbor seals in the Gulf of Alaska--a discussion of possible adverse effects based on results of this study plus information reported in the scientific literature.

20. Recommendations - discussion of ways to minimize adverse effects of OCS development on harbor seal populations. Outline of data gaps with recommendations for future work.

VIII. C. Visual Data (Tentative)

Parameter	Presentation	Unit of Measurement
Sex and Age Composition	Table	Years - Sex
Pregnancy Rates	Table	Percentage
Maturity Rates	Table	Percentage
Spermatogenetic Activity	Table	Percentage
Growth	Figures, Tables	mm, cm, g, kg,
Condition	Figures, Tables	mm
Food Habits	Tables	cc, occurrences, percentages
Harbor Seal Concentrations	Maps, Tables	Numbers of Seals
Hauling Area Counts	Tables, Figures	Numbers of Seals
Individual Movements	Maps	Geographical Locations

There will undoubtedly be a number of other graphical presentations but they must await data analysis to determine their appropriateness.

IX. Voucher specimen archival plans--I don't feel this section is appropriate. Intact voucher specimens for prey items are not avialable. Certain skeletal components, primarily fish otoliths and cephalopod beaks have been retained and are available if desired.

X. Logistic requirements - none required.

XI. Anticipated problems - none.

XII. Information required of other investigators - none.

XIII. Outlook - not applicable.

CPF-2 We agree to delete $1,500 from the travel and perdiem request providing the Juneau Project Office will bear all costs involved with synthesis or other required meetings.

The $1,500 requested will be used for the data management primarily for key punching quality control and taping, graphical presentations of data also will require funding.

You should receive a completed signature page from our Juneau office within several days.

Sincerely,

(DM)
Kenneth W. Pitcher

Kenneth W. Pitcher
Marine Mammals Biologist

cc: Boulder Program Office
OCSEAP - Alaska Program Office
Environmental Research Laboratories
Boulder, Colorado 80302

(1) COVER SHEET

Proposal Date: 26 June 1978

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Contract #: 03-5-022-53

Task Order #:

NOAA Project #: RU #230

Institution ID #: Alaska Department of Fish and Game

FY 1979 RENEWAL PROPOSAL

Research Unit Number 230

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

Cost of Proposal: $ 90,000

Lease Areas	
Beaufort	33.3 %
Chukchi	33.3 %
Norton Sound	33.3 %

Period of Proposal: October 1, 1978 through September 30, 1978

Principal Investigators: John J. Burns and Kathryn J. Frost

Institution: Alaska Department of Fish and Game
Division of Game
1300 College Road
Fairbanks, Alaska 99701

(3) Technical Proposal

I. Title: The natural history and ecology of the bearded seal, Erignathus barbatus, and the ringed seal, Phoca (Pusa) hispida.
Research Unit Number: RU #230
Contract Number: 03-5-022-53
Proposed Date of Contract: 1 October 1978 through 30 September 1979

II. Principal Investigators: John J. Burns and Kathryn J. Frost

III. Cost of Proposal: $90,000

A. Science--------------------------$86,600
B. PI provided logistics-------------3,400
C. Total----------------------------$90,000
D. Distribution of effort by designated lease area:
Beaufort Sea----------33.3%
Chukchi Sea-----------33.3%
Norton Sound----------33.3%

IV. Background:

This project has been concerned with intensive, year-round investigations of the biology, population dynamics, and ecology of the two ice associated seals of greatest importance to coastal residents of northern Alaska.

The two species differ widely in their biology as it is currently understood. The ringed seal is a small animal with greatest densities observed near shore, in drifting and landfast ice. For food it is dependent on zooplankton and small fishes. The bearded seal is a large animal and the more completely independent of the two. It occurs mainly off shore and feeds on benthos obtained from drifting ice platforms.

In order to understand the biology of these two northern seal species and to acquire information necessary to predict probable impacts of OCS development, several kinds of data are required. These data include: migration routes and timing, natality, mortality, growth (fetal and neonatal), population structure, longevity, age-specific reproduction, habitat requirements, and other process studies. To the extent that funding levels permit, the harvest of and dependency on these two species by Native Alaskans should be monitored.

The intensive data-gathering phase which has centered around field work in the four geographic areas (St. George Basin, Norton Sound, Chukchi Sea, and Beaufort Sea) will end in September 1978. Much of this field work has involved scientific expeditions such as long cruises on research vessels and significant periods of time spent in Eskimo villages where marine mammals hunting is conducted. So far as possible, the specimens obtained through April 1978 have been examined and the data compiled and reported as required. However, a thorough and integrated analysis of all available data has, as yet, not been accomplished.

During the period 1 October 1978 to 30 September 1979, it is our intention to reduce the field effort significantly, concentrating it in the Beaufort Sea during winter 1979 and in the Bering Sea during spring 1979 (pending availability of appropriate logistic support).

The majority of our time will be devoted to examination of material which will be in hand by 1 October (resulting from several large collections obtained in the spring-summer of 1978) and the various analyses of these data.

Our OCS research efforts are of a highly integrated nature. The project is characterized by taking the maximal amount of information from collected specimens, letting none of it go to waste, and making these analyses available to other projects (e.g. RU 232). Such a large number of determining parameters require extensive computer support for analytic work, and a multi-year systematic effort at data gathering. The 1978 effort was designed to shift emphasis to the Beaufort Sea, a region which has not been featured in previous years' work because of relatively high costs of operation and low densities of these seals. However, the much larger harvest-based collections now undergoing analysis will provide the context of variability in which necessarily small Beaufrot Sea samples can be interpreted. Successful continuation of Beaufort operations in winter and spring seasons will represent only the second year of effort in the region. Emphasis will be on analysis and synthesis of data, with field work filling only the most crucial data gaps.

Initial analysis of data will be accomplished at the University of Alaska Computer Center. Specimen material, as requested, will be made available to a variety of other investigators.

V. Objectives:

1. To determine the spatial and temporal distribution of these seals, including assessment of regional differences in density and distribution in relation to proposed OCS lease areas and major habitat conditions. Particular attention will be given to the effects of human activity on distribution and occurrence of seals and related species as indicated, for example, by existing coastal settlements.

   The relevance of this objective relates to the importance of lease areas as seasonal seal habitat or as routes of movement.

2. To determine population structure and dynamics of these two seal species as indicated by composition of the harvest taken by Eskimo subsistence hunters.

   Initial studies indicate significant segregation of age classes, especially of ringed seals within the various proposed lease areas. Demographic information is also required as predevelopment baseline data.

3. To determine current parameters of species productivity.

   Information about the biological productivity of bearded and ringed seals is basic to any determination of population health, vigor, trends, and standing stock. It is also a major baseline parameter required for comparison with information which may be obtained during and after petroleum development.

4. To determine important aspects of species natural history including natal and post-natal growth, behavior, condition, annual biological events, and habitat requirements.

   This information is a significant component of required baseline assessment of bearded and ringed seals.

5. To determine, to the extent that funding levels will allow, the magnitude of annual harvest of these seals by coastal residents of Alaska.

   Bearded and ringed seals are the species taken in largest numbers by village residents of the north coast. The dependence on these species is significant and should be determined.

6. To acquire specimen material necessary for the successful continuance of other studies, particularly RU #232.

   The proposed study of the natural history of bearded and ringed seals is an integral component of a group of investigations designed to investigate the ecological relationships among key components of proposed OCS lease areas.

7. To determine, so far as funding levels allow, major aspects of the distribution and natural history of belukha whales (Delphinapterus leucas) in the proposed OCS lease areas.

Collectively, the objectives stated above are intended to 1) provide the information required for an assessment of the susceptibility of bearded and ringed seals to proposed OCS development, 2) to provide a baseline against which future parameters as may be determined for these species can be compared, and 3) to accumulate information about the use of coastal areas in and adjacent to OCS leases by belukha whales.

VI. General Strategy and Approach:

The strategy which will be employed to meet project objectives indicated above is as follows:

1. Intensive field efforts will have been completed by the beginning of this proposal period (1 October 1978). Our first order of business

will be to complete the laboratory examination of a large volume of specimen material obtained during the summer of 1978.

2. At the same time we will intensify our efforts to further develop the computer programs required for detailed analysis of our total data base. Some of these programs will be unique to this project.

3. In accordance with the objective of broadening our data base in the Beaufort Sea, we will be involved in limited field programs during the winter and spring periods. Of necessity, field efforts conducted in the drifting ice (off shore) will involve the use of vessels and aircraft.

4. One objective, that of determining the magnitude of harvest by Native Alaskans, will be difficult to achieve in view of the reduced field effort and funding level of this project. To the maximum extent possible, we will rely on the activities of other personnel from the Alaska Department of Fish and Game to obtain information from the numerous Eskimo villages along the Bering, Chukchi, and Beaufort Sea coasts.

6. Analysis of the spatial and temporal distribution of bearded and ringed seals will be accomplished through detailed statistical analysis of survey results (shipboard and aircraft) which have been completed. An important survey of ringed seals in the fast ice of the Beaufort Sea was not accomplished during June 1978 because of unfavorable flying conditions. If statistical analysis of data presently in hand indicates that additional sampling is desirable, limited surveys will be flown in June 1979. We are presently exploring the possibility of utilizing a portable sonar system, mounted in a helicopter, as a means of determining the density of ringed seals within limited areas under the drifting sea ice in the Beaufort Sea. The mobility of such a unit, if it works, would provide a major breakthrough in determining the distribution and density of these seals in ice-covered regions of the far north.

7. To the maximum extent possible, species accounts of bearded and ringed seals will be completed during the proposed project period.

8. It has been recognized that belukha whales are an important component of the nearshore system in certain regions, particularly in the Hope Basin and eastern Beaufort Sea. So far as possible, we will obtain data and specimen material from belukhas taken by subsistence hunters in those regions, in order to evalute the basic parameters of the natural history of these animals and their dependence on the nearshore zone.

VII. Sampling Methods:

1. Limited collection of bearded and ringed seals will be accomplished in the Beaufort Sea during the winter of 1978-1979. These collections will be made using a helicopter operating from shore bases. The collections will be random in the sense that seals are taken in

restricted areas of open water and the occurrence of these openings depends on winds and currents during the time of field operations.

2. Collections in the Bering Sea will be made in conjunction with integrated research cruises in that area. Sampling is not random but is accomplished at locations where otter trawls and other sampling programs are conducted simultaneously. Animals collected will be selected in relation to age and behavioral activity (i.e. feeding, migrating, etc.).

3. Project personnel will not be involved in obtaining large samples of specimens from Eskimo villages during 1978-1979. However, we will utilize material which is acquired by other personnel of the Alaska Department of Fish and Game.

4. If a survey of ringed seals in the Beaufort Sea lease area is determined to be desirable (based on analysis of data in hand), it will be accomplished in accordance with a design appropriate for obtaining a statistically valid sample. Survey design will probably involve a stratified random sampling program.

5. The sampling of seals is accomplished as indicated below:

Weights and standard measurements are taken, when possible, from animals taken by Eskimo hunters, and from all animals selectively collected. The weights and measurements include: gross weight, hide and blubber weight, curvilinear length, standard length, axillary girth, maximum girth, front and hind flipper lengths and widths; navel to anus length, penis to anus length, tail length, and blubber thickness at the sternum. These data are used to establish fetal, pup, subadult, and adult growth rates; seasonal condition patterns; and to assist in making biomass calculations. In addition to weights and standard measurements, we attempt to obtain: specific location, date, and time of collection; group size and composition; tidal stage; and water depth.

The sex of a specimen is determined by examination of the external genitalia, or reproductive organs in those cases where the intact animal is not presented.

Aerial, ship, and ground surveys are being used to determine the distribution and densities of ringed and bearded seals killed by polar bears and arctic foxes. These dead seals are being examined to determine physical condition, and amount of each consumed by the predator. Specimens are collected for laboratory analyses. In addition, the geographic location, specific habitat (breathing hole, lead, lair, etc.), and ice type are noted. Standard measurements are taken whenever possible.

Seasonal migration patterns are determined through observations at coastal hunting sites, and from shipboard and aerial surveys.

Aerial, shipboard, and ground surveys are used to determine the distribution and densities of pinnipeds in the ice-covered Bering, Chukchi, and Beaufort Seas. These surveys are conducted chiefly in June during the post-reproductive and molting period of ringed and bearded seals, but by the end of this research surveys will have been conducted during every season and will have covered all ice types.

VIII. Analytical Methods:

The ages of all seals for which claws are available are initially estimated by claw examination. The claw provides a rapid and accurate means of age determination for seals up to six years of age, as growth rings or ridges are formed annually on the claw. After six years the claws are worn such that the initial ring ("constriction of birth") and usually subsequent rings are worn off. For these specimens, a canine tooth is sectioned and stained with paragon stain. The tooth sections are examined with the aid of a light microscope and the age of the seal is determined by enumerating the dentine or cementum annuli. Age determinations are necessary for development of growth rates, to determine population structure and productivity, and age-specific food habits.

Species productivity is determined through laboratory examination of reproductive tracts and correlation of these data with the age of each specimen.

Testes are weighed to the nearest 0.1 g with and without epididymides. Length and width at the middle of the testes are measured to the nearest millimeter. Testes volume (nearest cc) is determined by water displacement. Bacula are cleaned by boiling, air dried, and then measured (nearest mm) and weighed (nearest 0.1g).

The presence of sperm in the epididymides is used to ascertain breeding condition. The epididymides are sliced and a drop of fluid is squeezed onto a slide and examined under 78x or 300x magnification. Sperm presence or absence in the epididymal fluid is quantified as: none found, trace, or abundant.

Ovaries are weighed to the nearest 0.1 g and then cut into 2 mm longitudinal sections. The sections are left joined at the base to preserve their relative position. The sections are examined macroscopically for corpora lutea, corpora albicantia, follicles, and ovarian masses or abnormalities. The largest diameter of corpora lutea, corpora albicantia, and largest follicle are measured to the nearest mm. Drawings are made of each ovary for later reference. The presence or absence of a fetus is noted at necropsy.

Samples (about 125 cm^3) of heart, liver, kidney, skeletal muscle, and skin and blubber are wrapped in aluminum foil, labeled, and frozen. These tissue samples will be provided to other investigators for microbiological, hydrocarbon, pesticide, and heavy metal analyses.

Teeth and claws are collected to determine the age of the prey. Reproductive tracts are examined for sex and reproductive condition following standard techniques. Blubber, selected organs and tissues, stomach and digestive tracts of prey species are examined for parasites, diseases, or pathologic conditions and food habits, and will be provided to cooperators for analyses for pesticides, heavy metals, and petrochemicals.

Several ecological and behavioral parameters will be investigated to determine factors affecting prey availability and selection and hunting success of predators. For example, polar bears tend to take seals at breathing holes, hauled out on the ice, or in lairs; therefore, these factors influence hunting success of bears. The numbers and kinds of seals seen on the ice during surveys will be related to ice conditions, weather, and seal biology data to obtain environmental and natural history correlates to hauling out behavior.

Population structure of ringed and bearded seals is assessed through sex and age determination of samples obtained at coastal hunting sites and during the course of selective collection. Eskimo collectors have been established in various villages with hopes of obtaining jaws and claws and other specimen material from seals killed by the villagers. The collectors also maintain logs of dates, species, and sexes of kills.

References which describe the methodologies and applications of these methods include: Benjaminsen 1973; Burns 1967; Eley 1977; Laws 1956, 1962; McLaren 1958, 1961, 1966; Smith 1970, 1973, 1976; Tikhomirov 1966.

The analysis of data, for reporting purposes, will involve statistical evaluation of samples according to standard statistical procedures as indicated by Snedecor and Cochran (1959), Dixon (1971), and Nie et al. (1975).

IX. Deliverable Products:

A. Digital Data

1) Parameters recorded
   a) species of seal
   b) sex of seal
   c) age of seal
   d) date and time of location
   e) collection location
   f) reproductive status
   g) reproductive condition
   h) number of fetuses
   i) ovary weight
   j) number of corpora lutea and corpora albicantia
   k) diameter of corpora lutea and corpora albicantia
   l) number of follicles and uterine scars
   m) testes length, width, and weight
   n) testes volume
   o) sperm presence or absence
   p) ice condition
   q) number of seals observed
   r) general behavior

2) List of digital products

See attached Data Products Schedule.

B. Narrative Reports

To date, our involvement in this OCS project has resulted in several reports additional to the required quarterly and annual reports. These have included papers dealing with the results of aerial censuses, the relationship between ringed seals and bowhead whales, and two synthesis reports for the Beaufort Sea.

At this time it is anticipated that the information generated by this project will eventually result in a series of published papers on such topics as population dynamics, long-term trends in production rates, taxonomic characteristics of bearded and ringed seals, natural history notes, etc. However, our efforts during the proposed project year will require a full-time commitment to the stated objective. We do not anticipate having an opportunity to generate additional published papers and reports until after 30 September 1979.

C. Visual Data

At this time we do not anticipate the production of visual data other than that submitted in required OCSEAP reports.

D. Other Data

At this time we do not anticipate the production of what can be termed "other data."

X. Quality Assurance Plan:

Procedures for obtaining data in the field have been standardized. Opportunities for joint field work by personnel working on this project insure that the variety of parameters are obtained in the same way.

Data submitted in accordance with the established data management plan are checked prior to and after keypunching. A computerized program for the detection of errors has also been and will continue to be used by OCSEAP personnel.

Questions concerning the interpretation of anomalous occurrences and results will be directed to appropriate experts. A system of peer review is utilized for critique and evaluation of scientific findings and conclusions.

XI. Special Sample and Voucher Specimen Archival Plans:

Appropriate tissue samples from bearded and ringed seals (mainly preserved organs and histological sections) are maintained in collections at the Alaska Department of Fish and Game. Examples of unusual specimen material will be archived at the University of Alaska Museum. Specimens of special interest to other investigators will be made available, on request, when possible.

XII. Logistics Requirements:

See attached forms.

XIII. Anticipated Problems:

Provided that appropriate logistics arrangements can be made, we do not anticipate any problems with respect to proposed field work. We have made allowances for the unpredictable weather and sea ice conditions "normally" encountered during work in the waters of northern Alaska.

We do not anticipate any major difficulties in accomplishing the appropriate programming and computer analysis of our data. However, we do point out that these services are vital to the accomplishment of our objectives during this project, to wit: the analysis, summarization, and reporting of all data acquired to date. In the event that adequate arrangements cannot be made through existing facilities, we will negotiate with the Arctic Project Office to make alternate arrangements. Adequate computer services may be the most important potential problem.

XIV. Information Required from Other Investigators:

Trophic relationships information on bearded and ringed seals will be analyzed by OCSEAP RU #232. In addition, necessary information on the relationships of marine mammal distribution, densities, and activities to sea ice conditions will be provided by OCSEAP RU #248/249.

Tissue samples are obtained from as many specimens as possible and the samples are frozen in aluminum foil for later analyses. A project needs to be instituted that will determine the contaminant levels in these tissues for comparison to behavioral, biological, and ecological data obtained through this research unit, as well as RU #232.

XV. Management Plan:

1. Fiscal management of funds which may be obtained for this project will be handled through Mr. John Stewart, Division of Administration, Alaska Department of Fish and Game, Juneau. This Division provides monthly accountings of expenditures and encumbrances as well as current information on all financial aspects of the contract in accordance with mutual requirements of the contractor and contractee.

2. Scientific management within ADF&C will be the responsibility of John Burns, Fairbanks. Responsibilities include general coordination of all aspects including commitments relating to data management, field operations, logistic requirements, laboratory work, and editing of reports.

3. Research activities are the responsibility of John J. Burns and Kathryn J. Frost. These co-principal investigators are responsible for actually accomplishing the scientific studies called for under terms of the contract.

4. Outside coordination, review, and direction will be provided by the OCS Arctic Project Office, Geophysical Institute, University of Alaska.

5. Activity/Milestone/Data Management Charts are attached. These do not include indications of when data collected in the field will be submitted as we are already bound to a data submission schedule following every field endeavor.

XVI. Outlook:

By the end of this proposed project year we will have essentially completed our studies of the major aspects of the natural history and ecology of ringed and bearded seals as can be determined through examination of large samples of these animals in all areas except for the Beaufort Sea. The detailed species account for these seals will have been submitted.

Several new aspects of investigation are obvious to us and would represent logical extensions of current research efforts. However, the desirability of these new undertakings will depend upon the attitudes and needs of OCSEAP project managers.

A. Belukha Whales:

By 30 September 1979 we will have completed a very limited study of the belukha whale. The project managers may find it desirable to continue the study of this species through FY 1980. It should be kept in mind that we were asked to investigate belukha whales almost as an afterthought and have done so to the limit allowed by the constraints of money and manpower mainly already committed to other objectives. An intensified study of belukha whales in FY 79 would require approximately $40,000. Work would be accomplished from selected coastal hunting sites.

B. Seal-Polar Bear Interactions:

Polar bears take more ringed seals in a single year than do Eskimo subsistence hunters. We have demonstrated the impact of coastal settlements, including OCS support facilities, as far as reducing the density of ringed seals immediately around them. This appears to result from displacement rather than mortality. Most human activities occur in the nearshore zone where fast ice is present. It would be desirable to determine the distributional relationship between bears and ringed seals, the hunting success of bears in different ice habitats, the frequency of kills made by bears, sex and age structure of their prey, and the effect of bears on the ringed seal population.

Such a study could be conducted in the northeast Chukchi and Beaufort Seas. It would require approximately $50,000, not including logistic support. This logistic support would involve one or two UH1H helicopters (depending on desired intensity of the program) operating during March and April 1980.

C. Regional Density of Ringed Seals during the Winter-Spring Period:

There is a very real possiblity that new methodologies, involving the use of a portable sonar system mounted in a helicopter, can provide a significant breakthrough in our studies of ringed seals under the ice. Such a technology would allow us to determine the density of resident seals in many areas such as around drilling platforms, adjacent to settlements, and in the different ice habitats during winter. The feasibility of such a program is not known but is being investigated. If current technology is applicable, it could be used in FY 80. The cost of such a project would be about $30,000, not including the costs for sonar and logistic support. Logistic support would involve one UH1H helicopter during the period February through April. This project could be combined with project "B" (above), to some extent.

XVII. Standard Statements:

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise of any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year
Specimen collection data, weights, measurements, reproductive data and age	Coded data sheets, cards, mag tapes	up to 50 specimens, 5000 cards, 1 tape	025	format-yes processing-yes	10/78 to 12/78	2/79
Specimen collection data, weights, measurements, reproductive data and age	Coded data sheets, cards, mag tapes	up to 50 specimens, 5000 cards, 1 tape	025	format-yes processing-yes	1/79 to 3/79	5/79
Specimen collection data, weights, measurements, reproductive data and age	Coded data sheets, cards	up to 50 specimens, 5000 cards, 1 tape	025	format-yes processing-yes	4/79 to 6/79	8/79
Specimen collection data, weights, measurements, reproductive data and age	Coded data sheets, cards,	up to 50 specimens, 5000 cards, 1 tape	025	format-yes processing-yes	7/79 to 9/79	10/79
Aerial survey data location, tracks, conditions, animals observed	Coded data sheets, cards,	up to 60 survey legs, 1000 cards, 1 tape	026	format-yes processing-yes	4/79 to 6/79	9/79

Marine Mammal Specimen

Common to all Records
- X File Type
- X File Identifier
- X Record Type
- X Specimen Number
- X Sequence Number

Record Type '1' - Location
- X Geographic Position
- Water Depth
- Tide Stage
- Habitat (code)
- Behavior (code)
- X Ice Characteristics (codes)
- Transect Width (code)

Record Type '2' - Physical Characteristics I
- X EDS Taxonomic Code/Subspecies
- X Sex (code)
- Mammal Activities (codes)
- Group Size
- X Collection Method (code)
- X Individual Mammal Measurements

Record Type '3' - Physical Characteristics II
- X Individual Mammal Measurements
- Stomach Condition (code)
- X Gross Weight/Standard Length

Record Type '4' - Age/Reproduction - Male
- X Age and Age Determination (code)
- X Baculum/Testes Measurements
- X Sperm Determination (codes)

Record Type '5' - Age/Reproduction - Female
- X Age and Age Determination (code)
- X Reproduction Status (codes)
- X Number of Fetuses
- X Ovary/Corpora Lutea/Corpora Albicantia/ Follicles Measurements
- X Number of Uterine Scars

Record Type '6' - Stomach Contents
- Weight of Full/Empty Stomach
- Weight and Volume of Food Contents

Record Type '7' - Stomach Content Species
- EDS Taxonomic Code/Subspecies
- Life History (code)
- Misc. Stomach Contents (code)
- Number/Volume/Weight of Identified Items
- Mean/Maximum/Minimum Length of Identified Items

Record Type '8' - Text
- X Text

Common to all records
- X File type
- X File Identifier
- X Record Type
- X Flight/Station Number
- X Sequence Number

Record Type "1" - Header
- X Starting date/time, longitude and latitude
- X Ending time, longitude and latitude
- Elapsed time
- Distance along track
- X Number of Observers
- Type of Leg

Record Type "2" - Environmental
- X Platform type, ID, and direction
- X Altitude
- True Ground Speed
- X Primary, Secondary, and Total track width
- Total area surveyed for 1° and 2° tracks
- Visibility
- Cloud Amount
- Air Temperature
- Wind speed and direction
- Sea state
- Weather
- X Collection method

Record Type "3" - Ice
(Replicates 1, 2, 3 & 4)
- X Time of Observation
- X Ice type
- X Octas and characteristics of thin ice
- X Octas and characteristics of moderate ice
- X Octas and characteristics of heavy ice
- X Deformation
- X Transect width

Record Type "4" - Sighting
- X Taxonomic and subspecies code
- X Number of individuals and confidence codes for 1° and 2° tracks
- X Number of pups and groups on 1° and 2° tracks
- Mammal activity
- X Total number of individuals sighted

Record Type "5" - Group
- X Taxonomic Code
- Subspecies Code
- X Time
- X Track number
- X Group numbers

Record Type "6" - Text
- X Any alphanumeric data

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MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date

RU # 230 PI: Burns and Frost

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

MAJOR MILESTONES	1978			1979											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Specimen Collections															
Ringed Seals - Beaufort Sea		0			0	0									
Ringed, Bearded Seals - Bering Sea							0								
Surveys - Beaufort Sea									0						
Belukha Whales - Hope Basin								0	0						
Laboratory Activities															
Complete Analysis, repro material															
bearded seals	- -	- -	- -	0											
Complete Analysis, repro material															
ringed seals	- -	- -	- -	- -	- -	- 0	(Limited material thru Sept.)								
Age determinations - major collections															
of seals	- -	- -	- -	0 (Limited material thru Sept.)											
Complete Analysis of Belukha material															
in hand	- -	- -	- -	0											

0 - Planned Completion Date

X - Actual Completion Date

RU # 230 PI: Burns and Frost

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

		1978					1979								
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Analytical Activities															
Complete development computer programs		O													
Analyze data		- -	- -	- - -	- -	O									
Write-up Phase															
Distribution Data															
Bearded Seals			O												
Ringed Seals											O				
Species Productivity															
Bearded Seals				O											
Ringed Seals												O			
Complete Species Accounts															
Bearded Seals					O										
Ringed Seals															O

MILESTONE CHART

O - Planned Completion Date

X - Actual Completion Date

RU # 230 PI: Burns and Frost

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
Summarization of Belukha Studies Conducted to Date											O				

C. AIRCRAFT SUPPORT - HELICOPTER To accompany SURVEYOR in April

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed). Flights will be conducted within a 50-mile radius (or as deemed appropriate by ship's personnel) of the ship's position

2. Describe types of observations to be made.
Collection of seal specimens, determination of geographical differences in species composition and density through aerial surveys.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

1 April to 1 May, or 1 April to 25 April.

4. How many days of helicopter operations are required and how many flight hours per day?

6-8 flight hours per day for a maximum of 25 possible days.
Total flight hours? approximztely 175

5. How many people are required on board for each flight (exclusive of the pilot)?
Two

6. What are the weights and dimensions of equipment or supplies to be transported?
100 lbs of personal gear - rifles, packs, field gear. We anticipate carrying seals weighing up to 600 lbs.

7. What type of helicopter do you reommend for your operations and why?
Bell 206B equipped with floats. We have found this type of helicopter to be very satisfactory on our previous work of this type.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

NOAA

9. What is the per hour charter cost of the helicopter?

N/A

10. Where do you reommend that flights be staged from?
NOAA ship SURVEYOR in the Bering Sea ice front.

11. Will special navigation and communications be required?
Yes - Transponder, GNS-500 Navigation System, 30 human body bags, slings and sling ropes, floats, baskets on each float, intercom for 2 passengers and pilot.

C. AIRCRAFT SUPPORT - HELICOPTER Beaufort Sea

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed). We would propose to base a helicopter at Deadhorse and later Barrow and fly over the shore ice to leads at which we would collec seals. Most flying should be within 40 miles of the coast.

2. Describe types of observations to be made.

   Collection of seal specimens.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

   5-20 November would be optimum. A departure of 3 days earlier or later would be acceptabl

4. How many days of helicopter operations are required and how many flight hours per day? Approximately 10 days of helicopter operations will be required with about 4 hour: of flight per day.

   Total flight hours? 40

5. How many people are required on board for each flight (exclusive of the pilot)?

   Two

6. What are the weights and dimensions of equipment or supplies to be transported? 100 pounds of personal gear including rifles, packs, field gear. We anticipate carrying seals weighing up to 600 pounds.

7. What type of helicopter do you reommend for your operations and why? UH1H equipped with floats. We have found this type of helicopter to be very satisfactory in previous work of this type. Fixed wing cover is not required, fuel capacity is large.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

   NOAA

9. What is the per hour charter cost of the helicopter?

   Unknown

10. Where do you recommend that flights be staged from?

    Deadhorse, later Barrow

11. Will special navigation and communications be required?

    Yes - Transponder, GNS-500 Navigation System, 30 human body bags, slings and sling ropes, floats, baskets on each float, intercom for two passengers and pilot.

C. AIRCRAFT SUPPORT -- HELICOPTER Beaufort Sea

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed). We would propose to base a helicopter at Deadhorse (later Barrow) and fly over the shore ice to leads at which we would collect seals. Most flying would be within 60 miles of the coast.

2. Describe types of observations to be made.

   Collections of seals.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? The period 15 Feb. to 15 March is desirable. Within that period optimal time is 15 Feb. to 1 March.

4. How many days of helicopter operations are required and how many flight hours per day? Approximately 10 days of helicopter operations will be required with about 4 hour of flight time per day.
   Total flight hours? 40

5. How many people are required on board for each flight (exclusive of the pilot)?

   Two

6. What are the weights and dimensions of equipment or supplies to be transported? 100 pounds of personal gear including rifles, packs, field gear. We anticipate carrying seals weighing 600 pounds.

7. What type of helicopter do you recommend for your operations and why? UH1H equipped with floats. We have found this type of helicopter to be very satisfactory in previous work. Fixed wing support is not required, fuel capacity is large.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

   NOAA

9. What is the per hour charter cost of the helicopter?

   unknown

10. Where do you recommend that flights be staged from?
    Deadhorse, later Barrow

11. Will special navigation and communications be required?
    Yes - Transponder, GNS-500 Navigation System, 30 human body bags, slings and sling ropes, floats, baskets on each float, intercom for two passengers and pilot.

B. AIRCRAFT SUPPORT - FIXED WING Barrow

1. Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)
Eight fixed wing flights in areas of landfast ice between Point Lay and Barter Island.

2. Describe types of observations to be made.
Survey of ringed seals in the nearshore fast ice areas. Correlation of density with ice conditions.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.) Significant changes in seal density have occurred in the last seven years. Our surveys are always conducted during the peak of seal molting - 5-20 June.

4. How many days of flight operations are required and how many flight hours per day?
8 flight days
Total flight hours? 40 flight hours

5. Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback? Principal Investigation.

6. What types of special equipment are required for the aircraft (non carry-on)?
GNS or On Trac Navigation System in Twin Otter
What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment. None (should be part of the aircraft equipment)

7. What are the weights, dimensions and power requirements of carry-on equipment?
None

8. What type of aircraft is best suited for the purpose?
Single engine or Twin Otter

9. Do you recommend a source for the aircraft?
If "yes", please name the source and the reason for your recommendation.
NARL

10. What is the per hour charter cost of the aircraft?
C-180 at $85/hr Twin Otter at $350/hr

11. How many people are required on board for each flight (exclusive of flight crew)?
Two

12. Where do you recommend that flights be staged from?
Barrow

(1) COVER SHEET

Proposal Date: June 26, 1978

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Contract #: 03-5-022-53

Task Order #:

NOAA Project #:

Institution ID #: Alaska Department of Fish and Game

FY 1979 RENEWAL PROPOSAL

Research Unit Number 232

Title: Trophic relationships among ice inhabiting phocid seals and functionally related marine mammals

Cost of Proposal: $ 122,000

Lease Areas	
Beaufort Sea	50 %
Chukchi Sea	21 %
Norton Sound	11 %
St. George Basin	11 %
Bristol Bay	7 %

Period of Proposal: October 1, 1978 through September 30, 1978

Principal Investigators: Lloyd F. Lowry, Kathryn J. Frost and John J. Burns

Institution: Alaska Department of Fish and Game
Division of Game
1300 College Road
Fairbanks, Alaska 99701

(3) Technical Proposal

I. Title: Trophic relationships among ice inhabiting phocid seals and functionally related marine mammals
Research Unit Number: 232
Contract Number: 03-5-022-53
Proposed Dates of Contract: 1 October 1978 to 30 September 1979

II. Principal Investigators: Lloyd F. Lowry, Kathryn J. Frost and John J. Burns

III. Cost of Proposal:

A. Science--------------------------$120,040
B. PI provided logistics---------------1,960
C. Total----------------------------$122,000
D. Distribution of effort by lease area:
Beaufort Sea----------50%
Chukchi Sea-----------21%
Norton Sound----------11%
St. George Basin------11%
Bristol Bay------------7%

The above figures indicate the approximate distribution of total funds among the lease areas. Some areas such as the Beaufort Sea will require a large field effort and result in relatively few specimens, thus requiring little laboratory work. Others such as the Chukchi Sea may produce many specimens, requiring considerable laboratory time for a much smaller field effort.

IV. Background:

Four species of ice inhabiting phocid seals are the focus of this investigation. These are the ringed seal, *Phoca* (*Pusa*) *hispida*; the bearded seal, *Erignathus barbatus*; the spotted (also commonly called largha) seal, *Phoca vitulina largha*; and the ribbon seal, *Phoca* (*Histriophoca*) *fasciata*. The ringed seal and the bearded seal are circumpolar in distribution while the ribbon and spotted seal are restricted to the Bering, Chukchi, and Okhotsk Seas. The total number of these four species in Alaskan waters is approximately 1.5 to 2 million animals. About 10,000 of these seals, in aggregate, are taken annually by Alaskan Eskimo subsistence hunters. Ringed seals, and to a much lesser extent bearded seals, are the primary food items of polar bears (*Ursus maritimus*).

Prior to our investigations, published information on the foods of ice inhabiting seals in Alaskan waters included six studies, all quite limited in temporal or geographical coverage (Kenyon 1962; Shustov 1965; Kosygin 1966, 1971; Burns 1967; Johnson et al. 1968). Considerable work in this field has been done by Soviet investigators; however, most of it pertains to the western Bering Sea. We have translated several important papers previously available only in Russian (see 1977 Annual Report RU #232) and are presently collaborating with those persons active in this work (Bukhtiyarov, Frost and Lowry, in prep.).

During the first year of work by this research unit (FY 76), a considerable amount of effort was devoted to acquiring the capability to quickly and accurately identifiy prey items found in seal stomachs. This involved acquisition of a considerable amount of literature and specimens for comparative purposes. A search for published and unpublished data on foods of ice inhabiting phocid seals was begun. Collections of specimen material were made from a number of villages in order to begin to assess geographical variation in foods and to identify areas and species of particular interest. Most specimens were obtained from the times and places where Native hunters are most active, i.e. the northern Bering and Chukchi Seas in late spring and summer. A large sample of ringed and bearded seals was obtained from the village of Shishmaref to examine age- and sex-related dietary differences. Shipboard work in the Beaufort Sea and in the ice front of the Bering Sea was begun. The Bering Sea ice front is of particular interest because it is the pupping and breeding habitat of spotted and ribbon seals and is a region where major conflicts among OCS development, fisheries, and marine mammals are likely.

In FY 77 the search for literature on food habits of seals was completed and several important Soviet articles were translated. Collections in some villages were repeated in order to increase sample sizes and verify results from the previous years. Several new localities were sampled. As lease areas began to be prioritized, emphasis was shifted to priority areas (Beaufort and Chukchi Seas, and Norton Sound). Shipboard work in the Beaufort Sea was expanded and included limited studies of the distribution and natural history of key prey species. Ringed seals were collected from Norton Sound at several times of year to look at seasonal shifts in prey. Shipboard ice front work was continued. Collection of specimen material from belukha whales was begun. Considerable data analysis was done and accumulation and synthesis of other trophics-related data was begun.

In FY 78 a considerable amount of effort was devoted to the Beaufort Sea. Specimen collections in November and March produced the first non-summer data from that area. Presently available trophics data from the Beaufort Sea were synthesized and plans were made for an integrated Beaufort Sea trophics cruise in summer 1978. Spring collections were continued at villages with good historical data to examine year-to-year dietary differences. Specimens were collected at selected villages during fall and winter to verify seasonal prey utilization patterns. Shipboard work was done in the ice remnants of the Bering Sea, an important area for spotted and ribbon seals. Analysis and synthesis of data were intensified.

In FY 79 we propose to continue and largely conclude field collection efforts of this research unit. November and March collections in the Beaufort Sea will be repeated to verify results of the previous year and increase our sample size and geographical coverage. The utilization of prey in relation to availability will be examined directly by collection of ringed seals and forage organisms in Norton Sound. Collection of specimens will be made in the spring at several villages selected for monitoring purposes. These collections will be done at a reduced level and will involve minimal participation by project personnel. Baseline data will be collected from villages in the southern Bering Sea from which no data are now available. Shipboard work will be conducted in the Bering Sea ice front to examine relative utilization of capelin and pollock by spotted and ribbon seals. Specimen material will be collected from belukha whales and if possible arctic foxes. Considerable effort will be devoted to analysis and synthesis of data and a final report for the Beaufort Sea will be prepared and submitted.

Our work will provide input to other studies on the biology of marine mammals in the areas concerned (RU #230), baseline studies of hydrocarbons and heavy metals in the environment (RU #288, 276), and studies of ecosystem dynamics (RU #99). We will extensively utilize information gathered by many studies concerned with the abundance, distribution, natural history, and hydrocarbon sensitivity of invertebrates, fishes, birds, and marine mammals (e.g. RU #5/303, 6, 175) in the evaluation of our results.

V. Objectives:

The general objectives of this research unit are as follows:

1. Compilation of existing literature and unpublished data on food habits of ringed seals, bearded seals, spotted seals, and ribbon seals. Pertinent works by Soviet investigators will be located and translated. In addition, available information on distribution, abundance, and natural history of potentially important prey species is being gathered. This will allow an assessment of the present state of knowledge and facilitate identification of major information gaps which require immediate study by OCSEAP.

2. Collection of sufficient specimen material (stomachs) for determination of the spectrum of prey items utilized by the species being studied throughout the geographic range involved and during all times of year that the species occurs in a particular area. The contents of these stomachs will be 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. This will result in identification of critical prey species which merit in-depth study by other OCSEAP projects. Critical foraging areas (if such exist) will be delineated. This may have direct effect on the suitability of certain tracts for leasing.

3. Analysis of feeding patterns in relation to distribution, abundance, and other life history parameters of key prey species. This will involve 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. Such analyses are an initial step toward ecosystem level evaluation of the possible effects of OCS development on the species being investigated. The accomplishment of this objective is largely dependent on information gathered by other OCSEAP projects involving benthic and pelagic organisms.

4. Analysis of trophic interactions among these species and other potential competitors such as walruses, whales, marine birds, fishes, and humans (c.f. Lowry, Frost and Burns, 1978). Input from other OCSEAP studies will be critical in this phase of the project.

5. With the understanding thus obtained of the trophic interrelationships of ice inhabiting phocids in the Bering, Chukchi, and Beaufort marine systems, 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 influences on populations of competitors for food resources.

Specific objectives for FY 79 are as follows:

1. Collections of ringed seals and if possible bearded seals will be made at two locations on the Beaufort Sea coast (Barrow and Prudhoe Bay) in November and March. To the maximum extent possible these collections will be done in conjunction with proposed integrated winter ecological studies. Subsequent to these collections, data from the Beaufort Sea will be synthesized and a final report for that area prepared.

2. The utilization of prey by ringed seals in relation to the available spectrum of prey will be examined in Norton Sound. Otter trawls will be done in the same locations from which seal specimens are obtained. Species composition of the trawl catch will be quantitatively compared to the stomach contents of the seals. We will attempt to do this in November and in June.

3. Limited collections of stomachs from ringed and bearded seals will be made in the spring at several villages selected for monitoring purposes. The villages are Nome, Gambell, Diomede, and Shishmaref. A large amount of historical data is available from each of these locations. These collections will be reduced in size from previous years and will involve minimal field participation by project personnel.

4. Seal food habits data will be collected during the spring from villages in the southern Bering Sea. Only very limited data are now available from that area.

5. Shipboard work will be done in the Bering Sea ice front in April. The purpose of this work is to refine our evaluation of the utilization of forage fishes by spotted and ribbon seals. This is a question of major interest not only for OCSEAP but also for multi-species fishery management.

6. Whenever possible, specimen material from belukha whales will be collected and analyzed. It is anticipated that most material will come from the Chukchi Sea.

7. If possible, stomachs from arctic foxes trapped along the Beaufort Sea coast will be examined. Material will be provided by other OCSEAP investigators as arranged through the Arctic Project Office.

8. Literature necessary for the preparation of final reports will be accumulated. Final analysis of our data will be begun. Extensive use of OCSEAP data in the NODC data banks is anticipated.

VI. General Strategy and Approach:

The strategy proposed to evaluate the trophic relationships among ice inhabiting seals is as follows:

1. A large number of stomachs from the four seal species will be collected from coastal and offshore localities in the Bering and Chukchi Seas at various times of year (see Section VII). Particular emphasis will be placed on sampling in the Beaufort Sea.

2. Volume of stomach contents will be determined and prey items identified and quantified (see Section VIII).

3. From these samples, the major food dependencies of each seal species will be correlated with the important variables of age, sex, season, and geographical areas.

4. Prey utilization will be compared with prey abundance (as indicated by the literature, results of other OCSEAP projects, and trawling conducted by this project) to determine degree of selectivity and availability of primary and alternate food sources (see Section VII).

5. Trophic interactions among the ice inhabiting phocids as well as trophic interactions among these species and other major components of the marine system will be examined.

6. Finally, we will integrate information on life histories of important prey species with the information described above and evaluate at the system level the potential impact of OCS development on the species of seals being considered.

VII. Sampling Methods:

As during the previous contract years, we will obtain specimen material in two primary ways:

1. The bulk of our specimen material will be collected at coastal hunting villages located in the study areas.

2. In areas and at seasons of the year where specimen material cannot be obtained in the above manner, we will collect specimen material ourselves, mainly from ships and helicopters. When collecting from ships, we will sample the available food resource by means of otter trawls.

Location	Sampling Schedule
Village Collections	
Southern Bering Sea	April-May
Nome	May-June
Gambell	April-May
Diomede	May-June
Shishmaref	July
Ship and Helicopter Collections	
St. George Basin/Bristol Bay ice-reinforced vessel with helicopter	April
Norton Sound small boat	November, June
Beaufort Sea helicopter	November, March

Field collection efforts will be substantially reduced from previous years. Village collections will be made in conjunction with other ADF&G activities and will not require direct participation by the principal investigators. All collections are designed for specific purposes such as monitoring or filling of major data gaps. The adequacy of small samples will be evaluated in light of variability observed in large samples.

VIII. Analytical Methods:

Seal stomachs will be preserved and taken to the ADF&G office in Fairbanks. The contents will be separated and identified using appropriate keys and comparative material on hand. Some identifications will be made at the University of Alaska Marine Museum/Sorting Center. Estimates of the numbers and sizes of individuals, and measurements of volume (water displacement) will be made for each prey type. Results will be compiled and tabularized, and comparisons will be made of foods utilized by species, age group, sex, locality, and time of year. Comparisons will also be made of food utilization in relation to availability, both on a narrow scale by comparing the results of otter trawls in areas where seals are collected with the food items found in seal stomachs, and on a broad scale by comparing overall distribution and abundance of prey (as determined by other investigators) with stomach contents of seals taken from the same geographical area. Many of the techniques used and problems encountered in investigations of feeding habits of pinnipeds have been discussed by Spalding (1964).

IX. Deliverable Products:

A. Digital Data

1. Parameters Recorded

File Type 025
Marine Mammal Specimen

Common to all records:
- File Type
- File Identifier
- Record Type
- Specimen Number
- Sequence Number

Record Type 1 - Location
- Latitude/Longitude
- Date/Time of Collection

Record Type 2 - Physical 1
- Taxonomic Code
- Subspecies/Sex Code

Record Type 6 - Stomach contents
- Total Volume of Contents

Record Type 7 - Stomach Contents Species
- Taxonomic Code/Subspecies
- Number/Volume of Items Identified

Record Type 8 - Text
- Text

Record Type 9 - Age
- Age/Age Accuracy Code
- Age Unit Code
- Age Determination Code

The above data parameters will be used to analyze the food habits of seals with respect to time, location, age, and sex.

2. List of digital products.

See attached Data Products Schedule.

B. Narrative Reports

It is not anticipated that any reports other than quarterly, annual, and final reports will be generated by this project.

C. Visual Data

All visual data will be included in quarterly, annual, and final reports. These data will be in map, diagram, and table form.

D. Other Nondigital Data

None

X. Quality Assurance Plan:

The identification of prey items found will be verified as necessary by the University of Alaska Marine Museum/Sorting Center, or other experts as appropriate. Additionally, field work, especially on ships, will involve direct collaboration with investigators of other disciplines. Comparison of findings with results of other studies conducted in Canada and the USSR will continue to be undertaken. Methods are described in Sections VII and VIII. Processing of data involves sorting into subsets followed by calculations of means and percents. Such sorting and calculations are done manually or with computers or calculators.

XI. Special Sample and Archival Plans:

A reference collection of representative organisms found in the stomachs of seals is being assembled and stored at the ADF&G office in Fairbanks. Examples of unusual specimens will be given to the University of Alaska Marine Museum/Sorting Center. Specimens of special interest to other investigators will be made available whenever possible.

XII. Logistics Requirements:

See attached logistics requirements forms.

XIII. Anticipated Problems:

The success of field collections of seal specimen material is by nature somewhat unpredictable. Certain periods of very active hunting in coastal villages are quite predictable. All village collections will be done during those active hunting periods.

Most ship and helicopter operations will require OCSEAP logistics support. Lack of appropriate logistics and inclement weather are the major problems anticipated in those operations.

Data retrieval and analysis will be extremely important during the upcoming contract year. Negotiations are presently underway for the purchase of a data microprocessor to facilitate in-house data entry and data analysis. We anticipate an initial shakedown period in which to familiarize ourselves with hardware and during which software must be written and debugged. After that period data analyses should proceed smoothly. In addition to analyses of in-house data we will require retrieval of data from other OCSEAP research units by NODC in order to more broadly examine trophic relationships among seals and their prey species. Without such data from other investigators and from NODC our analyses will of necessity be incomplete.

XIV. Information Required from Other Investigators:

Supporting information on the natural history of two of the four species of seals being studied (ringed and bearded) will be provided by OCSEAP RU #230. Information on ribbon and spotted seals is available from other sources including unpublished data of ADF&G.

Detailed information on the distribution, abundance, natural history, and hydrocarbon sensitivity of key food items is needed in order to assess potential effects of OCS development on the seal species being studied. Listings of key prey species and the types of information needed have been made repeatedly in quarterly and annual reports of this project and in direct communications with project office personnel. Some examples are included in Section 5-E.

XV. Management Plan:

1. Fiscal management of funds which may be obtained for this project will be handled through Mr. John Stewart, Division of Administration, Alaska Department of Fish and Game, Juneau. This Division provides monthly accountings of expenditures and aspects of the contract in accordance with mutual requirements of the contractor and contractee.

2. Scientific management within ADF&G will be the responsibility of John Burns, Fairbanks. Responsibilities include general coordination of all aspects including commitments relating to data management, field operations, logistic requirements, laboratory work, and editing of reports.

3. Research activities are the responsibility of Lloyd Lowry, Kathryn Frost, and John Burns. These principal investigators are responsible for actually accomplishing the scientific studies called for under terms of the contract. They shall actively lead the proposed work and shall take full responsibility for timely completion of all objectives.

4. Outside coordination, review, and direction will be provided by the OCS Project Office, Geophysical Institute, University of Alaska.

XVI. Outlook:

The only field activities planned for FY 80 would be conducted in the Norton Basin lease area. Two distinct projects are presently being contemplated. One project will involve an in-depth study of the seasonal changes in major food items of ringed seals. The abundance and food habits of primary forage fish species (arctic and saffron cod) will also be examined. The second project will examine summer utilization of the coastal zone of Norton Sound and the southern Seward Peninsula by spotted seals and belukha whales. Distribution of these species will be compared with distribution of forage fishes which has already been determined by another OCSEAP project. Limited selective collections of spotted seals will be made to verify the forage species being utilized. Analysis and synthesis of data and preparation of final reports for most lease areas are planned. Computer and graphics assistance will be required. A funding level of $80,000 should be adequate for FY 80.

XVII.

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship.

DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
total volume of stomach contents and volume and number of individuals of each species found in contents	coded data sheets, cards mag tape	up to 50 stomach samples, 1500 cards 1 tape	025	format-yes processing-yes	10/78 to 12/78	3/79
total volume of stomach contents and volume and number of individuals of each species found in contents	coded data sheets, cards mag tape	up to 50 stomach samples, 1500 cards 1 tape	025	format-yes processing-yes	1/79 to 3/79	6/79
total volume of stomach contents and volume and number of individuals of each species found in contents	coded data sheets, cards mag tape	up to 250 stomach samples, 7500 cards 1 card	025	format-yes processing-yes	4/79 to 6/79	9/79
total volume of stomach contents and volume and number of individuals of each species found in contents	coded data sheets, cards mag tape	up to 150 stomach samples, 4500 cards 1 tape	025	format-yes processing-yes	7/79 to 9/79	12/79

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April 7, 1978

Dr. Gunter Weller
OCS Arctic Project Office
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Dear Gunter:

In the process of considering the potential sensitivity, particularly from the trophic point of view, of the Beaufort Sea to OCS development, arctic cod (Boreogadus saida) repeatedly appear as a key element. Other types of organisms such as euphausiids, amphipods and mysids are certainly also important but it appears that among the small crustaceans there are several species which fill similar ecological roles. Arctic cod are the only common plankton eating fish found both nearshore and offshore. As trophics studies in the area have progressed, the apparent importance of this species to other vertebrates, particularly to ringed seals in the winter, has increased greatly. I suspect that arctic cod are also important in the diet of belukha whales in the Beaufort Sea. They also function as competitors for food with other plankt ores such as bowhead whales.

We have discussed in the past the desirablility of petrochemical tolerance studies on Boreogadus. I'd like to take the liberty to suggest some desirable information products that would be of great value both in prediction and evaluation of OCS development effects.

A survey of available literature indicates that the eggs of arctic cod are released under ice in the winter and float. They presumably end up in a layer just below the ice where they stay for several months. They transform into larvae in spring and again are usually found near the surface although they apparently can and do move vertically in the water column. As we know, oil also floats and therefore a release of oil or gas under ice in winter (the most likely type of disaster given present development scenarios) would put the petrochemicals and eggs and larvae in very close proximity. The vertical distribution of arctic cod eggs and larvae in the water column throughout the winter and spring should be verified. The exact position of the eggs relative to the ice could make a major difference in mortality caused by oil. It seems to me that collections could be made quite simply with some sort of pump system operated through the ice. This could also be done at several locations (perhaps at only one time of year after the peak of spawning) to get a picture of geographical distribution of eggs. Preliminary data we collected last summer indicate that adult Boreogadus are less common east of Prudhoe Bay than to the west. In conjunction with temporal sampling of vertical distribution of eggs and larvae, the petrochemical sensitivity of these developmental stages should be investigated. It seems quite common for different life history stages to have different tolerances to petrochemicals. Attention should be given to induced morphological abnormalities as well as lethal limits. It should then be quite easy, given some basic information on dispersion and diffusion of oil and its constituents in the water column, to predict the effect of an oil release on early life stages of arctic cod. In the event of an actual release of oil it should be possible to easily do on-site collections, make comparisons with baseline data, and actually evaluate effects.

Adult arctic cod should also prove useful as an indicator. In summer they are distributed throughout the water column and as such only a portion of the population would contact surface oil. It would nonetheless be valuable to have baseline data on effects of oil on survival and vitality of adults. The most likely effects on adult arctic cod would be mediated through the food chain and would be manifested as reduced abundance, reduced fecundity, reduced growth or a shift in food habits. Samples can be collected relatively easily in summer by otter trawls and in winter by jigging through the ice. I would suggest selecting three stations within the proposed lease sale area and collecting arctic cod at those stations in August and November. These samples should be examined for age and growth, food habits, and reproductive status. When development commences, on-site samples should be collected. When compared with baseline samples these should allow evaluation of effects of drilling muds and petrochemicals. It would also be wise to monitor levels of hydrocarbons and heavy metals in adult fish collected near development activities.

As you can see I feel there is great potential to use Boreogadus as an indicator species. The position of this species in arctic food chains is such that it could serve as a monitor of the health of much of the pelagic food web provided that sufficient baseline data are available. If the effects of environmental insults on arctic cod are known, the effects on higher trophic levels can be reasonably well predicted. Data collected in the Beaufort Sea would be of considerable value in other areas as well since Boreogadus is important in the trophic systems of the Chukchi and northern Bering Seas. I hope that studies such as suggested here will be initiated soon because I feel they would substantially increase our ability to predict and subsequently evaluate the effects of OCS development in arctic waters.

Sincerely,

Lloyd F. Lowry
Marine Mammals Biologist
LFL:lm

Table 18. Key prey species of ribbon, spotted and bearded seals in the Bering, Chukchi and Beaufort Seas.

	Southeastern Bering Sea	Northern Bering Sea	Chukchi Sea	Beaufort Sea
Ribbon seals	*Theragra chalcogramma* *Lycodes* spp. *Mallotus villosus* *Pandalus* spp.	*Theragra chalcogramma* *Boreogadus saida* *Pandalus goniurus*		
Spotted seals	*Mallotus villosus* *Theragra chalcogramma* *Clupea harengus* *Pandalus* spp.	*Eleginus gracilus* *Clupea harengus* *Osmerus esperlanus* *Ammodytes hexapterus* *Pandalus goniurus*	*Clupea harengus* *Eleginus gracilus* *Boreogadus saida* *Crangon septemspinosa*	
Ringed seals	*Eleginus gracilus* *Neomysis rayi* *Parathemisto libellula*	*Boreogadus saida* *Eleginus gracilus* *Pandalus* spp.	*Boreogadus saida* *Eleginus gracilus* *Crangon septemspinosa* *Ampelisca* spp.	*Boreogadus saida* *Parathemisto libellula* *Thysanoessa* spp. *Mysis litteralis*
Bearded seals	*Chionocetes opilio* *Hyas* spp. *Argis lar* *Crangon dalli*	*Hyas coarctatus* *Chionocetes opilio* *Serripes groenlandicus* *Argis lar*	*Hyas coarctatus* *Serripes groenlandicus* *Crangon septemspinosa* *Argis lar*	*Hyas coarctatus* *Sabinea septemcarinata* *Boreogadus saida*

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

JAY S. HAMMOND, GOVERNOR

1300 COLLEGE ROAD
FAIRBANKS 99701

February 16, 1978

Dr. Gunter Weller
OCS Arctic Project Office
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Dear Gunter:

Lloyd and I have spent considerable time during the last week thinking about Beaufort Sea trophic interactions and the direction of future work. We have come to the not so startling conclusion, as have many others before us, that "we" (the marine mammal team, OCS, and/or the scientific community) can't learn everything about everything, and even if we could we probably wouldn't understand all the implications. We can, however, make a better stab at some parts of the system than at others. We can probably make a reasonable evaluation of pelagic food webs - identification of important species and interactions among those species. In the Beaufort Sea, the pelagic system is in general less species-rich, the energy inputs are fewer, and the higher trophic level species, i.e. mammals and birds, are more obvious than in the benthic system.

Benthic communities are a much different story. In many parts of the world they have been much studied and are still a puzzle. They will probably remain so in the Beaufort Sea for some time. Ideally we should know something about the diversity and standing stock of the benthos, species composition, and seasonality of all those parameters. Some of this information is available at present, particularly for infauna. Additionally we should know something about production rates within the system, the input and flow of energy and materials, and the interaction of species. This we simply do not have the time or money to do a good job on. There are too many species and too many connections within the benthic community. The best we can do is accumulate data on community structure and as time goes on hope to fill in bits and pieces on interspecies dependencies.

One of the prime data needs in the benthic system is information on the gross distribution of the invertebrate epifauna. In addition to species lists and distributions we need identification of epifaunal associations -

e.g. identifiable epifaunal communities. We might then be able to rank the importance of the various communities to the ecosystem as a whole and develop priorities relative to what areas development should or should not be impacted.

One of the reasons the pelagic system is more approachable is that food webs are fairly simple and key species for future research have already been identified. This, to date, has not been done in the benthic system. If epifaunal associations or communities could be identified, one could then determine one or two characteristic or "key" species from a community and proceed to determine physical and trophic sensitivities of those few species. We at present have no focal point within the benthos. Data exist on a variety of species but there is no adequate way to prioritize importance within the community.

The ideal situation, for those of us doing the science and for user agencies, would be a perfect understanding of all links within the system. Such understanding would allow the development of a model which could give complete predictability of the consequences of petroleum-associated development. Obviously such complete understanding is not within reach. Desirable, though less than ideal, would be thorough understanding of at least the major links within the system, effects of natural variation on those links, and reliable predictability of the effects of human-caused perturbations. Even this is probably not attainable. What the study of trophic interactions within a system can do is provide partial understanding of small parts of the system and actual or hypothetical interactions among some of those parts. With this understanding of parts we can make educated guesses as to possible or probable ramifications of disruption to the system. We cannot make absolute statements about what will happen. We <u>can</u> identify potential differential sensitivity of parts of the system, evaluate which times or places or species appear to be most or least vulnerable, and make recommendations as to how to minimize potential detrimental effects of OCS development.

Some realistically obtainable goals, which should increase our understanding of the system, are as follows:

1) Delineation of major species interactions or "key links" in the Beaufort Sea. We can do this in a general manner for the benthic food web and in a much more specific manner for the pelagic/planktonic food web.

2) Assessment of the sensitivity of key links to both natural fluctuations and to expected human-caused perturbation.

3) Extrapolation from the sensitivity of parts to the sensitivity of entire systems or subsystems.

An example of delineation of species interactions within a subsystem is as follows:

Sun → phytoplankton → copepods → arctic cod → seals, birds, people

Prior to this summer the link now entitled copepods would have read zooplankton. In light of data acquired during the 1977 GLACIER cruise, we now know that in offshore areas during the summer copepods form the bulk of the arctic cod diet. Additionally it appears that arctic cod may select for a certain size or species of copepod (Calanus hyperboreas and Euchaeta glacialis, large predominantly deep water arctic species, were two of the most abundant prey items). This is a subsystem we can really do something with. Some historical data are available on copepod distribution. Determining physical parameters are known for at least some species in some parts of the world, and some species have been tested for hydrocarbon sensitivity (Calanus hyperboreas was treated in the Canadian arctic and found to be "surprisingly resistant to oils tested"). Analysis of data such as these should provide a basis for beginning to assess sensitivity. About arctic cod we know relatively little. We do, however, know enough to establish it as a key link. Ringed seals utilize a very few prey species in the Beaufort Sea. Of these prey species some seem to be only seasonally available in large quantities (euphausiids, hyperiid amphipods) while others are available in smaller numbers and amounts (amphipods, mysids) but apparently over a wider temporal and geographical range. Arctic cod is the remaining major prey item. Cod are available year-round in apparently more or less constant numbers. They are relatively large and energetically efficient prey species. They seem to be a mainstay item in the diet of ringed seals. With the aforementioned information we can extrapolate as to the sensitivity of that subsystem. Were copepod numbers to be depleted by a large-scale environmental perturbation it seems reasonable to guess that offshore arctic cod will be affected. This might be in the form of worsened physical condition and heightened susceptibility to predation, movement of arctic cod to unaffected areas, or arrested production and development of next year's young. Any of these may result in lessened availability of food to ringed seals. Depending on time and location this may lead to poorer physical condition, causing increased susceptibility to disease or predation, production of fewer or smaller young, or migration from the area.

Examination of the above system does provide us with a basis upon which to predict effects of perturbation. It will probably not lead to recommendations of where or when to develop, but it does begin to allow evaluation of the magnitude of effects of catastrophic events and give us a baseline picture of what the system looks like.

A second type of subsystem analysis might give information which would bear on lease tract selections. For example, bearded seals are closely tied to the benthic food web. Upon identification of benthic community types, it would be possible to evaluate which of those types are most suitable as bearded seal foraging areas. With information on geographical distribution of those communities we can recommend sensitive areas where, for example, the sinking of oil or perturbation of the bottom would not be desirable.

All of this is leading up to a slightly different approach to the 1978 Beaufort Sea trophics cruise, and to the trophics work in general. As has been discussed previously, we would like to have a three-week plankton, fish, benthic invertebrate, and marine mammal cruise. Participants would include Alaska Department of Fish and Game and University of Alaska personnel, Rita Horner and Drew Carey. Sampling operations to take place on board would include trawling, plankton tows, grabs, and seal collecting. Presumably a second cruise would address similar questions from the bird point of view. We would attempt to further delineate species interactions in the pelagic system and determine basic community composition in the benthic/epifauna system. Projects would break down as follows:

Phytoplankton and zooplankton - Rita Horner
Benthos - Drew Carey
Epifauna, demersal fishes, seals - Frost/Lowry/Mueller, Fay/Shults

Table 1 outlines a suggested field sampling program.

We would like to sample several discrete areas or "stations" rather than do survey type sampling. Recommended station locations for the three-week cruise are: the edge of pack ice at approximately 156° (off Barrow); 153° (off Pitt Point) to accommodate historical benthic sampling at that location; 14°-150° (between Prudhoe and Harrison Bays); and 145° (off Camden Bay). These locations bracket the proposed lease area and incorporate areas where historical data are available. In addition to these designated stations we need to retain the flexibility to stop and examine areas of high biological activity. From last summer's work it is obvious that the Beaufort Sea is not homogenous as regards biological activity. If critical areas do in fact exist they will be in areas of greater activity. At present we have little way to predict where they may be.

A model cruise for the first three weeks would be:

Aug. 1	onload in Barrow, proceed to station off Barrow
Aug. 2-4	work Barrow station
Aug. 5	transit and trawls
Aug. 6-9	Pitt Point station-historical benthic and station work
Aug. 10	transit, trawls, etc.
Aug. 11-15	Prudhoe/Harrison station
Aug. 16	transit, trawls, etc.
Aug. 17-20	Camden Bay station
Aug. 21	transit to Prudhoe, offload mammal people

In addition to field sampling, we would suggest the following associated data analyses:

Frost/Mueller - analyze trawl data for patterns of epifaunal invertebrate distribution, and identification of epifaunal communities.

Carey - analysis of feeding types within the benthos, identification of major trophic links.

Horner - compilation of historical information on fluctuations in algal production, analysis of determinants of annual algal production (e.g. light, temperature, salinity, ice cover, nutrients, etc.).

Table 1. Field sampling.

Phytoplankton	Horner	Production, how does ice affect production, etc.		
Zooplankton	Horner	Sample fish food availability concurrent with otter trawls (esp. copepods)		
	Horner	Sample seal, bird and bowhead whale food availability concurrent with bird or mammal collections		
	Horner & Carey	Sample underice and pelagic amphipods and determine food habits (do this on a seasonal basis)		
Benthos (Grabs)	Carey	Pitt Point - continue present work on seasonality		
	Carey & Horner	Sample benthic amphipods and determine foods on a seasonal basis. Compare with pelagic and underice amphipods		
	Carey	Sample demersal fish food availability by sampling infauna concurrently with otter trawls. Grabs to be worked up primarily for those species or groups appearing as food items.		
Epifauna/ Demersal Fish	Frost/Lowry	Demersal fish distribution	Carey	Demersal fish food habits
	Frost/Lowry	Polar cod natural history	Lowry/Mueller	Polar cod food habits
	Frost/Mueller	Epifaunal invertebrate distribution, community structure		
	Fay/Shults	Parasitology/pathology of demersal fishes		
	Carey	Food habits, predator/prey ratios of major invertebrate species (Hyas, sea stars, snails, etc.)		
Seals	Frost/Lowry	Seal food habits		
	Fay/Shults	Parasitology/pathology of seals		

Horner - analysis of historical data and literature for requirements of Thysanoessa spp., Mysis spp., and Parathemisto spp. - relation to temperature and salinity, and what's known about reproductive periodicity, life span, seasonal and yearly fluctuations in distribution and abundance, food habits with whatever seasonal variation might be known.

Frost/Lowry - analysis of demersal fish distribution.

Fay/Shults - estimate parasite load, rates of occurrence of pathogens and pathological conditions in seals of the Beaufort Sea and compare these with rates in like hosts over a wide area of the Alaskan continental shelf.

Success of this sampling approach will depend on timely sample analysis and good communication and data exchange among investigators. If sample analyses could be complete within 4-6 months, or at least major crucial comparative station work done, there could be time to put together synthetic reports by the spring, reevaluate the year's effort, and redirect sampling effort for the following summer if desirable.

The following products might result from this sampling approach:

1) An assessment of the sources of offshore production, integrated with available ice, oceanographic, and meteorologic data. Magnitude and causes of natural variation should be discussed, relative rates of production in open water vs. under sea ice be compared, and the predicted effects of heavy or light ice years on algal production presented. With this information one should be able to delineate areas and/or times which oil spills would be most detrimental to production, i.e. under the ice or in open water, during winter or summer months. Horner

2) Analysis of historical data and compilation of existing Beaufort Sea records on distribution and abundance of Thysanoessa spp., Mysis spp., and Paramethisto spp., and delineation of determining factors. Compilation and analysis of literature on life history events, seasonal food habits, reproductive periodicity, etc. of the same species. This should give us some idea of the kinds and magnitude of natural variation to expect, and of the sensitivity of species to changing environmental parameters. Until we have some idea of natural variation and sensitivity, we stand little chance of being able to evaluate man-caused perturbations.
Horner

3) Comparison of arctic cod foods with copepod distribution and determining factors. This species interaction is a key link in the pelagic/planktonic system. By examining prey specificity, seasonal variation in prey, availability of alternate prey items, determining factors for those prey items, and sensitivity of prey to hydrocarbons, we can evaluate the sensitivity of this particular trophic link.
Lowry/Mueller and Horner

4) Comparative seasonal food habits of benthic and under ice amphipods. Gammarid amphipods seem to be widely distributed and available throughout the year. They are a major link between production/detritus

and fishes, birds, and mammals. An understanding of what sustains them in winter as well as summer months is important in predicting how sensitive they may be to disrupted algal production or contamination of the bottom. Comparison of food items with availability of those species would be valuable when possible. Seasonal information may be partially obtainable through analysis of archived samples. Horner and Carey

5) Comparison of demersal fish stomach contents and bottom grab samples from the same location should identify some key benthic links. Species dependencies can be looked at in relation to distribution of both predator and prey species. Carey and Frost/Lowry

6) Identification of epifaunal associations/communities. This should give a place to start looking for key species within those communities, critical needs of key species, and their susceptibility to disturbance. Frost/Mueller

7) Food habits of key epifaunal invertebrate species, feeding type analysis of major benthic invertebrates, and predator/prey relationships within the benthos/epibenthos. Carey

8) Occurrence of parasites, pathogens, and pathological conditions in seals of the Beaufort Sea. Examination of host/parasite relationships in conjunction with food habits of seals should help delineate mechanisms for transfer of parasites through the food web. Magnitude of parasite load and pathogen occurrence, correlated with physical condition of the seals, may shed light on the recent decline in numbers of ringed seals in the Beaufort Sea. Fay/Shults

In addition to the summer icebreaker cruise we would suggest extending this general sampling scheme to a winter program. Phytoplankton studies could be modified to concentrate more on ice algae. Zooplankton studies could be continued through the ice with the use of, for example, a one meter vertical plankton net and under ice tows from hole to hole. Fish and epibenthos could not be sampled in the same manner as in summer. However, arctic cod could be sampled by jig fishing. Seals could be sampled from the same general geographical area. Such winter sampling could be done at either two or three different times during the winter - for example, November and April, or November, February-March and May-June. Joint sampling efforts would be desirable - all participants could utilize the same ice holes and logistic support. Somewhere off the Prudhoe Bay area would be a logical winter station. There is a possibility that industry cooperation and/or assistance could be enlisted in providing equipment with which to get through the ice, lab space, etc. Were it deemed desirable, such a seasonal sampling program could be implemented as early as this spring in order to provide the maximum amount of data possible by leasing time.

Gunter, I think I've written a book and I'm worn out. Hope these thoughts are useful.

Sincerely,

Kathryn J. Frost

Kathryn J. Frost
Marine Mammals Biologist
Division of Game

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date

RU # 232 PI: Lowry, Frost and Burns

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

	1978			1979											
MAJOR MILESTONES - Specimen Collections	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Beaufort Sea															
Barrow - helicopter		0				0									
Prudhoe Bay - helicopter		0				0									
Chukchi Sea															
Shishmaref - village										0					
Belukha whale collections								0	0						
Norton Sound/Northern Bering Sea															
Nome		0						0	0						
Gambell							0	0							
Diomede								0	0						
Southcentral Bering Sea							0	0							
St. George Basin - Bristol Bay															
Ice-reinforced vessel w/helicopter							0								

MILESTONE CHART

O - Planned Completion Date

X - Actual Completion Date

RU # 232 PI: Lowry, Frost and Burns

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

MAJOR MILESTONES - Other Project Activities		1978					1979								
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Acquisition and archival of reference specimens	O						O					O			
Processing of stomach contents	O					O						O			
Analysis of data	O						O					O			
Submission of data			O			O			O			O			
Preparation of quarterly and annual reports			O			O			O			O			
Submission of Beaufort Sea final report												O			
Preparation of FY 80 proposal								O							

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION ADF&G, Fairbanks PRINCIPAL INVESTIGATOR L.F. Lowry, et al

A. SHIP SUPPORT Ice reinforced vessel with helicopter - St. George Basin/ Bristol Bay

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions. We propose to work within the ice front from Bristol Bay to approximately 174 W. Location of operations will depend on position of the ice at that time and can be located to optimally suit all projects.

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible. On stations, small boats and helicopter will be used to collect seals which will be analyzed for stomach contents, age and physical condition. Material will be provided to other projects. Bottom tows will be made with a small otter trawl.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.) Single cruise 1 April to 1 May. Desire only one leg. 1 April to 25 April would be acceptable.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.) Thirty sea days in a single leg is desirable. Twenty-five would be acceptable.

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? Our operations can run concurrently with other biological and/or oceanographic projects.

Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations. We will hunt seals during all daylight hours. Otter trawls will require approx. 2 hours per day on station. Sample processing will be done during all transit hours, the time required dependent on collection success. Otter trawls will be conducted during transit.

6. What equipment and personnel would you expect the ship to provide? Two small boats (17 foot Boston whalers) and associated equip., deck space w/ flowing sea water for autopsy, of seals, materials to construct a 4'x10' autopsy table, laboratory space for specimen workup.

7. What is the approximate weight and volume of equipment you will bring?
800 pounds 120 cubic feet

8. Will your data or equipment require special handling? no If yes, please describe.

9. Will you require any gases and/or chemicals? Formalin If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge.

10. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying. Yes - The NOAA ship SURVEYOR is necessary because it is the only NOAA vessel equipped with a helicopter.

11. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability? N/A

12. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals. Three persons will be specifically named at a later date. At this time none we know of will be foreign nationals.

C. AIRCRAFT SUPPORT - HELICOPTER To accompany SURVEYOR in April

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed). Flights will be conducted within a 50-mile radius (or as deemed appropriate by ship's personnel) of the ship's position

2. Describe types of observations to be made.
Collection of seal specimens.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

1 April to 1 May, or 1 April to 25 April.

4. How many days of helicopter operations are required and how many flight hours per day?

6-8 flight hours per day for a maximum of 25 possible days.
Total flight hours? approximztely 175

5. How many people are required on board for each flight (exclusive of the pilot)?
Two

6. What are the weights and dimensions of equipment or supplies to be transported?
100 lbs of personal gear - rifles, packs, field gear. We anticipate carrying seals weighing up to 600 lbs.

7. What type of helicopter do you reommend for your operations and why?
Bell 206B equipped with floats. We have found this type of helicopter to be very satisfactory on our previous work of this type.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

NOAA

9. What is the per hour charter cost of the helicopter?
N/A

10. Where do you reommend that flights be staged from?
NOAA ship SURVEYOR in the Bering Sea ice front.

11. Will special navigation and communications be required?
Yes - Transponder, GNS-500 Navigation System, 30 human body bags, slings and sling ropes, floats, baskets on each float, intercom for 2 passengers and pilot.

C. AIRCRAFT SUPPORT - HELICOPTER Beaufort Sea

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed). We would propose to base a helicopter at Deadhorse and later Barrow and fly over the shore ice to leads at which we would collect seals. Most flying should be within 40 miles of the coast.

2. Describe types of observations to be made.

Collection of seal specimens.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

5-20 November would be optimum. A departure of 3 days earlier or later would be acceptable.

4. How many days of helicopter operations are required and how many flight hours per day? Approximately 10 days of helicopter operations will be required with about 4 hours of flight per day.

Total flight hours? 40

5. How many people are required on board for each flight (exclusive of the pilot)?

Two

6. What are the weights and dimensions of equipment or supplies to be transported? 100 pounds of personal gear including rifles, packs, field gear. We anticipate carrying seals weighing up to 600 pounds.

7. What type of helicopter do you reommend for your operations and why? UH1H equipped with floats. We have found this type of helicopter to be very satisfactory in previous work of this type. Fixed wing cover is not required, fuel capacity is large.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

NOAA

9. What is the per hour charter cost of the helicopter?

Unknown

10. Where do you reommend that flights be staged from?

Deadhorse, later Barrow

11. Will special navigation and communications be required?
Yes - Transponder, GNS-500 Navigation System, 30 human body bags, slings and sling ropes, floats, baskets on each float, intercom for two passengers and pilot.

C. AIRCRAFT SUPPORT - HELICOPTER Beaufort Sea

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed). We would propose to base a helicopter at Deadhorse (later Barrow) and fly over the shore ice to leads at which we would collect seals. Most flying would be within 60 miles of the coast.

2. Describe types of observations to be made.

Collections of seals.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? The period 15 Feb. to 15 March is desirable. Within that period optimal time is 15 Feb. to 1 March.

4. How many days of helicopter operations are required and how many flight hours per day? Approximately 10 days of helicopter operations will be required with about 4 hours of flight time per day.
Total flight hours? 40

5. How many people are required on board for each flight (exclusive of the pilot)?

Two

6. What are the weights and dimensions of equipment or supplies to be transported?
100 pounds of personal gear including rifles, packs, field gear. We anticipate carrying seals weighing 600 pounds.

7. What type of helicopter do you reommend for your operations and why?
UH1H equipped with floats. We have found this type of helicopter to be very satisfactory in previous work. Fixed wing support is not required, fuel capacity is large.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

NOAA

9. What is the per hour charter cost of the helicopter?
unknown

10. Where do you recommend that flights be staged from?
Deadhorse, later Barrow

11. Will special navigation and communications be required?
Yes - Transponder, GNS-500 Navigation System, 30 human body bags, slings and sling ropes, floats, baskets on each float, intercom for two passengers and pilot.

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Proposal Date: June 26, 1978
Contract #: 03-6-022-35208
Task Order #: 237
NOAA Project #: ______
Institution ID#: 23703265

RENEWAL PROPOSAL

Submitted to OCSEAP/NOAA Arctic Project Office

Research Unit Number 237 (includes R.U. #238, 447)

TITLE: Ecology of Seabirds in the Bering Strait Region

Cost of Proposal: $33,506.50

Lease Area: Norton Sound

College of the Atlantic

CPF1:	$22,006.50
CPF2:	5,000.00
CPF5:	3,000.00
CPF7:	3,500.00

Period of Performance: Federal fiscal year 1979 (Oct. 1, 1978 - Sept. 30, 1979)

Name of Principal Investigator: William H. Drury
Institution: College of the Atlantic
Eden Street
Bar Harbor, Maine 04609

Principal Investigator

Name William H. Drury (M.C.D.) Date June 26, 1978

Address 10 High Street, Bar Harbor, Maine 04609

Telephone Number 207-288-5363

Required Organization Approval

Name Edward D. Kaelber Date June 26, 1978

Position President

Address College of the Atlantic, Bar Harbor, Maine 04609

Telephone Number 207-288-5015

Organization Financial Officer

Name R D Pro[illegible] Date June 26, 1978

Address College of the Atlantic, Bar Harbor, Maine 04609

Telephone Number 207-288-5015

Technical Proposal

I. Title: Ecology of Seabirds in the Bering Strait Region

Research Unit # 237 Contract # 03-6-022-035208

Proposed Dates of Contract: October 1, 1978 to September 30, 1979

II. Principal Investigator

William H. Drury
College of the Atlantic
Eden Street
Bar Harbor, Maine 04609

III. Cost of Proposal for Federal fiscal year

A.	Science		$33,506.50
B.	Principal Investigator provided logistics -	None	
C.	Total		33,506.50
D.	Distribution by Lease Area		Norton Sound

IV. Background

The major river drainage of interior Alaska, the Yukon River and Kuskokwin Rivers, dumps onto the shallow coastal shelf southeast of Norton Sound. Low saline water dominated by river-born materials moves north through Norton Sound and joins high saline water coming from the basin of the Southern Bering Sea and rising over the shelf to flow north primarily west of Saint Lawrence Island. The confluence of these water masses is a central feature of the water of this study area and is presumably in part responsible for the exceptionally high productivity of the Chirikov Basin and Bering Strait.

The northward movement of water through the Bering Strait during the summer suggests that the effluent of oil development and secondary economic development in the area of central and northern Bering Sea will move northward and enter the area which supports a phenomenal population of wildlife. The seabirds population of this area (which is barely larger than the Gulf of Maine) is at least twice as large as the population of all seabirds in northeastern North America south of the Arctic, i.e., from Central Labrador to Cape Hatteras.

During the field seasons of 1975-1978 we have surveyed the distribution and concentrations of shorebirds, waterfowl and seabirds in the region of Norton Sound, Chirikov Basin and Bering Straits.

We have made systematic studies of seabird breeding concentrations at Square Rock, Bluff Cliffs, Sledge Island (Ayak), King Island (Ookvok) and Little Diomede Island (Ignalook).

These studies have included counts of numbers of nesting seabirds, measurement of the reproductive success, and identification of the foods brought to the young. We have surveyed the waters where these seabirds feed for concentrations.

We have also surveyed the wetlands of the Southern Seward Peninsula between Brevig Mission and Unalakleet for distribution of waterfowl. We have run transects along the road running northwest, north, and northeast from Nome for the distribution of breeding shorebirds on the lowlands and uplands.

V. Objectives

The present proposal is for funds to pull together these four field seasons of data and provide summary, analytical, interpretive and synthetic reports including:

1. Complete analysis of processes in Bering Straits seabird colonies including analysis of regional differences and secular changes in colony composition at the several sites.

2. Interpretation of data in terms of reproductive success, feeding area, limiting resources, trophic relations and hence the areas to be considered in terms of effects of economic development.

3. To compare our knowledge with what has been learned in other parts of Alaska (primarily in OCSEAP studies such as those at Cape Lisburne, and Cape Thompson, Saint Lawrence Island, the Pribilof Islands, Cape Newenham, the Semidi Islands, Kodiak Island and the small colonies in the northeast Gulf of Alaska.)

For some species, such as Kittiwakes and Murres, which have been studied intensively elsewhere, we will weave into our reports the biological generalizations from which we may predict the effect of future environmental changes.

I hope especially to use this time and opportunity to bring together data from our New England Herring Gull Studies (nest by nest data at one colony over 5 years combined with island by island data for 23 colonies over 2-7 years) with parallel data available for Kittiwakes in Alaska waters. In this way I want to analyze ecological processes of these similar species, to compare our observations with ecological models and hence explain the geography of certain key species of alcids and gulls which are indicators of oceanographic conditions. These generalizations will be used to discuss the special situation among those alcids which by their restricted distributions are especially vulnerable to disturbance associated with marine transportation.

The sorts of analyses, the theme, and assumptions upon which my models are based have been discussed in previous annual reports. See especially "Present State of Knowledge" in report for 1976 and "Introduction" to Annual Reports # 237 and 447 for 1977.

Relevance to environmental assessment:

Seabirds are more readily counted and their reproductive success measured than are nearly all other species of the biological structure of northern seas.

They provide clues to the biological generalizations which apply and are indicator species for changes in the biological structure of trophic levels upon which they depend. Dr. George Hunt and I prepared a report on the use of seabirds in the assessment of oceanographic conditions earlier this year.

Because they are amenable to study and to the formulation of generalizations which apply to other vertebrates and especially because their welfare is a concern of many Americans, the state of the seabird population must be a central element to any environmental assessment.

In the past the seabird cliffs of the Diomede Islands, King Island, Saint Lawrence Island, Cape Denbigh and Egg Island were an important source of food for natives. At present a hot political wind is blowing about evidently unrestricted spring hunting of waterfowl by natives, a pursuit claimed to be an integral part of the tattered remains of their traditional culture, but a pursuit which is clearly against the International Migratory Bird Convention of 1918.

Thus seabirds and waterfowl, whether as biological indicators or present and potential food resources, are important parts of the human and natural environment of the Norton Sound, Saint Lawrence Island waters and Bering Straits region.

VI. and VIII. General Strategy of Approach and Analytical Methods

(VII. - Sampling Methods - is not applicable)

Methods: we analyze, combine and interpret data from:

1. Colony surveys as a whole, as well as diurnal, seasonal, and year to year changes in sample plots.

2. Detailed comparisons of numbers of pairs, nests built, eggs laid to numbers of young reaching fledging. This will include year to year similarities and differences in the same nests and same areas of cliffs over three years.

3. Comparison of data on the oceanic distribution of seabirds and differences in breeding success with such data as are available on composition and abundance of prey species and on oceanographic conditions. These data on prey species and oceanography are the weakest of our data. We will use those seabird data gathered by other workers (Principal Investigators Burns, Terrsink, Divoky) as those data become available. We hope also to be able to make use of fisheries data recently becoming available from the work of Drs. Barton and Wolotira.

IX. Deliverable Products

A. Digital Data

1. Data will be digitized on formats 033 and 035. Format 033 will be used for data on distribution of species by habitats and seasons including transects of wetlands and over the sea.

   Format 035 will be used for colony censuses, for data collected at study sites (the numbers of pairs of breeding birds, nests, eggs laid and breeding success).

   We are digitizing our data as required by NOAA management, but we are not yet sure whether, or how, we may use digitized data for our analyses, results, or products.

2. We plan to submit digitized data on "floppy discs" within 3 months of when we have the data entry equipment and applicable programs. We estimate that the programs for 033 will be available in September and hope that those for 035 will be available at the same time.

   Formulating and entry of digital data into OCSEAP format will be done by the project.

B. Narrative Reports

1. A summary and interpretive report on the period 1975-1979.

   a. Special summaries of major species studied.
   b. Report specifying methods and study areas including maps and photographs.
   c. Overview of breeding biology of local seabirds, their zoogeography and trophic position in the general biological structure of the region.
   d. Discussion of the breeding biology of seabirds as these characteristics affect the kinds of effects, primary and secondary, which economic development may have.
   e. Review of material available on physical and biographical oceanography of the area, as these materials may apply to the biology of seabirds, hence future effects (e.g., reports of Aagard, Barton, Wologira).

      Suggestions for methods and timing of activities (censuses measurements of reproductive success) which will be useful and minimally labor intensive in a monitoring program.
   f. Will include maps, graphs, drawings, tables and photographs. Maps will use the base maps supplied by NOAA. The presentation will emphasize usefulness in interpretation rather than extensive documentation of the data collected. We estimate that these will be in the order of 50 maps, and 25 drawings and photographs.

X. Quality Assurance Plan

The headings listed are not applicable to our work. We do intend to confirm the accuracy and precision as well as relevance of our counts.

Accuracy of data entered in digital formats will be checked against data on field forms — that is the main advantage of the direct data entry equipment.

XI. Sample and Voucher Specimen Archiving

Specimens of the seabird species studied are not required because the species are well known.

Specimens of more questionable species may be collected in the course of our studies on feeding grounds during 1978. Archiving of voucher specimens will be dealt with as appropriate.

XII. Logistics Requirements -- not applicable -- field work is not planned

XIII. Anticipated Problems and Contingency Plans -- not applicable -- field work is not planned. If problems arise in data entry, we will resolve these with Fischer and Murphy at the Boulder office.

XIV. Data Required From Other Workers: annual and final reports from fisheries, marine mammal, and oceanographic studies made in our region. We have approached principal investigators of those Research Units we know about but will continue to search for useable information.

XV. Management Plan

I will have 2 assistants. These individuals will be responsible for gathering and processing data such as putting data in proper form for archiving and preparing them for analysis.

I will take the necessary time from my teaching duties to analyze data and write reports.

DIGITAL DATA PRODUCTS SCHEDULE

ata Type i.e. Intertidal, enthic Organisms, tc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submissio (Month/Ye
Distribution of Species by Habitats and Seasons	Disc	(unknown)	033	Yes	6/11/78 - 9/20/78	1/1/79
Colony censuses	Disc	(unknown)	035	Yes	6/11/78 - 9/20/78	1/1/79

Activity/Milestone/Data Management Chart

	1978 Sept	Oct	Nov	Dec	1979 Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Quarterly Reports		X			X			X			X			X		
Annual Reports								X								
Final Reports														X		
Digitizing Data					X											

XVI. Outlook

We have concluded that the effort/results of our research program has reached an asymptote. We believe that it is best to stop, to consider and to report on our work and what we have learned to date. The reports have been sketched out above, but they in essence must consider:

1. What we have observed in our field work.

2. How these observations relate to what others have reported about seabird/waterfowl biology and their trophic relations.

3. How these results relate to what is known in other disciplines..

4. How these may be valuable to OCS/BLM.

Once that reappraisal has been completed, it may be profitable to plan a coordinated project in which several principal investigators from several disciplines work together as one research group on a specific areal/functional analysis. We wonder whether the principal investigators which might be involved and the NOAA management personnel are prepared to dedicate the effort necessary to carry that out, but until the combination is formed we doubt the efficiency of continued independent specialized projects. So far, a synthetic approach has existed post facto, as a result of individual efforts of principal investigators or through the efforts of the Arctic Project Office.

When that decision has been made, the several prospective principal investigators must decide:

1. Whether they are willing to submit their own plans to the overall direction of group process instead of continuing to act as independent feudal barons.

2. To combine logistic efforts so that one unfortunate soul concentrates on seeing that recalcitrant equipment, missing supplies and incomplete arrangements are tidied up instead of maintaining the frustration level of principal investigators at an intolerance threshold by the press of problems for which academic excellence is no qualification.

3. To have available aircraft, vessels and crews of suitable size and qualifications instead of the present overkill of NOAA vessels vs. patched up local inadequacies or the capricious action of the so-called market system.

XVII. Standard Statements

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October; Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the Principal Investigator is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Docementation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The Principal Investigator will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgement is standard:

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer

Continental Shelf Environmental Assessment Program
(OCSEAP) Office."

Submission of Proposal

One signed original and four copies of the proposal are required. Proposals shall be sent or delivered to the appropriate office Not Later Than June 26, 1978:

OCSEAP/NOAA Rx4 Boulder Colorado 80303	OCS Project Office Bering Sea-Gulf of Alaska P.O. Box 1808 Juneau, Alaska 99802	NOAA Arctic Project Office Room 506, Elvey Building Geophysical Institute University of Alaska Fairbanks, Alaska 99701

Changes to Proposals

Requests for changes to proposals, including deletions of any items of work listed by the work statement, changes (delays) in submissions of reports or data, budget changes, or changes of contract expiration dates must be submitted in writing to the appropriate Project Office for approval. The Project Office in turn will submit recommendations (through the Boulder Program Office) to the Contracting Office for official authorization. Requests handled in any other manner will be delayed until Project Office approval is secured.

To: National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental Assessment Program
Bering Sea-Gulf of Alaska Project Office
P.O. Box 1808 — Proposal Date: June 12, 1978
Juneau, Alaska 99802 — Contract # : 03-5-022-69

FY 1979 RENEWAL PROPOSAL

Research Unit 243

POPULATION ASSESSMENT, ECOLOGY AND TROPHIC RELATIONSHIPS
OF STELLER SEA LIONS IN THE GULF OF ALASKA

Cost of Proposal: $145,000

Lease Areas:

Kodiak	34%
Lower Cook Inlet	44%
NEGOA	22%

Period of Proposal: October 1, 1978 through September 30, 1979

PRINCIPAL INVESTIGATOR(S):

Name: Donald G. Calkins, Kenneth W. Pitcher — Date: Aug 22, 1978

Signature: Donald G. Calkins, Kenneth W. Pitcher

Address: 333 Raspberry, Anchorage, Alaska 99502

Telephone Number: 344-0541 — FTS:

INSTITUTION (include Department, if appropriate)

Alaska Department of Fish and Game

REQUIRED ORGANIZATION APPROVAL:

Name: Ronald O. Skoog — Date: 8/29/78

Signature:

Position: Commissioner

Address: Subport Bldg., Juneau, AK.

Telephone Number: 465-4100

ORGANIZATION FINANCIAL OFFICER:

Name: John Stewart — Date:

Signature:

Position: Finance Officer

Address: 219 S. Franklin, Juneau, AK

Telephone Number: 465-4120

Technical Proposal

I. Title:

Population Assessment, Ecology and Trophic Relationships of Steller sea lions in the Gulf of Alaska.

Research Unit No. - 243

Contract No. - 03-5-022-69

Proposed dates of Contract - Oct. 1, 1978 - Sept. 30, 1979

II. Principal Investigators:

Donald G. Calkins

Kenneth W. Pitcher

III. Cost of Proposal:

A.	Science	-	$123,000
B.	PI provided logistics	-	22,000
C.	Total	-	145,000

D. Distribution by lease area:

Kodiak	- 34%
Lower Cook Inlet	- 44%
Negoa	- 22%

IV. Background

Sea lions

Steller sea lions *Eumatopias jubatus* are abundant and conspicuous marine mammals along much of the coast of the Gulf of Alaska, with a population estimated at more than 95,000 animals (Alaska Department of Fish and Game 1973 and Calkins et al. 1975). Because they are at the tertiary consumer trophic level, they are an important component of marine ecosystems in the Gulf. There are at least 62 hauling grounds and rookeries in the area which are used on a regular, predictable basis with 44 more used on a casual basis.

While restricted to land for breeding, pupping and to some extent resting, sea lions are known to be somewhat pelagic feeders and nomadic wanderers (Fiscus and Baines 1966). They have been reported at distances of 70 and 85 miles from shore (Kenyon and Rice 1961) and have been seen at many localities offshore in the northern Gulf of Alaska (Fiscus and Baines 1966). We have noted individual movements of 900 miles away from their birthplace.

Population assessment work carried out during this study is the first to be accomplished since 1956-1958 (Mathisen and Lopp 1963). Changes in seasonal distribution are becoming clearer although much work remains to be done in this area. It is apparent that there is considerable movement from exposed summer rookeries and haul outs to more protected winter areas. There may also be a net movement offshore in winter although this is not clearly understood. Large scale movements by sea lions in Oregon have been noted by Mate (1973). Bartholomew and Boolootian (1960) suggest seasonal migratory movements correlated with age and sex in California. Seasonal movements are known to occur in British Columbia although they are not fully understood (Spalding 1964 and Smith 1972).

Sex and age segregation by sea lions using the various rookeries and hauling areas throughout the Gulf of Alaska definitely does occur but as yet is not completely understood. A knowledge of the degree of segregation is important so that any localized disturbance or kill of animals can be evaluated in terms of importance to the total population. Data collected so far indicates that there is considerable interchange between rookeries and haul out areas. It appears as though animals from the large rookeries at Sugarloaf Island in the Barren Islands and Marmot Island off Afognak Island move extensively throughout the Gulf. We do not know if these animals will return to their birth place to breed. This information will begin to become available in the next two years as the first females branded during this study reach sexual maturity and enter the breeding population.

Adequate information is lacking on reproduction and growth in the Steller sea lion. Data from other species of marine mammals (Sergeant 1966, 1973) suggest that population productivity may be a good indicator of relationship to carrying capacity. Law (1959) showed that seals with plentiful food supplies grew faster and became sexually mature earlier, thus increasing population productivity. There are some indications that reproductive rates of sea lions in Alaska are lower than in other portions of their range (Brooks 1957, Pike and Maxwell 1958 and Thorsteinson and Lensink 1962). Why is this so? Have populations in some areas reached carrying capacity? There is some evidence that this is the case. Recent studies in Prince William Sound indicate that numbers are much the same now as they were 18 years ago (Pitcher M.S.). What are the various biological parameters exhibited by a stable (?) population of marine mammals?

The role of sea lions in the Gulf of Alaska and their impact on the marine system cannot be overlooked. For the sake of general discussion it is useful, using conservative values, to estimate the annual food requirements of these animals. Assuming a population of 95,000 animals (excluding pups), a mean weight of 700 pounds, a daily food intake of 6 percent of body weight (Richardson 1973 and Sergeant 1973) for 300 days per year, sea lions in Gulf waters of Alaska would consume 3,990,000 pounds of food per day, or 598,500 tons per year. Fiscus and Baines (1966) found that food contained in the stomach of a non-captive steller sea lion amounted to 9.4 percent of its body weight. Food habits of sea lions in the Gulf of Alaska are being elucidated by this study. Previous studies of food habits have mostly been incidental in nature and nearly all during summer months (Mathisen, et al. 1962, Spalding 1964, Imler and Sarber 1947, Fiscus and Baines 1966 and Pike 1968).

The importance of establishing trophic relations in the Gulf of Alaska prior to development is evident. With data now being collected in a number of O.C.S.-Gulf of Alaska biological studies it should be possible, through continuation of food habit studies initiated under this contract, to establish the role of the sea lion in the food web.

Knowledge of sea lion populations is crucial to intelligent decisions concerning sea lions in relation to oil and gas development and production. If consideration is to be given to conservation of this species with respect to development in the Gulf of Alaska, it is of primary importance that we fully understand the extent of the poulation as well as it's movements and distribution, and productivity.

Collection of materials for baseline data on heavy metal loads will continue throughout this project. Environmental contaminants are concentrated in top level predators such as the sea lion.

Sea otters

Sea otters are the most vulnerable of all marine mammals to the effects of oil spills. They rely on a layer of air trapped in their dense fur for insulation and buoyancy. When soiled the fur loses its water repellency and insulative qualities. As a high trophic level species sea otters are particularly vulnerable to impacts through the food chain.

Sea otter populations in many areas are still recovering from the period of overexploitation during the 18th and 19th centuries. Some populations have very restricted ranges and could be eliminated by single oil spills. Other populations are expanding their ranges into unoccupied former sea otter habitat. Oil spills could retard this range expansion for many years.

Sea otters tend to be dynamic feeders and over time can have drastic influence on the invetebrate communities in which they prey (Estes and Palmisano 1974, Calkins 1978). However, their trophic role in the ecosystem cannot be overlooked. These changes could be occuring so slowly that they may not be noticeable within the lifetime of oil production on the continental shelf. It is essential that we determine, at least qualitatively, what prey species are important to the sea otters. It would also be of great value to determine what prey are available to the otters through benthic studies.

Belukha Whales

The belukha whale population of Cook Inlet is thought to number 500 animals although recent surveys indicate the population may be somewhat larger. Sears 1977 sighted over 400 belukhas concentrated in one place at one time in lower Cook Inlet. It seems unlikely that this is more than a fraction of the population. It is not known whether some of these animals leave Cook Inlet periodically or whether all remain generally within the inlet and only occasionally stray. Sightings of belukhas have been made as far away as Yakutat

(Calkins 1977) and infrequently in the vicinity of Prince William Sound (Fay pers. comm. and Hall pers. comm.)

Sightings of belukha in upper Cook Inlet are quite common in the late spring and summer. As the ice forms in the upper Inlet in the fall the belukhas are forced to move south into the lower inlet. By winter ice cover prevents belukhas from utilizing the upper inlet. During the winter we know that the bays in the lower inlet such as Tuxedni Bay, Chinitna Bay and Iniskin Bay are frequented by belukhas as well as the shallow areas around Kalgin Island. It is not known what proportion of the population remains in these areas over the winter and where others might go if they do leave the Cook Inlet area.

Studies of distribution and abundance initiated under this research unit in FY 78 have begun to answer some of the important questions concerning belukha whale distribution and abundance in lower Cook Inlet. However, the surveys were plagued by bad weather and only limited information was gained. The surveys should be continued for one more year in cooperation with Fay and Murray under a more extensive, but complimentary program.

V. Objectives

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

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

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

To determine daily and seasonal activity patterns of sea lions. To investigate the use of specific rookeries and haul outs on a short term basis. To determine the optimum time to survey sea lions, and to provide information crucial to the interpretation of survey data already in hand.

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

To determine the distribution of sea otters and identify areas critical to the survival of the sea otter populations in the northern Kodiak area. To determine food habits and prey selection of sea otters in the northern Kodiak, Afognak, Shuyak Islands.

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

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

To determine daily and seasonal activity patterns of sea lions. To investigate the use of specific rookeries and haul outs on a short term basis. To determine the optimum time to survey sea lions, and to provide information crucial to the interpretation of survey data already in hand.

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

To determine the distribution of sea otters and identify areas critical to the survival of the sea otter populations in the northern Kodiak area. To determine food habits and prey selection of sea otters in the northern Kodiak, Afognak, Shuyak Islands.

To delineate seasonal distribution and numbers of belukha whales in Cook Inlet. To incidentally collect distribution information on all cetaceans in Cook Inlet.

To synthesize information available and produce a report on marine mammals in Lower Cook Inlet.

VI. Strategy and Approach

Sea lion studies will continue in the Gulf of Alaska much the same as in FY 78 but with some modifications. Distribution and movements studies will be carried out with increased emphasis on locating branded sea lions at rookeries and hauling grounds over the entire Gulf of Alaska. Rookeries and hauling areas will be visited in the area from Dixon Entrance to Cape Spencer at least once during the contract period to search for branded animals. Major rookeries and hauling areas within the O.C.S. lease areas in the Gulf of Alaska will be visited on a seasonal basis for sex and age compostion counts and search for branded animals.

The long term study will continue on one or two selected haul outs. This study will investigate daily sea lion movements and distribution on specific haul out areas and use of areas by branded animals. Information will be gathered on optimum timing for survey work. Results of this type of work will have direct and significant implications on the interpretation of data already gathered by survey work under this research unit as well as several other research projects.

Sea otter feeding habits will be studied by direct observation (Calkins 1972, 1978; Ebert 1968, Hall and Schaller 1964, Barabash-Nikiforov 1947). Observations are made from advantageous locations on land with the use of telescopes and binoculars. Identifications can occasionally be made to species under optional conditions, but generally classifications are much broader. Most commonly identifications are made to groups such as clams, crabs, sea stars, fishes etc.

Sea otter feeding habits will also be studied through the analysis of scats collected from the study area. Sea otter scats have been found on many of the small islands and rocks of the northern Kodiak archepelago. Scats will be collected from as many locations as possible, but at least from Latax rocks and from Sea Otter Island. Sea otter prey species can again be identified to major groupings and occasionally to species from diagnostic shells or skeletal material found in the scats.

Surveys will be flown with fixed wing aircraft to search for and enumerate belukha whales. ADF&G personnel stationed in Homer and Kenai will participate in these surveys, making it possible to survey the entire inlet at little or no extra costs. A graduate student from the University of Alaska will participate in the field phase of this work.

A. Sampling Methods

Sampling methods will remain essentially the same in FY 79 as they have been in the past. Prince William Sound and Kayak Island will be visited as well as the Kenai Peninsula, Barren Island, Kodiak, Chirikof, The Semidis and the Alaska Peninsula. Each of these areas will be visited in the summer.

Prince William Sound will be visited again in the winter as well as the haul outs along the Kenai Peninsula, the Barren Islands and around Kodiak Island. At each location, all accessable hauling areas and rookeries will be visited for sex and age composition count (see Harstadt 1975) and branded animals will be searched for.

Two people will be stationed at Marmot Island from mid March through mid July and at Sugarloaf Island from early May through mid July. These people will carry out intensive, daily searches for branded sea lions as well as study sea lion daily activity patterns.

From the above visits we will derive sex and age composition, distribution and abundance, and movements information, productivity, daily activities and optimum survey times.

Specimen material will be collected on an opportunistic basis in conjunction with other studies. Some specimen material collected in FY 78 will be analyzed in FY 79.

On the basis of information obtained in FY78, we expect to be able to identify the optimal time and place in which an aerial census of belukhas will be most likely to give reliable results. A stratified sampling design will be developed, based on the results of a preliminary survey of distribution, and will be repeated on two or three consecutive days (weather permitting), using the distributional information from each survey for planning the next. Interpretation of the census data, i.e. estimation of the number of animals actually present, as a function of the number sighted, will be based on observations made prior to the surveys of the animals' behavior, in terms of surface and sub-surface time, since the animals are visible only when at the sruface in this murky, silt-laden water.

Also on the basis of the FY78 survey results and interviews the areas of greatest and most frequent occupation by belukhas will be identified. An attempt will be made to correlate these with the physical and biotic characteristics of the environment as determined by other OCSEAP projects.

B. Analytical Methods

Analysis of population data including distribution and abundance and seasonal movements will be similar to methods used by Mathisen and Lopp (1962), Kenyon and Rice (1961), Pike and Maxwell (1958), Smith (1972) and Mate (1973). Analysis of daily activity patterns will be similar to those used by Sandgren (1970).

Specimens collected from animals will be analyzed in the following manner:

A. Age determination: laboratory techniques include decalcification of a premolar tooth from each animal, using a microtome to produce thin sections and staining with a hematoxylin hot bath (Johnson and Lucier 1975). Actual age determinations are made by microscopic counts of annual growth layers in the teeth (see Klevezal and Kleinenberg 1967 for review of techniques and their basis).

B. Female reproduction: ovaries and uteri are collected from each female sea lion. Standard laboratory techniques (Bishop 1967, Bigg 1969 and Fisher 1954) for reproductive analyses are used through which the presence or absence of a conceptus is established and a partial reproductive history is reconstructed by examination of ovarian structures.

C. Weights and measurements are taken from each collected animal (see Scheffer 1967).

D. Stomach contents from each sea lion are preserved in formalin. Weights and volumes are determined for all contents. Identifications of prey species are made by examination of recognizable individuals and skeletal materials of diagnostic value. Frequency of occurrence of prey species is then determined (Spalding 1964).

E. Intestinal contents from each sea lion are strained through mesh sieves to recover fish otoliths. Otoliths, which are diagnostic to species, are compared to a reference collection and identified (Pitcher MS).

F. Tissue samples are being collected and frozen so that baseline levels of heavy metals, pesticide residues and hydrocarbons can be determined. Tissues will be collected only on an opportunistic basis.

VII. Deliverable Products

A. 1. Digital morphometric, reproductive ecology, sighting, food habits, and census data submitted in OCSEAP format under File Types 025 - Mammal Specimen, and 027 - Mammal Sighting 01 as appropriate. Data collected on sea lions under RU 194 will be merged with RU 243 upon completion of analysis.

2. See Tables 1 and 2 for minimum and maximum values for data submission.

3. Data submissions are checked for error after each keypunching step.

B. A synthesis report on marine mammals of lower Cook Inlet will be prepared. The report will be developed to describe and evaluate the potential impact on marine mammals of lower Cook Inlet by Outer Continental shelf oil and gas exploration, development and production. This objective is extremely important and is the basic goal of the marine mammal research in lower Cook Inlet. The identification of areas of potential risk will be derived from several sources including the location of exploratory platforms, the BLM development scenarios, the results of trajectory analysis which is being accomplished by OSCEAP in FY78, the results of vulnerable habitat analysis conducted by OCSEAP investigators in FY77 and other existing literature on the sensitivity of specific components. The first draft of this report will be prepared by May 1, 1979.

C. The following visual data representations will be supplied on standard mylar overlap as agreed by PI and OCSEAP.

°Maps identifying (a) major sea lion rookeries and hauling grounds, (b) marked sea lion release and recovery locations, (c) sampling locations, and distribution of sea otters.

°Charts illustrating (a) seasonal abundance and distribution of sea lions, (b) seasonal changes in their foraging areas, and (c) their major migration routes.

°As appropriate, figures or tables illustrating:

(a) Condition of sea lion populations, including seasonal census information, age and sex composition, growth rates, and seasonal condition;

(b) Reproductive colony of sea lions at major rookeries, including age of maturity, age specific reproductive rates, breeding season, age specific mortality rates, and progression of life history events (i.e. birth, lactation, weaning and molting);

VIII. Special Sample and Voucher Specimen Archival

No samples collected for future reference.

IX. Logistics Requirements

See attached logistics form.

X. Anticipated Problems

None

Kenneth W. Pitcher*	10%
Dennis McAllister	50%

E. None

F. Person Authorized to Conduct Negotiations:

Karl Schneider

Regional Research Coordinator

Alaska Department of Fish and Game

333 Raspberry Road

Anchorage, Alaska 99502

Phone: 907-344-0541

XIII. Outlook: Presently the outlook for this project is to continue the field work on a limited scale searching for branded sea lions and collecting less than 10 animals in the same areas as the past with a general overall reduction in the field work and preparation of the final report. Costs will depend entirely upon timing, but by fiscal year should not exceed this year's budget and may be slightly reduced.

Sea lion work in the eastern Aleutian Islands is extremely important and should be considered as the next major step in learning about sea lion distribution and abundance.

XIV. A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held and shipped to an official OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

D. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

E. Data products will be submitted to the Project Data Manager in the form and format specified in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by Data Documentation Form (NOAA Form 24-13).

F. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office. The NODC Taxonomic Code is to be used for biological data submissions.

G. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA for 24-23) will be submitted to the Project Data Manager.

H. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor". (copy attached.) Updated copies of these inventories will be submitted quarterly.

I. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they become available.

J. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgement is standard:

"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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Sea lion Specimen data	Mag tapes	75 animals at 12 cards per animal	File types 025,026	Yes	Oct. 1978 through Sept. 1979	Dec. 31, 1979
Sea lion Sighting data	Mag tapes	Undetermined	File type 027	Yes	Oct. 1978 through Sept. 1979	Dec. 31, 1979
Sea otter Sighting data	Mag tapes	Undetermined	File type 027	Yes	Oct. 1978 through Sept. 1979	Dec. 31, 1979
Belukha Sighting Data	Mag tapes	Undetermined	File type 027	Yes	Oct. 1978 through Sept. 1979	Dec. 31, 1979

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION Alaska Department of Fish and Game   PRINCIPAL INVESTIGATOR Donald G. Calkins

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.
   Cape St. Elias to Cold Bay

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible.
   No shipboard sampling. All observations will be made from helicopter or skiffs.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

   June 20, July 15

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

   14

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback?
   Must be principal
   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.

   8 hours per day.

6. What equipment and personnel would you expect the ship to provide?

   Bell Jet Ranger Helicopter

7. What is the approximate weight and volume of equipment you will bring?
   1000 lbs.

8. Will your data or equipment require special handling? No If yes, please describe.

9. Will you require any gases and/or chemicals? No If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge.

10. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.

NOAA Ship Surveyor with helicopter

11. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability?

None recommended

12. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals. Six

All Alaska Department of Fish and Game employees, no foreign nationals. Donald Calkins, Kenneth Pitcher, Karl Schneider and 5 others.

C. AIRCRAFT SUPPORT - HELICOPTER

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

Four Two trips Homer to Barren Islands (2)
Kodiak to Marmot Island (2)

2. Describe types of observations to be made.

Transport equipment from base to field camps.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

April 15 to May 7 July 15 to August 1

4. How many days of helicopter operations are required and how many flight hours per day? 4 days 6 hr/day

Total flight hours? 24 hours

5. How many people are required on board for each flight (exclusive of the pilot)?

Four

6. What are the weights and dimensions of equipment or supplies to be transported?

Approximately 3,000 lbs. field gear and cabin materials

7. What type of helicopter do you reommend for your operations and why?

Bell 205 - need large cargo capacity

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

NOAA

9. What is the per hour charter cost of the helicopter?

10. Where do you reommend that flights be staged from?

Homer and Kodiak

11. Will special navigation and communications be required?

No

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 243 PI: Donald G. Calkins

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

MAJOR MILESTONES	1978			1979											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Belukha Surveys	0	0	0	0	0	0	0	0	0	0	0	0			
Helicopter Surveys on Rookeries															
Establish Field Camps (sea lion)								0	0	0					
Sea Otter Observations	0					0	0								
Vessel charter (NOAA) Surveys									0	0					
Quarterly Report				0				0		0			0		
Annual Report						0									
First draft LCI Synthesis Report								0							
Lab Analysis	0	0	0	0											
Raw data analysis	0					0				0	0	0			
Data punching and verification		0					0				0	0	0		
Submission of Data to OCSEAP			0					0				0	0	0	

Table 2. Types of data, limits and frequency of collection, file type 025, RU 243.

Data field	Normal limits	Frequency of coll.
Location of collection	NA	Always
Date of collection	NA	Always
Time of collection	NA	Most of the time
Taxonomic code	9221010501	Always
Sex code	0-2	Always
Lactating	Y-N	Occasionally
Mammal sunk	Y-N	Most of the time
Group size	0-15,000	Most of the time
Curvilinear length	0.0-500.0	Most of the time
Girth	0.0-500.0	Most of the time
Hind flipper length	0.0-100.0	Most of the time
Blubber thickness sternum	0.0-10.0	Most of the time
Blubber thickness chest	0.0-10.0	Most of the time
Age	0-50	Most of the time
Age unit code	1 or 2	Most of the time
Age determination technique	1 thru 4	Most of the time
Baculum length	10-200	Some of the time
Baculum weight	0.1-30.0	Some of the time
Testes weight with epididymis	1.0-200.0	Most of the time
Testes weight without epididymis	0.5-200.0	Most of the time
Testes volume	0.0-200.0	Most of the time
Testes length	1-150	Most of the time
Testes width	1-100	Most of the time
Presence of sperm in epididymis	0-3	Most of the time
Sperm method of determination	0-2	Most of the time
Reproductive status code	0-3	Most of the time
Reproductive condition code	0-8	Most of the time
Number of fetuses	0-2	Most of the time
Ovary weight	0-3	Most of the time
Number of Corpora lutea	0-30.0	Most of the time
Diameter of longest Corpora lutea	0-300	Most of the time
Number of Corpora Albicantia	0-10	Most of the time
Diameter of longest Corpora Albicantia	0-200	Most of the time
Number of follicles greater than 5mm in diameter	0-10	Most of the time
Diameter of largest follicle	0-300	Most of the time
Number of uterine scars	0-3	Some of the time
Weight of food contents	0-7000.0	Some of the time
Total volume of food content	0-7000.0	Some of the time
Taxonomic code	NODC code	Most of the time
Life history code	0-9	Occasionally
Miscellaneous stomach contents	01-11	Occasionally
Number of items identified	0-10,000	Some of the time
Volume of items identified	0-7000.0	Some of the time
Weight of items identified	0-7000.0	Some of the time
Mean length of items identified	0-1000	Occasionally
Maximum length of item identified	0-1000	Occasionally
Minimum length of item identified	0-100	Occasionally

Table 1. Types of data, limits and frequency of collection for RU 243 (file type 027 only).

Data field used	Normal limits	Frequency of coll.
Flight Sta. No.	NA	Always
Starting date/time	NA	Always
Starting Lat/Long	NA	Always
Ending Lat/Long	NA	Always
Sighting date/time	NA	Always
Sighting Lat/Long	NA	Always
Taxanomic Code	NA	Always
Number of individuals	0 to 300,000	Always
Number of adults	0 to 10,000	Sometimes
Number of pups	0 to 10,000	Sometimes
Total subadults	0 to 10,000	Sometimes
Total adult males	0 to 10,000	Sometimes
Total adult females	0 to 10,000	Sometimes
Marked animal code	0 to 10,000	Sometimes
Text	NA	Sometimes

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STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

JAY S. HAMMOND, GOVERNOR

333 RASPBERRY ROAD
ANCHORAGE 99502

October 4, 1978

Dr. Herb Bruce
National Oceanic and Atmospheric Admin.
Outer Continental Shelf Environmental Assessment Prog.
Bering Sea-Gulf of Alaska Proj. Office
P.O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

In accordance with an October 2, 1978 telephone conversation with Rod Swope, I would like to add the following to the FY 1979 renewal proposal for Research Unit 243:

1. In the cost proposal form under PI provided logistics (CPF-4) I have budgeted $17,000 for Helicopter charter and $11,000 for fixed wing charter. It is extremely important to remember that this charter time will be used during periods of inclement weather and therefore has to be flexible if I am able to accomplish my goals. The dates I set for this work can only be approximate. If NOAA provides logistic support for this work I must request at least five additional days for each trip to allow for weather related delays. In my opinion it is more important to remain as flexible as possible and this can only be done by me arranging my own logistics as I proposed. I expect to follow the following approximate schedule for helicopter work:

Date	Hours/days	Location	Total hours
Feb. 18-24	3 hrs per day for 4 days	Kenai Peninsula	12
Feb. 25-Mar 3	3 hrs per day for 4 days	Kodiak	12
Apr. 1-7	3 hrs per day for 7 days	Prince William Sound and Cape St. Elias	21
May 25-30	4 hrs per day for 2 days	Homer	8
		Total	53

2. I expect to pay the following rates:

Helicopter		- 53 hrs at $325/hr = $17,225
Fixed wing	single engine	- 8 hrs at $125/hr = $ 1,000
	twin engine	- 54 hrs at $185/hr = $ 9,990

3. In the cost proposal section CPF-6 I have identified $14,000 for drafting and report preparation. Most of this money will be used for the Lower Cook Inlet Marine Mammal Synthesis report but some will also be used for the preparation of the annual report, quarterly reports and preparation of materials for additional synthesis meetings and vertebrate consumer meetings etc. I expect to contract for drafting and preparation of overlays for maps, charts, graphs and figures for all of these reports as well as provide some assistance to RU 229 and RU 3.

4. Under the cost proposal section CPF-2, the following per diem rates are paid by the State of Alaska:

   Cordova $58/day/person; 4 people for 4 days = $ 978
   Kodiak $54/day/person; 4 people for 6 days = $1,296
   Homer $54/day/person; 4 people for 5 days = $1,080
   Field per diem for field camps - $21/day/person; 4 people for 71 days = $5,964

5. In Section IV, Background under heading Sealions, change the last paragraph to indicate collection of materials for baseline data on heavy metals will continue on an opportunistic basis only.

6. Under Section VIII, special sample and voucher specimen archival, add the following:

   all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held and shipped to an officeal OCSEAP designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are studied, and sexes where these are morphologically distinguishable.

I hope these revision will meet with your approval and allow for satisfactory completion of the renewal proposal.

Sincerely,

Donald G. Calkins
Marine Mammal Biologist

File Type 025

rine Mammal Specimen

Common to all records
- File Type
- File Identifier
- Record Type
- Specimen Number
- Sequence Number

Record Type 1 - Location
- Latitude/Longitude
- Date/Time of Collection
- Water Depth/Tide Stage
- Habitat/Behavior Codes
- Ice Codes/Ice Characteristic
- Deformation Code
- Transect Width
- Ice Codes/Deformation/Transect Width

Record Type 2 - Physical 1
- Taxonomic Code
- Sub Species/ Sex Code
- Accompanied by Pup
- Mammal Lactating/Sunk
- Group Size/Collection Method Code
- Weight of Hide and Blubber
- Curvilinear Length
- Axillary Girth
- Maximum Girth
- Front Flipper Length/Width
- Hind Flipper Length/Width (OCCASIONALLY)

Record Type 3 - Physical 2
- Navel to Anus/Penis to Anus Length
- Tail Length
- Blubber Thickness
- Neck Circumference
- Stomach Condition
- Gross Weight/Standard Length

Record Type 4 - Age-Reproductive-Male
- Age/Age Unit Code
- Age Determination/Accuracy Code
- Baculum Length/Weight
- Testes Weight With/Without Epididymis
- Testes Volume/Length/Width
- Presence of Sperm/Sperm Method of Determinatio

Record Type 5 - Age-Reproductive-Female
- Age/Age Unit Code
- Age Determination/Accuracy Code
- Reproductive Status/Condition Code
- Number of Fetuses
- Ovary Weight
- Number of Corpora Lutea
- Diameter of Largest Corpora Lutea
- Number/Diameter of Corpora Albicantia
- Number/Diameter of Follicle
- Number of Uterine Scars

Record Type 6 - Stomach Contents
- Weight of Full/Empty Stomach
- Weight of Food Contents
- Total Volume of Contents

Record Type 7 - Stomach Content Species
- Taxonomic Code/Sub Species
- Life History Code
- Miscellaneous
- Number/Volume of Items Identified
- Weight of Items Identified
- Mean/~~Maximum/Minimum~~ Length
- Digestive Organ Code

Record Type 8 - Text
- Text

Record Type 9 - Age
- Age/Age Accuracy Code
- Age Unit Code
- Age Determination Code

NATION[illegible] OCEANIC AND ATMOSPHERIC ADMIN[illegible]RATION

completed set of instructions sent 5-19-78

RFx41-243-340

MAY 18 [illegible]

Standardization of map Products mailed w/memo on 5/23/79.

Mr. Donald O. Calkins
State of Alaska
Dept. of Fish and Game
333 Raspberry Road
Anchorage, AK 99502

Reference: OCSEAP Research Unit 243

Dear Mr. Calkins:

At this time we are soliciting renewal proposals for the 1979 fiscal year starting 1 October 1978 and ending 30 September 1979. Requests for these proposals are based on the Technical Development Plan for the environmental assessment of the Alaska continental shelf.

We are inviting you and Mr. Pitcher to submit a renewal proposal for continued Steller sea lion studies in the Kodiak, Lower Cook Inlet, and northeastern Gulf of Alaska lease areas. Your proposal should include additional FY 79 field and laboratory studies and the analysis and interpretation of data collected during FY 78.

The funding guidance for FY 79 is $115,000.00, to be distributed between the lease areas approximately as follows:

44% Kodiak
30% Lower Cook Inlet
26% NEGOA

Field Studies of sea lions in FY 79 should be restricted to locating and identifying branded animals and visiting selected rookeries for sex and age composition counts. A secondary task of the field program in the Kodiak lease area will be to continue an observational study of sea otter behavior and ecology in the Afognak-Marmot Islands area. The objective of this latter work is to obtain information on (1) seasonal changes in distribution, (2) habitat use, (3) food habits, and (4) behavior. A secondary task of field efforts in the Lower Cook Inlet lease area will be to continue monthly aerial surveys to delineate seasonal distributions, migration patterns, and numbers of belukha whales and other cetaceans.

FILE COPY

CODE	SURNAME	DATE	CODE	SURNAME	DATE
	[illegible]	5/5		[illegible]	5/15
	[illegible]	5/5			
	[illegible]	5/12		RPB	5/15

NOAA FORM 61-2
3/77

Expected products from this research activity include:

1. Digital morphometric, reproductive ecology, sighting, food habits, and census data submitted in OCSEAP format under File Types 025-Mammal Specimen and 027-Mammal Sighting 01 as appropriate. Before submission to NODC, all digital data will be checked for correct use of format in addition to ensuring that it falls within the normal limits and ranges porvided by the P.I. All data management activities will remain under the direct supervision of the principal investigator.

2. Narrative reports containing descriptions of (a) observation and collection locations, (b) observation and collection frequencies, (c) measurement and analytical techniques, (d) results of analyses, and (e) conclusions. Specific subject areas to be addressed include population size and discreteness, major breeding rookeries, hauling grounds, migration routes, seasonal changes in density and foraging areas, reproductive ecology, food habits and selected biological parameters. Emphasis should be placed on any behavioral aspects of Steller Sea lion ecology which may relate to OCS activities.

3. Visual data supporting the narrative report in the form of:

   - Maps identifying major sea lion rookeries and hauling grounds, branded pup release and recovery locations, sampling locations, and habitat use and distribution of sea otters.

   - Charts illustrating seasonal distributions, migration patterns, and numbers of belukha whales and cetaceans in Cook Inlet.

   - As appropriate, figures or tables illustrating:

     - Status of sea lion populations, including seasonal census information, age and sex composition, growth rates, seasonal variability in body condition, foraging areas, and movement patterns.

     - Reproductive ecology of sea lions at major rookeries, including age of maturity, age specific reproduction rates, breeding season, age specific mortality rates, and reproductive biology and life history events.

     - A list of major prey species showing the frequency of occurrence by season, area, and age of consumer.

     - Food habits of sea otters in the Kodiak study area.

This year's proposal format is requesting information on future years' research efforts for those investigators who expect to continue into FY 80 and beyond. We are asking for this additional information because: (1) We believe a better program will result when research can be viewed in a perspective longer than a single fiscal year, (2) we will be able to estimate future total program costs and the impact of different total budget levels, (3) our information base will be improved for writing research plans for FY 80. Please be assured that we are well aware of the uncertainties associated with environmental research, and that no future commitment is implied by your furnishing this information.

Please prepare your renewal proposal according to these guidelines and the enclosed instructions for delivery to the Juneau Project Office no later than 1 June. If, in preparation of your renewal proposal, you have any questions, please call or write the Juneau Project Office. Lease area coordinators responsible for setting research requirements are Jawed Hameedi in Kodiak and the Aleutians, Paul Becker in Cook Inlet and Laurie Jarvela in NEGOA. Their planning is based on advice from Rod Swope will continue as your primary contact and who is responsible for contract compliance. Questions concerning the requirements placed on data processing and scheduling may be addressed to Francesca Cava, Data Manager.

We have made our best estimate of what this project should accomplish during FY79 to meet BLM needs. However, we encourage you to bring to our attention specific aspects in which you feel that the above guidance might be modified or improved to enhance the overall scientific quality and output of the project. You should also keep in mind that OCSEAP must issue guidance and invite renewal proposals at this time in order to complete review and funding procedures before 1 October 1978.

We would like to thank you for your contributions to the OCSEA Program and look forward to another year of cooperative effort.

Sincerely,

Herbert E. Bruce, Ph. D.
Bering Sea-Gulf of Alaska Project Manager

cc:
Program Office
John Burns, OCS Coordinator, ADF&G
Karl Schneider

27 APR 1978

File Type 027

Marine Mammal Sighting

Common to all records
- File Type
- File Identifier
- Record Type
- Flight/Station Number
- Sequence Number

Record Type 1 - Location
- Starting Date/Time
- Starting Latitude/Longitude
- Elapsed Time/Distance Along Track
- Completeness Code
- Ending Latitude/Longitude

Record Type 2 - Environmental 1
- Sighting Date/Time
- Sighting Latitude/Longitude
- Platform Type/I.D. Codes
- Platform Direction/Altitude
- Air Speed/Tide Range
- Current Speed/Current Direction
- Ice Codes

Record Type 3 - Environmental 2
- Sighting Date/Time
- Sighting Latitude/Longitude
- Wind Speed/Direction
- Visibility/Cloud Type Code
- Cloud Amount/Weather Codes
- Air Temperature
- Sea State Code
- Water Surface Temperature
- Water Color Code/Surface Visibility
- Barometric Pressure/Inclinometer Angle
- Water Depth

Record Type 4 - Sighting 1
- Sighting Starting Date/Time
- Sighting Latitude/Longitude
- Distance/Area Surveyed
- Mammal Activity/Number of Observers
- Collection Method Code/Group Size
- Animal Movement Direction
- Units Code for Sighting Distance
- Distance from Platform
- Bearing to Animals
- Platform Heading

Record Type 5 - Sighting 2
- Taxonomic/Subspecies Codes
- Behavior/Confidence Codes
- Number of Individuals
- Confidence Code (repeated 4 times)
- Number of Adults/Pups/Subadults/
- Adult Males/Adult Females
- Marked Animal Code
- Static/Telemetry Code
- Decomposition Stage Code
- Completeness Code

Record Type 6 - Sighting 3
- Distance from Ice Edge/Shore
- Identification Reliability
- Glare Area Code/Debris Code
- Text

Record Type 7 - Text
- Text

Record Type 8 - Ice
- Sighting Date/Time
- Sighting Latitude/Longitude
- Ice Codes

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

Proposal Date: June 26, 1978

Contract #: 03-5-022-55

Task Order #: 11

NOAA Project #: N/A

Institution ID#: GI78-97

FY 1979 RENEWAL PROPOSAL

Research Unit Number 250

TITLE: Mechanics of Origin of Pressure Ridges, Shear Ridges and Hummock Fields in Landfast Ice

Cost of Proposal: $25,245

Lease Areas: Beaufort Sea 100 %

Period of Proposal: October 1, 1978 through September 30, 1979

Date 6/10/78
Lewis H. Shapiro
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7196

Date June 21, 1978
William D. Harrison
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7137

Date June 21, 1978
Howard F. Bates
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7417

Date 6/21/78
Neta J. Stilkey
Business Manager
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7644

Date 6-21-78
Juan G. Roederer
Director
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7282

Date 6/22/78
Keith B. Mather
Vice Chancellor for Research and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7314

IV. Background

Landfast ice is the subject of several OCSEAP projects (Barry, R.U. #244; Weeks and Kovacks, R.U. #88; Stringer, R.U. #257) in addition to the studies proposed here. This project is concerned with the mechanisms and processes involved in the deformation of landfast ice including ridging, hummocking and the forces associated with these, and with the interaction of the ice with the sea floor and the shoreline.

Studies in progress on this project include:

1. Distribution and morphology of pressure ridges formed within the field-of-view of the University of Alaska sea ice radar system at Barrow;

2. Mechanism of formation of ridges and ice piles along the beach at Barrow in late spring;

3. Vibration of the ice sheet as an indicator of rising stress levels;

4. Rate of formation of gouges in the sea floor in the Barrow area, (in cooperation with P. Barnes of the U.S.G.S.).

Little work has been accomplished on the first of these objectives because, since the inception of OCSEAP, ice conditions in the area have not been suitable for a study of this type. However, the study of the formation of ridges along the beach in late spring has yielded useful results. These have been observed to form on two separate occasions, and extensive observations have been made which provide information on failure mechanisms, rates of motion, and the ridging process proper. It is proposed that this work be continued as opportunities for field study occur.

The theoretical aspects of the study of vibration of sea ice sheets as indicators of high stress levels has progressed well. Solutions have been obtained for the cases of propagation of waves in the ocean-ice system for no energy losses and for small energy losses. There is a need to extend the theoretical work to the case of a viscoelastic ice sheet, and this is planned for the coming year under a project funded by the National Science Foundation. The observational data upon which this project is based were acquired fortuitiously in conjunction with other studies. The recording systems employed, while accurate enough for qualitative study, were not adequate to provide data for quantitative testing of the theory. Acquisition of suitable data is thus required, and is planned under this project.

During the past year, a side-scan sonar survey was conducted along approximately 50 km of track line within the field-of-view of the sea ice radar by P. Barnes (U.S.G.S.). Ice motion in the area has been monitored by the radar system during the past year (as in previous years) and it is intended that the survey be repeated in the coming summer. This will permit the identification of new groups formed during the year, and their possible correlation with ice events. Analysis of the data, and a possible third survey of the area if ice conditions warrent, will be conducted under the time period covered by this proposal.

V. Objectives

The objectives of this project are to examine the mechanics of origin of ridges and hummock zones in the area normally occupied by landfast ice. Within this general subject, the following specific objectives are addressed:

1. Determination of the morphology and mode of origin of suitable ridges formed along the beach at Barrow in late-spring, and of any other ridges which form within the field-of-view of the sea ice radar system at Barrow during the winter of 1978-79;

2. To cooperate with P. Barnes (U.S.G.S.) in the continuation of the side scan sonar survey of the Barrow area in order to assess the rate of formation of gouges in the sea floor;

3. To gather data related to the relationship between long period vibration of the ice sheet and increasing stress levels.

4. Observations of the distribution and frequency of occurrence of ice pile-ups along barrier islands and beaches of the Beaufort Sea Coast of Alaska.

5. To attempt to extend the data base regarding the occurrence of unusual or extreme ice events along the Beaufort Sea Coast through interviews with local Eskimos who formerly resided in the area. Note that this aspect of the project is currently funded under a small supplement to RU 265. Extension of the work will require additional funding beyond that shown in the attached budget for RU 250.

VI. General Strategy and Approach

Ridging and hummocking in sea ice are processes which reflect high stress concentrations resulting in failure of the ice sheet. An understanding of these processes requires knowledge of the failure mechanisms which operate during ridging, the forces required, and other parameters (such as relative motion of the ice across the prospective ridge line, and the water depth) which influence the final form of the resulting ridges. Previous work on this project involving the study of the formation of ridges along the beach at Barrow in late spring has produced useful results toward these requirements. That work was done in 1975 and 1976. No such ridges formed in 1977, because the ice went out earlier than usual. However, field study during the coming summer is anticipated if the appropriate conditions occur, and similar work will also be done in the summer of 1979.

The problem of the relationship between rising stress levels and long period vibration of the ice is being examined theoretically using stability theory. To date, solutions for wave propagation in the ice sheet have been obtained which provide the basis for further work. Funding has been obtained from the National Science Foundation to support the additional theoretical work requried. The related observational and experimental work will be accomplished under this proposal. This includes operation of the radar system, a suitable tide gauge, a stress transducer array, and an 8 mm time-lapse motion picture system. It was intended that a tide gauge and a stress-transducer array be installed at Barrow during the past year. However, a combination of equipment problems and adverse ice conditions prevented the acquisition and installation of these. An attempt will be made to conduct these measurements during the winter of 1978-79.

The study of the rate of formation of gouges in the sea floor off Barrow will require detailed analyses of ice motion in the Barrow area using the sea ice radar data. This work will commence following the field survey to be completed during the coming summer after the ice moves out of the area, and will be completed during the time covered by this proposal. Correlation of the results with the side scan sonar data can then be made, and an additional survey conducted during the summer of 1979 if warranted.

The distribution of ice pile-ups along beaches and barrier islands will be determined by a series of flights along the coast. The first of these will be made in late February or early March to identify those features formed by winter movements of the ice. If possible, a second flight will be made in early July to determine whether additional pile-ups formed during the period of active ice motion during break-up. An effort will be made to visit any sites to make measurements. However, such visits will depend upon the availability of suitable aircraft, as it would not be possible to schedule flights prior to the first determination of the existence of pile-ups at various locations.

The program of interviewing local Eskimos regarding ice conditions presently is done by two members of the Barrow community who conduct the interviews, translate and prepare manuscripts. Their efforts are closely monitored and supervised by us, and we supply the questions to be asked. Present funding is adequate for the pilot project in progress. The results will be evaluated both for the quality of the information obtained and the method of operation. Based upon these, a proposal will be submitted for additional work if warranted.

VII. Sampling Methods

N/A

VIII. Analytical Methods

N/A

IX. Deliverable Products

A. Digital Data:

None

B. Narrative Reports:

Narrative of observations, methods, and procedures and results.

C. Visual Data:

Maps and cross-sections of ridges and maps gouge distribution to be included with narrative reports. Time lapse movies from sea-ice radar screen and 8 mm camera mounted on radar tower.

D. Other Non-Digital Data:

None

E. Data Submission Schedule:

None

Data Products Schedule Attached

B. AIRCRAFT SUPPORT - FIXED WING ~~GI78-97~~

1. Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)

   local Barrow area

2. Describe types of observations to be made.

   ice conditions

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

   open

4. How many days of flight operations are required and how many flight hours per day?

   Total flight hours? 1

5. Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback?

   open

What types of special equipment are required for the aircraft (non carry-on)?

What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.

N/A

What are the weights, dimensions and power requirements of carry-on equipment?

N/A

What type of aircraft is best suited for the purpose?

open

Do you recommend a source for the aircraft? Yes
If "yes", please name the source and the reason for your recommendation. NARL

What is the per hour charter cost of the aircraft?

NARL rate

How many people are required on board for each flight (exclusive of flight crew)?

2

Where do you recommend that flights be staged from? 11
NARL

XIII. Anticipated Problems:

None.

Contingency plan: The field program includes four seperate aspects, and it is unlikely that conditions will be unsuitable for all of these. In the event that this should occur, we will devote time to considering mathematical models of the ridging process.

XIV. Information Required from Other Investigators

We are interested in the reports of other investigators regarding landfast ice, but have no need for immediate access to the data.

XV. Management Plan

1. Fiscal management of funds which may be obtained for this project will be handled by the business manager, Geophysical Institute, University of Alaska. The University provides monthly summary of expenditures and encumbrances as well as current information on all financial aspects of the contract in accordance with mutual requirements of the contractor.

2. Scientific management will be the responsibility of the principal investigators who will lead and supervise all phases of the proposed work and assure the timely completion of the objectives.

3. Outside coordination, review and direction will be provided by the OCS Arctic Project Office, Geophysical Institute, University of Alaska.

See Attached Milestone Chart

Milestone Chart

O - Planned Completion Date

X - Actual Completion Date

RU # 250 PI: Shapiro/Harrison/Bates

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
ıstallation of tide gauge and stress ·ansducers					Δ										
eld studies										Δ					
de Scan Sonar Survey (possible)												Δ			
mplete data analysis												Δ			

GI78-97

XVI. Outlook

The final result of this project is as stated in the objectives above. That is, to develop an understanding of the mechanisms and processes by which ridges and hummock fields form in landfast ice. The emphasis is on mechanisms, and therefore, the rate at which data are acquired depends less upon the actions of the investigator, than on the occurrence of certain natural events at an appropriate time and location. To date, the most significant data gap with regard to this study, remains the study of pressure and shear ridges which form during fall and winter. Only minor examples of these have developed within the study area during the time the project has been active, so that none have been examined as yet. Some work of this type will, however, be required for the successful completion of the project.

The study of the ice gouging of the sea floor is not yet sufficiently advanced for predictions to be made regarding when milestones will be reached. However, completion of the survey planned for the coming field season, and subsequent analysis of the data should make estimates possible.

The study of the vibration of the ice sheet under compressive stress should reach an important milestone during the period covered by this proposal. That will be the solution for the vibrating viscoelastic plate under impulsive loading. Additional milestones will depend upon the acquisition of data with which to test the model, and that depends upon the occurrence of natural events. If sufficient examples can be collected during the current year it is possible that this phase of the project can be completed during this proposal period.

There are no changes anticipated in the field location or in logistics requirements.

XVII. Contractual Statements

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

To: Bering Sea - Gulf of Alaska Project Office
P.O. Box 1808
Juneau, Alaska 99802

Revised Budget Date: October 10, 1978

Contract #: 03-5-022-55

Task Order #: 2

NOAA Project #: N/A

Institution ID#: GI 78-99b

FY 1979 Revised Budget

Research Unit Number 251

TITLE: Seismic and Volcanic Risk Studies - Western Gulf of Alaska

Cost of Proposal: $ 187,737

Lease Areas Kodiak 50 %

Lower Cook Inlet 50 %

Period of Proposal: October 1, 1978 through September 30, 1979

Date Oct 10 1978
Hans Pulpan
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7424

Date 10/11/78
Neta J. Stilkey
Business Manager
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7644

Juergen Kienle Date Oct. 10, 78
Juergen Kienle
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7467

Juan G. Roederer Date 10/11/78
Juan G. Roederer
Director
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7282

GI 78-99a

TECHNICAL PROPOSAL

I.

A. Title: Seismic and Volcanic Risk Studies - Western Gulf of Alaska
B. Research Unit Number: 251
C. Contract Number: 03-5-022-55
D. Proposed Dates of Contract: October 1, 1978 - September 30, 1979

II. Principal Investigator(s)

A. Hans Pulpan

B. Juergen Kienle

III. Cost of Proposal Federal Fiscal Year 1979

A. Science: $198,347

B. P. I. Provided Logistics: $4,800

C. Total: $203,147

D. Distribution of effort by lease area:

1. Aleutians
2. Beaufort Sea
3. Bristol Bay
4. Chukchi Sea
5. Kodiak 50%
6. Lower Cook Inlet 50%
7. NEGOA
8. Norton Sound
9. St. George Basin
10. Non-lease-area laboratory management

IV. Background

Seismicity and Seismic Risk

The western Gulf of Alaska is an area of high seismic and volcanic activity. This activity is the consequence of plate convergence, the Pacific crustal plate underthrusting the North American plate in a north-westerly direction along the Aleutian Island arc and its extension into mainland Alaska. Portions of this area have been the subject of seismotectonic and volcanological research by several agencies since the late 1960's and early 1970's. The Geophysical Institute, in particular, had initiated a comprehensive study of Augustine Volcano in Lower Cook Inlet in 1970, in the course of which study a seismic network was installed on Augustine Island and at the shores of Kamishak Bay. Similarly, the Geophysical Institute began seismotectonic studies of the Alaska Peninsula area with the gradual installation of a ten-station short period seismic network in that area, starting in 1973. With the start of the Outer Continental Shelf Environmental Assessment Program one additional seismic station was installed in Lower Cook Inlet and a new network was installed on Kodiak Island beginning in 1975. The purpose of that network, in conjunction with the existing stations, was to identify in the western Gulf of Alaska the potential seismic risk associated with offshore petroleum development activities.

In its present configuration, the network is an integral portion of a seismic monitoring system, extending continuously over an approximately 1,000 km portion of the Aleutian-Alaska arc system, operated by several agencies (Lamont-Doherty Geological Observatory, United States Geological Survey, NOAA through its Alaska Tsunami Warning System), both for basic scientific research and in connection with the OCSEA program.

Reliable year-round operation of the seismic network proved difficult in the initial years. However, a number of technical and logistic changes, as well as a complete replacement of all field units by laboratory calibrated units during the last annual station service have apparently resolved most of the technical problems and provided one year of data that is fairly homogeneous in space and time over the whole study area.

Some of the principal results based on the data collected so far are:

1.) Delineation of the Benioff zone as the prime seismotectonic feature, with which the largest portion of seismic strain release is associated in the area. The Benioff zone is about 30-40 km thick and reaches a maximum depth of about 200 km. The depth to the top of the seismic zone beneath the line of volcanoes is approximately 100 km.

2.) Identification of areas of special interest with regard to seismic risk associated with OCS development, including:

   a.) an area of high rate of seismic strain release in the Benioff zone below the area of Iliamna Volcano;

   b.) a seismically active fault, previously unmapped, on Kodiak Island near Deadman Bay;

   c.) an area of high level seismicity off the southwest coast of Kodiak Island near the continental shelf edge;

   d.) shallow seismic activity with a pronounced east-west linear trend just seaward of Marmot Island, east of Afognak Island.

3.) Identification of other clusters of seismic activity:

   a.) clusters of shallow seismicity with high spatial and temporal variability along the volanic axis;

b.) shallow seismic activity with linear trends near the recently formed Ukinrek Maars on the Alaska Peninsula.

4.) Demonstration of the general diffuseness of the shallow seismicity which apparently has no preferred association with the major known fault systems of the area.

Hypocenter data files and epicenter maps have been generated routinely since January, 1976.

The seismic system, after becoming reliable, has demonstrated its ability to detect seismically active faults and other clusterings of seismic events at a rather low magnitude ($M_L = 1.5$) threshold level. Research so far has provided us with a good general understanding of the nature of the seismicity of the area and points out several regions of special interest with regard to seismic risk. Results derived so far will form the basis for representing the seismicity of the area in a fashion suitable for use in a quantitative seismic risk analysis.

Augustine Volcano

We have now entered the eighth year of basic volcanological research at Augustine, which in the past has included passive and active seismology, magnetics, magnetotellurics, geodesy, heat flow studies, petrology, geochemistry, eruption phenomenology and impact of eruptions on the atmosphere. A major eruption took place in early 1976, which allowed us to evaluate the seismicity of the volcano prior, during and following an eruptive cycle. This aspect of our research is important in terms of volcano monitoring and eventual eruption prediction.

Since we began seismic monitoring of Augustine Volcano in 1970, we have observed two distinct types of microearthquake activity. One class of seismicity is strongly temperature dependent and occurs only during cold winter months; the other class of events is related to movement of magma (molten rock).

Knowing the three-dimensional structure of the volcano, as determined by an active seismic experiment, it was possible to resolve the position of the precursor events to the 1976 eruption as close as 500 m. We found that the precursor seismicity began eight months prior to the eruptions, is epicentrally restricted to the central conduit system and is shallower than 6 km.

The monthly seismic energy release increased systematically as the eruption was approached. The conduit system began to break up in a major earthquake swarm only ten hours prior to the vent clearing eruptions of January 23-25, 1976. The total seismic precursor energy (10^{16} ergs) was still 7-8 order of magnitude lower than the thermal energy released in the eruptions (10^{23-24} ergs).

We have not observed any precursor or eruption related seismicity at depths greater than 6 km or at the underlying Benioff zone. This suggests that the 1976 eruption is the result of magmatic processes in a shallow magma chamber located not deeper than 6 km beneath Augustine Volcano. Independent confirmation of this conjecture comes from geochemical data. D. A. Johnston in his 1978 Ph.D. thesis presents a convincing petro-chemical model based on the chemistry of ejecta and gas inclusions, suggesting that basaltic melt was injected into a shallow, 2 to 10 km deep, magma chamber which contained dacitic melt. The injection may have coincided with the onset of the precursor seismicity in May, 1975. Mixing of the basaltic and dacitic melts produced an andesitic magma which was erupted about eight months later. In early 1976 the instability developed in the magma chamber that led to the energetic vent clearing eruptions of January 22-25.

Evaluation of the eruption potential and volcanic hazard of a given volcano requires knowledge of (1) its eruptive history as far back in time as possible and (2) recognition of its typical mode of eruption, which is related to its chemistry, structure, configuration and dimension of its internal plumbing.

We have now compiled a fairly complete eruptive history of Augustine since its discovery by Captain Cook in 1778. In the last 200 years it has erupted five times (1812, 1883, 1935, 1963/64, 1976) with repose times between eruptions as short as 12 years and as long as 71 years. We have examined its structure and internal plumbing by geophysical and geochemical means. The cone consists of a central complex of lava domes, mantled almost exclusively by pyroclastic flows, mudflows and rock avalanche debris. Lava flows are rare, a fact which reflects the high explosiveness of the volcano. The volcano is underlain by partially uplifted marine sediments of primarily Mesozoic age. A magma chamber is inferred to lie at a maximum depth of 6 km.

Augustine's eruptions typically begin with energetic vent clearing explosions, a phase which is followed by the arrival of new dacitic-andesitic melt, usually forming a new dome over the vent. The magma reservoir is likely to be fairly small, as indicated by apparent yields of ejecta of the order of 0.1 to 0.2 km^3 during each eruptive cycle.

The principal hazards of Augustine Island are pyroclastic flows and surges, mudflows and floods, minor lava flows, bomb and ash falls, noxious fumes, poisonous gases and acid rains, and tsunamis. Ballistic studies indicate that the ejection range of large bombs is mainly restricted to the Island itself. Ash from past eruptions fell at distances up to 1100 km, at Talkeetna, Anchorage and Sitka. The dispersal is strongly dependent on the prevailing wind directions. The 1883 eruption produced tsunamis that crossed the entire Lower Cook Inlet. Other near offshore hazards include heavy ash falls, acid rains and clouds of noxious fumes.

The most serious hazard that Augustine Volcano poses to offshore oil and gas development are pyroclastic flows. Practically all deposits below the 1000 foot contour line at Augustine Volcano, except for a small uplifted sedimentary wedge on the south side of the Island, consist of pyroclastic flows, mudflows and debris avalanches. We have now evidence that these flows could extend to distances of at least 5 km offshore. This data suggests that in previous reports we may have underestimated the mobility of pyroclastic avalanches along the sea floor. In fact, we thought they could only travel to very limited distances beyond the shoreline. In light of this evidence we now have to readdress the problem of on- and offshore hazards due to pyroclastic flow activity associated with Peléean type eruptive activity at Augustine.

Redoubt Volcano

We have now assembled in some detail the events of the 1965-68, 1933 and 1902 eruptions. Previous eruptions occurred in 1819 and 1778. In general, the volcano appears to be much less explosive than Augustine, as indicated by the predominance of lava rather than pyroclastic flows. It is interesting to observe that in this century Redoubt tended to erupt within a few years of Augustine, i.e., exhibited a similar periodicity. Redoubt is a much more mature (older) volcano than Augustine, more than twice as high and heavily glaciated.

The principal hazard of Redoubt arises from melt water accumulation in the ice-covered summit crater. Increased heat flux associated with the 1966 eruptions resulted in two crater outburst floods in January, 1966, which caused a break-up of the Drift River in mid-winter and two flash floods in that valley. Such flooding poses a direct threat to the Drift River Tanker Terminal. Presently, the upper Drift River is nearly dammed up by a glacier which descends from Redoubt's summit ("North Glacier"). Future advances of this glacier could easily dam up the valley, creating a lake that could drain catastrophically.

Last year, with helicopter support from the U. S. Army, we spent four days (July 14-17, 1977) on Redoubt's summit to conduct reconnaissance geologic studies and to establish geodetic base lines for photogrammetric work. Two topographic maps of the crater ice surface and the upper reaches of the "North Glacier" are being prepared from pre- and post-1966/68 aerial photography to monitor fluctuations of the ice surface in response to volcanic heating. This year we are planning to investigate the lower reaches of the "North Glacier:, including the terminus which is nearly damming the Drift River today. Clearly, any potential further expansion of the Drift River facility in response to the development of Lower Cook Inlet requires a careful assessment of this obvious volcanic hazard.

V. Objectives

The specific objectives of the proposed work are:

1. To record the locations and magnitudes of all detectable earthquakes within the study area and evaluate the potential seismic hazards to OCS petroleum development.
2. To determine the seismic activity of surface and near surface faults identified by geologic mapping.
3. To evaluate the observed seismicity in cooperation with research units 16 (Davies) and 210 (Lahr) toward a seismic risk analysis of the Gulf of Alaska region.
4. To perform field studies and seismic monitoring on volcanoes within the study area in order to evaluate volcanic hazards to OCS petroleum-related activities. The principal volcanoes to be investigated are Augustine and Redoubt. We also propose to conduct a one day field reconnaissance of Douglas Volcano at the southern end of the Cook Inlet lease area.

VI. Strategy and Approach

Seismicity and Seismic Risk

The objective of the continued compilation of an earthquake catalogue of the area at a sufficiently low threshold level will be achieved through the continued operation of the regional seismic network in its present configuration. The present low detection threshold is necessary to identify seismic activity of mapped or unmapped surface and near-surface faults. Though it has been stated above that the shallow seismicity (hypocentral depth) less than 50 km) is rather diffuse throughout the region, there are areas of special interest, and the seismically active fault detected near Deadman Bay would have gone undetected, both on the basis of the seismic station distribution before initiation of this program and the tectonic-geological information presently available. We also do not yet have a good picture of the space-time variability of the other seismic clusters.

Besides the continued routine determination of hypocenters and the preparation of epicenter maps and hypocentral cross sections, data analysis and recording will shift more towards specific aspects of seismic risk analysis. With respect to the instrumentation we intend to:

1. Very carefully calibrate 4 to 5 selected stations of the network for the purpose of investigating our ability to perform short period attenuation studies. We do not know whether we shall succeed in achieving the necessary stability to do such a study, but we intend to provide both a complete systems calibration over the frequency range of interest at service time and a daily calibration at the selected stations.

2. Improve the present mode of installation of the strong motion instruments that are now in place (i.e. maintaining the interfacing with the short period system that permits absolute timing of the strong motion records) and probably add a few units. Strong motion data is probably the single most important information presently lacking in the area. There is, of course, no guarantee that an event sufficiently large enough to trigger any instrument will occur in the near future, but it appears that the gradual build-up of a dense strong motion instrument network in the area should be part of the program.

With respect to data analysis which we will emphasize more than previously, we shall address ourselves to the following specific problems:

1. Improve the accuracy of routinely determined hypocenter parameters by using an improved crustal and upper mantle velocity structure. Travel time-epicentral distance data pairs from well-located events will be inverted into a P-wave velocity structure using the "hedge-hog" procedure, a variation of the Monte Carlo method developed by Keilis-Borok and Knopoff. We are performing this data inversion presently for data from the interior of Alaska.

2. Express the seismicity of the area (as determined both from historic data and data collected from the regional seismic network) in a format required for performing a quantitative seismic risk analysis. This would, as a first step, consist of the subdivision of the area into different seismic source regions, the determination of magnitude-frequency relationships for these regions, and the derivation of the pertinent input parameters for seismic risk analysis from these relationships.

3. Perform "pilot" risk analyses for selected areas, i.e. providing an estimate of the likelihood that any specified peak value of ground motion intensity will be equalled or exceeded in an arbitrary future time period. We shall follow, at least for the time being, the approach of Cornell (1971). We term this "pilot" analysis because the outcome of such an analysis will to a certain extent depend on how one uses the existing data base as input to the risk analysis. This is not necessarily a straightforward matter but depends frequently upon the judgement of the person conducting the analysis. We shall therefore concentrate on the question, whether the present data base permits a meaningful risk analysis at all and if so, how different, but reasonable, use of input data influences the results of any particular risk scheme.

Augustine Volcano

As discussed in the previous section, the principal volcanic hazards of Augustine are pyroclastic flows descending the volcano at great speed (order 50 m/sec) during Peléean type eruptive activity.

Very little is known from worldwide historic data how far out to sea pyroclastic avalanches and subjacent glowing clouds would travel once they pass the shoreline.

In the past year, J. Whitney from the Conservation Division, U.S. Geological Survey, Anchorage, discovered deposits which he suspects to be pyroclastic flows as far as 5 km off Augustine Island! In a joint effort with J. Whitney and A. Bouma (OCSEAP Research Unit 327) we will conduct a pilot study in June and August, 1978 to verify whether the deposits are indeed pyroclastic flows, and if so to try to correlate them with onshore deposits. Supplemental funding will likely be requested by us and Research Unit 327 if the pilot study yields positive identification of offshore pyroclastic flow deposits at great distances from Augustine.

At the present modest funding level for volcanology, we propose to accomplish the following:

1. Continue to operate the island based four-station seismic array to continue our now eight year long baseline record of seismicity. This data is important to study the thermal-mechanical evolution of the volcano in between and during eruptive cycles, as discussed in section IV. Understanding the patterns may eventually lead to prediction. The recent eruptions were preceded by eight months of precursor seismicity.

2. Based on photogrammetric data calculate the volumes of the 1963/64 and 1976 pyroclastic flow deposits in order to arrive at

typical eruption volumes and estimates of thermal energy release. This kind of study will give an estimate of the size (class) of eruptions to be expected from Augustine. We will also continue the cooling study of the 1976 pyroclastic flows which we began directly following their emplacement and which are described in previous reports.

3. During the next field season, 1979, we will continue to ground check Detterman's (1973) geologic map of Augustine which is largely based on photo interpretation. In order to extend the eruptive history of Augustine beyond the historic record, which begins 1788, we plan to age date prehistoric pyroclastic and other debris flow deposits using C^{14} dating techniques.

Redoubt Volcano

On Redoubt we plan to accomplish the following:

1. Continue to operate the single seismic station on the southern flank of the volcano. One station is, of course, not enough to locate hypocenters of any volcanic earthquakes and thus to study movement of magma, but it is valuable to get some idea on the state of activity of the volcano. If this volcano is ever to be monitored seriously, a small network like the one on Augustine needs to be established.

2. Focus our attention on the glacier (North Glacier) that descends northward from the main summit crater into the Drift River Valley,

now nearly blocking the stream. This year we are planning to establish geodetic bench marks in the vicinity of the terminus of the glacier and plant stakes on the glacier. Next year's survey will give us ablation rates and rates of movement. This data, combined with photogrammetric mapping of the entire glacier as discussed in section IV, is needed to evaluate the flooding potential of Drift River and the resulting threat to the Drift River Tanker Terminal

3. We will continue our geologic reconnaissance of the volcano and complete the literature search to document the historic activity of the volcano.

VII. Deliverable Products

A. Digital Data:

Derived earthquake parameters (date, time, longitude, latitude, depth, magnitude) will be submitted on punched cards in the standard hypocenter data file format.

B. Narrative Reports:

The narrative reports will describe the operation of the seismic network, number and spatial density of instruments and the resulting accuracy of derived earthquake parameters. A summary interpretation of seismic events recorded will be presented. Reports will include an evaluation of frequency versus magnitude relationships, activity of surface and near surface faults, volcanic hazards of Augustine and Redoubt Volcanoes, and conclusions regarding implications for OCS exploration and development.

C. Visual Data:

Visual data will include (1) epicenter maps (including magnitude), (2) maps and graphs of earthquake magnitude versus frequency relationships for relected areas, (3) maps with supportive text summarizing seismic activity of surface and near surface faults identified in geologic mapping, (4) seismic risk maps, and (5) a volcanic hazard map of Augustine Island; preparation of this map has been delayed by the unexpected evidence of potential offshore pyroclastic flows.

DATA PRODUCTS SCHEDULE

ata Type (.e. Intertidal, enthic Organisms, tc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)		Submissio (Month/Ye
Seismic	Punched cards	250 cards/mo.		Yes	Oct. 1978	Dec. 1978	March 197
					Jan. 1978	March 1979	June 1979
					April 1979	June 1979	Sept. 197
					July 1979	Sept. 1979	Dec. 1979

GI 78-99 a

Seismic Station Service
GI 78-99

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION University of Alaska PRINCIPAL INVESTIGATOR Hans Pulpan

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.
   Seismic station service on Chowiet Island and Chirikof Island (see attached map).

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible.
   Service of existing field station.

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

   No chronology requirement. Time period: June - August ± 1/2 mo.

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

   N/A

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? Can piggyback.

   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.

   Time required at each station, approximately 3-4 hours.

6. What equipment and personnel would you expect the ship to provide?
   Helicopter

7. What is the approximate weight and volume of equipment you will bring?
   500 lbs. It will fit into any type of helicopter.

8. Will your data or equipment require special handling? NO If yes, please describe.

1. Will you require any gases and/or chemicals? No If yes, they should go on board the ship prior to departure from Seattle or time allowed for shipment by barge.

0. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.

NOAA ship Surveyor, as it has helicopter pad.

1. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability?

2. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.

One person.

AIRCRAFT SUPPORT - FIXED WING

Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)

Any seismic stations indicated on attached map, except CHI and CHO.

Describe types of observations to be made.

1.) Emergency visits to seismic station in case of failure.

What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

Unpredictable

How many days of flight operations are required and how many flight hours per day?

Total flight hours? 25 hours

Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback?

Principal

What types of special equipment are required for the aircraft (non carry-on)?

Floats or skis as warranted

What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.

What are the weights, dimensions and power requirements of carry-on equipment?

200 lbs. It will fit in any single engine fixed wing.

What type of aircraft is best suited for the purpose?

Any single engine

Do you recommend a source for the aircraft? Local companies as warranted
If "yes", please name the source and the reason for your recommendation.

What is the per hour charter cost of the aircraft? $80 - $100

How many people are required on board for each flight (exclusive of flight crew)?

Two

Where do you recommend that flights be staged from? Kodiak, King Salmon or Homer as warranted for seismic stations.

C. AIRCRAFT SUPPORT - HELICOPTER
Seismic Station Service

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

 1.) All stations on attached maps, except for CHI and CHO which require ship based operation.

2. Describe types of observations to be made.

 Annual service and maintenance of seismic stations.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

 July 1 through September 1 ± 1 month

4. How many days of helicopter operations are required and how many flight hours per day? 20 - 25 days at 5 hrs./day

 Total flight hours? 100

5. How many people are required on board for each flight (exclusive of the pilot)?

 2 - 4

6. What are the weights and dimensions of equipment or supplies to be transported?

 500 lbs.

7. What type of helicopter do you reommend for your operations and why?

 UH1H or Bell 206B. Both aircraft have proven satisfactory in the past.

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

 NOAA

9. What is the per hour charter cost of the helicopter?

 N/A

10. Where do you reommend that flights be staged from?

 Kodiak, King Salmon, Port Heiden, and Kenai

11. Will special navigation and communications be required?

 No

D. QUARTERS AND SUBSISTENCE SUPPORT

1. What are your requirements for quarters and subsistence in the field area? (These requirements should be broken down by (a) location, (b) calendar period, (c) number of personnel per day and total man days per period).

A) Accomodations required during service trips to seismic stations in Kodiak, Homer and King Salmon.

2. Do you recommend a particular source for this support? If "yes", please name the source and the reason for your recommendation. Kodiak: U.S. Coast Guard Station, King Salmon: U.S. Fisheries cabin or Air Force station. The above have proven the most convenient and cheapest accomodations.

3. What is your estimated per man day cost for this support at each location?

$35

How did you derive this figure, i.e., what portion represents quarters and what portion represents subsistence and is the figure based on established commercial rates at the location or on estimated costs to establish and maintain a field camp?

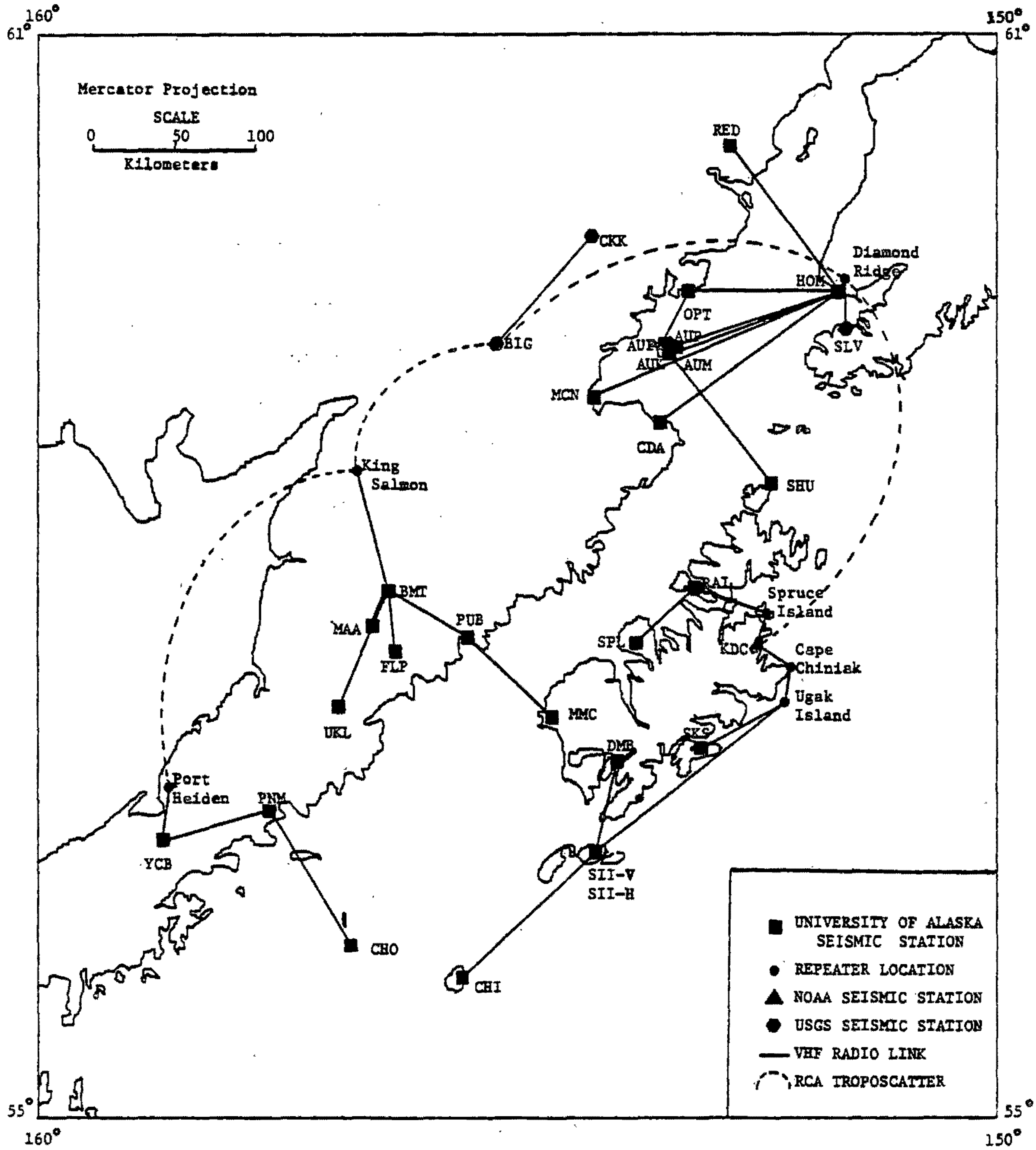
30% quarters, 70% subsistence
Based on past experience. Cost will be higher.

E. SPECIAL LOGISTICS PROBLEMS

1. What special logistics problems do you anticipate under your proposal and how do you propose that the problems be solved? (Provide cost estimates and indicate whether you propose handling the problems yourself or whether you must depend on NOAA to solve them for you?

None

72-HI


160°
61°
150°
61°
Mercator Projection
SCALE
0
50
100
Kilometers
RED
CKK
Diamond Ridge
HOM
OPT
SLV
BIG
AUB
AUP
AUK
AUM
MCN
CDA
King Salmon
SHU
BMT
MAA
PUB
FLP
SPI
RAI
Spruce Island
KDC
Cape Chiniak
Ugak Island
UKL
MMC
DMB
SKS
Port Heiden
PNM
YCB
SII-V
SII-H
CHO
CHI
UNIVERSITY OF ALASKA SEISMIC STATION
REPEATER LOCATION
NOAA SEISMIC STATION
USGS SEISMIC STATION
VHF RADIO LINK
RCA TROPOSCATTER
55°
160°
55°
150°

AIRCRAFT SUPPORT - FIXED WING - VOLCANIC HAZARDS

GI78-99a

Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)

1) Homer - Augustine Island;

Describe types of observations to be made. 1) Field work at Augustine Volcano

What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

Snow-free conditions -- spring, summer

How many days of flight operations are required and how many flight hours per day?

Total flight hours? 10

Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback? principal

What types of special equipment are required for the aircraft (non carry-on)?

floats

What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.

What are the weights, dimensions and power requirements of carry-on equipment?

What type of aircraft is best suited for the purpose?

1.) Otter or Beaver

Do you recommend a source for the aircraft? Yes

If "yes", please name the source and the reason for your recommendation.

1.) Kachemak Air Service, Homer

What is the per hour charter cost of the aircraft?

1.) $130/hr.

How many people are required on board for each flight (exclusive of flight crew)?

1.) Four

Where do you recommend that flights be staged from? 1.) Homer

C. AIRCRAFT SUPPORT - HELICOPTER VOLCANIC HAZARDS

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

1.) Kenai - Redoubt Volcano, field work similar to 1977 operations (sketch attached)
2.) reconnaissance flight to Douglas Volcano 3.) Few hours of geologic work at Augustine.

2. Describe types of observations to be made. 1.) (a) continued geologic investigations on Redoubt, (b) geodetic surveys at "North Glacier" - Drift River Valley, (c) reconnaissance of Drift River Valley for flood effects
2.) Reconnaissance of Douglas Volcano. 3) Augustine work will principally be done by Zodiac (available) -- a few hours of helicopter time may be needed to reach more inaccessible points.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

1.) and 2.) Snow free conditions -- July, August

4. How many days of helicopter operations are required and how many flight hours per day? 1.) 6 (4) 2.) 1 (4-6) 3.) 1 (4-6)

Total flight hours? 1.) 24 2.) 4 - 6 hours 3.) 4-6 hours

5. How many people are required on board for each flight (exclusive of the pilot)?

1.) Kenai - Redoubt: 4 2.) Two 3.) 2-3

6. What are the weights and dimensions of equipment or supplies to be transported?

1.) field camp 600 - 800 lbs., on site 100 - 500 lbs.
2.) 200 lbs.
3.) 200 lbs.

7. What type of helicopter do you reommend for your operations and why?

1.) and 2.) UHIH or Bell 206

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

NOAA

9. What is the per hour charter cost of the helicopter?

N/A

10. Where do you reommend that flights be staged from?

1.) Kenai 2.) and 3.) Homer or Kenai

11. Will special navigation and communications be required?

No

D. QUARTERS AND SUBSISTENCE SUPPORT

GI78-99 a

1. What are your requirements for quarters and subsistence in the field area? (These requirements should be broken down by (a) location, (b) calendar period, (c) number of personnel per day and total man days per period).

a) 1.) Homer or Kenai
2.) Augustine - field camp
3.) Redoubt - field camp

b) July/August

c) 1.) 4-16
2.) 3-30 to 50
3.) 3-15
Total: 60 - 80 man-days

2. Do you recommend a particular source for this support? If "yes", please name the source and the reason for your recommendation.

1.) Homer: U/A field site 2.) Kenai: Hotel 3.) like seismic program 4.) tents

3. What is your estimated per man day cost for this support at each location?

$35

How did you derive this figure, i.e., what portion represents quarters and what portion represents subsistence and is the figure based on established commercial rates at the location or on estimated costs to establish and maintain a field camp?

U/A per diem, based on experience living cost will be higher.

E. SPECIAL LOGISTICS PROBLEMS

1. What special logistics problems do you anticipate under your proposal and how do you propose that the problems be solved? (Provide cost estimates and indicate whether you propose handling the problems yourself or whether you must depend on NOAA to solve them for you?

None

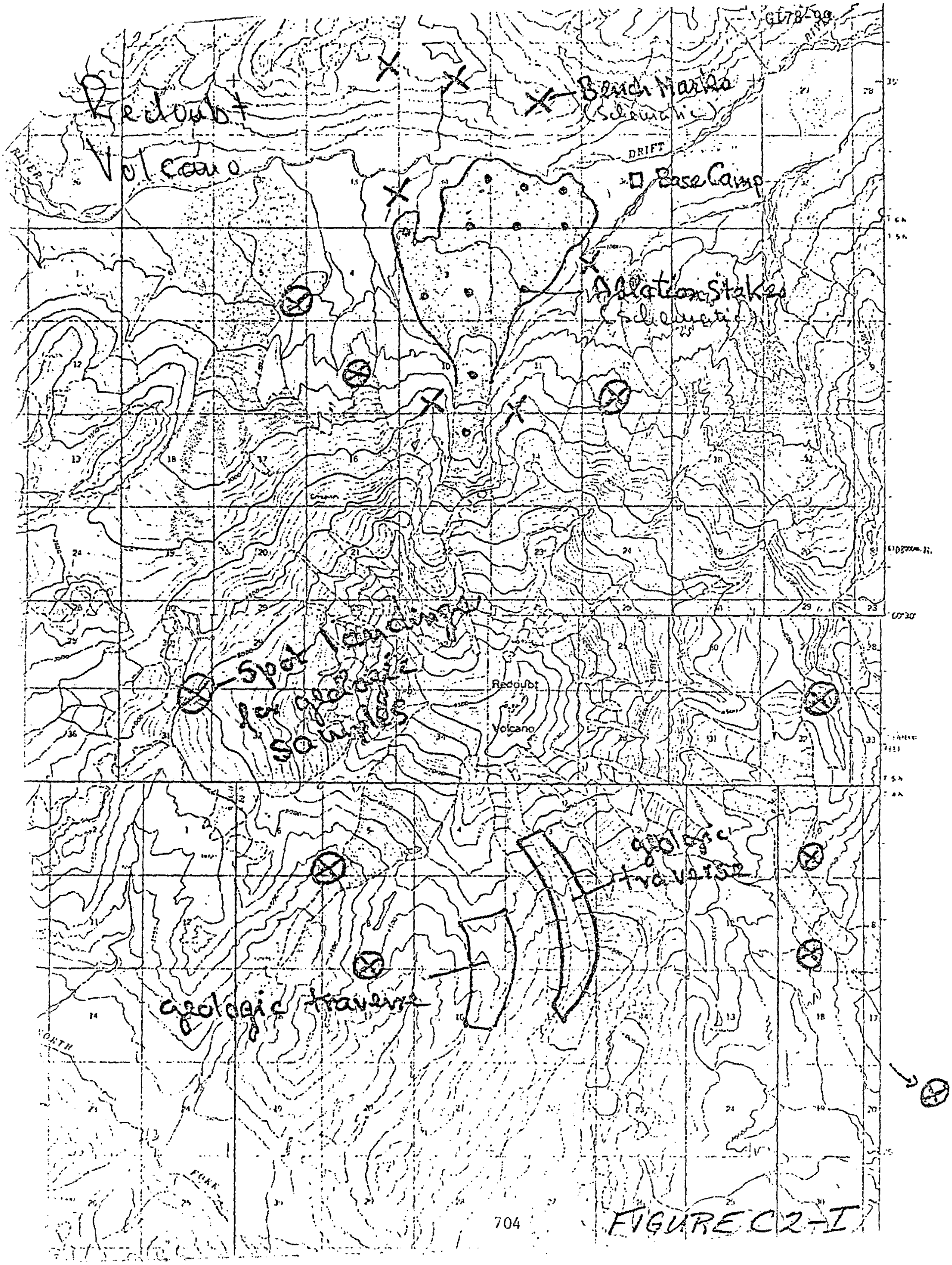

GI78-99
Redoubt Volcano
Bench Marks (Schematic)
DRIFT
Base Camp
Ablation Stakes (Schematic)
Spot landings for geologic soundings
Redoubt
Volcano
geologic traverse
geologic traverse

FIGURE C2-I

X. Anticipated Problems

None.

Contingency plan: In the case of a long term shutdown or lacking support to service and maintain the seismic network, the emphasis of the program would shift towards analysis of data at hand, and analytical methods of seismic risk analysis (see Section XIII for details).

XI. Information Required from other Investigators:

Data from the USGS and LDGO networks are required occasionally. Data are being exchanged routinely between the three agencies involved in OCSEAP seismic risk studies in the area. Results from studies of offshore faulting in the Lower Cook Inlet and off Kodiak Island (Research Unit 327) are very relevant and complementary to our attempt of delineating active faults from seismicity data.

Marine geophysical data off Augustine acquired during a pilot study in August, 1978, by Research Unit 327 (Arnould Bouma, USGS) will be used to decide on future plans and programs to evaluate offshore hazards to structures due to submarine pyroclastic flows.

XII. MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date

RU # 251 PI: Hans Pulpan

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

MAJOR MILESTONES	1978			1979											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Quarterly narrative reports			0						0			0			
Annual narrative report						0									
Epicenter maps and earthquake parameters for period Oct. 78 - Dec. 78						0									
Jan. 79 - March 79									0						
April 79 - June 79												0			
July 79 - Sept. 79															0
Seismic hazard maps			0						0						
Annual seismic station service trips									0	0	0				
Augustine field work										0					
Redoubt field work										0					
Douglas field work										0					
Augustine preliminary hazard map						0									

GI78-99 a

XIII. OUTLOOK

Seismic Risk Studies

Ideally, the result of a seismic risk study for an arbitrary point of a given area would provide to the design engineer the exact time histories of input motions onto a given structure during its lifetime. It would then be a rather straight-forward (though not necessarily easy) matter to design that structure seismically safe. However, since the input motion at a given site, due to a given earthquake, is the consequence or number of physical processes which, though qualitatively understood, are still elusive in terms of a quantitative, deterministic description, a variety of approaches at many levels of sophistication are presently in use, reflecting both specific needs at hand and different philosophies of the person(s) conducting the analysis.

Since a risk map essentially constitutes the (usually simplified) graphic display of the outcome of any such risk study in the light of the above it appears necessary to stipulate exactly what one wants to attempt with such an analysis and how one should go about it. Since there appears to be presently no clear cut definitions as to the exact data products desired, and methodologies to be employed with respect to seismic risk analysis for the OCS, we shall discuss what we believe this project can and should provide eventually in this respect within the framework of the whole risk problem, in order to (a) indicate that we are presently addressing only a small portion of the risk problem and (b) the exact method to be used will eventually be the one best fit to the data at hand and will have to be modified as the data base changes.

The input motion onto a structure of a given site, due to a given earthquake will depend upon:

1) The motion generated in the source area due to the dislocation process represented by the earthquake. The nature of this motion will primarily depend upon the stress drop, total displacement, size of slipped area, details of the slipping process, etc.

2) The modification of the source motion, during propagation through the earth. This will involve geometrical spreading, attenuation through energy dissipation, dispersion, etc.

3) Further modification of the motion due to surficial geology. This includes the filtering (or amplification) effects of soils and other surficial layers, the influence of surface topography, etc.

4) The soil-structure interaction.

In order to solve the practical risk problem in the light of our ignorance of the details of the processes mentioned above, one can:

a) Subdivide the whole problem essentially along the four points indicated above, and proceed to attempt a solution of each sub-problem. Presently the state of the art and our understanding of this individual subproblem is quite different.

b) Replace the ultimate quantity one is looking for, i.e., the time history of motion (or the spectrum) by some other quantity which describes the gross properties of the motion and hopefully is more easily attainable. Presently,peak values (acceleration, velocity, displacement) duration, spectra shape,envelope function, etc., are used as risk functionals.

c) Use of empirical relationships to obtain expressions for the quantities above as functions of the most important parameter influencing them. Unfortunately, most measurements on which these empirical relationships are based on involve the whole process from source to site and hence involve a large number of parameters as is evident from the usually high statistical variability of the data.

d) Combination of the expressions (both theoretical and empirical) for the motion generation and propagation process with an expression for the earthquake occurrence process.

Presently we are concerned primarily with the last of the above points. As presented in the "Strategy and Approach" section of this proposal we shall perform risk analyses for selected points which relate peak intensity of the motion (e.g. peak acceleration) with the return period for that intensity, using a particular scheme. This requires:

1) Description of the local and regional seismicity in a fashion suitable for quantitative risk analysis (geographic and geometric breakdown of the area into different source regions of seismicity.
2) Determination of the magnitude-frequency relationships for these different source regions.
3) Selection of the lower and upper bounds in the above magnitude-frequency relations.
4) Selection of the (statistical) model of earthquake occurrence.
5) Expression for the attentuation of the amplitude of motion as a function of distance.

The particular model we shall use initially (Cornell, 1968, 1971); Merz and Cornell (1973), assumes a Poisson process for the earthquake occurrence and a linear or quadratic relationship between the logarithm of the cumulative frequency of events and the magnitude. Initially, we shall (1) determine how different working assumptions and use of the data base influence the analysis and (2) identify existing data gaps, that strongly influence the outcome of the analysis. The scheme may have to be modified depending on the pilot studies. Other risk schemes, more suitable for the given situation, may have to be adopted or developed (e.g. the assumption of the Poisson process and our present concept of the Shumagin seismic gap are not in agreement).

Extreme value statistics for the occurrence process might be more proper proper for this area, but its use will depend upon the existing seismicity record. After finding the most suitable risk scheme(s) for the area, analysis would eventually be performed for a sufficiently dense grid of points which would allow for graphic interpolation to provide contour maps for pertinent parameters.

Volcanic Hazard Studies

By the end of FY79 the volcanic hazard evaluation of Augustine Volcano should be fairly complete, except for the mapping of potential offshore pyroclastic flows. This work will result in a volcanic hazard map. The problem of the mobility of pyroclastic flows along the sea floor once they enter the sea might have to addressed by a separate program, perhaps jointly with the U.S. Geological Research Unit 327. We distinguish volcanic hazard, which describes the various effects of volcanic eruptions (e.g. ash falls, pryoclastic and debris flows, tsunamis, etc.) based on the historic record from volcanic risk, which involves knowledge of recurrence rate of eruptions, at Augustine of the Peleéan type. Volcanic risk evaluation of Augustine will have to wait until we complete the dating of the older pyroclastic deposits on the lower flanks of Augustine Volcano. Field work on this problem will begin in summer 1979.

It is already clear that Augustine poses a considerable threat to nearby offshore industrial development, even though we are still working out the details of the severity of the hazard.

The logical continuation of the Augustine program beyond FY79 would then be a transition into a monitoring program of suitable geophysical parameters (earthquakes, deformation-tilt, geochemistry, temperature) with the goal of eventual eruption prediction. The long (eight year) baseline of seismic information to date is the key to understanding the volcano's internal magmatic processes which periodically develop instabilities leading to eruptions. Hand in hand with the monitoring program, a volcano warning system coordinated between the industry should be established. If this commitment were made, funding levels would have to be considerably higher than at present.

The hazard evaluation of Redoubt Volcano has just begun. We plan to concentrate on (1) the problem of understanding how the volcano influences the dynamics of the North Crater, which has the potential of damming up Drift River, and on (2) what are the flood hazards in the Drift River valley due to meltwater outbursts in the summit crater (e.g. January, 1966 floods).

Since this is a long-term problem, funding at a moderate level will be needed well beyond FY79. Serious monitoring of the volcano by geophysical methods similar to Augustine is needed and requires substantial additional funds beyond FY79.

XIV. Contractural Statements

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

NPAS INC.
PHOTOGRAMMETRY
TOPOGRAPHIC MAPPING
AERIAL PHOTOGRAPHY

NORTH PACIFIC AERIAL SURVEYS, INC.
800 CORDOVA STREET 274-3548
ANCHORAGE, ALASKA 99501 274-3549

ALFRED G. HANDLEY
WARREN S. NIESEN
ANTHONY B. FOLLETT

August 22, 1978

Dr. Jurgen Kienle
Geophysical Institute
University of Alaska
Fairbanks, AK

Dear Jurgen:

I am writing to confirm our telephone conversation on Friday, August 18, concerning aerial photography and photogrammetric mapping a Augustine Island and Redoubt Volcano.

First of all, for the alva flows on the NE side of Augustine radiating from a point near the summitt down towards station Burr, we propose to prepare mays and cross-section data as follows. Using 1957, 1962, and either 1974 or 1976 aerial photographs, we will prepare a planimetric map at a scale of 1:10,000 showing the location of bodies of water, major drainages, control stations used, and the location of profiles digitized for each date of photography. From the 1976 coverage, we will also prepare a final drafted topographic map at the sme scale of 1:10,000 with a 10 meter contour interval. From each of the three dates of photography, we will digitize approximately 2500 points and prepare this cross-section data on magnetic tape with hard copy listing. This cross-section information will be in the same format as that previously done for Dr. Carl Benson on the North Crater of Mt. Wrangell. These digitized points will have approximately a 100 meter spacing. Our price for the foregoing products and services will be $2,165,00.

The second area of interest is that of Redoubt Volcano and the Drift River area. The following quotation is for acquisition of color aerial photographht, as well as prepartion of profiles and selected cross-sections on the North Glacier of Redoubt.

We will obtain color vertical aerial photography of the entire lenght of Drift River at a scale of 1"=2000'. This 25 mile length will require approximately 21 exposures at this scale for stereoscopic coverage. We will also obtain color vertical aerial photography of Redoubt Volcano from the Cresent River to Drift River at a scale of 1"=3000'.

NPAS INC

After processing the film, we will furnish you with one set of color contact prints, and will then proceed with digitizing the profile and selected cross-sections on the Glacier. We will prepare these profiles and cross-sections from both the 1954 and new 1978 photographs. We will provide you with a listing of the digitized points exaggerated vertical scales. The cost for aerial photography including one set of color contact prints will be $1,540.00. Preparation of the cross-sections and profiles from both 1954 and 1978 photographys, including plotting this information, will be $1,150.00.

Please advise me as to whether you wish to proceed with these projects. If you have any questions concerning the foregoing proposal, please do not hesitate to contact me. Thank you.

Sincerely,

Anthony B. Follett
Photographic Engineer

ABF/ers

5. Other Information

The United States Department of Energy through the Engineering, Mathematics and Geosciences Office of Basic Energy Sciences is supporting a program which overlaps with the proposed program. Funded at a level of $58,636 (of which $15,363 is for the lease of commercial telephone lines) for one year, it provides for the operation of a short period network on the Alaska Peninsula and the Semnidi Islands. The purpose of this network is to collect seismic data important towards understanding the tectonic processes associated with a portion of the Aleution-Alaska arc system. The program complements studies of the Shumigan seismic gap conducted by Lamond-Doherty Geological Observatory of Columbia University.

Hans Pulpan is the principal investigator of this program.

See attached sheets for personal data of the principal investigators.

GI 78-105

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

Proposal Date: June 29, 1978

Contract #: 03-5-022-55

Task Order #: 1

NOAA Project #: ______

Institution ID#: GI 78-105

FY 1979 RENEWAL PROPOSAL

Research Unit Number 253

TITLE: Subsea Permafrost: Probing, Thermal Regime and Data Analysis

Cost of Proposal: $59,935

Lease Areas Beautiful Sea 100 %

______ ______ %

Period of Proposal: October 1, 1978 through September 30, 1979

T. E. Osterkamp Date 8/4/78
T. E. Osterkamp
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Telephone Number: (907) 479-7548

W. D. Harrison /by TES Date 8/5/78
W. D. Harrison
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Date 8/4/78
Neta J. Stilkey
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Tel. (907) 479-7644

Date 8/7/78
Juan G. Roederer
Director
Geophysical Institute
University of Alaska

Fairbanks, Alaska 99701
Tel. (907) 479-7282

______ Date ______
Keith B. Mather
Vice Chancellor for Research
and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7314

3. TECHNICAL PROPOSAL

I. Title: Subsea Permafrost: Probing, Thermal Regime and Data Analysis
Research Unit Number: 253
Contract Number: 03-05-022-55
Proposed Dates of Contract: October 1, 1978-September 30, 1979.

II. Principal Investigators:

T. E. Osterkamp, Associate Professor of Physics and Geophysics

W. D. Harrison, Associate Professor of Physics

III. Cost of Proposal for Federal Fiscal Year 1979

A. Science: $59,935

B. P. I. Provided Logistics θ

C. Total: $59,935

D. Distribution of Effort by Lease Area

1. Aleutians
2. Beaufort Sea $59,935
3. Bristol Bay
4. Chukchi Sea
5. Kodiak
6. Lower Cook Inlet
7. NEGOA
8. Norton Sound
9. St. George Basin
10. Non-lease-area laboratory or management

IV. Background

The existence and some of the characteristics of subsea permafrost have been established at Prudhoe Bay, Barrow, and other locations in the Beaufort and Chukchi Seas by drilling, probing, and seismic methods, as well as by studies of shoreline history, sea-bed temperature, and regional geology. We now know that ice-bearing permafrost probably occurs over most of the Beaufort Sea shelf. Ice always occurs at very shallow depths in near-shore areas, and a hole 4 1/2 miles north of Reindeer Island where ice occurs 8 m below the sea bed, illustrates that ice may occur close to the sea bed anywhere in the Beaufort Sea lease sale area. Theoretical concepts of the nature of the heat and salt transport mechanisms have begun to shed some additional light on the distribution and nature of subsea permafrost. The approach is to complete measurements made in key representative areas, and to make measurements in other new areas, while using the theoretical concepts to infer characteristics of unstudied regions. This work is coordinated with other related OCSEAP studies, particularly the drilling efforts of RU 105, the seismic work of RU 271 and the shoreline studies of RU 473.

V. Objectives

Develop the capability to predict the presence or absence of subsea permafrost, its thickness, and thermal, mechanical and chemical states, also massive ice bodies and the presence of gas hydrates, specifically by:

1. Collecting and analyzing environmental data (sea bottom temperature, ice cover, sediment characteristics and shoreline history) from available records.
2. Collecting some of these data, including the depth below the surface of the ice-bonded subsea permafrost level, by simple driving and jetting techniques in the field.
3. Analyzing available data, both onshore and offshore, to assess the possible presence of massive ice (large segregated ice) bodies and the presence and state of gas hydrates.

VI. General Strategy and Approach

The research to-date has involved sampling at a few representative offshore sites, with wider inferences made on the basis of regional geology, shoreline history, and heat and salt transport models. This approach has been used because of the thousands of kilometers of Alaskan coastline potentially subject to subsea permafrost conditions. As noted earlier, coordinated efforts among a number of investigators using different techniques have been made. Our present project is to investigate subsea permafrost conditions with the help of light-weight probes, and to infer larger-scale conditions from other data, and from theory.

Broadly speaking, our strategy in the Beaufort Sea has been to concentrate our efforts at sites in two major areas--west of Harrison Bay and east of Harrison Bay--which are characterized by very different permafrost conditions, at least onshore. West of Harrison Bay, the permafrost is thin (≈ 350 m) with low ice content at depth and fine-grained soils. East of Harrison Bay the permafrost is thick (≈ 600 m) with high ice content at depth and coarse-grained soils. It is tentatively assumed that these conditions can be extrapolated offshore. By concentrating our efforts at a few sites in these two areas, we hope to be able to extrapolate the information obtained over most of the areas. To-date, most of our research and that of others has been performed at Prudhoe Bay and at Elson Lagoon near Barrow with only fragmentary evidence from other sites.

Many questions remain to be answered; a partial list is a follows:

1. What are the permafrost conditions on the barrier islands?
2. What are the permafrost conditions in areas of very rapid coastline retreat, such as near Cape Simpson?

3. What are the probability of occurrence and the nature of gas hydrates?
4. Does segregated ice occur, as found in the Canadian Beaufort Sea (MacKay, 1972)? This is a potentially serious problem for bottom-founded structures and hot oil production.
5. What is the depth to the ice-bonded permafrost and what factors are controlling it?
6. What is the nature of the subsea bed material--lithology, temperature, interstitial water salinity, water and/or ice content, etc.
7. Why is the subsea permafrost distributed the way it is, and how can an understanding be used to predict its properties in unstudied areas?
8. Since every field season brings unexpected results, what further surprises are in store for us?

Our driving, jetting and theoretical program, and the work of other investigators, are capable of answering some of these questions.

Besides the desirability of working in the Beaufort Sea lease sale area, our program will be in part determined by the outcome of a large (about 25 holes) proposed USGS Conservation Division offshore drilling program in that area, and the part that we play in it. If the program comes to pass, it will be an important opportunity for a dramatice improvement in the data base for subsea permafrost. Cooperation with this program would have our top priority. It is probably that we will do the temperature measurements, and analyze them to determine equilibrium temperature and depth to ice-bonded permafrost when it is indicated by a break in the temperature gradient.

If we do play this role in a USGS drilling program, our other efforts will be rather minimal and will probably consist of the following:

1. Jet several holes, probably on Stump and Pingok Islands, in summers of 1978 and 1979, or one of these years. We would like to set up our driving rig at the same time but time and personnel availability will probably limit us to a few hand-driven holes.
2. A small effort at Prudhoe Bay to refine our interstitial water sampling probes, and use of them to determine interstitial water salinity and hydraulic conductivity in one or two holes there.
3. Possibly one or two holes for verification of Roger's and Morack's seismic estimate of depth to bonded permafrost, if necessary.
4. Possibly a small effort at Barrow ($\simeq$ 10% of total field effort) to help evaluate subsea permafrost problems in fine-grained soils.
5. A consideration of gas hydrates. This will consist of a review of available Canadian information, Prudhoe Bay drilling results and a discussion of how these relate to the Alaska offshore lease area.
6. An assessment of the possible presence of segregated ice in the subsea sediments using onshore permafrost data and our offshore subsea permafrost data.
7. Analysis modelling, and prediction. A serious problem of the past year has been our failure to find time for a complete study of all the available data and to see what it tells us about conditions in unstudied areas. We also have accomplished but not written up some work on heat and salt transport mechanisms with NSF support. A large effort is required in these categories. This effort is supported by NSF.

If the proposed USGS drilling program does not come to pass, or our participation in it is minimal, our program will include all of the above items, but a much bigger field program of driving, jetting, and interstitial water sampling in the lease sale area will be carried out. Plans for this alternative, if necessary, are best made after the fate of the USGS drilling project is known.

VII. Sampling Methods

Data beneath the sea bed will be obtained by the driving or jetting of probes that can be transported by snow machine, airplane, or helicopter. The depth accessible depends upon soil type; 35 m below the sea bed is our record so far. Temperature, interstitial water salinity, and hydraulic conductivity (or permeability) can be determined by this technique. The techniques for determination of salinity and permeability have been developed with NSF support. Ice thickness, sea-bed temperature, and water depth profiles are also measured.

VIII. Analytical Methods

The results can be used as control by a seismic search for a bonded subsea permafrost table (R.U. 271). The results of these studies can be extended over a larger area with the help of shoreline history data (R.U. 473), sea bed temperature data, and the regional geology, as noted earlier. We plan an analysis of such an extension using existing knowledge of heat and salt transport mechanisms in subsea permafrost. These mechanisms are under investigation in NSF sponsored research.

IX. Deliverable Products

A. Digital Data:

N/A

1. Recorded Parameters:

2. List of Digital Products:

B. Narrative Reports:

Narrative reports containing data, graphs, tables, etc., and discussion of larger-scale permafrost distribution. Most of the data will be collected in March through May, 1979, and submitted in the quarterly reports as soon as reduced. A description of the data obtained will be given in the June, 1979, quarterly report.

C. Visual Data:

N/A

X. Quality Assurance:

Temperatures will be measured with thermistors calibrated with ice baths and triple-point cells, and will be accurate to about 0.01°C. Electrical conductivity apparatus is calibrated with standard sea water, and results are accurate to about 0.2 parts per thousand.

XII. Logistics Requirements

Our logistics requirements are complicated by the proposed U.S.G.S. drilling program in the lease area. This program will probably be carried out during late winter and early spring 1979 and we plan to participate to the greatest extent possible. However, the decision on the drilling dates have not been made, nor has the contract been awarded. We expect the contract to be awarded during fall 1978 and we will provide a detailed logistics plan at that time. At this time we can state that our general requirements are for 4-6 weeks helicopter support during the drilling period (probably March and April) at Prudhoe Bay. About 7-10 days helicopter support 1 week after the drilling period and again about 1 month after the drilling period. We will also need food and lodging during these periods at Prudhoe Bay. We would also need about 7-10 days food and lodging and 2-3 days helicopter time starting about May 23rd at Prudhoe Bay and also about 5-7 days food, lodging and helicopter time at Prudhoe Bay during the late summer.

In the event that the U.S.G.S. drilling program is not done we will expand our field effort in the lease area to include most of the last half of May 1979 and possibly the 1st week of June 1979.

We will submit a detailed logistics plan when we are informed of the firm drilling dates of the U.S.G.S. program. In the meantime, we will keep in contact with Mr. T. Flesher of the Arctic Project Office to keep him informed of further developments in the program.

XIII. Anticipated Problems:

Drilling in arctic waters always presents difficult and unanticipated problems, but based on our four field seasons, we expect most of our holes to be successful.

Access to our sampling sites will be by helicopter and snow machine. In the event of mechanical failure of the former, the latter will suffice, but the variety of sites that can be sampled would be curtailed.

XIV. Information Required from Other Investigators:

As in the past we plan to maintain contact with all the other researchers in subsea permafrost or marine geology. Their results may influence our choice of field sites to some extent. Usually the information we require is available in the annual reports before we go to the field.

XV. Management Plan:

Management will be by the principal investigators, with help from the Geophysical Institute Business Office. Our schedule is outlined in the attached milestone chart.

MILESTONE CHART

0 – Planned Completion Date

X – Actual Completion Date

RU # 253 PI: Osterkamp/Harrison

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

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Reduction of 1978 data	0														
Analysis of 1978 data						0									
Field work with U.S.G.S. program (tentative)								0							
Annual Report						0									
Quarterly Reports			0			0			0			0			
Field Work								0	0		0				

GI 78-105

XVI. Outlook:

A large part of the material in Section VI is appropriate to this section. It should be noted that our effort this year (1979 field season) will be almost entirely in the proposed Beaufort Sea lease sale area. Research for later lease sales will also be required in the other offshore lease areas in the Chukchi and Bering Seas since the data base there is almost nil. We discussed some of the work needed in these areas in last years proposal. The present discussion will be limited to the Beaufort Sea lease area.

The proposed U.S.G.S. offshore drilling program will represent a dramatic improvement in our data base in the lease area. If the measurements are done carefully it could provide the basis for a regional model of subsea permafrost, although many questions will still remain. The influence of the Colville, Saganavirktok and Canning Rivers on subsea permafrost by their effect on soil conditions, water temperature, annual salinities etc., is probably a major, yet unexplored, factor governing the distribution and character of subsea permafrost. It should be noted that this influence is not confined to the river deltas but can extend over wide areas far offshore (eg. through paleo-river valleys).

The mutual interaction of offshore islands and subsea permafrost is a question that has not been properly addressed.

The important question of the thickness of subsea permafrost cannot be answered by shallow drilling programs. The state and federal governments should write stipulations into offshore drilling permits that require information on the presence of excess ice, frozen soils, depth to the permafrost base and temperature logs to be obtained and put into the public domain.

The increased data base (assuming the successful completion of the U.S.G.S. drilling program) will require a substantial effort for analysis and for consolidation of the results obtained to date.

XVII. CONTRACTUAL STATEMENTS:

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

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6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

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> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

GI 78-96

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

Proposal Date: June 26, 1978

Contract #: 03-5-022-55

Task Order #: 6

NOAA Project #: N/A

Institution ID#: GI 78-96

FY 1979 RENEWAL PROPOSAL

Research Unit Number 265

TITLE: In-situ Measurements of the Mechanical Properties of Sea Ice.

Cost of Proposal: $ 102,130

Lease Areas Beaufort Sea 100 %

%

Period of Proposal: October 1, 1978 through September 30, 1979

Date June 16, 1978
Lewis H. Shapiro
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7196

Date 6/22/78
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Business Manager
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Date 6-22-78
Juan G. Roederer
Director
Geophysical Institute
University of Alaska

Fairbanks, Alaska 99701
Tel. (907) 479-7282

Date 6/22/78
Keith B. Mather
Vice Chancellor for Research
and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7314

GI 78-96

TECHNICAL PROPOSAL

I.

A. Title: In-Situ Measurements of the Mechanical Properties of Sea Ice
B. Research Unit Number: 265
C. Contract Number: 03-5-022-55
D. Proposed Dates of Contract: October 1, 1978 - September 30, 1979

II. Principal Investigator(s)

A. Lewis Shapiro

Contributing Scientist: Earl R. Hoskins

III. Cost of Proposal Federal Fiscal Year 1979

A. Science: $102,130

B. P. I. Provided Logistics: None

C. Total $102,130

D. Distribution of effort by lease area:

1. Aleutians
2. Beaufort Sea 100%
3. Bristol Bay
4. Chukchi Sea
5. Kodiak
6. Lower Cook Inlet
7. NEGOA
8. Norton Sound
9. St. George Basin
10. Non-lease-area laboratory management

IV. Background

The most significant hazard to offshore activites in the Beaufort and Chukchi Seas is that presented by sea ice, and the techniques to be used to reduce these hazards are largely dependent upon a knowledge of the mechanical properties of sea ice. However, large data gaps exist in the state of knowledge of these properties.

It should be recognized that those responsible for the evaluation of the design of installations or vessels which will be utilized for offshore development require the same information regarding ice properties as is available to the designer. In addition, other investigators concerned with the movement, deformation and failure of sea ice (as in the ridging process) have need of similar data, particularly regarding the strength of sea ice. However, there is little work currently in progress in the public domain on the subject.

The general objective of this project is to contribute towards filling gaps regarding the mechanical properties of sea ice, particularly those related to creep and failure of the ice. In previous work on this project, techniques have been developed for conducting in-situ experiments from which these properties can be determined. In addition, theoretical work has been done regarding the form of the viscoelastic stress-strain law which might apply to the ice, and this has been extended to include a failure criterion. During the field season just concluded, the theoretical predictions were tested by a series of experiments, and preliminary results suggest that the agreement is satisfactory over the range of conditions at which the experiments were conducted, i.e., uniaxial compression tests on the top 30 cm of the ice sheet.

The studies proposed for the coming year will be designed to repeat these experiments under different conditions than occurred during the past year, and to extend the test program to include other ice types and loading conditions. Tests will be run on blocks taken from deep in the ice sheet, to assess the effects of grain size and orientation on the strength and viscoelastic parameters. In addition, the surface ice will be systematically tested in uniaxial and biaxial stress fields in order to examine the effect of confining pressure on these properties. Finally, a short series of tests will be run on multi-year ice to determine the form of the strength-load-rate relationship.

It should be noted that the funding available from OCSEAP for this project is not sufficient to accomplish all the objectives in the next section. We anticipate the receipt of additional funds from other sources primarily the oil industry, to permit this work to be done, as has been the case in the past. However, should these not materialize, the objectives of the project will be scaled back to fit the available funds.

V. OBJECTIVES

Within the period covered by this proposal, the following studies will be done, pending anticipated receipt of additional funding from other sources:

1. A series of in-situ tests will be run in uniaxial and biaxial compression for determination of elastic, viscoelastic and strength properties of the first-year sea ice. In the past year, 119 uniaxial compression tests were run on nearly identical samples in order to test the validity of the stress-strain law noted above. The work proposed here differs in that these tests will be done to evaluate the effect of orientation of the samples, grain size, and confining pressure on the mechanical properties.

2. A series of constant load rate tests will be done on multi-year ice. If suitable samples are not available in the immediate area of NARL, then an ice floe camp will be established for a short duration in order to permit the tests to be run.

3. Theoretical work on the stress-strain law will be continued with emphasis on the balance between stored and dissipated energy during deformation. This may provide indications as to the nature of the brittle-ductile transition in fracture mechanisms.

The objectives of this work are:

1. To determine the effect of grain size orientation and confining pressure on the strength and viscoelastic properties of sea ice;
2. to expand our observations on fracture mechanisms;
3. to continue development of techniques for in-situ testing, and,
4. to extend the development of the stress-strain law to provide further information on the deformation and fracture of the ice.

VI. General Strategy and Approach.

The mechanical properties of sea ice depend up on several variables including temperature, salinity, grain size and fabric and the rate of loading or strain at which the testing is done. In addition, sample size, and strain and temperature history can also influence the results. Therefore, a relatively large number of tests must be performed in order to establish representative values for various properties over the range of conditions which can exist in nature. However, the existence of a workable stress-strain law (such as described above) might tend to reduce the number of such tests required by providing calculated curves of the relationship between various parameters which can be used to extrapolate between data points.

During the past field season, the testing program was arranged so that the effects of grain size and orientation were not considered as variables. This followed from the objective of conducting a relatively large number of tests in order to evaluate the stress-strain law. For the coming year, the test program on first-year ice will emphasize the grain size and orientation as variables, as well as the effect of confining pressure. The exact proportion of tests of each type to be run will depend upon conditions encountered in the field.

During the past season, a relatively simple set-up procedure was used which, with available personnel, permitted a total of 119 tests to be run. The set-up time for the tests envisaged for this proposal will involve significantly more work, and will reduce the number of tests which can be run to about 60, in addition to the series of tests on multi-year ice noted above.

VII Sampling Methods

The test specimen used in the proposed program will be rectangular prisms with dimensions of 30 x 30 x 60 cm. These will be cut from the ice sheet, the bottom of the resulting hole lines with two layers of plastic sheeting, and the block replaced and frozen back in. The plastic sheeting eliminates any shear stress at the base of the block during loading. Loads will be applied through flatjacks installed at the block margins, and strain will be measured by linear potentiometers or strain extensometers attached to the surface of the speciman and by strain gauges embedded within it. The data will be analyzed using procedures described in the next section.

Two types of tests are planned for first-year ice. The first are to be tests in uniaxial compression on samples collected from the surface of the ice sheet and at various depths. The latter will be cut at different orientations with respect to the dominant c-axis direction, to assess the effect of anisotropy of the ice. Strength will be determined using creep-rupture and constant-loading rate tests. In addition simple rapid loading tests for elastic properties, and creep tests for viscoelastic properties will be run.

A series of biaxial compression tests will be run on samples taken from the surface of the ice sheet to evaluate the effect of confining pressure on the strength of the ice. As in the case for the uniaxial tests, both creep-rupture and constant-loading rate tests will be used.

Ice temperatures will be monitored continuously and salinity measurements will be taken from each test sample. In addition, grain size and orientation will be determined.

Tests on multi-year ice will be restricted to uniaxial compression tests at constant loading rates. A series of about 20 tests is planned, covering about four orders of magnitude in the loading rate. However, it is possible that strain data will not be not be acquired during the tests, particularly if it is necessary to establish a floe camp to obtain suitable samples.

VIII. Analytical Methods

The procedures for calculating elastic parameters from uniaxial and biaxial compression test data are well known. Viscoelastic properties are determined by fitting calculated stress-strain curves to creep test data. Given these results, strength parameters can be calculated and compared with the experimental data.

IX. Deliverable Products

A. Digital Data:

1. Recorded Parameters:

   None.

2. List of Digital Products:

   None.

B. Narrative Reports:

Narrative reports of methods of testing and results of <u>in-situ</u> tests, further work on derivations of stress-strain laws and failure criteria, and comparison of the laboratory and field data sets.

C. Visual Data:

Plots of various test results generally incorporated into narrative reports.

D. Other Non-Digital Data:

None.

E. Data Submission Schedule:

N/A.

Data Products Schedule Attached

B. AIRCRAFT SUPPORT - FIXED WING

1. Delineate proposed flight lines on a chart of the area. Indicate desired flight altitude on each line. (Note: If flights are for transportation only, chart submission is not necessary but origin and destination points should be listed.)

Barrow Area

2. Describe types of observations to be made.

Search for suitable multi-year ice floe for testing program.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

N/A

How many days of flight operations are required and how many flight hours per day?

Total flight hours? Maximum of 15

Do you consider your investigation to be the principal one for the flight, thus precluding other activities or requiring other activities to piggyback piggyback or could you piggyback?

Other activites to piggyback.

What types of special equipment are required for the aircraft (non carry-on)?

None

What are the weights, dimensions, power requirements, and installation problems unique to the specific equipment.

What are the weights, dimensions and power requirements of carry-on equipment?

None

8. What type of aircraft is best suited for the purpose?

Open

9. Do you recommend a source for the aircraft? Yes
If "yes", please name the source and the reason for your recommendation. NARL-local

10. What is the per hour charter cost of the aircraft? NARL rates

11. How many people are required on board for each flight (exclusive of flight crew)?

3

12. Where do you recommend that flights be staged from? Barrow

XIII. Anticipated Problems:

As noted above, the funding available from OCSEAP for this project is not sufficient to meet all of the objectives of this proposal. Funding from other sources is anticipated, but if it does not materialize modification of the program proposed will be required. This will include:

Contingency Plan

1. A short field program to repeat tests previously conducted in order to verify results.
2. A major effort devoted to analysis of previous results, particularly with respect to theoretical aspects of the brazil and direct shear tests developed under this project, and,
3. further work on the stress-strain law described above.

XIV. Information Required from other Investigators:

N/A.

XV. Management Plan

1. Fiscal management of funds which may be obtained for this project will be handled by the business manager, Geophysical Institute, University of Alaska. The University provides monthly summary of expenditures and encumbrances as well as current information on all financial aspects of the contract in accordance with mutual requirements of the contractor.

2. Scientific management will be the responsiblity of the principal investigators who will lead and supervise all phases of the proposed work and assure the timely completion of the objectives.

3. Outside coordination, review, and direction will be provided by OCSEAP through the OCS Arctic Project Office.

4. Milestones for the project are attached.

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date

RU # 265 PI: Lewis H. Shapiro

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

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Completion of planning of field program	Δ														
Completion of acquisition and fabrication of equipment			Δ												
Start field work				Δ											
Floe camp (if required)							Δ								
Complete field work								Δ							
Complete analysis of data											Δ				
Complete report of field work												Δ			

XVI. Outlook

Assuming that the objectives outlined above are completed, some repetition of the results may be required in the next year. This will be the case if, for example, an adequate range of temperatures are not encountered during the coming year. If repetition is not required, then the next logical step is to develop a program of tests in tension and shear, as well as mixed modes of loading. This will provide an opportunity for further evaluation and refinement of the stress-strain law.

Given that the stress-strain law is applicable to the results of small-scale tests, the problem still remains of its utility for predicting the behavior of the full thickness of the ice sheet. This is critical for engineering purposes, and will require a series of tests at that scale. The availability of a stress-strain relationship will tend to minimize the number of tests which must be run, but even a relatively short program of large-scale tests would require a substantial increase in funding.

No changes are anticipated in logistics requirements or in the site of field operations.

XVII. CONTRACTUAL STATEMENTS:

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U. S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

Proposal Date: June 15, 1978

Contract #: 03-5-022-55

Task Order #: 10

NOAA Project #: N/A

Institution ID#: GI78-98

FY 1979 RENEWAL PROPOSAL

Research Unit Number 267

TITLE: Operation of an Alaskan Facility for Applications of Remote-Sensing Data to OCS Studies

Cost of Proposal: $ 110,000

Lease Areas Beaufort 41 %

Other Alaskan 59 %

Period of Proposal: October 1, 1978 through September 30, 1979

Albert E. Belon Date 6/18/78
Albert E. Belon, Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Telephone Number: (907) 479-7393

Date 6/16/78
Neta J. Stilkey, Business Manager
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Telephone Number: (907) 479-7644

Date 6/16/78
Juan Roederer, Director
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Telephone Number: (907) 479-7282

K.B. Mather Date 6/20/78
Keith B. Mather, Vice Chancellor for Research and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
Telephone Number: (907) 479-7314

3. TECHNICAL PROPOSAL

I. TITLE: Operation of an Alaskan Facility for Applications of Remote-Sensing Data to OCS Studies
RESEARCH UNIT NUMBER: OCSEAP R.U. 267
CONTRACT NUMBER: 03-5-022-55, Task Order No. 10
PROPOSED DATES OF CONTRACT: October 1, 1978, to September 30, 1979

II. PRINCIPAL INVESTIGATOR: Albert E. Belon
Professor of Physics
Geophysical Institute
University of Alaska

The Principal Investigator will spend 25% time, and will be involved in all phases of the project. He also will serve as remote-sensing advisor to OCSEAP.

III. COST OF PROPOSAL:

A. Science - $110,000
B. P.I. provided logistics - $0
C. Total - $110,000
D. Distribution of effort by lease area -

Beaufort	$45,000
Chukchi	$25,000
Norton	$20,000
Bristol Bay	$10,000
St. George	$10,000

IV. BACKGROUND:

Remote sensing, by satellites and aircraft, of the vast and varied continental shelf of Alaska is an important, and in many cases the only, tool for environmental assessments. This project has collected, compiled, catalogued, and distributed all available remote-sensing data in the coastal areas of Alaska and has provided services and advice in analyzing and interpreting the imagery. From 30-50 OCSEAP projects have routinely and repeatedly used the services and facilities of this project, which will hopefully be continued for the duration of OCSEAP.

V. OBJECTIVES:

The principal objective of the project is to make remote-sensing data processing facilities and interpretation techniques available to OCSEAP investigators by:

1. the acquisition, cataloging and distribution of all available imagery.

2. the operation of a facility for photographic, optical and digital processing of remote-sensing data.

3. the development of photographic, optical and computer techniques for processing data.

4. the active interaction (including assistance in data search and processing) with all OCSEAP R.U.'s needing remote-sensing data and data analysis/interpretation assistance.

Special emphasis will be placed on the acquisition of recent and historical imagery of the Beaufort Sea lease area to address site specific details of importance to final environmental assessment work.

VI. GENERAL STRATEGY AND APPROACH:

Three basic approaches are followed in the performance of the project:

1. Search, acquisition, cataloging and dissemination (in Arctic Project Bulletins) of all relevant LANDSAT and NOAA satellite data, and aircraft remote-sensing data (USGS, NASA, NOAA, U. S. Army, etc.).

2. Development and adaptation of photographic, optical and computer methods for analyzing remote-sensing data, including contrast stretching, density slicing, color coding, and computer-aided physical and ecological classification of digital satellite data.

3. Applications of remote-sensing data to OCS studies in cooperation with other OCSEAP projects.

VII. SAMPLING METHODS:

Satellites - For mapping of sea-ice, sediments, and coastal ecosystems.

- LANDSAT multispectral imagery of coastal zone with less than 30% cloud cover.
  Coverage: 185 x 185 km; ground resolution: 80 m; frequency: every 18 days.
- LANDSAT 3-RBV imagery will be available with improved resolution, starting in mid-1978
  Coverage: 185 x 185 km; ground resolution: 30 m; frequency: every 18 days.
- NOAA visible and infrared imagery irrespective of cloud cover.
  Coverage: 1000 x 1000 km; ground resolution: 1 km; frequency: daily.

Aircraft - For detailed mapping and, in conjunction with satellite data, multistage sampling of sea-ice, sediment patterns, and coastal zone ecosystems.

- High altitude (65,000 ft.) natural color and color-infrared aerial photography obtained by NASA - Mostly historical data.

- Medium altitude (30,000 ft.) color and black and white aerial photography obtained by NASA - Historical data.

- Low altitude (5,000 to 10,000 ft.) color and black and white aerial photography, and all-weather side-looking radar (SLAR) imagery. Historical and current data obtained for OCSEAP by USGS, NOAA/NOS, U. S. Army, etc.

VIII. ANALYTICAL METHODS:

The available remote-sensing data from satellite and aircraft will be searched for their applicability to the OCS program with respect to spatial and temporal coverage, cloud cover, quality and usefulness for specific disciplinary objectives. Selected imagery will be ordered and a catalog will be published through the OCS Arctic Project Bulletins for dissemination to OCS investigators.

The analytical methods for processing and interpreting remote-sensing data will be developed for, and in cooperation with, the OCS users of remote-sensing data. Therefore, it is not possible at this time to state precisely and comprehensively what these methods will be; but on the basis of previous experience, they are expected to be:

- visual photo interpretation of enhanced remote-sensing images primarily to map sea-ice and sea-surface suspended sediment patterns

- optical processing and color-coding of multispectral or multidate data for studies of temporal variability

- analog density slicing (using a VP-8 image analyzer) to enhance and quantify offshore sediment patterns and sea-ice distributions

- computer analysis of imagery in digital format for digital density-slicing, spectral reflectance signatures of sea-ice and landform types, thematic classification of sea-ice and onshore ecosystems and landforms.

Reference:

Belon, A. E., J. M. Miller, and W. J. Stringer, Environmental assessment of resource development in the Alaskan coastal zone based on LANDSAT imagery, Proceedings of the NASA Earth Resources Survey Symposium, NASA/JSC, Vol. II-B, 242-260, 1975. Also, OCSEAP Arctic Project Bulletin, Nos. 6 and 7, 1975.

IX. DELIVERABLE PRODUCTS:

Raw remote-sensing data will be acquired and archived by the project for the use of OCSEAP principal investigators. Therefore, delivery of these data to OCSEAP under the contract would be counterproductive. However, catalogs of available remote-sensing data will be prepared and delivered under the contract through the series of Arctic Project Bulletins. Interpreted data will be generated for, and in cooperation with, other OCSEAP projects. Therefore, they will be reported and delivered by the user projects.

With these qualifications, the deliverable products of the project are expected to be:

A. Digital data
   1) Selected tapes of LANDSAT and NOAA satellite images
   2) Analyzed tapes of sea-ice reflectance profiles and of thematic classification of sea-ice and coastal ecosystems

B. Narrative reports
   1) Catalogs of available satellite and aircraft remote-sensing data of the Alaskan coastal zone, to be distributed through the series of Arctic Project Bulletins
   2) Narrative description of project activities, facilities and analysis/interpretation techniques, to be distributed through project reports and, when appropriate, through the series of Arctic Project Bulletins

C. Visual data
   1) Satellite (LANDSAT and NOAA) imagery, including custom mosaics of imagery
   2) Aircraft (photographic and side-looking radar) imagery

D. Other non-digital data
   None

X. QUALITY ASSURANCE PLANS:

Satellite-acquired remote-sensing data include a density step tablet which calibrates the densities on the film with reflectance of the ground or sea, as well as providing a system (relative) calibration. Absolute calibration in terms of environmental parameters (e.g., sediment load in offshore waters) requires concurrent field measurements.

Aircraft-acquired remote-sensing data, particularly aerial photography, seldom include accurate calibrations. For these data, calibration will be obtained, when necessary, by cross-calibrations with concurrent satellite and/or field data.

XI. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS:

The original remote-sensing data from satellites and NASA aircraft are already archived and entered in the public domain (USGS/EROS and NOAA/NESS) when copies are obtained by the project.

Remote-sensing data acquired by aircraft programs under contract with OCSEAP are stored under appropriate controlled conditions in the library archives of the Geophysical Institute.

Catalogs of all acquired data are published in the series of Arctic Project Bulletins.

XII. LOGISTICS REQUIREMENTS:
None anticipated (see attached forms)

XIII. ANTICIPATED PROBLEMS:

In general it is not anticipated that insurmountable problems will prevent the successful achievement of the project's objectives. In practice, the most significant problem for remote-sensing data acquisition projects, which are limited in space and time, will be the prevailing cloud-cover and availability of remote-sensing aircraft. In particular, close coordination will be required to insure the success of multistage sampling experiments which depend on the concurrent acquisition of ground-based (or sea-based) data, and cloud-free aircraft and satellite data. The recommended solution to this problem is to include a (weather-insensitive) side-looking radar (SLAR) as part of the aircraft remote-sensing instruments.

XIV. INFORMATION REQUIRED FROM OTHER INVESTIGATORS:

The principal objective of the project is to make remote-sensing data, processing facilities and interpretation techniques available to the OCS investigators so that the promising applications and cost-effectiveness of remote-sensing techniques can be incorporated in their disciplinary investigations. Therefore, in principle, the project will supply data and interpretation assistance to the other investigators and will only require a request or statement of need from the other investigators. In practice, particularly for cooperative projects, the project will need field data to correlate with remote-sensing data as part of the multistage sampling technique. We anticipate no problems in obtaining these field data because the investigation will be performed at the request of, and in cooperation with, the user project which obtained the field data.

XV. MANAGEMENT PLAN:

The activities of the project will be managed in three main groupings. With reference to the activity/milestone chart on the next page, these are:

A. Continuous Support Activities - (1, 2, and 4). These cover the most important support functions of the project. They involve direct daily interaction of the project's personnel with OCS investigators. The usual point of contact will be the remote-sensing data librarian and secretary who will answer requests for data and refer requests for data processing assistance to the principal investigator and remote-sensing specialist, photographer, computer programmer, or instrument technician, as appropriate.

B. Research and Coordination Activities - (3, 5 and 6). These activities cover the coordination of the aircraft data acquisition program and the development of remote-sensing data processing and interpretation techniques, often in anticipation of the needs of the OCS investigators, rather than their stated short-term needs. These activities will be handled by the principal investigator of the project with the assistance of the remote-sensing specialist and other support personnel.

C. Reporting Activities - (7, 8, and 9). These activities cover the publication of remote-sensing data catalogs, reduced and interpreted data, progress reports, and articles. These activities will be performed by the principal investigator with the assistance of the data librarian and secretary.

Financial management of the project will be handled by the Geophysical Institute Business Manager and the principal investigator.

XVI. OUTLOOK:

On the basis of the experience of the last three years, it is expected that there will be a continuing need for the contributions of the project for the duration of OCSEAP. The number of OCS users of the project's services has gradually increased from 10-15 initially to currently 30-50. As investigators phase their activities from field data collection to data analysis and synthesis, the synoptic characteristics and value of remote-sensing data will increasingly become essential ingredients of the final environmental assessment.

Special attention will be required within individual lease areas, on a case by case basis, to focus on specific factors important to the leasing process.

It is expected that the scope and level of effort of the project will be maintained over the duration of OCSEAP; however, the cost will increase each year in relation to inflation in the cost of labor and materials. In particular, the cost of LANDSAT data has nearly tripled during the past year, and although we are keeping the requested budget level by being much more selective in the purchase of remote-sensing data from USGS/EROS, further cutbacks in the acquisition of data would be deleterious to the program.

MILESTONE CHART

RU #: 267 PI: Albert E. Belon, University of Alaska

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
1. Search for, select, and acquire available satellite and aircraft remote-sensing data	Δ	←	—		continuous					—	→	Δ			
2. Maintain and operate remote-sensing data processing equipment and facilities	Δ	←	—		continuous					—	→	Δ			
3. Develop data processing and interpretation techniques	Δ	←	—		continuous					—	→	Δ			
4. Provide assistance to OCS investigators in remote-sensing data acquisition, processing, & interpretation	Δ	←	—		continuous					—	→	Δ			
5. Serve as remote-sensing advisor to OCSEAP	Δ	←	—		continuous					—	→	Δ			
6. Coordinate aircraft remote-sensing data acquisition	Δ	←	—		continuous					—	→	Δ			
7. Publish catalogs of remote-sensing data through OCSEAP Arctic Project Bulletins		Δ			Δ			Δ			Δ				
8. Submit quarterly report to OCSEAP	Δ			Δ			Δ			Δ			Δ		
9. Submit annual report to OCSEAP							Δ								

GI78-98

Δ Planned Completion Date ▲ Actual Completion Date

XVII. CONTRACTUAL STATEMENTS:

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

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5. OTHER INFORMATION

1. The qualifications of the proposer are described at the beginning of this proposal (Section 2) and in the attached curriculum vitae (personal data). It is noted that the proposer has been engaged in optics research (photography, photometry and spectroscopy) since 1956, and specifically in remote-sensing research since 1970, for which he received the 1974 NASA Exceptional Scientific Achievement Award.

2. The proposer does not presently have another contract with OCSEAP.

3. The proposer (principal investigator) shall actively lead and supervise the proposed work, and shall take full responsibility for timely completion of all objectives, in accordance with the provisions of contract 03-5-022-55.

4. Personnel assigned for direct work on the project (see also Management Plan):

   Principal Investigator - Albert E. Belon, Professor of Physics

   (See attached curriculum vitae and statement of qualifications.) Professor Belon was coordinator of the NASA-sponsored University of Alaska Earth Resources Technology Satellite Program (12 projects), in addition to being principal investigator of one of these projects, from 1972 to 1975, for cooperative applications of remote-sensing data with operational agencies of government and industry. He is chief of the EROS Applications Assistance Facility for Alaska under contract with the U. S. Geological Survey. He is also currently principal investigator under contract with NOAA for OCSEAP Research Unit No. 267, for which this proposal seeks a one-year extension.

   Remote-Sensing Specialist - Mr. Thomas George

   Mr. George received a Bachelor of Science degree from Oregon State University in 1973. He has been associated with the University of Alaska Remote-Sensing Program (see projects under "principal investigator") since 1974, and has developed considerable expertise in all aspects of remote-sensing data processing equipment and techniques (photographic, optical and digital).

<u>Remote-Sensing Data Librarian and Technical Secretary</u> - Mrs. Katherine Martz

Mrs. Martz has been the Remote-Sensing Data Librarian and Technical Secretary of the University of Alaska Remote-Sensing Program (see projects under "principal investigator") since 1972. She is without doubt the best informed person in Alaska on the availability and sources of remote-sensing data and has established excellent working relationships with these sources, in particular the EROS Data Center, the local NOAA/NESS satellite data acquisition facility, and various governmental and industrial Alaskan sources.

<u>Photographer</u> - Mr. Malcom Lockwood

Mr. Lockwood is the member of the Geophysical Institute Photographic Laboratory who has been the most involved in the photographic processing of remote-sensing imagery since 1975. His activities include processing and printing of black and white and color remote-sensing imagery, reconstitution of false-color images from multispectral or multidate remote-sensing data, image enhancement for disciplinary applications and generally a full line of photographic services.

<u>Computer Programmer</u> - Mr. Steve Leonard

Mr. Leonard recently joined the Geophysical Institute and has taken charge of software development for remote sensing digital data analysis. His past work included five years program development for Electromagnetic Systems Laboratories on their Interactive Digital Image Manipulation System.

5. Other Relevant Data: None.

6. Names and Telephone Numbers of Persons Authorized to Conduct Negotiations:

   This information is provided on the cover page of the proposal.

Proposal Date:	June 19, 1978
Contract #:	03-5-022-55
Task Order #:	3
NOAA PROJECT ID:	N/A
Institution ID#:	GI 78-100

To: Arctic Project Office
506 Elvey Building
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

FY 1979 RENEWAL PROPOSAL

Research Unit Number 271

TITLE: Arctic Offshore Permafrost Studies

Cost of Proposal: $ 40,000 Lease Area Beaufort Sea 100%

Period of Proposal: October 1, 1978 through September 30, 1979

James Rogers (JM) Date 6/23/78
James C. Rogers, Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Telephone Number (907) 479-7644

Date 6/23/78
Neta J. Stilkey
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Telephone Number: (907) 479-7644

John Morack Date 6/23/78
John Morack, Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Telephone Number: (907) 479-7339

Juan G. Roederer Date 6-23-78
Juan G. Roederer, Director
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Telephone Number: (907) 479-7282

K. B. Mather Date 6/23/78
Keith B. Mather, Vice Chancellor for
Research and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
Telephone Number: (907) 479-7314

3. TECHNICAL PROPOSAL

I. TITLE: Arctic Offshore Permafrost Studies
RESEARCH UNIT NUMBER: OCSEAP R.U. 271
CONTRACT NUMBER: 03-5-022-55, Task Order No. 3
PROPOSED DATES OF CONTRACT: October 1, 1978, to September 30, 1979

II. PRINCIPAL INVESTIGATOR: James C. Rogers
Assistant Professor of Electrical Engineering
Geophysical Institute
University of Alaska

CO-PRINCIPAL INVESTIGATOR: John Morack
Professor of Physics
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

III. COST OF PROPOSAL:

A. Science - $40,000
B. P.I. provided logistics - $0
C. Total - $40,000
D. Distribution of effort by lease area -
Beaufort Sea 100%

IV. BACKGROUND

A. Beaufort Sea

Subsea permafrost represents a hazard to offshore operation both from a human safety standpoint and from an environmental standpoint. In order to increase the small amount of information available about offshore permafrost, a continuing research effort has been conducted by this research unit and others including Hopkins (RU 204/473), Sellman (RU 105), and Osterkamp and Harrison (RU 255/256).

No single type of data is sufficient to determine the origin, state, distribution and dynamics of subsea permafrost. Thus, although bottom temperatures are considerably below 0°C in many places the sea bottom is not ice bonded. Hence, temperature data alone will not indicate the presence or absence of ice bonded materials. In most cases, temperature and salinity of interstitial fluids are needed to determine the state of the sub-bottom materials. These data are gathered only by drilling and represent local conditioning. Seismic refraction and reflection methods have been successfully used by this research unit to map the upper surface of the permafrost along a drill line produced by other research units and extending some 18 kilometers offshoe at Prudhoe Bay. Several important conclusions regarding the nature of subsea permafrost have come from these coupled efforts. Among these is the necessity to distinguish between ice bearing materials and ice bonded materials. In some cases, notably on some of the offshore islands, drilling information indicates ice in drill cuttings, but seismic velocities are low, thus indicating the materials are not ice bonded. This is an important distinction from the standpoint of the mechanical properties of the soils.

Other important features that have been discovered are the high degree of roughness of the upper permafrost surface and the possible absence of permafrost beneath Prudhoe Bay. Studies along the drill line from the West Dock through Reindeer Island indicate that relatively shallow permafrost (20 to 30 m beneath the ocean surface) is found further offshore. This fact alters the projections made in previous years. While it was once believed that the surface of the bonded permafrost dipped gradually and continuously offshore at Prudhoe Bay it is now clear that this is not the case.

The work proposed here will extend the previous research effort to include a larger area around Prudhoe Bay. It will include the offshore islands nearby and the effects of the Sag River on the permafrost surface. Also, of interest is the area between Reindeer Island and Cross Island where bonded materials 7 m beneath the ocean floor are indicated by our seismic data. This is at a location approximately 18 km from shore, a distance once postulated to be great enough so that near surface permafrost could pose no problems to offshore activities. The new information clearly calls for caution in dredging and burial operations, however. Ultimately broad regional coverage of subsea permafrost distribution will be required and this will be dealt with by other research units using available industry data. The purpose of the seismic work proposed herein is to provide complementary information to site specific studies carried out by others, so that the results of these studies can be synthesized into a broader understanding of the offshore permafrost hazards. Presently there is not a satisfactory "general description" of the permafrost beneath the Beaufort Sea. Integrated drilling, seismic geothermal, geochemical and geological programs aimed at providing such information are required. Other general information (industry seismic data and drilling information) can't substitute for a coordinated effort but can only be used to complement that effort.

An example of such a coordinated effort is the planning that is proceeding between the OCSEAP permafrost investigators and the USGS. The later agency is mounting an extensive drilling program for next spring, to drill 22 holes, some down to 300 feet, throughout the Beaufort Sea lease area. In order to obtain a better correlation between seismic velocities and material conditions a program to log velocities in one or more of their drill holes that encounter bonded permafrost materials is planned by this research unit.

V. OBJECTIVES

1. To investigate the distribution of subsea permafrost at Prudhoe Bay through seismic investigation. In particular, additional North-South lines are needed between the mouth of the Sag River and Reindeer Island to determine if either of the two major north south lines run to date are typical. On one line the permafrost surface is known to dip steeply offshore while on the other line no dipping occurs.
2. To investigate the distribution of permafrost beneath the barrier islands near Prudhoe Bay. Some islands appear to be relatively free of bonded materials while others are underlain by essentially continuous permafrost.

3. To map the boundary of the shallow permafrost North and West of Reindeer Island and to relate this to probing data which has determined the temperatures of these materials. This study will be coordinated with the drilling program of the USGS to be done in the coming spring.
4. To integrate the seismic data with drilling probing and other data gathered by OCSEAP in order to synthesize a picture of permafrost distribution in the Beaufort Sea.
5. To acoustically log one or more of the drill holes planned by the U.S.G.S. in the Beaufort Sea, in order to correlate seismic velocities measured during the marine seismic work to bonded permafrost and other materials.

The relevance of the proposed work and objectives relating to an environmental assessment of the Alaskan Continental Shelf have been stated clearly in the OCSEAP 1978 Beaufort Sea Synthesis Report. Some potential problems related to the offshore permafrost hazard are: thaw subsidence of buried hot oil pipelines and well bores, frost heaving of bottom founded structures and cold gaslines, and variable engineering properties associated with salt brine laden materials. A primary concern of our studies is to provide adequate knowledge about subsea permafrost, to enable proper design of oil exploration and development facilities and to ensure that adequate and reasonable development controls are promolugated by government regulatory agencies.

VI. GENERAL STRATEGY AND APPROACH

During the spring one or more of the drill holes planned by the U.S.G.S. in the Beaufort Sea will be acoustically logged. A measurement of seismic velocity as a function or depth will be made by lowering a pair of receiving transducers separated by a fixed distance (approximately 2 meters) into a drill hole cased with plastic pipe. By measuring the travel time of the seismic signal produced by an airgun, the average velocity as well as local velocities on a scale of two meters will be measured. Helicopter support will be used to transport personnel and equipment to the site.

Marine seismic refraction and reflection equipment will be used during the summer season to investigate subsea permafrost. It will be necessary to use a shallow draft boat in the near shore region. A boat has been obtained that will provide a highly flexible platform for the required offshore permafrost investigation discussed in section V above. Work will be conducted during the months of July and August. Near shore work along the barrier islands will be possible, as well as transport of probing equipment and land seismographs along the islands. Also, the shallow northern shoal area off Reindeer Island can be examined to further determine the nature of the permafrost in this region. If ice conditions restrict boat operations during part of the field season, helicopter transport will be used for the island studies.

The seismic source will be airguns and an analog recording system will be used.

VII. SAMPLING METHODS

The sampling method will involve periodic shots of the airguns while pulling a hydrophone streamer behind the boat. Lines will be reversed where necessary to determine surface slopes, and some lines will be run on land to provide a velocity data base for interpretation of marine seismic velocities. Additional lines will be run with a hammer enhancement seismograph on offshore islands.

VIII. ANALYTICAL METHODS

Standard seismic refraction and reflection data reduction methods will be used. Examples can be found in past annual and quarterly reports of this research unit.

IX. DELIVERABLE PRODUCTS

A. Digital Data - In keeping with memos dated August 24 and August 30, 1976 from F. M. Cava, Assistant Data Manager, NOAA/OCSEAP, Juneau Project Office, no digital data are required on magnetic tape. The quarterly reports and annual reports serve the data requirement.

B. Narrative Reports - N/A

C. Visual Data - N/A

D. Other Non-Digital Data - N/A

E. Data Submission Schedule

Data Collection Period June, July, August 1979

Data will be submitted by quarters in quarterly reports.

X. QUALITY ASSURANCE PLANS

The electronics will be tested and calibrated in the laboratory before actual field work. Onshore measurements of acoustic velocities in permafrost will be performed at all sites for instrument calibration. Additional testing will be performed at existing drill hole sites which have indicated ice bonded materials.

XI. SPECIAL SAMPLE AND VOUCHER SPECIMEN PLANS - N/A

XII. LOGISTIC REQUIREMENTS - See attached forms.

C. AIRCRAFT SUPPORT - HELICOPTER - Bell 206 Helicopter

1. Delineate proposed transects and/or station scheme on a chart of the area. (Note: If flights are for transport of personnel or equipment only from base camps to field camps and visa versa, chart submission is not necessary but origin and destination points should be listed).

   Nine hours, Bell 206 helicopter will be used to carry two personnel and equipment from Deadhorse to offshore islands and drill holes.

2. Describe types of observations to be made.

3. What is the optimum time chronology of observations on a seasonal basis and what is the maximum allowable departure from these optimum times?

4. How many days of helicopter operations are required and how many flight hours per day?

   Total flight hours? Nine hours, Bell 206 helicopter to carry two personnel and equipment

5. How many people are required on board for each flight (exclusive of the pilot)?

6. What are the weights and dimensions of equipment or supplies to be transported?

7. What type of helicopter do you reommend for your operations and why?

8. Do you recommend a particular source for the helicopter? If "yes", please name the source and the reason for your recommendation.

9. What is the per hour charter cost of the helicopter?

10. Where do you reommend that flights be staged from? Deadhorse to offshore islands and drill holes. March and April and last two weeks in July through August.

11. Will special navigation and communications be required?

XIII. ANTICIPATED PROBLEMS / CONTINGENCY PLAN

In past field seasons, the limited time available to the project on the RV Karluk coupled with inclement weather have limited the scope of the data collected. The purchase of a Boston Whaler for the 1978 field season,which is dedicted to the project for approximately three weeks, should provide adequate field time to accomplish the proposed field objectives. Additionally, some helicopter support will be used to conduct seismic work on offshore islands during periods when winds or ice conditions make offshore work impossible.

XIV. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

Location and information concerning the drill holes of Osterkamp and Harrison (RU 255, 256) will be needed. Continuing contacts are established to acquire this information. Also, shoreline history information will be required from Hopkins (RU 473).

XV. MANAGEMENT PLAN

Reduction of the 1978 field data will begin in November and be completed in time to be included in the annual report on April 1, 1979. Planning for the 1979 field season at Prudhoe will begin in April. Island and offshore data will be collected in the Prudhoe Bay area from the third week in July through the first week in September. Preliminary data reduction will take place during September and October. (See attached milestone chart).

MILESTONE CHART

0 – Planned Completion Date

X – Actual Completion Date

RU # 271 PI: J. C. Rogers and J. L. Morack

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

MAJOR MILESTONES	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
Data reduction of 1978 field work		0	0	0	0	0									
Planning for 1979 field season							0	0	0						
Field work in Prudhoe Bay area						0	0			0	0	0			
Preliminary reduction of 1979 data												0	0		
Writing of quarterly reports			0				0		0			0			
Writing of annual report							0								

XVI. OUTLOOK

Beaufort Sea work proposed for FY '80 includes some work on the barrier islands near Prudhoe Bay and in the adjacent shallow waters. A cooperative effort with RU 253 to examine the temperature salinity and permafrost profile on selected islands in the Beaufort Sea is anticipated for FY 80. The results should provide a knowledge of how the barrier islands effect subsea permafrost. The first detailed distribution of the permafrost beneath a selected island and the related temperature and salinity data will be obtained.

Work proposed for FY 80 and 81 include the first near-shore seismic refraction efforts in the Chukchi Sea. This work will be in close support of the previous efforts by RU 253 and 473 in an effort to extend their drilling information and knowledge of shoreline history. It is anticipated that permafrost will be found principally near shore. As such, the first work will be somewhat localized. It will be necessary to extend the coverage north along the Chukchi coastline in the following research period to provide a broader picture of near shore permafrost in the Chukchi. Additional cooperation with Harrison and Osterkamp (RU 253) in linking temperature salinity measurements along the coast with seismic refraction measurements is anticipated. The final results and program bench mark should be a knowledge of the general nature and distribution of near shore permafrost along the shore of the Chukchi Sea.

Logistic requirements for the Beaufort Sea and Chukchi Sea work are tied closely together. These requirements will be similar to past seasons and pose no unusual problems.

It is anticipated that with the increased geographical coverage, more investigator time will be required for data gathering interpretation. Thus, the Beafort/Chukchi proposal cost will be $50,000 for FY 80 and $60,000 for FY81. No major equipment needs are anticipated.

XVII. CONTRACTUAL STATEMENTS:

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a Data Documentation Form (DDF 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U. S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" (copy attached). Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

5. OTHER INFORMATION

A. Most of the background, experience and qualifications of the investigators are contained in the attached personal data sheets and Part 2. It should be noted that J. C. Rogers has been involved in these studies since 1973 (since 1975 under OCSEAP sponsorship), and J. L. Morack has been involved with the project since the 1975 field season.

B. Close cooperation will be maintained with complementary work of RU 253 (Osterkamp and Harrison).

C. The investigators shall actively lead and supervise the proposed work, and shall take full responsibility for timely completion of all objectives.

D. Personal: J. C. Rogers and J. L. Morack will both be involved with data collection, data reduction and the presentation of reports and results. See part E for recent experience with the project.

E. None

F. James C. Rogers
277-1018 (home)
272-5522 (work)

Date: 6/30/78
Contract: 03-5-022-56
Task Order: #5
R.U.: #275
Proposal No.: OCS 79-7

Renewal Proposal
FY '79

to

National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado 80302

HYDROCARBONS: NATURAL DISTRIBUTION AND DYNAMICS
ON THE ALASKAN OUTER CONTINENTAL SHELF
Research Unit: 275
Total Cost: $39,992

Institute of Marine Science
University of Alaska
Faribanks, Alaska 99701

D. Shaw, Principal Investigator
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7723

J. R. Moore, Director
Institute of Marine Science
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(907) 479-7531

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Administrative Services
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Fairbanks, Alaska 99701
(907) 479-7340

Keith B. Mather
Vice Chancellor for Research and
Advanced Studies
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7314

2. QUALIFICATIONS OF PROPOSER AND RELATED INSTITUTION

Principal Investigator

Dr. D. G. Shaw has had seven years experience in the analysis of trace organic substances in the marine environment. While at the University of Alaska, he has developed a research program in marine hydrocarbon chemistry which uses state of the art methods of analytical chemistry to obtain quantitative information about the marine environment. Biographical information is attached.

Facilities

Chemical laboratories of the Institute of Marine Science in Fairbanks, were analyses will be done, are well suited for this work. These laboratories are equipped with gas chromatographs, a gas chromatograph-mass spectrometer-computer system as well as an extensive array of ancillary equipment and freezer facilities for sample storage.

3. TECHNICAL PROPOSAL

I. TITLE

Hydrocarbons: Natural Distribution and Dynamics on the Alaskan Outer Continental Shelf.
Research Unit Number: 275
Contract Number: 03-5-022-56
Task Order Number: 5
Proposal Period: 1 October 1978 - 30 September 1979

II. PRINCIPAL INVESTIGATOR

Dr. D. G. Shaw

III. COST OF PROPOSAL

A.	Science	$39,992
B.	Logistics	$ 0
C.	Total	$ 39,992

IV. BACKGROUND

This project has surveyed the ambient hydrocarbons in biota, water and sediment from numerous Alaskan environments which may be impacted by OCS oil development. While most regions and materials examined have been dominated by biogenic hydrocarbons, two important exceptions to this generalization have been identified. Pyrolytic and fossil aromatic hydrocarbons have been identified in nearshore Beaufort Sea sediments. Geochemically produced diterpenoid hydrocarbons have been formed in sediments and organisms of lower Cook Inlet.

This project has also investigated processes involved in the transloca-tion of petroleum in the marine environment. Processes examined include hydrocarbon sorption by sediments and sedimentation via zooplankton. In FY 78 an investigation was begun of the hydrocarbon impact of current off-shore oil production in upper Cook Inlet and of tidally driven variability within the inlet. By understanding the way in which the Cook Inlet environ-ment responds to the current loading of oil it should be possible to better predict the impacts which might result from future oil development in the lower inlet.

V. OBJECTIVES

This project will concentrate on a site specific study in Cook Inlet. Field sampling will be designed to investigate the water column dispersion of hydrocarbons from upper Cook Inlet offshore production operations and to investigate their potential accumulation in organisms of the area.

Upper Cook Inlet is the only current site of offshore oil production in Alaska. Information about the kinds and amounts of hydrocarbons being released as a result of these operations and the extent of their bioaccumulation, if any, will provide an important guide for estimating probable input rates for future potential offshore developments in lower Cook Inlet and other Alaskan OCS areas.

VI. STRATEGY AND APPROACH

Samples of water, suspended matter and plankton were collected in Cook Inlet in May 1978. Samples collected at two time series stations in lower Cook Inlet (Kachemak Bay and Redoubt Bay) and in the vicinity of production platforms in the upper inlet. Analysis of the water from these stations has shown undetectably low amounts of hydrocarbons in lower Cook Inlet and very low but distinct petroleum hydrocarbon concentrations around the production platforms of the upper inlet. An additional time series investigation will be conducted in August 1978; however, based on the data presently in hand, it does not appear that the time series approach will be effective in providing information about the dispersion of petroleum hydrocarbons from upper inlet production activities. Therefore, we propose a modified sampling approach for 1979.

We will collect water, suspended matter and plankton on transects running away from upper Cook Inlet production platforms. These transects will be taken with the tidal current. That is, on the ebb a transect toward the lower inlet would be run, while on the flood a transect toward Anchorage would be run. By accurate notation of sampling times and with knowledge of the tabulated tidal current data it should be possible to estimate the elapsed time since the water sampled passed a platform. To investigate the potential accumulation of petroleum hydrocarbons on biota of the area, intertidal biota for hydrocarbon analysis will be collected from Trading Bay.

Technical management will be provided by the Principal Investigator. Fiscal and data management will be provided by the University of Alaska OCS Coordination Office. Management of this project will be a relatively straightforward matter. All of the personnel have experience doing OCSEAP funded work in Cook Inlet.

Sampling and analytical methodology for this project will be the same as presently in use by RU 275. This includes solvent extraction of heavy hydrocarbons from environmental samples, column chromatography clean-up and analysis by gas chromatography and chromatography-mass spectrometry. In the field replicate water samples will be collected to assess sampling variability. Intra-laboratory separation and recovery precision will be determined using a hydrocarbon mixture of known composition. Inter-laboratory comparability will be determined by the analysis of a reference sediment supplied by OCSEAP.

VII. DELIVERABLE PRODUCTS

A. Digital Data

Data produced by this project will be submitted to OCSEAP in NODC format 044. In addition data previously collected by RU 275 which is judged to be of sufficient quality will be submitted in the same format. This project will make the appropriate data available to the University of Alaska OCS Coordination Office whose responsibility it will be to digitize the data and forward it to OCSEAP.

B. Narrative Report including Visual Data

This project will result in a narrative report including a discussion of objectives, methods, and techniques used in sampling, sample preparation, storage and analysis. Discussion of the data and results will include appropriate graphic and tabular presentations. All hard copies of chromatograms and spectra will be archived.

VIII. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLAN

We will implement a voucher specimen plan when such is agreed upon by OCSEAP and the University of Alaska OCS Coordination Office.

IX. LOGISTIC REQUIREMENTS

See attached.

X. ANTICIPATED PROBLEMS

In the event that adverse conditions or other failures prevent field collections, analytical efforts will be directed to analysis of archived samples with the objective of using present techniques on duplicate samples collected early in the OCSEAP and NEGOA programs.

XI. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

Coordinated sampling and sharing of results will be required from RU's 480, 152, 153, 029, 190, 557, 417, 425 and 500. The necessary interchange will be facilitated through informal contacts and OCSEAP Review, Planning and Synthesis Meetings.

XII. MILESTONE CHART

See attached.

XIII. OUTLOOK

The successful accomplishment of this project will largely complete the task of providing reconnaissance hydrocarbon data for the Alaskan OCS areas with petroleum potential. However, two significant data gaps will still remain: the water column of the Bering Sea and the nearshore water column of the Beaufort Sea. In order to obtain these two kinds of data in FY80 approximately 2 weeks of non-exclusive ship time in the Bering and Beaufort Seas and $50,000 would be required.

XIV. CONTRACTUAL STATEMENTS:

A. A schedule for data submission for each task order has been, and will continue to be, submitted and updated each quarter.

B. This statement is in accordance with our base contract, and we will continue to comply.

C. See Section VIII of this proposal. The University of Alaska will continue to negotiate a Voucher Specimen Policy with NOAA/OCS. We will comply with the then-agreed-to policy.

D. See Section VI of this proposal. The University of Alaska agrees that the Principal Investigators can travel to the Project Office at least twice during the contract year, provided that such travel is in accordance with University of Alaska travel policy and consistent with other University duties of the Principal Investigator. Funds for travel labeled "Administrative Travel" have been allocated in previous funding cycles for R.U. 350. We believe sufficient funds remain for this FY.

E. Data will be provided in the form and format agreed to by the University and NOAA/OCS in the negotiating of the Data Management Plans. Digital data will be accompanied by the D.D.F. (NOAA Form 24-13).

F. As per Article 9 of the base contract, the University of Alaska agrees to the following: "...all archivable data is to be submitted to the contractor to the Contract Data Manager within 120 days after acquisition. Certain data sets such as plankton counts or volume are not available until sorting of samples is complete. The data so obtained are archivable 120 days following the actual sorting or other laboratory procedure." NODC Taxonomic Code will be used where appropriate for FY79 data submission.

G. Within ten days of the completion of a cruise or data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager by the Chief Scientist.

H. As per the contract, the University of Alaska will maintain a property inventory including all information required by form CD-281 for all non-expendable equipment purchased with funds allocated under this contract. Furthermore, we will comply with the quarterly reporting of said inventory.

I. Three copies of all publications or presentation abstracts or manuscripts pertaining to technical or scientific material developed under OCSEAP funding will be submitted to the COTR prior to publication or presentation. Copies of all news releases mentioning OCS or using information gathered by OCS funding will be sent to the COTR. When made available, during the lifetime of the appropriate task order, five reprints will be sent to the Project Office.

J. The following acknowledgment of sponsorship is standard:

> "This study was supported under contract 03-5-022-56 between the University of Alaska and NOAA, Department of Commerce, through the Outer Contintental Shelf Environmental Assessment Program to which funds were provided by the Bureau of Land Management, Department of the Interior."

DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (if known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Hydrocarbons in water and biota	Tape	FY79-40	044	Done by University of Alaska OCS Coordination Office	See note below	

NOTE: R.U. 275 and R.U. 350 are presently working to identify prior data for formating in 044 and making sure that 044 is workable with existing data. Until this identification and de-bugging process is complete a firm data submission schedule cannot be given.

LOGISTICS REQUIREMENTS

Please fill in all spaces or indicate not applicable (N/A). Use additional sheets as necessary. Budget line items concerning logistics should be keyed to the relevant item described on these forms.

INSTITUTION Institute of Marine Science University of Alaska PRINCIPAL INVESTIGATOR D. G. Shaw

A. SHIP SUPPORT

1. Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions.

   Upper and lower Cook Inlet

2. Describe types of observations to be made on tracks and/or at each grid station. Include a description of shipboard sampling operations. Be as specific and comprehensive as possible.

   Water samples, net tows, small boat operations

3. What is the optimum time chronology of observations on a leg and seasonal basis and what is the maximum allowable departure from these optimum times? (Key to chart prepared under Item 1 when necessary for clarification.)

   Optimum Mid-May Allowable Departure: 3 Weeks

4. How many sea days are required for each leg? (Assume vessel cruising speed of 14 knots for NOAA vessels. Do not include running time from port to beginning point and from end point to port and do not include a weather factor.)

   10 Days

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? Can piggyback

   Approximately how many vessel hours per day will be required for your observations and must these hours be during daylight? Include an estimate of sampling-time on station and sample processing time between stations.

   4 hrs/day sampling 10 hrs for sample processing

6. What equipment and personnel would you expect the ship to provide?

   Winch and operator

7. What is the approximate weight and volume of equipment you will bring?

   300 pounds 20 cubic feet

8. Will your data or equipment require special handling? No If yes, please describe.

9. Will your require any gases and/or chemicals? ________ If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge.

   N/A

10. Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying.

    Require a research vessel which can operate in Upper Inlet

11. If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have your verified its availability?

12. How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals.

    2 persons

MILESTONE CHART

0 - Planned Completion Date
X - Actual Completion Date

R.U. # 275 P.I. D. G. Shaw

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

MAJOR MILESTONES	1978			1979											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Field work (Cook Inlet)								0							
Analysis											0				
Quarterly Report			0			0			0			0			
Annual Report						0									
Data Submission			0			0			0			0			

Date: December 8, 1978
Contract: 03-5-022-56
Task Order: #19
R. U.: #289
Proposal No.: OCS 79-8 modified
Amended.

Renewal Proposal Amendment
FY 1979

National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado 80302
Juneau Project Office

CIRCULATION AND WATER MASSES IN THE GULF OF ALASKA

Research Unit: #289
Total Cost: $101,948
Lease Areas: Aleutians 10%
Kodiak 10%
Cook Inlet 10%
NEGOA 70%

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(907) 479-7314

The following amendments and corrections are to be made a part of the FY79 renewal proposal as submitted on November 6, 1978, for R. U. 289, contract 03-5-022-56.

Page 6. III. Strategy and Approach, add the following:

While the primary work of this research unit this year is analysis and synthesis, it is believed that a modest field effort, utilizing funds from the previous funding cycle, would enhance this analysis. The field work would monitor for changes in the circulation on the shelf and the Alaska current and better define the exchanges between Prince William Sound and the adjacent shelf.

Page 7. Add the following to the second paragraph:

At least nine (9) transects have been made through this region with the eddy being present in all transects. In addition, at least three (3) detailed STD grids have been taken in the region. The latest grids were taken in early August and late September coincident with the period of highest runoff and precipitation. Satellite tracked drifter data and three current meter moorings have been made within the region. Analysis of these data plus the employment of the diagnostic model from R. U. 140 will be carried out and improve our knowledge of the mechanisms governing the circulation here.

Replace X. Anticipated Problems, page 15, with the following:

X. Anticipated Problems.

The new task of managing the physical oceanography synthesis for NEGOA is a primary obligation of this research unit. This requirement plus the analysis of the existing data for its inclusion into the synthesis constitutes nearly all of the effort displayed in the FY79 budget. The field program outlined in this proposal will be primarily accomplished using resources carried forward from the previous OCSEAP contract. (A portion of these resources are available from the Principal Investigator's 1977-78 sabbatical leave where a major portion of his salary came from other sources while analysis was being carried out on OCSEAP data.) Therefore, the field program will not use funds allocated for this year's analysis and synthesis. If the field program is curtailed due to weather or ship scheduling problems, the effort would be diverted to data analysis.

Contingency Plan

If adverse field conditions do not allow the collection of samples, alternate stations in semi-sheltered areas can be occupied. There are also stations where short-term time series would be of great value such as in Hinchinbrook Entrance and the mouth of Resurrection Bay (Station 1). If field data for FY79 were not obtained at all (an extremely unlikely circumstance), then our efforts would be devoted to the analysis previously acquired data for the region.

The active participation of the other OCSEAP Principal Investigator's in the synthesis is essential for its success. Some reservations exist

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The active participation of the other OCSEAP Principal Investigator's in the synthesis is essential for its success. Some reservations exist

concerning the ability of this principal investigator to hold the others to schedules. The other PI's must also be active in analysis along with synthesis.

Add the following under section Logistics Requirements starting on page 22:

IX. Logistics Requirements.

Seven-day cruises are requested for February, May and September. The ship or ships used must be able to deploy and recover current meter arrays and carry out hydrographic surveys. The hydrographic work and current meter recovery will take place on each cruise with deployments only in February and May. Of the three ships apparently available, DISCOVERER, SURVEYOR, and ACONA, only the DISCOVERER is capable of carrying out all segments of this work in the seasons requested. The SURVEYOR does not have the deck space required for current meter array deployments using our methods. It is able to recover them, however. The ACONA cannot carry out hydrographic operations in moderate seas and is therefore unsuitable for the February survey work. It is suggested that the ACONA be used for the current meter work in February with the hydrographic survey being carried out by the SURVEYOR, since, apparently, the DISCOVERER is not available. Either the DISCOVERER or ACONA could be used for all the operations in May and September, and the SURVEYOR is suitable for all operations in September.

These current meter moorings are a continuation of present moorings. They do not require additional meters and are being accomplished using funds from the previous OCSEAP carry forward also.

COVER SHEET FORMAT

Proposal/Revision Date: __________

TO: Appropriate Project Office

Contract #: __________

NOAA Project #: __________

Institution ID#: __________

FY 1979 RENEWAL PROPOSAL

Research Unit Number 327

TITLE: Shallow faulting, bottom instability, and movement of sediments in lower Cook Inlet and western Gulf of Alaska

Cost of Proposal: $120,000 Lease Areas Lower Cook Inlet 34 %

Kodiak Shelf 66 %

(If joint proposal, show cost for each institution; if more than one fiscal year, show cost for each year - SEPARATE BUDGET SHEETS ALSO REQUIRED)

Period of Proposal: October 1, 1978 through September 30, 1978
(If proposal is for other than this period, please explain)

PRINCIPAL INVESTIGATOR(S)

Name Monty A Hampton, Arnold H. Bouma Date January 5, 1979

Signature Monty A Hampton Arnold H Bouma

Address USGS 345 Middlefield Rd., Menlo Park, CA 94025

Telephone Number (415) 856-7062 or 856-7058 FTS: 467-7062

INSTITUTION (include Department, if appropriate)

U.S. Geol. Survey, Pacific-Arctic Branch of Marine Geology

REQUIRED ORGANIZATION APPROVAL:

Name H. E. Clifton Date January 19, 1979

Signature H. E. Clifton

Position Chief, Pacific-Arctic Branch of Marine Geology

Address 345 Middlefield Road, Menlo Park, CA 94025

Telephone Number (415) 856-7141 FTS 467-7141

ORGANIZATION FINANCIAL OFFICER:

Name __________ Date __________

Signature __________

Position __________

Address __________

Telephone Number __________

TECHNICAL PROPOSAL

I. Title: Shallow faulting, bottom instability, and movement of sediments in lower Cook Inlet and western Gulf of Alaska

Research Unit Number: 327

Proposed Dates of Contract: October 1, 1978 - September 30, 1979

II. Principal Investigators:

Monty A. Hampton and Arnold H. Bouma

III. Cost of Proposal:

A. Science $120,000

B. PI.I provided logistics . . . . (see ship budget)

C. Total $120,000

D. Distribution of effort by Lease Area:

34% lower Cook Inlet
66% Kodiak shelf

IV. Background:

Our work conducted during 1976, 1977 and the first three quarters of 1978 clearly shows the presence of a number of geologic features that can pose serious hazards to offshore development. The baseline study approach conducted in 1976 showed that in order to establish if such features can pose a hazard we have to study dynamics and processes. The following topics will be investigated:

Lower Cook Inlet

Mobility of large bedforms (sand waves and dunes) can pose a serious threat to large and small offshore installations. Change may take place over a number of years, or can be very rapid as in response to a single storm, hurricance or tsunami. The lateral shifting of sand in configurations such as subaquous sand waves, sand dunes, and sand ridges with heights of several meters, can threaten semi-submersible rigs, anchors, pilings, and pipe lines. It can influence the lateral capacity on an underwater structure (Palmer, 1969). It can cause scouring in two different modes around a group of pilings. One mode is a conical hole around each piling that penetrates the sediment, the other mode is a general lowering of the bottom under the whole structure tapering off at zero at a considerable lateral distance. The reasons for the forming of one mode versus the other is still not understood (Posey, 1971). The second type is less common but its effects are more serious.

An artificial structure can influence the local bottom current to a large degree. Wilson and Abel (1973) conducted experiments about the effect of scour created by 80-ft diameter pontoons of a semi-submersible drilling rig to be placed in water 90 feet deep on the Nova Scotia shelf with tidal currents reaching a maximum velocity of about 1.5 knots. They concluded that erosion would occur under and around the pontoons, which in turn would cause adverse settlement of the rig even at current velocities as low as 0.43 knots.

Flutter of pipelines can occur in areas where sand is moving causing parts of a pipeline to become suspended. Flutter is a phenomenon that occurs when the frequency of vortices shedding in the wake of a stationary long slender object in a moving current approaches the natural frequency of the cylindrical object, or about half of that when couplings are involved. The shedding of vortices must occur in a regular frequency on alternate sides of the body in order to establish alternating forces that induce motion at right angles to the current direction (Goepfert, 1969). The phenomenon of flutter has been described from upper Cook Inlet, Alaska (Goepfert, 1969), and from the North Sea.

We establish that sand waves, dunes, ridges, and ribbons are the most common bedforms in this area, covering a major part of the lease sale areas. Bottom television observations show that sand is moving in pulsating sheetflows over the crests of 6-10 m high bedforms with velocities of 25-30 cm/sec. Studies on the vertical distribution of drill cuttings, released by the OCEAN RANGER (C.O.S.T. well #1) during a period of 100 days in the summer of 1977, show that at least 14 cm of sand is in motion. However, the size of the bedforms (wave length 400-1000 m, wave height 4-10 m) is such that it takes many years to establish migration with the 10-20 m inaccuracies in positioning from the Mini-Ranger navigation system.

So far we have limited information about the current directions and velocities in lower Cook Inlet, especially near the bottom. Summer 1978 observations revealed that sand transport took place only during the last few hours of ebb and flood tide, and only during spring tide. Vertical current profiles showed an eliptical distribution of current directions in the upper water during a tidal cycle. However, near the bottom a trimodal system is operationally, more or less similar as observed at the C.O.S.T. well site by Dames and Moore. It is likely, however, that winter storms have a significant influence.

Kodiak shelf

Geo-environmental surveys of the Kodiak shelf have been conducted during the summers of 1976, 1977 and 1978 aboard the R/V SEA SOUNDER. Over 6500 km of seismic-reflection and bathymetric profiling lines including 160 kj sparker, minisparker, uniboom, 3.5 kHz, and 12 kHz have been run, and 188 bottom samples (piston core, gravity core, hydroplastic core, grab sample) have been taken. Limited visual-format observations have been made using underwater TV, side-scanning sonar, and bottom cameras. Prior to our work, very little geologic data had been gathered on the Kodiak shelf. The 1976 cruise was of a reconnaissance nature, with the objective of defining the general geo-environmental setting and identifying and geologic hazards of concern to resource development. The 1977 and 1978 cruises were directed toward a detailed study of certian environmentally critical areas identified in 1976.

The principal geo-environmental concerns on the Kodiak shelf are related to sediment distribution and movement, and to the structural-tectonic setting. Shelf sediments are distributed in relation to physiography. Much of Albatross and Portlock Banks are covered with a thin veneer of coarse-grained sediments, generally sparse in clay sizes and locally containing abundant shells. The veneer is absent over large areas yielding exposures of semi-lithified to lithified siltstones, silty sandstones, and pebbly mudstones. Within broad, shallow depressions on the banks, the coarse debris is covered with a few cm of fine-grained sediment that is rich in volcanic ash. The banks appear to be formed of relatively stable foundation material, but the actual behavior during cyclic or static loading is unknown.

Kiliuda, Chiniak, and Amatuli Troughs contain surficial layers of fine-grained sediment up to 20 m thick. Surface samples are composed almost entirely of volcanic ash from the 1912 eruption of Katmai volcano. These troughs appear to be quiet areas of sedimentation, receiving fine-grained material winnowed from the adjacent banks. They are likely to act as long term storage sites for pollutants that reach the sea floor of the Kodiak shelf. The ash-rich sediment is weak, but its geotechnical properties and engineering behavior have not been studied in detail.

Stevenson Trough, which may connect with tidally dominated Cook Inlet to the north, contains relatively well sorted sand that has been molded into seaward-facing sand waves in one locality within the trough and has been spread onto the adjacent continental slope. A relatively high-energy bottom current regime in Stevenson Trough transports sediment seaward past the shelf break to deeper parts of the ocean floor. Pollutants carried into the trough can be expected to experience a similar fate. Scour of sediment, due to movement by high-energy bottom currents may affect structures located in the trough.

Transport of bottom sediment across the shelf break appears to be localized and does not occur in areas where physiographic barriers exist. Kiliuda and Chiniak Troughs, for example, have well defined sills near the shelf break that distinctly separate the ash-rich sediment within the troughs from fine-grained, ash-poor sediment on the adjacent upper continental slope. Although Stevenson Trough also has a sill, it is breached in a few places, and these breaches appear to be avenues of transport for sand into deeper waters.

Shoaling of the sea floor due to tectonic action has occurred near the shelf break on many parts of the banks, commonly with a broad depression on the landward side. Preliminary data from sediment samples indicate that transfer of bottom sediments from the shelf to the continental slope may be restricted to areas where an effective barrier has not been produced by shoaling. Transfer of shelf pollutants to deeper parts of the sea floor might also be localized due to this physiographic control on sediment dispersal. More seismic-reflection profiling, sediment sampling, and circulation data are needed to adequately describe the shelf-break dispersal patterns.

Numerous submarine slides, some being greater than 60 km^2 in area and 300 m thick, have been discovered on the upper continental slope off the Kodiak shelf and pose a hazard to structures close to the shelf break and also as development moves seaward of the continental shelf. The slides appear to occur in response to tectonically related fault movement, slope steepening, and seismic accelerations. The geotechnical properties of these sediments, and those of the adjacent continental shelf where no significant sliding has been identified, require study to properly predict their engineering behavior.

The Kodiak shelf is located within one of the world's most seismically active regions and is affected by earthquakes of greater than magnitude 8.0. Shallow faults, several offsetting the sea floor and therefore likely to be active, occur across the shelf, especially in a zone directly offshore of the Pacific coast of Kodiak and adjacent islands. Hazards related to seismic activity and faulting, all documented to have occurred on or adjacent to the Kodiak shelf, include strong-motion ground shaking, fault rupture, sediment displacement, tectonic deformation of the sea floor, and tsunamis.

V. Objectives:

Lower Cook Inlet

The objectives of our geologic environmental studies in lower Cook Inlet are to characterize the various geologic features that may pose hazardous conditions, to generally outline their locations, and to attempt to delineate the degree they may influence any of the phases of industrial activity.

Seismicity is high in the area, but it is unlikely that accelerations cause local sediment instability, except along coastlines. General warping and forming of faults may occur but cannot be predicted. Slumps may form locally on steep slopes, but nowhere in the lease area is sufficient unconsolidated material to form more than thin sheetslides. Liquefaction may occur, but the thinness of the local sand cover likely will not cause any significant result.

Volcanism may pose a hazard and is studied by Kienle.

No faults of any size have been observed cutting through the present sea bottom. Assuming insignificant changes of the sediment-water interface during the last couple thousand years, the probability is high that little or nothing will happen during the next half century.

The major feature that can cause problems is the unconsolidated sand, forming a blanket over more indurated pebbly muds. The blanket is modified into a number of bedform types ranging in height from a few centimeters up to 12 m. Sand motion now becomes the prime object of study and we will attempt to evaluate the importance of migration of different types and sizes of bedforms. The larger the bedform the more material has to be moved before migration can be detected.

A selected number of lines run by industry in 1973 and 1974 have been resurveyed in 1977 and 1978. Comparison studies have been started. Unless abnormal weather conditions do occur prior to the summer of 1979 no further field-work on this aspect is planned. It may take tens of years between surveys before conclusive evidence can be obtained.

A combination of high resolution seismic profiling, side scan sonar, and stations will provide sufficient detail to study relationship of types and sizes of bedforms, directions of crests, and asymmetry. Vertical current measurements and GEOPROBE data may provide the information needed to produce predictive models.

Additional samples collected by us, other NOAA contractors, and industry should provide an adequate distribution of sample locations to construct a sediment distribution map. All samples will be analyzed via the smear-slide method providing sand-silt-clay ratios. A selected number of samples will be analyzed in detail to provide grain size analyses and grain size parameters, as well as to calibrate the smear slides. Sand-silt-clay rations, however, are more important to biologists and most other investigators than accurate size analyses they are not used to do work with. During the 1979 season we plan to collect samples for such a map at locations necessary to avoid serious gaps in the final product.

A possibility exists to utilize the rotating side scan developed in our branch by Dave Rubin and Dave McCulloch. The instrument makes a 360° scan from a fixed bottom-positioned frame. It is presently used in San Francisco Bay with an electrical cable going to the shore to the recorder. We should deploy it from a semi-submersible away from the influence area with a request to the company to make a scan a few times a week. If we are able to leave the instrument in for a number of months it will provide data on migration of bedforms. We have been in contact with Phillips Petroleum but no final answer has been obtained yet. They had problems with shipping anchors in the unconsolidated sands and are too busy to study our proposal.

Kodiak Shelf

Work on Kodiak shelf in 1979 will have two main objectives: 1) extend the areal coverage southwest of Kodiak Island to the boundary of the lease-sale area, near Chirikof Island and 2) study gas-charged sediments.

Only minimal coverage has been obtained in the area between Kodiak and Chirikof Island. A high-resolution profiling grid with trackline spacing of 9 miles and orthogonal tie lines at 12 miles will be run. Approximately 30 sediment samples will be collected, at trackline crosspoints and at environmentally critically locations. Additional side-scanning sonar profiling and bottom camera work will be done if deemed necessary from shipboard analysis of data.

Gas-charged sediment was recovered in cores at four stations in 1978. Evidence for extensive occurrence of gas charging, in the form of acoustic anomalies, has been found in seismic reflection records. Vibracores from the acoustically anomalous unit will be collected to determine sediment properties (e.g., gas and organic carbon content, geotechnical index properties). We plan to occupy about 15 stations for coring. Additional seismic surveying, over about 100-200 miles of trackline, will be run to help determine the extent of the anomalous units and the relation with other seismic-stratigraphic units. The areas to be studied are in Kiluda and Chiniak Troughs and on southern and middle Albatross Banks.

Although the full hazard potential of gas-charged sediment has yet to be determined, slope instability (Whelan et al., 1976) and weak sediments (Nelson et al., 1978) have been found to be associated with them. Our work on the Kodiak shelf will be to identify areas of gas-charged sediment and determine if potential hazards exist. Process studies are necessary for adequate environmental assessment.

A preliminary attempt was made in 1978 to determine the recency of fault movement on the Kodiak shelf by doing detailed high-resolution and side-scanning sonar surveying over a fault that is known to offset the sea floor. These data were to provide guidance for subsequent bottom TV/camera work and sampling. No distinctive features were detected on the side-scan records to guide camera and sampling efforts. This, coupled with a tight cruise schedule, forced us to discontinue this study. As a second-order priority item, it will be resumed in 1979.

Shelikof Strait

If time and funds will be made available we will conduct a reconnaissance survey, consisting of about 800 miles of trackline (sparker, uniboom, 3.5 kHz, 12 kHz) and 20-25 sampling stations. The reason for this reconnaissance is that this area has been included in the upcoming sale #60.

VI. Strategy and approach:

A. Sampling methods:

The sampling and data-collection schemes are described for lower Cook Inlet and Kodiak Shelf in section V. State-of-the-art high-resolution geophysical equipment (160 KJ sparker, uniboom, mini-sparker, 3.5 kHz, side-scanning sonar), bottom samplers (gravity and vibra-cores, grab samplers), visual format instrumentation (underwater TV and 70 mm camera), and navigation (integrated Mini-Ranger - satellite - Loran C) will be used.

Sample and trackline spacings on the order of 5-10 miles have proven adequate to construct general sediment distribution and structure maps. Samples gathered within one mile of each other, within a single sedimentary province, have shown differences that are insignificant compared to differences between provinces. Where detailed studies are conducted, as across small bedform fields for example, sample and trackline spacings will be as close as a few hundred meters to detect local variability.

B. Analytical methods:

The geophysical records will be analyzed by standard methods, whereby slumps and shallow faults are identified by discontinuity of reflectors and by geometry, and seismic stratigraphic units are correlated by their continuity and seismic reflection signature. The sediment cores and samples will be studied megascopically in order to classify sedimentary units and to gather data for deciphering dispersal patterns. Cores will be X-radiographed for study of internal structures that provide implications as to depositional mechanics and post-depositional disturbance.

Where possible a first overview and selection of grain sizes will be made using smear slides. Calibration as well as additional textural measurements will be made in the shore-based laboratory with sieves, settling tube, and hydrophotometer. Results will generally be presented in terms of clay-silt-sand-coarser-than-sand ratios, which adequate for general environmental and engineering assessment. More precise size distributions, at 1/2-Ø intervals, will be provided for some areas of detailed investigation, as applies to the sand-wave study, for example.

VII. Deliverable Products:

A. Digital Data: grain size analysis data as available from the USGS data processing facility (Graig McHendrie) according to the attached data products schedule.

B. Narrative Reports: reports describing survey and sampling techniques, analytical and interpretative methods, and summarizing the nature and severity of actual and potential sea floor hazards in lower Cook Inlet and on the Kodiak shelf. If proper we will furnish recommendations on approaches to minimize environmental hazards to development. These reports will be in the form of U.S. Geological Open-file Reports, oral presentations at scientific meetings with their submitted abstracts, scientific journals, and OCSEAP Quarterly and Annual Reports.

C. Visual data: maps (conforming to OCSEAP requirements of scale and projection) displaying tracklines, stations, shallow structures (faults and folds), sediment distribution, bedforms, and extent of gas-charged sediment. A surficial geologic map of the Kodiak shelf is currently being prepared at the USGS Conservation Division office in Anchorage, to be released as an Open-file Report. We do not plan to duplicate this effort.

D. Other non-digital data: microfilm of seismic-reflection records and navigation records. Navigational accuracy will be reported in terms of average and standard deviations of cross-track, along-track, and radial components of satellite updates to DRC positions.

E. Data Submission Schedule: a cruise report dealing with cruise data, scientific crew, cruise tracks, stations, and a description of all tasks accomplished will be submitted within four weeks after termination of the cruise.

VIII. Special Sample and Voucher Specimen Archival Plans:

All samples collected will be analysed but a representative portion (half core) will be stored as an archive sample in a refrigerated core storage in our building. Bulk samples will be stored refrigerated or non-refrigerated, depending on the nature of the sample and consequently the importance to maintain its natural moisture. Sands and gravels will be stored in a dry storage area.

IX. Logistics: Requirements:

Ship support and other logistic requirements will be provide by the USGS. See ship budget.

X. Anticipated problems:

The only significant problem we have encountered in the past is adverse weather, which has hampered, but not completely prevented, our work at sea. In the event of poor weather, we typically cease on-deck operations such as coring and attempt to do seismic-profiling work. If weather is too poor even for profiling, we head for shelter and wait for clearing. If for some reason we were totally prevented from accomplishing our objectives, the obvious alternative would be to work with records and samples gathered previously. Doing this, we might gain more insight into problems that have been exploring in past years, but would not be able to delve deeply into the plans outlined here.

XI. Information Required From Other Investigations:

Physical oceanographic, seismic, volcanic, and biologic information collected by other OCSEAP investigators is necessary. We have kept in contact with these investigators in the past and plan to continue in the future.

XII. Activity/milestone Chart: See attachment

XIII. Outlook:

Completion of our work proposed for 1979 should provide adequate information for a general geo-environmental assessment of lower Cook Inlet and the Kodiak shelf, meaning that the surface and shallow subsurface geology have been described and that potentially hazardous features have been identified and mapped. However, we feel that process studies are necessary for in-depth understanding and perhaps quantification of the hazard potential of the features we are encountering. We are carrying on some process-oriented studies presently, such as our studies of bedform dynamics in lower Cook Inlet, but long-term efforts are needed. These studies need not be area-specific. They have application to many OCS areas and should be studied where optimum conditions exist.

Examples of process studies required for thorough geo-environmental understanding of lower Cook Inlet include: resurveying of selected lines, use of rotating side scan sonar, coring for study of distribution of drill cuttings, and vibra coring to study internal structures of bedforms. On the Kodiak shelf, geotechnical studies of the fine-grained, ash-rich sediments are necessary to define the foundation properties of this unusual material. Geotechnial studies of the unstable upper continental slope sediments are also needed if development proceeds into these areas. Geochemical, geotechnical, and geological studies of gas-charged sediments are required to define methods of identifying areas where bubble-phase gas is present, its origin, and its engineering significance. Gas-charged sediments have also been identified in the northeastern Gulf of Alaska and in the northern Bering Sea.

Evidence exists that the Kodiak shelf is structurally segmented, with two relatively highly deformed areas in the vicinity of southern-middle Albatross Bank and Portlock Bank, respectively, and a relatively moderately deformed area around middle Albatross Bank (Hampton and Bouma, 1977). Sediment dispersal has been shown to be affected by the structuers on the shelf (Hampton and Bouma, 1978), and very likely the seismic and tectonic activity varies among the three segments. For example, the highly deformed areas might experience higher seismicity and more severe tectonic deformation faulting, shaking, etc. The nature of the structural segmentation should be understood and its environmental significance.

XIV. Standard Statements:

A. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

B. Quarterly reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October. Annual Reports are due by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

C. At the option of OCSEAP, the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate in program review or synthesis meetings as required. It is understood that costs of the travel and per diem for these trips will be borne by OCSEAP.

D. Data products will be submitted to the Project Data Manager in the form and format specific in Deliverable Products Section VII, A thru E. Digital data submissions will be accompanied by a Data Documentation Form (NOAA Form 24-13).

E. Digital Data will be submitted to the Project Data Manager within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

E. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA Form 24-23) will be submitted to the Project Data Manager.

G. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. All new equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information will be recorded on Form CD-281, "Report of Government Property in Possession of Contractor:, (copy attached). Updated copies of these inventories will be submitted quarterly.

H. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OCSEAP funds, will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty days will be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office. Five copies of all reprints which pertain to technical or scientific material developed under OCSEAP funds will be submitted to the appropriate Project Office when they became available.

I. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

"This study was supported by the Bureau of Land Management through inter-agency agreement with the National Oceanic and Atmospheric Administration, under which a multi-year program responding to needs of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office".

REFERENCES

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Self, G.W., and Mahmood, A., 1977, Assessment of relative slope stability of Kodiak shelf, Alaska, using high-resolution acoustic profiling data: Marine Geotechnology, v. 2, p. 333-347.

Whelan, T., Coleman, J.M., Roberts, H.H., and Suhayda, J.N., 1976, The occurrence of methane in Recent deltaic sediments and its effect on soil stability: Bull. Intl. Assoc. Engineering Geology, v. 14, p. 55-64.

Wilson, N.D. and Abel, W., 1973, Seafloor scour protection for a semi-submersible drilling rig on the Nova Scotian shelf. Offshore Technology Conf., Preprint OTC 1891, p. II 631-646.

DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP format (If known)	Processing and Formating done by Project (Yes or NO)	Collection Period (Month/Year to Month/Year)	Submission Month/Year
Grain size	tape or cards, map	50-75 spls	073	Yes*	August 1979	April 1, 1980
Seismic profiles	microfilm	2000 km	___	Yes**	August 1978	Aug. 1, 1979
Seismic profiles	microfilm	2000 km	___	Yes**	August 1979	Aug. 1, 1980
Gas analyses	tables, maps	20-50 spl	___	Yes	August 1979	April 1, 1980
allow structure (Kodiak)	map	1	___	Yes	1976 - 1978	Aug. 1, 1980

* Graig McHendrie

** Tom Chase

MILESTONE CHART

0 – Planned Completion Date

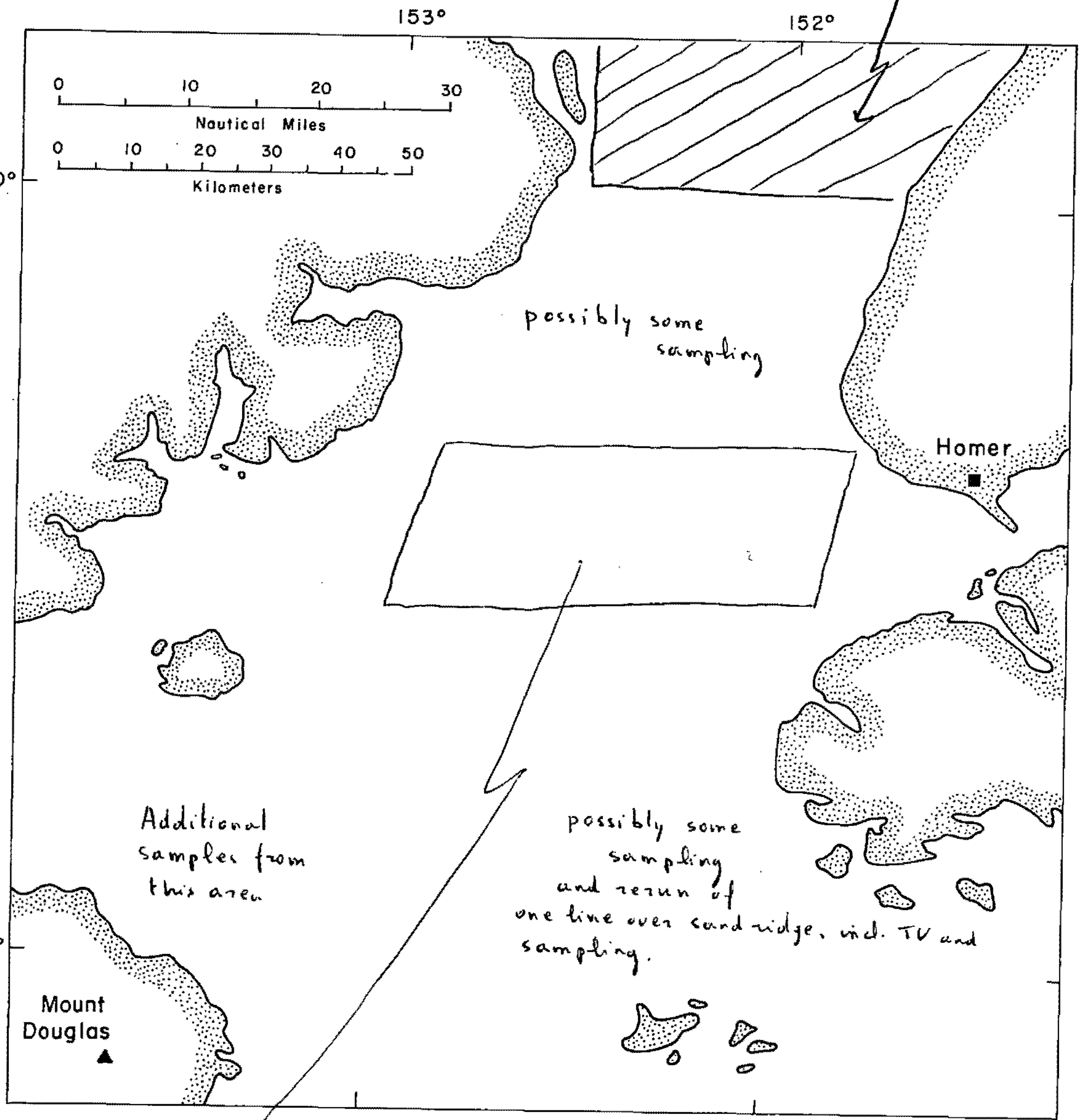
X – Actual Completion Date
(to be used on quarterly updates)

RU # 327 PI: Hampton/Bouma

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

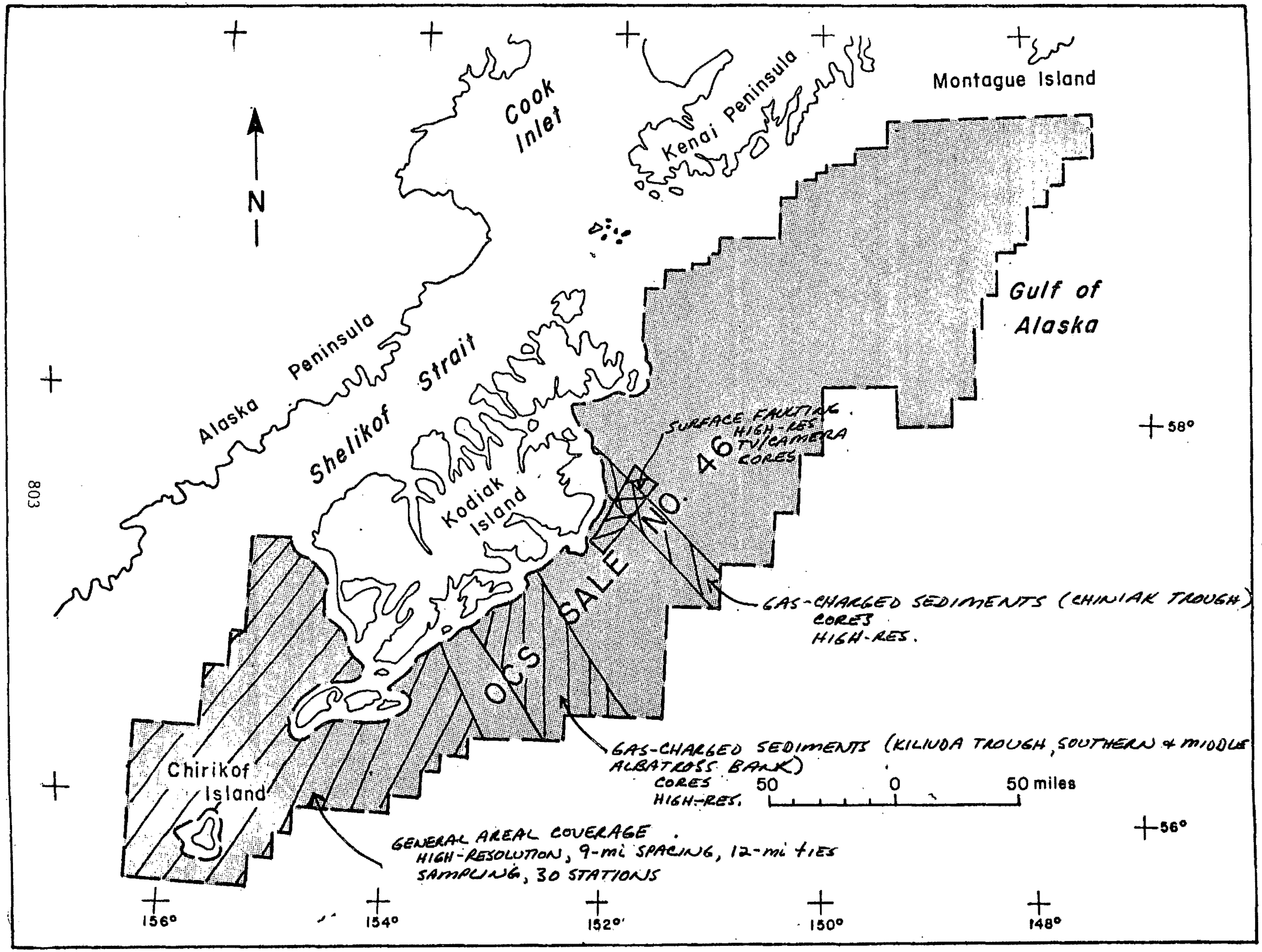
MAJOR MILESTONES	O (1978)	N	D	J (1979)	F	M	A	M	J	J	A	S	O	N	D	J (1980)	F	M	A	M	J
Analyses seismic records 1978 data	—	—	—	—	—	—	0														
Compilation and systheses 1978 data				—	—	—	—	—	—	0											
Collection data and samples											0										
. .alyses seismic records 1979 data (Distribution and movement of bed-forms, general geology of SW Kodiak shelf, gas-charged sediments)											—	—	—	—	—	—	—	0			
Analysis of samples (grain sizes, composition, gas content)											—	—	—	—	—	—	—	0			
Compilation and synthesis 1979 data (same topics as above – hazard assessments)																—	—	—	—	—	—
Quarterly Reports	0			0						0			0		0						
Annual Report							0														

complete coverage of seismic profiling and sampling.



lower Cook Inlet.

Area of concentrated efforts: rerun a number of side scan lines to study changes over one or two years. TV/camera observations on selected bedforms and sampling. Few vertical current meter profiles, mainly in the west of this block in geoprobe area. Vibrocoring over different types of bedforms.



Montague Island
Cook Inlet
Kenai Peninsula
N
Gulf of Alaska
Alaska Peninsula
Shelikof Strait
Kodiak Island
OCS SALE NO. 46
SURFACE FAULTING
HIGH-RES
TV/CAMERA
CORES
GAS-CHARGED SEDIMENTS (CHINIAK TROUGH)
CORES
HIGH-RES.
GAS-CHARGED SEDIMENTS (KILIUDA TROUGH, SOUTHERN & MIDDLE ALBATROSS BANK)
CORES
HIGH-RES.
Chirikof Island
50 0 50 miles
GENERAL AREAL COVERAGE
HIGH-RESOLUTION, 9-mi SPACING, 12-mi TIES
SAMPLING, 30 STATIONS
58°
56°
156°
154°
152°
150°
148°

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental
Assessment Program
Bering Sea-Gulf of Alaska Project Office
P. O. Box 1808
Juneau, Alaska 99802

RFx41-327-2555

FEB 27 1979

TO : Rudolf J. Engelmann, Director
OCSEAP - Alaska Program Office, Boulder

THRU : Kay Jentsch, Contract's
OCSEAP - Alaska Program Office, Boulder

FROM : Herbert E. Bruce, Manager
OCSEAP - Juneau Project Office

SUBJ : OCSEAP Research Unit 327.

REFS : (1) Juneau Project Office Ltr to Drs. Hampton and Bouma requesting renewal proposal dated May 19, 1978. (enclosed)
(2) Original Proposal dated June 28, 1978. (enclosed)
(3) Copy of project office internal comments on proposal (enclosed)
(4) Revised renewal proposal, dated January 5, 1979 (enclosed)

<u>Required Acceptance Letter for RU 327</u>
<u>Drs. Hampton and Bouma</u>

The enclosed revised FY 79 renewal proposal (p. 1-25) for RU 327, entitled "Shallow faulting, bottom instability, and movement of sediments in lower Cook Inlet and western Gulf of Alaska", has been reviewed by the Juneau Project Office and judged acceptable at the funding level of $132,000 (includes $12,000 for USGS overhead @ 10%. Please send an acceptance letter to Drs. Hamption and Bouma and initiate funding procedures for this amount.

Enclosures: refs: 1 - 4

TO: OCSEAP, NOAA
JUNEAU PROJECT OFFICE
P.O. BOX 1808
JUNEAU, ALASKA 99802

NOVEMBER 15, 1978
CONTRACT: 01-5-022-2538

FY 1979 RENEWAL PROPOSAL

RESEARCH UNIT: 337

TITLE: SEASONAL DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS

COST OF PROPOSAL: $50,327

LEASE AREAS:

Northeast Gulf of Alaska	35%
Kodiak Basin	50%
Cook Inlet	15%

PERIOD OF PROPOSAL: October 1, 1978 through April 1, 1979

PRINCIPAL INVESTIGATOR

Name: Calvin J. Lensink, Activity Leader
U.S.Fish & Wildlife Service,
Office of Biological Services,
1011 E. Tudor Road,
Anchorage, Alaska 99503

Signature: Calvin Lensink
Date: 11/20/78

Telephone Number: 907 276-3800

INSTITUTION

United States Fish and Wildlife Service, Biological Services Program,
Coastal Ecosystems Project

APPROVED BY

Name: LeRoy W. Sowl, Acting Area Director
U. S. Fish & Wildlife Service,
1011 E. Tudor Road,
Anchorage, Alaska 99503

Signature: LeRoy W. Sowl
Date: 11-22-78

Telephone Number: 907 276-3800

FINANCIAL OFFICER

Name: Barbara Copeland, Admin. Officer
U. S. Fish and Wildlife Service,
1011 E. Tudor Road,
Anchorage, Alaska 99503

Telephone Number: 907 276-3800

TECHNICAL PROPOSAL

I. TITLE AND CONTRACT

Title: Seasonal Distribution and Abundance of Marine Birds
Research Unit: 337
Contract: 01-5-022-2538
Proposed Dates of Contract: October 1, 1978 - April 1, 1979

II. PRINCIPAL INVESTIGATOR

Dr. Calvin J. Lensink
U.S. Fish & Wildlife Service
Biological Services Program
1011 E. Tudor Road
Anchorage, Alaska 99503

III. COST OF PROPOSAL

A. Science: $50,327
B. PI-Provided Logistics: None
C. Total: $50,327
D. Distribution of Effort By Lease Area:
   1. Northeast Gulf of Alaska.....35%
   2. Kodiak......................50%
   3. Cook Inlet..................15%

IV. BACKGROUND

Research Unit 337 is the only comprehensive OCSEAP study designed to provide information on offshore distribution and abundance of seabirds in Alaskan waters. The work proposed herein will provide a synthesis and analysis of data on selected seabird species within the Gulf of Alaska, Kodiak Basin and Lower Cook Inlet. This information is necessary for the development of marine ecosystem models and for the characterization of feeding and foraging stratigies related to the breeding and trophic studies conducted under RU 341.

V. OBJECTIVES

A. Determine the seasonal distribution and abundance of selected bird species in marine habitats of the Gulf of Alaska.
B. Contribute supportive data pertinent to temporal and spatial changes in primary foraging areas in the vicinity of the Chisik Island, Sitkalidak Strait and Middleton Island colonies to RU 341.

VI. GENERAL STRATEGY AND APPROACH

Field data on the distribution and abundance of seabirds in Alaskan offshore habitats were collected between January 1975 and November 1977. This data has been digitized and verified, and is now being converted to NODC format by Dr. Hal Petersen (RU 527). Upon completion of this conversion process, Dr. Peterson will provide NODC and us with magnetic tapes of all RU 337 data sets. In addition, Dr. Petersen will provide us with a magnetic tape of RU 337 data in the original USFWS format as the latter contains essential data not included in the NODC format. When we have received all of the RU 337 data on magnetic tapes we will begin a computer analysis of that data. Once data analysis has been completed, we will prepare a final report detailing the known distribution and abundance of selected seabirds over Alaska's Outer Continental Shelf. Dr. CAlvin Lensink will be the administrative coordinator and overall quality control manager for this project. Dr. Patrick Gould will be responsible for all work up to and including the preparation of the final report.

VII. SAMPLING METHODS

No sampling will be conducted during this phase of RU 337.

VIII. ANALYTICAL METHODS

Data will be handled "in house" using a Tektronic 4081 graphics system for on-line editing and data entry, and the Boeing Computer Service CDC Cyber 70 series computer for analysis. Data will be taken from finalized tapes (in NODC format) and computer sorted on the basis of 10-minute latitude-longitude blocks. The data will then be computer summarized and stored as 20-minute latitude by 30-minute longitude blocks and sorted on the basis of Month-Year, Major Species (including Total Birds), Total Number of Transects, Number of Transects on which a Species was Seen and Number of Individuals (retained as the "sum of squares" for statistical analysis). Area and habitat summaries will then be developed by aggregating appropriate latitude-longitude blocks. Listings of species occurrence for those species not selected for density analysis will be produced from the 10-minute latitude-longitude program sort. This will be supplemented by a hand search of raw data on specific details for some species. Shipboard and aerial data will be analysed separately. These analyses, however, will result in compatible end products which will be combined in all tables, figures, discussions and summaries.

For selected species, species group, or for total birds within selected reference areas, an index to density of birds per square kilometer will be established. The basic unit of analysis will be the 10-15 minute transect (=strip census). For all selected geographical areas and time periods a range of transect densities (Minimum-Maximum), a mean transect density, and two standard errors (+,- 2 S.E.) around this mean will be calculated. Standard errors will be derived by log transform procdures. These values will be presented in tabular form. Indices will not be corrected for observational biases, although such biases will be discussed in narrative analyses. Distribution maps will be developed based on mean index values for 20-minute latitude by 30-minute longitude blocks.

IX. DELIVERABLE PRODUCTS

A. Digital Data: Table 1 is a detailed list of data parameters collected during shipboard and aerial surveys. Reduced funding restricts our use of these data fields to the following:

1. FILE IDENTIFIER & STATION NUMBER will define a transect.
2. START LATITUDE & LONGITUDE will define the location of the observations.
3. DATE will define the time period of the observations.
4. START LATITUDE & LONGITUDE, END LATITUDE & LONGITUDE, ELAPSED TIME, SPEED and TRANSECT WIDTH will define the size of the sampling area.
5. OBSERVER CONDITIONS and STATION NUMBER will define the suitability of the transect for density calculations.
6. DEPTH and STATION NUMBER will define the marine habitat.
7. TAXONOMIC CODE will define the species.
8. NUMBER OF INDIVIDUALS will be used to calculate density.
9. OUTSIDE ZONE RECORDS will define the use of the record (i.e., density or occurrence).

Magnetic tapes of verified and edited data will be provided for 113 USFWS shipboard and aerial surveys. Table 2 is a listing and summary of the present status of each of these operations.

B. Narrative Reports: The final report will cover the basic distribution and abundance patterns of Alaskan seabirds as determined from shipboard and aerial surveys over Alaska's Outer Continental Shelf. It will include appropriate sections on background information, methods of data collection and treatment, results, discussion, conclusions, and needs for further study. Descriptive data will be presented in a species account format and special sections will be devoted to appropriate lease sale areas.

Fifty-five trip reports have been completed and are available upon request from the USFWS/OBS-CE office (see Appendix I). These reports range from sketchy rough drafts to finished documents with data analysis summaries.

C. Visual Data: A data products schedule is presented in Table 3.

1. Thirty-six tables will be prepared as described under Analytical Methods. Computer outputs will be reformatted by hand for inclusion in the final report as shown in Table 4. These tables will portray month/year values for: Arctic Seas north of the Bering Strait, the Bering Sea, the Gulf of Alaska, the northeast Gulf of Alaska, the Kodiak Basin and the Cook Inlet. One table will be prepared for each of the following species or species groups: Total Birds, Shearwaters, Glaucous-winged Gulls, Kittiwakes, Murres and Tufted Puffins. Tables for additional species (e.g., Least Auklet, Crested Auklet, Parakeet Auklet, Horned Puffin, Arctic Tern, etc.) will be prepared if time and money are available after completion of the above 36 tables.

2. Four maps will be prepared on the basis of total birds as described under Analytical Methods. These will include all Alaskan waters and each will portray 1 season: Winter (December-February), Spring (March-May), Summer (June-August), Fall (September-November). Each map will be divided into three parts representing Arctic Seas, Bering Sea, and Gulf of Alaska. The scale of these maps will be 1:2,500,000.

   Four maps, with mylar overlays, for each of three lease sale areas (Cook Inlet, Kodiak and NEGOA) will be prepared using composite protraction diagrams on the scale of 1:500,000. These maps will be for total birds by season by 20-minute latitude x 30-minute longitude blocks.

X. QUALITY ASSURANCE PLAN

The procedure for processing raw data is presented in Table 5. It contains four levels of data validation which will assure 99% error-free products.

Quality control within the data analysis program will be based on the following data selection parameters incorporated into the computer program:

A. Shipboard and aerial surveys will be analyzed separately and then compared on an area and time frame basis.

B. Density (birds per square kilometer) calculations will be derived only for those transects which fulfill the following requirements:

1. Observation conditions are average to excellent,
2. Ships speed is between 6 and 15 knots,
3. Elapsed time is between 10 and 15 minutes for shipboard surveys,
4. Latitude and longitude coordinates are available to the nearest minute,
5. Transect width was 300 meters for shipboard surveys and 100 meters for aerial surveys,
6. Transect area is greater than 0.5 KM2 for aerial surveys,
7. Observations were made on a transect basis as opposed to ship follower survey, station count, general observation, etc.

C. All data analysis and interpretation will be reviewed by the project leader and the principal investigator before incorporation into the final report.

XI. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

All digital data will be supplied to NODC on magnetic tapes to be incorporated into their data base. Raw data, trip reports, and digital data will be incorporated into one of several USFWS data bases.

XII. LOGISTICS REQUIREMENTS

The work proposed herein does not require logistic support.

XIII. ANTICIPATED PROBLEMS

Sixty-nene percent of the data needed to complete the work proposed herein is presently being edited and reformatted by Dr. Hal Petersen (RU 527). We will need 120 days to complete the proposed final report beginning on the day we receive the last of the finalized data tapes. The present proposal is based on a final report submittal date of April 1, 1979. Any renegotiation of this submittal date past April 1, 1979 will also require renegotiation of the funding level.

Analysis of data beyond the scope indicated in this Technical Proposal will require additional funding. It is very difficult to estimate the cost of analyzing our large data base (ca. 100,000 cards) by computer. We consider the cost estimate contained within the present proposal a minimum without which we will be unable to produce a final report.

XIV. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

For each cruise leg on which marine bird data was collected we would like information on surface water temperature, surface water salinity, location and direction of flow of surface currents, areas of upwelling and downwelling, location of boundaries of major water masses or domains (i.e., those identified by F. Favorite, A. J. Dodimead, and K. Nasu in Oceanography of the Subarctic Pacific Region, 1969-71, Number 33, 1976), and the distribution and concentration points of such marine organisms as Capelin, Sand Lance, Euphasiids, Copepods and Squid. In all cases, a computer map would be especially useful.

XV. MANAGEMENT PLAN

An Activity/Milestone/Data Management Chart is presented in Table 6. The project leader (Patrick Gould) is responsible for data management, data analysis and the preparation of the final report. The Principal Investigator (Calvin Lensink) will supervise this work and have final authority on the interpretative aspects of the final report.

XVI. OUTLOOK

The early termination of RU 337 field work resulted in complete and partial data gaps for some geographical areas and seasons. These data gaps will eventually need to be filled, especially those existing in future lease sale areas. We suggest that consideration be given to including RU 337 type data collection as part of future proposals (especially RU 341). RU 341 will require concurrent information on the seasonal distribution and abundance of marine birds as a basis for evaluating food web studies, colony studies, and energy flow assessments.

XVII. STANDARD STATEMENTS

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are used, and sexes where these are morphologically distinguishable.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non-expendable equipment purchased with OCSEAP funds. Information should be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" copy attached. Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific

material developed under OCSEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgement is standard: "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 of petroleum development of the Alaskan Continental Chelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

Table 1. Digital Data Parameters for RU 337

PARAMETERS	VOLUME*	DATA RANGES
Header		
File Type	A	Always "033"
File Identifier	A	FW5003-FW8029
Station Number	A	00100-99999
Location		
Record Type	A	Always "1"
Latitude (start)	A	Always N(orth), 20-73 degrees
Longitude (start)	A	Usually W(est), 120-190 degrees
Date	A	Any in contract period
Time	A	Any in contract period
Latitude (end)	F	Always N(orth), 20-73 degrees
Longitude (end)	F	Usually W(est), 120-190 degrees
Elapsed Time	A	01-99, usually 10 or 15
Time Zone	A	+07 - +12
Speed	A	0-140
Course	A	Any
Height	F	001-100
Platform Type	F	1-9
Sampling Technique	F	1-9
Ship Activity	F	1-9
Observation Condition	A	0-7
Transect Width	F	000-999, usually 030 or 010
Environment		
Record Type	A	Always "2"
Depth to Bottom	F	Any
Depth of Thermocline	S	Any
Surface Temperature	F	+ or - 0.0-25.0
Surface Salinity	S	30.0-50.0
Dry Bulb Temperature	F	00.0-25.0
Wet Bulb Temperature	F	00.0-25.0
Barometric Pressure	F	0000.0-1025.0
Barometric Trend	F	+, 0, -
Wind Direction	F	Any
Wind Speed	F	00-75
Sea State	F	WMO code 3700
Swell Height	F	00-15
Weather	F	WMO code 4677
Visibility	F	WMO code 4300
Glare Intensity	F	1-9
Glare Area	F	1-9

Table 1. Digital Data Parameters for RU 337 (continued)

PARAMETERS	VOLUME*	DATA RANGES
Data		
File Type	A	Always "5"
Time	S	Any
Taxonomic Code	A	Always begins with 91 or 92
Subspecies	S	Any
Species Group	F	00-15
Age Class	F	1-9, N or Q
Sex	F	1-9
Color Phase	F	1-7
Plumage	S	1-9
Molt	S	1-9
Number of Individuals	A	00000-99999
Direction of Flight	F	00-36
Association Code	S	01-15
Linkage	S	001-010
Number of Species	S	01-10
Behavior	F	00-99
Debris Code	S	1-9
Sequence Number	A	001-400
Outside Zone Records	A	1-9
Text		
File Type	F	Always "4"

---

* A = Always
F = Frequent
S = Seldom

Table 2. Present Status of RU 337 Data

1. Data validation and format conversion have been completed by RU 527 for 28 field operations including:

FW5004	FW5008	FW5009	FW5014	FW5018	FW5027	FW5030
FW5032	FW5034	FW6001	FW6015	FW6025	FW6026	FW6028
FW6029	FW6093	FW7026	FW7027	FW7028	FW7029	FW7031
FW7032	FW7033	FW7034	FW7035	FW7036	FW7042	FW7045

2. Data validation and format conversion is currently being conducted by RU 527 for 63 field operations including:

FW5003	FW5006	FW5010	FW5011	FW5012	FW5013	FW5015
FW5016	FW5020	FW5021	FW5022	FW5023	FW5024	FW5025
FW5026	FW5029	FW5031	FW5033	FW5035	FW5036	FW5037
FW6002	FW6004	FW6005	FW6006	FW6007	FW6008	FW6009
FW6010	FW6011	FW6012	FW6013	FW6014	FW6016	FW6018
FW6019	FW6021	FW6027	FW6050	FW6051	FW6052	FW6057
FW6064	FW6066	FW6067	FW6069	FW6070	FW6074	FW6077
FW6078	FW6082	FW6083	FW6084	FW6085	FW6086	FW6087
FW6088	FW6089	FW6092	FW6094	FW6095	FW6186	

3. Keypunching and initial data validation are now being conducted by the USFWS for 22 field operations including:

FW5028	FW6200	FW6300	FW6400	FW7047	FW8006	FW8007
FW8008	FW8012	FW8014	FW8015	FW8016	FW8017	FW8018
FW8019	FW8023	FW8024	FW8025	FW8026	FW8027	FW8028
FW8029						

All of the above operations except FW8029 have been keypunched and only FW5028 will require format conversion by RU 527.

Table 3. RU 337 Data Products Schedule.

DATA TYPE	MEDIA	ESTIMATED VOLUME	OCSEAP FORMAT	PROCESSING AND FORMATTING DONE BY PI	COLLECTION PERIOD MO/YR	to MO/YR	SUBMISSION MO/YR
Ship & Aerial Bird Census	Tape	11*	033	Part by USFWS, Part by RU 527	03/75	09/78	01/79**
Narrative Report	Typed Manuscript	1	-	Yes	03/75	11/77	04/79
Total Bird Distribution Maps	Paper	4	-	Yes	03/75	11/77	04/79
Density Tables Birds	Paper	48	-	Yes	03/75	11/77	04/79

* 11 tapes will contain about 100,000 cards and about 10,000 transects.
** 81% of this volume has already been submitted, refer to Table 2 of this proposal.

Table 4. Format of Tables to be Used in the RU 337 Final Report.

Table (1-36). Abundance of (species) in the (area).

	NUMBER OF TRANSECTS[1]	MAXIMUM B/KM2	MEAN B/KM2[4]	CONFIDENCE LIMITS[2]		FREQUENCY OF OCCURRENCE[3]
				LOWER	UPPER	
MONTH/YEAR			+			
Oceanic						
Shelf Break						
Continental Shelf						
Coastal						
Total						
MONTH/YEAR						
Oceanic						
Shelf Break						
Etc.						

1: The basic unit of analysis for density data is the individual transect.
2: Based on a log transform of 2 standard errors of the mean (=<u>ca</u>. 95% confidence interval).
3: Number of transects on which a species was seen divided by the total number of transects.
4: A "+" will be portrayed if the species was seen in the area but the record was deleted because the sighting was outside the transect area or the transect was discarded for some reason such as poor observation conditions.

Table 5. RU 337 Data Processing and Validation Scenario.

FIELD WORK

DATA TRANSCRIPTION

DATA VALIDATION I

KEYPUNCHING

DATA VALIDATION II

MAGNETIC TAPE

DATA VALIDATION III

FORMAT CONVERSION

FINAL TAPE

DATA ANALYSIS

DATA VALIDATION IV

REPORT PREPARATION

Data Validation I: Visual checking for gross errors and content.

Data Validation II: Visual checking of computer printouts for consistency and symmatry errors and a sort program for taxonomic codes.

Data Validation III: Computer program (RU 527) based on pre-established data and code parameters.

Data Validation IV: Inconsistent or intuitively erroneous results resolved by rechecking raw data stored in USFWS/OBS-CE files.

Table 6 MILESTONE CHART

O - Planned Completion Date

X - Actual Completion Date

RU # 337 PI: Dr. CAlvin Lensink

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

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Digital Data Submission					X										
Quarterly Report				X											
Data Analysis:															
Arctic Seas				X											
Bering Sea					X										
Gulf of Alaska						X									
Final Report:															
Arctic Seas							X								
Bering Sea							X								
Gulf of Alaska							X								

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
1011 E. TUDOR RD.
ANCHORAGE, ALASKA 99503
(907) 276-3800

IN REPLY REFER TO:

November 20, 1978

Dr. Herbert E. Bruce
Project Manager
OCSEAP/NOAA
Juneau Project Office
P. O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

Enclosed is the FY 1979 renewal proposal for RU 337. Our delay in submitting this proposal is the result of having to re-assess costs based on the severe reduction of funding level from the $61,100 outlined on our proposal dated July 15, 1978, to the $45,000 stated in your guidance letter of October 31, 1978.

As outlined in the present proposal, we have been able to reduce our costs by reducing personnel time and by reducing our level of analysis. It will be impossible, however, to reduce our costs below the stated $50,327 and still prepare a final report on the distribution and abundance of marine birds in Alaskan waters.

You may note that overhead charges may differ from those of our other projects. The Fish and Wildlife Service does not impose a fixed overhead charge on contracted projects. Rather, estimates are made of administrative costs appropriately charged to individual projects, thus overhead will vary slightly between projects depending on their characters. Administrative costs, including secretarial and cartographic services, will normally approximate about 50% of salaries including COLA or 40% of total project costs.

Sincerely yours,

Calvin J. Lensink

CAlvin Lensink
Principal Investigator

RECEIVED

JAN 18 1979

OCS PROGRAM
OFFICE

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Outer Continental Shelf Environmental
Assessment Program
Bering Sea-Gulf of Alaska Project Office
P. O. Box 1808
Juneau, Alaska 99802

RFx41-337-2495

JAN 17 1979

TO : Rudy Engelmann, Director
OCSEAP - Alaska Program Office, Boulder

THRU : Kay Jentsch, Contract's Assistand
OCSEAP - Alaska Program Office, Boulder

FROM : Herbert E. Bruce, Manager
OCSEAP - Juneau Project Office

SUBJ.: OCSEAP Research Unit 337

REFS: (1) FWS revised renewal proposal, dated 15 November 1978 (enclosed).
(2) Juneau Project Office ltr to FWS, dated 15 December 1978 (enclosed).
(3) FWS ltr to Juneau Project Office, dated 26 December 1978 (enclosed).

Required Acceptance Letter For R.U. 337, Calvin Lensink

The enclosed proposal and letters (refs 1 - 3) constitute the substance of an acceptable proposal at a funding level of $50,327. With respect to reference (3), we concur with FWS that it is not worthwhile to produce seasonal distribution maps of seaducks. Please send an acceptance letter to Dr. Lensink and initiate contracting procedures based on the above referenced documentation and $50,327 funding level.

Enclosures: refs 1 - 3 (above)

TO: OCSEAP, NOAA
JUNEAU PROJECT OFFICE
P.O. BOX 1808
JUNEAU, ALASKA 99802

DECEMBER 20, 1978
CONTRACT: 01-5-022-2538

FY 1979 RENEWAL PROPOSAL

RESEARCH UNIT: 341

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

COST OF PROPOSAL: $344,500

LEASE AREA:
NEGOA..................20%
KODIAK.................33%
COOK INLET.............37%
WESTERN GULF...........04%
BRISTOL BAY............04%
ST. GEORGE BASIN.......02%

PERIOD OF PROPOSAL: October 1, 1978 through September 30, 1979

PRINCIPAL INVESTIGATORS

Calvin J. Lensink — Calvin J. Lensink 12/20/78

Patrick J. Gould — Patrick J. Gould 12/20/78

Gerald A. Sanger

INSTITUTION

U.S. Fish & Wildlife Service, Office of Biological Services, 1011 E. Tudor Road, Anchorage, Alaska 99503. 907-276-3800

APPROVED BY

Jan Riffe, Acting Area Director — Jan C. Riffe 12/26/78
U.S. Fish & Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska 99503
907-276-3800

FINANCIAL OFFICER

Barbara Copeland, Admin. Officer
U.S. Fish & Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska 99503
907-276-3800

TECHNICAL PROPOSAL

I. TITLE AND CONTRACT

<u>Title</u>: Population Dynamics and Trophic Relationships of Marine Birds in the Gulf of Alaska
<u>Research Unit</u>: 341
<u>Contract</u>: 01-5-022-2538
<u>Proposed Dates of Contract</u>: October 1, 1978 - September 30, 1979

II. PRINCIPAL INVESTIGATORS

Calvin J. Lensink
Patrick J. Gould
Gerald A. Sanger

III. COST OF PROPOSAL

A. <u>Science</u>: $344,500
B. <u>Logistics</u>: 0
C. <u>Total</u>: $344,500
D. <u>Distribution of Effort By Lease Area</u>:

1. Northeast Gulf of Alaska 20%
2. Kodiak 33%
3. Cook Inlet 37%
4. Western Gulf of Alaska 04%
5. Bristol Bay 04%
6. St. George Basin 02%

IV. BACKGROUND

Work proposed here essentially continues or completes previous work done under Research Units 338, 340, 341 and 342. In helping to satisfy the objectives of Task E of the OSCEA Program, this research unit will continue to define the role of seabirds in Alaskan marine environments. Work during FY 79 will focus on analysis and synthesis of data collected during previous years, and on the preparation of reports. Field work will be restricted to studies of the breeding biology of seabirds at Chisik Island in Cook Inlet.

V. OBJECTIVES

The broad objective of studies proposed here is to provide information necessary to identify and evaluate potential impacts to marine birds from development of petroleum resources on the Alaskan Outer Continental Shelf. Following the guidance of the Bering Sea-Gulf of Alaska Project Office, the specific objectives of the proposed work are:

1. To characterize selected marine bird rookeries by determining population size and structure, chronology and habitats used by individual species.

2. To determine the annual productivity (breeding success) of selected species as indicated by number of eggs, chicks and fledglings produced.

3. To describe annual variations in the chronology and productivity of major species of seabirds as a function of geographic location, climatic conditions, feeding strategies and other pertinent environmental factors.

4. To describe the trophic relationships of selected species of seabirds and their variation by season and location.

5. To describe primary foraging areas of seabirds in coastal waters, particularly within foraging range of the rookeries studied, and their use by selected species.

VI. GENERAL STRATEGY AND APPROACH

A. General Approach and Experimental Design

Two major components have comprised the field work in RU 341: Colony Studies and Trophic Studies. These studies are interrelated in the apparent strong influence that the kind and availability of prey has on the local productivity and distribution of seabirds. However, integrated studies repeated over several years will be required before this apparent relationship is clearly understood.

1. Studies on the nesting colonies emphasize population assessment, productivity, growth rates, breeding chronology, habitat use and feeding strategies. Data are analyzed at the conclusion of each field season and final efforts will mainly involve inter-area comparisons. Field studies at Chisik Island, Cook Inlet,

will be conducted during the spring and summer of 1979 with emphasis on the productivity, chronology, growth rates and feeding strategies of Horned Puffins, Black-legged Kittiwakes and Common Murres.

2. Studies of trophic relationship emphasize feeding habits, foraging behavior and foraging areas of primary species. By calculating the Index of Relative Importance (IRI), the relative importance of each prey species to each bird species can be estimated. Synthesizing data on populations of birds, trophic levels of prey, and ingestion rates will enable us to estimate the total consumption of each prey species for each area. And finally, evaluating the nutritional value of the prey will help determine their importance to the birds, and will yield clues to the ultimate consequences to birds from changes in population levels of their prey.

B. Strategy

Work during FY 79 will involve four major tasks: Annual Reports, Digital Data, Chisik Island Field Work and Final Reports. These are outlined below and detailed in subsequent sections of the technical proposal.

1. Annual Report

   a. Colony Studies

      i. NEGOA: analysis of Middleton Island field data (see Table 1)
      ii. KODIAK: analysis of Chiniak Bay and Sitkalidak Strait field data (see Table 1)
      iii. COOK INLET: analysis of Chisik Island field data (see Table 1).

   b. Trophic Studies

      i. KODIAK: analysis of selected aspects of FY 78 field data from the R/V Commando food web study and Chiniak Bay winter feeding habits studies.
      ii. COOK INLET: analysis of selected aspects of FY 78 field data from Kachemak Bay winter feeding habits studies.

2. Digital Data

   a. Colony Studies: all data need to be digitized, keypunched, verified and submitted on magnetic tapes.

i. NEGOA: Wooded Islands (1976-77)
Hinchinbrook Island (1976)
Middleton Island (1978)

ii. KODIAK: Chiniak Bay (1977-78)
Sitkalidak Strait (1977-78)

iii. COOK INLET: Barren Islands (1976-77)
Chisik Island (1978)

iv. WESTERN GULF OF ALASKA: Ugaiushak Island (1976-77)
Shumagin Islands (1976)
Semidi Islands (1976-77)

v. BERING SEA: Cape Peirce (1976)

b. Seawatch Studies: all data need to be verified and submitted on magnetic tapes.

i. NEGOA: Middleton Island (1976)
Hinchinbrook Island (1976)

ii. COOK INLET: Barren Islands (1976)

iii. WESTERN GULF OF ALASKA: Semidi Islands (1976)
Shumagin Islands (1976)
Ugaiushak Island (1976)

iv. BERING SEA: Unimak Pass (1976)
Cape Peirce (1976)

c. Trophic Studies: all data are now on a preliminary tape, but need to be verified. Some data may need to be re-keypunched.

i. NEGOA: Various shipboard (1975-76)
Hinchinbrook Island (1976)
Middleton Island (1978)

ii. KODIAK: R/V Commando data (1978)
Yankee Clipper data (1977)
Chiniak Bay, spring-summer (1976-77)
Chiniak Bay, winter (1977-78)
Sitkalidak Strait, spring-summer (1977-78)
Sitkalidak Strait, activity cycle (1977-78)
Various shipboard (1975-76)

iii. COOK INLET: Various Shipboard (1975-76)
Kachemak Bay, winter (1977-78)
Chisik Island, spring-summer (1978)

iv. WESTERN GULF OF ALASKA: Various shipboard (1975-76)
Ugaiushak Island (1976-77)
Semidi Islands (1976)

v. ST. GEORGE BASIN: Various shipboard (1975-76)

vi. BRISTOL BAY: Various shipboard (1975-76)
Cape Peirce (1976)
Nelson Lagoon (1977)

3. Chisik Island Breeding Biology Field Studies

   a. Obtain estimates of production or nesting success of Common Murres, Horned Puffins, and Black-legged Kittiwakes.

   b. Determine the amounts and kinds of foods used by Black-legged Kittiwake chicks, and determine the daily foraging cycles of Black-legged Kittiwakes, Common Murres, and Horned Puffins.

   c. Determine the chronology and phenology of events in the biology of breeding birds.

   d. Obtain a comparison of current data with recent historical data.

4. Final Report

   a. Colony Studies

      Upon completion of the annual report all data on breeding biology from RU341, relevant literature and pertinent information from other studies such as trophics RU341 and distribution/abundance RU337 will be synthesized to produce a species-oriented report on the breeding biology of selected species in the Gulf of Alaska.

   b. Trophic Studies

      Upon completion of the annual report separate species-oriented reports will be written on the feeding ecology and trophic relationships of selected marine bird species in Kachemak Bay, and the Kodiak area. An additional report will synthesize all trophics data including what limited information we have from other lease areas.

VII. SAMPLING METHODS

A. Colony Studies: the only field studies to be conducted during FY/79 will be at Chisik Island in Cook Inlet. These will begin about May 7 and will continue through about September 5.

1. Time-lapse photography will be used to obtain data on colony attendance, phenology, predation rates, feeding rates and food types of individually marked Common Murres and Horned Puffins. This method will be used primarily for murres because they are physically distributed in the area such that we cannot look into their nests without disturbing them. Disturbance of murres from their eggs or chicks results in excessive predation by gulls, so techniques generally employed to study more tolerant seabirds are not applicable. Time-lapse photography has proved successful in accumulating information on other species.

2. Proximity relay equipment will be used to monitor Horned Puffin burrows on a 24-hour basis to establish the frequency with which the nests are visited.

3. Spotting scopes will be used at intervals during daylight hours to monitor individually colored marked Horned Puffins. This will also provide a control for the remote detector data described in 2 above. Thirty-one adult puffins were banded with color codes in 1978. These marked birds will facilitate identifying behavioral traits such as nest site tenacity, permanence of pair-bonds and feeding rates.

4. Infra red photographs of otherwise inaccessible Kittiwake nesting areas will be used to determine nesting success.

5. Sampling plots established in 1978 for Horned Puffins and Black-legged Kittiwakes will be monitored to observe difference in densities of birds on plots between years. A total of 30 Horned Puffin plots, five Black-legged Kittiwake areas and five Common Murre areas will be monitored in 1979.

6. Marked nests, eggs and young of selected Horned Puffins, Common Murres, and Black-legged Kittiwakes will be monitored every three to five days to determine nesting success, nesting phenology and growth rates of young. The sample size will depend upon the availability of suitable nests with 30 considered a minimum and 60 considered optimal.

7. Regurgitation samples of Black-legged Kittiwake chicks will be taken to determine food types.

B. Trophic Studies: There will be no sampling program in FY 79 beyond that mentioned under the Chisik Island study.

VIII. ANALYTICAL METHODS

Complex data products which require rigorous statistical treatment of small data sets will be analyzed "in house" on a Hewlett Packard 9800-A mini computer. For larger data sets, programming will be done by personnel in the USFWS Alaska Information Management System

(AIMS) and by trained OBS-CE personnel. Analysis will be accomplished with the Boeing Computer Service CDC Cyber 70 series computer, and to a lesser extent by the Honeywell Computer at the University of Alaska.

A. Colony Studies

Productivity will be analyzed on the basis of separate stages within the breeding cycle. The major measures of productivity will include:

1. Nests with eggs per nest built
2. Clutch size
3. % of breeding pairs which hatched one or more eggs
4. brood size at hatching
5. eggs hatched per eggs laid
6. % breeding pairs fledging at least one young
7. Brood size at fledging
8. Chicks fledged per chicks hatched
9. Chicks fledged per eggs laid
10. Chicks fledged per nest with eggs
11. Chicks fledged per nest built

Analytical methods for remaining data include:

1. Analysis of variance between years and among colony sites with respect to: clutch size, brood size and number of fledglings.
2. Analysis of co variance of growth curves between years and among colonies.
3. Analysis of variance of the adjusted means of the above curves (no. 2) with multiple range tests for significant differences.
4. Canonical analysis of the important habitat parameters which may influence productivity.
5. Chi-square analysis of important habitat parameters.
6. Analysis of variance of prey lengths over all months of one year.
7. Factor analysis and diversity indices of the principal components of each species' diet.
8. Chi-square with accompanying tests like Wilke's lambda or Rao's v of these principal components.

B. Trophic Studies

Selected fields from our File Type 031 database will be used to calculate the % volume, % frequency of occurrence, Report Syntheses, Field Notes and Digitized on the now defunct 035 format. A major effort will be made in FY 79 to translate this data into the new 135 format. Data requiring digitization exist for the following field operations:

a.	NEGOA:	FW6081, FW7081, FW6022, FW8021
b.	KODIAK:	FW7069, FW8013, FW7037, FW8009
c.	COOK INLET:	FW6054, FW7054, FW8010
d.	WESTERN GULF:	FW6060, FW6061, FW7060, FW6062, FW6063, FW6024, FW6059, FW7030
e.	BERING SEA:	FW6023

2. Seawatch Studies

The following field operations will be included in the final data sets submitted to NODC:

a.	NEGOA:	FW6022, FW6073
b.	COOK INLET:	FW6054
c.	WESTERN GULF:	FW6024, FW6059, FW6063, FW6061, FW6099
d.	BERING SEA/UNIMAK PASS:	FW6091, FW6076, FW6020, FW6056, FW6023

3. Trophic Studies

Approximately 25,000 cards of marine bird specimen and feeding studies data from about 3,050 food samples currently exist in three formats including File Type 031. All trophics data has been keypunched, but most of it requires translation to the approved format. This is now being accomplished.

The following field operations will be included in the data sets submitted to NODC in the approved 031 format:

a.	NEGOA:	FW5020, FW6003, FW6022, FW6051, FW6073, FW6079, FW6090, FW8021
b.	KODIAK:	FW5007, FW6064, FW6069, FW6087, FW6095, FW6101, FW7032 to FW7037, FW7069, FW8003, FW8006 to FW8009, FW8014, FW8015, FW8017 to FW8019
c.	WESTERN GULF:	FW6012, FW6016, FW5022, FW6024, FW6029 to FW6031, FW6053 to FW6059, FW6078, FW7030, FW7060
d.	BERING SEA;	MM4001, FW5033, FW6021, FW6023, FW6056, FW6057, FW6067, FW6075, FW6085, FW6091, FW7056
e.	ALEUTIAN ISLANDS:	MF9001, MF0001, MF1001, FW6097
f.	COOK INLET:	FW6092, FW7101, FW7102, FW8001, FW8002, FW8004, FW8005, FW8010

B. Narrative Reports

1. Colony Studies

a. Annual Report

In order to avoid duplication of effort with respect to data synthesis in the annual and final reports, the annual report will be restricted to intra-colony comparisons. Four colony reports will be produced, one for each colony, synthesizing all data available for that site (see Table 1). Introductory sections on methods, area description, relevant literature and background will be included in each report. These reports will be united by a brief introduction and "executive summary". Inter-colony comparisons and a discussion of the implications of OCS development will be deferred to the final report.

b. Final Report

This report will be a synthesis of all available information on breeding biology of seabirds in the Gulf of Alaska. It will be based on RU341 colony studies and will stress both inter- and intra-colony comparisons and, when available, annual variations. Although it is difficult at this juncture to know the exact contents and format of the final report, we envision the following outline:

i. Introduction

Rationale for study
Current state of knowledge
Pre-existing perturbations
Area description
Methods
Field Schedule

ii. Results: This will be in a species account format with the following species being included (an asterisk indicates the most intensively studied species).

Northern Fulmar*
Storm Petrels*
Cormorants*
Common Eider
Black Oystercatcher

Glaucous-winged Gull*
Mew Gull
Black-legged Kittiwake*
Terns*
Murres
Pigeon Guillemot
Parakeet Auklet
Rhinoceros Auklet
Horned Puffin*
Tufted Puffin*

Each species account will include; where available, the following topics:

Breeding distribution and abundance in the Gulf of Alaska
Nesting habitat
Breeding phenology
Colony Attendance
Productivity
Factors affecting productivity
Growth of chicks
Feeding habits and feeding ecology

iii. Discussion

Major conclusions
Problems associated with petroleum development of the Outer Continental Shelf

2. Trophics Studies

a. Annual Reports

The annual report for trophics work will discuss selected aspects of the feeding habits of birds in Kachemak Bay (Lower Cook Inlet) in winter, and for the Kodiak area in Spring, Summer and Winter. The report will be limited to work done in FY 78 and will not synthesize prior years' work. Synthesis of all of our data and information in the literature will be accomplished in the final report, as described below. The annual report will only include information calculable manually plus narrative information from field notes. Two trophics reports will be compiled as follows:

i. "INDICES OF RELATIVE IMPORTANCE (IRI) FOR THE PREY OF MARINE BIRDS IN KACHEMAK BAY, NOVEMBER 1977 TO APRIL 1978" by Sanger, Jones and Wiswar. This report will essentially include tables with supporting text of the IRI's of samples aggregated for the whole study period for Oldsquaw, White-winged Scoters, Common Murres and Marbled Murrelets.

ii. "THE VOLUMETRIC COMPOSITION OF THE PREY OF MARINE BIRDS IN THE KODIAK AREA, 1978", by Krasnow, Sanger and Wiswar. This report will be based on collections of bird stomach samples aboard the R/V Commando in the Kodiak area from April to August 1978, and on a winter collection in Chiniak Bay in February 1978. It will include tables and "pie charts" of the volumetric composition of the prey of Sooty Shearwaters, Short-tailed Shearwaters, Oldsquaw, White-winged Scoters, Black-legged Kittiwakes, Marbled Murrelets, Pigeon Guillemots, Common Murres and Tufted Puffins. Data will be separated by cruise and bay of collection. Supporting text will supplement the tables and graphs.

b. Final Reports

The final reporting of bird trophics work will attempt to synthesize available data and information in the literature. It will include food habits data from shipboard and colony studies, and population, distribution and behavioral data from the colony and shipboard studies plus pertinent data from other OSCEAP research units. Three separate reports will be prepared. One will cover the Kachemak Bay winter feeding study, a second the Kodiak area, and the last will include our scattered information from other lease areas, and attempt to integrate and synthesize our entire data base from a species standpoint. The anticipated titles and contents of the three reports are:

i. "THE WINTER FEEDING ECOLOGY AND TROPHIC RELATIONSHIPS OF MARINE BIRDS IN KACHEMAK BAY, LOWER COOK INLET, ALASKA", by Sanger, Jones and Wiswar. "THE FEEDING ECOLOGY AND TROPHIC RELATIONSHIPS OF MARINE BIRDS IN THE AREA OF KODIAK ISLAND, ALASKA", by Sanger, Krasnow and others. These two reports will:

aa. Discuss the major species of marine birds, their estimated population sizes, feeding behavior, general distribution patterns and foraging areas.

% numerical abundance and the Index of Relative Abundance (Pinkas et al., 1971) of the prey of the major species of birds. As appropriate to a lease area and a particular data set, intra- and inter-specific comparisons of these values will be made on a geographic and seasonal basis. Tests for analysis of variance will be run to determine the statistical adequacy of sample sizes. Average weights of birds and their fat indices will be compared geographically and seasonally where possible to determine physiological condition. Indices of stomach fullness will be examined in relation to time of day. These data will be compared to breeding success and breeding chronology, particularly as influenced by kinds and volumetric composition of prey.

Foraging and feeding behavior and areas will be determined by examining pelagic transect data and the cruise reports and field notes of the personnel who conducted the work. Data from studies of foraging/activity/behavior in the Sitkalidak (Kodiak) area will be examined for consistency of behavior patterns.

C. References

1. Gnanadesikn, R. 1977. Methods for statistical data analysis of multivariate observations. Wiley.
2. Guenther, W. C. 1964. Analysis of variance. Prentice-Hall.
3. Patten, B. C. 1976. Systems analysis and simulation in Ecology. Volumes 1-4. Academic Press.
4. Pinkas, L., M. S. Oliphant and J. K. Iverson. 1971. Food habits of albacore, bluefin tuna and bonito in California waters. Calif. Dept. Fish and Game, Fish. Bull. 152:1-105.
5. Rao, C. R. 1973. Linear statistical inference and its applications. Wiley.
6. Sokal, R. R. and F. J. Rohlf. 1969. Biometry. Freeman.

IX. DELIVERABLE PRODUCTS

A. Digital Data

1. Colony Studies

Data on breeding biology is presently available in three forms:

final report. Depending on the specific needs of BLM, i.e. what details they want in the overlays, we anticipate generating a minimum of 15 to 20 overlays up to a maximum of 100. The overlays will show foraging areas on the east coast of Kodiak, in Kachemak Bay and in the Gulf of Alaska by season depending on the availability of data. The locations where major prey species occurred in bird stomachs will be shown on the overlays.

D. Provision of Data to other RUs

Upon written request to us from other OCSEAP investigators, we will provide them with copies of our annual or final reports as soon as they are available. Specific data sets, in the form of tables or graphics, may be available sooner for distribution to requesting research units.

We understand that RU 108 will need certain of our data for their simulation model for the Kodiak area. These data will be provided to them under the general guidelines given above. For extensive data sets, or data requiring extraction from our digitized database, investigators should make their requests directly to the Juneau Project Office. We have neither the time nor the funding to provide this service to other RUs.

X. QUALITY ASSURANCE PLAN

A. Colony Studies

1. Only two pieces of equipment requiring calibration are used in our field studies: Pesola brand scales for weighing birds and Dial calipers for measuring birds. These pieces of equipment are calibrated before each field season by measuring known objects.

2. Procedures used for field measurements and samples are kept simple and fully documented. This documentation includes the permanent marking of all study plots and habitat transects with labeled stakes, paint or with carefully labeled photographs. The equipment used in establishing plot and transect boundaries include metal metric tapes, compasses and Abnee levels. Individual food samples (regurgitations and bill loads) are placed in separate plastic bags (whirl Pacs) and a complete data label is enclosed with each. This label contains information on: bird species, location, date, time, how sample was obtained, collector and special remarks.

bb. Discuss the feeding habits of the birds based on the % volume, numbers, frequency of occurrence, and Indices of Relative Importance of their prey.

cc. Diagram the food webs of each species, considering the trophic levels, volumetric composition, and IRI of the prey.

dd. Estimate consumption rates of each prey type by the birds.

ee. Discuss possible implications of the birds trophic relationships to fish stocks.

ff. Discuss implications to the birds of petroleum development.

ii. "THE FEEDING HABITS OF MARINE BIRDS IN THE GULF OF ALASKA AND ADJACENT AREAS: A GENERAL SYNTHESIS OF INFORMATION COLLECTED DURING OSCEAP MARINE BIRD STUDIES", by Sanger, Krasnow and Wiswar.

This report will provide a general synthesis of information on the feeding habits of marine birds in the Gulf of Alaska, and adjacent areas, particularly the Bristol Bay and St. George Basin lease areas in the eastern Bering Sea. It will take a "species account" approach synthesizing and integrating basic information from all areas. It will focus on species which comprise most of the avian numbers and/or biomass, namely: Sooty Shearwater, Short-tailed Shearwater, Pelagic Cormorant, Oldsquaw, White-winged Scoter, Glaucous-winged Gull, Black-legged Kittiwake, Common Murre, Thick-billed Murre, Pigeon Guillemot, Tufted Puffin and Marbled Murrelet. Time allowing, other species will be covered.

C. Visual Data

1. Colony Studies

There will be no visual data products other than those included in the annual and final reports.

2. Trophic Studies

As required by BLM, some of the trophics data will be presented on Mylar film overlays in addition to their incorporation in the

Observational data are kept in rite-in-the-rain notebooks and carefully labeled as to time date, observer, conditions and methods.

3. Observational data are sorted and collated in the office by the qualified biologist who made the observations.

4. No special processing or analysis techniques are used other than those described in section VIII of this technical proposal. All digital data will be processed by use of a Texas Instrument's Model 771 "Intelligent Terminal" system. This provides for immediate visual and mechanical verification of entered data. If time and money are available under RU 527 (Hal Petersen) we suggest that a final computer check program be written and implemented as a final verification process for record type 135 data.

B. Trophic Studies

Food samples collected in our study on Chisik Island will be sorted, weighed, measured and identified in the field. Questionable identifications will be sent to specialists for verification.

Several specimens of gammarid amphiphods from Oldsquaws collected in our winter Kachemak Bay study remain to be identified. Sanger will identify these as completely as possible (he has had two years experience in the taxonomy of amphipods) and have the identifications verified by other specialists at the University of Alaska Marine Sorting Center or the U.S. National Museum.

Since there will be no comprehensive field sampling program on trophics beyond the effort on Chisik Island, there will be no routine analyses and processing of samples in the laboratory.

We will continue to curate our collection of taxonomic reference (voucher) specimens and prepare a representative collection for submission to the California Academy of Sciences.

XI. VOUCHER SPECIMEN ARCHIVAL PLAN

The trophics section of RU 341 established a taxonomic reference collection of the prey and potential prey of marine birds at the beginning of the project in 1975. The collection has increased in size and diversity as we acquired specimens and their identifiable parts from bird stomachs, other researchers and direct sampling.

A representative collection of voucher specimens to be reported in our File Type 031 database will be assembled and forwarded to the California Academy of Sciences when a mutually agreeable submission schedule has been established.

XII. LOGISTICS REQUIREMENTS

We will not require logistic support during FY 79.

XIII. ANTICIPATED PROBLEMS

At this point in time it is difficult to assess how long it will take to transcribe, digitize, verify and submit digital data, especially for the 135 format. October 1, 1979 is probably a realistic completion date, but should we encounter any major problems it might take longer. The October 1 date, for example, is based on our having the Texas Instrument's "Intelligent Terminal" system in operation by mid-January.

XIV. INFORMATION REQUIRED FROM OTHER INVESTIGATORS:

This work will continue to support and be a part of the integrated ecosystem studies in Kodiak and Lower Cook Inlet. Both informally and within formal channels of data exchange set up by the Juneau Project Office, we will continue to require information on the descriptive physical oceanography, and the distribution, abundance and trophic relationships of marine mammals, pelagic and demersal fishes, zooplankton and the benthos of Kodiak and Lower Cook Inlet.

XV. MANAGEMENT PLAN

The project will be managed by the three Principal Investigators, Dr. Calvin Lensink, Dr. Patrick Gould and Mr. Gerald Sanger. There will necessarily be a degree of overlap in responsibility and function, but Lensink will be responsible for the overall administrative and technical direction. Gould will supervise and direct the breeding biology studies and related data analysis. Sanger will supervise the analysis of feeding ecology and trophics data and the curating of the collection of voucher specimens. Under the guidance of the PIs, Field Study Leaders will be responsible for analysis of data and report preparation of their particular phase of the overall project.

An Activity/Milestone/Data Management Chart is provided in Table 3.

XVI. OUTLOOK

Data from the FY 79 Chisik Island field work will not be analyzed in time for inclusion in the Final Report. A special addendum report could be completed for 1979 Chisik breeding biology studies by February 1, 1980, at a FY 80 cost of about $35,000. This would include data processing as well as analysis and report preparation.

A total of 10 colony areas have been studied more or less intensively in the Gulf of Alaska since 1976. These include by area:

	1976	1977	1978	1979
Northeast Gulf				
Hinchinbrook Entrance	x	*	*	
Middleton Island	x		x	x
Wooded Islands	x	x		
Lower Cook Inlet				
Barren Islands	x	*	*	
Chisik Island			x	X
Kodiak and the Alaska Peninsula				
Chiniak Bay	x	x	x	
Semidis Islands	x	x	*	
Sitkalidak Island		x	x	x
Ugaiushak Island	x	x		
Shumagin Islands	x			

x - Funded by OCSEAP; * - Funded by FWS

Although these studies cover a relatively small sample of the several hundreds of colonies within the region, they are perhaps adequately representative of conditions which have existed for several key species. A major conclusion from the studies is that there is a very large variation in reproductive success. The variation tends to be synchronized throughout the Gulf of Alaska and is apparently also influenced by local conditions as much of the variation occurs both within and between regions.

The uncertainties which remain relate to interpretation of this significant variation which is of major importance to prediction of long-term impacts from petroleum development on the Outer Continental Shelf.

These uncertainties are caused primarily by:

- Lack of long-term studies necessary to evaluate the degree, nature and causes of annual variation.

- Inadequate geographic continuity of effort; although 8 areas were studied in 1976, 7 in 1977, 4 in 1978, and 3 in 1979, only 4 sites will have been studied intensively for as long as three years.

- Inadequate integration with other disciplines, particularly in 1976 and 1977.

Although funding will not permit continuation of a desirable number of intensive studies, this lack could be partially mitigated by annual monitoring of a relatively few parameters on each colony where intensive effort is terminated. Although logistically difficult, such effort would substantially increase predictive understanding of annual and geographic variation in populations and production.

Because variations in distribution and productivity of marine birds are probably tied closely with the kinds and availability of prey, it will be important to continue to monitor the feeding habits and trophic relationships of the birds in each area.

Through the integrated ecosystem studies in Kodiak and Lower Cook Inlet, we have just begun to understand the relationships between birds and the rest of the ecosystems. Therefore, it will be important that work on marine birds continue to be included in any future inter-disciplinary studies and that such studies consider more carefully all species and size classes of prey used by birds or other top carnivores.

XVII. STANDARD STATEMENTS

1. Updated milestone charts will be submitted quarterly. A schedule for processing and analysis of past year's data will be submitted to the Project Office upon request be used to arrive at a result or product.

2. Quarterly Reports will be submitted to the appropriate Project Office during the contract year to be in OCSEAP hands by the first day of January, July, and October, Annual Reports by April 1. The Final Report will be submitted within 90 days of the expiration of the contract.

3. Where biota are concerned, all species and higher categories will be represented by the voucher specimens that will be preserved, labeled, held, and shipped to an official OCSEAP-designated repository in conformity with OCSEAP voucher specimen policy. Vouchering will include life history stages (e.g., larvae, juveniles, adults) when these are used, and sexes where these are morphologically distinguishable.

4. At the option of the Project Office the PI is prepared to travel to the Project Office at least twice during the contract year to review project status and progress. Such reviews will be scheduled on dates mutually satisfactory to both parties. It is understood that costs of the travel and per diem for these trips will be borne by the Project Office.

5. Data will be provided in the form and format specified by OSCEAP, accompanied by a data documentation form (NOAA 24-13).

6. Data will be submitted within 120 days of the completion of a cruise or three month data collection period, unless a written waiver has been received from the Project Office.

7. Within 10 days of the completion of a cruise or any data gathering effort, a ROSCOP data collection inventory form (NOAA 24-23) will be submitted to the Project Data Manager.

8. Title for all property purchased with OCSEAP funds remains with the U.S. Government pending disposition at contract expiration. New equipment purchased will be reported quarterly and inventoried annually. The PI will maintain inventories of all expendable and non expendable equipment purchased with OCSEAP funds. Information should be recorded as shown on form CD-281, "Report of Government Property in Possession of Contractor" copy attached. Updated copies of these inventories will be submitted quarterly.

9. Three (3) copies of all manuscripts for publication or presentation which pertain to technical or scientific material developed under OSCEAP funds will be submitted to the appropriate Project Office at least sixty (60) days prior to release, for information and for forwarding to BLM. The release of such material within a period of less than sixty (60) days shall be made only with prior written consent of the Project Office. News releases will first be cleared with the appropriate Project Office.

10. All publications and presentations of material developed under OSCEAP funds will acknowledge BLM/OCSEAP sponsorship. The following acknowledgment is standard:

> "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 of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office."

TABLE 1. Basic Data Base for Marine Bird Colony Studies.

SPECIES	POPULATION	CHRONOLOGY	PRODUCTIVITY	GROWTH	FOOD	HABITAT
MIDDLETON ISLAND						
Pelagic Cormorant	8[a]	8	8	-	8	8
Red-faced Cormorant	8	-	-	-	-	8
Common Eider	-	-	-	-	-	-
Black Oystercatcher	8	-	-	-	-	8
Glaucous-winged Gull	8	8	8	-	-	8
Mew Gull	-	-	-	-	-	-
Black-legged Kittiwake	8	8	8	8	8	8
Arctic Tern	-	-	-	-	-	-
Aleutian Tern	-	-	-	-	-	-
Common Murre	8	8	-	8	-	8
Pigeon Guillemot	-	-	-	-	-	-
Horned Puffin	-	-	-	-	-	-
Tufted Puffin	8	8	-	8	8	8
Rhinoceros Auklet	8	8	-	-	8	8
CHISIK ISLAND						
Pelagic Cormorant	-	-	-	-	-	-
Red-faced Cormorant	-	-	-	-	-	-
Common Eider	8	8	8	-	-	8
Black Oystercatcher	8	8	8	-	-	8
Glaucous-winged Gull	8	8	-	-	-	8
Mew Gull	-	-	-	-	-	-
Black-legged Kittiwake	8	8	8	8	8	8
Arctic Tern	-	-	-	-	-	-
Aleutian Tern	-	-	-	-	-	-
Common Murre	8	8	-	-	-	8
Pigeon Guillemot	-	-	-	-	-	-
Horned Puffin	8	8	8	8	8	8
Tufted Puffin	-	-	-	-	-	-
Rhinoceros Auklet	-	-	-	-	-	-

TABLE 1. Basic Data Base for Marine Bird Colony Studies (continued).

SPECIES	POPULATION	CHRONOLOGY	PRODUCTIVITY	GROWTH	FOOD	HABITAT
SITKALIDAK STRAIT						
Pelagic Cormorant	7,8	7,8	7	-	7	-
Red-faced Cormorant	7,8	7,8	7	-	7	-
Common Eider	-	-	-	-	-	-
Black Oystercatcher	-	-	-	-	-	-
Glaucous-winged Gull	7,8	7,8	7,8	7,8	7,8	7,8
Mew Gull	-	-	-	-	-	-
Black-legged Kittiwake	7,8	7,8	7,8	7,8	7,8	7,8
Arctic Tern	7,8	7,8	7,8	7,8	7,8	7,8
Aleutian Tern	7,8	7,8	7,8	7,8	7,8	7,8
Common Murre	-	-	-	-	-	-
Pigeon Guillemot	-	-	-	-	-	-
Horned Puffin	-	-	-	-	-	-
Tufted Puffin	7,8	7,8	7,8	7,8	7,8	7,8
Rhinoceros Auklet	-	-	-	-	-	-
CHINIAK BAY						
Pelagic Cormorant	5,7,8	5,7,8	7,8	-	-	5,7,8
Red-faced Cormorant	5,7,8	7,8	7,8	-	-	5,7,8
Common Eider	7,8	7,8	7,8	-	-	5,7,8
Black Oystercatcher	5,7,8	7,8	7,8	-	-	5,7,8
Glaucous-winged Gull	5,7,8	5,7,8	7,8	-	-	5,7,8
Mew Gull	5,7,8	7,8	7,8	-	-	5,7,8
Black-legged Kittiwake	5,7,8	5,7,8	7,8	8	-	5,7,8
Arctic Tern	5,7,8	7,8	7,8	-	-	5,7,8
Aleutian Tern	5,7,8	7,8	7,8	-	-	5,7,8
Common Murre	5,7,8	-	-	-	-	-
Pigeon Guillemot	5	5,7	-	-	-	5
Horned Puffin	5	5,7	-	-	-	5
Tufted Puffin	5	5,7,8	7,8	8	-	5,7,8
Rhinoceros Auklet	8	-	-	-	-	8

a: 5 = 1975, 7 = 1977, 8 = 1978

TABLE 2. DIGITAL DATA PRODUCTS SCHEDULE

Data Type (i.e. Intertidal, Benthic Organisms, etc.)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by Project (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year)
Breeding Biology Studies	Magnetic Tape	2-4 tapes (ca. 10,000-25,000 cards)	135	Done by PI	04/76 to 09/78	09/79
Marine Bird Specimen and Feeding Studies	Magnetic Tape	4 tapes (ca. 25,000 cards)	031	Done by PI	06/75 to 08/78	04/79
Seawatch Studies	Magnetic Tape	2 tapes (ca. 32,000 cards)	038	Part done by PI	04/76 to 09/76	04/79

TABLE 3. Major Milestones.

RU: 341 PI'S: Lensink, Gould, Sanger

0 = planned completion date
X = actual completion date

	1978			1979											
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Annual Reports (Colony & Trophics)							X								
Quarterly Reports (Colony)				X			X			X			X		
Quarterly Reports (Trophics)				X			X			X					
Chisik Island Field Work												X			
Digital Data (Colony)												0			
Digital Data (Seawatches							0								
Digital Data (Trophics)							0								
Final Report (Colony)												0			
Final Report (Kachemak Bay Trophics)										0					
Final Report (Kodiak Island Trophics)												0			
Final Report (Gulf of Alaska Trophics)												0			

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